SAFETY EVALUATION REPORT RELATED TO POINT BEACH UNIT 1 STEAM GENERATOR TUBE DEGRADATION DUE TO DEEP CREVICE CORROSION

April 4, 1980

INTRODUCTION

In accordance with the Confirmatory Order dated November 30, 1979, Point Beach Unit 1 was shutdown on February 29, 1980 for steam generator hydrostatic testing and eddy current inspection after having completed the authorized operating period of sixty (60) effective full power days (EFPD's) since the restart subsequent to the October 1979 steam generator inspection. The evaluation herein provides an update of the SER issued in support of the Confirmatory Order to reflect the operating experience at Unit 1 since the Order was issued, and the results of the steam generator inspection obtained during the February 29, 1979 outage. The background information and results of two consecutive inspections (August and October, 1979) as discussed in the November 30, 1979 SER are incorporated into this evaluation by reference.

BACKGROUND

CONFIRMATORY ORDER DATED NOVEMBER 30, 1979

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 of the return to power.

DEFECTS AT OR ABOVE TUBESHEET

The Safety Evaluation issued in support of the November 30, 1979 Confirmatory Order reflected thestaff's understanding that the extensive degradation observed during the August and October 1979 inspections involved general intergranular attack and cracking within the tubesheet crevices, exclusively. Subsequent to the Confirmatory Order, however, the staff became aware of five (5) tubes with defect indications at or above the tubesheet which had not been addressed in the November 30 SER.

In response to our request, the licensee submitted by letter dated December 21, 1979 additional details regarding the defects in these five tubes andan evaluation of their significance. The licensee reviewed the single frequency eddy current test results since 1975 for the subject five tubes and compared the signals of these past inspections to the same frequency signal obtained during the multi-frequency inspection in October 1979. This comparison showed that the signals have not changed through three or four inspections since 1975. On the basis of this review the licensee concluded that the defects observed in October 1979 at or above the tubesheet have remained essentially unchanged since at least 1975 and occurred as a result of earlier thinning or cracking rather than to the intergranular attack phenomenon currently being experienced in the tubesheet crevice area and which was only first observed in November, 1977.

In response to our request, the licensee submitted by letter dated December 21, 1979 additional details regarding the defects in these five tubes and an evaluation of their significance.

Based upon our review of this submittal and a subsequent conference call with the licensee on December 22, 1979, we concluded that (1) the eddy current indications at or above the tubesheet, which were observed during the October 1979 inspection, are old defects, possibly due to wastage or stress corrosion cracking, which were active mechanisms in 1975 and earlier, (2) these indications are not related to the active phenomenon of general intergranular attack and cracking currently being experienced in the tubesheet crevices, and (3) the staff conclusions set forth in the November 30, 1979 SER remained valid and that the unit could continue to be safety operated under terms of the Confirmatory Order. Nonetheless, we have continued our investigation into the significance of the defects found at or above the tubesheet, particularly with regards to eddy current capabilities to detect these defects and their safety significance. This matter is addressed in further detail in this evaluation.

OPERATING EXPERIENCE SUBSEQUENT TO THE CONFIRMATORY ORDER

Following the issuance of the Confirmatory Order, Point Beach Unit 1 was returned to power on December 1, 1979. On December 11, 1979, Unit 1 experienced a rapid increase in primary to secondary leak rate, to 260 gpd, and was forced to shutdown under terms of the Confirmatory Order. The source of the leak was identified as one leaking tube and two leaking plugs in steam generator B. Although not required by either the Technical Specifications or the Confirmatory Order, the licensee performed multifrequency eddy current examinations in both the A and B steam generators. A total of approximately 1900 tubes were inspected. The inspection bounded all areas of previously observed deep crevice corrosion by at least one row and column of tubes. The inspection boundaries were expanded when new indications were observed near the boundary. A set of randomly selected tubes outside the boundaries were also inspected. Representatives from the NRC staff and consultants were at the site on December 16, 1979 to observe the inspection in progress. As a result of this inspection, twenty (20) tubes were plugged in steam generator A and fifteen (15) tubes were plugged in steam generator B. None of the observed indications occurred at or above the top of the tubesheet. The inspection program and results were formally documented in Licensee Event Report 79-021/01T-0 dated December 22, 1979.

