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FACIL:50-335 St. Lucie Plant, Unit 1, Florida Power & Light Co. 05000335
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RECIP.NAME RECIPIENT AFFILIATION

SUBJECT: LER 98-009-00:on 981223,noted that facility operated outside of design basis.Caused by non-conservative MSLB analysis inputs.Will review SR component differences between units & will re-baseline LTOP analysis.With 990120 ltr.

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Florida Power & Light Company, 6351 S. Ocean Drive, Jensen Beach, FL 34957

January 20, 1999

L-99-012
10 CFR § 50.73

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

Re: St. Lucie Unit 1
Docket No. 50-335
Reportable Event: 1998-009-00
Date of Event: December 23, 1998
Non-Conservative MSLB Analysis Inputs Result in Operation of Facility Outside Design Bases

The attached Licensee Event Report 1998-009 is being submitted pursuant to the requirements of 10 CFR § 50.73 to provide notification of the subject event.

Very truly yours,

J. A. Stall
Vice President
St. Lucie Nuclear Plant

JAS/EJW/KWF
Attachment

270007

cc: Regional Administrator, USNRC Region II
Senior Resident Inspector, USNRC, St. Lucie Nuclear Plant

NRC FORM 366 (6-1998) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 06/30/2001

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LICENSEE EVENT REPORT (LER)

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TITLE (4)

Non-Conservative MSLB Analysis Inputs Result in Operation of Facility Outside Design Bases

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
12	23	1998	1998	- 009 -	00	01	20	1999	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	1
POWER LEVEL (10)	100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	20.2201(b)		20.2203(a)(2)(v)		50.73(a)(2)(i)		50.73(a)(2)(viii)
	20.2203(a)(1)		20.2203(a)(3)(i)	X	50.73(a)(2)(ii)		50.73(a)(2)(x)
	20.2203(a)(2)(i)		20.2203(a)(3)(ii)		50.73(a)(2)(iii)		73.71
	20.2203(a)(2)(ii)		20.2203(a)(4)		50.73(a)(2)(iv)		OTHER
	20.2203(a)(2)(iii)		50.36(c)(1)		50.73(a)(2)(v)		Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iv)		50.36(c)(2)		50.73(a)(2)(vii)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Kenneth W Frehafer, Licensing Engineer	(561) 467 - 7748

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
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-	-	-	-	-		-	-	-	-	-

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	YES (If yes, complete EXPECTED SUBMISSION DATE).	X NO				

ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)* (16)

On December 23, 1998, St. Lucie engineering personnel determined that the draft results of a Unit 1 main steam line break containment re-analysis indicate an unexpected higher peak containment pressure of 55.946 psig. The Unit 1 containment design pressure is 44 psig.

The difference in the re-analysis value and the original containment peak pressure value is attributed to some non-conservative assumptions in the original analysis. The most significant assumptions were feedwater flow, feedwater isolation, and initial containment pressure. The non-conservatism identified is in the input data originally used to perform the analysis.

St. Lucie determined that containment remains operable with an operability assessment performed pursuant to Generic Letter 91-18. Long term corrective actions include review of safety related component differences between Units 1 and 2, re-base lining the low temperature over pressure analysis, and either perform modifications or change the licensing and design basis of the MSLB peak containment pressure analysis.

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TEXT *(If more space is required, use additional copies of NRC Form 366A)* (17)

Description of Event

On December 23, 1998, St. Lucie Unit 1 was in Mode 1 at 100 percent reactor power. After reviewing a draft Unit 1 Main Steam Line Break (MSLB) Containment re-analysis, St. Lucie Engineering concluded that the draft analysis results indicated an unexpected higher peak containment pressure of 55.946 psig. The Unit 1 containment design pressure is 44 psig. The draft calculation, CENP 007-ST98-C-012, "St. Lucie Unit 1 Containment MSLB Mass and Energy and Pressure/Temperature Response Analysis," was performed by ABB and was transmitted by ABB-CE letter ST-98-763 for FPL to review and comment.

