St. Lucie Unit 1
Docket No. 50-335
L-96-273 Enclosure 4

IN-SITU PRESSURE TEST RESULTS

FOR

ST. LUCIE UNIT 1 SPRING 1996 OUTAGE

REPORT NO. 00000-OSW-16 REV. 00

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Section 1.0

INTRODUCTION

This report presents the results of in-situ pressure testing of 17 St. Lucie Unit 1 steam generator (SG) tubes during the Spring 1996 refueling outage. The tubes that were tested had eddy current test (ECT) indications of various types including upper bundle free span axial indications, axial indications above the tubesheet in the sludge pile, circumferential indications at the top of the tubesheet (hot and cold leg sides of the SG), axial indications at the eggcrate tube supports, and axial, circumferential and volumetric indications at the partial drilled support plates near the top of the tube bundle. The objective of the in-situ pressure testing was to demonstrate that tubes which contained large defects, as indicated by ECT examination, nevertheless, fully met the requirements of USNRC Regulatory Guide 1.121 (Draft), "Bases for Plugging Degraded PWR Steam Generator Tubes" (1). This objective was accomplished by pressurizing the tubes to the levels required by Reference 1 and observing for indications of leakage and/or structural failure (burst) of the tubes.

St. Lucie-1 is a two loop PWR designed by Combustion Engineering which commenced commercial operation in 1976 and had operated for 14.7 EFPY as of the 1996 refueling outage. Each of the Series 67 steam generators contains 8519 NiCrFe Alloy 600 tubes with a nominal outside diameter of 0.750 inch and a nominal wall thickness of 0.048 inch. The tubes were explosively expanded into 21.75 inch thick low alloy steel tubesheets which produced an expansion transition in each tube at the top (secondary face) of the tubesheet.

The heat transfer tubes are supported by six to ten horizontal supports. Six of these are full supports; the others are partial supports that support less than the full number of tubes because of the bundle geometry. The lower eight supports are eggcrate supports formed by interlocking 1 inch and 2 inch wide by 0.090 inch thick carbon steel strips. The two uppermost supports are solid drilled plates of one inch thick carbon steel. In addition, the tubes are supported by two diagonal support straps and three vertical supports, also fabricated from carbon steel strips.

Section 2.0

IN-SITU PRESSURE TEST DESCRIPTION

2.1 General

The degradation of steam generator tubes leads to a decrease in their load bearing capacity and creates concern about the leak tightness of the reactor coolant system. When observed, tube degradation results in evaluations to demonstrate that the required structural margins are preserved and that leak rates (should leakage occur) will remain within allowable limits. Reference 1 provides the current regulatory requirements for steam generator tubes. These evaluations may be based on one or more of the following:

- NDE results (primarily eddy current testing but also ultrasonic test results) combined with analytical/semi-empirical calculations of burst pressures and leak rates.

- Laboratory burst and leak rate tests on degraded tubes removed from operating steam generators.

- In-situ pressure testing of sections of tubes with ECT indications of degradation.

Historically, a combination of the first two methods has formed the basis for the required evaluations. Testing of removed tubes provides the most informative information in that burst pressure that can be correlated with the actual amount of degradation as determined by destructive metallographic examination after burst testing. However, removal of defective tubes from a steam generator has some disadvantages including radiation dose associated with removal and laboratory activities, cost including possible critical path time, evaluation without the effects of steam generator internals (tubesheet, supports, etc.), and damage to the tubes during the removal process which can lead to inaccurate burst or leak rate test results or in some cases inability to conduct such tests because of structural failure during removal. The latter is especially true for circumferentially oriented cracks or areas of intergranular attack.

The use of NDE results combined with analytical/semi empirical analysis provides an economic approach to degradation evaluation, but uncertainties in defect sizing have on occasion resulted in overly conservative assessments of the severity of degradation.

