January 12, 1990

Docket Nos. 50-348
and 50-364

Mr. W. G. Hairston, III
Senior Vice President
Alabama Power Company
40 Inverness Center Parkway
Post Office Box 1295
Birmingham, Alabama 35201

Dear Mr. Hairston:

SUBJECT: AUDIT OF ACTIONS RELATING TO NRC BULLETIN 88-09, "THIMBLE TUBE THINNING IN WESTINGHOUSE REACTORS," FOR JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2, (TAC NOS. 72659 AND 72660)

By letter dated April 17, 1989, we advised you of completion of our review of your November 2, 1988 response to the subject bulletin. As a followup action, we conducted a site audit on the issue of incore thimble tube wear on November 14 and 15, 1989. We appreciate your staff assistance during that audit.

A copy of the audit trip report is enclosed for your information. The audit concludes that the inspection program is responsive to the Bulletin requirements, uses acceptable inspection methods with technically justifiable acceptance criteria, and you have a schedule for conducting inspections every refueling outage. These interim actions are acceptable. In addition, your participation with the Westinghouse Owners Group working toward the final resolution of the issue is noteworthy.

Sincerely,

/S/

Edward A. Reeves, Senior Project Manager
Project Directorate II-1
Division of Reactor Projects I/II
Office of Nuclear Reactor Regulation

Enclosure:
As stated

cc: See next page

DISTRIBUTION:

Docket File	OGC (info only)	LMarsh
NRC & Local PDRS	EJordan	BBuckley
PD21 r/f	SVarga, 14/E/4	ACRS (10)
GLainas, 14/H/3	EAdensam	EReeves
PAnderson	DVerrelli, RII	

DF01
1/1

OFC	:LA:PDII-1	:PM:PDII-1	:D:PDII-1	:	:	:	:
NAME	:PAnderson	:EReeves:sl	:EAdensam	:	:	:	:
DATE	:1/11/90	:1/11/90	:1/11/90	:	:	:	:

9001250143 900112
PDR ADOCK 05000348
Q PDC

Docket Nos. 50-348
and 50-364

Mr. W. G. Hairston, III
Senior Vice President
Alabama Power Company
Post Office Box 2641
Birmingham, Alabama 35291-0400

Dear Mr. Hairston:

SUBJECT: AUDIT OF ACTIONS RELATING TO NRC BULLETIN 88-09, "THIMBLE TUBE THINNING IN WESTINGHOUSE REACTORS," FOR JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2, (TAC NOS. 72659 AND 72660)

By letter dated April 17, 1989, we advised you of completion of our review of your November 2, 1988 response to the subject bulletin. As a followup action, we conducted a site audit on the issue of incore thimble tube wear on November 14 and 15, 1989. We appreciate your staff assistance during that audit.

A copy of the audit trip report is enclosed for your information. The audit concludes that the inspection program is responsive to the Bulletin requirements, uses acceptable inspection methods with technically justifiable acceptance criteria, and you have a schedule for conducting inspections every refueling outage. These interim actions are acceptable. In addition, your participation with the Westinghouse Owners Group working toward the final resolution of the issue is noteworthy.

Sincerely,

Edward A. Reeves, Senior Project Manager
Project Directorate II-1
Division of Reactor Projects I/II
Office of Nuclear Reactor Regulation

Enclosure:
As stated

cc: See next page

DISTRIBUTION:

Docket File	OGC (info only)	LMarsh
NRC & Local PDRS	EJordan	BBuckley
PD21 r/f	SVarga, 14/E/4	ACRS (10)
GLainas, 14/H/3	EAdensam	EReeves
PAnderson	DVerrelli, RII	

OFC	:LA:PDII-1	:PM:PDII-1	:D:PDII-I	:	:	:	:
NAME	:PAnderson	:EReeves:sl	:EAdensam	:	:	:	:
DATE	:1/10/90	:1/10/90	:1/ /90	:	:	:	:

Docket Nos. 50-348
and 50-364

Mr. W. G. Hairston, III
Senior Vice President
Alabama Power Company
Post Office Box 2641
Birmingham, Alabama 35291-0400

Dear Mr. Hairston:

SUBJECT: AUDIT OF ACTIONS RELATING TO NRC BULLETIN 88-09, "THIMBLE TUBE THINNING IN WESTINGHOUSE REACTORS," FOR JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2, (TAC NOS. 72659 AND 72660)

By letter dated April 17, 1989, we advised you of completion of our review of your November 2, 1988, response to the subject bulletin. As a followup action, we conducted a site audit on the issue of incore thimble tube wear on November 14 and 15, 1989. We appreciate your staff assistance during that audit.

A copy of the audit trip report is enclosed for your information. The audit concludes tht the inspection program is responsive to bulletin requirements. You use acceptable inspection methods with technically justifiable acceptance criteria. You have a schedule for conducting inspections every refueling outage. These interim actions are acceptable. In addition, your participation with the Westinghouse Owners Group working toward the final resolution of the issue is noteworthy.

Sincerely,

Edward A. Reeves, Senior Project Manager
Project Directorate II-1
Division of Reactor Projects I/II
Office of Nuclear Reactor Regulation

Enclosure:
As stated

cc: See next page

RR

DISTRIBUTION:

Docket File	OGC (info only)	LMarsh
NRC & Local PDRS	EJordan	BBuckley
PD21 r/f	SVarga, 14/E/4	ACRS (10)
GLainas, 14/H/3	EAdensam	EReeves
PAnderson	DVerelli, RII	

OFC	:LA:PDII-1	:PM:PDII-1	:D:PDII-1	:	:	:	:
NAME	:PAnderson	:EReeves:sl	:EAdensam	:	:	:	:
DATE	:1/ /90	:1/ /90	:1/ /90	:	:	:	:

Mr. W. G. Hairston, III
Alabama Power Company

Joseph M. Farley Nuclear Plant

cc:

Mr. R. P. McDonald
Executive Vice President
Nuclear Operations
Alabama Power Company
P. O. Box 1295
Birmingham, Alabama 35201

Mr. B. L. Moore
Manager, Licensing
Alabama Power Company
P. O. Box 1295
Birmingham, Alabama 35201

Mr. Louis B. Long, General Manager
Southern Company Services, Inc.
Houston County Commission
P. O. Box 2625
Birmingham, Alabama 35202

Mr. D. N. Morey
General Manager - Farley Nuclear Plant
P. O. Box 470
Ashford, Alabama 36312

Mr. J. D. Woodward
Vice-President - Nuclear
Farley Project
Alabama Power Company
P. O. Box 1295
Birmingham, Alabama 35201

Resident Inspector
U.S. Nuclear Regulatory Commission
P. O. Box 24 - Route 2
Columbia, Alabama 36319

Regional Administrator, Region II
U.S. Nuclear Regulatory Commission
101 Marietta Street, Suite 2900
Atlanta, Georgia 30323

Chairman
Houston County Commission
Dothan, Alabama 36301

Claude Earl Fox, M.D.
State Health Officer
State Department of Public Health
State Office Building
Montgomergy, Alabama 36130

ENCLOSURE

AUDIT TRIP REPORT

PURPOSE: Audit of Joseph M. Farley Units 1 & 2 on Bulletin 88-09 Issues (BMI Thimble Tube Wear)

LOCATION: Joseph M. Farley Nuclear Plant, Dothan, Ala.

DATE: November 14-15, 1989

NRC PERSONNEL: S.N. Hou (NRC), G. DeGrassi (BNL)

LICENSEE PERSONNEL: A.E. Hammett (APCo), C.M. Scrabis (Westinghouse) and others (See Attachment 1)

1.0 INTRODUCTION

The purpose of this audit was to review the Licensee's activities related to the Bulletin 88-09 issues on BMI thimble tube wear. This bulletin requires the establishment of an inspection program to monitor thimble tube wear. The program should include the establishment, with technical justification, of appropriate acceptance criterion, inspection methodology and inspection frequency. The program should be implemented in accordance with the given schedule (next refueling outage for most plants), and corrective actions should be taken for tubes which fail to meet the established acceptance criterion.

The Alabama Power Company's written response to the bulletin was included in a letter dated November 2, 1988 and is included as Attachment 3. A copy of the audit agenda is included as Attachment 2 and meeting attendance lists for the entrance and exit meetings are included in Attachment 1.

An entrance meeting was held on November 14. The Licensee gave an overview of the plant's inspection program and results. On November 15, more detailed discussions on these subjects were held primarily with Al Hammett and Chuck Scrabis. Documentation including eddy current inspection reports, analyses and design drawings were made available for our review. Additional information was provided after the audit to resolve some open issues raised during our discussions. A brief exit meeting was held at the end of the audit to summarize our findings and recommendations.

2.0 HIGHLIGHTS OF FARLEY EXPERIENCE AND LICENSEE ACTIONS

- APCo established an eddy current inspection program in 1986 with an inspection frequency of every refueling outage. This frequency will be maintained until sufficient data is available to justify a longer interval between inspections.

- To date, no thimble tube leaks have occurred at Farley.

- To date, three eddy current inspections have been performed on Unit 1 thimble tubes and two inspections have been performed on Unit 2. Significant wear has been detected in several tubes and corrective actions including tube repositioning and capping have been taken.

- A 65% wall loss acceptance criteria was established based on Westinghouse analysis.

- The thimble tubes have manual isolation valves which could isolate a tube leak if it should occur.

- The Licensee has considered long term corrective actions but has made no definite commitment to date.

- The Licensee is participating in the Westinghouse Owners Group (WOG) program on thimble tubes. This program was scheduled for completion by the end of this year, but significant delays are expected.

3.0 AUDIT SUMMARY

The following is a summary of the information obtained through our discussions and document reviews.

3.1 Thimble Tube Inspection Program

The Licensee had established a thimble tube eddy current inspection program before the issuance of NRC Bulletin 88-09. Inspections were conducted during each refueling outage since 1986. Unit 1 was inspected during the cycle 7, 8 and 9 refueling outages in October 1986, March 1988 and September 1989. Unit 2 was inspected during the cycle 5 and 6 outages in November 1987, and April 1989. The first three inspections were performed by Cramer and Lindell. The last two 1989 inspections were performed by Echoram, a Westinghouse subsidiary. Both vendors used similar eddy current test equipment and a multifrequency inspection procedure. Measurement uncertainty was quoted as 10% by Echoram and 15% by Cramer and Lindell. The wear scar calibration standards were different. Cramer and Lindell used a 180° crescent-shaped standard. Echoram used a 90° flat tapered wear scar. Since eddy current inspection is based on volumetric measurement, the 90° wear scar should be more conservative.

A summary of all the eddy current inspection results for both units is provided in Attachment 5. It is difficult to compare exact changes in wall loss between cycles because of the uncertainties and the differences in the two vendors' reporting methods. Cramer and Lindell reported a range of values while Echoram reported a single value but added a 10% uncertainty factor. Nevertheless, it is clear that tube wear has been observed since the first inspection and tends to increase after each cycle. Wear has been occurring mainly in the lower core plate area. The core map figures summarize the latest inspection results. In Unit 1, there are 36 out of 50 tubes with wear between 17% and 67%. Three tubes with wall losses of 62%, 63% and 67% have been capped. One tube was capped because it was blocked and could not be inspected. Four tubes with wear between 45% and 51% have been repositioned. In Unit 2, there are 10 out of 50 tubes with wear between 13% and 53%. Two tubes with 53% wear were repositioned. One tube (L9) had been repositioned after the first inspection although the 1989 inspection did not measure any detectable wear of the L9 tube. No Unit 2 tubes have yet been capped.

