U.S. NUCLEAR REGULATORY COMMISSION

REGION II

Docket Nos:	50-390, 50-391
License Nos:	NPF-90 and Construction Permit CPPR-92
Report Nos:	50-390/99-08, 50-391/99-08
Licensee:	Tennessee Valley Authority
Facility:	Watts Bar, Units 1 and 2
Location:	1260 Nuclear Plant Road Spring City TN 37381
Dates:	August 15 through September 25, 1999
Inspectors:	P. Van Doorn, Senior Resident Inspector D. Rich, Resident Inspector P. Taylor, Project Engineer, RII (Section M1.1) D. Jones, Senior Radiation Specialist, RII (Sections R1.3, R1.4, R1.5 and R8.1) D. Thompson, Security Inspector, RII (Section S2.1)
Approved by:	P. E. Fredrickson, Chief Reactor Projects Branch 6 Division of Reactor Projects

Enclosure

EXECUTIVE SUMMARY

Watts Bar, Units 1 and 2
NRC Inspection Report 50-390/99-08, 50-391/99-08

This integrated inspection included aspects of licensee operations, maintenance, engineering, and plant support. The report covers a six-week period of resident inspection and a regional radiological controls inspection.

Operations

- The conduct of operations was professional and safety conscious. Requirements were met for control room conduct and other areas reviewed such as turnovers, tagouts, documentation, staffing, and assistant unit operator activities (Section O1.1).

- An engineered safety feature system walkdown of portions of the auxiliary feedwater and 120 volt DC vital control power system identified system lineup, material condition, and housekeeping to be acceptable (Section O2.1).

- The Management Review Committee exhibited a questioning attitude regarding corrective action plans and adequacy of immediate corrective actions for problems associated with problem evaluation report (PER) initiations. Corrective action plans were typically thorough; however, the inspector identified that some corrective actions taken were not always documented thoroughly in the PERs. The licensee had previously recognized incomplete documentation as a general problem, and steps were being taken to correct the problem (Section O7.1).

- The Plant Operations Review Committee exhibited thorough questioning of issues brought to the committee for approval (Section O7.1).

- An Operations self-assessment showed that a comprehensive review had been performed of the configuration control area (Section O7.1).

- A non-cited violation was identified for having one vital battery board inoperable for greater than the Technical Specification time limit (Section O8.1).

Maintenance

- Fifteen maintenance and surveillance activities were adequately performed. Maintenance personnel were knowledgeable and carefully followed procedures to resolve plant equipment and component problems. Work performed was typically well documented (Section M1.1).

- A Maintenance program self-assessment was very thorough and performance oriented (Section M7.1).

Engineering

- Engineering activities reviewed were thorough and technically viable. Plant equipment problems were being addressed commensurate with plant safety (Section E1.1).

- Ice condenser (IC) basket coupling screw testing conducted during the Spring 1999 refueling outage demonstrated that the installed and warehouse screws could resist the accident loads with 2 or 4 screws missing from a 12-screw ring and that the probability of having multiple screws missing from a single joint was small. IC operability was not impacted by missing screws; and, although the testing analysis contained weaknesses, none of the weaknesses resulted in an unsafe condition with regard to the IC baskets. The installed and warehouse ice basket coupling screws were satisfactory for use (Section E2.1).

Plant Support

- Radiological controls were adequate. Radiological areas were properly posted and high radiation areas were labeled and locked. Personnel were attentive and followed requirements. The licensee provided thorough management oversight of chemistry results, and regulatory limits reviewed were met (Section R1.1).

- The licensee properly monitored and controlled personnel radiation exposure and radiologically controlled areas during the preparation of two tritium producing burnable absorber assemblies (TPBAAs) for shipment. The licensee handled the TPBAAs and prepared the TPBAA cask for shipment in accordance with approved procedures (Section R1.2).

- The licensee was maintaining an effective program for the control of liquid and gaseous radioactive effluents from the plant. The radiation doses from those releases were a small percentage of regulatory limits (Section R1.3).

- The licensee has complied with the sampling, analytical and reporting requirements for the radiological environmental monitoring program, the environmental sampling equipment was being well maintained, and the monitoring program was effectively implemented (Section R1.4).

- The licensee has effectively implemented a program for shipping radioactive materials in accordance with NRC and Department of Transportation regulations (Section R1.5).

- Security personnel followed requirements for access control, and problems were not identified with barriers and zones (Section S1.1).

- The licensee was in compliance concerning implementation of compensatory measures that were provided to effectively compensate for loss of security-related equipment (Section S2.1).

Report Details

Summary of Plant Status

Unit 1 began this inspection period operating in Mode 1 at 100 percent reactor power. On August 29, 1999, reactor power was reduced to 84 percent for leak repair on 1A number 3 heater drain tank pump. Reactor power was returned to 100 percent on August 30 and remained at 100 percent for the remainder of the inspection period.

Unit 2 remained in a suspended construction status.

I. Operations

O1 Conduct of Operations

O1.1 General Comments (71707)

The inspectors conducted frequent inspections and reviews of ongoing plant operations. This included observation of routine control room (CR) crew activities and turnovers; review of logs, standing and night orders, CR staffing, and tagouts; and observation of assistant unit operator (AUO) activities.

The conduct of operations was professional and safety conscious. Requirements were met for CR conduct and other areas reviewed such as turnovers, tagouts, documentation, staffing, and AUO activities. Operations carefully followed requirements during tritium producing burnable absorber assembly (TPBAA) transfer and shipment, as documented in Section R1.2.

O2 Operational Status of Facilities and Equipment

O2.1 Engineering Safety Feature System Walkdown (71707)

The inspector performed an engineered safety feature systems walkdown of portions of the following systems:

- Auxiliary Feedwater
- 120 Volt DC Vital Control Power

System lineup, material condition, and housekeeping were acceptable in all cases. No substantive concerns were identified as a result of this walkdown.