In an effort to combat these inadequacies, ABB CENO developed an in-situ pressure test technique which has been used for structural integrity/leak-rate evaluations. Both a full tube technique and a localized test (only a small part of the tube is pressurized) have been used successfully to verify Reference 1 margins were maintained when uncertainties in defect sizing and material properties and the limiting assumptions involved with strength evaluations based on inspection data did not permit the same conclusions. The use of this technique is now sufficiently widespread that industry guidelines (Reference 2) have been developed to standardize performance of in-situ pressure testing and application of test results. The Reference 2 procedures and requirements were used to develop the procedure for the St. Lucie-1 testing described in this report.

2.2 Localized In-situ Pressure Test Description

The ABB CENO localized in-situ pressure test system consists of an in-situ pressure test tool for testing localized areas of degraded tubes and the ancillary equipment necessary to pressurize and monitor the tube pressure or leak rate during test. Figure 2-1 shows the tool used for St. Lucie-1 testing described in this report. The major parts of the tool are:

a) a stainless steel upper and lower shaft which have been drilled to permit pressurizing of the hydro-test chamber and the gripper and seal bladders. The two sections of the shaft are connected by a spring arrangement which permit the two sections to move independently of one another and insure axial stresses during the test are comparable to those during a capped tube hydro-test.

b) an upper and lower gripper bladder which, when energized, secures the tool against the ID of the tube.

c) an upper and lower seal bladder that seals the hydro-test chamber.

d) various o-rings, sleeves, caps, connectors, etc., required to complete assembly of the tool.

In addition to the tool itself, the system consists of a 2 HP air operated Haskel positive displacement pump to provide pressurized water to the test chamber, a smaller air operated Haskel positive displacement pump for energizing the bladder system (both gripper and sealing bladders), hoses and fittings to connect the tool to the pumps, gauges for monitoring test and bladder system pressures, and a strip chart recorder to document the output of a pressure transducer providing a record of pressure as a function of time. The strip chart output is the permanent record of test results.

Leak rates, for the case of throughwall defects, can be calculated from the number of pump strokes over a period of time. Each pump stroke displaces 1.08 cu. in. (0.0047 gal.) of water. The system can supply 1.0 gpm at 1000 psi which decreases to 0.5 gpm at 4700 psi.

The above system was developed for testing primarily circumferential and short axial cracks. A modification to the tool increased the hydro-chamber length to five inches, thereby permitting testing of axial cracks greater than five inches. The axial crack system is basically the same as described above except the grippers have been eliminated.

2.3 Summary of Localized Tool Uses

The original in-situ pressure test tool was designed to hydrostatically pressure test a short portion (approximately 3 inches) of a steam generator tube at the location of a defect (as opposed to testing the full length), such that the resultant loading would be identical to that imposed during a capped hydrostatic test. The system can be used in one of three modes as follows:

a) <u>Hydrostatic load testing</u>, in which the tool is used to pressurize a three (3) inch length of the tube with proper axial tensile forces imparted to the tube from the test pressure. The five inch chamber length provides proper hoop stresses only. The objective is to demonstrate that the defective tube section is capable of sustaining a pressure of at least three (3) times the normal operating pressure differential without rupture. In the absence of throughwall penetration, this is a static test.

b) <u>Hydrodynamic leak rate testing</u>, in which the tool is used to evaluate leak rates at various pressures for tubes with throughwall defects. The system can deliver approximately 1 gpm of ambient temperature water at 1000 psi, decreasing to 0.5 gpm at 4700 psi.

c) <u>Hydrostatic burst testing</u>, which is used to test tubes with throughwall defects so large that pressures equal to three (3) times operating pressure differential cannot be attained because of pump capacity limitations. In this test, the through-wall defect is covered with the upper seal bladder of the tool to limit through-wall leakage and then the tool is pressurized in the normal manner. The pressure within the seal bladder will impart the proper hydrostatic level of hoop stress in the tube defect region while the gripper bladders (circumferential tool only) impart the proper hydrostatic level of axial tensile load. This approach to pressure testing tubes with throughwall defects is consistent with the EPRI guidelines for conducting SG tube burst testing which requires the use of a bladder to overcome throughwall leakage.

For the St. Lucie-1 SG tubes, there were several through-wall defects. Thus, all three modes of testing were employed.

