



GPU Nuclear Corporation
Post Office Box 480
Route 441 South
Middletown, Pennsylvania 17057-0191
717 944-7621
TELEX 84-2386
Writer's Direct Dial Number:

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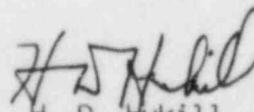
Office of Nuclear Reactor Regulation
Attn: J. F. Stolz, Chief
Operating Reactors Branch No. 4
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Sir:

Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
TMI-1 Steam Generator Long Term Corrosion Test Status

Attached for your information is the TMI-1 Long Term Corrosion Test report for the first quarter of 1984.

Sincerely,


H. D. Hukill
V.P. TMI-1

cc: H. Silver

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Long Term Corrosion Test Status
Report for the First Quarter 1984 (MTI-1458)

HIGHLIGHTS

Operation of all test loops continued in accordance with our previously established schedule. The tests are scheduled to be completed in mid-May, 1984.

Four C-rings were removed for metallographic evaluation. Three showed minor surface intergranular attack typical of as-received Inconel 600 tubes. One C-ring showed an IGA-island typical of isolated areas of IGA previously seen during failure analysis of as-removed TMI-1 OTSG tubes.

DISCUSSION

Operations

All loops were started in the next-to-last operating cycle (Operating cycle 5 for loops 1 & 2, cycle 3 for loops 3 & 4) on December 19, 1983. They completed the operating cycle as scheduled on February 23, 1984.

No unanticipated shutdowns occurred during the period. Loop 3 was shut down from January 27 to 30 for removal of a sample to check for surface sulfur.

The tests were restarted for the final operating cycle on March 12, 1984. The loop testing is scheduled to be completed on May 17, 1984.

Specimen Evaluations

All full tube sections (2 each in loops 1, 2 and 4, 1 in loop 3) were eddy current examined at the end of the operating cycle. No changes in previous eddy current patterns were noted.

All C-rings were visually examined (12 each in loops 1 & 2, 10 in loop 3) at the end of the cycle. No deviations from previous results were noted.

Four C-rings were removed and metallographically examined. Three of the rings exhibited slight intergranular attack 1-2 mils deep on the inside surface. This type of condition is common to the TMI-1 and other Inconel 600 steam generator tubes and is the result of pickling during fabrication.

One C-ring (1B4) exhibited an "island" of intergranular attack extending approximately 30% through the wall. This C-ring was made from a TMI-1 tube. It is our judgement that the IGA was present when the test program began and is not a result of long term corrosion testing. A detailed discussion of C-ring 1B4 condition is presented in Appendix A.

Sulfur Analysis of C-Ring Surfaces

A C-ring which had been subjected to the peroxide cleaning, hot functional testing and 2-1/2 operating cycles was analyzed for sulfur on the surface. The analysis method was x-ray photoelectron spectroscopy (XPS).

No sulfur was detected on the C-ring surface.

Appendix A - Evaluation of C-Ring 1B4

DESCRIPTION

C-Ring 1B4 was removed from Test Loop 1 (thiosulfate) at the end of operating cycle 5. A metallographic mount of the upper edge of the ring showed an area of intergranular attack approximately 30% through wall (11 mils) deep and 25 mils wide (Figure 1).

OPERATING HISTORY

C-Ring 1B4 was inserted in Loop 1 (thiosulfate) after the first operating cycle and was removed after the fifth cycle. Thus, it received 4 operating cycles of 66 days each, or 164 days (approx. 6336 hrs.).

The sulfur contaminant in Loop 1 is 0.100 ppm (nominal) of thiosulfate.

MATERIAL HISTORY

C-Ring 1B4 was removed from tube A-24-94 at approximately the 29 inch elevation below the upper tube sheet face. Tube A24-94 was removed from A-OTSG during the third tube pull effort in the spring of 1982. The tube was removed to characterize multiple eddy current indications.

The following eddy current indications were detected and characterized as noted in B&W's failure analysis (Ref. 1):

<u>Elevation</u>	<u>(1) Eddy Current Results</u>		<u>Results of Metallography</u>	
	<u>% Thru Wall</u> in field	in lab	<u>% T.W.</u>	<u>Comments</u>
0.2	95		NE	
1.3	95	80-100	100	
2	95	80-100	100	@ 3.4
9	95	40-70	NE	
15	95	40-100 ⁽²⁾	70	@ 12.8, IGA nearby
34	95	90-100	NE	
44	95	NE	NE	
52	95	NE	NE	

(1) in. below upper tube sheet surface

(2) @ 12.3/12.5

(3) NE - not examined

Other specimens from A-24-94 contained in the long term test program are:

- 1) long term lead test sample - section from 19.3 to 25.4 inches. In loop #1. Presently in operating cycle #6. Originally non-defective via eddy current. Eddy current response has not changed during HFT and first 5 operating cycles.

- 2) C-rings - per table below:

<u>I.D.</u>	<u>location in inches</u>	<u>loop</u>	<u>HFT</u>	<u>op</u>	<u>results/status</u>
1B1	26 - 26.75	1	x	1	1-2 mil surface IGA
1B2	26.75 - 27.5	1	x	1-6	still on test-remove 5/18
1B3	27.5 - 28.25	2	x	1-6	still on test-remove 5/18
1B4	28.25 - 29	1		2-5	removed after cycle 5
1B5	29 - 29.75	1		6	remove 5/18/84

- 3) Westinghouse has a 9/16" long section of tube material from below C-ring 1B5 at the R&D center.

