UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION REPORT
RELATED TO POINT BEACH UNIT 1
STEAM GENERATOR TUBE DEGRADATION
DOCKET NO. 50-266

Introduction

In accordance with the Order dated April 4, 1980, Point Beach Unit 1 was shut down on July 25, 1980 for steam generator hydrostatic testing and eddy current inspection after having completed ninety (90) effective full power days (EFPD's) of operation since the restart following the March 1980 steam generator inspection. The evaluation herein provides an update of the SER's issued in support of the Confirmatory and Supplementary Orders, respectively, to reflect the recent operating experience at Unit 1 and the results of the August 1980 steam generator inspection. The background information and results of previous steam generator inspections as discussed in the November 30, 1979 and April 4, 1980 SER's are incorporated into this evaluation by reference.

Background and Discussion

Inservice inspections of the Point Beach Unit 1 steam generators performed during the August and October 1979 outages indicated extensive general intergranular attack (IGA) and stress corrosion cracking on the external surfaces of the steam generator tubes within the thickness of the tubesheet (generally referred to as "deep crevice corrosion"). In view of these findings and of the apparent high rate at which this corrosion phenomenon was developing, the licensee agreed to certain conditions to assure safe operation of Unit 1 for a period of sixty (60) effective full power days. This commitment was formalized by a Confirmatory Order dated November 30, 1979, amending the Operating License to include, in part, the following conditions:

1. a) Hydrostatic testing to be performed within 30 EFPD's.

   b) Hydrostatic testing and eddy current inspection within 60 EFPD's. Submittal of the proposed eddy current inspection program for NRC staff review. Eddy current inspection results also to be submitted, with no resumption of power until the Director, Office of Nuclear Reactor Regulation determines in writing that the results are acceptable.

2. More restrictive limits on primary to secondary steam generator leakage.

3. More restrictive limits on primary coolant activity.

4. Unit 1 not to be operated with more than 18% of tubes plugged in either of the steam generators.

While not covered under terms of the Confirmatory Order, the licensee implemented additional measures in an attempt to retard further tube degradation. These measures included: 1) a crevice flushing program to remove harmful chemicals from the tubesheet crevices, 2) reduced operating temperature and pressure, 3) continued close surveillance of feedwater chemistry and condenser tube leakage, and 4) sludge lancing to be performed within 12 months from the return to power.

In accordance with the Confirmatory Order, Unit 1 shut down on February 29, 1980 after having completed sixty (60) EFPD's of operation. The March 1980 eddy current results indicated a marked reduction in the number of tubes with indicated defects compared to the August and October 1979 inspections. By Order dated April 4, 1980, Unit 1 was required to be shut down for steam generator hydrostatic and eddy current inspections after ninety (90) EFPD's. With the exceptions that the operating period had been changed from 60 to 90 EFPD's, and that no shutdown to perform hydrostatic tests was required before the end of this period, the conditions of the Confirmatory Order remained in force under the April 4, 1980 Order.

July-August Steam Generator Inspection Results

Subsequent to the plant shutdown on July 25, 1980, both steam generators were subjected to hydrostatic tests and eddy current examination in accordance with the April 4, 1980 Order. A tubesheet inspection during the secondary to primary hydrostatic leak test revealed two "dripping" tube plugs and two "wet" tube plugs in the hot leg side of steam generator A, and one wet tube plug and one dripping tube (at rate of one drip per two minutes) in steam generator B. At the time of shutdown on July 25, the Unit 1 steam generators had been leaking (primary to secondary) at a very low level, approximately 20 gpd.

The dripping tube identified in steam generator B was inspected up through the U-bend using the multifrequency eddy current test (ECT) technique, but only a 46% through wall indication, located three inches above the tube end (within the tubesheet thickness), was identified. A possible explanation suggested by the licensee is that the source of the leak may be a small volume defect located in the transition region of the expanded tube zone (near the bottom of the tubesheet) which would be particularly difficult to discriminate, even with multifrequency ECT. This tube has subsequently been plugged.