Prior to resuming power operation, 2000 psid primary to secondary and 800 psid secondary to primary hydrostatic tests were performed. No tube failures or additional leakage resulted from these tests.

Based upon our review of the December 11 tube leak occurrence and the inspection results we concluded that the conclusions reached in the November 30, 1979, SER remained valid and that the operating restrictions imposed by the Confirmatory Order continued to provide adequate assurance of safe operation.

Point Beach Unit 1 was returned to power on December 22, 1979 and operated to the completion of its authorized 60 EFPD operating period (on February 24, 1980) with only a very minor, but equivalent to a constant 30 gpd primary to secondary leak. This was within the trace amount of equivalent leakage normally experienced at this unit.

MARCH 1980 INSPECTION RESULTS

FIELD EDDY CURRENT TESTING

The eddy current testing (ECT) program implemented during the March 1980 steam generator inspection was submitted for NRC staff review by letter dated February 26, 1980. This program was modified to incorporate NRC staff comments. ECT of 100% of the tubes in regions of previously observed deep crevice corrosion activity (including the kidney shaped central bundle region) was performed within boundaries bounding previously observed defects by at least one tube row and column. Where defects were observed to occur at the boundary, the inspection was expanded to bound these defectives by one tube row and column. An additional 3% random sample was inspected on the cold leg side and also among tubes on the hot leg side in areas not being 100% inspected. Representatives of the NRC staff were on site during the inspection to monitor the inspection as it proceeded, and to facilitate timely decisions from NRC/NRR regarding the need for additional inspection or tube pulling for laboratory examination.

Multifrequency eddy current testing (ECT) conducted in accordance with the approved program revealed 18 defect indications on the hot leg side in steam generator A and 24 defect indications on the hot leg side in steam generator B. In addition, 3 tubes in S.G. B and 6 tubes in S.G. A were found with undefinable indications within the tubesheet. On March 31, a hydrostatic test conducted after the ECT inspection revealed two tubes leaking at approximately 2 drips/minute and two wet plugs in S.G. B. Following plugging of these tubes and repair of the wet plugs a second hydrotest revealed another leaking tube in S.G. B which was plugged. Table I summarizes the ECT indicated defect depths in the two steam generators. Table II summarizes the elevation of the defect indications above the lower, primary surface of the tubesheet which is about 23 inches thick. Some defects affected several inches of tube length and one tube had indications running from the tube expansion at the primary surface of the tubesheet to approximately one inch below the upper, secondary tubesheet surface. The elevations indicated in Table II are the highest elevations reached by each defect.

TABLE I ECT INDICATED DEFECT DEPTHS		
DEFECT DEPTH IN PERCENT OF TUBE WALL	NUMBER OF TUBES	
	S.G. A	S.G. B
90 to 100	5	3
80 to 89	7	7
70 to 79	2	7
60 to 69	3	3
50 to 59	-	2
40 to 49	1	2

TABLE II ELEVATION OF ECT DEFECT INDICATIONS		
DISTANCE ABOVE THE PRIMARY TUBESHEET SURFACE (INCHES)	NUMBER OF TUBES	
	S.G. A	S.G. B
0-4	-	1
5-9	-	2
10-14	2	2
15-19	8	6
20-21	8	12
1/2" ABOVE SECONDARY T.S. SURFACE	-	1

No defective tubes were discovered outside of the central bundle region on the hot leg side nor anywhere on the cold leg side of either steam generator.

Tables I and II in Appendix I provide a tube by tube evaluation of ECT indicated defect depths and elevations and results of re-evaluations of ECT tapes from previous inspections for each defective tube. Study of these tables reveals that 15 tubes in steam generator A and 4 tubes in steam generator B had the same ECT indications but were overlooked in either the December or the December and October 1979 inspections. All of the tubes with defect indications were plugged except those that were removed for laboratory examination. All the ECT indications were of small amplitude and indicate very small volume defects.