The criteria for capping or repositioning thimbles was based on Westinghouse recommendations. Westinghouse had performed a finite element analysis to demonstrate the structural adequacy of a thimble tube with a two inch long flat wear scar covering 90° of the tube circumference. The corrective action criteria is to cap any tube with wall loss exceeding 65% and to reposition any tube that is predicted to exceed 65% wall loss before the next inspection. For Unit 1, Westinghouse assumed an average wear rate of 11.8% wall loss per cycle to predict total wear at the end of the next cycle. Although wear rates exceeding that amount were observed between cycles for several tubes, Westinghouse feels that this rate is conservative in the longer term.

In reviewing the inspection reports, it was noted that the calibration tube wear scar used by Echoram was not in agreement with the wear scar used in the finite element model. The model assumed a flat scar with a surface parallel to the tube axis. The calibration standard used a flat wear scar with a surface inclined relative to tube axis. Westinghouse was asked to justify the difference and agreed to provide additional information (see Section 3.4).

The Licensee stated that eddy current inspections will be performed during every refueling outage until there is sufficient data to justify longer inspection intervals.

3.2 Design Parameters

The Licensee provided design information and drawings on the thimble tube systems and reactor internals. The thimble tubes are fabricated from SA213 Type 316 stainless steel cold drawn, heat treated tubing with .300" OD and .201" ID. The lower reactor internals guide column dimensions were not available but Westinghouse agreed to provide the information (see Section 3.4). The ID at the lower core plate is .545" in Unit 1 and .600" in Unit 2. The high pressure conduits which support the thimbles from the reactor vessel to the seal table have an ID of .400" in 42 tubes and .600" in 8 tubes. It was noted that these dimensions are smaller than most other plants and would restrict the use of larger thimble tubes. Both Farley Units are three loop plants with 12 foot cores. Best estimate flow rates are 95900 gpm in Unit 1 and 95200 gpm in Unit 2. Unit 1 went into commercial operation in December 1977. Unit 2 went into commercial operation in July 1981.

Both Units have the same bottom mounted incore instrumentation system with thimble tubes that extend from the reactor core down through high pressure conduits to the seal table. The system consists of drive units, 5 path rotary transfer devices, 10 path rotary transfer devices and manual isolation valves. High pressure seals form part of the reactor pressure boundary at the thimble tube to seal table interface. In the event of a thimble tube leak, water would enter the ten path transfer devices. Each ten path device has a drain line which feeds into a common drain header. A level sensing switch is installed in the drain header. In the event of a leak, the switch would sound an alarm on the flux mapping panel in the control room and open the drain valve which allows the water to drain to the containment sump. In the event of a leak, plant personnel would have to enter the containment, identify the leaking tube and close the manual isolation valve.

The Licensee provided a set of photographs of the seal table (see Attachment 4). The photographs show the BMI transfer cart which is a frame structure that supports the isolation valves and 10 path transfer devices. During refueling, the thimble tubes must be withdrawn. This is accomplished by disconnecting the tube coupling at the seal table, jacking up the upper portion of the transfer cart and rolling the entire assembly to the side to provide vertical clearance for tube withdrawal (see photograph). When the transfer cart is in the normal operating position, the upper part of the cart is bolted to supports at each end. However, it was not clear that the lower part of the cart was restrained. A concern was raised that during an earthquake the cart could roll and sever the thimble tubes. The Licensee could not explain how the lower portion of the cart is restrained but agreed to provide additional information (see Section 3.4).

3.3 Licensee Evaluation and Corrective Action Plans

The eddy current inspections showed tube wear at scattered core locations. There were no apparent trends suggesting that certain core locations are more susceptible to wear than others. The most severe wear was generally observed at the lower core plate elevation. More wear has been observed in Unit 1 than in Unit 2, as may be expected since Unit 1 has been operating for a longer period of time.

The Licensee has been working closely with Westinghouse in the thimble tube inspections and evaluations. The acceptance criteria for capping or repositioning tubes was developed by Westinghouse. The use of a linear wear prediction technique based on a wear rate of 11.8% wall loss per cycle appears nonconservative since increases in wear as high as 35% were observed between cycles 8 and 9 in Unit 1. In the long term, the 11.8% rate appears conservative for predicting total wear of tubes over many cycles. However, as seen in other plants, the increase in wear for any particular tube in a given cycle is unpredictable and can vary significantly. If a tube leak should occur, however, Westinghouse has demonstrated that maximum leakage of 35 gpm per tube for three tubes can be accommodated by the normal makeup capacity of the system. Furthermore, there are manual valves available to isolate a leak. Experience at other plants has demonstrated the feasibility of isolating a leak with the manual valves. Actual leakage rates have also been well below the worst case 35 gpm predictions. Therefore, although the wear rate prediction method appears nonconservative, the overall program seems reasonable when consideration is given to the consequences of tube leaks, the tube isolation capability, and the planned inspection frequency.

The Licensee has considered some long term corrective actions but has made no definite plans or commitments at this time. The use of sleeves in the lower internals guide column have been considered. The Unit 2 guide column ID could be reduced from .600" to .468". Unit 1, however, has a unique problem in that the ID is only .545". Installation of sleeves would require boring out a larger diameter in the core plate and upper guide column to make sleeve installation possible. The use of larger diameter thimble tubes is not feasible due to the use of some small diameter (.400" ID) high pressure conduits between the seal table and lower reactor vessel. Westinghouse has been working on wear resistant coatings for thimble tubes but they are not presently being considered by the Licensee. Although there is not commitment, the Licensee has allocated funds for tube replacement, if that should be necessary in the future.

The Licensee is participating in the Westinghouse Owners Group (WOG) Program on thimble tube wear. This program will develop more accurate wear scar standards and refine the acceptance criteria for wear based on testing of tube samples from operating plants. The program is behind schedule because of the difficulty in obtaining tube samples. At this time, Westinghouse has four sample tubes available from Diablo Canyon. Eddy current inspections indicated 90% wear on one tube. Westinghouse plans to repeat the eddy current inspections and compare the results against hot cell examinations of the sample. Burst testing of the tube samples is also planned. Westinghouse expects to receive additional tube samples from Kewaunee and other plants. A firm completion date for the program could not be obtained at this time.

3.4 Closeout of Open Items

By the end of the audit, there were three open items for which the Licensee agreed to provide additional information. This was provided in a letter dated November 29, 1989 which is included as Attachment 6. The information was reviewed and found acceptable. The following is a summary description of the open items and their resolution.

<u>Item 1</u> The wear scar geometry described in the Westinghouse finite element analysis report, RPVSA-89-1351, to justify the 65 percent allowable wall loss criteria is different from that described for the wear scar calibration standard in the Echoram ECT Report.

<u>Resolution 1</u> The wear scar geometries in the two reports are different. The geometry used by Westinghouse in the finite element analysis was judged to be conservative for predicting maximum stress values for given wear scar depths. The geometry used by Echoram as a calibration standard for measuring wear is considered to be a more representative approximation of actual scars and would be more conservative, for estimating wear depth for a given volume of material removed, than that defined by the finite element analysis model. ECT inspections determine wall loss by measuring the volume of material removed.

A new finite element analysis has been performed by Westinghouse, modeling the geometry of the Echoram calibration standard. The results of this new analysis shows that the predicted stress values for 65 percent wall loss are less than originally predicted. This confirms the original analysis assumption that the scar geometry was conservative.

A summary stress report of this new analysis was included in the November 29th transmittal (Attachment 6).

Item 2 — It is not clear how the bottom portion of the BMI transfer cart, which contains the track wheels for rolling the transfer cart away from the seal table, is restrained from rolling or against seismic excitation after the upper portion of the transfer cart is bolted down to its front and back anchor post.

Resolution 2 — The upper and bottom portions of the BMI transfer cart are never separated from each other. The 4 bottle jacks that raise and lower the upper portion relative to the bottom portion are permanently fixed at the top with 4 bolts each to the top portion and at the bottom with 4 bolts each to the bottom portion of the transfer cart. Once the upper portion is bolted to its anchor posts above the seal table the entire transfer cart is restrained from moving in a seismic event.

The seismic qualification reports for the Farley transfer carts and copies of drawings showing the areas of concerns were included in the November 29th transmittal (Attachment 6).

Item 2 — Design drawings of the instrument columns in the lower core area through which the thimble tubes pass showing the variation in internal diameter were not available for review.

Resolution 3 — Westinghouse prepared sketches of the Farley Unit 1 and 2 lower internals area showing 3 instrument columns with the changes in internal diameter along the lengths. These sketches were included in the November 29th submittal (Attachment 6).

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the information obtained during and after the audit, our conclusions and recommendations are as follows:

- The Licensee has defined and implemented an adequate program which is responsive to Bulletin 88-09 requirements.
- The program applied acceptable state of the art inspection methods with technically justifiable wear acceptance criteria. The inspection frequency of every refueling outage is acceptable.
- The Licensee has taken appropriate short term corrective actions (capping and repositioning) to minimize the potential for leaks in tubes with significant wear.

- The Licensee has considered long term corrective actions and is prepared to replace tubes if necessary. Although no long term commitments have been made, we understand that the Licensee will continue participating in industry programs (such as WOG) and follow new developments related to this issue.

- Concerns raised at other plants regarding the seismic restraint of the seal table frame assembly do not apply to Farley.

ATTACHMENT 1

Audit Meeting Attendees

DATE: 11/14/89

NRC INSPECTION BRIEFING
ATTENDEE LIST

	NAME	ORGANIZATION	TITLE
1.	R. D. Hill	APCo	Asst Gen Mgr - Ops
2.	S. Fulmer	APCo	Supv Sfty Audit & Engr Revie
3	Shou-nien Hou	NRC	Sr Mech. Engr
4.	Giuliano DeGrassi	BNL/NRC	Sr. Research Eng
5.	Bill Miller	NRC	Resident Inspector
6.	Bob Berryhill	APCo	SP Mngr
7.	Jim Thomas ←	APCO	Manager Maintenance
8.	A.E. Hammett	APCo	Nuclear Maintenance Support
9.	C.M. Scrabis	Westinghouse NATD	Engineer
10.	J.W. Cherry	APCO	I&C Supervisor
11.	J.K. Osterholtz	APCO	Manager - Ops
12.			
13.			
14.			
15.			
16.			
17.			
18.			
19.			
20.			
21.			
22.			
23.			
24.			

Tom Mager - Westinghouse Contact for WOG EMI Program
(412) 256-6112

DATE: 11/15/89

NRC INSPECTION EXIT CONFERENCE
ATTENDEE LIST

	NAME	ORGANIZATION	TITLE
1.	Shou-nien Hou	NRC	Sr. Mechanical Engr
2.	Giuliano DeGrassi	BNL/NRC	Sr. Research Engr.
3	A.E. Hammett	Ala Pwr.	Nuclear Maint Support
4.	W.H. Miller Jr	NRC	Resident Inspector
5.	R.D. Hill	APCo	Asst Gen Mgr - Ops
6.	S. Fulmer	APCo	Supv Sfty Audit & Engr Review
7.	H. Stinson	APCo	Asst Gen Mgr - Support
8.	C.M. Scrabis	Westinghouse NATD	Engineer
9.	K.M. Patton	Westinghouse	Site Engineer
10.	T.W. Cherry	APCO	I&C Supervisor
11.	R.H. Marlow	APCo	Tech Supv.
12.			
13.			
14.			
15.			
16.			
17.			
18.			
19.			
20.			
21.			
22.			
23.			
24.			