O7 Quality Assurance in Operations

O7.1 Licensee Self-Assessment Activities (40500)

The inspectors reviewed various self-assessment activities which included the following:

- Observation of Management Review Committee (MRC) meetings;

- Review of selected problem evaluation reports (PERs) for adequacy of corrective actions and implementation of procedural requirements;
- Observation of two Plant Operations Review Committee (PORC) meetings;
- Review of PER initiations; and
- Review of Operations Self-Assessment SA-OPS-99-016.

The MRC exhibited a questioning attitude regarding corrective action plans and adequacy of immediate corrective actions for problems associated with PER initiations. Corrective action plans were typically thorough, however, the inspector identified that some corrective actions taken were not always documented thoroughly in the PERs. The licensee had previously recognized incomplete documentation as a general problem and steps were being taken to correct the problem. The PORC exhibited thorough questioning of issues brought to the committee for approval. The Operations self-assessment showed that a comprehensive review had been performed of the configuration control area. A total of 10 personnel was utilized, five from offsite and two from another utility. Five findings were identified and 12 areas for improvement were identified.

O8 Miscellaneous Operations Issues (92700)

O8.1 (Closed) Licensee Event Report (LER) 50-390/1999-06: Misalignment of Battery Charger 6-S. On July 27, 1999, vital battery board II (a B-Train channel) was placed on a spare charger (6-S) which was aligned to an A-train power source. The battery board is not considered operable when its associated charger is aligned to the opposite train of AC power. The charger remained misaligned for approximately 18 hours. Technical Specification (TS) 3 8 4 requires the battery to be restored to operable status in two hours or begin a shutdown and be in Mode 3 within six hours. The licensee discovered the problem and conducted a thorough investigation. The primary cause of the problem was determined to be poor communication during a pre-job brief. Other problems included perceived pressure to complete the task, poor supervisory oversight, inadequate post-job review, and poor labeling. Although the TS action time was exceeded by a large percentage, several factors mitigated the risk significance. The battery was adequate to carry required loads during a loss of all AC (station blackout) for four hours and for a station blackout with accident loads for two hours. Alarms would have warned operators in sufficient time to take appropriate actions to realign the charger. During the event, diesel generators and offsite power remained available with no threats to their loss This Severity Level IV violation is being treated as a non-cited violation (NCV), consistent with Appendix C of the NRC Enforcement Policy. This violation is identified as NCV 50-390/99-08-01: Misalignment of Battery Charger, and is in the licensee's corrective action program as WBPER 99-010371.

II. Maintenance

M1 Conduct of Maintenance

M1.1 General Comments

a. Inspection Scope (62707, 61726)

The inspectors observed preplanned and emergent maintenance activities including all or portions of the following work orders (WOs) and surveillance instructions (SIs) and reviewed associated documentation:

- SI 0-SI-82-12-A, 2A-A Diesel Generator Start and Load Test DG 2A-A, Revision 7
- Exit Portal Daily Response Check, RCI-122, Calibration and Response Check of the National Nuclear Corporation's Gamma 60 Portal Monitor, Revision 2
- WO 99-012215-000, Replace 2A-A Diesel Generator Crankcase Pressure Switch
- WO 99-008336-000, Repair Seat Leakage/Overhaul Actuator 1-FCV-63-0084
- WO 99-009044-000, Repair Seat Leakage/Overhaul Actuator 1-FCV-63-0023
- WO 99-005731-000, Diesel Generator 2B-B Day Tank Calibration Check
- WO-99-011876-000, Trouble Shoot Auxiliary Feedwater Valve 1-LCV-3-171
- SI 1-SI-3-903B, Valve Full Stroke Exercising During Mode 1, Auxiliary Feedwater (Train B), Revision 5
- SI 1-SI-72-901B, Containment Spray Pump 1B-B Quarterly Performance Test, Revision 4
- WO 98-013944-000, Check CCP Auxiliary Oil Pump Coupling Alignment, Investigate Dust and or Filings Around the Coupling Guard
- WO 98-013945-000, CCP 1B-B Pump Bearing Defector Ring Clearance to Housing Appears Excessive
- WO 99-008919-000, Inspect, Clean, and Lube CCP Pump Motor Bearings
- WO 99-004587-000, Inspect and Change Oil in the Pump Gear Box and in Line Bearings

- WO 99-008979-000, Disassemble, Inspect Pump Gear Box Oil Strainer and Reassemble
- WO 99-007616-000, 1-PI-62-0104 CCP Pump Gear Box Pressure Gauge Stuck at 14.7 PSIG

b. Observations and Findings

The inspectors observed the activities identified above and determined that personnel involved in the work were qualified and knowledgeable in the tasks being performed. The work instructions were observed being followed, and problems, if encountered during the performance of the work, were properly dispositioned. Work performed was also typically well documented. Where appropriate, radiation control measures were in place.

c. Conclusions

Fifteen maintenance and surveillance activities were adequately performed. Maintenance personnel were knowledgeable and carefully followed procedures to resolve plant equipment and component problems. Work performed was typically well documented.

M7 Quality Assurance in Maintenance Activities

M7.1 Licensee Self-Assessment Activities (40500)

The inspector reviewed documentation of Maintenance self-assessment SA-99-MM-08 and held discussions with the assessment leader. The assessment was a general assessment of the implementation of the maintenance program. Past performance was reviewed to provide insight for focused activities. The team consisted of two managers, three engineers, six craft personnel, and three managers from the Sequoyah station. Many field observations were conducted. A finding and many areas for improvement were identified which were being tracked for completion.

In summary, the assessment was very thorough and performance oriented.

III. Engineering

E1 Conduct of Engineering

E1.1 General Observations (37551)

The inspectors observed Engineering support activities for emergent issues, PER evaluations, review of plant equipment problems and associated corrective action plans, PORC meetings, and MRC meetings.

