



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

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(info)

JAN 04 1980

MEMORANDUM FOR: D. G. Eisenhut, Acting Director
Division of Operating Reactors *266 P* *A-4*

FROM: V. S. Noonan, Chief
Engineering Branch
Division of Operating Reactors

THRU: L. C. Shao, Acting Assistant Director
for Engineering Programs
Division of Operating Reactors

SUBJECT: POINT BEACH UNIT 1 - INFORMATION RELATING TO OCTOBER 1979
STEAM GENERATOR INSPECTION - IMPACT ON SAFETY EVALUATION
DATED NOVEMBER 30, 1979

The Confirmatory Order issued by the Commission on November 30, 1979 for Point Beach Unit 1 imposed additional operating restrictions on the licensee to permit operation of Unit 1 for 60 effective full power days following the October 1979 refueling outage. The Safety Evaluation prepared by the staff in support of the Confirmatory Order reflected the staff's understanding that the extensive degradation observed during the August and October 1979 steam generator inspections involved general intergranular attack and cracking within the tubesheet crevices ("deep crevice corrosion"). Subsequent to the November 30, 1979 Confirmatory Order, however, the staff became aware of data in Licensee Event Report 79-017/01T-0, dated November 16, 1979, which indicated five tubes with eddy current (ECT) indications at or above the tubesheet. The Engineering Branch became aware of this information on or about December 7, 1979. This data had not been addressed in the November 30, 1979 SER nor had it been addressed by the staff during the November 28, 1979 briefing for the Commission.

This memorandum reviews the bases and chronology of events affecting our understanding of the condition of the steam generator tubes outside the tubesheet crevice region following the October 1979 inspection, the actions taken upon learning of the ECT indications outside the tubesheet crevices, and our conclusions.

Original Information Available to Staff

Prior to the Confirmatory Order of November 30, 1979, extensive communication between the licensee and staff took place regarding the results and significance of the steam generator inspections performed in August and October 1979. The bases and chronology of events affecting our understanding of the condition of the steam generator tubes outside of the tubesheet crevices is summarized below:

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XA

10/29/79 - Conference Call with Licensee

In response to a direct question, the licensee indicated no indications above the tubesheet. We routinely ask this question since once in a while a few defective tubes due to wastage are still found in plants that have operated with coordinated phosphate secondary chemistry and later converted to AVT.

11/5/79 - Meeting with Licensee

In response to direct questioning, the licensee described the observed tube degradation as limited to the tubesheet crevice region. This is confirmed by the meeting minutes prepared by the staff (Attachment 1) and also in the meeting minutes prepared by Mr. L. L. Smith of the Public Service Commission of Wisconsin (Attachment 2).

11/20/79 - Meeting with Licensee (attended by Wisconsin Environmental Decade)

Licensee's viewgraph no. 1 indicated no tubes plugged because of defects due to thinning or cracking outside the tubesheet crevice.

Viewgraph 7 showed distribution of defects within the tubesheet crevice. No mention was made of any defects above the tubesheet. The staff made it very clear during the discussion of the distribution of defects that its primary concern was the proximity of the defects to the top of the tubesheet. In this light it is difficult to understand why the information regarding the five defects was not volunteered by the licensee.

11/23/79 - Licensee Submittal

All materials passed out and discussed in the 11/20/79 meeting were documented. Again, no mention was made of tube degradation outside the tubesheet crevice region.

Thus, the staff worked on the assumption that the recently observed tube degradation was confined exclusively to within the tubesheet crevices. This assumption was reflected in the staff presentation at the November 28, 1979 Commission briefing and in the November 30, 1979 SER.

Staff's Discovery of ECT Data Outside the Tubesheet Crevices

Subsequent to the issuance of the November 30, 1979 Confirmatory Order, and supporting SER, cognizant staff individuals learned of data contained in Licensee Event Report 07-017/01T-0, dated November 16, 1979 (Attachment 3) which was not consistent with the information presented to the staff in our meetings with the licensee. A listing of the plugged tubes, defect sizes, and defect locations was included in the LER, and indicated one tube with a defect 1/2" above the top

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of the tubesheet and four tubes with defects at the top of the tubesheet. Although copies of this LER were received by NRC on November 19, 1979, they were not logged into the NRC Docket Room TERA system until November 30, 1979, and they did not come into the possession of cognizant staff individuals within the Engineering Branch, DOR until on or about December 7, 1979. The staff had no knowledge of these five defects at the time of November 28, 1979 Commission briefing or at the time the November 30, 1979 SER was issued.