The multifrequency ECT inspection program for both steam generators consisted of an examination of 100% of the tubes to the first support plate on the hot leg side, and 3% of the tubes inspected over their entire length (i.e. hot and cold leg). The results of these inspections are summarized as follows:

ECT Inspection Summary

S.G.		% Tubes Inspected	Eddy Current Indications	Elevation
S.G.A	Hot Leg	100%	1 tube - undefinable signal 3 tubes - <20% 3 tubes - 20 to 39% 7 tubes - 40 to 59% 5 tubes - 60 to 79% 9 tubes - 80 to 99%	Within thickness of tubesheet
			1 tube - 34%	Top of tubesheet
			1 tube - 34%	½" above tubesheet
	Cold Leg	3%	1 tube - 29%	½" above tubesheet
			5 tubes - <21%	1 to 2" above tubesheet
S.G.B	Hot Leg	100%	7 tubes - 40 to 59% 8 tubes - 60 to 79% 6 tubes - 80 to 99%	Within thickness of tubesheet
			1 tube - leaker	Unknown
	Cold Leg	3%	None	-

As seen in the summary Table, a total of 28 and 22 tubes in the hot leg of steam generators A and B, respectively, were identified to contain tubesheet crevice indications; i.e., indications located within the thickness of the tubesheet. The elevations of these indications range from three (3) inches above the tube ends to in excess of one inch below the top of the tubesheet. Two (2) additional tubes on the hot leg side of steam generator A were found to contain 34% small volume indications at the top of the tubesheet and one-half inch above the top of the tubesheet, respectively. Six (6) tubes on the cold leg side of steam generator A were indicated to contain minor through wall penetrations (<30%) located ½ to 2 inches above the top of the tubesheet elevation. No cold leg tubesheet crevice indications were identified which is consistent with previous experience.

Eddy current tapes from previous inspections dating back to October 1979 are being reviewed by the licensee for each of the tubes found during this inspection (July-August 1980) to contain eddy current indications. For some tubes, the licensee determined that small volume indications were probably present (but were not identified by the data evaluators) in one or more previous inspections by reviewing the previous tapes in close detail over the specific area of interest. These include ten (10) of the total of 50 tubes identified during this inspection as containing tubesheet crevice indications, and two (2) tubes in the hot leg of steam generator A found to contain indications at one-half inch above the top of the tubesheet. It is the licensee's evaluation that the eddy current data evaluators were unsuccessful in discriminating these small volume defects because of the low signal-to-noise ratio of the eddy current signal during previous inspections. However, the licensee's review of the previous eddy current tapes has established that the majority of the eddy current indications were not previously detectable.

The previous inspection in March 1980 included a 100% sample of tubes in the central bundle region ("Kidney zone") of each steam generator (approximately 1000 tubes), and a 3% random sample inspection outside this zone. The central region where 100% inspection was performed was defined to encompass the region of previously observed activity. However, the results of the latest inspection revealed 24 tubesheet crevice indications located up to several tubes beyond the boundary of this previously defined zone that were not inspected in March 1980. As indicated to the staff during discussions held on August 6, 1980, the licensee does not consider these results to be unexpected since the concentration of chemicals in the tubesheet crevices will occur regardless of whether there is a sludge pile at the surface. The licensee believes that, while the sludge pile may contribute chemicals for concentration in the crevice, there is no reason to believe that the crevice corrosion will be limited to the kidney zone, since chemicals from the bulk water will also concentrate in the tubesheet crevices.

All 50 tubes with indications in the tubesheet crevice, including the leaking (dripping) tube, have been mechanically plugged. In addition, three tubes were inadvertently plugged. The two dripping plugs in steam generator A were weld repaired and the steam generator was subsequently and successfully hydrostatically

leak checked. The two tubes in steam generator A containing 34% indications outside the tubesheet crevice region were left unplugged since these indications are less than the 40% Technical Specification plugging limit and these indications appear to have remained unchanged since at least October 1979. The licensee has committed to re-examining these tubes during the next eddy current inspection.

To date, approximately 12.2% of the total number of steam generator tubes at Unit 1 have been plugged, which is well within the 18% tube plugging assumed in the LOCA-ECCS analysis for this unit.

Plans For Continued Operation

Based upon the results of this inspection, the licensee has concluded that the condition of the Point Beach Unit 1 steam generators has not changed significantly since the previous inspection in March 1980. The licensee plans to return Unit 1 to service for an additional 90 effective full power days until its scheduled refueling outage in early November 1980.

Evaluation

The July 1980 inspection of 100% of unplugged tubes at the completion of 90 effective full power days (EFPD) has satisfied the requirements of NRC's Confirmatory Order, dated April 4, 1980. The 2000 psi primary-to-secondary hydrostatic test and 800 psi secondary-to-primary test required by the April 4 Order confirmed that no tubes had reached a state of degradation that would cause a sudden primary-to-secondary leakage during the 90 EFPD operation.