2.4 Summary of Qualification Testing

The individual parts of the tool and the complete tool were tested in a variety of ways to demonstrate adequate performance of the tool. The most important tests were conducted to demonstrate that the stresses (or strains) imposed by the in-situ test tool would be identical to those imposed by a capped tube hydrotest. Test sections of 3/4 inch OD by 0.048 inch wall Alloy 600 steam generator tubes were instrumented with biaxial stain gages which were positioned at the section mid-point and 180 degrees apart. Strains were measured during a capped tube hydrostatic test and during a hydrostatic test using the in-situ pressure test system. The results indicated that the strains imposed by the in-situ pressure test tool were the same as for the capped tube hydro test. Reference 3 provides the details of the qualification tests for the localized in-situ test tool. The tool described in Reference 3 was developed to pressure test primarily circumferentially oriented defects in the expansion transitions at the top of the tubesheet. This too, although referred to as the "circumferential tool", may also be used for testing axial indications. An additional tool has evolved for testing of axial defects which are greater in length than those which can be tested in the original "circumferential tool". Since the tool design for the circumferential defects has greater restrictions than the tool for axial defects, the test report is bounding for the axial tool.

For the St. Lucie-1 testing, an additional set of tests were performed to further qualify the tools. Reference 3 noted that for the case of a leaking SG tube, the pressure at the pump discharge and in the tube will be different because of pressure losses for the water through the hoses. Also, because of the cyclic operation of the pump, the pressure will fluctuate.

A specific configuration, not identical to St. Lucie-1, was tested for Reference 3 and from that testing the pressure in the tube could be estimated from the pump pressure for various leak rates. Reference 3 noted that the results applied only to the configuration tested and will differ for other configurations. For St. Lucie-1, longer hoses were required by the need to test defect indications in the upper bundle region of the SGs. For non-leaking defects, the length of the hoses has no effect on the test chamber pressure. However, for a leaking tube the pressure in the test chamber could not be determined without additional testing. Attachment A (Reference 4) describes the testing and provides the adjustments to be applied to pump pressures to insure test chamber pressures exceed the target pressures.

2.5 Test Condition Adjustments

Reference 2 noted that the main issue of interpretation and application of in-situ pressure test data is ascertaining their significance relative to regulatory requirements and to conditions incurred during normal operating or accident conditions. Guidelines for extrapolating test data to operating or accident conditions are contained in Reference 2 and were considered when developing the target pressures for the St. Lucie-1 tests.

Extrapolation of in-situ test results from ambient conditions where the testing occurs to service conditions requires a correction to account for temperature. The average flow strength (average of yield and ultimate strengths) which governs burst pressures, decreases with increasing temperature. To insure that the severity of loading during the test was equivalent to that in operation, the test pressures were increased by 13 percent. The value is consistent with temperature adjustments in laboratory burst testing of steam generator tubes removed from operating plants (Reference 5, for example). The value resulted from laboratory tests at ambient temperature and 650°F on non-defective steam generator tubes (Reference 6).

For axially oriented free span cracks, only the hoop pressure stresses are of interest. For tubes with circumferentially oriented defects, axial stresses must be applied across the degraded section. The qualification testing summarized in section 2.4 indicated that the tool applied axial stresses equivalent to a capped tube hydrotest which would be consistent with service induced stresses. As long as the tube is free to move axially during the test, there is no need for an additional correction factor.

The eggcrate supports and the tube support plates at St. Lucie-1 are carbon steel. In many plants with carbon steel supports, corrosion of the carbon steel in the tube -to-support crevices has resulted in corrosion product build-up to the point where tubes become locked (or frozen) at the supports. The presence of this condition at St. Lucie-1 could not be discounted. Accordingly, the design of the in-situ test plan for St. Lucie-1 assumed that the tubes were locked at the tube supports.