Not only did the staff have a passive lack of knowledge regarding these defects, the staff had understood based on direct questioning during telephone conference and meetings with the licensee and the licensee's November 23, 1979 submittal that tube defects above the tubesheet did not exist. In short, it was the staff's belief that it had in hand all the relevant information regarding the condition of the Point Beach Unit 1 steam generators, and further that all relevant information had been fully discussed at the Commission briefing and in the SER supporting the Confirmatory Order.

Subsequent Actions by Staff

In a telephone conference call on December 13, 1979, the licensee was requested to check the accuracy of the LER data and to provide an explanation of the five defects outside the tubesheet crevice region. Also on December 13, we discussed the LER data with Mr. Peter Anderson of Wisconsin's Environmental Decade. We had previously mailed Mr. Anderson a copy of the LER on or about December 7, 1979.

In response to our request, the licensee submitted by letter dated December 21, 1979 (Attachment 4) additional details regarding the five defects at and above the top of the tubesheet and their evaluation of their significance. Based upon the staff review of this submittal and a subsequent conference call with the licensee in the evening of December 21, the staff reached the conclusion that although these defects would have been addressed in the staff's evaluation (had their existence been known), the staff's conclusions in the November 30, 1979 Safety Evaluation remain valid. As a result of this finding, the staff also concluded that Point Beach Unit 1 could be permitted to be returned to power at the conclusion of the then current steam generator repair outage within the restrictions of the November 30, 1979 Confirmatory Order. It should be noted that Point Beach Unit 1 had been previously shutdown on December 11, 1979 following detection of steam generator leakage of about 250 to 260 gpd in accordance with the aforesaid Confirmatory Order.

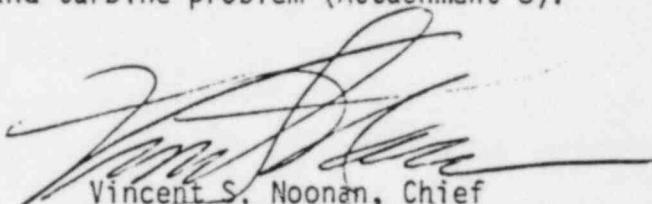
With regards to an explanation as to why the existence of these defects was not brought out during our meetings, the licensee states that viewgraph 1 presented during the November 20 meeting was in error in including these defects in the "crevice corrosion" column. The licensee states that because eddy current testing does not reliably detect the presence or absence of intergranular attack (in the absence of cracks), no attempt was made to relate the eddy current inspection results contained in the LER with the presence of intergranular attack. Rather their conclusion with respect to the absence of intergranular attack above the tubesheet is based upon the laboratory examinations of the removed tube samples. Nonetheless, the licensee has provided no explanation as to why no mention was made during the meetings regarding eddy current

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indications outside the crevice region when questions during the meeting clearly indicated our concern regarding the proximity of defects to the top of the tubesheet.

Attachment 5 summarizes the chronology of events leading to the staff's becoming aware of defects outside the tubesheet crevice region, and to the staff's review of these defects.

Our Safety Evaluation Supplement addressing the ECT indications located outside the tubesheet crevice region is attached to this memorandum (Attachment 6). Also attached are our evaluations of the December 11, 1979 steam generator inspection results (Attachment 7) and turbine problem (Attachment 8).



Vincent S. Noonan, Chief
Engineering Branch
Division of Operating Reactors

Contact: B. D. Liaw X27354
E. L. Murphy X27041

Attachments: As stated

cc: F. R. Denton
E. G. Case
D. G. Eisenhut
F. Tedesco
W. Gammill
A. Schwencer
C. M. Trammell
E. D. Liaw
J. Strosnider
E. L. Murphy
F. M. Almeter



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

NOV 16 1979

Docket No. 50-266

LICENSEE: Wisconsin Electric Power Company

FACILITY: Point Beach Nuclear Plant, Unit No. 1

SUMMARY OF MEETING HELD ON NOVEMBER 5, 1979 WITH WISCONSIN ELECTRIC POWER COMPANY AND WESTINGHOUSE ELECTRIC CORPORATION TO DISCUSS RECENT INSPECTION OF STEAM GENERATOR TUBES AT POINT BEACH UNIT NO. 1

On November 5, 1979, the NRC staff met with representatives of Wisconsin Electric Power Company and Westinghouse Electric Corporation (W) to discuss the results of a recent steam generator (SG) tube inspection at Point Beach Unit No. 1. In addition, W presented the results of an examination of 3 SG tubes removed from the "A" SG. A list of attendees is contained in Attachment 1. Highlights of the meeting are summarized below.