Engineering activities reviewed were thorough and technically viable. Plant equipment problems were being addressed commensurate with plant safety.

E2 Engineering Support of Facilities and Equipment

E2.1 Evaluation of Ice Condenser Basket Screws

a. Inspection Scope (37551)

The results of a licensee conducted ice condenser (IC) basket screw test, documented to the NRC on April 28, 1999, were reviewed by the NRC.

b. Observations and Findings

A TVA letter dated April 28, 1999, from the Manager, Licensing and Industry Affairs, forwarded the results of inspections and testing of IC screws which were conducted during the Unit 1 Cycle 2 Outage (February 28 through April 16, 1999). The inspections and testing results were used to; (1) confirm the presence of or replace missing IC screws in the upper and lower ring connectors, (2) evaluate screw strength by performing shear tests of joints fabricated from a portion of a randomly selected sample of installed screws to determine a capacity that is representative of those installed in the ice condenser system, and (3) assess the effects of both the extent of missing screws and the screw strength on the functionality of the as-installed IC system. The licensee stated in its evaluation, "... the adequacy of the screws was sufficient for the structural functionality of the ice condenser baskets."

The NRC reviewed and witnessed a portion of the Unit 1 basket screw testing and documented the results in NRC Special Inspection Report 50-390, 391/99-06. The NRC review of the licensee's April 28, 1999 evaluation was completed on August 5, 1999, and is included as an attachment to this report. The NRC plans to continue inspections and evaluation of IC performance and also to evaluate any new vendor information to ensure continued operability of the IC system.

c. Conclusions

The NRC concluded: (1) TVA demonstrated that the installed and warehouse screws could resist the accident loads with 2 or 4 screws missing from a 12-screw ring and that the probability of having multiple screws missing from a single joint is small, (2) IC operability was not impacted by missing screws, and (3) although TVA's analysis contained weaknesses, none of the weaknesses resulted in an unsafe condition with regard to the IC baskets. The NRC confirmed that the installed and warehouse ice basket coupling screws were satisfactory for use.

IV. Plant Support

R1 Radiological Protection and Chemistry (RP&C) Controls

R1.1 General Observations (71750)

The inspectors routinely observed radiologically controlled areas to verify adequacy of access controls, locked areas, personnel monitoring, surveys, and postings. The inspectors also routinely reviewed primary and secondary chemistry results.

Radiological controls were adequate. Radiological areas were properly posted and high radiation areas were labeled and locked. Personnel were attentive and followed requirements. The licensee provided thorough oversight of chemistry results and regulatory limits reviewed were met.

R1.2 TPBAA Cask Shipping Preparations and Radiation Exposure Controls

a. Inspection Scope (71707, 71750)

The inspectors observed TPBAA handling and preparations for shipment and the licensee's radiation exposure control practices during those activities.

b. Observations and Findings

The inspectors observed handling and preparation for shipment of two TPBAAs during this inspection period. The operations involving the transfer of a TPBAA from the spent fuel pool to the shipping cask and the transfer of the cask to the transport vehicle were observed by the inspectors. During these operations, the inspectors observed that the workers were wearing the dosimetry and protective clothing required by the radiological work permit; the work areas were properly posted for the existing radiological conditions; and surveys for area dose rates and contamination levels were routinely performed. The inspectors reviewed the licensee's Fuel Handling Instruction (FHI)-18, Tritium Producing Burnable Assembly Rod (TPBAR) Shipping Cask, Revision 3, and verified, by direct observation, that selected sections of this procedure were followed.

c. Conclusions

The licensee properly monitored and controlled personnel radiation exposure and radiologically controlled areas during the preparation of two TPBAAs for shipment. The licensee handled the TPBAAs and prepared the TPBAA cask for shipment in accordance with approved procedures.

R1.3 Radioactive Effluent Control Program

a. Inspection Scope (84750)

The inspector reviewed the overall results of the radioactive effluent control program as documented in the Annual Radioactive Effluent Release Report for 1998. The amounts

of radioactivity released and the resulting radiation doses for the years 1996 through 1998 were also tabulated to evaluate long term performance of the effluent control program relative to the design objectives in 10 CFR 50, Appendix I for radiation doses from plant effluents.

b. Observations and Findings

The inspector compiled the data presented in the table below from the licensee's effluent release reports for the years 1996 through 1998. That data and the content of the report for 1998 were discussed with the licensee.

WATTS BAR RADIOACTIVE EFFLUENT RELEASES

LIQUID EFFLUENTS

	Curies Released			Dose* (mrem)	
Year	F&AP	^{3}H	D&EG	Total Body [3 mrem]	Organ [10 mrem]
1996	0.05	223	3.30E-1	9.76E-4 (0.033%)	1.41E-3 (0.014%)
1997	1.32	639	7.73E-0	2.53E-1 (8.43%)	3.57E-1 (3.568%)
1998	0.23	713	1.14E-2	6.16E-3 (0.205%)	8.20E-3 (0.082%)

GASEOUS EFFLUENTS

	Curies Released				Dose	
Year	F&AP	Iodines	Part.	^{3}H	Air [γ 10 mrad] [β 20 mrad]	Organ* (mrem) [15 mrem]
1996	194	0.00E-0	0.00E-0	9	γ 3.81E-2 (0.38%) β 1.04E-1 (0.52%)	1.940E-2 (0.13%)
1997	371	6.75E-4	1.73E-4	3	γ 7.66E-2 (0.77%) β 2.13E-1 (1.06%)	3.44E-2 (0.23%)
1998	71	0.00E-0	0.00E-0	70	γ 2.93E-1 (2.93%) β 1.15E-1 (0.57%)	5.71E-2 (0.38%)

F&AP Fission and Activation Products
^{3}H Tritium
D&EG Dissolved and Entrained Gases
[ ] Limits/Unit
( ) % of Limits/Unit
Part Particulates
γ Gamma
β Beta
* Dose to maximally exposed individual

The inspector made the following observations from the above tabulated data and discussed those observations with the licensee. The radiation doses and the amounts of activity released during 1997 were slightly larger than those for 1996 due to the Unit 1 Cycle 1 refueling outage. The doses for 1998 were less than three percent of regulatory limits.