TUBE PULLING AND LABORATORY EXAMINATIONS

In their February 26, 1980 submittal the licensee committed to remove a tube from the Unit 1 steam generators if one was found with an eddy current testing indicated defect at or above the top of the tubesheet, such as were observed in five tubes during the October 1979 inspection. The primary interest in removing this type of tube was two fold: (1) to determine if the intergranular attack occurring within the tubesheet crevices is resulting in tube degradation at or above the upper secondary surface of the tubesheet and (2) to correlate field ECT with laboratory examination of the defects. As indicated in Table II one tube was discovered in steam generator B with an indication approximately 1/2" above the top of the tubesheet. This was tube R19-C37 and the indication was 58% deep. In accordance with their commitment, this tube was removed from the steam generator for laboratory examination. In addition, the NRC (after a review of the ECT results) required removal of two other tubes for laboratory examination. These were tubes R30-C41 which had a 47% indication approximately 21" above the primary face of the tubesheet and tube R26-C53 which had a 86% indication approximately 18" above the primary face of the tubesheet. Removal of these tubes was intended to provide additional data regarding the extent and magnitude of IGA and the accuracy of ECT. The tube removal procedures extended the outage time approximately six days and resulted in approximately an additional 155 manrem exposure.

LABORATORY RADIOGRAPHY AND EDDY-CURRENT TESTING

Radiography and ECT were performed on all three of the removed tube specimens by Westinghouse at their Pittsburgh R&D facility.

As a result of the pulling process the original 22.1/2" length of tube R30-C41 within the tubesheet was elongated to approximately 24-3/4". This measurement was based on the ring left on the tube at the top of the tubesheet. Radiography of the removed tube revealed many defect indications in the region up to 23-1/4" from the tube end. Many ECT indications existed up to 23-1/2" from the tube end. No radiographic or ECT indications existed at or above the ring marking the top of the tubesheet.

The laboratory ECT examination indicated an approximately 70 to 80% defect based on evaluation of the single frequency (400 KHZ) signal, located 23-1/2" from the tube end. Based on the elongation caused in the tube removal process, 23-1/2" corresponds to approximately 21.3" from the tube end in the unstrained tube.

The field ECT indicated a 47% defect at 400 KHZ approximately 21" from the tube end. Field evaluation of the defect based on the multi-frequency signal estimated the defect depth in the same 70% to 80% range as obtained in the laboratory* (at 400 KHZ) in the absence of tubesheet interference effects. Defect depths are reported based on the single frequency signal when possible since it is the technique currently approved by the ASME Code.

The pulling of tube R26-C53 elongated the original 22.5" of tube in the tubesheet crevice to approximately 25-7/16". Radiography of the removed tube revealed many defect indications in the region up to approximately 19.8" from the tube end as well as a single defect 25" above the tube end. Eddy current testing revealed many defect indications up to 19.8" from the tube end. Eddy current testing also revealed two 90% defects located approximately 7/16" and 2-7/16" below the tubesheet ring. No radiographic or ECT indications existed at or above the ring marking the top of the tubesheet.

None of the above laboratory ECT indications for tube R26-C53 were specifically identified in the field. Some of the indicated defects may have been introduced or made worse during the tube pulling operation. "Squirrel" indications (minor disturbances in the ECT signal of underterminable origin) were observed in the field over the full length of tube within the tubesheet. It was not possible to verify through laboratory ECT the 86% ECT indication observed in the field 18" above the tube end, since this corresponded to one of the locations where the tube broke during pulling. However, this field ECT indication will be compared with the results of the fractography analysis of the fracture surface as part of a detailed report which the licensee has committed to submit by April 30, 1980.

Tube R19-C37 was of particular interest because of the field ECT indication of a 58% defect located approximately 1/2" above the tubesheet. Unfortunately, when the tube was examined there was no ring clearly indicating the top of the tubesheet as there was on the other two tubes which were removed. Since the section of tube within the tubesheet experiences a different load and elongation during the removal process than the section of tube above the tubesheet, the exact location of the top of the tubesheet relative to the tube cannot be directly quantified.