The licensee presented a brief history of steam generator operating experience for Unit 1:

- 1971 - Initial operation on phosphate chemistry control. Some tube cracking/wastage experienced.
- 1974 - Switched chemistry control to AVT.
- 1977 - First deep crevice cracking experienced. Three leaking tubes plus other ECT indications. Eight tubes plugged.
- September 1978 - More deep crevice cracking. Ten tubes plugged.
- March 1979 - More deep crevice cracking. Nine tubes plugged.
- August 1979 - Plant shutdown due to tube leaks. 100% ECT. Forty-five tubes plugged in B SG; 52 in A SG, all due to deep crevice cracking. ECT technique was at single frequency with some multi-frequency samples.

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PDR/LPDR

August 29, 1979 - 1.5 gpm leak developed. Two tubes plugged which were inadvertently not plugged following earlier 100% inspection.

October 5, 1979 - Refueling shutdown plus 100% ECT testing. Three tubes removed for metallurgical examination. Seventy-five tubes plugged in A SG (3 due to tube removal); 65 tubes plugged in B SG. ECT technique used multi-frequency testing.

Total number of SG tubes plugged in Unit 1:

A - 326
B - 316 or about 10%

The licensee stated that the Wisconsin PSC has ordered a public hearing to take place November 26 to discuss the economic impact of tube degradation at Point Beach (the Wisconsin PSC attended this meeting).

Three tubes were removed for detailed metallurgical examination - two from the "kidney" area (a good tube and a bad tube), and one from the periphery. All tubes exhibited intergranular caustic stress corrosion cracking in the "deep crevice" area. The SG tubes at Point Beach were expanded only 2-1/2" at the bottom of the tube sheet, leaving a crevice between the tube and tube sheet over the balance of the tube sheet thickness. About 35 plants world-wide have this partial expansion design. Other plants (San Onofre, H. B. Robinson, Ginna) have experienced deep crevice cracking, but not to the degree seen at Point Beach. Metallurgical results to date:

Tube 1 (R1EC45). "A" SG kidney region (bad tube in bad region). Indications of intergranular attack over the full length of crevice zone. Twenty mils general attack. Deepest crack 40 mils. (All tubes are 50 mils thick). A pH test of tube surface indicated alkalinity. Na, P, K, Cl, Si, S, Ca detected. Reason for attack: Caustic stress corrosion cracking.

Tube 2 (R2OC73). Periphery region - outside kidney zone (good tube, good area). Results: similar to tube 1 but attack less extensive. Five mils general attack, 15 mils deepest crack.

Tube 3 (R22C37). Good tube from kidney area (good tube, bad area). Similar results. 5 mils general attack, deepest crack 25 mils.

The worst tube (No. 1) showed 89% tube degradation by ECT. However, tubes 2 and 3 showed no ECT indications.

Esselman presented a preliminary structural evaluation of the degraded tubes. See Attachment 2 for viewgraphs presented.

Tube degradation appears to be accelerating. Although a different ECT technique was used in the October 1979 inspection (multi-frequency testing), the licensee stated that the same results were achieved with single frequency testing at 400 KHz as the multi-frequency response at 400 KHz. Therefore, the additional

number of tubes plugged this time (which is beyond previous experience) does not appear to be attributable to the new inspection method. There are indications that defects have grown in size. The licensee did a comparison of 75 tubes between August and October. Two-thirds of these have new indications or indicate some growth over this relatively short operating period. Penetration depth was about the same, but the defect size had increased. Therefore, there is strong evidence that degradation is accelerating, although the number of tubes plugged this time does include some which should have been plugged earlier as a precautionary measure.

Tube degradation is restricted entirely to the deep crevice zone.