The current multifrequency ECT results, compared with similar ECT results performed in March 1980 and December 1979, do not indicate an appreciable increase in tube degradation within the tubesheet crevice. Of the 14 tubes in steam generator A containing ECT tubesheet crevice indications and which were previously examined in March 1980 and December 1979, none had tubesheet crevice defects which did not show an increase in defect size. Regarding the five (5) tubes that now show a significant ECT indication, but did not show indications previously, we believe that intergranular corrosion attack existed which could not be identified in previous inspections. This had been demonstrated in the laboratory analysis of tubes pulled in March 1980 and November 1979.

With regard to the 18 tubes in steam generator A with new ECT indications within the tubesheet crevice, it should be noted that the current inspection is the first time that 100% of the tubes in steam generator A have been examined for tubesheet crevice defects since October 1979. Thus, there is no basis to indicate that identification of these new tubes reflects a rapid deterioration of the Point Beach Unit 1 steam generators.

The above analysis applies also to the ECT indications found with the tubesheet crevices of steam generator B.

The current ECT results for both steam generators show that intergranular corrosion attack has not progressed above the tubesheet. The two tubes in steam generator A with small volume defects at the top of the tubesheet or just above were present during the October 1979 inspection and have not shown an increase in defect size. Steam generator B had no tubes with defects of this kind.

The random ECT inspections of tubes on the cold leg side confirm that tubesheet crevice corrosion is confined to the hot leg side of each steam generator.

As was the case during the previous inspection in March 1980, the latest ECT results continue to show a marked reduction in the number of tubes with indicated tubesheet crevice defects relative to the August and October 1979 inspections during which approximately 230 tubesheet crevice indications were identified. In addition, ten (10) of the 50 tubes in both steam generators identified to contain tubesheet crevice indications during the latest inspection have been shown to have been present since at least October 1979 based upon a re-examination of the eddy current tapes from the previous inspections. Similarly, 20 of the 41 tubes identified in March 1980 to contain tubesheet crevice indications were also shown to have been present during the October 1979 inspection. The latest inspection findings continue to suggest that some of the remedial actions taken by the licensee following the October 1979 inspection, particularly the lower temperature operation, may be succeeding in retarding the rate of tubesheet crevice corrosion. In this regard, it should be noted that the deep crevice indications first identified during this inspection, but which were apparently present during the October 1979 inspection, have essentially remained stable since that time without developing into leaks.

Analysis of the six (6) tube specimens removed from the Unit 1 steam generator during the October 1979 and March 1980 outages has demonstrated that the presence of integranular attack within the tubesheet crevice cannot be reliably detected with single or multifrequency ECT until cracks are developed along the grain boundaries. Partially through wall cracks of significant size are generally detectable with ECT, even in the tubesheet region. However, very small volume defects, which in turn result in very small ECT signal-to-noise ratios in the tubesheet region, may be easily overlooked by the data evaluators. As noted earlier, several of the eddy current indications observed in the current inspection and the March 1980 inspection were apparently present since October 1970, but were not identified at that time. We believe the licensee's inability to identify the source of the leaking tube in steam generator B to be a further example of the difficulties in discriminating very small volume defects in the tubesheet region. However, we believe tubes with small volume defects (small signal to noise ratio) can generally maintain

their integrity during the full range of normal operating and accident conditions.

The safety significance of intergranular attack and stress corrosion cracking within the tubesheet crevices was evaluated in our November 30, 1979 SER. Based upon our review of the latest inspection results, the November 30, 1979 evaluation remains valid and is incorporated into this SER by reference.

Conclusions

We conclude that the Point Beach Unit 1 steam generator may operate under the conditions of the November 30, 1979 Order and the January 3, 1980 Order without impairment to the health and safety of the public for the following reasons:

1. The 100% inspection and hydrostatic tests have identified all tubes with significant defects to ensure an adequate margin of safety for the proposed period of operation.

2. The operating conditions (i.e., reduced pressure and temperature) during the past 150 EFPD has been successful in retarding the rate of tube degradation.

3. The cumulative number of tubes plugged (12.2%) is well below the 18% assumed for the LOCA-ECCS analysis.

Dated: August 8, 1980