

**TURKEY POINT UNIT 4  
FLUX MAP THIMBLE TUBE  
EDDY CURRENT TEST REPORT  
FOR  
NRC BULLETIN 88-09**

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## Introduction

An eddy current examination (ECT) of the Turkey Point Unit 4 flux map thimble tubes was performed during the Cycle XI to Cycle XII refueling outage. The examination was performed by the Florida Power and Light (FPL) Materials, Codes, and Inspections group using standard eddy current techniques. The results showed that none of the thimble tubes required immediate replacement or repositioning.

## Acceptance Criteria

The acceptance criteria for the eddy current examination results was developed by the FPL Nuclear Engineering Department. Westinghouse was commissioned to perform a Turkey Point specific analysis for the maximum allowable wall loss that could be sustained, and still maintain the pressure boundary integrity. The Westinghouse analysis determined that up to a 60% wall loss over a 0.75 inch length could be sustained and still maintain the thimble tube integrity. The Nuclear Engineering Department developed the test acceptance criteria by reducing the 60% wall loss by both the maximum anticipated error for the eddy current technique, 10%, and by the amount of wall thickness required, based on an assumed linear wear rate, for a 3 cycle surveillance interval, 27%. This resulted in an acceptance criteria for the eddy current examination of 23% wall loss over a 0.75 inch long area.

## Performance

Forty nine (49) of the fifty (50) tubes were cleaned and flushed by Westinghouse prior to the eddy current examination. The fiftieth (50th) thimble tube, in core location C-12, was blocked by a fixed incore detector from a demonstration project implemented in 1975 and could not be removed at this time because of ALARA concerns. The examination probe was inserted and withdrawn manually, with data being recorded during the withdrawal phase. The area of the thimble tubes examined ranged from between 94.6 feet and 82.5 feet from the seal table. This insertion distance covered the area from approximately one foot above the lower core support plate to the bottom of the reactor vessel penetration.

## Results

The ECT data was analyzed by the FPL Materials, Codes, and Inspections group to determine the percent wall loss and wear scar length for each thimble tube. The results from the data analysis identified the thimble tube locations with 10% or greater wall loss. A total of 13 thimble tubes showed a wall loss of 10% or more. Two of these thimble tubes showed a wall loss exceeding the test acceptance criteria of 23%, with the worst location indicating a 32% wall loss.

### Analysis

The ECT results were reviewed by Reactor Engineering to determine if there was any correlation between thimble tube wear and either core location or seal table location. The diagrams showing these locations are included with this report as Attachment 1 and Attachment 2. Several of the thimble tubes also showed measurable wear marks in more than one location. Attachment 3 is a chart of the wear mark locations relative to the lower core support plate. This part of the data analysis revealed no significant patterns in the occurrence of thimble tube wear that would indicate problems with either the RCS flow path or the reactor internals.

The two locations that exceeded the test acceptance criteria, and the one unmeasured location, were evaluated by FPL Nuclear Engineering. The engineering evaluation concluded that no immediate corrective action is required, and that based on predicted wear rates, the thimble tubes will not need to be re-inspected until after two more operating cycles.

### Conclusion

The ECT inspection of the flux map thimble tubes revealed no operability concerns or requirements for immediate corrective action. The analysis of the results concluded that sufficient wall thickness existed at the worst wear location to preclude additional examinations for two more operating cycles. Although it is not required from the analysis, a re-inspection of the thimble tubes will be performed after the next operating cycle to confirm the predicted wear rates.

### Inspection Program

The upper limit of the acceptance criteria for thimble tube wall loss has been established at 60% wall loss for scars less than 0.75 inches long over 60° of the tube circumference by the Westinghouse analysis. The establishment of a specific inspection frequency based on the current inspection results would be predicted on an assumed wear rate. To measure the thimble tube wear rate, the results of this initial inspection will be considered as baseline data, and another thimble tube inspection will be performed during the next refueling outage. After the measured wear rate has been determined, a specific inspection frequency will be established based on the worst wear locations that will prevent the acceptance criteria from being exceeded. A permanent plant procedure will be developed to implement the thimble tube inspection program prior to the next refueling outage.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
							11% 1.8"								R
															P
		*		17% 0.2"		*	*		*						N
												*			M
*			32% 0.7"		13% 0.8"	*		*	*	*					L
															K
*			12% 0.6"		*			12% 0.2"		*		18% 0.1"			J
		*		*					*		*	*		13% 0.2"	H
	*					28% 2.0"		10% 0.2"							G
		*		*		*	*		*		13% 0.2"		11% 1.4"		F
			21% 0.2"							*					E
		*		*				*		*		*			D
		Not Tested				*									C
			*		*	*		*		*					B
						*									A

