ENCLOSURE

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

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Report No.:	50-313/99-009; 50-368/99-009
Licensee:	Entergy Operations, Inc.
Facility:	Arkansas Nuclear One, Units 1 and 2
Location:	Junction of Hwy. 64W and Hwy. 333 South Russellville, Arkansas
Dates:	August 2 through November 8, 1999
Team Leader:	C. J. Paulk, Senior Reactor Inspector Engineering and Maintenance Branch
Inspectors:	P. A. Goldberg, Reactor Inspector Engineering and Maintenance Branch W. M. McNeill, Reactor Inspector Engineering and Maintenance Branch J. E. Whittemore, Senior Reactor Inspector Engineering and Maintenance Branch
Accompanying Personnel:	C. R. Jones, Mechanical Engineering Contractor Beckman and Associates M. C. Nolan, Project Manager, Project Directorate IV Division of Licensing Project Management Office of Nuclear Reactor Regulation S. R. Spiegelman, Mechanical Engineering Contractor Beckman and Associates
Approved By:	Dr. Dale A. Powers, Chief Engineering and Maintenance Branch Division of Reactor Safety

ATTACHMENTS:

Attachment 1	Supplemental Information
Attachment 2	Licensee White Paper on Throttling Service Water Flow from Shutdown Cooling Heat Exchangers and Closure of Emergency Diesel Generator Keep Warm System Cross-Flow Valve

EXECUTIVE SUMMARY

Arkansas Nuclear One, Units 1 and 2
NRC Inspection Report No. 50-313/99-09; 50-368/99-09

This team inspection was a safety system engineering inspection and was performed using the guidance of NRC Inspection Procedure 93809, "Safety System Engineering Inspection (SSEI)." The team focused on the service water systems for each unit to assess the systems' design and engineering performance capabilities.

Engineering

- The team identified six examples of inadequate design controls as a noncited violation of Criterion III of Appendix B to 10 CFR Part 50 (Sections E1b.1, E1b.2, E2b.4, E3b.2, E3b.3, and E4b.2).

- The team identified five examples of failure to promptly identify or correct conditions adverse to quality as a noncited violation of Criterion XVI of Appendix B to 10 CFR Part 50. These examples pertain to engineers failing to initiate condition reports (Sections E1b.1, E4b.1, and E7.1).

- The team identified an unresolved item pertaining to the need for additional licensee evaluation of the combined effects on the Unit 2 emergency diesel generators of under-predicting the maximum heat load and microfouling of the heat exchangers (Section E1b.3).

- The team identified an unresolved item pertaining to the need for additional NRC review of the licensee's consideration of instrument uncertainties in calculations and acceptance criteria (Sections E2b.2, E3b.2, and E4b.3).

- The team identified four examples of failure to implement procedures as a noncited violation of Criterion V of Appendix B to 10 CFR Part 50 (Sections E2b.3, E3b.1, and E3b.2).

- The team identified an unresolved item pertaining to the need for additional evaluation, by the licensee, of the potentially adverse erosion/corrosion and fatigue effects of excessive service water flow on Unit 1 components served (Section E2b.4).

- The team identified an unresolved item as a result of the need for additional licensee evaluation of the integral effects of throttling the butterfly valve on the outlet of the Unit 2 containment air coolers and the flashing potential associated with a clean heat exchanger (Section E3b.2).

- Failure to provide an adequate acceptance limit for the testing results of the Unit 1 reactor building air coolers was identified as a noncited violation of Criterion XI of Appendix B to 10 CFR Part 50 (Section E4b.3).

exchanger. Without the additional evaluation, the licensee was not able to demonstrate that the verification of the adequacy of the design was acceptable, as required by Criterion III of Appendix B to 10 CFR Part 50 (Section E3b.2).

- Failure to provide an adequate acceptance limit for the testing results of the Unit 1 reactor building air coolers was identified as a noncited violation of Criterion XI of Appendix B to 10 CFR Part 50 (Section E4b.3).

- The team identified an unresolved item as a result of the need for additional evaluation, by the licensee, of the available net-positive suction head with only one service water pump operating during a normal plant shutdown of Unit 1. Without the additional evaluation, the licensee was not able to demonstrate that the verification of the adequacy of the design was acceptable, as required by Criterion III of Appendix B to 10 CFR Part 50 (Section E4b.4).

- A noncited violation of Technical Specification 3.1.6.3.b was identified in Licensee Event Report 50-313/98-001 for operating Unit 1 with flaws in the once-through steam generators that exceeded the technical specification limit (Section E8.1).

REPORT DETAILS

Summary of Plant Status

Both units were operating at 100 percent power during this inspection.

III. Engineering

This seven-person team inspection was a safety system engineering inspection and was performed using the guidance of NRC Inspection Procedure 93809, "Safety System Engineering Inspection (SSEI)." The team focused on the service water systems for each unit to assess the systems' design and engineering performance capabilities. The inspection included reviews of design changes; corrective action documents; safety evaluations; engineering evaluations; normal, abnormal, and emergency operating procedures; and operability evaluations.

E1 Conduct of Engineering (93809)

a. Inspection Scope

a.1 The team reviewed portions of Calculation 91-D-2003-01, Revision 3, "Emergency Diesel Generator Capacity Ratings By Coltec, Fairbanks Morse Division," which established the limiting temperatures, flows, and fouling for the air cooler heat exchanger, lube oil cooler, and jacket water cooler to determine if the diesel would be capable of delivering its credited electrical output.

a.2 The team reviewed Calculation 91-E-0050-01, "Software Validation of STER [Shell and Tube Exchanger Rating] Version 5.04," Revision 04, which documented the validation of the software used by the licensee's engineers to evaluate heat exchanger thermal performance test results and to model heat exchanger performance at design conditions.

a.3 The team reviewed portions of the heat exchanger test program with respect to the development of tube-side microfouling on heat transfer surfaces and its impact on the overall heat transfer coefficient.

b. Observations and Findings

b.1 Review of the Unit 2 Emergency Diesel Generator Heat Exchanger Design Calculation

The team found that Calculation 91-D-2003-01 demonstrated the Unit 2 emergency diesel generators' capacities would be limited by the performance of the air, lube oil, and jacket water coolers during the response to design basis conditions. The team also found that the air cooler heat exchangers were the most limiting of the coolers. With an increase in the combustion air temperature, as a result of the marginal air coolers, the output of the emergency diesel generators would be derated.

To address potential derating of the emergency diesel generators, licensee engineers performed a step-wise transient analysis to demonstrate that the emergency diesel generators have adequate margins to provide reasonable assurance that they can perform their design function. This analysis took into account the increasing temperature of the emergency-cooling pond during the response to post-accident conditions along with a required electrical loading profile, which showed decreasing loads with respect to time during the accident response. Therefore, the licensee's engineers demonstrated that the maximum service water temperature would not occur at the same time as the peak electrical load requirement.

The licensee's engineers selected three bounding cases to demonstrate that the emergency diesel generators were capable of performing their design functions. As a result of questions asked by the team, the licensee's engineers reviewed Calculation 91-D-2003-01 and determined that a non-conservative error was made in calculating the maximum heat load for the air, lube oil, and jacket water coolers. The team noted that the diesel generator efficiency was not considered in determining the corresponding heat load generated for a specific electrical output. As a result, the maximum calculated heat loads for these heat exchangers were approximately 2.6 to 7.9 percent higher than documented in the design calculation for the case corresponding to the peak service water temperature. The air cooler heat exchanger was most affected by the error, showing a 7.9 percent increase in the corrected calculated heat load.

Because the output of the diesel generator is limited by the inlet air temperature, the increased heat load on the air cooler heat exchanger could result in a derating of the emergency diesel generator output. The licensee's engineers generated Condition Report CR-ANO-2-1999-0528 to document this error and take the appropriate corrective actions; to assess the generic implications to Unit 1; and to determine the cause and develop a corrective action plan to correct the condition.

Criterion III of Appendix B to 10 CFR Part 50 requires, in part, that design control measures shall provide for verifying the adequacy of design by the performance of design reviews. The team found the measures established for verifying the adequacy of the emergency diesel generators were inadequate in that the licensee's engineers failed to appropriately consider the effect of emergency diesel generator efficiency in determining the required heat loads for the affected heat exchangers in a design calculation. This is a Severity Level IV violation (first example) of Criterion III of Appendix B to 10 CFR Part 50 and it is being treated as a noncited violation (50-313; -368/9909-01) consistent with Appendix C of the NRC Enforcement Policy. This violation is in the licensee's corrective action program as Condition Report CR-ANO-2-1999-0528.

The team asked the licensee's engineers to review the as-found condition of the Unit 2 emergency diesel generators as determined from heat exchanger testing performed during Refueling Outage 2R12. Specifically, the licensee's engineers were asked to demonstrate that the emergency diesel generators were capable of supplying the required electric load when the effect of the generator efficiency was accounted for, in addition to the as-found conditions (e.g., actual loading and fouling factors). The licensee's engineers performed Engineering Report 991920-E201, "Evaluation of EDG Operability Under 2R12 As Found Condition," Revision 0, and determined that the lube oil and jacket water coolers for Emergency Diesel Generator 2K4A and the air cooler and the jacket water cooler for Emergency Diesel Generator 2K4B would have failed to remove the required heat with a service water flow of 3407 Lpm [900 gpm]. However, the licensee's engineers concluded that the emergency diesel generators were operable during the 12th operating cycle by crediting the margin available using actual values for emergency diesel generator loading and heat exchanger fouling.

