Report on
Inspection of Leaks and Cracks in the
(A) Steam Generator at H. B. Robinson II

Report No. DC 89 June 23, 1971

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Division of Compliance
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by: Dr. Stanley Weiss
Materials Department
University of Wisconsin-Milwaukee

through: Parameter, Inc.
Consulting Engineers
Elm Grove, Wisconsin

NOTICE

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I. Discussions and Observations Prior to Inspection

A visit was made to the H. B. Robinson II site by Mr. Donald Kirkpatrick of Region II and the writer on June 18, 1971 to review and inspect the reported leaks and cracks occurring in the A steam generator.

Prior to the inspection, discussions were held with Messrs. G. P. Beatty and R. Bessac of Carolina Power and Light. We were informed that we would be allowed into the steam generator for only a limited time (approximately 12-15 minutes) because of existing conditions and their safety requirements. The following information was presented to us during these inital discussions:

(1) The inconel cladding overlay was bonded to the base plate by the explosion bonding process.

(2) Continuous leaks in the form of droplets were observed in the A generator in two locations, approximately in the region of the 40th and 44 tubes, as counted from the north direction towards the south, in the row of tubes adjacent to the divider plate in the cold leg of the generator.

The C steam generator was reported to exhibit dampness but no droplet formation, whereas, the B generator was reported as dry with no apparent leaks.

(3) Ultrasonic testing performed by Westinghouse indicated that separation had occurred at the bond interface between the cladding and the 22 inch thick tube sheet material between the rows of tubes immediately adjacent to the divider plate

in the hot and cold legs of the A generator. The bond separation is believed to be extensive so as to encompass at least 80 tubes along these first rows. Ultrasonic testing further indicates that bond separation between the cladding and base plate ceases approximately at the mid-point of each of the first rows of tubes adjacent to the divider plate.

(4) Cracks were reported in the fillet welds extending through the cladding between the tubes containing the cracked fillets in the cold leg of the A generator. Approximately 20 to 30 tube fillets were reported as visually cracked.

(5) It was reported that the C generator was dry boiled whereas the A and B generators were not.

(6) Preliminary reports indicate that Point Beach may be experiencing a similar problem although the intensity of the problem is not yet fully known.

II. Inspection of the Steam Generator

Mr. Kirkpatrick and the writer were "suited-up" and proceeded to enter individually and inspect the cold leg of the A steam generator. The inspection was performed visually using a low power magnifying lens. Mr. Kirkpatrick attempted to photograph the conditions we observed with a 35 mm. camera using a close-up lens. The following conditions were observed during this inspection: (See Figs. 1,2 & 3)

(1) Severe cracks were present in the fillet welds of approximately 30 tubes. The highest intensity of fillet cracking was apparent in the region included in and surrounding the 35th

to 45th tubes (as counted from the north towards the south). These cracks were opened approximately . 030 to . 050 inches and were approximately semi-circular on the side of the fillet welds facing the flow divider plate.

(2) Cracking in the 1/4 inch thick cladding was extensive in the region described above. These cracks were linear in the north-south direction (parallel to the divider plate) and were located approximately in line with the center of the first row of tubes. These cracks were tighter than those observed in the fillets and appeared to range in the vicinity of . 005 to . 010 inches wide and extended the entire length of the cladding between the cracked tubes.

(3) Rusting and corrosion products were observed in the immediate vicinity of the fillet weld cracks progressing into the cladding cracks. This evidence shows that galvanic action and electrochemical corrosion has already occurred between the tube sheet material and the austenitic materials involved, through the borated solution which acted as an electrolyte.

(4) The writer visually observed a contoured region of the cladding, adjacent to the divider plate and in the vicinity of the 40th to 50th tubes that showed definite signs of having been separated from the tube sheet.

(5) Linear crack indications in the fillet weld joining the flow divider plate to the tube sheet cladding were observed. These

cracks appeared to be very tight, were located in the toe of the weld adjacent to the cladding and, were aligned in the direction of the weld.

(6) The fillets of the tube welds appeared to be undersized in various locations. A throat size of 1.5 T is required for this joint where T is nominally .050 inches, the tube wall thickness.

(7) Inspection of the fillet weld joining the opposite end of the flow divider plate to the steam generator wall indicated no apparent defects.