ATTACHMENT 2

Audit Agenda

AGENDA

NRC Audit of Bulletin 88-09 Issues

Farley Units 1 & 2

I. Audit Discussion Items

A. Thimble Tube Inspection Program

- Inspection Methods Description including assumptions and uncertainties
- Inspection Frequency and basis
- Wear Acceptance Criteria and basis
- Corrective Action
- Inspection Results

B. Review of Parameters Affecting Tube Wear

- Hardware Design - Thimble tubes, Tube supporting structures internal and external to Reactor
- Flow rates
- Isolation capability
- Operating History

C. Licensee Evaluation of Wear

- Evaluation of inspection results/significant findings
- Westinghouse Owners Group findings/recommendations
- Root cause analysis
- Assessment of safety significance

D. Long Term Corrective Action Program Status

- Addition of sleeves
- Addition of isolation valves
- Hot cell examination
- Other Long Term Plans

II. Document Review

- Inspection Reports/Results
- Design drawings
- Analyses supporting acceptance criteria and inspection frequency
- Other relevant Licensee or Westinghouse reports

III. Hardware Inspection

- Seal table room inspection (if accessible)

ATTACHMENT 3

Licensee Response to Bulletin 88-09

Alabama Power Company
600 North 18th Street
Post Office Box 2641
Birmingham, Alabama 35291-0400
Telephone 205 250-1837

W. G. Hairston, III
Senior Vice President
Nuclear Operations

Alabama Power
the southern electric system

Docket Nos. 50-348
50-364

November 2, 1988

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Gentlemen:

Joseph M. Farley Nuclear Plant - Units 1 & 2
Thimble Tube Thinning in Westinghouse Reactors
NRC Bulletin No. 88-09

NRC Bulletin No. 88-09 requests that each addressee establish and implement an inspection program to monitor thimble tube performance and take appropriate corrective actions should the thimble tube fail to meet the established acceptance criterion. This program should include the establishment and technical justification of an appropriate thimble tube acceptance criterion and inspection frequency and the establishment of an inspection methodology. Holders of operating licenses that already had an established inspection program to monitor thimble tube integrity consistent with that requested by this bulletin and, based upon the results of the last inspection, took appropriate corrective actions for the thimble tubes that failed to satisfy the established acceptance criterion, are requested to implement the inspection program in accordance with their established inspection frequency.

Alabama Power Company began to utilize the services of an eddy current vendor to perform incore flux measuring system thimble tube eddy current testing (ECT) at Farley Nuclear Plant in 1986. In order to be able to identify a wide range of defects, the ECT vendor developed a calibration standard to include ASME Boiler and Pressure Vessel Code standard defects, typical wear patterns, and service defects. The current program includes performing ECT at each refueling outage until adequate confidence is established in wear rate projections. Thimble tubes that do not meet the current acceptance criteria are either slightly withdrawn, in order to align the wear scar to a new location and provide an undamaged thimble tube wear surface at locations where the degradation had been previously identified, or capped, depending upon the percentage of wall loss.

During the Unit 1 seventh and eighth refueling outages and the Unit 2 fifth refueling outage, all thimble tubes (except those blocked or capped) were inspected full length and appropriate corrective actions were taken. In the future, thimble tubes that cannot be eddy current inspected due to blockages will be preventively capped.

IE18
1/1

Alabama Power Company will continue to monitor thimble tube wear by periodic testing and will participate in Westinghouse Owners Group (WOG) activities to establish recommended testing options, acceptance criteria, and recommended corrective actions. When issued, the WOG recommended actions will be reviewed and the Alabama Power Company program modified, as appropriate. In the interim period prior to issuance of the WOG recommendations, Alabama Power Company will continue with its currently established program which is consistent with the requirements of NRC Bulletin 88-09.

If there are any questions, please advise.

Respectfully submitted,

W. G. Hairston III

W. G. Hairston, III

WGH/AEH

cc: Mr. L. B. Long
Mr. M. L. Ernst
Mr. E. A. Reeves
Mr. G. F. Maxwell

Sworn to and subscribed before me this 2 day of November, 1988

James H. Miller III
NOTARY PUBLIC
My commission expires

MY COMMISSION EXPIRES MARCH 23, 1990

ATTACHMENT 4

Seal Table Photographs

Photo # 1 - Seal Table with BMI Transfer cart in normal operating position.

Photo # 2 - Seal Table with BMI transfer cart rolled to side and thimble tubes withdrawn.