The difference in the re-analysis value and the original containment peak pressure value is attributed to some non-conservative assumptions in the original analysis. The most significant assumptions were feedwater flow, feedwater isolation, and initial containment pressure. The non-conservatism identified is in the input data originally used to perform the analysis. This condition was reported to the NRC via the emergency notification system (ENS) as a non-emergency report pursuant to 10 CFR 50.72(b)(1)(ii) on December 23, 1998.

Engineering performed an operability assessment in accordance with Generic Letter 91-18 and determined that containment remains operable. Long term corrective actions are being formulated to either implement changes to restore the MSLB containment analysis results or change the MSLB containment analysis licensing basis.

Cause of Event

The cause for the higher peak pressure in the re-analyzed MSLB event is that non-conservative assumptions were used in the original analysis of record. The original MSLB analysis of record was developed jointly between Combustion Engineering (mass energy input) and EBASCO (containment performance). This analysis considered a spectrum of break sizes, initial power levels, and single failures. The most significant non-conservative input assumptions dealt with feedwater flow, feedwater isolation, and initial containment pressure. This condition was not previously identified because, as discussed below, a formal re-analysis of the MSLB containment response was never performed.

Subsequent sensitivity studies against the original MSLB containment response analysis of record were performed during the St. Lucie Unit 1 stretch power analyses. Additionally, the more recent Steam Generator Replacement Project (SGRP) did not include a re-base line of the original MSLB containment response analysis of record.

Replacement steam generators (RSGs) were installed during the Fall 1997 Unit 1 refueling outage. The SGRP did not include a re-baseline of the affected UFSAR accident analyses. The impacts to existing analyses, including MSLB, were evaluated pursuant to 10 CFR 50.59. The evaluations addressed potential impacts of critical parameter changes on the analyses of record. In all cases, the RSG impacts on critical parameters were evaluated as being bounded by the analysis of record, but did not identify the latent non-conservatisms in the original MSLB inside containment analysis.

Because the RSGs' changes represented competing effects on the MSLB analysis, a calculation was performed by Framatone Technologies Inc. (FTI) to quantify the net

Cause of Event (cont'd)

impact on the analysis of record. The most significant compensating effect was from an integral steam line flow orifice. The orifice was designed to reduce the effective break size. This orifice was more than sufficient to offset the other SGRP changes (i.e., higher operating pressure/temperature) that adversely impact the MSLB analysis). Therefore, the original MSLB analysis remained bounding for the RSGs.

Engineering conducted self-assessment reviews of motor operated valves (MOVs) in preparation for an NRC audit of the GL 89-10 Program in October 1997. During review of the MFIVs concerns were identified with respect to feed water assumptions used in the original MSLB analysis. Specifically, the feed water flow isolation was assumed as a 60-second linear ramp. Actual valve characteristics for the MFIVs were more consistent with a step change in flow at 60 seconds. Additionally, the analysis did not appear to consider blowdown of water remaining in the feed water piping after MFIV actuation. Also, the original assumptions for the flow split between the faulted and unfaulted generator were indetermanent and potentially non-conservative. The effect of these assumptions could mean that the actual flow is higher than that assumed in the analysis.

Because the MSLB analysis of record had been augmented by the FTI calculations performed for the SGRP, these effects needed to be evaluated in addition to the RSG effects. The SGRP was requested to perform additional sensitivities to ensure that the impact of the newly discovered feed water assumption concerns remained bounded by the original MSLB analysis. A re-analysis of the FTI calculation was performed, and it was concluded that sufficient margin from the steam line orifices remained to accommodate the new feed water flow assumptions. Based on this evaluation, all evaluated effects remained bounded by the original MSLB analysis of record, and no operability or design concerns existed. Although not required, a decision was made at this time to re-baseline the MSLB analysis to facilitate future operability and modification evaluations.