RESULTS ON OTHER C-RINGS

To date, a total of 23 C-rings have been removed from the test loops and metallographically evaluated. None have showed IGA beyond the shallow, 1-2 mil surface attack common to Inconel 600 tubes that have been pickled during fabrication.

The following table summarizes the exposure history of C-rings that have been metallographically evaluated:

<u>Test₍₁₎</u> <u>Loop</u>	<u>No. of Test</u> <u>Cycles</u>	<u>No. of C-Rings</u> <u>Evaluated</u>	<u>Notes</u>
1	1	2	
	2	1	C-Ring 1B1
	3	1	
	4	3	1 Archive, 1-1B4
2	1	1	
	2	1	
	4	4	1 Archive
3	0	2	H ₂ O ₂ cleaning only
	1	2	
	2	2	
	3	2	
	4	2	

Notes

- (1) Loop 1 - sulfur species is .1 ppm thiosulfate
 2 - sulfur species is .1 ppm sulfate
 3 - first exposed to peroxide cleaning
 sulfur species is .1 ppm sulfate

OTHER EXAMINATIONS

All full tube specimens are eddy current examined after each operating cycle. All tubes initially without indications have continued to be indication-free. Tubes with indications have shown no evidence of change.

All full tube and C-ring specimens are visually examined after each operating cycle. No specimen deterioration has been detected.

EVALUATION

The largest number of C-rings have been removed after 4 cycles of exposure (see previous table). C-ring 1B4 is the only specimen in which IGA deeper than 1-2 mils has been found.

The reported IGA was present on the upper edge of C-ring 1B4. A metallographic mount prepared through the center detected only surface IGA. Since only surface IGA was previously detected on ring 1B1, which was located approximately 2 inches higher on the tube, the observed IGA is of limited extent.

The morphology of the largest area of IGA is identical to that reported by Battelle in their report on the first round failure analysis (Ref. 2, Figures 17, 24, and 50). There is no evidence of any crack extending from the IGA.

CONCLUSION

The identical morphology to as-removed tubes and lack of similar IGA on any other C-ring specimens indicate that the observed IGA on C-ring 1B4 occurred while the tube was in service and not during the long term corrosion test. Under the near yield strength loading of a C-ring specimen, crack formation would have been expected if an active corrosion environment existed in the test loop.

FUTURE ACTIVITY

Additional characterization of the extent of IGA on 1B4 and tube A-24-94.

REFERENCES

- 1) S. C. Inman, "Examination of OTSG Tubes From TMI-1 Third Pulling Sequence - Final Report," B&W Report RDD:83:5068-03:01, December 1982.
- 2) A. K. Agrawal, W. N. Stiegelmeier and W. E. Berry, "Final Report on Failure Analysis of Inconel 600 Tubes from OTSG A and B of Three Mile Island Unit 1," Battelle Columbus Laboratories, June 30, 1982.

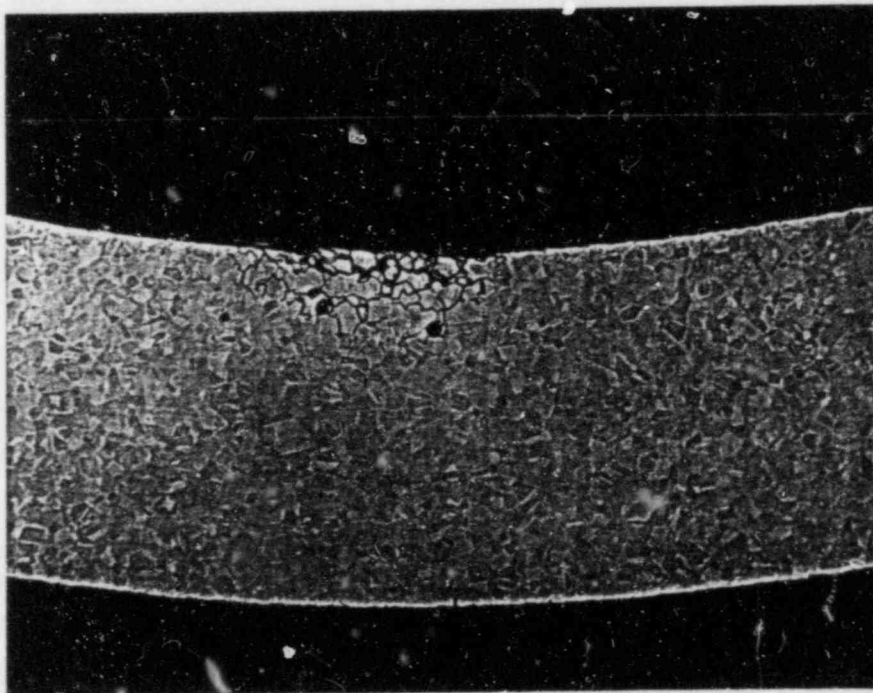


Figure 1. Surface Attack Detected in C-Ring 1B4 (50X)