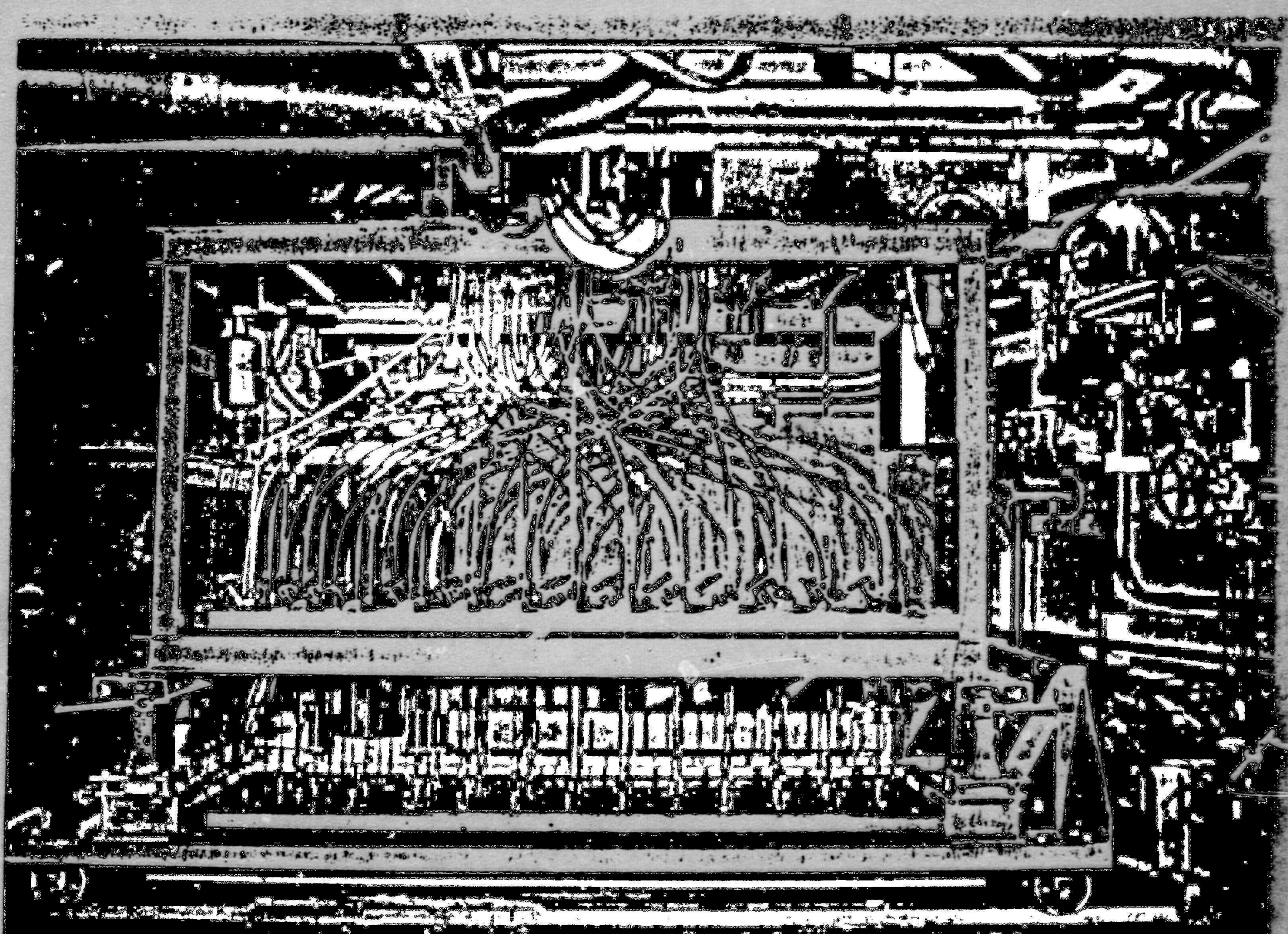


Photo # 1

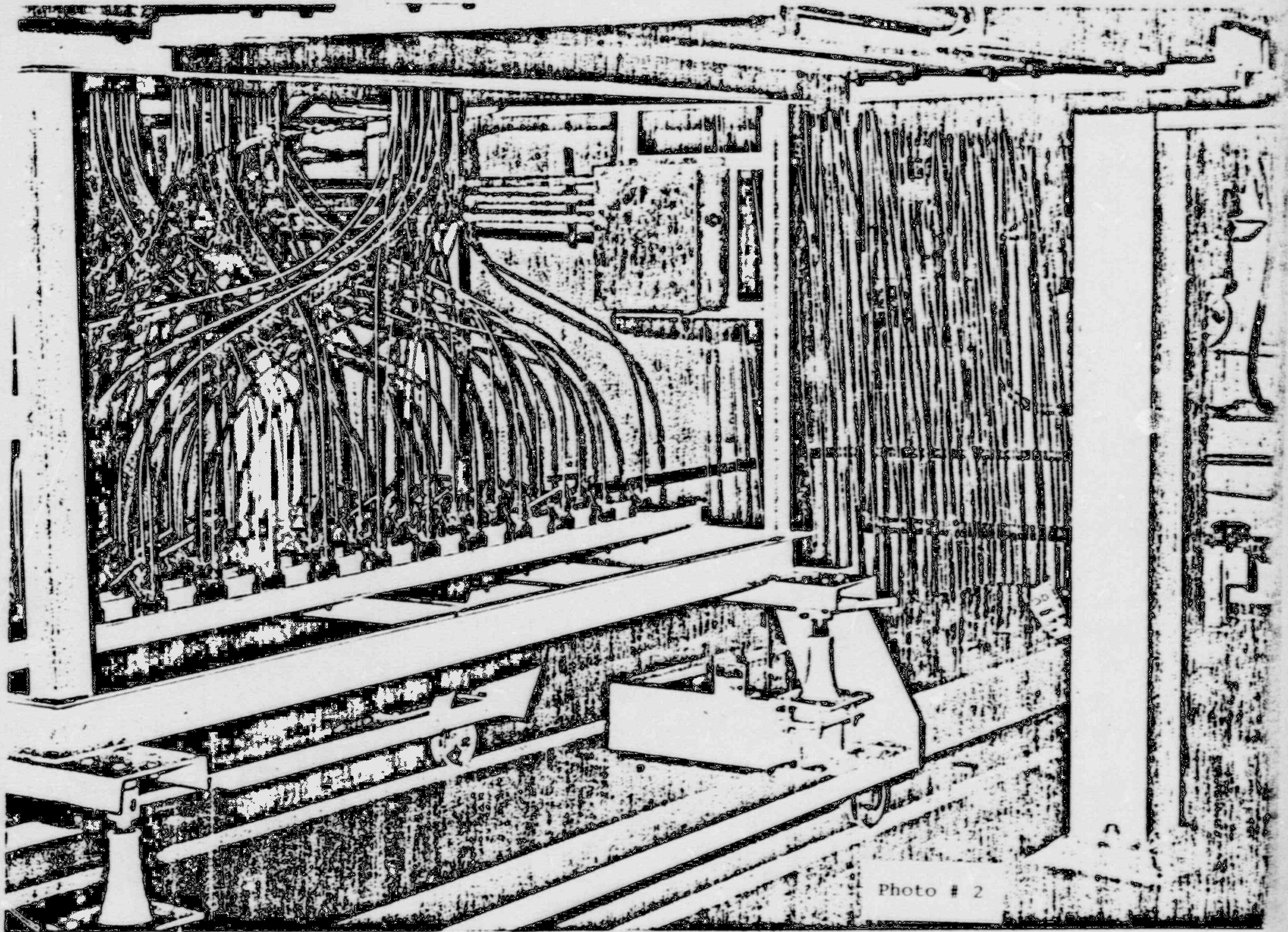


Photo # 2

ATTACHMENT 5

Eddy Current Testing Inspection Results

Unit 1 Thimble Tube ECT results During
The 7th and 8th and 9th Refueling Outages

	YEAR	TUBE #	PERCENT WALL LOSS	LOCATION
1.	1986	01-J7	10-20%	LCP
	1988	01-J7	17-20%	LCP
	1989	J7	0%	-
	1989	J7	0%	-
2.	1986	02-G7	10-20%	LCP
	1988	02-G7	16-21%	LCP
	1988	02-G7	17-19%	TP
	1989	G7	26%	-
3.	1986	03-G9	BLOCKED	83'
	1988	03-G9	BLOCKED	Considered permanently blocked.
*	1989	G9	BLOCKED	Capped and isol. vlv. shut. w/D 3"
4.	1986	04-H6	10-20%	LCP
	1988	04-H6	18-26%	LCP
	1988	04-H6	16-19%	TP
	1989	H6	20%	-
5.	1986	05-F8	0%	-
	1988	05-F8	0%	-
	1989	F8	0%	-
6.	1986	06-J10	0%	-
	1986	06-J10	0%	LCP
	1988	06-J10	24-35%	TP
*	1989	J10	47%	W/D 1"
7.	1986	07-F9	0%	-
	1988	07-F9	0%	LCP
	1988	07-F9	18-33%	TP
	1989	F9	20%	-
8.	1986	08-F6	10-20%	LCP
	1988	08-F6	17-38%	LCP
	1989	F6	27%	-
9.	1986	09-H11	0%	-
	1988	09-H11	0%	LCP
	1988	09-H11	10-19%	TP
	1989	H11	0%	-
10.	1986	10-L8	0%	-
	1988	10-L8	0%	-
	1989	L8	0%	-
11.	1986	11-L9	0%	-
	1988	11-L9	0%	LCP
	1988	11-L9	17-21%	TP
	1989	L9	17%	-
12.	1986	12-J5	0%	-
	1988	12-J5	0%	-
	1989	J5	0%	-
13.	1986	13-L6	25%	LCP
	1988	13-L6	19-33%	LCP
	1988	13-L6	17-25%	CSF
	1989	L6	29%	-
	1989	L6	35%	
14.	1986	14-F11	25-34%	LCP
	1988	14-F11	17-24%	LCP
	1989	F11	38%	-

15.	1986	15-H4	10-20%	LCP
	1988	15-H4	17-26%	LCP
	1989	H4	19%	-
16.	1986	16-J12	0%	-
	1988	16-J12	0%	LCP
	1988	16-J12	19-35%	TP
	1989	J12	31%	-
17.	1986	17-D7	0%	-
	1988	17-D7	0%	LCP
	1988	17-D7	9-21%	TP
	1989	D7	18%	-
18.	1986	18-L11	20%	LCP
	1988	18-L11	17-27%	LCP
	1988	18-L11	24-42%	TP
	1989	L11	20%	-
19.	1986	19-L5	25%	LCP
	1988	19-L5	18-39%	LCP
	1988	19-L5	17-20%	TP
	1988	19-L5	16-19%	DP
	1989	L5	20%	-
20.	1986	20-E5	10-20%	LCP
	1988	20-E5	0%	-
	1989	E5	0%	-
21.	1986	21-E11	25%	LCP
	1988	21-E11	8-28%	LCP
	1989	E11	29%	-
* 22.	1986	22-F4	50-77%	W/D 3", capped & Iso. vlv. shut.
*	1988	22-F4	CAPPED	W/D an additional 1/2".
	1989	F4	23%	-
	1989	F4	30%	-
*	1989	F4	62%	Replaced cap.
23.	1986	23-D10	34-35%	LCP
	1988	23-D10	11-39%	LCP
	1988	23-D10	20-39%	TP
	1988	23-D10	16-31%	CSF
	1989	D10	27%	-
	1989	D10	28%	-
24.	1986	24-H13	25-30%	LCP
	1988	24-H13	24-36%	LCP
	1989	H13	36%	-
25.	1986	25-N8	0%	-
	1988	25-N8	0%	LCP
	1988	25-N8	16-17%	TP
	1989	N8	0%	-
26.	1986	26-L4	25%	LCP
	1988	26-L4	19-35%	LCP
	1989	L4	30%	-
27.	1986	27-H3	0%	-
	1988	27-H3	0%	LCP
	1988	27-H3	0%	-
	1988	27-H3	16-19%	TP
	1989	H3	36%	-
28.	1986	28-D5	0%	-
	1988	28-D5	0%	LCP
	1988	28-D5	16-18%	TP
	1989	D5	18%	-

29.	1986	29-C8	0%	-
	1988	29-C8	0%	-
	1989	C8	0%	-
30.	1986	30-N7	0%	-
	1988	30-N7	0%	-
	1989	N7	0%	-
31.	1986	31-J3	0%	-
	1988	31-J3	0%	LCP
	1988	31-J3	15-26%	TP
	1988	31-J3	16-33%	CSF
	1989	J3	38%	-
32.	1986	32-N10	10-20%	LCP
	1988	32-N10	0%	LCP
	1988	32-N10	0%	-
	1989	N10	0%	-
33.	1986	33-F13	10-20%	LCP
	1988	33-F13	0%	LCP
	1988	33-F13	16-28%	TP
	1989	F13	24%	-
34.	1986	34-D12	25%	LCP
	1988	34-D12	9-38%	LCP
	1988	34-D12	18-38%	CSF
	1989	D12	24%	-
	1989	D12	33%	
35.	1986	35-N5	25%	LCP
	1988	35-N5	19-31%	LCP
	1988	35-N5	18-30%	TP
	1989	N5	33%	-
36.	1986	36-B8	0%	-
	1988	36-B8	0%	-
	1989	B8	0%	-
37.	1986	37-B7	10-20%	LCP
	1986	37-B7	0%	CSF
	1988	37-B7	19-25%	LCP
	1988	37-B7	16-18	CSF
	1989	B7	24%	-
38.	1986	38-G14	10%	LCP
	1988	38-G14	17-26%	LCP
	1989	G14	38	-
39.	1986	39-F2	10-20%	LCP
	1988	39-F2	16-19%	LCP
	1989	F2	22%	-
40.	1986	40-B10	25-27%	LCP
	1988	40-B10	20-38%	LCP
	1988	40-B10	16-24%	TP
	1989	B10	28%	-
41.	1986	41-N12	0%	-
	1988	41-N12	0%	LCP
	1988	41-N12	15-18%	TP
	1989	N12	18%	-

	42.	1986	42-M3	40%	LCP
		1988	42-M3	26-43%	LCP
		1988	42-M3	19-36%	TP
		1988	42-M3	22-36%	CSF (top)
*		1988	42-M3	22-33%	W/D 1/2".
		1989	M3	40%	-
*		1989	M3	46%	W/D an additional 1".
	43.	1986	43-D3	0%	-
		1988	43-D3	0%	-
		1989	D3	0%	-
	44.	1986	44-C12	25%	LCP
		1988	44-C12	17-39%	LCP
		1988	44-C12	19-35%	CSF
		1989	C12	20%	-
*		1989	C12	45%	W/D 1"
	45.	1986	45-L14	0%	-
		1986	45-L14	0%	-
		1988	45-L14	0%	-
		1988	45-L14	0%	LCP
		1988	45-L14	28-35%	CSF
*		1989	L14	67%	W/D 1", capped & iso. vlv. shut.
	46.	1986	46-B5	30%	LCP
		1988	46-B5	14-37%	LCP
		1988	46-B5	15-17%	CSF
		1989	B5	31%	-
	47.	1986	47-R8	0%	-
		1986	47-R8	0%	92'
		1988	47-R8	0%	-
		1988	47-R8	22-37%	CSF (TOP)
		1988	47-R8	34-37%	CSF (BASE)
		1989	R8	52%	-
*		1989	R8	63%	W/D ~~2.5~~ 2 7/8", capped & iso. vlv. shut.
	48.	1986	48-H1	40%	LCP
		1988	48-H1	30-38%	LCP
*		1988	48-H1	16-18%	W/D 1/2".
		1989	H1	26%	-
*		1989	H1	51%	W/D an additional 1".
	49.	1986	49-J15	0%	-
		1988	49-J15	0%	-
		1988	49-J15	0%	60'-65'
		1989	J15	0%	-
	50.	1986	50-A9	0%	-
		1988	50-A9	17-23%	LCP
		1988	50-A9	20-36%	CSF
		1989	A9	20%	-
		1989	A9	40%	-

6 PULLED BACK
4 CAPPED
1 BLOCKED (G-9 blocked & capped)

NOTE: * = A THIMBLE TUBE WITHDRAWN OR WORKED DURING THAT OUTAGE

Unit 2 Thimble Tube ECT Results
During The 5th & 6th Refueling Outage

		TUBE #	PERCENT WALL LOSS	LOCATION	COMMENTS
1.	1987	01-J7	0%	-	GOOD LCP
	1989	01-J7	NDD		
2.	1987	02-G7	0%	-	SLIGHT DIST @ LCP
	1989	02-G7	NDD		
3.	1987	03-G9	0%	-	SLIGHT DIST @ LCP
	1989	03-G9	NDD		
4.	1987	04-H6	0%	-	GOOD LCP
	1989	04-H6	25%		
5.	1987	05-F8	0%	-	SLIGHT DIST @ LCP
	1989	05-F8	NDD		
6.	1987	06-J10	0%	-	SLIGHT DIST @ LCP
	1989	06-J10	NDD		
7.	1987	07-F9	0%	-	GOOD LCP
	1989	07-F9	NDD		
8.	1987	08-F6	0%	-	GOOD LCP
	1987	08-F6	0%	45'	DEPOSIT
	1989	08-F6	NDD		
9.	1987	09-H11	0%	-	SLIGHT DIST @ LCP
	1987	09-H11	0%	CSF	DEPOSIT
	1989	09-H11	NDD		
10.	1987	10-L8	0%	-	GOOD LCP
	1989	10-L8	27%		
* 11.	1987	11-L9	22-48%	90'	W/D ~~1/2"~~ 2 1/2"
	1989	11-L9	NDD		
12.	1987	12-J5	0%	-	GOOD LCP
	1989	12-J5	NDD		
13.	1987	13-L6	0%	-	GOOD LCP
	1989	13-L6	NDD		
14.	1987	14-F11	0%	-	SLIGHT DIST @ LCP
	1989	14-F11	NDD		
15.	1987	15-H4	0%	-	GOOD LCP
	1989	15-H4	NDD		
16.	1987	16-J12	0%	-	GOOD LCP
	1987	16-J12	0%	TP-RC	DEPOSITS
	1989	16-J12	NDD		
17.	1987	17-D7	0%	-	SLIGHT DIST @ LCP
	1987	17-D7	0%	TP	DEPOSITS
	1989	17-D7	NDD		
18.	1987	18-L11	26-45%	105'	ID DEFECT
	1987	18-L11	0%	-	GOOD LCP
	1989	18-L11	NDD		
19.	1987	19-L5	0%	-	GOOD LCP
	1987	19-L5	0%	-	DEPOSITS ALONG COND
	1989	19-L5	NDD		
20.	1987	20-E5	0%	-	GOOD LCP
	1989	20-E5	NDD		