During the review of this operability evaluation, the team questioned the licensee's engineers' treatment of the below design minimum service water flow condition that was documented in Condition Report CR-ANO-2-1997-0320 for both emergency diesel generators during the 12th operating cycle. The licensee's engineers indicated that the actual design minimum flow of 3407 Lpm [900 gpm] for each emergency diesel generator was used in the operability determination, instead of using the actual flow observed during the testing. The failure to use the actual flow resulted in a non-conservative evaluation of the operability of the emergency diesel generators during the operating cycle prior to Refueling Outage 2R12. That is, the calculated output was greater than the actual output. The licensee's engineers agreed with the team's understanding that a low service water flow condition existed for both emergency diesel generators during the time frame under consideration for this operability evaluation. The licensee's engineers issued a revision to the engineering report that accounted for the low service water flow.

The licensee's engineers revised Engineering Report 991920-E201 to evaluate the operability of the Unit 2 emergency diesel generators for the operating cycle prior to Refueling Outage 2R12 to account for both the error documented in Condition Report CR-ANO-2-1999-0528 and the low service water flow condition identified in Condition Report CR-ANO-2-1997-0320. The team noted that the licensee's engineers concluded that the emergency diesel generators were capable of performing their design function while subjected to this degraded condition on the basis of the revised engineering report. The suggested corrective action, as described in Condition Report CR-ANO-2-1999-0528, was to revise and correct Calculation 91-D-2003-01.

During the review of Engineering Report 991920-E201, Revision 1, the team questioned the licensee's engineers' selection of the limiting condition for this operability evaluation. The licensee's engineers evaluated the time period greater than 21 hours following the postulated loss-of-coolant accident. At this point, service water temperature would be at its peak value of 49.4°C [121°F]. However, this condition resulted in the lowest electrical output requirements of the three cases evaluated in Calculation 91-D-2003-01. The team noted that the time period between 2 and 21 hours following the design basis accident credited a significantly higher electrical loading and only a slightly lower service water temperature. Thus, the team questioned whether the case selected for evaluation in the licensee's engineers' operability determination was the bounding case. The licensee's engineers evaluated the 2 to 21-hour case and determined that it was the limiting condition for which the operability determination should evaluate.

The licensee's engineers revised Engineering Report 991920-E201 to assess the impact of low service water flow and results from the Refueling Outage 2R12 heat exchanger thermal performance testing to determine whether, as a result of the error in Calculation 91-D-2003-01, the Unit 2 emergency diesel generators would have been capable of performing their design function. In Engineering Report 991920-E201, Revision 2, the licensee's engineers considered the bounding case (which would occur between 2 and 21 hours into the accident response) and determined that the emergency diesel generators were capable of performing their design function while subjected to this degraded condition. The team found this conclusion to be reasonable.

The team reviewed the information contained in Engineering Report 991920-E201 and Calculation 91-D-2003-01 and concluded that the jacket water cooler for Emergency Diesel Generator 2K4A was the limiting component. This information demonstrated that the credited diesel capacity in Calculation 85-S-0002-01, "Emergency Diesel Generator Loading Profiles," Revision 0, was within 10 kW of the capability of Emergency Diesel Generator 2K4A. The close proximity of the actual capacity of the diesel to its credited load represented a significant challenge to continually ensure that the engine would perform its design function while subjected to this degraded condition.

In addition, the team identified a failure to adequately address the performance of equipment subjected to degraded conditions. Licensee engineers revised their initial operability evaluation for the use of non-conservative assumptions on two separate occasions after prompting from the inspection team. However, the licensee's engineers failed to document these degraded conditions in the corrective action program. It did not appear that the degraded performance of the emergency diesel generators would have been recognized and corrected by the licensee had not the NRC inspection taken place.

Procedure 1000.104, "Condition Reporting and Corrective Actions," Revision 15, refers to Attachment A, "Guidelines For Identification of Conditions To Be Reported," to describe conditions to be entered into the corrective action program. Item 8.0, "Deviation From Design/Licensing Basis Conditions," lists the following as a condition to be reported:

> Functional inaccuracies in safety-related documents (procedures, technical manuals, work plans, drawings, etc.) which could degrade plant safety.

Engineering Report 991920-E201 is a safety-related evaluation that utilized non-conservative assumptions on two different occasions. These non-conservative assumptions caused the licensee's engineers to underestimate the safety significance of the degraded condition. The failure of the licensee's staff to identify this issue as a condition adverse to quality and enter it into their corrective action system was a violation. The issue of not identifying the condition adverse to quality in the corrective action program will be addressed during the resolution of Condition Report CR-ANO-2-1999-0528.

Criterion XVI of Appendix B to 10 CFR Part 50 requires, in part, that measures shall be established to assure that conditions adverse to quality, such as failures, deficiencies, and deviations are promptly identified and corrected. The team found the failure to identify and correct the low flow condition to be a violation. Specifically, the licensee failed to take corrective actions to either increase the flow to a level that met the acceptance criteria (design values), change the design values so that the measured flow would be acceptable, or take other actions to have corrected the condition that was adverse to quality (i.e., a condition "which could degrade plant safety").

This is a Severity Level IV violation (first example) of Criterion XVI of Appendix B to 10 CFR Part 50 and is being treated as a noncited violation (50-313; -368/9909-02) consistent with Appendix C of the NRC Enforcement Policy. This violation is in the licensee's corrective action program as Condition Report CR-ANO-2-1999-0528.

b.2 <u>Review of Heat Exchanger Performance Prediction Software Validation Calculation</u>

The team noted that the STER software was developed by Holtec International and used by the licensee's engineers to evaluate the performance of the Unit 1 emergency diesel generator jacket water coolers; the Unit 1 decay heat removal coolers; the Unit 2 emergency diesel generator air, lube oil, and jacket water coolers; and the Unit 2 shutdown cooling heat exchangers. Holtec International Report HI-941175, "Resolution of Discrepancies in STER Models of ANO Diesel Generator Coolers," Revision 0, was included as an attachment to the validation calculation. In order to evaluate the performance of heat exchangers, assumptions must be made as to the effects on heat transfer as a result of fouling, either macrofouling (large flow restictions from corrosion or damage) or microfouling (thin layers that reduce the heat transfer coefficients).

During the review of this report, the team noted that the report documented differences between the manufacturer's component rating sheets, used by the Unit 2 emergency diesel generator original equipment manufacturer, and the performance predicted by the STER software. The team noted that the report described Holtec International's efforts to obtain geometric and performance data for the air, lube oil, and jacket water cooler heat exchangers from the original manufacturer (American Standard). American Standard provided Holtec International with the requested geometric data. However, American Standard did not endorse any thermal performance values.

Holtec International concluded that the STER software predicted the actual heat removal rate for the lube oil cooler and jacket water coolers would exceed that indicated on the rating sheet by 7.6 percent and 35.8 percent, respectively. The performance of the air cooler heat exchanger was predicted by the STER software to be 12.8 percent below the value indicated on the rating sheet. The licensee's engineers failed to appropriately revise, or otherwise resolve, these discrepancies for the Unit 2 emergency diesel generator heat exchangers to reflect the changes in predicted heat removal rates. Without resolving these differences, the licensee's engineers did not have the requisite assurance that the emergency diesel generator heat exchangers could remove the required heat.

The team noted that Calculation 91-D-2003-01 used the original fouling factors and resulting temperatures to define the limiting conditions for the engines. The team asked the licensee's engineers to identify the design fouling factors for these heat exchangers. The licensee's engineers' response referred the team to the fouling factors contained in Calculation 91-D-2003-01, which, based on the information provided by Holtec International, and confirmed by licensee engineers, were incorrect. If the fouling factors listed in Calculation 91-D-2003-01 were used in conjunction with the STER software in the performance prediction mode to evaluate the air, lube oil, and jacket water coolers at design conditions, non-conservative results would have been obtained for the air cooler heat exchanger, which, analytically, was the limiting cooler.

Additionally, there was no evidence that the nonconservative fouling factors had been provided to Coltec Industries, Fairbanks Morse Engine Division, to verify that the vendor considered and accepted actual heat exchanger performance when responding to technical questions or developing engineering evaluations as an operating service to the licensee. The licensee's engineers had written Condition Report CR-ANO-2-1999-0535 to address this issue. The licensee's engineers agreed with the team that the results would be nonconservative, but indicated that this issue did not result in an immediate operability concern because the test results indicated that the heat exchangers were capable of removing the required design-basis heat. The STER software predictions were considered by the licensee's engineers to be more accurate than those given in the original heat exchangers' data sheets, and they provided for a more conservative indication of the air cooler heat exchangers' performance.

Criterion III of Appendix B to 10 CFR Part 50 requires, in part, that design control measures shall provide for verifying the adequacy of design by the performance of design reviews. Holtec International Report HI-941175 demonstrated significant discrepancies between actual heat exchanger performance and the performance assumed by the original equipment manufacturer. Additionally, this report indicated that a previous assumption (i.e., fouling factors) regarding the performance of the air cooler heat exchangers was non-conservative. The team found the measures for verifying the adequacy of design to be inadequate in that the licensee's engineers failed to appropriately consider the impact of the information provided in Holtec International Report HI-941175 and revise, as appropriate, the corresponding design basis documents for the air, lube oil, and jacket water coolers.