For axially oriented cracks, only hoop stresses are important in assessing tube integrity, and thus, no connections need to be applied to in-situ test pressures to account for the effect of tubes locked at tube supports. For circumferentially oriented cracks, axial stresses induced by the in-situ pressure test must be applied across the degraded section. During the test, the tube will expand in the axial direction. If a tube is free to move axially through the supports, test results can be used without correction. However, as a result of support corrosion, the tubes being tested may become locked at the supports, thereby hindering axial tube displacements (in effect, reducing axial loads during the test, making the test results non-conservative). References 2 and 7 noted calculations had been performed to determine axial stresses in tubes with axisymetric circumferential degradation for several different axial boundary conditions. Two general cases of interest were noted:

1) loading applied by a localized pressurized tool to produce an axial force in a locked, degraded tube surrounded by locked, non-degraded, non-pressurized adjacent tubes and

2) full length pressure loading of a locked, degraded tube surrounded by locked, non-degraded, non-pressurized adjacent tubes.

Reference 2 argues that Regulatory Guide 1.121 structural margins are adequately demonstrated when in-situ pressure test tooling provides an axial stress equivalent to the axial stress experienced by an in-service tube subjected to an internal pressure of 3 times the normal operating pressure differential. The calculations summarized by Reference 2 and 7 indicate that a correction factor needs to be applied to the in-situ test pressure to create the same axial stress as experienced by an in-situ service tool. The size of the correction factor is affected by the distances between tubesheet and support where locking has occurred and by the mechanical properties (yield strength) of the tubes. The largest correction factors for localized in-situ pressure testing result for the shortest distances and the highest yield strengths. A correction factor of 1.127 (increase in pressure of 12.7 percent) bounded all of the localized in-situ pressure test cases evaluated. Reference 7 also described an analytical evaluation of a full tube in-situ test of a locked tube. The result for this test was a correction factor of 1.78, indicating that testing of a locked tube with circumferential cracking was of marginal value. Laboratory test comparison of locked and non-locked tubes (Reference 7) confirmed the reduction in axial loads for the locked tube, thereby indicating the need to increase the test pressures to insure that the test provided stress conditions at least as severe as those expected for an in-service tube.

Prior to testing at St. Lucie-1, ABB CENO determined a St. Lucie-1 specific correction factor to be applied to localized tests of circumferentially oriented defects. For the case of 3/4 inch OD by 0.048 inch tubing, assuming tubes are locked at the first eggcrate support, this correction factor was 8.5% (pressure to be increased by factor of 1.085).

In summary, at St. Lucie-1 target test pressures were increased by:

a) 13 percent for axial and volumetric indications to correct for temperature

b) 21.5% for circumferentially oriented indications to correct for temperature and for tubes locked at support locations.

To further insure that target pressures were attained, an additional 50 psi was added as a pressure gauge calibration correction.