21.	1987	21-E11	0%	-	GOOD LCP
	1989	21-E11	NDD		
22.	1987	22-F4	0%	-	GOOD LCP
	1989	22-F4	NDD		
23.	1987	23-D10	0%	-	GOOD LCP
	1989	23-D10	NDD		
24.	1987	24-H13	0%	-	GOOD LCP
	1989	24-H13	NDD		
25.	1987	25-N8	27-44%	84'	WEAR @ TP
	1987	25-N8	0%	-	GOOD LCP
*	1989	25-N8	53%		W/D ~~2.0" [illegible] 0.25"~~ 1 7/8"
26.	1987	26-L4	0%	-	GOOD LCP
	1989	26-L4	NDD		
27.	1987	27-H3	0%	-	GOOD LCP
	1989	27-H3	NDD		
28.	1987	28-D5	0%	-	GOOD LCP
	1989	28-D5	NDD		
29.	1987	29-C8	0%	-	GOOD LCP
	1989	29-C8	NDD		
30.	1987	30-N7	0%	-	GOOD LCP
	1989	30-N7	NDD		
31.	1987	31-J3	0%	-	GOOD LCP
	1987	31-J3	0%	-	SLIGHT DIST @ CSF
	1989	31-J3	NDD		
32.	1987	32-N10	0%	-	GOOD LCP
	1989	32-N10	NDD		
33.	1987	33-F13	0%	-	GOOD LCP
	1989	33-F13	NDD		
34.	1987	34-D12	0%	-	GOOD LCP
	1989	34-D12	NDD		
35.	1987	35-N5	0%	-	GOOD LCP
	1989	35-N5	NDD		
36.	1987	36-B8	0%	-	GOOD LCP
	1989	36-B8	16%		
37.	1987	37-B7	0%	-	GOOD LCP
	1989	37-B7	13%		
38.	1987	38-G14	0%	-	GOOD LCP
	1989	38-G14	NDD		
39.	1987	39-F2	22-43%	87'	WEAR @ LCP
	1989	39-F2	29%		
40.	1987	40-B10	22-34%	92'	WEAR @ CSF
	1987	40-B10	0%	-	GOOD LCP
	1989	40-B10	28%		
41.	1987	41-N12	20-40%	94'	WEAR @ TP
	1987	41-N12	0%	-	GOOD LCP
	1987	41-N12	0%	108'	DEPOSIT
	1989	41-N12	26%		
42.	1987	42-M3	0%	-	GOOD LCP
	1989	42-M3	NDD		
43.	1987	43-D3	0%	-	GOOD LCP
	1989	43-D3	NDD		
44.	1987	44-C12	0%	-	GOOD LCP
	1989	44-C12	NDD		

45.	1987	45-L14	0%	-	GOOD LCP
	1987	45-L14	0%	-	DEPOSIT @ TOP-DP
	1989	45-L14	NDD		
46.	1987	46-B5	20-26%	85'	WEAR @ CSF
	1987	46-B5	0%	-	GOOD LCP
*	1989	46-B5	53%		W/D ~~2.5" - 0.25"~~ 2 3/8"
47.	1987	47-R8	0%	-	GOOD LCP
★	1989	47-R8	14%	-	cut off 9/16" of thimble to change fitting
48.	1987	48-H1	0%	-	GOOD LCP
	1989	48-H1	NDD		
49.	1987	49-J15	0%	-	GOOD LCP
	1989	49-J15	NDD		
50.	1987	50-A9	0%	-	DIST @ LCP
	1989	50-A9	NDD		

~~3~~ 4 PULLED BACK
0 CAPPED
0 BLOCKED

STATUS OF FARLEY NUCLEAR PLANT

INCORE THIMBLES

UNIT ONE

AS OF 10/89

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1								51 W/D							
2										22					
3				46 W/D			38	$\boxed{36}$				0			
4					30			19		62 CAP					
5			33		$\boxed{20}$		0				$\boxed{0}$	18		31	
6					35			20		27					
7			0				0		26			18		24	
8	63 CAP		$\boxed{0}$		0					0			$\boxed{0}$	0	
9					17				BLOCK CAP	20					40
10			0				47 W/D					28		28	
11					$\boxed{20}$			0		38	$\boxed{29}$				
12			18				31					33	45 W/D		
13								$\boxed{36}$		24					
14					67 CAP				38						
15							0								

"NUMBER" = PERCENTAGE BLOCKED

W/D = WITHDRAWN

CAP = CAPPED

☐ = SYMMETRIC THIMBLE

STATUS OF FARLEY NUCLEAR PLANT

INCORE THIMBLES

UNIT Two

AS OF 3/89

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1								0							
2										29					
3				0			0	$\boxed{0}$				0			
4					0			0		0					
5			0		$\boxed{0}$		0				$\boxed{0}$	0		53 W/D	
6					0			25		0					
7			0				0		0			0		13	
8	14		$\boxed{53 \text{ W/D}}$		27					0			$\boxed{0}$	16	
9					0				0	0					0
10			0				0					0		28	
11					$\boxed{0}$			0		0	$\boxed{0}$				
12			26				0					0	0		
13								$\boxed{0}$		0					
14					0				0						
15							0								

"NUMBER" = PERCENTAGE BLOCKED

W/D = WITHDRAWN

CAP = CAPPED

☐ = SYMMETRIC THIMBLE

ATTACHMENT 6

November 29, 1989 Submittal

Alabama Power Company
40 Inverness Parkway
Post Office Box 1295
Birmingham, Alabama 35201
Telephone 205 870-6011

Alabama Power

November 29, 1989

Mr. Giuliano DeGrassi
Strurtural Analysis Division
Department of Nuclear Energy, Building 129
Brookhaven National Laboratory
Upton, New York 11973

J. M. Farley Nuclear Plant - Units 1 & 2
NRC Audit of Bulletin 88-09 Issues

Dear Mr. DeGrassi:

Enclosed are copies of the following documents to resolve all open items from your recent audit of Bulletin 88-09 issues:

(1) Westinghouse letter report MED-RPV-2574: Evaluation of the Echoram Wear Scar
(2) Westinghouse letter report ALA-87-608: Unit 1 Flux Mapping System Seismic Analysis
(3) Westinghouse letter report ALA-86-741: Unit 2 Flux Mapping System Seismic Analysis
(4) Sketch showing Unit 1 BMI instrument column thimble tube dimensions
(5) Sketch showing Unit 2 BMI instrument column thimble tube dimensions
(6) 26350 (4 sheets) EANCO Inc. drawings: Control System - Flux Mapping
(7) 26353 (1 sheet) EANCO Inc. drawing: Carriage Assembly

If there are any questions please advise.

Yours truly,

A. E. Hammett

A. E. Hammett
Nuclear Maintenance Support

AEH
Attachments
Distribution:
Mr. Giuliano DeGrassi - w/1
Mr. A. E. Hammett - w/1
File: C-56 - w/0

MED-RPV-2574

From MECHANICAL EQUIPMENT DESIGN
WIN 236-6366
Date November 27, 1989
Subject Evaluation of Echoram Wear Scar

To J. A. Knochel/EC-West 232A
L. F. Dougherty/EC-West 232

cc: C. H. Boyd/STC 701-306
C. M. Scrabis/STC 701-303
D. E. Boyle/STC 701-306
D. Merkovsky/STC 701-303

REFERENCE: Calc. Note RPVSA-89-1505

We have completed an evaluation of the Echoram wear scar identified as the "check-mark" configuration. Please transmit the following information to the ALA customer.

As a follow-up to conversations between Primary Component Engineering personnel and the ALA customer we have completed, and are hereby documenting, the evaluation of the Echoram wear scar with the "check-mark" configuration. The results for the "check-marked" configuration indicate a maximum stress intensity of 22,109 psi which is less than the previously report value of 23,318 psi.

This analysis was based on wear scars identified in Echoram drawing WS-A-007-89, and can be described as a 90° wear scar, with 65% wall loss, and a length of 0.97 inches.

All other features of the previous report remain as presented. The only purpose of this report is for a comparison to the previous analysis.

Attached with this letter are color plots of the stress intensity contours from this evaluation.