This is a Severity Level IV violation (second example) of Criterion III of Appendix B to 10 CFR Part 50 is being treated as a noncited violation (50-313; -368/9909-01) consistent with Appendix C of the NRC Enforcement Policy. This violation is in the licensee's corrective action program as Condition Report CR-ANO-2-1999-0535.

b.3 <u>Treatment of Biological Fouling within the Heat Exchanger Testing Program</u>

Generic Letter 89-13, "Service Water Problems Affecting Safety-Related Equipment," provides a recommended test program for heat exchangers cooled by service water. The team reviewed the licensee's commitments regarding Generic Letter 89-13 as documented in a letter dated January 26, 1990. The team determined that the heat exchanger testing program was consistent with commitments made in the above-mentioned letter regarding test scope, frequency, and methodology.

The team noted that licensee personnel conducted full scale thermal performance testing on the following heat exchangers: Unit 1 emergency diesel generator jacket water coolers; Unit 1 decay heat removal heat exchangers; Unit 2 emergency diesel generator air, lube oil, and jacket water coolers; and Unit 2 shutdown cooling heat exchangers. Full scale thermal performance testing was utilized to determine if the heat transfer capability of a heat exchanger at test conditions, combined with the mathematical projection of measured performance at design conditions, would be sufficient to remove the required heat load under worst case conditions. The performance of all other heat exchangers included within the scope of Generic Letter 89-13 was verified through either periodic flow testing or component inspections.

The heat exchangers, evaluated using the full-scale thermal performance test methodology, were typically maintained in a standby condition with service water flow isolated during normal operations. Service water was typically treated with a corrosion inhibitor and a biocide when flow was initiated to these components. Therefore, these heat exchangers were not exposed to an environment that would support the development of tube-side microfouling prior to testing.

The licensee's engineers had quantitative evidence that continuous biocide injections were effective in controlling biological fouling. The team noted that this evidence had been obtained through the use of "bio-boxes," which licensee personnel used to monitor the development of organic species that contribute to fouling, and through component inspections, which typically indicated that heat transfer surfaces remained free of a slime layer.

The team questioned the licensee's engineers' understanding of the quantitative impact of tube-side microfouling on heat exchanger performance. The licensee's engineers indicated that their understanding of the impact of tube-side microfouling on heat exchanger performance, when crediting biocide injections, was limited to their observations from component inspections. Thermal performance tests were conducted shortly after service water flow had been initiated to the heat exchanger and, therefore, may not represent bounding conditions because of the time-dependent nature of microfouling.

The licensee's engineers indicated that they had no specific quantitative data regarding heat exchanger performance for conditions during which the biocide injection system was not available. A water treatment consultant representing the licensee indicated that, for the untreated case, tube-side microfouling would reach its maximum value within 30 days for the water conditions typically experienced in the service water systems. However, this consultant was unable to quantify a corresponding value for fouling resistance to be used to address heat exchanger performance.

For the Unit 1 decay heat removal heat exchangers and the Unit 2 shutdown cooling heat exchangers, the impact of tube-side microfouling would not be expected to impact the ability of these heat exchangers to perform their design function. The team found that the worst-case accident heat load will occur early in the accident response, such that any increase in heat exchanger fouling due to biological growth will be more than offset by the reduction of heat loads calculated during the 30-day response to an accident condition.

However, the impact of tube-side microfouling would be more significant for the emergency diesel generator coolers, in both units, which are required to operate near full load for the duration of the 30-day accident response. In addition, the biocide injection system is nonsafety-related and is not provided with emergency power. Therefore, this system would not necessarily be able to function in the event of a loss-of-offsite power during which the emergency diesel generators would be relied on to provide vital power. Nevertheless, licensee chemists indicated that they would have the ability to inject chemicals manually. The team found, however, that the effectiveness of these chemicals had not been proven; the alternate injection method had not been proceduralized; and the importance of these injections was not well understood by the licensee's chemistry, operations, and engineering department personnel.

The team found the Unit 2 emergency diesel generator air coolers as the components that limited the emergency diesel generator output because of the small fouling margin available and the increased service temperature resulting from the variations in emergency cooling pond temperature during the accident response. However, any component with limited margin that operates at or near its maximum heat loading for the duration of the accident response (e.g., decay heat removal room coolers) is potentially impacted by this condition. The team found the licensee's engineers and chemists' inability to quantify the impact of tube-side microfouling was a weakness in the heat exchanger testing program.

Licensee personnel generated two condition reports to address the issues raised by the team regarding the treatment of tube-side microfouling within the heat exchanger testing program. Condition Report CR-ANO-C-1999-0211 was written to review the status of the biocide injection system to determine whether it should be included in the scope of the Maintenance Rule program, citing the importance of the reliability of this system. In addition, this condition report directed the establishment of procedures to allow for the alternate injection of biocide, if the normal injection system was out of service. Condition Report CR-ANO-C-1999-0215 was written to recommend the monitoring of tube-side microfouling into the heat exchanger test program to develop quantitative values for this fouling component to demonstrate the ability of the effected heat exchangers to perform their design function.

The team found that the documentation on the Unit 2 emergency diesel generator heat exchangers identified limited available margin. As a result, the non-conservative error identified in Section E1b.1 (i.e., the under-prediction of the maximum heat load), when considered with the failure to adequately assess the impact of tube-side microfouling on heat exchanger performance, represented a challenge to the ability of the Unit 2 emergency diesel generators to perform their design function.

As stated above, licensee engineers wrote condition reports on both of these items. These condition reports have been evaluated independently with each condition report classified as nonsafety significant. The team noted that, when combined, the potential effect could be more significant than indicated by licensee personnel. At the end of the inspection, licensee personnel were considering the combined effects of these two issues. Without the additional evaluation, the licensee was not able to demonstrate that the verification of the adequacy of the design was acceptable. The team identified this as an unresolved item (50-368/9909-03) pending NRC review of the licensee's evaluation of the combined effects of the under-prediction of the maximum heat load and microfouling.

c. Conclusions

c.1 Licensee personnel failed to consider generator efficiency in determining the maximum heat loads for the Unit 2 emergency diesel generator heat exchangers in a design calculation. Additionally, licensee personnel failed to use the actual service water flow and bounding electrical loads in the operability determination that evaluated the impact of the failure to consider the generator efficiency. These failures were a violation (first example of six) of Criterion III of Appendix B to 10 CFR Part 50. Also, a violation (first example of five) of Criterion XVI of Appendix B to 10 CFR Part 50 was identified for the failure to identify low service water flow to the Unit 2 emergency diesel generators as a condition adverse to quality and enter it into the corrective action program.

c.2 Licensee personnel failed to consider the impact of exceeding the manufacturer's rating for heat removal rates provided in Holtec International Report HI-941175 and revise, as appropriate, the corresponding design basis documents for the air cooler, lube oil cooler, and jacket water coolers. This was a violation (second example of six) of Criterion III of Appendix B to 10 CFR Part 50.

c.3 Tube-side microfouling was not evaluated in the heat exchanger test program for the emergency diesel generator coolers, in either unit. This was because the licensee was unable to quantify the effects microfouling.

An unresolved item was identified as a result of the need for additional licensee evaluation of the combined effects on the Unit 2 emergency diesel generators of under-predicting the maximum heat load and microfouling of the heat exchangers. This item will remain open pending NRC review of the completed licensee evaluation.

E2 Engineering Support of Facilities and Equipment (93809)

a. Inspection Scope

a.1 The team reviewed Engineering Report 91-R2017-05, "2R12 Service Water System and Flow Test Analysis," Revision 0, to evaluate engineering personnel's effectiveness in the support of the units and equipment.

a.2 The team reviewed operating, abnormal, and emergency operating procedures for both units to verify that the operation of the service water systems was consistent with facility license requirements and the design bases. This review prompted a further review of events, safety evaluations, and corrective actions. The team also identified all instrument and operating setpoints and determined the adequacy of the setpoints and the validity of the setpoint bases.

The team reviewed the following documents to identify the setpoints associated with the service water systems:

> Procedure 1104.029, "Unit 1 Service Water and Auxiliary Cooling System," Revision 52;
>
> Procedure 2104.029, "Unit 2 Service Water System Operations," Revision 07;
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> Procedure 1203.030, "Unit 1 Loss of Service Water," Revision 11;
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> Procedure 2203.022, "Unit 2 Loss of Service Water," Revision 47;
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> Procedure 1203.012I, "Annunciator K10 Corrective Action," Revision 38;
>
> Procedure 2203.012E, "Annunciator 2K05 Corrective Action," Revision 25;
>
> Engineering Action Request 91-0174, "Unit 1 SW System Setpoint Documentation," Revision 1;
>
> Engineering Report 92-R-2009-25, "Unit 2 Setpoint Documentation Packages for Service Water System," Revision 3; and
>
> Emergency Operating Procedure Technical Guidance Setpoint Documentation for Both Units.

a.3 The team reviewed plant changes, design change packages, and limited change packages listed in the attachment to this report. Modifications were reviewed to assure the changes made to the original service water systems did not change the design or licensing bases.

a.4 The team reviewed calculations used to support the Unit 1 service water system's ability to provide adequate total flow under all operating conditions and configurations.

b. Observations and Findings

b.1 Evaluation of Service Water Flow Test Data

During Refueling Outage 2R11, the as-left flow for Jacket Water Cooler 2E-20A (Table 1) was 3547 Lpm [938 gpm]. The subsequent as-found flow in Refueling Outage 2R12 for Cooler 2E-20A was 3290 Lpm [869 gpm], an operating cycle flow degradation of 261 Lpm [69 gpm]. (The minimum allowable flow was 3407 Lpm [900 gpm].) The as-left flow for the cooler was 3430 Lpm [907 gpm]. The as-found flow in Refueling Outage 2R13 was 3221 Lpm [851gpm], an operating cycle flow degradation of 212 Lpm [56 gpm]. The as-left flow rate for Cooler 2E-20A was 3486 Lpm [922 gpm] at the end of Refueling Outage 2R13.