The 1998 effluent release report indicated that there were no effluent monitors inoperable for greater than 30 days, but there was one abnormal release of liquid radwaste. On July 18, 1998, the monitor tank and the cask decontamination collector tank (CDCT) were prepared for release and a release permit had been issued for the monitor tank. The permit for the CDCT had not been completed but it was released instead of the monitor tank. The licensee's corrective actions, as documented in WBPER 98-0824, included revision of the liquid waste disposal procedure to require senior reactor operator approval and verification that releases are authorized and that procedures are correct for each release. The inspector verified that those procedure changes had been implemented.

The inspector also observed the collection of the weekly samples from the auxiliary building vent gaseous effluent pathway. By direct observation, the inspector determined that charcoal cartridge, particulate, noble gas, and tritium samples were collected in accordance with applicable procedures and promptly analyzed. Analytical results indicated that the radionuclide concentrations and projected doses were well within regulatory limits.

c. Conclusions

The licensee was maintaining an effective program for the control of liquid and gaseous radioactive effluents from the plant. The radiation doses from those releases were a small percentage of regulatory limits.

R1.4 Radiological Environmental Monitoring Program

a. Inspection Scope (84750)

The inspector reviewed the overall results of the radiological environmental monitoring program as documented in the Annual Radiological Environmental Operating Report for 1998. Those results were compared to the program requirements delineated in the Offsite Dose Calculation Manual (ODCM).

b. Observations and Findings

The inspector noted that, in accordance with the ODCM, the report included a description of the program, a summary and discussion of the results for each exposure pathway, analysis of trends during the operational years as compared to the preoperational years, and an assessment of the impact on the environment based on program results. The report also included a tabulation of the summarized analytical results for the samples collected during 1998. From a review of the data, the inspector determined for selected exposure pathways that the sampling and analysis frequencies

specified in the ODCM had been met. As indicated in the report, very low concentrations of man-made isotopes were occasionally detected in a few of the samples but were of negligible dose consequence. It was further concluded that any activity which may be present in the environment as a result of plant operations did not represent a significant contribution to the exposure of the public.

The inspector also observed the licensee's collection of samples from four air sampling stations. The inspector noted that the sampling equipment was operable and in good working order, the sampling stations were located as indicated in the ODCM, and good sampling techniques were employed by licensee personnel in collection of the samples.

c. Conclusions

The licensee was complying with the sampling, analytical and reporting requirements for the radiological environmental monitoring program, the environmental sampling equipment was being well maintained, and the monitoring program was effectively implemented.

R1.5 Transportation of Radioactive Materials

a. Inspection Scope (86750)

The inspector evaluated selected elements of the licensee's radioactive materials transportation program for consistency with the requirements delineated in 49 CFR Parts 170 - 179, 10 CFR Part 20, and 10 CFR Part 71.

b. Observations and Findings

The inspector reviewed the licensee's procedures for shipping radioactive materials and determined that the procedures adequately addressed the following: assigning the form, quantity type, and proper shipping name of the material to be shipped; classifying waste destined for burial; selecting the type of package required; labeling and marking the package; placarding the vehicle; assuring that the radiation and contamination limits were met; and preparing shipping papers.

The inspector reviewed the shipping papers for five recent shipments and verified that the recorded hazardous material description information and emergency response information were accurate and in accordance with the requirements of 49 CFR 172 Subparts C and G. The records of the radiological surveys of the shipping packages and transport vehicles indicated that the radiation and contamination levels were well within the limits specified in 49 CFR 173, 441, and 443. The licensee's records also indicated that shipping package marking and labeling and vehicle placarding were in accordance with the requirements of 49 CFR 172 Subparts D, E, and F. The inspector also determined the licensee had maintained records of shipments of licensed material as required.

The inspector also verified that the licensee possessed a current "Quality Assurance Program Approval for Radioactive Material Packages" (NRC Form 311). The inspector noted that the certificate of approval expiration date was August 31, 1999. The licensee requested renewal of the Quality Assurance Program approval by letter dated August 27, 1999.

c. Conclusions

The licensee has effectively implemented a program for shipping radioactive materials in accordance with NRC and Department of Transportation regulations.

R8 Miscellaneous RP&C Issues (92904)

R8.1 (Closed) Inspection Follow-Up Item 50-390/99-02-01: Review of Potential Personnel Exposure. During the Unit 1 Cycle 2 refueling outage, radiation exposures to the work crew assigned to install lead shielding in lower containment were reviewed by inspector and by the TVA Radiological Effects Advisory Group (REAG). REAG's review was continuing at the end of that inspection. REAG's "Dosimetry Evaluation" report for this issue documented a thorough investigation of the exposures incurred by the individuals involved in that work. Exposures were determined to have been well within regulatory limits for occupational exposure. This item is closed.

S1 Conduct of Security and Safeguards Activities

S1.1 General Observations (71750)

The inspectors routinely observed security activities for conformance to requirements which included protected area barriers, isolation zones, personnel access, and package inspections. Security personnel followed requirements for access control, and problems were not identified with barriers and zones.

