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SUBJECT: Forwards analysis to support 800123 request for extension of two effective full power months operation prior to performing next steam generator insp. Analysis evaluates normal plant operation for 10 effective full power months.

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FLORIDA POWER & LIGHT COMPANY

February 1, 1980
L-80-40

Office of Nuclear Reactor Regulation
Attention: Mr. A. Schwencer, Chief
Operating Reactors Branch #1
Division of Operating Reactors
U. S. Nuclear Regulatory Commission
Washington D. C. 20555

Dear Mr. Schwencer:

Re: Turkey Point Unit 4
Docket No. 50-251
Steam Generator Inspection

On January 23, 1980 (L-80-32), Florida Power & Light Company requested an extension of two effective full power months operation prior to performing the next steam generator inspection. This letter forwards information in further support of our request.

The attached analysis conservatively evaluates normal plant operation for ten effective full power months since the previous steam generator inspection, and postulated accident conditions, i.e., main steam line break. The analysis concludes that Turkey Point Unit 4 can be safely operated for an additional effective two months beyond the currently authorized eight effective months operation.

Florida Power & Light Company believes that the result of the recent steam generator inspection, preventive tube plugging for ten effective months operation, recent leak-free operating experience, and the attached supporting analysis justifies an additional two months extension prior to performing the next steam generator inspection.

Please feel free to call if you should have any question in this matter.

Very truly yours,

Robert E. Uhrig
Vice President
Advanced Systems & Technology

REU/RAK/td

Attachment

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TURKEY POINT UNIT 4

EXTENSION OF AUTHORIZED OPERATING INTERVAL

Turkey Point Unit 4 is presently authorized by the NRC to operate for eight equivalent operating months beyond the last steam generator inspection outage (April, 1979). At that time, Turkey Point was regarded as beyond full closure of the tube lane flow slots by approximately 15.5 EFPMs. Therefore, the current authorized operating interval permits operation to 23.5 EFPM beyond closure. This analysis evaluates continued operation of Turkey Point Unit 4 for an additional two equivalent months (i.e. 25.5 EFPM beyond closure), for which preventive tube plugging was in fact implemented during the April, 1979 outage.

Turkey Point Unit 4 has had two S/G re-inspections at points beyond full closure of flow slots (at approximately 5 EFPM and 15.5 EFPM).

In the last inspection (April, 1979), an extensive program was conducted, wherein the following items were accomplished:

1. Gauging of steam generator hot leg and cold leg tubing - all steam generators.
2. Measurements of visible flow slots in all steam generators.
3. Annulus measurements of steam generator B.
4. Eddy current inspection of small radius U-bends in steam generator A.
5. Regulatory Guide 1.83 eddy current measurements in the hot legs and cold legs of all steam generators.
6. Preventive plugging based on 10 EFPM's additional operation.

A. Inspection Programs

The tube gauging program in the tubelane area was based on expected regions of high tube deformation. These regions were determined by previous inspection experience and by the finite element analysis which, when combined with tube strain tests results, yields tube hoop strains versus tube location and extent of plate deformation. The tube hoop strain contours estimated for 15.5 EFPMs beyond full closure were utilized to determine the 15% boundary for the inspection in the tubelane region. Additional inspection programs were defined for the periphery, wedge, and patch plate regions. These programs were based on previous tube leakage histories at the TUrkey Point and Surry sites, as well as previous gauging results at those sites, as deemed appropropriate. Due to the current awareness of the potential for tube deformation on the cold leg side, inspections of all three steam generator cold legs were performed. Additionally, if a restricted tube was found close to the inspection boundary, the inspection was expanded in that area.

The U-bends of unplugged tubes in rows 2 thru 5 in steam generator A were examined with 100 kHz. These inspections are performed to confirm the integrity of the small radius U-bends in low number rows. In addition, annulus measurements were taken in steam generator B. These measurements provide a qualitative indicator of the upper plate expansion trends in the most affected steam generator. This was the fourth such measurement of this type for steam generator B. Visible flow slots were photographed in all three steam generators.