The team noted that the licensee's engineers determined that Jacket Water Cooler 2E-20A was capable of removing the required heat with the as-found service water flows, which were less than the design value. The team did not identify any corrective actions that the licensee was planning to undertake to restore the heat exchanger performance other than the cleaning of the cooler. This was a concern to the team because of the trend in flow degradation, even with cleaning. As a result, the team questioned the future ability of this cooler to pass the design service water flow when tested at the beginning of the next refueling outage since the trend in flow degradation would, in the opinion of the team, bring the as-found flow rates below the minimum design flow rate if no further licensee action occurred.

A licensee engineer issued Condition Report CR-ANO-2-1999-0561 in response to the team's questioning the ability for the service water flow to Jacket Water Cooler 2E-20A to be above the design requirement of 3407 Lpm [900 gpm] during the current operating cycle. The licensee's engineer stated that an evaluation would be performed to determine whether any interim actions were needed between the date the condition report was initiated and the next refueling outage to assure that a low-flow condition would not occur.

TABLE 1

TEST DATA FOR THE UNIT 2 EDG JACKET WATER COOLER, 2E-20A, LOOP 1

Refueling Outage	As-Found/As-Left	Corrected Flow Lpm [gpm]
2R11	As-found	3498 [924]
2R11	As-left	3547 [938]
2R12	As-found	3290 [869]
2R12	First as-left	3112 [822]
2R12	Second as-left[1]	3361 [888]

TABLE 1

TEST DATA FOR THE UNIT 2 EDG JACKET WATER COOLER, 2E-20A, LOOP 1

Refueling Outage	As-Found/As-Left	Corrected Flow Lpm [gpm]
2R12	Third as-left[2]	3430 [907]
2R13	As-found	3221 [851]
2R13	As-left	3486 [922]

1 The outlet valve to shutdown cooling heat exchanger was throttled to allow more flow to the emergency diesel generator.

2 There was no test. The licensee's engineers removed some conservatism in the calculation, such that the resultant value met the acceptance criterion. Also, the licensee's engineers limited the degradation, allowed by the inservice testing program, to 7 percent instead of 10 percent.

The team noted that the Unit 2 service water flow tests had, during three refueling outages, as-found flows for Jacket Water Cooler 2E-20B (Table 2) less than the required flow of 3407 Lpm [900 gpm]. In addition, the as-left test flows for Refueling Outages 2R11 and 2R12 were less than the required flow. During Refueling Outage 2R13, maintenance personnel replaced piping for the Train B emergency diesel generator, which improved the overall flow to the service water components. The as-left flow test for Jacket Water Cooler 2E-20B was 4024 Lpm [1063 gpm], which exceeded the minimum flow requirement.

TABLE 2

TEST DATA FOR THE UNIT 2 EDG JACKET WATER COOLER, 2E-20B, LOOP 2

Refueling Outage	As-Found/As-Left	Corrected Flow Lpm [gpm]
2R11	As-found	3202 [846]
2R11	As-left	3187 [842]
2R12	As-found	3055 [807]
2R12	First as-left	3131 [827]

TABLE 2

TEST DATA FOR THE UNIT 2 EDG JACKET WATER COOLER, 2E-20B, LOOP 2

Refueling Outage	As-Found/As-Left	Corrected Flow Lpm [gpm]
2R12	Second as-left[1]	3399 [898]
2R12	Third as-left[2]	3399 [898]
2R13	As-found	3312 [875]
2R13	As-left	4024 [1063]

1 The outlet valve to shutdown cooling heat exchanger was throttled to allow more flow to the emergency diesel generator.

2 There was no test. The licensee's engineers removed some conservatism in the calculation, such that the resultant value met the acceptance criterion. Also, the licensee's engineers limited the degradation, allowed by the inservice testing program, to 7 percent instead of 10 percent.

Subsequent to the onsite inspection, the team was informed that the piping for the Unit 2, Loop 1 emergency diesel generator would be replaced during the mid-cycle outage scheduled for November 1999. Mr. C. Randy Hutchinson made this commitment during the exit meeting on November 8, 1999. The team noted that the replacement of the same piping for the Loop 2 emergency diesel generator resulted in significant improvement in flow to Cooler 2E-20B.

b.2 Validation of Setpoints and Their Bases

The team requested that the licensee's engineering staff provide uncertainties and bases for service water flow measurement and indication for the Unit 2 Loop 1 shutdown cooling heat exchanger and Containment Fan Coolers 2A and 2B. Containment Fan Coolers 2A and 2B were Loop 1 coolers in a parallel configuration on the air and water side. The licensee's engineers stated that they had only identified an uncertainty for the primary element (orifice) and did not include the uncertainty for the differential pressure transmitter used to develop the signal. The incorporation of this additional uncertainty meant that the service water flow for the Loop 1 shutdown cooling heat exchanger was, when including the differential pressure transmitter uncertainty, 12492 Lpm [3300 gpm], instead of the expected 13249 Lpm [3500 gpm]. The team identified the inadequate consideration of instrument uncertainty as an unresolved item (50-313; -368/9909-04) pending further NRC review.

During the review of Calculation 97-E-0004-03, "Shutdown Cooler 2E-35A Thermal Performance Test," Revision 1, the team verified that the required accident heat removal rate would still be met at the lower service water flow; however, the heat exchanger was not configured to operate within the design basis (i.e., with a flow greater than or equal to 16656 Lpm [4400 gpm]). The issue of shutdown cooling heat exchanger performance, and operation below the design service water flow rate, is more fully discussed in Section E3b.2.

b.3 Design Changes and Modifications

The team noted that Plant Change Package PC-97-4899-P201, "2R13 Service Water Pipe Replacement," failed to identify ASME Section XI inservice inspection as an "impacted area." This plant change package identified that hangers (pipe supports) were to be removed or modified. ASME Section XI hangers are required to be visually inspected as part of the inservice inspection program. The service water system was mostly ASME Class 3 with a few ASME Class 2 components. Changes to ASME Class 1 and 2 could involve the addition or deletion of piping lines and hangers.

Procedure 1000.153, "Engineering Request Process," Change 004-03-0, requires physical changes to the plant configuration to be evaluated against the engineering screening criteria. Engineering screening criteria shall identify the impacted areas or engineering disciplines. The team noted that on page 328 of the plant change package, referenced above, licensee personnel failed to identify ASME Section XI inservice inspection as an "impacted area." The licensee's staff issued Condition Report CR-ANO-2-1999-0559 concerning this team-identified problem.

Criterion V of Appendix B to 10 CFR Part 50 requires, in part, that activities affecting quality shall be prescribed by documented instructions, procedures, or drawings of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions procedures or drawings. The team found the failure to perform an impact evaluation in accordance with Procedure 1000.153 to be a violation.

This is a Severity IV violation (first example) of Criterion V of Appendix B to 10 CFR Part 50 and is being treated as a noncited violation (50-313; -368/9909-05) consistent with Appendix C of the NRC Enforcement Policy. This violation is in the licensee's corrective action program as Condition Report CR-ANO-2-1999-0559.

b.4 Service Water System Flow

During the review of the ANO-1 service water system for adequacy of total flow, the team found that original architect engineers' design basis calculations had been voided and not replaced. The team also found that, when compared to the architect engineers' design calculations, the new service water system pumps had a lower total flow capability than the original design.

Licensee engineers confirmed that the architect engineers' calculations were no longer valid and initiated the reconstruction of the limiting design condition for system flow (i.e., a normal plant shut-down with one pump operational). The licensee's engineers determined that flow during this condition would exceed the maximum pump flow limit of 30283 Lpm [8000 gpm] by approximately 946 Lpm [250 gpm]. Operating outside of the design range can lead to a pump failure and the reduced ability to cool-down the plant because of inadequate flow to the service water system heat exchangers. The licensee's engineers wrote Condition Report CR-ANO-1-1999-0254 and performed an operability assessment to evaluate this condition; to define the design bases for the one service water pump cooldown case; and to review the service water normal and abnormal operating procedures with respect to the results of the design bases determination to identify procedural enhancements.

The licensee's engineers determined, in the operability assessment, that the plant would remain operable during the time required for operators to realign the system to reduce service water flow. Abnormal Operating Procedure 1203.030, "Unit 1 Loss of Service Water," Revision 11, requires a plant trip following the loss of two service water pumps if one pump cannot be quickly restored. The team noted, in Condition Report CR-ANO-1-1999-0254, actions for licensee engineers to define the design basis for plant cool-down with one service water pump operational, and actions to review the normal and abnormal procedures to identify procedural enhancements. Through discussions with licensee engineers, the the team understood that the condition report was to be expanded to provide design bases analyses for all operating conditions.

Criterion III of Appendix B to 10 CFR Part 50 requires, in part, that "design control measures shall provide for verifying or checking the adequacy of design . . . by the use of alternate or simplified calculational methods . . . ." Contrary to this requirement, the licensee's design control measures failed to verify the adequacy of the design by not maintaining the design bases calculations. As a result, replacement service water pumps, which were not capable of providing the required flow under all operating conditions, were purchased and installed.