(8) The divider plate is located significantly closer to the first row of tubes in the cold leg of the A generator than to the first row of tubes in the hot leg of this generator.

III. Post Inspection, Discussions, and Observations

In the late afternoon a meeting was held between Mr. Kirkpatrick, myself and personnel from CP and L, Westinghouse and Ebasco as indicated by the attached meeting list. The personnel shown on this list had participated during the morning and early afternoon of June 18 in a closed meeting to review the cause of the problem and proposed repair procedures. Pertinent facts brought out by our later discussions with them were as follows:

(1) During the initial manufacturing of these steam generators all processing was completed with the exception of the fillet weld joining the flow divider plate to the tube sheet. Prior to completing this joint, the unit was stress relieved to code requirement. The final weld joining the divider plate to the

tube sheet was then performed without any subsequent stress relief.

(2) Westinghouse has not arrived at final conclusions with regards to the cause of the overall problem. They will attempt to perform a failure analysis based on samples removed during the intended repair. At this time they believe the problem is primarily related to deficiencies in the bond strength associated with the explosive cladding process (commercial process generally used is "Detaclad"). They believe that stress relief, operating stress conditions, and stress vibration considerations were not primary factors in causing this failure.

(3) Westinghouse has eliminated the explosion cladding process based on numerous difficulties which they have experienced with obtaining consistent bond strengths. They have reverted back to conventional arc fusion cladding techniques.

(4) Westinghouse reported that the worst stress condition which they believe the A generator had been subjected to was a one-time hydrotest subjecting it to 3106 pounds on the chamber side. They believe this resulted in a 40,000 psi stress in the divider plate and consequently a 20,000 psi stress on the cladding. Although they have experienced widely varying bond strengths in the explosion clad tube sheet (reportedly ranging from 30,000 to 50,000 psi), they are not able at this time to determine

whether or not the hydrotest performed initiated the failure.

(5) Westinghouse stated that no serious problems are anticipated related to boric acid attack resulting from the leakage which had occurred. They furthermore indicated that stress corrosion and hydrogen cracking problems will not arise.

(6) When asked about the adequacy of their stress analysis of this vessel Westinghouse replied that they are currently undertaking a thorough re-study of this subject.

(7) When questioned with regards to the anticipated life of a repaired vessel, Westinghouse replied that they believe the repair will eliminate the defective areas and perform in a service manner so that reoccurrence of the problem is precluded. It was admitted, however, that a more complete answer to this question would be forthcoming when the failure analysis and factual reasons for the cause of the problem have been determined.

(8) Westinghouse personnel stated they do not have sufficient information at this time to determine the generic nature of the problem; however, it is their belief at this time that it is not widespread. No data or information was presented at this time to substantiate this opinion.

(9) Ultrasonic inspection by Westinghouse of the hot leg of the A generator has confirmed that separation has occurred between the cladding and tube sheet. Although there is no visual confirmation of cracking in this location, it is suspected that a cracking condition does exist.

(10) A repair procedure proposed by Westinghouse was described to us. The following repair considerations were discussed:

(a) A minimum amount of material, including the fillet welds, be removed from the divider plate.

(b) Defectively bonded cladding will be removed by arc and grinding methods.

(c) Attempts will be made to utilize the removed material as the basis for a failure analysis study to implement a more thorough understanding of the cause of the basic problem.

(d) The tube sheet will be re-clad using shielded metal arc (coated electrodes) techniques and the cracked tubes will be ground back and permanently blocked off by seal-welding.

(e) The repaired region will be locally stress relieved at 1000°F prior to accomplishing the final weld between the flow divider plate and the tube sheet.

(f) The final divider plate to tube sheet weld would then be performed without any subsequent stress relieving.

(g) Inspection procedures planned were to perform penetrant testing to the code requirements. When asked if that was the only non-destructive testing to be performed, it was stated that supplementary ultrasonic testing will be used

at their discretion to assure adequacy of the repair.