B. Summary of Inspection Results

Summary comments resulting from the review of the date obtained in the last inspection are as follows:

1. No leaking tubes were identified during the previous operation period.
2. Tubes in the tubelane region that restrict the 0.650 inch probe or less lie within the 15% strain boundary.
3. Tubes in the tubelane region restricting a 0.540 inch probe (hot leg and cold leg) were adjacent to hard spots and were in row 4 or below.
4. Restricted tubes developed adjacent to previous activity. Areas of activity were consistent with past historical data for this and other plants. Areas of note were rows 1-15 and 77-92 near the flow slots which finite element analysis predicts should progress much more rapidly than other flow slot areas. The wedge and tubelane interaction appears to be causing the finite element analysis to over predict this reaction since the activity in this area is consistent with the remainder of the tubelane flow slots. It is intended that in future inspections, this area will be plugged under the same criteria as the tubelane area.
5. Tube restrictions were noted in the hot leg wedge areas of all steam generators and appears consistent with previous experience at this and other units.
6. Relatively few tube restrictions were noted in the cold leg tubelane regions when compared to the hot leg. Activity was noted in one of the cold leg wedge areas inspected (steam generator B) and appears to be consistent with previous activity noted in prior Turkey Point inspections. The overall level of activity appears to be progressing at a slow rate when compared to the hot leg.
7. The U-bends of unplugged tubes in rows 2 thru 5 in steam generator A were examined at 100 kHz. No indications were noted in those small radius U-bends.
8. Annulus measurements were recorded in steam generator B. This was the fourth such measurement and allowing for standard deviation of the measurements, no obvious trends were noted. This technique is used to monitor large deviations from anticipated behavior. None were noted.
9. The results of the flow slot measurements indicate that plate expansion is proceeding consistently with previous behavior.
10. Regulatory Guide 1.83 inspections were conducted in the hot leg and cold leg of all three steam generators. Extensions of these inspections were performed in steam generator A and B. As a result of these inspections six tubes were preventively plugged in steam generator A and no tubes were plugged in either steam generators B or C. An evaluation of the inspection results seems to indicate that little systematic change in tube wall degradation has occurred since the December 1977 inspection.

C. Discussion of Plugging Criteria

1. Gauging Program

The progression of strain contours over the intended operating period is utilized as the basis for preventive plugging of tubes in the tubelane region which are located in rows beyond 0.540 inch restricted tubes. In earlier inspections the closeness of the strain contour lines prevented identification of the appropriate contour which most reasonable indicated the extent and progressions of tubes with greatest deformation. Initially, the 15% strain contour was chosen when limited plant specific data was available and the strain contour lines indicated the finite element analysis fell close together on the plots. A review

of the relationship between the most restricted tubes at Turkey Point Units 3 and 4 and finite element analysis strain contours seems to indicate that the 17.5% strain contour conservatively estimates the boundary of these restricted tubes. This strain contour was the basis to estimate the anticipated progression during the current operating period.

The growth of the 17.5% strain contour was evaluated and a conservative rate of growth for a ten month operating period was projected, that is, tubes three rows beyond existing 0.540 inch restrictions should be plugged in the tube-lane region.

The criterion established for plugging tubes in the region of the patch-plate differs from that used for other regions of the bundle. All tube leaks in the patch-plate region have occurred at the perimeter of the plate or near the patch-plate boundary, where plug welds connect the patch-plate to the main body of the bundle. All observed data appear to indicate that the phenomenon at the be represented by the finite element model. While the hoop strains in this region do not appear high enough to cause severe tube deformation, they may act as catalysts for the local phenomenon which occurs at the patch-plate. Due to these factors, the region of the patch-plate has its own inspection program and corresponding plugging criteria. Leaking tubes, tubes that restrict the 0.540 inch probe, and the tubes surrounding both are plugged. (in the 4/79 inspection, there were no leaking tubes.) In addition, tubes that restricted the 0.610 inch probe were plugged and tubes on either side of the patch-plate boundary (plate perimter on one side the plug welds on the other three sides) that restricted the 0.650 inch probe were also plugged.