This is a Severity IV violation (third example) of Criterion III of Appendix B to 10 CFR Part 50 and is being treated as a noncited violation (50-313; -368/9909-01) consistent with Appendix C of the NRC Enforcement Policy. This violation is in the licensee's corrective action program as Condition Report CR-ANO-1-1999-0254.

During the review of the service water system heat exchanger flows, which were measured in the performance tests and compared with the design flows, the team found that many of the results significantly exceeded the design flow, some in excess of 800 percent. The licensee's engineers determined that, based on the most current data, 17 of 26 heat exchangers in Unit 1 and 29 of 40 heat exchangers in Unit 2 had flows that exceeded the respective design flows. The team requested the maximum allowable flow for each heat exchanger. The team reviewed the ANO test procedures and found that flow tests focused on the minimum allowable flow for a design basis accident without regard for the maximum flow.

The licensee's engineers were not able to obtain the maximum allowable flow limits from the vendors during the onsite inspection. A licensee engineer stated that both sides of the service water-supplied heat exchangers and other safety-related heat exchangers would be examined, and a non-destructive test would be performed on the heat exchanger with the highest flow velocity.

The team considered the past failure to evaluate the effects of high flow conditions to be indicative of weak erosion/corrosion and fatigue programs. This finding was based on the fact that excess flow can lead to premature failure of a heat exchanger tube because of erosion or vibration, potentially leading to unavailability of cooling water during a design basis accident. An evaluation by licensee engineers concluded that there were no immediate problems stemming from the excess flow; however, the licensee's evaluation stated that selected plant changes might be required to control maximum flow. Further evaluation was required to demonstrate that the verification of the adequacy of the design was acceptable, as required by Criterion III of Appendix B to 10 CFR Part 50. This issue was identified as an unresolved item (50-313; -368/9909-06) pending NRC review of Condition Report CR-ANO-C-1999-0209 and the completed evaluation.

c. <u>Conclusions</u>

c.1 The licensee committed to replacing the service water piping for the Unit 2, Loop 1 emergency diesel generator during the mid-cycle outage scheduled for November 1999.

c.2 The lack of consideration of uncertainty associated with the differential pressure transmitter used to develop the flow signal for the Unit 2 Loop 1 shutdown cooling heat exchangers resulted in nonconservative service water flow. This was identified as an unresolved item pending further NRC review.

c.3 The failure to perform an impact study for the removal of pipe supports was identified as a violation (first example of four) of Criterion V of Appendix B to 10 CFR Part 50.

c.4 A violation (third example of six) of Criterion III of Appendix B to 10 CFR Part 50 was identified for the failure to verify or check the adequacy of design calculations related to total service water flow.

One unresolved item was identified for the potential adverse erosion/corrosion and fatigue effects of excessive service water flow.

E3 Engineering Procedures and Documentation

a. <u>Inspection Scope</u>

a.1 The team reviewed the results of various heat exchanger thermal performance test results for Unit 1 and 2.

a.2 The team reviewed the engineering evaluation associated with the flow balancing effort performed during the Refueling Outage 2R13.

a.3 The team reviewed the actions taken by the licensee to correct a condition related to the Coltec Industries, Fairbanks Morse Engine Division, engine design in which a cross-flow loop can be created through the engine keep-warm system and which has the potential to over load the emergency diesel generator air cooler heat exchanger.

b. Observations and Findings

b.1 Review of the Documentation for the Evaluation of Thermal Performance Test Results

During the review of previously conducted Unit 1 heat exchanger thermal performance test evaluations, the team observed that the licensee's engineers used three different methods to document their analyses. The first method observed was the use of a formal calculation as controlled by Procedure 5010.015, "Engineering Calculations," Revision 1, which defines a calculation as:

> A design analysis or documented engineering evaluation performed by a technically qualified individual using the necessary design inputs and appropriate methodology to provide a conclusion.

For the second method, other evaluations (Engineering Report 93-R-1035-01, -02, -03) were documented as engineering reports. Procedure 5010.017, "Control of Engineering Reports," Revision 1, defines an engineering report as:

> The formal documentation of test results, research or other engineering work. The report is more of a verbal description of results of work conducted and is not a detail design analysis or analytical evaluation in itself. Examples are: Special NSSS Vendor Study, Root Cause Investigations, or Documentation of Review of Specific Plant Conditions such as HPI Backflow Condition.

Based on these definitions, the team questioned whether it was appropriate: 1) to perform an evaluation, which utilized test results from a heat exchanger thermal performance test to calculate the actual conditions of the heat exchanger, using a validated computer program combined with a statistical treatment of measurement uncertainty; 2) to extrapolate the results of the evaluation to the design basis case; and 3) to verify that the heat exchanger would be capable of performing its design function, as an engineering report. The licensee's engineers agreed that the calculation process was the appropriate method for performing this analysis based on their procedures. The team noted that the licensee's engineers wrote Condition Report CR-ANO-1-1999-0251 to address this concern.

The team observed that, as a third method, the Unit 2 emergency diesel generator heat exchanger thermal performance test results from Refueling Outage 2R11 were evaluated under the control of Job Orders 950824 and 950906. (The job order process was used to control work in the field.) These job orders were used to proceduralize the steps, in lieu of developing a test procedure, required to conduct the thermal performance test for the emergency diesel generator heat exchangers during Refueling Outage 2R11. The computer output sheets, that the licensee's engineers used to evaluate the test results at test and design conditions, were included as attachments to these job orders. The team noted that Step 9.4 of Job Orders 950824 and 950906 were signed off on August 24, 1995, and September 8, 1995, respectively, and stated:

> An analysis and trending of the heat exchanger data collected by the performance of this procedure, shall be performed by the System Engineer and the results presented in a separate report.

The team noted that "Engineering Report 91-R-2014-04" was written next to both job steps. A licensee engineer confirmed that this number was assigned; however, there was no record that an engineering report had been performed. The licensee's engineer relied on the calculated results from these tests, which were based on an evaluation that was performed outside of the design control process, Procedure 5010.017, and ANSI N45.2.11, "Quality Assurance Requirements for the Design of Nuclear Power Plants." In addition, the job orders were incorrect in reference to a "separate report," rather than a calculation as identified in Condition Report CR-ANO-1-1999-0251. Condition Report CR-ANO-2-1999-0573 was written to document the failure to adequately document the analysis of the Unit 2 emergency diesel generator heat exchanger test results from Refueling Outage 2R11.

Criterion V of Appendix B to 10 CFR Part 50 requires, in part, that activities affecting quality shall be prescribed by documented instructions, procedures, or drawings of a type appropriate to the circumstances and shall be accomplished in accordance with these instruction procedures or drawings. The team found the failure to follow the instructions contained within Job Orders 950824 and 950906 and Procedure 5010.017 to perform a separate engineering evaluation to be a violation.

This is a Severity Level IV violation (second example) of Criterion V of Appendix B to 10 CFR Part 50 violation and is being treated as a noncited violation (50-313; -368/9909-05) consistent with Appendix C of the NRC Enforcement Policy. This violation is in the licensee's corrective action program as Condition Reports CR-ANO-1-1999-0251 and CR-ANO-2-1999-0573.

b.2 Review of Engineering Evaluation 991457, "Throttling of the SDC Heat Exchanger"

Condition Report CR-ANO-2-1999-0036 was written to document the licensee's determination during Refueling Outage 2R13 that the service water flow was below the minimum acceptance criterion for both trains of the Unit 2 shutdown cooling heat exchangers and the emergency diesel generator air, lube oil, and jacket water coolers.

Preliminary Licensee Actions

The solution arrived at, by the licensee's engineering staff, was to replace the service water carbon steel piping between the emergency diesel generators and the service water headers with stainless steel piping. By using the stainless steel pipe, there would be less fouling from corrosion. Therefore, more flow would be experienced.

The team noted that the service water pipe replacements on the inlet and outlet to the Loop 2 emergency diesel generator were successful in correcting the degraded condition and resulted in flow above the minimum acceptance criterion (see Table 2). This was demonstrated by the as-left flow test. Inspections by licensee personnel, of the removed piping, showed significant fouling from corrosion nodules that had resulted in as much as a 30 percent reduction in flow area. The licensee's engineers considered this flow area reduction to be the primary cause of repeated failures to achieve acceptable flows through this component over the last four flow tests.

Licensee management elected not to implement similar service water pipe replacement modification to the Loop 1 emergency diesel generator during Refueling Outage 2R13. However, the inlet and outlet service water piping to the Loop 1 emergency diesel generator was suspected to be in a similar state of advanced corrosion that could affect the shutdown cooling heat exchangers; the emergency diesel generator air, lube oil, and jacket water coolers; and the low pressure safety injection seal cooler. Instead, licensee management decided to perform a flow balance on Loop 1 of the Unit 2 service water system while in the emergency safety feature line-up. The team noted that licensee management elected to defer the work on the Loop 1 emergency diesel generator on the basis of safe shutdown operational issues, resource issues, and constraints imposed by other work in progress.