S2 Status of Security Facilities and Equipment

S2.1 Compensatory Measures

a. Inspection Scope (81700)

The inspector reviewed safeguards events and held discussions with security management to determine if adequate compensatory measures were in effect when security equipment was degraded or had failed.

b. Observations and Findings

The inspector reviewed safeguards events and discussed with security management their understanding of the need to provide compensatory measures and how they determined if proper compensatory measures have been implemented in the event of security equipment failures. The inspector also discussed reporting or logging of safeguards events in accordance with regulatory requirements. While reviewing and

discussing safeguards events, the inspector noted that an event related to compensatory measures occurred at approximately 11:06 a.m., on July 8, 1999, in which an individual performing compensatory measures for failed intrusion detection zones 8, 9, 10, 11 and 12 was found inattentive to duty. The licensee informed the inspector that the event had been documented in the 24-hour safeguards event log. Based on a review of the events concerning the inattentive compensatory officer, the inspector noted that since the zones of detection had not been functionally tested to ensure operability and unauthorized access to the protected area could have been gained, the event should have been a 1-hour report rather than a 24-hour logged event. 10 CFR 73.71, Appendix G, Section I(c), requires any degradations in a safeguards system that could have allowed unauthorized access to be reported within one hour. This failure constitutes a violation of minor significance and is not subject to formal enforcement action.

c. Conclusion

The licensee was in compliance concerning implementation of compensatory measures that were provided to effectively compensate for loss of security-related equipment. The licensee failed to properly report an event of failure of the compensatory measures.

V. Management Meetings

X1 Exit Meeting Summary

The resident inspectors presented inspection findings and results to licensee management on September 28, 1999. The licensee acknowledged the findings presented.

The inspectors asked the licensee whether any materials examined during the inspection should be considered proprietary. No proprietary information was identified. However, subsequent to the exit meeting, the inspector determined that some proprietary information had been reviewed with respect to the ice condenser screw issue, but is not contained in this report.

PARTIAL LIST OF PERSONS CONTACTED

Licensee

R. Beecken, Maintenance and Modifications Manager
D. Boone, Radiological Control Manager
S. Casteel, Manager, Radiological and Chemistry Control
J. Cox, Training Manager
D. Kulisek, Operations Manager
W. Lagergren, Plant Manager
D. Nelson, Business and Work Performance Manager
P. Pace, Licensing and Industry Affairs Manager
R. Purcell, Site Vice President
J. Roden, Operations Training Manager
S. Spencer, Site Nuclear Assurance Manager

T. Wallace, Operations Superintendent
G. Vickery, Chemistry Manager
J. West, Assistant Plant Manager

NRC

P. Van Doorn, Senior Resident Inspector
D. Rich, Resident Inspector
D. Jones, Senior Radiation Specialist
P. Taylor, Project Engineer
D. Thompson, Security Inspector

INSPECTION PROCEDURES USED

IP 37551:	Onsite Engineering
IP 40500:	Effectiveness of Licensee Controls in Identifying, Resolving, and Preventing Problems
IP 62707:	Maintenance Observation
IP 71707:	Plant Operations
IP 71750:	Plant Support Activities
IP 84750	Radioactive Waste Treatment, and Effluent and Environmental Monitoring
IP 86750	Solid Radioactive Waste Management and Transportation of Radioactive Material
IP 92700:	Onsite Followup of Written Reports of Nonroutine Events at Power Reactor Facilities
IP 92904	Followup - Plant Support

ITEMS OPENED, CLOSED AND DISCUSSED

Opened

50-390/99-08-01	NCV	Misalignment of Battery Charger (Section O8.1).

Closed

50-390/1999-06	LER	Misalignment of Battery Charger 6-S (Section O8.1).
50-390/99-08-01	NCV	Misalignment of Battery Charger (Section O8.1).
50-390/99-02-01	IFI	Review of Potential Personnel Exposure (Section R8).

August 5, 1999

MEMORANDUM TO: Loren R. Plisco, Director
Division of Reactor Projects
Region II

FROM: Suzanne C. Black, Deputy Director
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

SUBJECT: TASK INTERFACE AGREEMENT (TIA) 99-012 - WATTS BAR NUCLEAR PLANT UNIT 1 (TAC NO. MA5405)

In a memorandum, dated May 11, 1999, you requested that the Office of Nuclear Reactor Regulation (NRR) review the report prepared by Tennessee Valley Authority (TVA) dated April 28, 1999, on its evaluation of ice condenser containment ice basket screws. Specifically, you requested us to address the question "Does the attached Watts Bar evaluation support the conclusions listed on Page 9 of both enclosures 2 and 3 to the evaluation." The attached assessment documents the NRR review.

In the attached assessment, the NRR staff concludes that: (1) TVA demonstrated that the installed and warehouse screws could resist the accident loads with 2 or 4 screws missing from a 12-screw ring and that the probability of having multiple screws missing from a single joint is small, (2) ice condenser basket operability was not impacted by missing screws as characterized by Region II and TVA's evaluation that was submitted as part of the TIA package, and (3) TVA's analysis contained engineering weaknesses wherein they incorrectly calculated the probability of a missing screw and failed to pursue an explanation for the outlier in the experimental data. However, none of these engineering weaknesses result in an unsafe condition with regard to the ice condenser baskets.

Please contact Bob Martin at (301) 415-1493 if you have questions on this topic.

Docket No. 50-390

Attachment: Assessment By NRR

cc w/attachment: A. R. Blough, Region I
G. E. Grant, Region III
K. E. Brockman, Region IV

Attachment

July 16, 1999

MEMORANDUM TO: Herbert N. Berkow, Director
Project Directorate II
Division of Licensing Project Management

FROM: William H. Bateman, Chief /S/
Materials and Chemical Engineering Branch
Division of Engineering

SUBJECT: SAFETY EVALUATION IN RESPONSE TO A REGION II TASK INTERFACE AGREEMENT - WATTS BAR NUCLEAR PLANT - EVALUATION OF ICE CONDENSER BASKET SCREWS

The staff has reviewed and evaluated the information provided by the Tennessee Valley Authority on the Watts Bar Nuclear Plant evaluation of ice condenser basket screws in response to a Task Interface Agreement from Region II. The staff's evaluation and conclusions are attached for transmittal to Region II.