Finally, due to the local plate cracking that is believed to occur at the periphery and near wedge locations, tube leaks may occur here at lower levels of tube restriction than in the tubelane. Thus, the wedge areas have their own inspection program and plugging criteria. The plugging criteria at hot leg wedge locations calls for treating leaking tubes and tubes that restrict the 0.540 inch probe in a similar manner. In addition, tubes that restrict the 0.610 inch probe and peripheral tubes that restrict the 0.650 inch probe are plugged. Cold leg plugging is based on the detected rate of activity and rates of progression observed from gauging.

For the proposed 10 month operating period, additonal preventive plugging was performed beyond the observed 0.540 inch restricted tubes. Therefore, another criterion was established that relied on plant specific information rather than finite element analysis results. The basis of the criterion was the comparison of the 0.650 inch restricted tubes remaining unplugged from the previous two inspections and the gauging results on these tubes during the 4/79 inspection. The resulting sample numbered 177 tubes. To generate a conservative prediction of behavior, tubes in this sample which currently restricted only a 0.650 inch probe were assumed to have reduced in size 40 mils (.650-.610). Tubes in this sample which now restricted a 0.610 inch probe were assumed to have reduced in size 110 mils (.650-.540). Tubes now restricting a 0.540 inch probe were assumed to have reduced by 150 mils, which is considered to be a conservatively high estimate. The average and conservative estimate of these reductions is calculated to be approzimately 100 mils for 10 months. Thus, it is conservative to assume that within 10 months, some of the currently 0.650 inch restricted tubes could approach or result in a restriction of 0.540 inch or less.

Based on these considerations, engineering judgement was exercised to choose those 0.650 inch restricted tubes which could possibly approach or result in a restriction of 0.540 inch. In general, tubes restricting a 0.650 inch probe located in "plugging valley" and those in close proximity to 0.610 inch and 0.540 inch restricted tubes were considered for plugging.

The ten month operating period, which covers the authorized 8 EFPMs plus the requested additional 2 EFPMs, was also evaluated relative to a postulated main steam line break accident (MSLB). In doing this, the finite element analysis plots for 18 and 24 EFPM beyond closure (Figures 1 and 2) were considered. These were considered to be representative of the anticipated advanced conditions of the Turkey Point Unit 4 steam generators over the ten month operating period. It was assumed that the actual boundary of the 17.5% tube hoop strain contour in steam generator (B) is indicated in the tubelane region by the previous (prior to April, 1979) plugging boundary and the 0.540 inch restricted tubes found in April, 1979. Using the finite element analysis results above, the advancement of the 17.5% tube hoop strain contour over the next ten months' period was estimated to be 1.9 rows. Since there are 92 tubes in a row, the total predicted tubes in the tubelane region within the 17.5% strain contour at the end of the ten months' period is:

1.9 rows in ten months x 92 tubes per row = 175 tubes

Subtracting out the tubes that were preventively plugged (26) in this area in steam generator B in April, 1979, results in a total of 149 unplugged tubes within the 17.5% strain contour at the end of the ten month's operating period. Assuming one intersection involvement per tube and assuming those tubes would leak during a postulated main steam line break, the total resulting leakage from those tubes would be:

$$149 \text{ tubes} \times 0.05 \frac{\text{GPM}}{\text{tube}} = 7.45 \text{ GPM}$$

This added to the 0.3 GPM leakage assumed to be present at the start of a postulated main steam line break (which would increase to approximately 0.7 GPM due to MSLB differential pressure) yields a total leakage less than 10 GPM, which has been determined in previous submittals to be an acceptable level of leakage during a postulated MSLB.

2. Regulatory Guide 1.83

The criteria for plugging tubes in this area are established in the regulatory guide. Only six tubes (all in SG-A) were plugged for tube wall degradation in April, 1979. No widespread increase in wall penetration occurred.