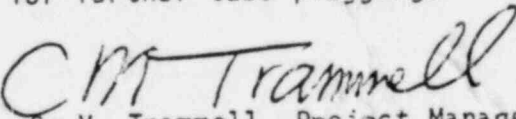
The licensee stated that the deep crevice cracking problem and present SG tube conditions do not present a safety concern with respect to continued operations, but that economic concerns remain, since plant availability is being affected due to shutdowns to plug and inspect tubes. The licensee is pursuing solutions up to and including SG replacement.

Before resuming power operations, the licensee will flush both SGs with demineralized water in an attempt to remove chemicals believed to be trapped in the deep crevice zone. Thermal cycling between 250°F and 200°F is planned to boil out the crevice zone, and draw water back into the crevice (4-5 days of flushing).

The SGs will be pressure tested at 800 psig (0 psig primary pressure) to inspect for leakage prior to reinstallation of the manway covers. A primary leak test will be conducted at 2335 psig (250 psig secondary side pressure) prior to resuming operation.

The licensee has submitted a Technical Specification change request which would lower the normal primary pressure to 2000 psia to reduce SG tube stress. The licensee is studying reductions in primary average temperature (or reduced power) since no cracking has been observed in the cold leg side of the SGs.

The licensee is conducting a revised ECCS analysis assuming 18% of SG tubes plugged in anticipation of the need for further tube plugging.