Radiography and ECT of the removed tube revealed many defect indications in the region up to 23.75" from the tube end. Radiography also showed crack like indications approximately 24-3/8" above the tube end and ECT indicated an approximate 60% defect 24-1/2" above the tube end. No ECT indications were observed above the 60% indication.

Although the 60% laboratory ECT indication corresponds well with the 58% field ECT indication, its elevation cannot be directly correlated to the field indications because the location of the top of the tubesheet is not identifiable. Calculations based on strains in the other tubes which were removed indicate that this defect would have been inside the tubesheet. Nonetheless, it is the defect with the highest elevation in the tube, its depth corresponds well to the field ECT depth and it could be the defect of interest given the non-uniform straining of the tubes during removal.

Metallographic Examinations

Metallographic examination consisted primarily of photomicrographs (PM) to determine at what elevation IGA existed in the tubes.

For tube R30-C41 PMs were prepared for sections centered on the top of the tubesheet and approximately 0.35" below and 0.45" above the top of the tubesheet. In each of these regions PMs of 50 and 200 power magnification were made. The 200 power PMs were centered on the region in the 50 power photomicrographs indicating the greatest surface irregularities. For the section of tube below the top of the tubesheet the PMs showed shallow grain boundary separation on the order of 0.0025" maximum. At the top of the tubesheet, shallow surface separation was observed affecting grain boundaries to just over 0.001" in depth. Similarly above the top of the tubesheet surface separation of the grain boundaries was observed to a depth of approximately 0.001 inches. Extensive general IGA as is occurring deeper in the tubesheet crevice was not observed in any of these regions.

Photomicrographs were also prepared for tube R26-C53. Again the PMs were centered about the top of the tubesheet and approximately 0.4" below and 0.2" above the top of the tubesheet. The section below the top of the tubesheet showed shallow grain boundary separation penetrating approximately 0.002" maximum.

The region centered about the top of the tubesheet showed no grain boundary separation although some surface irregularities penetrating less than 0.001" existed. Above the top of the tubesheet some areas of grain boundary separation penetrating approximately 0.003" were observed. Extensive general IGA as is occurring deeper in the tubesheet crevice was not observed in any of these regions.

Five photomicrographs were made of tube R15-C39. One was centered on the 60% defect described earlier while the other four were centered approximately 1-5/8" and 3/4" below and 1" and 1-3/4" above the defect. The two sections below the defect showed IGA penetrating to depths of nearly 0.004". Photographs of the tube surface at the defect show a crack running less than approximately 1/2" longitudinally then turning and running less than approximately 1/4" circumferentially. Photomicrographs of a section made through the defect show a crack penetrating approximately 0.017" surrounded by localized IGA. The longitudinal section made for the PM may not have included the deepest section of the crack. Section D above the defect indicates one localized area of grain boundary separation approximately 0.001" deep and section E above the defect shows no grain boundary separation but some shallow surface irregularities less than 0.001" in depth.

PROPOSED CONDITIONS FOR CONTINUED OPERATION

The licensee has proposed the following conditions to allow continued operation of Point Beach Unit 1.

1. Within 90 EFPD, a 2,000 psid primary-to-secondary hydrostatic test and a 800 psid secondary-to-primary hydrostatic test will be performed. An eddy current examination consisting of about 1,000 tubes in the central region of the hot leg in each steam generator and 3% of the remaining tubes outside this area will be performed.

2. Primary coolant activity for Point Beach Unit 1 will be limited in accordance with the provisions of Sections 3.4.8 and 4.4.8 of the Standard Technical Specifications for Westinghouse Pressurized Water Reactors, Revision 2, July 1979, rather than Technical Specification 15.3.1.C.