Concluding Statement

This analysis, in addition to the data obtained and preventive plugging program performed as a result of the last (April, 1979) inspection, as well as the steam generator corrosion experience gained with the Turkey Point units indicate that Turkey Point Unit 4 can safely operate for an additional two (2) equivalent operating months beyond the currently authorized eight (8) equivalent operating months.

The results of the extensive April, 1979 inspection showed that:

1. Tube wall degradation was minimal over the operating period preceeding the last inspection.
2. The denting activity observed was well-behaved; i.e., the restricted tubes found were adjacent to previous activity.
3. Annulus and flow slot measurements were consistent with previous data which does not indicate any acceleration in the progression of denting.

A conservative plugging program was conducted to permit operation for ten (10) equivalent months of operation, which includes the requested additional

period of two (2) equivalent operating months.

Based upon the aforementioned conservatisms inherent in this analysis and the considerable experience resulting from inspections performed at Turkey Point Units 3 and 4 (and other sites), it is concluded that the progression of denting in Turkey Point Unit 4 remains well characterized and predictable for the near-term. Therefore, Florida Power & Light Company has concluded that continued safe operation of Turkey Point Unit 4 for 2 EFPM's beyond the currently authorized 8 EFPM's is justified and will not significantly increase the risk to the health and safety of the public.