C. M. Trammell, Project Manager
Operating Reactors Branch #1
Division of Operating Reactors

Attachments

1. List of Attendees
2. Viewgraphs

LIST OF ATTENDEES

POINT BEACH STEAM GENERATOR MEETING

NOVEMBER 5, 1979

NRC Staff

E. Murphy
J. Smith
C. Trammell
B. D. Liaw
E. Jordan

Westinghouse

R. Kelly
H. Von Hollen
C. Hirst
F. Pement
E. Morgan
D. Malinowski
T. Esselman
R. Begley
W. White

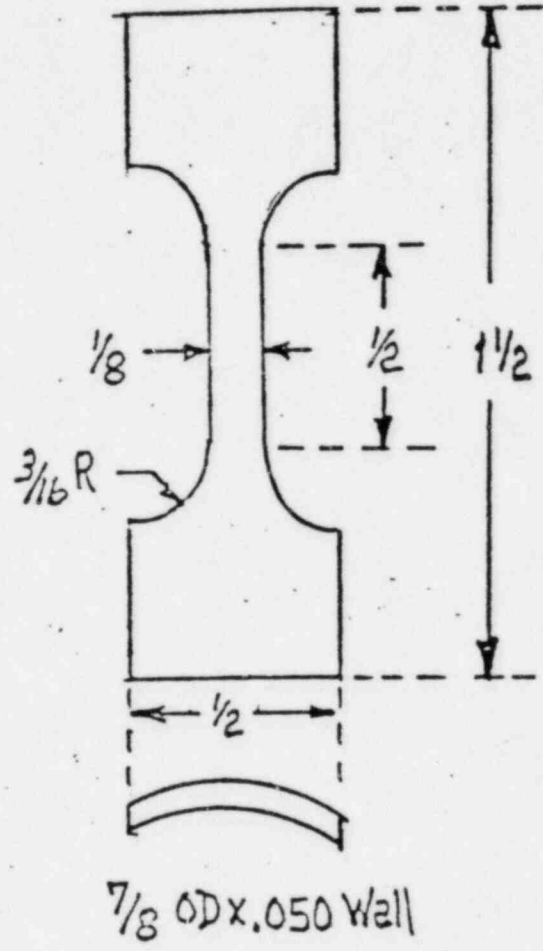
Wisconsin Electric Power

G. Frieling
C. W. Fay
D. Porter

Otrer J. Silberg, Shaw, Pittman, Potts & Trowbridge

L. Smith, Wisconsin Public Service Commission

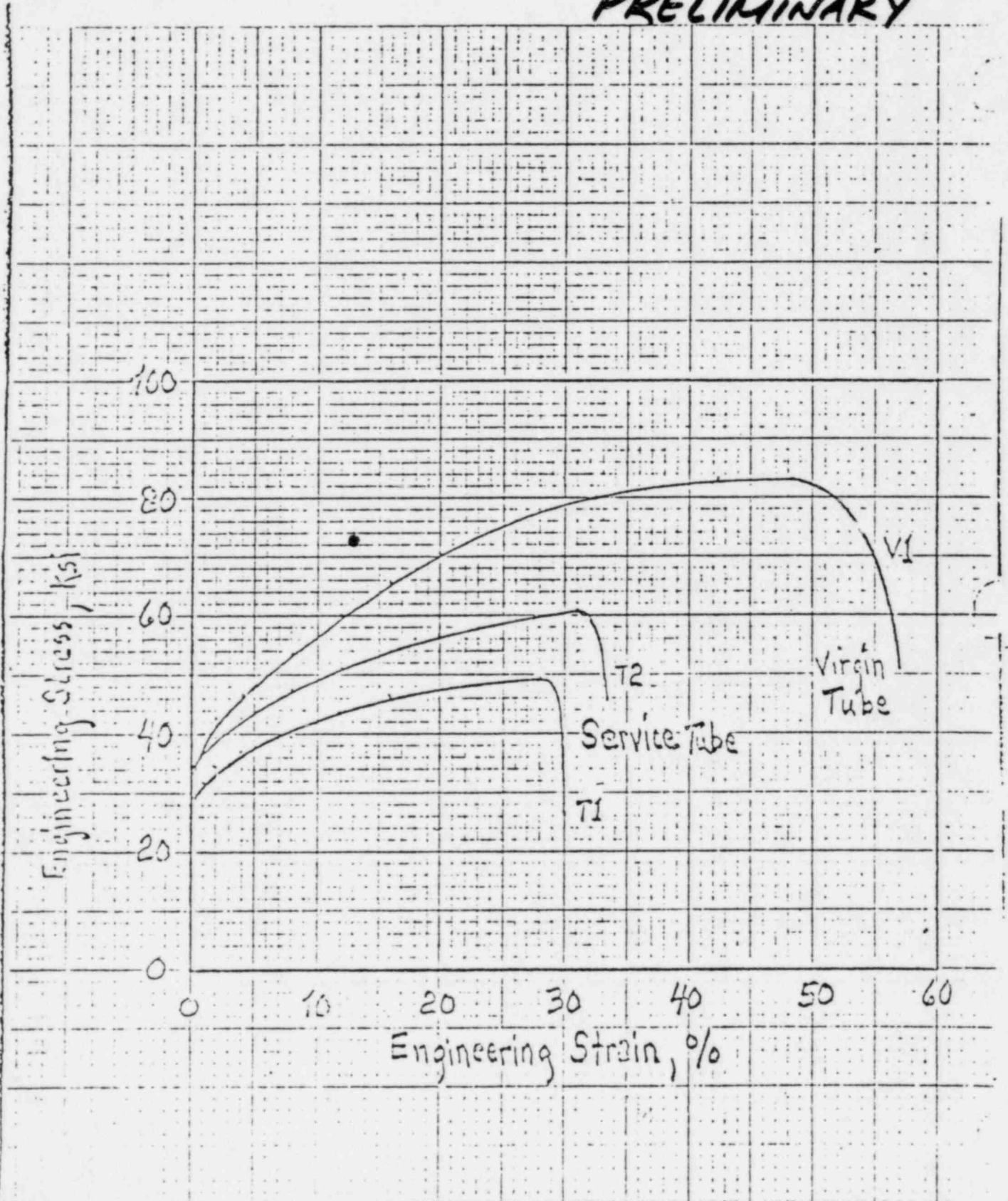
PRELIMINARY



TENSILE SPECIMEN

11/5/79

PRELIMINARY



11/5/79

CONDITIONS EVALUATED

PRELIMINARY

- o UNIFORM WASTAGE WITHIN OR OUTSIDE THE TUBESHEET

- o CRACKING OF THINNED TUBE WITHIN OR OUTSIDE THE TUBESHEET

- o EXAMINATIONS PERFORMED DO NOT INDICATE THAT WASTAGE OR CRACKING EXTENDS ABOVE THE TUBESHEET - THIS CONDITION IS EVALUATED FOR COMPLETE COVERAGE OF POSSIBLE CONDITIONS