3. Close surveillance of primary-to-secondary leakage will be continued and the reactor will be shutdown for tube plugging on confirmation of any of the following conditions:

a. Primary-to-secondary leakage of 150 gpd (0.1 gpm) in either steam generator;

b. Any primary-to-secondary leakage in excess of 250 gpd (0.17 gpm) in either steam generator; or

c. An upward trend (average over a three-day period) in primary-to-secondary leakage in either steam generator in excess of 15 gpd (0.01 gpm) per day, when measured primary-to-secondary leakage is above 150 gpd in that steam generator.

4. The reactor will be shutdown, any leaking steam generator tubes plugged, and an eddy current examination as described in Item 1., above, will be performed if leakage due to crevice corrosion in either steam generator exceeds the limits stated in Technical Specifications 15.3.1.D.

5. Unit 1 will be operated at a reactor coolant pressure of 2,000 psia with the associated parameters (i.e., overtemperature ΔT and low pressurizer pressure trip point) with the limits indicated in the Safety Evaluation Report appended to your letter of January 3, 1980.

On return to power operation, the licensee proposes to continue the following program to assist in retarding further tube degradation:

a. Unit 1 will be operated at a reduced reactor coolant system hot leg temperature.

b. Continue close surveillance of feedwater chemistry conditions and condenser tube leakage.

c. Perform sludge lancing within nine months of returning to power.

EVALUATION

ECT PROGRAM, RESULTS, AND CAPABILITIES

Members of the NRC staff and their consultant from Oak Ridge National Laboratory were on site during the inspection to review the testing and evaluation techniques.

Eddy current testing examinations were conducted in accordance with the program proposed in the licensee's February 26, 1980 submittal and approved, with comment, by the NRC. This program bounded the areas where deep crevice corrosion was previously observed and was expanded in any areas where new indications were found. The random inspection of peripheral hot leg tubes and cold leg tubes revealed no deep crevice corrosion. Therefore, the inspection performed is adequate to ensure that the great majority of tubes with deep crevice corrosion have been removed from service by plugging.

The March 1980 ECT results show a marked reduction in the number of tubes with indicated defects compared to the August and October 1979 inspections. In addition, fifteen of the 24 ECT indicated defects in steam generator B and 6 of the 18 ECT indicated defects in steam generator A were shown to exist previously through reexamination of the ECT tapes from previous inspections. Thus, the number of new defects discovered in this inspection is smaller than the raw data indicates. The inspection results 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 further deep crevice corrosion, especially since the time of the December 1979 outage.

As discussed in our November 30, 1979 SER the accuracy of the eddy current technique is somewhat diminished in the tubesheet region and cannot be fully relied upon to detect every tube degraded by deep crevice corrosion. This appears to be particularly true for tubes subject to general IGA, but which do not contain cracks. Partially through wall cracks of significance are generally detectable, even in the tubesheet region, with ECT. As experience has shown, however, very small volume defects which in turn produce very small amplitude ECT signals may be easily overlooked (as was the case with the 19 tubes above). Our evaluation of the safety significance of IGA and stress corrosion cracking occurring within the thickness of the tubesheet is discussed in our November 30, 1979 SER which is incorporated into this SER by reference.

With regard to the tubes observed during the October and March inspections to contain defects at or slightly above the top of the tubesheet, we have concluded that multifrequency ECT can detect defects of a significant size to threaten tube integrity during normal or postulated accident conditions. All of the defects discovered at or above the top of the tubesheet are small amplitude, small volume defects. Assuming the defects at or above the tubesheet to be wall thinning (wastage related), rough estimates of the size of the defects were made by the staff based on comparison with the ECT signatures from the ASME Code calibration standard. These estimates show that if these defects are wastage related, the volumes of these defects are very small compared to what is necessary to burst or collapse the tube under postulated accident conditions, as determined by independent tests sponsored by NRC (NUREG/CR-0718).