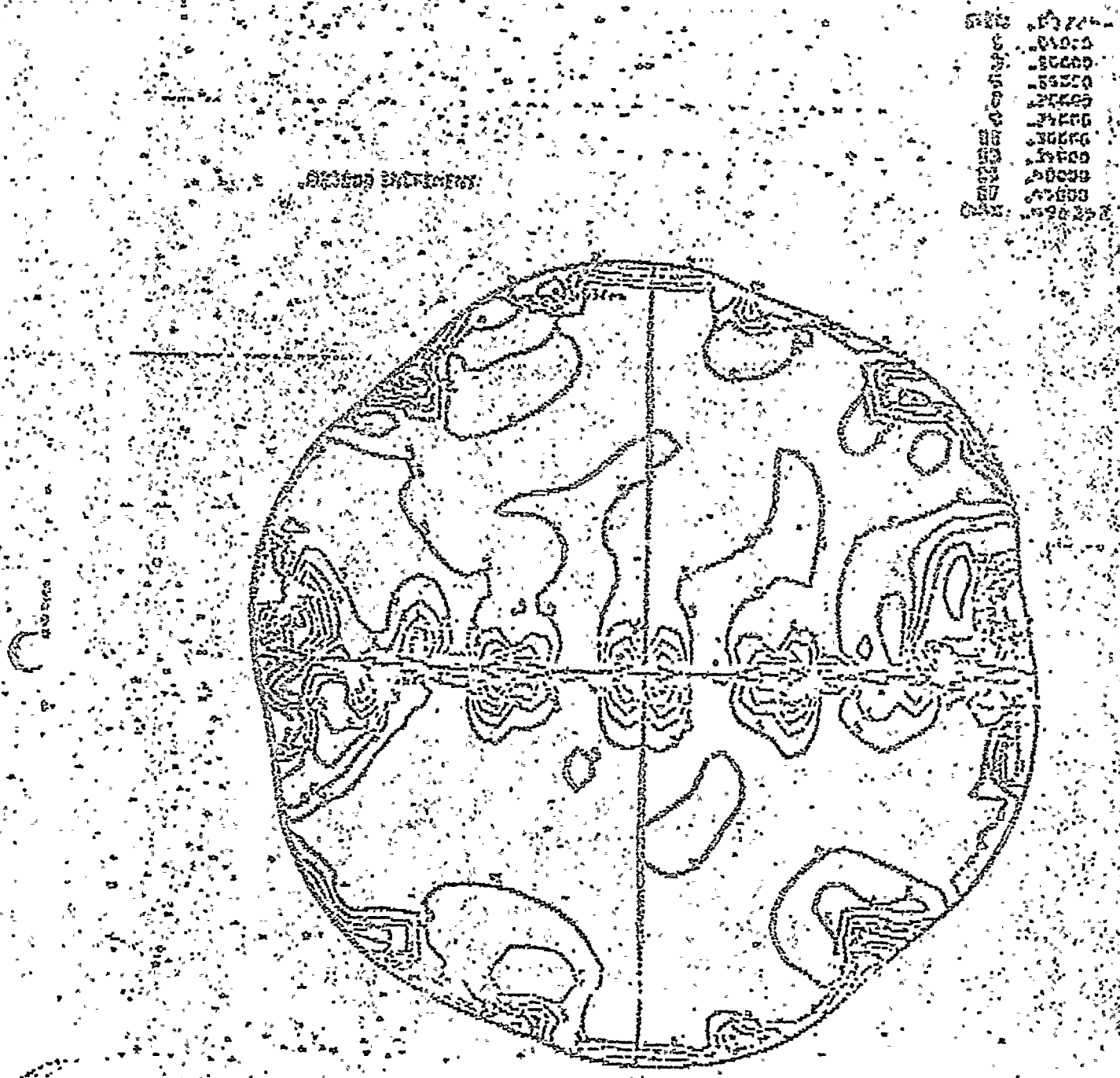

FIGURE 1 TUBE HOOP STRAIN AT 18 EFPY's BEYOND FULL CLOSURE

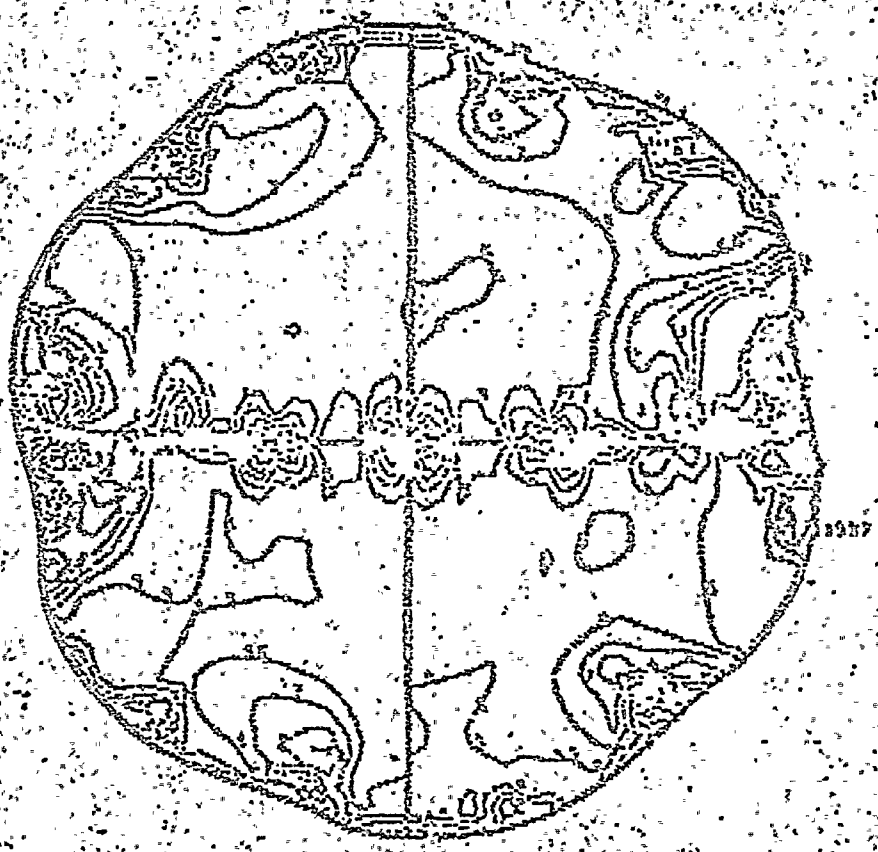

FIGURE 2 TUBE HOOP STRAIN
AT 24 EFPN'S BEYOND FULL CLOSURE