In order to assure emergency diesel generator performance by obtaining more cooling, the licensee's staff elected to throttle the service water return flow from the shutdown cooling and the containment fan coolers to increase service water flow to the emergency diesel generator heat exchangers, and possibly others. Significant throttling on the outlet of the shutdown cooling heat exchanger and the containment air coolers was required to achieve the minimum service water flow of 3407 Lpm [900 gpm] to the emergency diesel generator air, lube oil, and jacket water cooler and 30 Lpm [8 gpm] to the low-pressure safety injection seal cooler. This change had the desired effect and additional emergency diesel generator cooling was achieved.

The shutdown cooling heat exchanger was throttled to a flow of 13351 Lpm [3527 gpm], which was significantly below its minimum required flow of 16656 Lpm [4400 gpm]. The containment air cooler outlet butterfly-valve was throttled to a point where the valve was only 25 percent open. The licensee's engineers performed an evaluation of this condition as documented in Engineering Evaluations 991457-E201, Revision 0, and 991457-E202, Revision 0.

Engineering Evaluation 991457-E201

The team noted that Engineering Evaluation 991457-E201 discussed the throttling of the flow control valves and addressed a potential degradation mechanism associated with this configuration under normal operations, testing, and accident conditions. According to the accident analysis code (COPATTA) and using the most conservative assumptions, one train of Unit 2 containment fan coolers required a service water flow of 4731 Lpm [1250 gpm] to perform the train safety function. Procedure 2104.033, "Containment Atmosphere Control," Revision 37, required a minimum flow of about 5129 Lpm [1355 gpm] to maintain operability. Thus, the limit switch assembly for Valve 2CV-1519-1, "Service Water Return From Containment Cooling Coils 2VCC-2A/2B," was adjusted to provide at least the minimum acceptable flow. The team determined that the containment fan coolers would perform their safety function in that configuration.

Engineering Evaluation 991457-E202

The Unit 2 Final Safety Analysis Report, Table 9.2-1, showed a minimum service water flow of 16656 Lpm [4400 gpm], adjusted for uncertainties and instrument inaccuracies, for each shutdown cooling heat exchanger. Engineering Evaluation 991457-E202, documented that an unadjusted (indicated) flow of 13249 Lpm [3500 gpm] would be sufficient to satisfy the safety function. Thus, based on the engineering evaluation, the licensee lowered the minimum acceptable accident flow through the heat exchanger to an indicated flow of 13249 Lpm [3500 gpm]. To validate this expected performance, the licensee's staff had developed and performed a thermal performance test for the shutdown cooling heat exchangers. The licensee used Procedure 2311.001, "Shutdown Cooler Heat Exchanger Thermal Test," Revision 2, with Calculation 97-E-0004-03 to perform static testing and used spreadsheet methodology to evaluate heat exchanger performance at accident conditions.

The team reviewed the test package, including the procedure, calculation, raw data, and several test runs at varying conditions. The team determined that the test methodology and results were valid. The test results indicated that, under the most conservative conditions, such as loss of lake cooling (heat sink) and an elevated emergency cooling pond temperature of 48.9°C [120°F], the heat exchanger would be capable of satisfying its safety function at flows less than 9464 Lpm [2500 gpm]. Therefore, the team had no safety concern with this issue.

The team also noted that Engineering Evaluation 991457-E202 addressed the low-flow condition for the shutdown cooling heat exchanger. This evaluation reviewed past heat exchanger thermal performance test results and compared them to the design heat removal capability of the heat exchanger. The licensee's engineers changed the total available fouling factor on the heat exchanger from 0.0026 to 0.001, for a reduction factor of approximately 2.6 to accommodate the lower service water flow. The change of the fouling factor was necessary for the licensee's engineers to reduce the minimum acceptable flow by 25 percent, from 16656 Lpm [4400 gpm] to 12492 Lpm [3300 gpm].

The licensee decreased the service water flow through the heat exchanger by throttling Valve 2SW-11A, "Service Water Return From Shutdown Cooler 2E-35A," a manual butterfly valve. The team noted that the thermal performance testing was performed in response to Condition Report CR-ANO-2-1999-0036, which identified that Loop 1 shutdown cooling heat exchanger service water flow for accident conditions was set less than the minimum design. The team inquired if a screening or safety evaluation had been performed for the system configuration change to satisfy the requirements of 10 CFR 50.59, "Changes, Tests, and Experiments." The Unit 2 operation standards organization subsequently performed a safety evaluation screening for the change to Procedure 2104.029, "Service Water System Operations," Revision 44, that throttled the return valves for the heat exchangers. The screening indicated that an evaluation was not necessary.

The team reviewed Procedure 1000.131, "10 CFR 50.59 Review Program," Revision 2, and the screening for the change to Procedure 2104.029. The second screening question asked if the proposed activity would result in information in the Final Safety Analysis Report no longer being true or accurate. The team reasoned that changing the actual service water flow from the design flow value of 16656 Lpm [4400 gpm] to 13249 [3500 gpm] (a reduction of greater than 20 percent) for an entire fuel cycle should require this question to be answered yes and should have resulted in an evaluation. The engineering organization did not perform a screening or an evaluation for this change. Instead, a performance test was developed and performed to validate that the required heat removal rate (33.6E6 kJ/hr [31.85E6 Btu/hr]) was attained.

Criterion V of Appendix B to 10 CFR Part 50 requires, in part, that activities affecting quality shall be accomplished in accordance with procedures appropriate to the circumstances. Licensee Procedure 1000.131 was appropriate to the circumstances and required an evaluation to be performed. The failure to perform an evaluation in accordance with Procedure 1000.131 for a change that would result in information in the Final Safety Analysis Report being inaccurate was a violation.

This is a Severity Level IV violation (third example) of Criterion V of Appendix B to 10 CFR Part 50 and is being treated as a noncited violation (50-313; -368/9909-05) consistent with Appendix C of the Enforcement Policy. This example of the violation is in the licensee's corrective action program as Condition Report CR-ANO-2-1999-0580.

The team identified some deficiencies with the licensee's engineers' evaluations. The team noted that the licensee's engineers did not consider the sensitivity of the service water system flow balance to valve position and further piping degradation. Neither did the evaluations address issues of test repeatability and the periodic verification of flow to the emergency diesel generator and the shutdown cooling heat exchanger to assure that the flow did not drop below 3407 Lpm [900 gpm] and 13249 Lpm [3500 gpm], respectively. Additionally, the inaccessibility of the manual throttle valve on the outlet of the shutdown cooling heat exchanger, due to potential high radiation levels during the accident, was not considered.

Engineering Evaluation 991457-E203

The team also noted that Engineering Evaluation 991457-E201 did not address the potential to create two-phase flow conditions within the throttle valve at the outlet of the containment air cooler. The licensee's evaluation states:

> Valves 2SW-11A and 2CV-1519-1 are both Tricentric wafer stop butterfly valves. The valve body and disk are both made of 316L stainless steel. In order to provide tight shut off, the Tricentric valves use a laminated seal stack installed in the off set valve disk. The seal stack also uses 316L steel in the laminations. The use of butterfly valves in a throttling application is known to cause seat damage over long periods of operation in this manner and would be detrimental to these valves . . . Valve 2CV-1519-1 is the outlet valve for the containment air Coolers 2VCC-2A/2B and is a containment isolation valve.

The team also noted that Engineering Evaluation 991457-E201 did not discuss the potential for the existence of two-phase flow conditions and the potential to accelerate valve degradation mechanisms that could adversely impact the valve's ability to perform its safety function to provide containment isolation, as well as, limiting the flow to the containment air cooler. Additionally, the licensee's engineers did not evaluate potential impacts on previous responses to Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," that could have been created by the change in valve position from open to throttled. The licensee's engineers initiated Condition Report CR-ANO-2-1999-0550 to address this issue.

The licensee's engineers also initiated Engineering Evaluation 991457-E203 to evaluate this condition. The licensee's engineers determined that flashing in the valve would not occur. The team questioned the licensee's engineers' analysis and found that the licensee's engineers had not evaluated the most limiting case of a clean containment air cooler when addressing flashing concerns. This oversight had the potential to invalidate the design basis assumptions used for two-phase flow conditions in the containment air coolers.

Condition Report CR-ANO-C-1999-0213 was written to address this concern. The integral effect of these two condition reports was under evaluation by the licensee. Without the additional evaluation, the licensee was not able to demonstrate that the verification of the adequacy of the design was acceptable, as required by Criterion III of Appendix B to 10 CFR Part 50. The team identified this as an unresolved item (50-313; -368/9909-07) pending NRC review of the licensee's evaluation of the integral effects of throttling the butterfly valve with a clean heat exchanger.

The team observed that Engineering Evaluation 991457-E202 analyzed a minimum service water flow of 13249 Lpm [3500 gpm] to the shutdown cooling heat exchanger. The licensee's engineers failed to recognize the need to update the associated design and licensing basis documents to reflect this change. For example, Procedure

2311.002, "Service Water System Flow Test," Revision 11, lists the minimum acceptance criterion for service water flow to shutdown cooling Heat Exchanger 2E35A as 16656 Lpm [4400 gpm]. This evaluation stated that:

> Restoration of 2E35A service water flow to the design value will be tracked by CR-2-1999-0036, Action item 05. As this degraded condition will be corrected via the condition reporting system, a configuration control check list is not required.

Subsequent to the team's questioning, the licensee's engineers wrote Condition Report CR-ANO-2-1999-0549 to document the failure to complete the configuration control check list as required by Procedure 1000.153, "Engineering Request Process," Revision 4. Criterion V of Appendix B to 10 CFR Part 50 requires, in part, that activities affecting quality shall be accomplished in accordance with procedures appropriate to the circumstances. Licensee Procedure 1000.153 was appropriate to the circumstances and required the completion of the configuration control checklist. The failure to complete a configuration control checklist in accordance with Procedure 1000.153 was a violation.