Stanley Weiss

Dr. Stanley Weiss
Wisconsin P. E. 11316

CP&L STEAM GENERATOR

REPAIR MEETING

June 18, 1971

N. B. Bessac	CP&L
W. W. Lowe	CP&L
B. H. Webster	CP&L
C. M. Clark	CP&L
G. P. Beatty, Jr.	CP&L
W. J. Fretague	Ebasco Services, Inc.
R. E. Cantrell	Westinghouse, Tampa
F. K. Shealy	Westinghouse, Atlanta
A. Lohmeier	Westinghouse, Tampa
R. F. Lehr	Westinghouse, PWRSD
W. Beers	Westinghouse, Tampa
S. Wismer	Westinghouse, Tampa
C. J. "Clete" Weber	Westinghouse, Tampa
W. M. Byerley	Westinghouse, Tampa
C. V. Burleson	Westinghouse, Raleigh
F. X. Brown	Westinghouse, Tampa

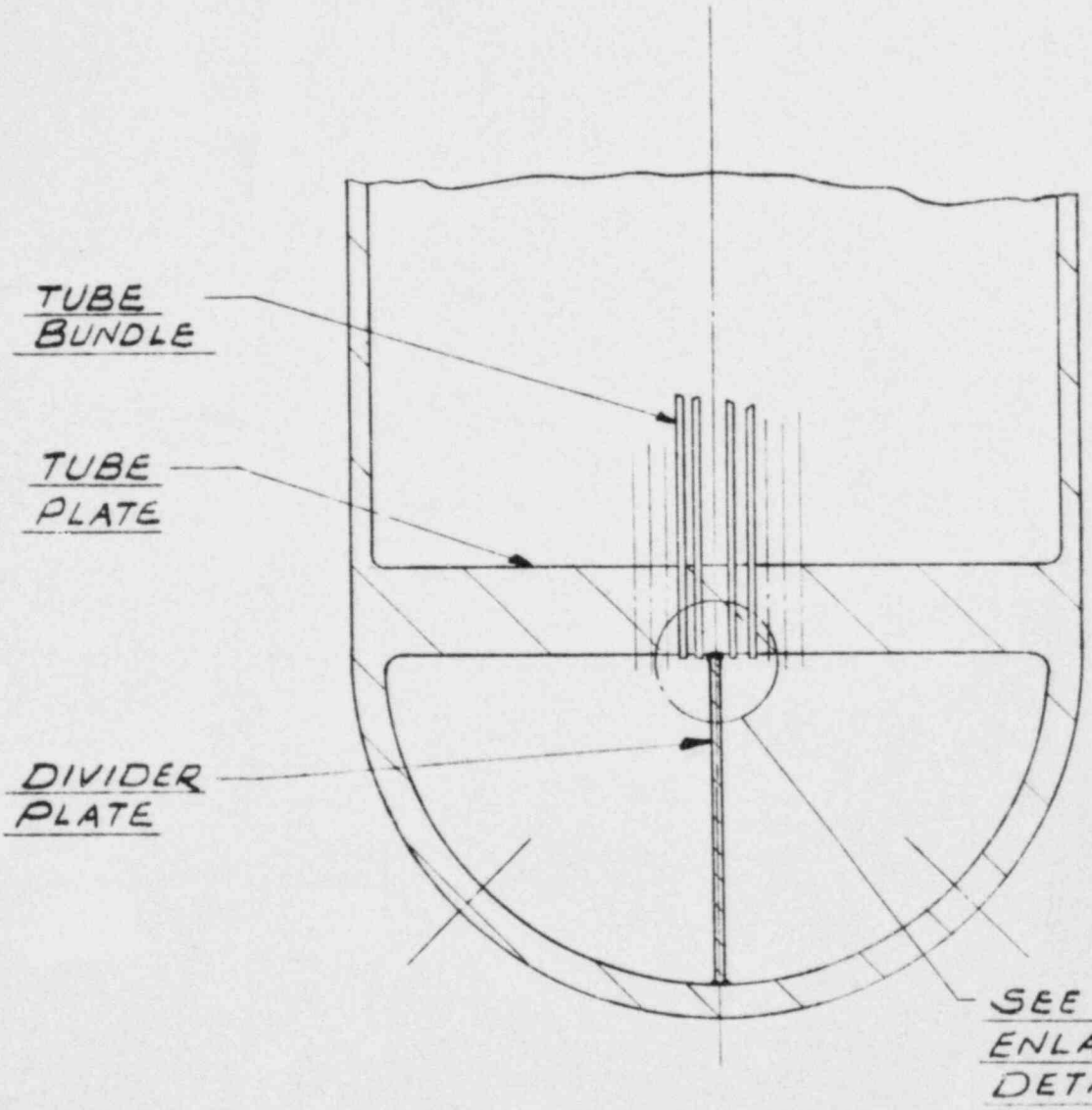

FIG. 1
"A" STEAM GENERATOR

REPORT DC-89
CONT. - AT(11-1)-1658, TASK A
LEAKS & CRACKS IN
"A" STEAM GENERATOR
H.B. ROBINSON II