In the case of tube R19-C37 which exhibited a field ECT indication of 58% approximately 1/2 inch above the tubesheet, the laboratory examination indicates that the defect indication observed in the field is most likely a crack. NRC sponsored burst and collapse tests (NUREG/CR-0718) have been performed on free standing tubes with EDM notches (simulating a crack) of up to 85-90% (through wall) in depth. The results indicate the lower bound burst strength to exceed the maximum primary to secondary pressure differentials during normal operation or postulated accidents for notches (cracks) ranging to about 1 inch in length. It should be noted that the burst strength of a tube containing a crack defect slightly above or below the top of the tubesheet is considerably higher than for free standing tubes, because of the restraint against radial expansion of the tube provided by the tubesheet. The above tests indicated a collapse failure to be a much less limiting failure mode than a burst failure mode for free standing tubes during postulated accidents. Cracks of sufficient size to cause a burst or collapse failure under postulated accidents are considered by the staff to be well within the detectable capability of the multifrequency eddy current technique, regardless of the location of the crack relative to the top of the tubesheet.

<u>Tube Removal and Laboratory Exam</u>

Laboratory radiography and ECT confirm the position taken by the staff that general IGA may not be detectable in the crevice of the tubesheet until it is severe enough for preferential crack growth to occur. Detection of defects below the top of the tubesheet by laboratory examinations is due partly to increased capability of ECT without the influence of the tubesheet and partly to the creation of new or the opening of old defects during the removal process. Laboratory radiography and ECT confirmed the absence of defects above the tubesheet in tubes R30-C41 and R26-C53. Unfortunately the top of the tubesheet could not be identified on tube R19-C37.

However, assuming that the upper most defect detected in the tube is the defect which was identified by field ECT, there is a good correlation between the laboratory and field ECT. More importantly, the defect which was detected was small enough so as not to jeopardize tube integrity. Primary-to-secondary and secondary-to-primary hydrostatic tests conducted on March 6 revealed one tube (R23-C44) which exhibited a slight leak at a rate of 3 drips per minute, and one wet plug in a previously plugged tube (R23-C50) both in S.G. B. No tube ruptures occurred. The defect found by ECT just above the tubesheet in tube R19-C37 in S.G. B withstood the simulated accident pressure differentials. This provides additional support to our previously stated conclusion that multifrequency ECT can detect defects at or above the top surface of the tubesheet which would jeopardize tube integrity during normal operating or postulated accident conditions.

The staff wants to emphasize that as inspection techniques with increased capabilities, such as multifrequency ECT, are developed, that many small volume defects which previously went undetected will now be found. These defects must be evaluated in the context of the magnitude of defects which jeopardize tube integrity during normal or postulated accident conditions. As inspection techniques become more capable, correspondingly more discriminate criteria must be established. Many plants which have not been inspected with multifrequency ECT are going to show new defects when multifrequency inspections are performed. These results must be dealt with rationally and requirements for tube inspection, plugging, and removal must be carefully applied.

METALLOGRAPHIC EXAMINATIONS

Members of the NRC staff and their consultant from Brookhaven National Laboratory met with representatives from WEPCO and their Westinghouse consultants in Pittsburgh on March 28, 1980 to review results of the metallographic examinations. Review of the photomicrographs described earlier revealed no general IGA similar to that occurring within the tubesheet crevice above the top of the tubesheet in tubes R26-C53 or R30-C41. Shallow grain boundary separation on the order of two grains or less existed on all photomicrographs of these tubes. Shallow grain boundary dissolution of this nature can result from several mechanisms including previous operating environments or tube pickling during manufacturing. This grain boundary separation is much less severe than that occurring within the tubesheet. The staff has concluded that the shallow grain boundary dissolution at and above the top of the tubesheet is not significant in terms of tube integrity. Metallographic examination of tube R19-C37 revealed stress corrosion cracking and shallow IGA of the tube near the top of the tubesheet. Re-evaluation of past ECT tapes showed that this defect existed as far back as 1976 but was overlooked using single frequency ECT. The nature of the crack is similar to that of stress corrosion cracks which occurred during previous operating periods. The staff believes that this is an old defect which has not significantly changed since 1976.

CONCLUSIONS

Based on the information presented above the staff has reached the following conclusions:

1) The inspection and tube plugging performed has been adequate to ensure the great majority of defective tubes have been removed from service.