This submittal completes the technical review to be performed by the Materials and Chemical Engineering and the Mechanical and Civil Engineering Branches on TAC No. MA5628.

Docket No.: 50-390

Attachment: As stated

CONTACT: James Davis, DE/EMCB
415-2713

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

EVALUATION OF ICE CONDENSER BASKET SCREWS

WATTS BAR NUCLEAR PLANT

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-390

1.0 INTRODUCTION

The Watts Bar Nuclear Power Plant (WBN) is an ice condenser plant with 24 ice condenser bays located 300° around the containment. Each bay holds 81 ice condenser baskets for a total of 1944 ice condenser baskets. Each ice condenser basket consists of four 12-foot long sections joined together as shown in Figure 1. Each ice condenser basket has a top ring with six pairs of screws at 60° intervals. The top ring provides a load path for servicing such as ice weighing operations. There are three intermediate joints that connect the 12-foot sections together. There are six pairs of screws at 60° intervals on the top section-to-coupling and six pairs of screws at 60° intervals on the bottom section-to-coupling. The intermediate joints must resist separation loads incurred during a design basis accident. The bottom ring has six pairs of screws at 60° intervals. The bottom ring restrains axial loads during accident conditions.

Prior to initial operation of WBN, ice condenser basket screws and screw heads were observed in the ice condenser melt tank. This led to concerns about the integrity of the ice condenser basket joints. The licensee at WBN evaluated these concerns and concluded that although some screws were broken or damaged during installation, the number of screws or screw parts was small compared to the total number of screws. The licensee at WBN concluded that the joints were not significantly degraded due to the loss of some screws or screw heads.

During the evaluation of the concerns, the licensee focused on the metallurgical condition of the screws. Some screws removed from service and some new screws contained shallow cracks that may have contributed to fracture during installation. The licensee concluded that the cracks formed as a result of the manufacturing process associated with the hardening of the screw surface. The licensee concluded that the highest loads on the screws occur during installation because installation stresses are a result of thread formation plus the torque reaction. These loads are higher than the loads produced during a design basis accident loading condition.

These concerns were closed by TVA based on: 1) Westinghouse conducted an analysis that showed that two of the 12 screws per joint could be missing and the design requirements would still be met; 2) the probability of having more than two screws missing from a joint is small; 3) the number of screws and screw parts found was small compared to the total number of screws; and 4) screw failures were more likely to occur during installation than during the design load conditions.

Recently, some non-TVA plants have had concerns about the integrity of the ice condenser basket joint integrity and/or missing screws. As a result of these concerns, Westinghouse tested some complete ice condenser baskets with either two or four screws missing from a

joint. The licensee at WBN developed a plan to definitively evaluate the reliability of the ice condenser basket joint integrity through a combination of inspections and laboratory tests and to compare the results with those obtained by Westinghouse.

2.0 DISCUSSION

The licensee at WBN inspected 46,480 ice condenser basket screw locations out of 186,624 total screw locations. Of the locations inspected, 23,012 were on the upper rings that were not subject to accident loads and 23,468 were on the lower rings and intermediate joints. Of the lower rings and intermediate joint locations, 23,328 were on the lower rings. The 140 screw locations on the intermediate joints were all in the first joint below the upper ring. Other intermediate screw locations were inaccessible for inspection due to the presence of ice in the baskets. The licensee reported that of the 46,480 screw locations inspected, 17 screws were found totally missing and 9 screws were found with the heads missing. The licensee reported that the rate of screws missing was 0.056 percent based on 26 missing or headless screws. The licensee then proposed that there is a 99.95 percent probability that no accident loaded joint will have more than two missing screws based on their inspection results.

The licensee at WBN conducted shear tests on splice joint specimens containing two screws on each side of the splice as shown in Figure 2. Five splice joint specimens were assembled using screws randomly selected from the WBN warehouse and 20 specimens were assembled using screws randomly selected and removed from the ice condenser baskets. The maximum loads were determined by applying a shear load to the specimen and measuring the maximum load required to break the joint. The results were fairly consistent with the exception of one outlier that failed at a significantly lower load compared to the other results.

The licensee calculated the maximum accident load per splice sample based on the loads being redistributed in a 12 screw accident loaded joint with two screws missing. The maximum load required to resist an accident was calculated. The measured and required loads were compared and the licensee pointed out that even the outlier could support in excess of the maximum accident load.

The licensee determined the average screw capacity for a joint with four screws missing and determined that the WBN design could resist the accident load with four screws missing.

The licensee at WBN compared their results with the full scale tests conducted by Westinghouse. Westinghouse tested full scale ice condenser basket joints with two and four missing screws. The worst case situation was tested where a pair of screws were missing, and two adjacent pairs were missing. The full scale tests were not conducted to failure, but were tested to a specified load. Based on these results, the Westinghouse joint load test results are higher than WBN design loads with two screws missing and with four screws missing.

3.0 STAFF EVALUATION

The staff was requested in the Task Interface Agreement (TIA) to review the conclusions listed on Page 9 of Enclosures 2 and 3 to the evaluation. The staff reviewed the TVA conclusions listed and drew the following conclusions.

1) "The load capacities of ice condenser basket screws installed in Watts Bar Nuclear Plant ice condenser baskets are more than adequate to accommodate the postulated loads and to compensate for the small number of missing screws."

The staff agrees that the load capacities of the ice condenser screws are more than adequate to accommodate the postulated loads and to compensate for a small number of missing screws. The load capacities were determined experimentally by TVA and the results were compared to the results obtained by Westinghouse and D.C. Cook. The assemblies could support the operating and accident loads with 2 or 4 screws missing from a joint.