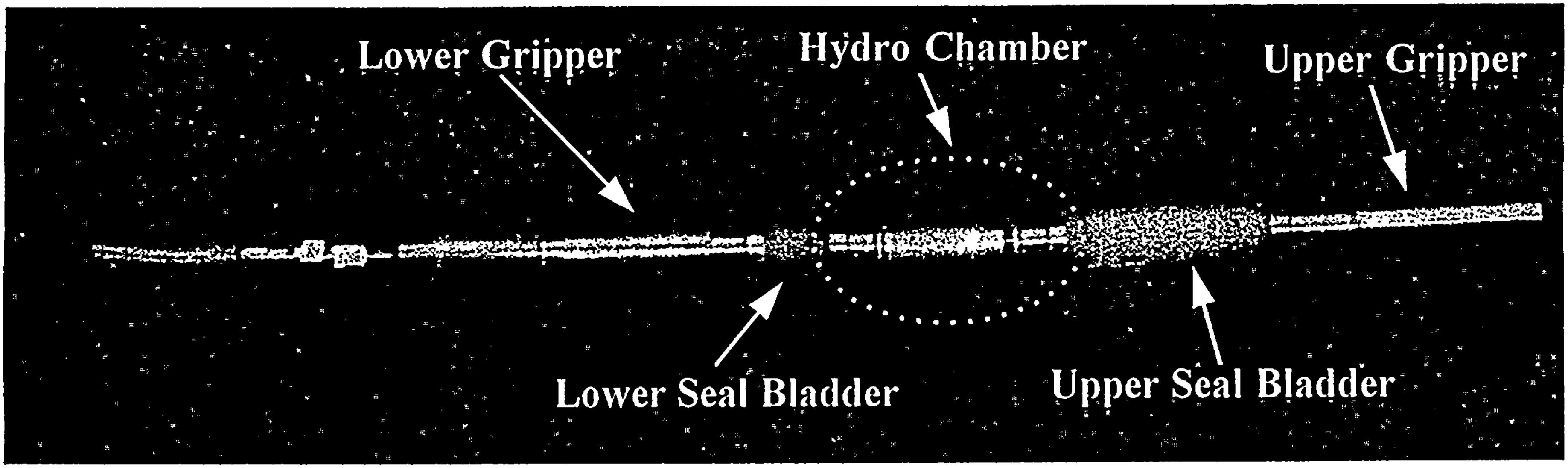

Figure 2-1. Schematic of In-situ Pressure Test Tool.

Section 3.0

ST. LUCIE-1 TEST PROCEDURES

In-situ pressure testing of St. Lucie-1 steam generator tubes was conducted in accordance with ABB CENO Procedure STD-100-204, Rev. 9, "Procedure for the Checkout and Operation of the Steam Generator Tube In-Situ Hydrostatic Test Tool" and Traveler No. PSL-007 Rev. 6, "In-Situ Hydro Test Traveler". A total of 17 tubes were tested, 14 with a localized tool and 3 with the full tube hydro equipment. The tubes had a variety of defect types including upper bundle free span axial indications, (b) top-of-the-tubesheet circumferential indications, (c) axial indications just above the tubesheet (sludge pile region), (d) axial indications at eggcrate locations, (e) axial indications at drilled support plates and (f) volumetric indications at drilled support plates. FPL selected the tubes for testing based on ECT results. The ECT data are included in Table 4-1 which summarizes the test results. The tubes selected for testing were:

a) upper bundle free span axial indications by full tube hydro:

SGA R89L107 - several free span indications
SGA R33L109 - several free span indications
SGA R42L128 - largest voltage by MRPC

b) circumferential indications at the top of the tubesheet

SGA R13L113 - cold leg side, maximum voltage by MRPC
SGB R40L98 - hot leg side, maximum percent degraded area
SGB R90L38 - hot leg side

c) axial indications just above the top of the tubesheet (sludge pile area)

SGB R29L47 - deepest bobbin coil indicated flaw

SGB R78L84 - bobbin coil highest voltage

SGB R88L44 - worst case indication which could be left in service

SGB R33L115 - maximum depth volumetric indication

d) axial indications at eggcrate locations

SGB R83L97 - major growth in defect size

SGB R99L119 - highest voltage indicated by bobbin coil

SGB R15L55 - deepest flaw indicated by bobbin coil

e) axial and volumetric indications at the lower partial drilled support plate

SGB R105L103 - highest voltage indicated by bobbin coil

SGB R109L81 - 7th deepest axial indication by bobbin coil

SGB R104L70 - NDD by bobbin coil, volumetric indication by MRPC

SGB R114L106 - highest voltage volumetric indication by bobbin coil

FPL provided the target test pressures, as adjusted for temperature (13% increase) axial load correction factor for tubes locked at supports (8.5% increase) and 50 psig added for pressure gauge calibration correction. The corrected target pressures for each defect type were:

Defect Type	Condition	Corrected Target Pressure, psi
Axial & volumetric indications	Normal operating ΔP	1672
	Main steam line break	2875
	3 times NOΔP	4915
Circumferential indications	Normal operating ΔP	1794
	Main steam line break	3088
	3 times NOΔP	5281

Prior to conducting a localized test, the in-situ pressure test tool was positioned in the tubesheet region of the tube and was then pressurized to three times normal operating pressure differential to verify that the tool was operating and to identify and measure any leakage past the bladders. The pressure was maintained for one minute. After verifying operability and the absence of bladder by-pass, the tool was re-positioned so that the defect region was covered by the hydro-test chamber of the tool. The defect area of each tube was then pressure tested in accordance with the following schedule:

1) The defect area of the tube was pressurized to the adjusted normal operating pressure differential and the pressure was maintained for five minutes to observe for leakage. Had there been any leakage, a leak test of five minutes duration would have been conducted to determine a leak rate.