LEGEND

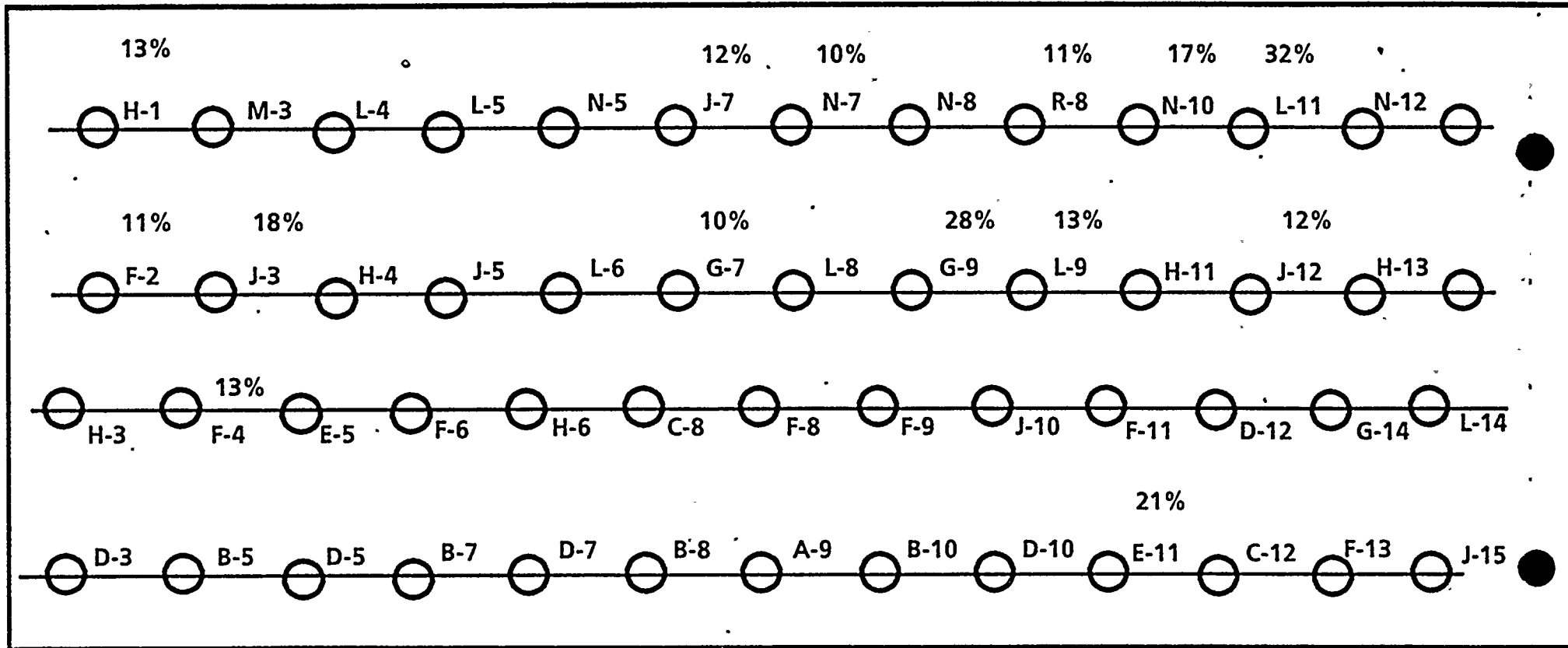
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Scar Length in Inches

## ATTACHMENT 2

### Turkey Point Unit 4 Cycle XI to Cycle XII

#### Seal Table Location of Flux Map Thimble Tube Inspection Results



### ATTACHMENT 3

#### Turkey Point Unit 4 Cycle XI to Cycle XII Chart of Wear Locations of Flux Map Thimble Tube Inspection Results