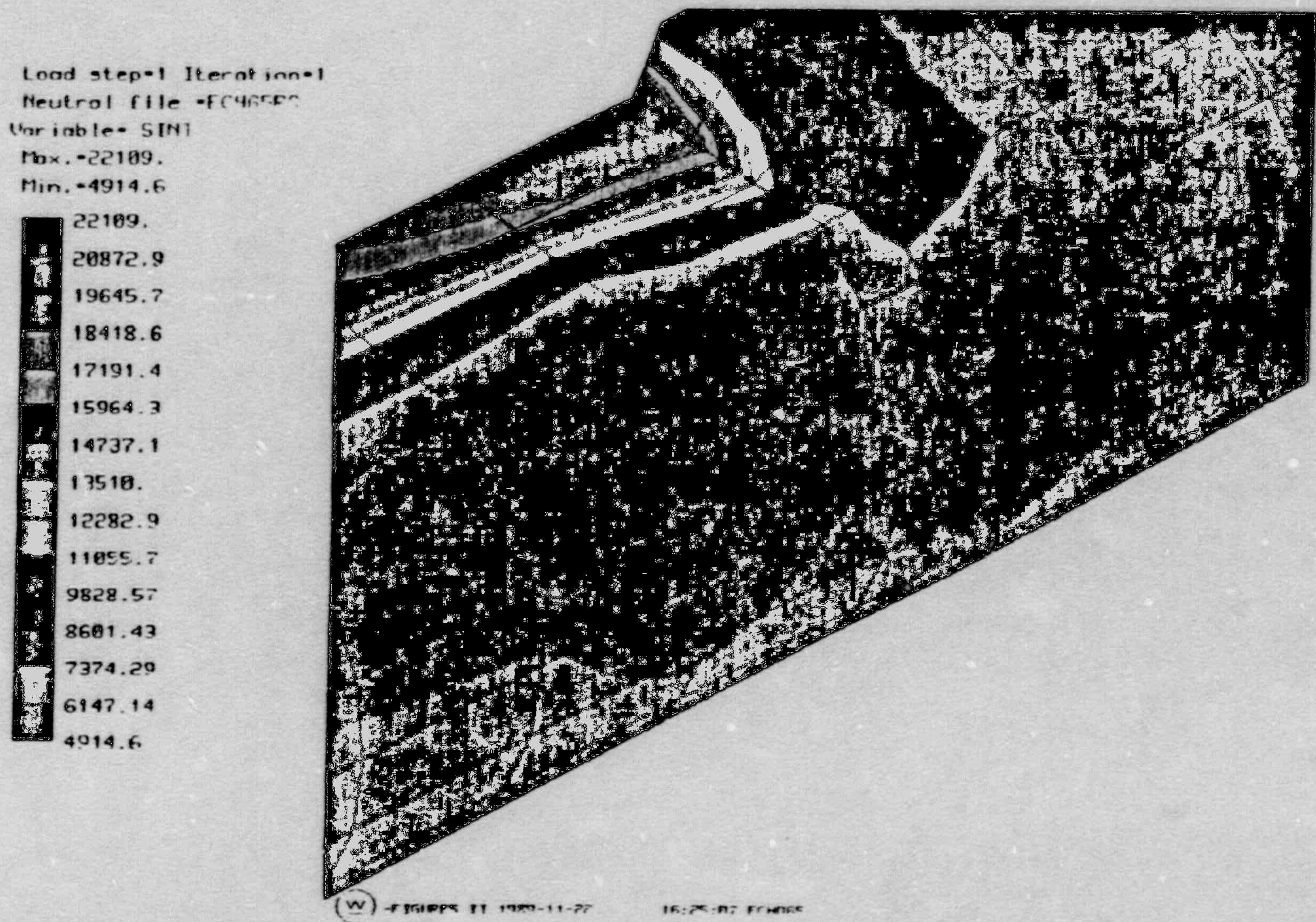
AJ Kuenzel

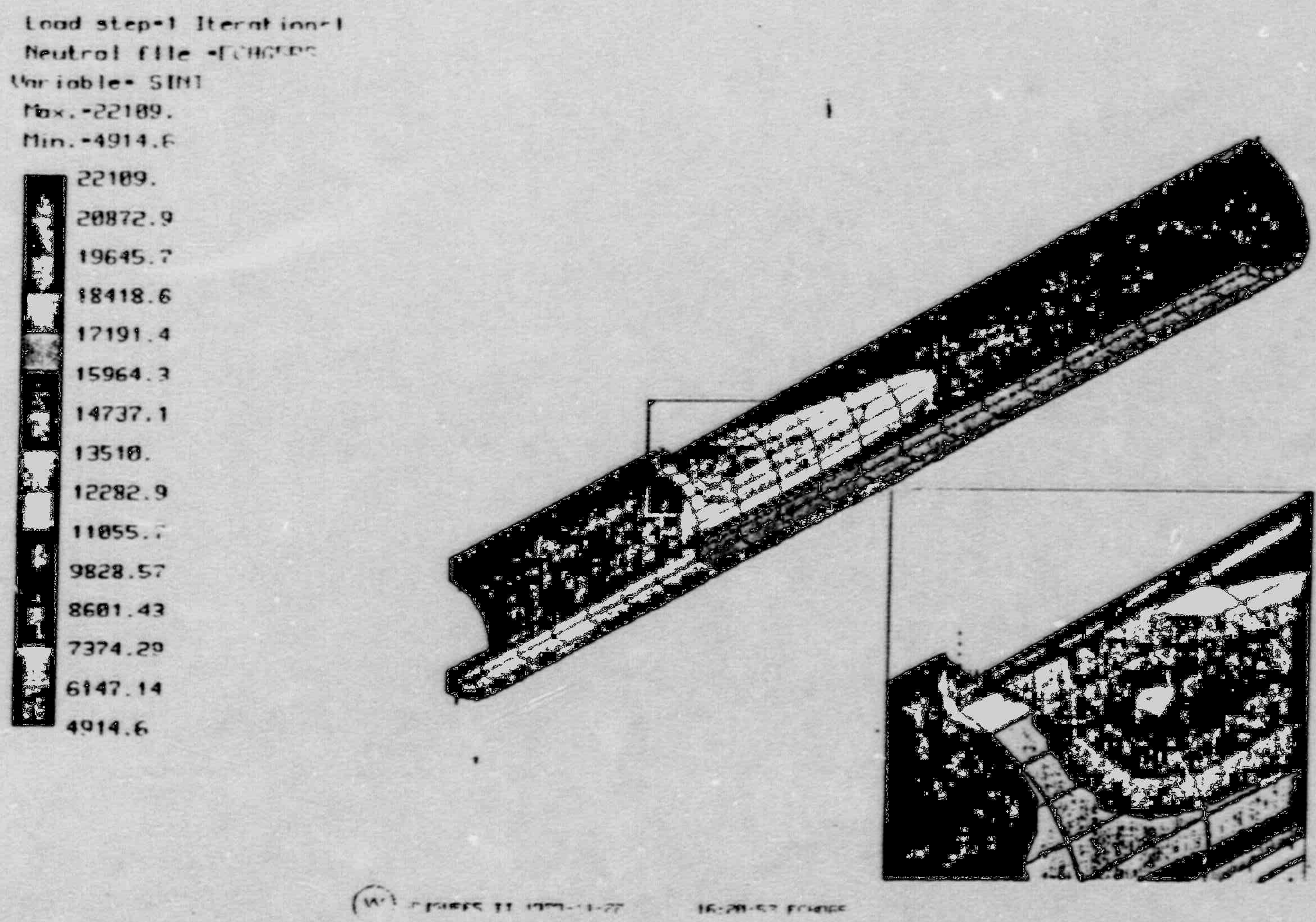
A. J. Kuenzel
Reactor Pressure Vessel
System Analysis

/kls

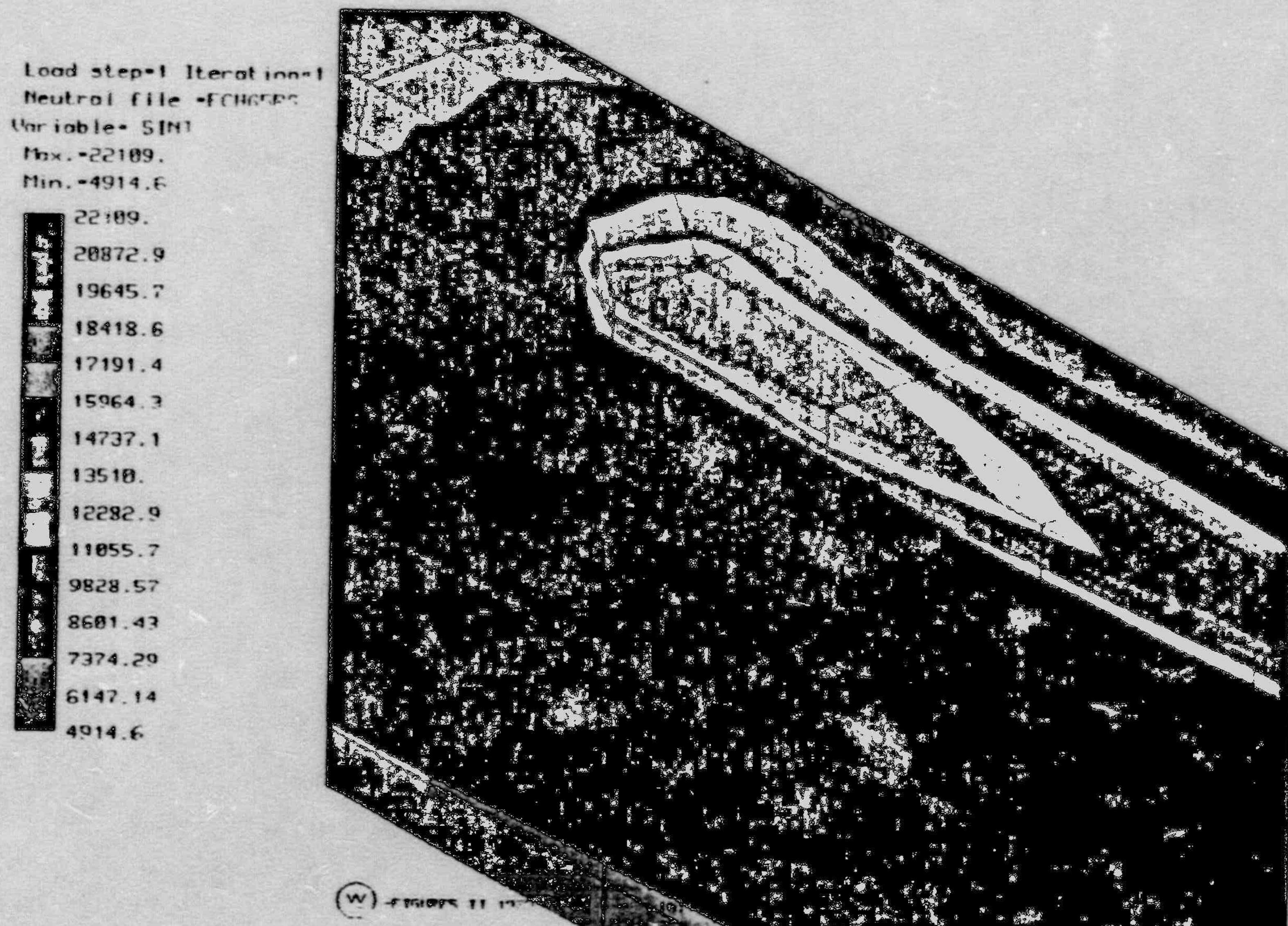
Attachment

FORM 3?


Load step=1 Iteration=1
Variable= SINT
Max.=22109.
Min.=4914.6
22109.
20872.9
19645.7
18418.6
17191.4
15964.3
14737.1
13510.
12282.9
11055.7
9828.57
8601.43
7374.29
6147.14
4914.6



Load step=1 Iteration=1
Neutral file =
Variable= SINT
Max.=22109.
Min.=4914.6
22109.
20872.9
19645.7
18418.6
17191.4
15964.3
14737.1
13510.
12282.9
9828.57
8601.43
7374.29
6147.14
4914.6



Load step=1 Iteration=1
Neutral file
Variable= SIN1
Max.=22109.
Min.=4914.6
22109.
20872.9
19645.7
18418.6
17191.4
15964.3
14737.1
13510.
12282.9
11055.7
9828.57
8601.43
7374.29
6147.14
4914.6

Westinghouse
Electric Corporation

Power Systems

[illegible]

CENTRAL ENGINEERING FILE
ALA - 144 - FMS - 212
ENGINEER: G. P. Hartman

ALA-87-608
Ref: G.O. BH-65061
FAR 90087

April 21, 1987

Mr. W. G. Hairston, III, General Manager
Nuclear Support
Alabama Power Company
600 North Eighteenth Street
Birmingham, AL 35291-0400

Attn: J. A. Ripple

Joseph M. Farley Nuclear Plant
Unit No. 1
FMS DRIVE SYSTEM SEISMIC ANALYSIS

Dear Mr. Hairston:

Attached for your information is the subject report. As discussed in the report, the four bolts in the Bechtel restraints which are used to hold the FMS cart in position over the seal table should be replaced at the next available opportunity. While the installed bolts will not yield or fail when subjected to the Farley seismic levels, the analysis showed they could be stressed beyond AISC allowable levels.

If you have any questions, please contact this office.

Bolts replaced as recommended by report in Units 1 & 2
Ref. telecon A E Hammett & G. DeGroff 12/5/89
RD

Very truly yours,
WESTINGHOUSE ELECTRIC CORPORATION

J A Koschel
for C. Eicheldinger, Manager
Alabama Project

JAK/flc
Attachment

7998e

cc: R. P. McDonald 1L
W. G. Hairston III 1L, 1A
J. D. Woodard 1L, 1A
K. C. Gandhi 1L, 1A
L. B. Long 1L
J. R. Crane 1L
R. H. Baulig 1L, 1A
R. W. Wise 1L
J. A. Ripple 1L, 1A

7998e

SEISMIC EVALUATION OF THE FARLEY, UNIT 1, FLUX MAPPING SYSTEM

Prepared by: Alan J. Hartmann
A.J. Hartmann
Equipment Qualification Technology

Reviewed by: Joan E Drexler
J.E. Drexler
Equipment Qualification Technology

Approved by: [signature]
L.J. Walker, Manager
Equipment Qualification Technology

SEISMIC EVALUATION OF THE FARLEY, UNIT 1, FLUX MAPPING SYSTEM

1.0 Introduction

A seismic analysis of the Farley Unit 1 Flux Mapping System (FMS) has been performed to address the concern that it may interact with and jeopardize the seal table pressure boundary during a seismic event. The analysis was performed in accordance with the recommended practices of IEEE 344-1975 (Reference 1) to determine if the FMS would maintain its structural integrity during a seismic event.

2.0 Equipment Analyzed

The equipment analyzed is the moveable FMS defined in Eanco Inc. drawing numbers 26350 Rev. C (Unit 1) and 26975 Rev. A (Unit 2). A walkdown of the equipment installed in Unit 1 was performed on October, 1986 to confirm the drawings and gather the necessary details to perform the analysis. The FMS is mounted to rails and is located above the seal table during operation at elevation 129'-0" in the containment building. The FMS is composed of structural steel which supports drive assemblies, transfer devices, and thimble tubing.

During the walkdown, the FMS equipment was inspected to determine what portions of the FMS could interact with the seal table and therefore require analysis. It was determined that only the moveable cart required analysis. The five (5) path transfer devices and their supporting structures are located off the moveable cart, at least 4 feet from the seal table. It was judged that these components could not interact with the seal table since they are located so far from the seal table. Furthermore, steel grating, as well as the plate on top of the FMS moveable cart, is located between these components and the seal table, and it is highly unlikely that these components or their supporting structures would fail during a seismic event. Therefore, only the moveable cart was judged to be able to interact with the seal table and was the only piece of FMS equipment analyzed.

3.0 Analysis

Finite element computer models were developed using the WECAN computer code. Three dimensional beam, mass, and shell elements were used to model the FMS. Model boundary conditions were chosen to result in the most realistic yet conservative results for each type of analysis. Bolted connection points within the model were constrained only in the appropriate translational and/or rotational directions for the type of connection. These bolted connections were evaluated with hand calculations using the combined loads derived from the computer analysis.