2) Multiple frequency eddy current testing used to perform the inspection is capable of detecting defects near the tubesheet and tube support plate interfaces which would jeopardize integrity of the tube during normal operation or postulated accident conditions.

3) Hydrostatic tests simulating postulated accident conditions performed prior to returning to operation will identify any significant defects overlooked during ECT examination.

4) Intergranular attack at and above the top of the tubesheet as observed in the removed tube samples is extremely shallow and poses no threat to tube integrity at or above the top of the tubesheet.

5) Based on the number of new defects, the rate of deep crevice corrosion appears to have decreased.

6) A maximum 90 effective full power day operating period, prior to the next ECT inspection as proposed by the licensee, will provide adequate assurance that a large number of tubes will not simultaneously reach a point of incipient failure.

7) Remedial actions proposed by the licensee will continue to mitigate the effects of postulated accidents and retard the rate of corrosion.

The staff has determined that the following conditions should be required for continued operation:

1) Within 90 effecting full power days from the date of this order, a 2,000 psid primary-to-secondary hydrostatic test and 800 psid secondary-to-primary hydrostatic test shall be performed. Also during this plant outage, an eddy current examination shall be performed on tubes in each steam generator. The program shall require such examinations of about 1000 tubes in the central region of the hot leg, three (3) percent of all hot leg tubes outside this central region and 3% of the cold leg tubes. The Central region shall encompass all areas where deep crevice corrosion has previously been observed.

2) Primary coolant activity for Point Beach Nuclear Plant Unit 1 will be limited in accordance with the provisions of Sections 3.4.8 and 4.4.8 of the Standard Technical Specifications for Westinghouse Pressurized Water Reactors, Revision 2, July 1979, rather than Technical Specification 15.3.1.C appended to License DPR-24.

3) Close surveillance of primary to secondary leakage will be continued and the reactor will be shut down for tube plugging on detection and confirmation of any of the following conditions:

   a) Sudden primary to secondary leakage of 150 gpd (0.1 gpm) in either steam generator;

   b) Any primary to secondary leakage in excess of 250 gpd (0.17 gpm) in either steam generator; or

   c) An upward trend in primary to secondary leakage in excess of 15 gpd (0.01 gpm) per day, when measured primary to secondary leakage is above 150 gpd.

4. The reactor will be shut down, any leaking steam generator tubes plugged, and an eddy current examination performed if any of the following conditions are present:

   a) Confirmation of primary to secondary leakage in either steam generator in excess of 500 gpd (0.35 gpm); or,

   b) Any two identified leaking tubes in any 20 calendar day period.

   This eddy current program will be as described in item 1.

5. The NRC Staff will be provided with a summary of the results of the eddy current examination performed under items 1 and 4 above. This summary will include a photograph of the tubesheet of each steam generator which will verify the location of tubes which have been plugged.

6. The licensee will not resume operation after the eddy current examinations required to be performed in accordance with condition 1 or 4 until the Director Office of Nuclear Reactor Regulation has determined in writing that the results of such tests are acceptable.

These conditions are similar to those in the November 30, 1979 Order except that the approved operating period has been lengthened from 60 to 90 effective full power days, and no shutdown to perform hydrostatic tests are being required prior to the end of the 90 day period. These conditions differ from the licensees proposal in that the primary to secondary leak rate limits and requirements for ECT examination are more conservative.

On the basis of our review and evaluation, we conclude that continued safe operation of Point Beach Unit 1 may be permitted within the stated terms of the Confirmatory Order.