The new analysis was competitively bid and a contract awarded to ABB-CE. It was recognized that inputs to the analysis would need to be refined and supplied by FPL in order for the reanalysis to remain bounded by the original UFSAR analysis. Specifically, the feed water flow would need to be modeled to evaluate the actual feed water flows expected and remove the simplifying assumptions. FPL and ABB-CE have been working closely to refine the inputs. However, during the project several additional non-conservative assumptions in the original analysis were identified which could not be justified for the reanalysis. The most significant of these are: (1) initial containment pressure was assumed as 0 psig instead of 2.4 psig as allowed by technical specifications; and (2) actual flow to the faulted steam generator could be higher than the twice normal feed water flow assumed in the original analysis due to the pumps being further out on the pump curve. These non-conservative inputs resulted in the higher peak pressures reported by this LER.

Cause of Event (cont'd)

Generic Implications

Analyses Re-Base Lining

The impact of the latent non-conservatisms in the original MSLB inside containment analysis was not realized until a complete re-analysis was performed. One potential generic implication would be for any other analyses that have not been re-base lined, but rather evaluated on an individual change basis. St. Lucie reviewed applicable analyses with the following results. The fuel analyses are re-analyzed for each fuel cycle. The LOCA containment analysis was re-analyzed in 1993. Only the Low Temperature Over Pressure (LTOP) analysis was identified as not having been re-run since original license. The LTOP analysis is currently being re-base lined. Therefore, all existing analyses of record have either been or are being base-lined.

The use of non-conservative inputs during the development of any new future analyses is precluded by existing engineering procedures. Procedural requirements ensure that inputs transmitted to A/E are independently verified prior to use by the A/E.

Unit Differences

The design of the Unit 1 and Unit 2 main feedwater isolation valves (MFIVs) are significantly different. The closure times for Unit 2 are approximately one tenth that for Unit 1. However, the containment design and other parameters significant to the MSLB event are essentially identical. Based on this observation, another generic corrective action will be to identify any similar significant differences in safety related systems and components between the two units and determine if they have been adequately reflected in the analyses.

The St. Lucie Unit 2 MSLB containment analysis does not contain these same non-conservative input data assumptions in its analysis. Therefore, this condition is not applicable to Unit 2.

Analysis of Event

The draft results of the Unit 1 containment MSLB mass and energy and pressure and temperature response analysis do not meet the maximum containment pressure design criteria of 44 psig. Based on the draft document, a condition was discovered during plant operation that results in the nuclear power plant, St. Lucie Unit 1, being in a condition that is outside the design basis of the plant. As a result, this condition was reported as a non-emergency report under 10 CFR 50.72(b)(1)(ii)(B), "Any event or condition during operation that results in the nuclear power plant being: 'In a condition that is outside the design basis of the plant.'" Based on this type of report, the Licensee is required to submit an LER within 30 days. The LER complies with 10 CFR 50.73(a)(2)(ii)(B) for reporting a condition that is outside the design basis of the plant.

Analysis of Safety Significance

The draft MSLB containment analysis was subsequently finalized and issued to St. Lucie. All conclusions in this section are based on the final analysis results. The results of the MSLB containment analysis do not affect the Technical Specification

Analysis of Safety Significance (cont'd)

operability of the containment or related systems. Specifically, Technical Specification operability for TS 3/4.6.1.2, CONTAINMENT LEAKAGE, and TS 3/4.6.1.6, CONTAINMENT VESSEL STRUCTURAL INTEGRITY, are based on a peak containment pressure of 39.6 psig for the limiting design basis LOCA, not the MSLB. During a MSLB event there is a relatively minor release of radioactivity into the containment. Also note that in the more limiting case for off-site dose, the MSLB is assumed to occur outside the containment where there is a direct path to the environment. Therefore, the licensing basis for the containment operability is the LOCA, not the MSLB.

As stated in the previous paragraph, the definition of containment operability is not based on the MSLB analysis. However, the function of this safety related structure can still be shown not to be compromised for the re-analyzed MSLB event. Although the calculated higher evaluated peak pressure is closer to the ultimate failure of the containment, significant margin above 56 psig remains. The St. Lucie Individual Plant Examination (IPE) submittal estimates a containment failure pressure of 95 psig.