2) "The rate of missing screws in the Watts Bar ice condenser baskets is extremely low at 0.056%. Thus, it is highly unlikely that more than two screws are missing from any load bearing joint in the ice condenser."

The staff agrees that the rate of missing screws is low although, as discussed later, the percentage was higher than stated above. There were 26 missing screws out of the 46,480 locations inspected. The licensee inspected 23,012 sites on the upper rings. Each upper ring contains 12 screws and 1,944 joints were fully or partially inspected. The licensee inspected 23,328 sites on the lower ring with 12 screws per ring or 1,944 rings. The licensee inspected 140 sites on the first row below the upper ring. Each joint contains 24 screws per joint and the licensee partially inspected 14 joints. The licensee inspected no locations in the second or third rows. The licensee calculated the probability of multiple screws missing in a joint, and that probability is extremely low

When the licensee at WBN calculated the probability of a missing screw, they used the estimate of the probability as the actual probability. They should have used the upper bound at an appropriate confidence level The upper bound at the 95% confidence level is 38.08 missing or broken screws which results in the probability of finding a missing or broken screw at any location of 0.082. This bounding approach should be used for regulatory programs. However, this error did not affect the outcome

3) "Tests of screws removed from service in the Watts Bar ice condenser baskets demonstrated shear load capacities well in excess of the bounding service loads calculated by Westinghouse."

The screw load capacities were determined experimentally. The experimental values were used to calculate the load on a joint with missing screws and the average load capacities exceeded the bounding service loads calculated by Westinghouse by a factor of [ ]. The staff agrees with this comparison.

4) " The Watts Bar test results were very comparable to the single-screw test results for the D.C. Cook Plant."

The experimental results obtained by TVA were compared to the experimental, single-screw values determined by the D.C. Cook Plant and the values were found to be comparable. The staff agrees that the values are comparable.

5) "Applying the [ ] factor for 2 missing screws to the bounding service load, the shear capacities of the screws still provide substantial margin against failure."

The staff agrees that with two missing screws, the accident loads can be resisted. This conclusion is based on the experimental results and calculations performed by TVA and comparison of the results to the accident loads supplied to TVA by Westinghouse.

6) "Results from the Westinghouse full basket joint test with 4 screws not installed in a 12-screw joint are consistent with the Watts Bar tests and the 12-screw joint analysis."

The staff agrees that the results from the Westinghouse full basket joint tests with four screws not installed in a 12-screw joint are consistent with the Watts Bar tests and 12-screw joint analysis based on the TVA experimental results and calculations.

7) "Based on tested sample, the screws in the Watts Bar warehouse are comparable to the in-service screws and also have ample capacity for use as replacement screws in the ice condenser baskets."

The staff agrees that the warehouse screws are comparable to the in-service screws and can be used as replacement screws based on the experimental results obtained by TVA. The licensee indicated that based on extensive testing of ice condenser screws, both new and taken from in-service baskets, and based on a review of testing done by Westinghouse and other ice condenser plants, they could not identify any abnormal effects of aging or corrosion of these screws. The licensee stated that normal component aging of the screws will be addressed with routine ice condenser maintenance.

8) "In light of these results, no further corrective actions (other than on-going maintenance activities) are required to resolve the concerns which were the subject of this evaluation."

The staff agrees that these results resolve the concerns which were the subject of this evaluation.

As part of its review under the subject TIA, the staff examined the consequences of the separation of two ice condenser basket sections by reviewing Westinghouse Summary Report MSE-REE-1371 dated June 22, 1995, titled "Watts Bar Unit 1 Ice Condenser System Westinghouse Assessment of Broken Ice Basket Sheet Metal Screws." About 70 percent of the ice baskets will be restrained by the intermediate deck structure. Some of the additional ice baskets may pass through the intermediate deck doors and would strike air handling units or the top deck structure. The air handling units are not safety-related and are not required to operate during or after a postulated loss-of-coolant accident. Westinghouse concluded that joint separation was not a significant contributor to risk.

In addition to the preceding, the staff has the following observations regarding the TVA report. The licensee found one upper ring with two missing screws and one ring with four missing screws. The licensee determined that the probability of finding a ring with two missing screws was approximately 2×10^{-5} and the probability of finding a ring with four missing screws was approximately 5×10^{-11}. The fact that the licensee found one ring with two missing screws and

one ring with four missing screws suggests that these events may be common mode effects not covered in the statistical analysis conducted by the licensee. However, in discussions with the licensee, they stated that the rings with two and four missing screws were not representative of the intermediate rings since the screws were missing as a result of weighing operations.

There was some confusion about where the missing and broken screws were found. The licensee summarized the results in a table on page (5) of Enclosure 2 of the submittal and gave more detailed information in Table 1 of Enclosure 2. The summary table and Table 1 do not agree. In a telephone call with the licensee, it was determined that the numbers in Table 1 and Table 2 are correct and the numbers in the summary table are incorrect.

The licensee observed an outlier in the sample of 20 tests with no explanations why the outlier occurred. The licensee stated that the maximum failure load for the outlier exceeds the acceptance criteria and that the outlier could support design and accident loadings. Therefore, no additional action is required by TVA with regard to the outlier.

4.0 CONCLUSION

The licensee inspected a large number of screw locations in the upper rings and lower rings and a small number of screw locations in the intermediate joints. The licensee also conducted a number of experimental tests on warehouse and in-service screws. The licensee demonstrated that the installed and warehouse screws could resist the accident loads with 2 or 4 screws missing from a 12-screw ring and that the probability of having multiple screws missing from a single joint is small.

The staff review concluded that ice condenser basket operability was not impacted by missing screws as characterized by Region II and TVA's evaluation that was submitted as part of the TIA package.

Finally, the licensee's analysis contained engineering weaknesses wherein they incorrectly calculated the probability of a missing screw, and failed to pursue an explanation for the outlier in the experimental data. However, none of these engineering weaknesses result in an unsafe condition with regard to the ice condenser baskets.