2) The defect area of the tube was then pressurized to the adjusted main steam line break pressure and held at that pressure for five minutes to observe for leakage and determine a leak rate. As discussed in the following section, one tube did not reach the target pressure because leakage developed at a lower pressure and exceeded pump capacity at a pressure less than MSLB. For leaking tubes, the pressure was decreased to normal operating pressure differential of five minutes for a leak rate determination after exposure to MSLB pressures.

3) The defect area of the tube was pressurized to 3 times adjusted normal operating pressures for five minutes. For specimens with leakage which prevented attaining the target pressures, the tool was repositioned so that the defect area was covered by the upper bladder and the tool re-pressurized to the target pressure.

For the full tube tests, the tube ends were plugged with the appropriate tools and the tube was pressurized in accordance with the same schedule as was used for the localized testing.

Section 4.0

RESULTS

Table 4-1 summarizes the full tube and localized in-situ pressure test results for the St. Lucie-1 steam generators. The table provides tube identification, flaw type, size and location, ECT data, target pressures, maximum pressures attained and leak rates at the various pressures.

There were not any catastrophic failures (burst) of any of the defective St. Lucie-1 tubes tested, even when pressurized to pressures of 3 times normal operating pressure differentials (3 NOΔP) (adjusted for temperature and tube lock-up). The three tubes with axial free span flaws did not develop leakage at test pressures up to 5000 psi although the flaws were long (up to 7.0 inches) and deep (100% throughwall, 88% degraded area) as indicated by MRPC testing.

The three tubes with circumferential crack indications at the top of the tubesheet survived pressures of 5300 to 5325 psi without developing leakage. The MRPC indicated depths and calculated percent degraded areas for these tubes were up to 86% and 55%, respectively.

Two of the four tubes with sludge pile axial defects survived test pressures of 4950 - 5000 psi without leakage developing. Tube R29L47 developed leakage during pressurization to adjusted MSLB pressures (2900 psi) which was measured at 0.26 gpm. When pressure was decreased to adjusted normal operating pressure differential (NOΔP) the leak decreased to 0.12 gpm. The defect was covered with a bladder for the final step of testing, but the bladder developed leakage at 4300 psi. However, leakage from the bladder was sufficiently small that the target pressure was achieved. A second tube (R78L84) developed a leak at 4400 psi but with the aid of a bladder, the target pressure was achieved.

Two of the three axial eggcrate flaws developed leaks during testing. Tube R83L79 began leaking at 2400 psi. Leak measurements were conducted at 2150 psi bladder pressure which attachment A indicates would equal a pressure of 1750 psi in the test chamber. A post leak rate attempt to attain MSLB pressure was not successful. Subsequent leak rate measurements at NOΔP produced a 0.40 gpm result which suggests some plastic deformation of the defect. When a bladder was used to cover the defect, the highest target pressure was attained without incident. The second leaking tube (R15L55) did not leak when first tested at NOΔP but did have a small leak (0.02 gpm) at adjusted MSLB pressure. When pressure was decreased to NOΔP, the leak rate decreased to 0.01 gpm. With the aid of a bladder over the defect, the maximum target pressure was achieved.

There was not any measurable leakage during test of the four tubes with defect indications at the 09H partial drilled support plate.