A best estimate case was also performed by ABB-CE. This best estimate case considered more realistic plant assumptions in lieu of the more conservative design basis assumptions. Specifically, the main feed regulating valves (MFRVs) are assumed to remain in their pre-accident position and both trains of emergency core cooling systems (ECCS) are assumed to be operable. The design basis case conservatively and non-mechanistically assumes that both MFRVs go fully open at the beginning of the accident. This results in a much larger inflow of feed water to the faulted generator than would actually occur. The best estimate assumption of the MFRVs remaining in their pre-accident condition is still conservative in that the most likely response to the break would be for the MFRVs to close down in response to generator swell. The best estimate assumption that both trains of ECCS would be available does not meet design basis requirements for single failure, but is reasonable for the evaluated scenario. The most probable means of a complete loss of one ECCS train (containment spray and coolers) would require a LOOP and subsequent emergency diesel generator failure. Because a LOOP would greatly reduce the peak pressure as a result of the reactor coolant pumps (RCPs) and main feed water pumps tripping, a LOOP scenario is not limiting for this accident. Therefore, the only applicable postulated failure of ECCS trains would involve a single ECCS component. These are safety related components of high reliability that are extensively tested and maintained.

The best estimate case results in a peak containment pressure of 43.339 psig, which is below the current UFSAR design pressure of 44 psig. Although the best estimate case assumes normal MFRV operation and that both trains of ECCS are available, operating constraints associated with these parameters are not imposed by the assessment. Technical Specification operability is based on the LOCA event and not the MSLB event. Significant margin exists between the peak calculated MSLB pressure and anticipated failure of the containment. The best estimate case demonstrates that under conditions that would normally be expected, the peak pressure from a postulated MSLB remains below design.

Analysis of Safety Significance (cont'd)

Design Bases

St. Lucie Unit 1 UFSAR Section 6.2.1.1 describes the design bases for containment. The containment vessel is designed in accordance with the ASME Code Section III, Class MC. The maximum internal pressure, as defined in Article NE-3112 of the code, is 44 psig. This value is documented in Section 6.2.1.2 of the Unit 1 UFSAR. This value is also documented in the Unit 1 Technical Specification design features, section 5.2.2. Due to the large inventory design steam generators of CE designed plants, the MSLB event typically produces the peak containment pressure and temperature. However, UFSAR Section 6.2.1.1.b notes that the equipment surface temperature is lagged and will generally not experience the elevated temperatures resulting from a pure steam blowdown response (MSLB). As such, for the temperature response, the LOCA event is bounding and establishes the environmental qualification criteria and temperature limitations, as described below. The MSLB containment re-analysis peak containment pressure value of 55.946 psig is the parameter evaluated in this LER.

Containment vessel failure is characterized in the St. Lucie Units 1 and 2 IPE submittal dated December 1993. Specifically, Appendix G, Containment Failure Pressure Characterization, provides an assessment of containment performance based on the methodology of NUREG/CR-2442. This assessment estimates a failure pressure of 95 psig for the St. Lucie Unit 1 and 2 containment vessels. Thus, a MSLB containment response analysis peak pressure of 55.946 psig is bounded by the estimated failure pressure of 95 psig.

It is noted that the LOCA containment analysis was updated from the original containment analysis for both St. Lucie Units 1 and 2 in 1993 and is documented in the respective UFSARs.

MSLB Re-Analysis Results - (Case 1)

The MSLB containment re-analysis peak containment pressure value for a 102 percent power with a failure of a containment spray pump and a 60 second MFIV closure time results in a maximum peak containment pressure of 55.946 psig. The design pressure for containment is 44 psig. The differences in the results are based on non-conservative assumptions in the original analysis. The parameters that most significantly affected the outcome were feedwater flow rate and initial containment pressure and humidity. In the original analysis, the feedwater flow rate to the faulted steam generator was assumed to ramp linearly for 60 second MFIV closure. The MFIVs are gate valves; therefore, this assumption would be non-conservative. A conservative approach would consider this assumption as a step change in the flow rate at 60 seconds. The initial containment pressure was assumed to be 14.7 psia. Technical Specification 3.6.1.4 allows for an internal range of pressures and permits a containment pressure of higher than 14.7 psia. The higher value is assumed for the revised MSLB accident analysis. Containment initial humidity, although not a Technical Specification, can non-conservatively impact peak containment pressure if not accounted for. The original assumptions, therefore, were determined to contain some non-conservatisms that resulted in higher than expected peak containment pressure when re-analyzed.