APPENDIX I

TABLE I

POINT BEACH #1 'A' S/G

Tube # R	C	% 1980	M.F. Dec. 1979	M.F. Oct. 1979			
12	19	80% 19-21" ATE	SAME R251 No change	SAME R651 N.C.			
7	22	29%/96% 12"ATE/17"ATE	SAME R251 N.C.	NDD/SAME 12"ATE/17"ATE R551			
18	22	66% 12-17" ATE	SAME R251 N.C.	NDD R551			
10	23	41% 20" ATE	NDD R251	R551			
7	24	83% 17"-20" ATE	MAYBE(?) NDD R251	NDD R551			
8	24	79% 17"-21" ATE	MAYBE(?) NDD R251	NDD R551			
25	45	69% 12"-20" ATE	Squirrels R351	NDD R851			
20	48	85% 21" ATE	SAME R251 N.C.	SAME R851			
9	49	90% 21" ATE	NDD R251				
17	50	85% 19" ATE	NDD R251				
19	50	97% 11" ATE	NDD R251				
20	50	97% 11" ATE	NDD R251				
12	59	87% 21" ATE	MAYBE(?) NDD R151	NDD R951			
12	61	83% 17" ATE	NDD R151				
14	63	83% 19" ATE	MAYBE(?) Squirrels R151				

POINT BEACH #1 'A' S/G

Tube # R	C	% 1980	M.F. Dec. 1979	M.F. Oct. 1979			
15	66	60% 18" ATE					
8	27	Squirrels 15-20" ATE	SAME R251 N.C.				
15	28	Squirrels 21" ATE	No Squirrels R251				
28	34	Squirrels 18-21" ATE	SAME R251 N.C.				
28	35	Squirrels 17" ATE	SAME R251 N.C.				
20	41	91% 19" ATE	NDD R351				
25	43	73% 17" ATE	SAME R351	Very S.V. N.D.D. R751			
11	46	Squirrels 12"-21" ATE	SAME R351				
29	52	Squirrels 14" ATE	SAME R151 N.C.				

APPENDIX I

TABLE II

B S/G INLET POINT BEACH #1

Tube # R	C	% 1980	M.F. Dec. 1979	M.F. Oct. 1979	S.F. Aug. 1979		
18	26	75% 18" ATE	SAME R151 No change	Changed R651	NDD R551		
13	26	73% 21" ATE	SAME R151 N.C.	SAME R651 N.C.	NDD R551		
13	33	71% 20" ATE	SAME R151 N.C.	Changed R651	NDD R552		
6	24	91% 11" ATE	SAME R151 N.C.	SAME R651 N.C.	NDD R552		
20	35	68% 21" ATE	SAME R151 N.C.	Changed R351	NDD R552		
8	37	89% 5" ATE	NDD R151				
19	37	58% 1/2" ATS	SAME 53% R151 N.C.	SAME R351 N.C.	NDD R552		
10	41	70% 21" ATE	SAME R251 N.C.	NDD R751	R651		
30	41	47% 21" ATE	SAME R251 N.C.	Some Change R751	NDD R651/R151		
30	42	48% 21" ATE	SAME R251 N.C.	Changed R751	NDD R151		
22	46	76% 15" ATE	SAME R251 N.C.	NDD R351			
24	48	84% 12" ATE	Changed R251	NDD R351	R652		
30	48	85% 21" ATE	SAME R251 N.C.	SAME R951 N.C.	NDD R652		
25	49	84% 5" ATE	Changed R251	NDD R351	R652		
20	51	99%(?) 16" ATE	SAME R251 N.C.	NDD R351	R652		
23	54"	86% Full length	Squirrels some are new R251	SAME AS DEC. R351			

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Tube # R	C	% 1980	M.F. Dec. 1979	M.F. Oct. 1979	S.F. Aug. 1979		
23	57	56% 17" ATE	NDD R251				
21	58	83% 21" ATE	SAME R251				
14	59	75% 21" ATE	NDD R251				
21	63	62% 21" ATE	SAME R351	NDD R1051			
12	67	66% 21" ATE	NDD R351	R1051			
2	72	92% Top of Roll	SAME R351 N.C.	NDD R1051			
26	53	86% (New) 18" ATE					
30	43	Squirrels 21" ATE	SAME R251	SAME R751			
26	53	Squirrels Full T.S.	NDD R251				
25	55	Squirrels Full T.S.	NDD R251				
22	63	Squirrels 21" ATE	SAME R251	SAME R1051			
22	64	Squirrels 20" ATE	SAME R351	No Squirrels R1051			
25	55	74% (New) 15" ATE					