This is a Severity Level IV violation (fourth example) of Criterion V of Appendix B to 10 CFR Part 50 and is being treated as a noncited violation (50-313; -368/9909-05) consistent with Appendix C of the Enforcement Policy. This example of the violation is in the licensee's corrective action program as Condition Report CR-ANO-2-1999-0549.

The licensee's engineers wrote Condition Report CR-ANO-2-1999-0554 during the inspection to document the failure to apply the 2.25 percent instrument error to the measured service water flow obtained during the Refueling Outage 2R13 testing of the containment air coolers and the shutdown cooling heat exchanger (as documented in Calculation 91-R-2013-01, "Service Water Performance Methodology," Revision 3). The team noted that the licensee's engineers demonstrated that the service water flow to the containment air coolers remained above the minimum required value, as specified in the technical specifications. However, the licensee's evaluation demonstrated that the service water flow to the shutdown cooling heat exchanger dropped from 13351 Lpm [3527 gpm] to 12545 Lpm [3314 gpm] as a result of this error. This value was below the minimum acceptable value considered in Engineering Evaluation 991457-E202. The evaluation was revised for a service water flow of 12492 Lpm [3300 gpm], thereby, consuming additional heat exchanger margin. The failure to apply the instrument error to the measured service water flow is considered as another issue for Unresolved Item 50-313; -368/9909-04, identified in Section E2b.2, above.

The licensee's engineers did not perform a screening or safety evaluation to address the requirements of 10 CFR 50.59 as part of this evaluation. However, an evaluation was performed for the associated procedure changes required to implement the valve manipulations. The failure to evaluate the design aspects of this change was an oversight on the part of the licensee's engineers. The licensee's engineers indicated that the screening of the procedure change was sufficient. However, Table 9.3-23 in the Final Safety Analysis Report specifies a fouling factor of 0.0026 for the shutdown cooling heat exchanger. The licensee changed this value to 0.001 as part of its evaluation to allow for lower service water flows by reducing heat exchanger margin.

In addition, Section 6.2.2.2.2 of the Final Safety Analysis Report states that containment air cooler Valve 2CV-1519-1 will receive an automatic signal to move to the open position in the event of a containment spray actuation signal. Based on the physical changes implemented by the licensee's engineers to limit Switch 2CV-1519-1, this valve will now move to a throttled position. Changes of this nature would not be readily detected if the screening process were applied only to implementing documents, such as procedure changes. Therefore, the inspection team did not agree with the licensee's position concerning the lack of need for a safety evaluation.

Based on questions from the inspection team, the licensee reviewed the screening activities associated with the procedure changes that implemented the changes to the Loop 1 service water system configuration. The licensee indicated that a safety evaluation should have been performed to address the changes associated with Procedure 2104.029, Revision 47. Specifically, Final Safety Analysis Report, Table 9.2-1, lists the service water flow to the shutdown cooling heat exchanger as 16656 Lpm [4400 gpm]. This value is no longer valid since the design minimum value was lowered. Condition Report CR-ANO-2-1999-0580 was written to document this issue.

The team found that the licensee failed to identify the change in the valve limit switch position at the outlet of the containment air coolers or the reduction in service water flow to the shutdown cooling heat exchanger as modifications, or design changes, to the plant.

With regard to the changes that the licensee implemented in the Loop 1 service water system, the inspection team considered the emergency diesel generator to be a degraded component. Throttling to reduce flow to the shutdown cooling heat exchanger and the containment air coolers as a means of diverting more flow to the emergency diesel generator was considered to be a compensatory action. Therefore, as stated in Procedure 1000.028, Attachment 2, Item 2, the compensatory action should be implemented via a temporary alteration. The team determined that the change of shutdown cooling heat exchanger service water flow to a value less than the minimum design for an entire fuel cycle required the implementation of a temporary alteration (modification). Instead, the licensee's staff had made the change to the system within the corrective action program and implemented a performance test to validate that the required heat energy could be transferred through the heat exchanger.

The team identified a number of deficiencies associated with the licensee's engineers' evaluation. The team found that the failure to recognize this change as a modification to the plant's design basis contributed to an engineering review which did not explore all the potential impacts of this change and failed to appropriately address the plant's licensing and design basis. The team's interpretation of the licensee's modification process also revealed that an engineering evaluation, pursuant to 10 CFR 50.59, would have also been required for the change in the system configuration.

The team also found that the failure to appropriately recognize these changes as modifications, and consider their impact on the design basis, was rooted in the licensee's engineers' understanding of operability requirements. Based on the licensee's engineers' responses to questions during the inspection, the team found that the licensee's engineers considered the entire service water system to be degraded as a result of the low service water flow conditions measured during Refueling Outage 2R13. Therefore, the licensee's engineers did not recognize the need to throttle the shutdown cooling heat exchanger and the containment air cooler outlet valves as compensatory actions, but, rather, considered it as a different degraded condition.

Criterion III of Appendix B to 10 CFR Part 50 requires, in part, that design changes, including field changes, shall be subject to design control measures commensurate with those applied to the original design. Contrary to this requirement, the changes to the design interfaces (i.e., the throttling of flow from heat exchangers) were not evaluated through the design change process. Specifically, the flow reduction was accomplished through the corrective action program without performing an evaluation of the detail required for design changes.

This is a Severity Level IV violation (fourth example) of Criterion III of Appendix B to 10 CFR Part 50 and is being treated as a noncited violation (50-313; -368/9909-01) consistent with Appendix C of the NRC Enforcement Policy. This violation is in the licensee's corrective action program as Condition Report CR-ANO-2-1999-0571.

Review of Licensee's Position to not Classify These Changes as Modifications

The licensee subsequently developed a "white paper," dated September 9, 1999 (Attachment 2), to address the concerns raised by the inspection team. This white paper provides a discussion that acknowledges deficiencies in the evaluations performed, but credits these deficiencies to human performance problems rather than process deficiencies. The white paper forwards a position that argues that the Procedure 1000.153 was the appropriate process to implement the changes due to the limited amount of physical work required to implement this design change.

The licensee's "Quality Assurance Program Manual," commits Arkansas Nuclear One, Units 1 and 2, to the guidance of Regulatory Guide 1.64, "Quality Assurance Requirements for the Design of Nuclear Power Plants," Revision 2. Regulatory Guide 1.64 endorses ANSI Standard N45.2.11-1974. ANSI Standard N45.2.11, Section 2.2, states, in part, that:

> Procedures shall be employed to assure that design activities are carried out in a planned, controlled, orderly and correct manner. Program procedures shall cover . . . [c]ontrolling design changes.

The licensee's quality assurance requirements make no distinction regarding the length of time that a design change be in effect to preclude the need for implementing the design change (modification) process. Furthermore, ANSI Standard N45.2.11, Section 8.1, states, in part, that:

> Design changes frequently result from such things as . . . [f]ailures of structures, systems, or components to meet functional requirements, and . . . [d]isposition of nonconforming items.

Licensee engineers identified that the low service water flow rate to the emergency diesel generator was a degraded condition and throttled the flow to other components in the system as a compensatory action. This new configuration resulted in changes to the design inputs for the affected containment air coolers and the shutdown cooling heat exchanger. Related to these changes, ANSI Standard N45.2.11, Section 3.1, states, in part, that:

> Changes from specified design inputs including the reasons for the changes shall be identified, approved, documented and controlled. The design change input shall be specified on a timely basis and to the level of detail necessary to permit the design activity to be carried out in a correct manner and to provide a consistent basis for making decisions, accomplishing design verification measures, and evaluating design changes.

ANSI Standard N45.2.11 also provides requirements for the update and control of design basis information resulting from design changes. The licensee's engineers performed an evaluation. However, their evaluation did not address all the design inputs applicable to the design changes and did not update the associated configuration control documentation as required by ANSI Standard N45.2.11. Additionally, the evaluation did not contain the rigor typical of a formal design change, but rather, resembled an operability evaluation that was generated to address an off design condition. The licensee's engineers failed to perform this activity in accordance with the temporary modification requirements of Procedure 1000.028, which the team found to be applicable to this change.

In addition, ANSI Standard N45.2.11, Section 3.2, provides a listing of design inputs that shall be considered in design evaluations. Related design inputs from this list are as follows:

1. Basic functions of each system, structure, and component . . .

4. Design conditions such as pressure, temperature, fluid chemistry [sic] and voltage . . .

7. Interface requirements including definition of the functional and physical interfaces involving structures, systems [sic] and components . . .

9. Mechanical requirements such as vibration, stress, shock and reaction forces . . .

10. Structural requirements covering such items as equipment foundations and pipe supports . . .

11. Hydraulic requirements such as pump net-positive suction head, allowable pressure drops, shock and reaction loads . . .

15. Operational requirements under various conditions, such as, . . . special or infrequent operations . . .

After review of the information provided in the "white paper," the team found that insufficient information was provided to change the classification of this issue as an example of a noncited violation. The team found that the information generally supported the team's original position.

b.3 Review of the Resolution for the Unit 2 Emergency Diesel Generator Jacket Water Cross-Flow Issue

The ANO, Unit 2 emergency diesel generators were designed by Coltec, Fairbanks Morse Engine Division. The engine design incorporates a jacket water keep-warm system that maintains the water temperature above a minimum value to enable quick starts from standby conditions and to facilitate the control of water chemistry. Jacket water is supplied to two independent cooling loops that share a common head tank. One loop transfers heat from the engine inner-cooler to the air cooler heat exchanger to maintain combustion air temperature. The second loop transfers heat from the engine cylinder liners to the jacket water cooler.