11/5/79

LIMITING CONDITIONS FOR UNIFORM WASTAGE
OUTSIDE THE TUBESHEET

PRELIMINARY

<u>CONDITION</u>	<u>REQUIRED THICKNESS</u>
<u>SAFETY REQUIREMENTS</u>	
• DOUBLE-ENDED FAILURE DURING SLB	.005 INCH
• TUBE RUPTURE DURING NORMAL OPERATION	.008 INCH
• TUBE RUPTURE DURING SLB	.013 INCH
• NO COLLAPSE DURING LOCA	.020 INCH (6% OVALITY)

HENCE, LIMITING CONDITIONS ARE $t = 0.020$ OUTSIDE THE TUBESHEET

11/5/79

LIMITING CONDITIONS FOR UNIFORM WASTAGE
WITHIN THE TUBESHEET

PRELIMINARY

<u>CONDITION</u>	<u>REQUIRED THICKNESS</u>
• DOUBLE-ENDED FAILURE DURING SLB	.005 INCH
• TUBE RUPTURE DURING NORMAL OPERATION	*
• TUBE RUPTURE DURING SLB	*

*DUCTILITY OF REMAINING MATERIAL MUST ALLOW THE TUBE TO EXPAND TO CONTACT TUBESHEET

11/5/79

PRELIMINARY

RESULTS OF LEAD PLUG TESTS
ON PULLED TUBE

<u>TEST NUMBER</u>	<u>DIAMETRAL INCREASE</u>
5A6	≈ .045 INCH
5A7	.045 INCH
5B2	.030 INCH

NOMINAL TUBE-TO-TUBESHEET HOLE DIAMETRAL
CLEARANCE = .016 INCH

EXPECTED TUBE-TO-TUBESHEET HOLE DIAMETRAL
CLEARANCE ZERO

THEREFORE, TUBE WILL BACK-UP AGAINST THE TUBESHEET

11/6/79

SUMMARY FOR THE UNIFORM
WASTAGE CONDITION

PRELIMINARY

REQUIREMENTS

- MINIMUM TUBE THICKNESS OUTSIDE TUBESHEET MUST BE GREATER THAN .020 INCH (40% OF WALL)
- EQUIVALENT TUBE THICKNESS INSIDE TUBESHEET MUST BE GREATER THAN .005 INCH (10% OF WALL)
- THE DUCTILITY OF THE TUBE INSIDE THE TUBESHEET MUST ALLOW EXPANSION TO THE TUBESHEET WALL

CONDITION OF THE TUBES EXAMINED AND TESTS PERFORMED INDICATE THAT THESE REQUIREMENTS ARE MET

11/5/79

PRELIMINARY

TUBE INTEGRITY VERIFICATION - CRACKING WITHIN TUBESHEET

- o LEAK RATE FOR CRACKING WITHIN THE TUBESHEET IS GOVERNED BY ANNULAR GAP

- o CIRCUMFERENTIAL CRACK
 - o LIMITING CASE - FULL CIRCUMFERENTIAL CRACK

 - o LEAKAGE - 7 GPM (LOWER BOUND ESTIMATE) WILL ALLOW DETECTION DURING NORMAL OPERATION

 - o EITHER 1) LEAKAGE WILL SHOW THAT THE BREAK HAS OCCURRED LEADING TO PLANT SHUTDOWN OR 2) BREAK WILL BE DEEP ENOUGH IN THE TUBESHEET THAT IT CANNOT CAUSE PROBLEMS

 - o TUBE WILL NOT PULL OUT DURING SLB BECAUSE OF TOTAL BUNDLE RESTRAINT

- o AXIAL CRACK
 - o RESULTS OF LEAD PLUG TESTS INDICATE TUBE HAS SUFFICIENT DUCTILITY TO BACK-UP AGAINST THE TUBESHEET

11/5/79

TUBE INTEGRITY VERIFICATION -
CRACKING ABOVE TUBESHEET

PRELIMINARY

- o FOR UNSUPPORTED TUBES, GOVERNING CRACK ORIENTATION IS AXIAL

- o FOR AXIAL THRU-WALL CRACKS SUPERIMPOSED ON THINNED TUBES, TEST RESULTS INDICATE THE LEAK-BEFORE-BREAK CRITERION IS VALID

- o THEREFORE, LEAK RATES WILL REQUIRE PLANT SHUTDOWN PRIOR TO CRACK REACHING CRITICAL LENGTH LEADING TO TUBE BURST