SUMMARY REPORT

CR#3 STEAM GENERATOR REPAIR

FLORIDA POWER CORPORATION

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Introduction and Summary

This report provides the results of the Steam Generator repair effort at Crystal River Unit III. The report summarizes all inspections and repairs and as such may duplicate info mation previously provided. All repairs have been successfully completed and the unit is now available for continued operation.

Discussion of Repairs

The planned repair which is now complete consisted of:

Video Inspection and Categorization of Tube Damage

Search for Tube Leaks

Installation of Shielding

Installation of Screens in Lower Generator Piping

Repair Leaks NDE Repairs and Dress Damaged Tubes

100% Free Path Check of Tubes

Clean Obstructed Tubes

Plug Tubes From Which Debris Cannot be Removed

Perform a 3% Eddy Current Examination of Tubes

Gas Test Repaired and Plug Welded Tubes

Remove Shielding

Flush Tubes

Remove Screens and Close Up OTSGs

The planned repair has been very successful. Video inspections from two lines of sight of the tube end damage in the "B" generator were recorded on "stop-action" discs by two television cameras mounted on a modified remote eddy current manipulator. The recordings were viewed by B&W Engineering personnel on a television screen providing an approximate 5X magnification. This video inspection was used to classify the tube end damage into the following four categories:

Class I (55% of the tubes)

No damage or limited impact or rollover of tube ends. Deformed material does not include weld material.

Class II (6% of the tubes)

Partially separated metal chip existing with Class I, III, or IV damage.

Class III (26% of the tubes)

Minor weld damage extending into the upper 1/3 of the tube-to-tubesheet weld height.

Class IV (17% of the tubes)

Damage to tube ends and weld metal in excess of Class III.

The above percentages exceed 100% since Class II can exist with Classes I, III, and IV.

Seventeen pieces of debris found on the tubesheet surface were removed. The largest piece was the hub of the spider of a BPR assembly. Sixteen smaller pieces ranging from 1/8" x 1-1/4" x 3/4" to 1/8" x 1-1/2" x 2-1/2" were also removed and are believed to be part of the spider arms and poison rod clad.

The upper manway of the "A" generator was also opened and the visual examination revealed no debris on the upper tubesheet, no tube end damage, nor any tube-to-tubesheet weld damage. The program for this generator then consisted only of a leak detection program which found no leaks, a free path check from which no debris was detected, and a 7% eddy current examinatin of the tubing which resulted in no tubes with indications exceeding the plugging limit. One tube was plugged, however, as preventative maintenance.

The leak detection program for both steam generators was similar and consisted of pressurizing the secondary side with helium gas in excess of 100 psi. A mass spectrometer capable of detecting 10^{-8} cc/sec leak was used to interrogate each tube end with a probe remotely positioned by the modified eddy current manipulator. No leaks in either generator were found.

Specially designed dome shielding was installed and found to be quite successful in reducing radiation exposure. Aluminum sheets and lead blankets were placed on the tubesheet. A special B&W designed rapid installation dome was used to support lead blankets overhead.

Screens were installed in the piping leading from the lower generator head so that any debris that fell down a tube could readily be caught and removed.

The tube ends were then cleaned of the partially attached slivers. Small sections of the tubesheet were exposed by removing the shielding. Personnel were allowed to enter the upper head and slivers were removed. Two men teams were used for this operation. While one man removed the slivers, the other held a camera for remote viewing by quality assurance personnel.

A 100% free path check of all tubes was performed. The check was performed by remotely driving a free path probe up the tube at a constant known speed with a remote probe positioner in the lower head. This special B&W designed fixture was developed for this free path check and subsequent eddy current examination of tubes with damaged upper tube ends. Again, a television camera mounted in the upper head was employed to confirm the com-

pleted free pass of the probe. This inspection found nineteen tubes suspected of being blocked by debris. The final disposition of these nineteen tubes is given in Table 1.

Of the nineteen tubes, seven tubes were determined to be clear, debris was removed from five by pushing it out with a nylon coated stainless steel cable, and seven tubes were removed from service in order to isolate the nonremovable debris. Plugging of the tubes was accomplished by the standard explosive tube plugging technique or a special welded plug commonly used in the B&W fabrication shops. Plug selection was based on debris location within the tube. This data is also included in Table 1.