Using the available Farley Safe Shutdown Earthquake (SSE) Required Response Spectrum (RRS), 4% damping RRS curves were developed for the containment building at elevation 129'. A modal RRS analysis using these RRS was performed to derive loads and stresses in each principal axis of the FMS. The results from each mode were combined by the square-root-of-the-sum-of-the-squares (SRSS) method, except for closely spaced modes (within 10% of each other) which were combined absolutely. Static analyses were also performed to derive stresses and loads due to structure deadweight and Zero Period Acceleration (ZPA) levels in each of the equipment principal axes as defined by the Farley RRS. The ZPA analyses were performed to include the effects of higher frequency modes in the analysis. The RRS analysis results were combined absolutely with the ZPA results for each principal direction. The two horizontal principal direction RRS plus ZPA results and the vertical direction RRS plus ZPA results were combined by the SRSS method. Finally, an absolute sum method was used to combined these results with the deadweight results. The final results were considered in determining the acceptability of the structure when subjected to seismic loading. These resulting member stresses were evaluated for acceptability based on American Institute of Steel Construction (AISC) specifications as defined in Reference 2.

4.0 Results

Results of the stress evaluation revealed that the only elements which were stressed beyond AISC allowables (assuming A-307 bolts were used) were the two bolts connecting the FMS C-Channel restraint to the Bechtel designed restraints. However if the present bolts are replaced by 1/2 in. diameter A325 (or equivalent) bolts, the connection will be acceptable. All other elements were found to be stressed below AISC allowable levels, including connections which were evaluated with hand calculations using loads derived from the computer analysis.

The Bechtel designed restraints were included in our analysis. Table 1 provides the loads at the interface between the 4x2x1/4 angle and the 8x3 tube steel for the "C-channel" restraint. Table 2 provides the loads at the interface between the 4x4x1/4 tube steel and the 8x3 tube steel for the "tube steel" restraint.

5.0 Conclusions and Recommendations

A seismic required response spectrum analysis was performed on the Farley FMS using the WECAN finite element computer code. All seismic member stresses were found to be within AISC allowable levels, except for the bolts used in one of the Bechtel designed restraints. The bolts presently used to attach the C-channel to the Bechtel designed restraint must be upgraded to ASTM-A-325 bolts (or equivalent). As determined in a previous analysis (Reference 3), the bolts are not stressed beyond their yield stress limits. Therefore, the restraint will not yield or fail when exposed to the Farley seismic levels. However the existing 1/2 inch diameter ASTM-A307 bolts should be replaced with 1/2 inch diameter ASTM-A325 (SAE Grade 5) bolts at the next available opportunity. This will ensure that the design bolt stresses will remain within allowable limits.

6.0 References

1. "IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations", IEEE 344-1975, The Institute of Electrical and Electronics Engineers, Inc., New York, New York, January 31, 1975.

2. Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, Effective November 1978, AISC.

3. W Project Letter ALA-86-741, dated September 2, 1986, Subject: "FMS Drive System Seismic Analysis".

TABLE 1

"U-CHANNEL" RESTRAINT LOADS

Loads are provided at the interface between
the 4x2x1/4 angle and the 8x3 tube steel

Px = Force in x direction = 82 lbs.

Py = Force in y direction = 326 lbs.

Pz = Force in z direction = 630 lbs.

Mx = Moment about x direction = 6968 in.-lbs.

My = Moment about y direction = 325 in.-lbs.

Mz = Moment about z direction = 171 in.-lbs.

Where: x direction is parallel to rails (horizontal).

y direction is perpendicular to rails (horizontal).

z direction is vertical.

TABLE 2

"TUBE STEEL" RESTRAINT LOADS

Loads are provided at the interface between
the 4x4x1/4 angle and the 8x3 tube steel

Px = Force in x direction = 592 lbs.

Py = Force in y direction = 391 lbs.

Pz = Force in z direction = 610 lbs.

Mx = Moment about x direction = 10868 in.-lbs.

My = Moment about y direction = 7960 in.-lbs.

Mz = Moment about z direction = 1228 in.-lbs.

Where: x direction is parallel to rails (horizontal).

y direction is perpendicular to rails (horizontal).

z direction is vertical.

Westinghouse
Electric Corporation

Power Systems

Energy Systems
Service Division

Box 355
Pittsburgh Pennsylvania 15230 0355

ALA-86-741
Ref: G.O. BH-44284
FAR 91386
September 2, 1986

Mr. W. G. Hairston, III, General Manager
Nuclear Support
Alabama Power Company
600 North Eighteenth Street
Birmingham, AL 35291

Attn: J. A. Ripple

Joseph M. Farley Nuclear Plant
Unit No. 2
FMS DRIVE SYSTEM SEISMIC ANALYSIS

Dear Mr. Hairston:

Attached for your information is the subject report. As discussed in the report, the four bolts in the Bechtel restraints which are used to hold the FMS cart in position over the seal table should be replaced at the next available opportunity. While the bolts currently will not yield or fail when subjected to the Farley seismic levels, the analysis showed they could be stressed beyond AISC allowable levels.

A Safety Evaluation Checklist for the report is also attached.

Very truly yours,
WESTINGHOUSE ELECTRIC CORPORATION

JA Knochel
for C. Eicheldinger, Manager
Alabama Project

JAK/pmh
Attachment

6049e:12

cc: R. P. McDonald 1L, 1A
W. G. Hairston III 1L, 1A
J. D. Woodard 1L, 1A
K. C. Gandhi 1L, 1A
L. B. Long 1L, 1A
J. R. Crane 1L, 1A
R. H. Baulig 1L, 1A
R. W. Wise 1L, 1A
J. A. Ripple 1L, 1A

6049e:12

EQ&T-EQT-3864

From: Equipment Qualification Technology
WIN: 236-6287
Date: August 21, 1986
Subject: Farley Flux Mapping System Seismic Evaluation Summary Report

To: J.A. Knochel - MNC 237

cc: J.J. McInerney - MNC 409
W.F. Guerin - MNC 409
~~D.G. [illegible] - MNC 237~~
A.J. Hartmann - R&D 701/307
J.M. Ludwiczak - R&D 701/307
K.G. Lunz - ITTC 264
W.W. Wassel - ITTC 264
File: ALA-144-FMS/2

In response to the customer's request, attached is a summary report for the seismic evaluation of the Farley Flux Mapping System (FMS). Using a conservative load combination procedure, the analysis revealed that the only members which were stressed beyond allowable limits when subjected to Farley seismic levels were the bolts used in both Bechtel designed restraints. Further detailed analysis however, revealed that the bolts were not stressed beyond their yield stress limit. Therefore, although these bolts are stressed beyond allowable levels, they will not yield or fail when subjected to seismic loads. However, these 1/2 inch diameter ASTM-A307 bolts should be replaced with 1/2 inch diameter ASTM-A325 (SAE Grade 5) bolts or equivalent at the next available opportunity.

The detailed analysis package for this effort will be maintained at W GTSD central file under central file number ALA-144-FMS and is available for audit. Should further details on the analysis be required, or if there are any questions, please contact the undersigned.

Paul T. Smith

P.T. Smith
Equipment Qualification Technology

L.I. Walker, Manager
Equipment Qualification Technology

jj

attachment

Discard Date

SEISMIC EVALUATION OF THE FARLEY FLUX MAPPING SYSTEM

Prepared by: Paul T. Smith
P.T. Smith
Equipment Qualification Technology

Reviewed by: A. J. Hartmann
A.J. Hartmann
Equipment Qualification Technology

Approved by: [signature]
L.I. Walker, Manager
Equipment Qualification Technology

SEISMIC EVALUATION OF THE FARLEY FLUX MAPPING SYSTEM

1.0 Introduction

A seismic analysis of the Farley Flux Mapping System (FMS) has been performed to address the concern that it may interact with and jeopardize the seal table pressure boundary during a seismic event. The analysis was performed in accordance with the recommended practices of IEEE 344-1975 (Reference 1) to determine if the FMS would maintain its structural integrity during a seismic event.

2.0 Equipment Analyzed

The equipment analyzed is the moveable FMS defined in Eanco Inc. drawing numbers 26350 Rev. C (Unit 1) and 26975 Rev. A (Unit 2). A walkdown of the equipment installed in Unit 2 was performed on April 8, 1986 to confirm the drawings and gather the necessary details to perform the analysis. The FMS is mounted to rails and is located above the seal table during operation at elevation 129'-0" in the containment building. The FMS is composed of structural steel which supports drive assemblies, transfer devices, and thimble tubing.

During the walkdown, the FMS equipment was inspected to determine what portions of the FMS could interact with the seal table and therefore require analysis. It was determined that only the moveable cart required analysis. The five (5) five path transfer devices and their supporting structures are located off of the moveable cart, at least 4 feet from the seal table. It was judged that these components could not interact with the seal table since they are located so far from the seal table. Furthermore, steel grating, as well as the plate on top of the FMS moveable cart, is located between these components and the seal table, and it is highly unlikely that these components or their supporting structures would fail during a seismic event. Therefore, only the moveable cart was judged to be able to interact with the seal table and was the only piece of FMS equipment analyzed.

3.0 Analysis

Finite element computer models were developed using the WECAN computer code. Three dimensional beam, mass, and shell elements were used to model the FMS. Model boundary conditions were chosen to result in the most realistic yet conservative results for each type of analysis. Bolted connection points within the model were constrained only in the appropriate translational and/or rotational directions for the type of connection. These bolted connections were evaluated with hand calculations using the combined loads derived from the computer analysis.

Using the available Farley Safe Shutdown Earthquake (SSE) Required Response Spectrum (RRS), 4% damping RRS curves were developed for the containment building at elevation 129'. A modal RRS analysis using this RRS was performed to derive loads and stresses in each principal axis of the FMS. The results from each mode were combined by the square-root-of-the-sum-of-the-squares (SRSS) method, except for closely spaced modes (within 10% of each other) which were combined absolutely. Static analyses were also performed to derive stresses and loads due to structure deadweight and Zero Period Acceleration (ZPA) levels in each of the equipment principal axes as defined by the Farley RRS. The ZPA analyses were performed to include the effects of higher frequency modes in the analysis. The RRS analysis results were combined absolutely with the ZPA results for each principal direction. The two horizontal principal direction RRS plus ZPA results and the vertical direction RRS plus ZPA results were combined by the SRSS method. Finally, an absolute sum method was used to combine these results with the deadweight results. The final results were considered in determining the acceptability of the structure when subjected to seismic loading. These resulting member stresses were evaluated for acceptability based on American Institute of Steel Construction (AISC) specifications as defined in Reference 2.

4.0 Results

Results of the stress evaluation revealed that the only elements which were stressed beyond the AISC allowable levels were the bolts used in both Bechtel designed restraints. Further detailed analysis was performed with a less conservative load combination method which combined each RRS result with each ZPA result by SRSS rather than by absolute sum. This analysis of the 1/2" diameter ASTM-A307 bolts revealed that although they were stressed beyond the AISC shear allowable levels, they were not stressed beyond the material shear yield strength and therefore would not yield or fail during a seismic event. All other elements were found to be stressed below AISC allowable levels, including connections which were evaluated with hand calculations using loads derived from the computer analysis.

The Bechtel designed restraints shown in Bechtel drawing D-206116 were included in the analysis. Table 1 provides the loads at the interface between the 4 x 2 x 1/4 angle and the 8 x 3 tube steel for the "C-channel" restraint. Table 2 provides the loads at the interface between the 4 x 4 x 1/4 tube steel and the 8 x 3 tube steel for the "tube steel" restraint.