TABLE 1

ST. LUCIE-1 IN-SITU PRESSURE TEST RESULTS

Steam. Gen. Region	TUBE INFORMATION				MRPC DATA				BOBBIN DATA		IN-SITU TEST/ LEAKAGE DATA			
	Row	Line	Location	Length	Volts	Max %	PDA	Ax/Circ	Volts	Max%	GPM @ NOPD	GPM @ MSLB	GPM @ NOPD POST MSLB	Pressure 3xNOPD
					STEAM GENERATOR A									
Circ. Flaws	13	113	TSC+0.1	1.80	9.60	78	37	CSI	NA	NDD	0	0	NA	5300
Free Span	89	107	8H+12.0	2.50	2.00	100	80	ASI	NA	NDD	0	0	NA	5000
Free Span	89	107	8H+10.8	7.00	1.80	99	88	ASI	NA	NDD	0	0	NA	5000
Free Span	33	109	6H+17-19	5.1	1.61	84	61	ASI	0.20	29	0	0	NA	5000
Free Span	42	128	6H+10.63	4.8	1.75	100	94	ASI	NA	NDD	0	0	NA	4950
					STEAM GENERATOR B									
Circ. Flaw	40	98	TSH+0.1	2.00	2.13	77	55	CSI	NA	NDD	0	0	NA	5300
Circ. Flaw	90	38	TSH+0.1	1.40	1.97	86	37	CEI	NA	NDD	0	0	NA	5325
Sludge Pile	29	47	TSH+5.3	0.40	7.80	97	76	ASI	5.00	81	0	0.26	0.12	(1)5000
Sludge Pile	78	84	TSH+0.8	0.64	3.37	49	48	ASI	7.60	56	0	0	NA	5000
Sludge Pile	88	44	TSH+1.5	0.54	1.35	62	50	ASI	3.00	28	0	0	NA	5000
Sludge Pile	33	115	TSH+5.7	0.53	0.92	44	NA	VOL	1.50	69	0	0	NA	4950
Eggcrate	83	97	1H	0.96	10.80	86	76	ASI	5.60	81	0	0.25	0.40	(3)5100
Eggcrate	99	119	1H	0.73	10.00	90	75	ASI	6.60	80	0	0	NA	(2)5000
Eggcrate	15	55	1H	0.90	12.30	90	67	ASI	5.60	94/64	0	0.02	0.01	(3)5000
Drilled Sup.	105	103	9H	0.72	7.20	51	28	ASI	2.60	79	0	0	NA	5000
Drilled Sup.	114	106	9H	NA	3.80	37	NA	VOL	7.00	20	0	0	NA	5000
Drilled Sup.	109	81	9H	0.46	1.80	69	53	ASI	1.30	52	0	0	NA	5000
Drilled Sup.	104	70	9H	NA	2.20	81	NA	VOL	11.6	DNT	0	0	NA	4950

(1) Max. pressure achieved. Bladder failed at 4300 psi.
(2) Burst with bladder over flaw. < 0.25 GPM @ 4800 psi without bladder.
(3) With burst bladder over flaw.

Section 5.0

CONCLUSIONS

The seventeen St. Lucie-1 tubes that were in-situ pressure tested with the localized tools or by the full tube technique met the most limiting requirement of USNRC Regulatory Guide 1.121, that being that defective tubes must be able to withstand without burst a pressure of three times the normal operating pressure differential.

Section 6.0

REFERENCES

1. USNRC Regulatory Guide 1.121 (Draft), "Bases for Plugging Degraded PWR Steam Generator Tubes," August, 1976

2. EPRI Guidelines for In-Situ Pressure Testing of Steam Generator Tubes

3. B.F. Allen, "Final Report for the Steam Generator Tube In-Situ Hydrostatic Test Tool," TR-ESE-1030, Rev. 00, April 1, 1994

4. R.M. Orsulak, "Test Report Steam Generator Tube In-Situ Hydrostatic Pressure Test Tool Hydro Chamber Pressure Determination, "TR-9419-CSE-96-1101, Rev. 0," June 12, 1996

5. T.P. Magee and J.F. Hall, "Examination of Trojan Steam Generator Tubes Volume 1 Examination Results," EPRI TR-101427, November, 1992

6. "Steam Generator Tube Degradation at the Support Plates, CEOG Task 729," CE NPSD 957, October, 1994

7. "Steam Generator Tube In-Situ Pressure Testing Guidelines CEOG Task 844," CE NPSD-1005-P, June 1995