An eddy current examination was performed on three percent fo the OTSG tubes plus on those tubes from which debris was removed to give a high confidence level that tubes had not been damaged by debris removal or by debris that may have passed through during plant operation. This inspection revealed no indications exceeding the plugging limit.

The final stages of the repair consisted of testing the welded repairs with a gas/soap bubble test per ASME requirements, removing the shielding, flushing the tubes with a stream of water to remove any small particles that may have been generated during the repair, removal of the lower piping screens, and final cleaning of the upper and lower heads prior to installation of hand hold and manway covers.

Summary and Conclusions

Based on the above successfully completed repair program and the technical assessments previously provided in the reference letter, it is concluded

that the damage sustained by the OTSG will not have a detrimental effect on its safe operation over the time remaining on this fuel cycle. This conclusion is based on:

1) The "hard" rolled tube-to-tubesheet joint strength is independent of the seal weld and any damage to it.
2) The minimum leak path required by ASME Codes has not been violated.
3) Low cycle fatigue failures will only cause nuisance plant shutdowns for repair when leakage exceeds plant limitations.
4) Stress corrosion cracking requires an incubation period longer than the remaining time in the first fuel cycle.
5) Every upper tube joint has been visually inspected, catalogged, and appropriately dressed.
6) Every upper tube joint has been leak tested with sophisticated mass spectrometer and no leak found.
7) A 100% free pass check of all tubes has been performed. Debris not removed from tubes was isolated from the primary system by plugging the tubes.
8) A 3% eddy current examination of the tubes did not reveal any debris related damage.
9) Weld repaired and plugged tubes were gas tested per ASME requirements.
10) The upper and lower heads were appropriately cleaned after a tube flush prior to closing up the steam generators.

The number of tubes removed from service at this outage (seven in the "B" generator and one in the "A" generator) is extremely small (less than .02%) and will have no effect on the existing ECCS analysis.

Reference

1. Letter W. P. Stewart to R. W. Reid, dated May 16, 1978.

TABLE 1

"B" OTSG: DISPOSITION OF VERIFIED DEBRIS TUBES

TUBE LOCATION ROW	TUBE	DEBRIS LOCATION DEPTH FROM TOP	DEBRIS STATUS	ECT RESULTS	FINAL DISPOSITION	COMMENTS
4	5	>24"	REMOVED 18" BPR	NO INDICAT.	RETURNED TO SERVICE	
6	4	24"	LODGED @ 4-1/2"	N/A	PLUGGED	
7	1	>24"	LODGED @ 12'	N/A	PLUGGED	
13	4	1/2"	REMOVED 20" BPR	NO INDICAT.	RETURNED TO SERVICE	
19	2	FLUSH	LODGED @ 4-1/2-6"	N/A	PLUGGED	
22	91	4-1/2"	LODGED @ 4-1/2"	N/A	PLUGGED	
28	95	--	CLEAN	NO INDICAT.	RETURNED TO SERVICE	
46	79	--	CLEAN	NO INDICAT.	RETURNED TO SERVICE	
47	65	--	CLEAN	NO INDICAT.	RETURNED TO SERVICE	
48	2	--	CLEAN	NO INDICAT.	RETURNED TO SERVICE	
49	2	1"	REMOVED 18" BPR	***	RETURNED TO SERVICE	***30 - 40% ID INDICATION BETWEEN 15TH TSP AND UTS.
50	21	1"	REMOVED 24" BPR	NO INDICAT.	RETURNED TO SERVICE	
52	87	>24"	REMOVED BPR CHIP	NO INDICAT.	RETURNED TO SERVICE	
61	1	--	CLEAN	NO INDICAT.	RETURNED TO SERVICE	

TABLE 1 (Cont'd.)

"B" OTSG: DISPOSITION OF VERIFIED DEBRIS TUBES

TUBE LOCATION ROW	- TUBE	DEBRIS LOCATION DEPTH FROM TOP	DEBRIS STATUS	ECT RESULTS	FINAL DISPOSITION	COMMENTS
69	1	24"	LODGED @ 6"	N/A	PLUGGED	
70	34	--	CLEAN	***	RETURNED TO SERVICE	***20% ID INDICATION BETWEEN 13TH and 14TH TSP
82	1	7"	LODGED @ 30"	N/A	PLUGGED	
101	122	8 - 10"	LODGED @ 15'	/A	PLUGCED	
111	64	--	CLEAN	***	RETURNED TO SERVICE	***INDICATION BETWEEN 12TH AND 13TH TSP