Analysis of Safety Significance (cont'd)

The result of this re-analysis demonstrates a potential need for a reduction in feedwater mass addition to containment for Unit 1. Many engineering solutions can be considered, including modification of the MFIV closure times. A faster response in closure time, such as in the Unit 2 design, clearly benefits in increased margin to the design limit of 44 psig.

Best Estimate 102 Percent Power - With Safeguards Available (Case 2)

A best estimate 102% power case with safeguards available is provided in the ABB-CE calculation. Case 2 of the MSLB containment response credits normal operation of the main feedwater regulating valves and utilizes realistic input data. The results of this case demonstrate a peak containment pressure of 43.339 psig.

This value is below the containment design value of 44 psig. Although this case is not a bounding case for analysis consideration, it demonstrates that pressures remain below design for a MSLB mass and energy release inside containment with realistic input assumptions. This evaluated case provides part of the bases for operability of Unit 1 containment.

MSLB Temperature Response - EQ Effects

The MSLB analysis is postulated to reach a peak temperature of approximately 375°F at 42.2 seconds. It was identified that 11 of the 37 in-containment EQ Doc Pacs envelop the 375°F postulated peak temperature.

Section 4.3 of EQ Doc Pac 2998-A-451-1000 (page 1000-4-5) has a discussion of thermal lag for the Unit 2 inside containment MSLB, and concludes that the actual temperature experienced by components are bounded by the containment LOCA temperature profiles. These Unit 2 results are applicable for the Unit 1 in-containment EQ Doc Pacs that are not enveloped by the 375°F temperature peak. Figures 4-5 and 4-6 of the Doc Pac show a typical instrument cable and Rosemount transmitter and the temperature lag for .045 inches below the surface of the cable (typical thickness of a cable jacket) and the surface temperature of the transmitter when exposed to a typical MSLB profile. These items conservatively represent all of the EQ equipment that would be exposed to an in-containment MSLB. From the plot of the surface temperature of the cable in Figure 4-6 of the Doc Pac, the peak temperature is approximately 385°F at 45 seconds enveloping the postulated peak for Unit 1. The plots of the transmitter surface temperature and at .045 below the surface of the cable (at the cable insulation), shows that the temperature of the transmitter reaches approximately 245°F and the insulation of the cable just barely exceeds 260°F. Since both of these temperatures are below the Unit 1 LOCA temperature of 270°F, the qualification of the EQ equipment will not be adversely affected and would remain operable.

Conclusion

The dose consequences for a MSLB inside containment are bounded by the MSLB outside containment and the LOCA event. Technical Specification operability is based on the LOCA, not the MSLB event. Furthermore, significant margin exists above the

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Analysis of Safety Significance (cont'd)

calculated MSLB containment analysis peak pressure to ensure that the containment would not fail as a result of a MSLB inside containment. Best estimate analysis demonstrates that under more probable conditions the current design pressure of 44 psig will not be exceeded. Based on these considerations, no operability concern exists for the conditions stated in this LER, and continued plant operation poses no adverse risk to the health and safety of the public.

Corrective Actions

1. Long term corrective action will consist of either modifications to reduce feed water flow to the faulted generator or a change to the licensing basis of the MSLB peak containment pressure to a value of greater than 56 psig.
2. The low temperature over pressure LTOP analysis was identified as not having been re-run since original license and is currently being re-base lined.
3. St. Lucie will review the generic implications of similar significant differences (similar to the difference in MFIV closure time) in safety related systems/components between the two units.

Other Information

Similar Events

None

Failed Components Identified

None