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Attachments: 1. Figure 1
2. Figure 2

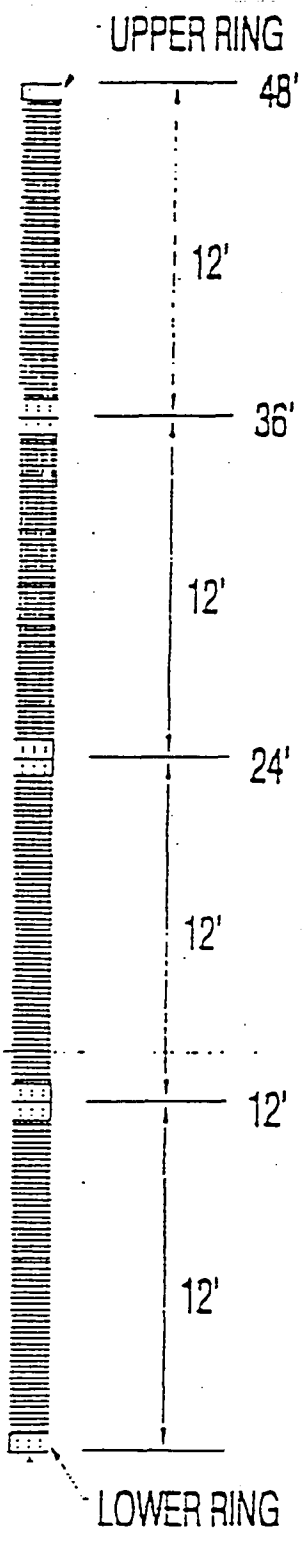

FIGURE 1 - ICE BASKET COLUMN - ELEVATION VIEW

WATTS BAR NUCLEAR PLANT
EVALUATION OF ICE CONDENSER BASKET SCREWS

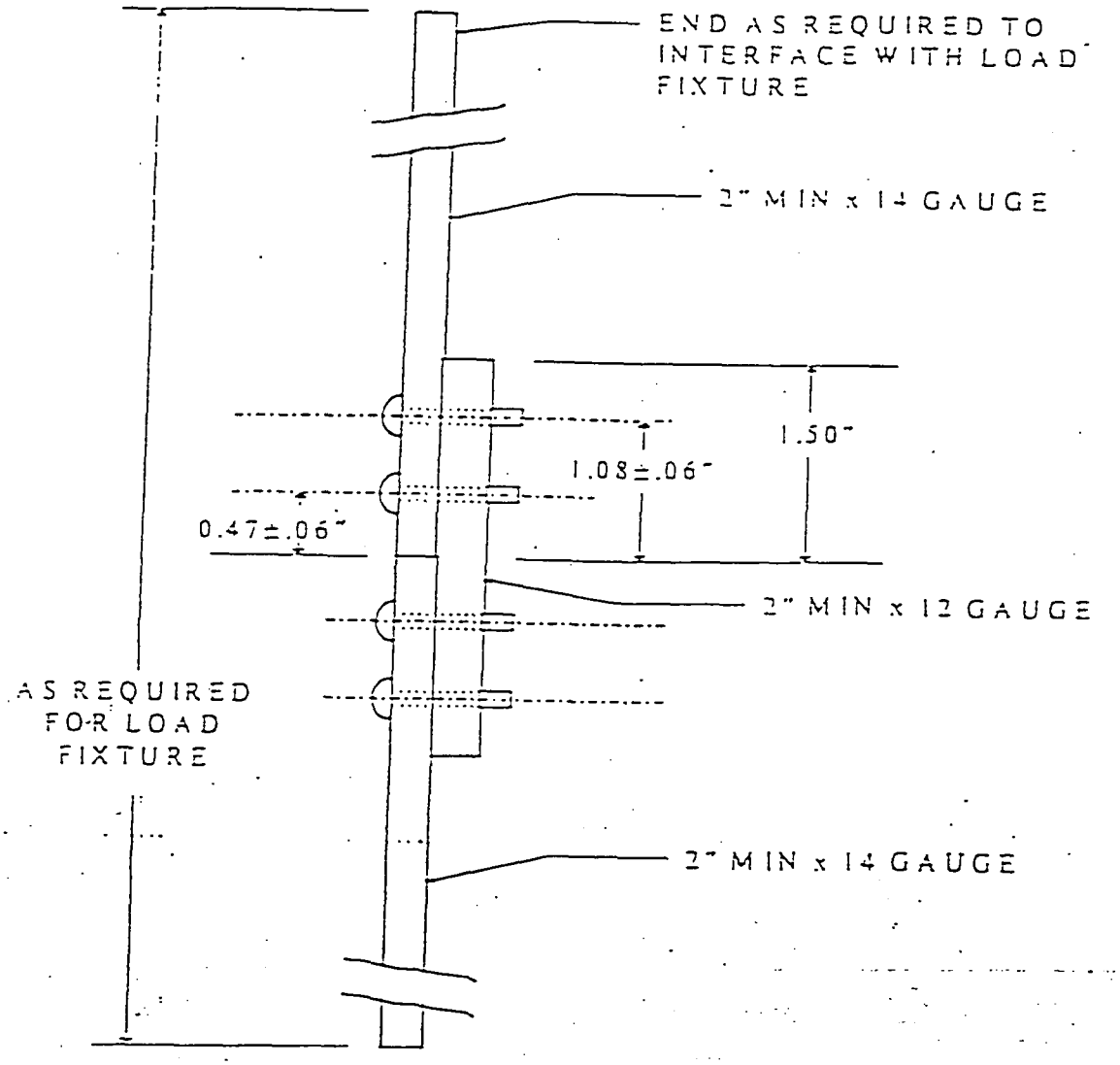

FIGURE 2 - TEST SPECIMEN SIDE VIEW