5.0 Conclusions and Recommendations

A seismic required response spectrum analysis was performed on the Farely FMS using the WECAN finite element computer code. All seismic member stresses were found to be within AISC allowable levels, except for the bolts used in both Bechtel designed restraints. Justification for interim operation is based on a further detailed analysis which showed that the restraint bolts were not stressed beyond their yield stress limits. Therefore, the restraints will not yield or fail when exposed to the Farley seismic levels. However, the existing 1/2 inch diameter ASTM-A307 bolts should be replaced with 1/2 inch diameter ASTM-A325 (SAE Grade 5) or equivalent bolts at the next available opportunity. This will ensure that the bolt stresses will fall within allowable limits.

6.0 References

1. "IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," IEEE-344-1975, The Institute of Electrical and Electronics Engineers, Inc., New York, New York, January 31, 1975.

2. Manual of Steel Construction, Eighth Edition, American Institute of Steel Construction, Chicago, IL, 1980.

TABLE 1

"C-CHANNEL" RESTRAINT LOADS

Loads are provided at the interface between
the 4 x 2 x 1/4 angle and the 8 x 3 tube steel

Px = Force in x direction = 76 lbs.

Py = Force in y direction = 321 lbs.

Pz = Force in z direction = 616 lbs.

Mx = Moment about x direction = 6913 in.-lbs.

My = Moment about y direction = 305 in.-lbs.

Mz = Moment about z direction = 87 in.-lbs.

Where: x direction is parallel to rails (horizontal).

y direction is perpendicular to rails (horizontal).

z direction is vertical.

TABLE 2

"TUBE STEEL" RESTRAINT LOADS

Loads are provided at the interface between
the 4 x 4 x 1/4 tube steel and the 8 x 3 tube steel

Px = Force in x direction = 535 lbs.

Py = Force in y direction = 349 lbs.

Pz = Force in z direction = 553 lbs.

Mx = Moment about x direction = 9595 in.-lbs.

My = Moment about y direction = 7077 in.-lbs.

Mz = Moment about z direction = 466 in.-lbs.

Where: x direction is parallel to rails (horizontal).

y direction is perpendicular to rails (horizontal).

z direction is vertical.

SECL NO. 86-319

Customer Reference No(s).
N/A

Westinghouse Reference No(s).
NSTS-37562

WESTINGHOUSE

NUCLEAR SAFETY EVALUATION CHECK LIST

1) NUCLEAR PLANT(S) Farley Unit 2

2) CHECK LIST APPLICABLE TO: Flux Mapping System
(Subject of Change)

3) The written safety evaluation of the revised procedure, design change or modification required by 10CFR50.59 has been prepared to the extent required and is attached. If a safety evaluation is not required or is incomplete for any reason, explain on Page 2.

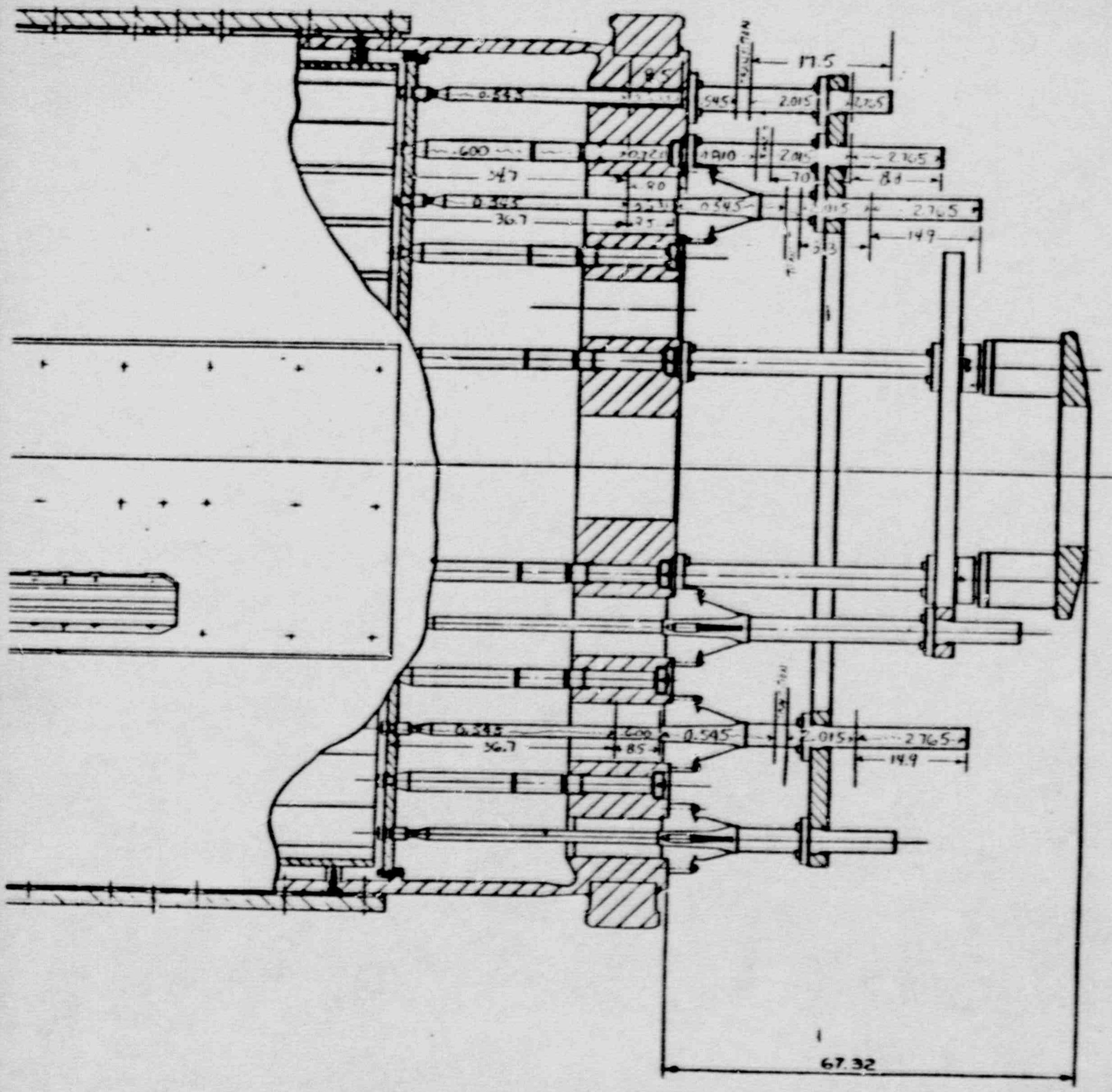
Parts A and B of this Safety Evaluation Check List are to be completed only on the basis of the safety evaluation performed.

CHECK LIST - PART A

(3.1) Yes ___ No ✓ A change to the plant as described in the FSAR?
(3.2) Yes ___ No ✓ A change to procedures as described in the FSAR?
(3.3) Yes ___ No ✓ A test or experiment not described in the FSAR?
(3.4) Yes ___ No ✓ A change to the plant technical specifications (Appendix A to the Operating License)?

4) CHECK LIST - PART B (Justification for Part B answers must be included on Page 2.)

(4.1) Yes ___ No ✓ Will the probability of an accident previously evaluated in the FSAR be increased?
(4.2) Yes ___ No ✓ Will the consequences of an accident previously evaluated in the FSAR be increased?
(4.3) Yes ___ No ✓ May the possibility of an accident which is different than any already evaluated in the FSAR be created?
(4.4) Yes ___ No ✓ Will the probability of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?
(4.5) Yes ___ No ✓ Will the consequences of a malfunction of equipment important to safety previously evaluated in the FSAR be increased?
(4.6) Yes ___ No ✓ May the possibility of a malfunction of equipment important to safety different than any already evaluated in the FSAR be created?
(4.7) Yes ___ No ✓ Will the margin of safety as defined in the bases to any technical specification be reduced?

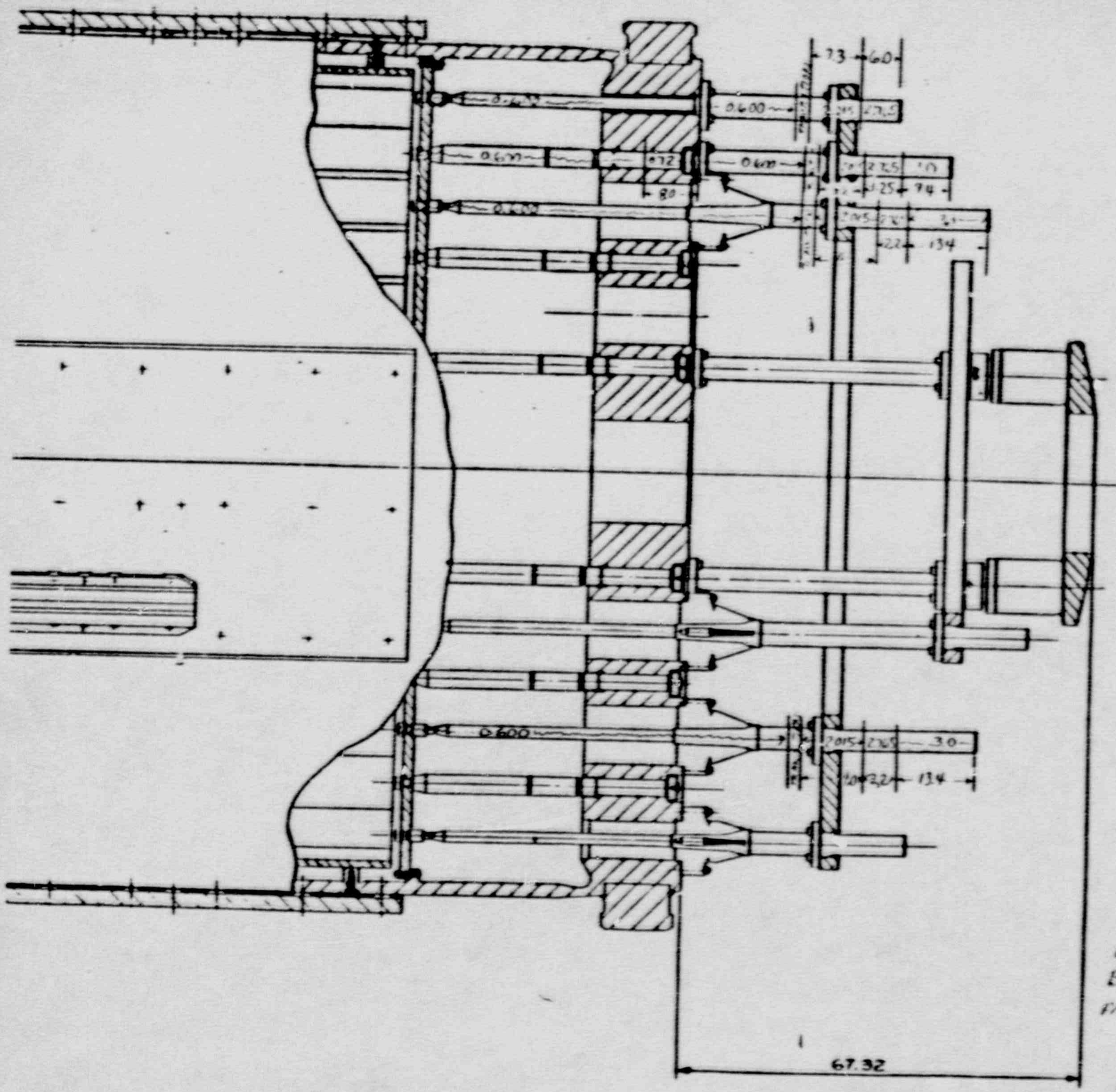


FARLEY UNIT #1

BMI INSTRUMENT COLUMN

PASSAGEWAYS FOR THIMBLE TUBES

[signature] 11/20/87



FARLEY UNIT #2
BMI INSTRUMENT COLUMN
PASSAGEWAYS FOR THIMBLE TUBES

[signature] 11/22/85