BY: D.S. 6/25/71

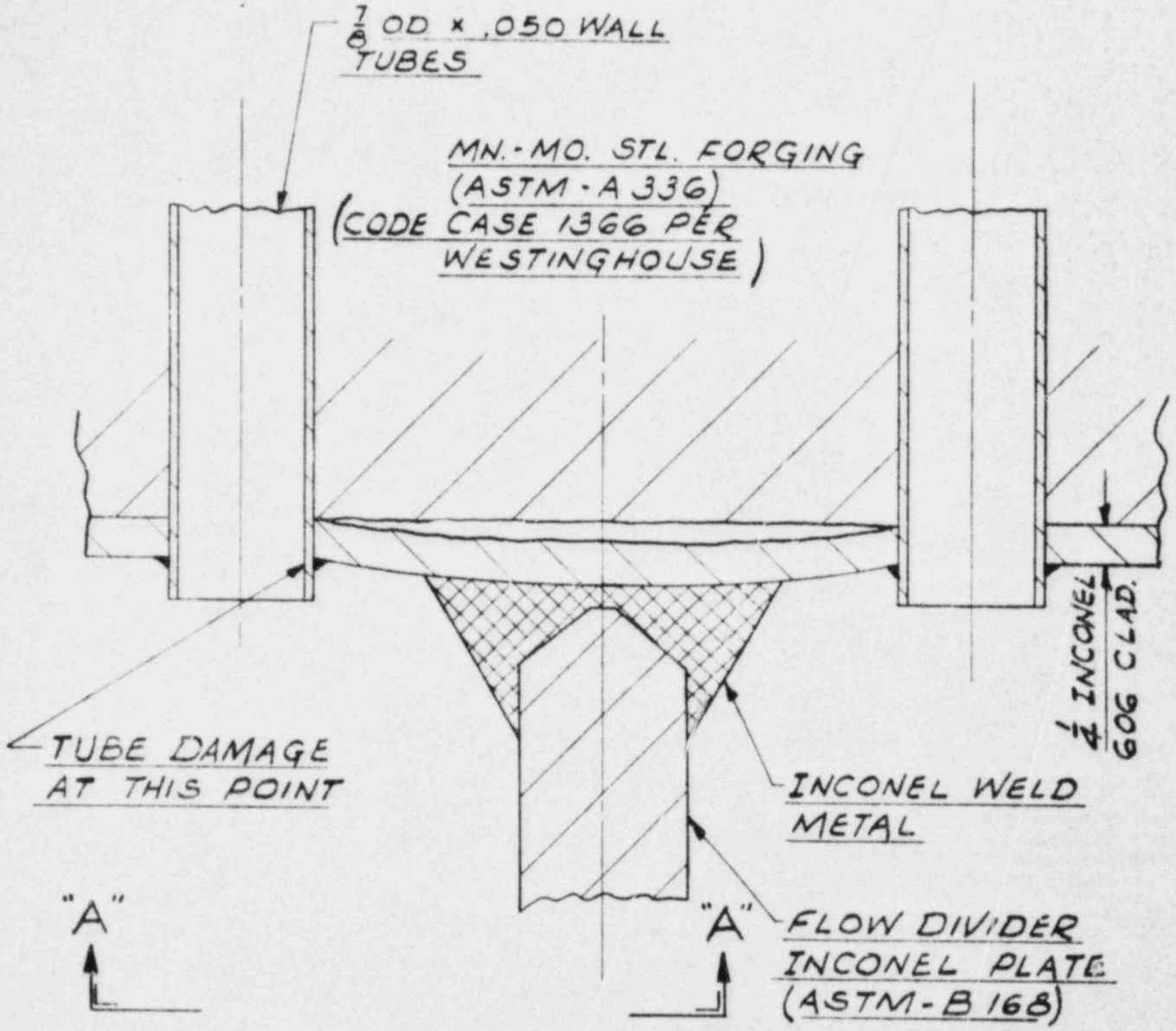

FIG. 2
ENLARGED VIEW OF CLAD SEPARATION

REPORT DC-89
CONT. AT(11-1)-1658 TASK A
LEAKS & CRACKS IN
"A" STEAM GENERATOR
H. B. ROBINSON II
BY: D.S. 6/25/71

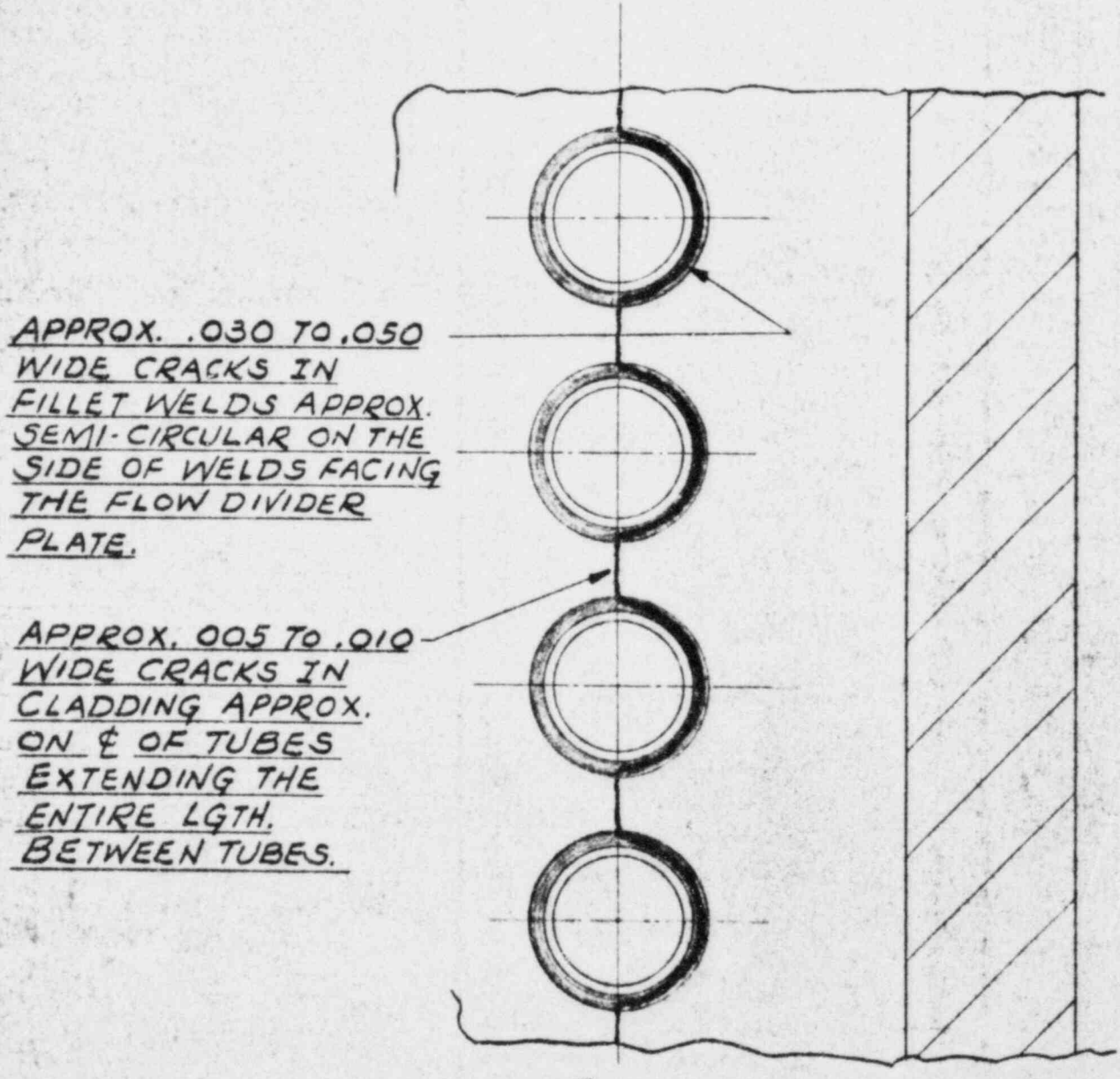

FIG. 3
VIEW "A-A"
FROM FIG. 2

REPORT DC-89
CONT-AT(11-1)-1658 TASK A
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