Licensee personnel identified a cross-flow loop during heat exchanger thermal performance testing of the air, lube oil, and jacket water cooler heat exchangers. This cross-flow loop transferred heat from the jacket water cooler to the air cooler heat exchanger through a reverse flow path in the keep-warm system. This condition challenged the engine's ability to maintain combustion air temperature within its normal band. The licensee documented this issue as Condition Report CR-ANO-2-1991-0514 and brought this issue to the attention of Coltec Industries, Fairbanks Morse Engine Division, the original equipment manufacturer. Coltec Industries, Fairbanks Morse Engine Division, evaluated this issue and submitted a report to the NRC under the requirements of 10 CFR Part 21, "Reporting of Defects and Nonconformance," in 1991.

As an immediate corrective action, the manual isolation valve in each emergency diesel generator's keep-warm system was closed to prevent this cross-flow from adversely impacting engine performance. The closure of these valves ensured the immediate operability of the engines. However, the valves' closure isolated the loops containing the air cooler heat exchangers and the engine inner-coolers from the keep-warm systems.

At the time of the inspection, the valves were maintained in the locked shut position. The team found that adequate measures were in place to prevent the inadvertent opening of these valves. The team noted that the chemistry control program was adequate to maintain the material condition of the system. The licensee's engineers incorporated temperature monitoring of the isolated portions of the keep-warm systems into the operators' logs to ensure that water temperature was maintained above the minimum value.

Instructions were in place to run the emergency diesel generator to maintain temperature if either approached its minimum value of 26.7°C [80°F] and to declare the emergency diesel generators inoperable if the temperature drops below the minimum value. The licensee's engineers performed a safety evaluation on June 21, 1994, to address the requirements of 10 CFR 50.59. This safety evaluation referred to the condition report as the controlling activity. The licensee's engineers were not able to explain why the safety evaluation was performed 3 years after the modification was implemented.

The team requested a copy of the design change package that resulted from the decision to permanently rely on the closed isolation valves to resolve this condition. The licensee's engineers indicated that no specific evaluation was performed but that the appropriate configuration control documents were updated as part of the corrective action plan for the condition report.

The team found that the closure of these manual isolation valves as an immediate compensatory action to the condition reports to have been a permanent plant change. This defacto modification has changed the function of the keep-warm systems for the Unit 2 emergency diesel generators. This defacto modification was of concern to the team because the plant design basis information had not been revised to reflect this change and it was not clear that the impact of this change had been fully evaluated. The team noted that Calculation 91-D-2003-01 included a September 10, 1991, Coltec Industries, Fairbanks Morse Engine Division, engineering report that evaluated the emergency diesel generator cross-flow issue and included a recommendation to install check valves in the keep-warm flow paths to eliminate the backflow condition. When questioned about the check valves, the licensee's engineers produced a letter dated July 8, 1992, from Coltec Industries, Fairbanks Morse Engine Division, recommending alternate solutions, one of which was to maintain the valves closed. However, the licensee's engineers did not update the design basis to reflect this as a permanent change.

On April 4, 1996, the Deputy Executive Director for Nuclear Reactor Regulation, Regional Operations and Research, issued a memorandum to the regional administrators on the subject of operator workarounds. In this memorandum, an operator workaround was defined as "a degraded or non-conforming condition that complicates the normal operation of plant equipment and is compensated for by operator action." Similarly, licensee guidance for determining what constitutes an operator workaround includes plant design deficiencies which cause an unusual burden to operations because a system will not work as originally designed because of a design flaw or oversight.

The team determined that the closure of the valves created an operator workaround regarding the actions required to monitor and maintain temperature of the isolated portions of the systems. The licensee's engineers and operators did not recognize this change as an operator workaround. Additionally, the licensee's engineers had not documented the rationale for opting to maintain the operator workaround rather then pursuing the installation of check valves.

Criterion III of Appendix B to 10 CFR Part 50 requires, in part, that design changes, including field changes, shall be subject to design control measures commensurate with those applied to the original design. The team determined that the licensee's actions to change the configuration of the keep-warm systems were not subjected to design control measures commensurate with those applied to the original design. The failure to use the appropriate design control measures was found to be a violation.

This is a Severity Level IV violation (fifth example) of Criterion III of Appendix B to 10 CFR Part 50 and is being treated as a noncited violation (50-313; -368/9909-01) consistent with Appendix C of the Enforcement Policy. This example of the violation is in the licensee's corrective action program as Condition Report CR-ANO-2-1999-0562.

Review of Licensee's Position to not Classify These Changes as Modifications

Subsequent to the onsite inspection, the licensee responded to the inspection team's concerns with a "white paper," dated September 9, 1999 (Attachment 2). This "white paper" described the licensee's position, which was based on three specific points. First, the change to the emergency diesel generator keep-warm systems pre-dated the current design control process. Second, the licensee indicated that the updates to the plant's design basis regarding the physical change to the emergency diesel generator keep-warm systems were made in accordance with an action plan developed under the control of the corrective action program. Additionally, this practice is still allowed under existing plant procedures. Third, the licensee determined that this condition does not represent an operator workaround due to the fact that there is no record of operator action taken as a result of isolating the air coolers from the keep-warm systems.

Licensee engineers identified that the reverse flow paths in the keep-warm systems challenged the ability of the emergency diesel generators to perform their design function. As an immediate compensatory action, the licensee closed the manual isolation valves in the keep-warm systems, isolating the air cooler portions of the systems. This action changed the design function of the keep-warm systems as the air cooler portions of the systems were no longer maintained in a standby condition. The licensee's engineers indicated that this action was taken as a compensatory action and was handled under the corrective action program, contrary to the licensee's procedures for design changes.

This compensatory action was taken to correct a nonconforming condition which challenged the ability of the emergency diesel generators to perform their design functions. When the licensee's engineers determined that this compensatory action would be accepted as a permanent corrective action, the design control process should have been entered to document the rationale for this permanent change and update the appropriate design basis documentation.

The licensee's engineers could not produce an engineering evaluation that addressed this change. The licensee's engineers indicated that the appropriate design basis information was updated in accordance with an action plan developed under the condition report.

ANSI Standard N45.2.11, Section 3.2, requires the licensee's engineers to document an evaluation that addresses the change in the function of the keep-warm systems, its impact on system performance and material condition, and the update of design basis information. The licensee's engineers indicated that the closure of these valves was not considered an operator workaround by operations personnel when the operator workaround program was initiated. The licensee's representatives further stated that this position had been re-verified by operations personnel. The basis for this not being considered as an operator workaround was given as "[n]o additional operator actions have been required to date as a result of closing the valve . . ."

The team found that the statement that no operator actions have been required to date does not mean that there was no operator workaround. The fact is, operator actions may be required as a result of the closure of the valve if certain conditions are met. It is the team's understanding that the creation of a configuration that would require operator action to assure the operation of a component is an operator workaround.

During the review of this issue, the team identified two occasions where design documentation was not appropriately updated. First, Calculation 91-D-2003-01 discussed the installation of the check valves, as proposed by the original equipment manufacturer, with no mention of the closed valves as a permanent condition. The team noted that a letter from the manufacturer, dated July 8, 1992, which describes alternate corrective actions, was provided to the team as a stand alone document, not part of a design basis document. Second, the team noted that Final Safety Analysis Report, Figure 9.5-9, shows the manual valves in the open position. The team found that the proximate cause of this discrepancy was the failure to implement the design change (modification) process, which requires the reviews to identify the need for changing the safety analysis report. This failure was identified previously as the fifth example of a noncited violation of Criterion III of Appendix B to 10 CFR Part 50 (50-313; -368/9909-01).

The team requested a copy of the design control procedure in place at the time this condition was made permanent. Procedure 6010.001, "DCP Development," Revision 6, was provided to the team. This procedure was reviewed and found to contain sufficient guidance to reasonably conclude that the appropriate design inputs would have been addressed had this guidance been followed.

After review of Attachment 2, the team found that the information did not result in a change to the team's original position.

c. <u>Conclusions</u>

c.1 Licensee personnel failed to follow the instructions contained within Job Orders 950824 and 950906 and Procedure 5010.017 to perform separate reports to evaluate test data from the Unit 2 emergency diesel generator heat exchanger performance tests. A violation of Criterion V of Appendix B to 10 CFR Part 50 was identified.

c.2 Licensee personnel failed to perform an evaluation in accordance with Procedure 1000.131 for a change that resulted in information about service water flow rates in the Final Safety Analysis Report being inaccurate. A violation of Criterion V of Appendix B to 10 CFR Part 50 was identified. Changes to the design interfaces (i.e., the throttling of flow from heat exchangers) were not evaluated through the design change process. A violation of Criterion III of Appendix B to 10 CFR Part 50 was identified.

An unresolved item was identified as a result of the need for additional licensee evaluation of the integral effects of throttling the butterfly valve on the outlet of the Unit 2 containment air coolers and the flashing potential associated with a clean heat exchanger.

Licensee personnel failed to complete a configuration control checklist for revising the minimum service water flow to 13249 Lpm [3500 gpm] in Engineering Evaluation 991457-E202. A violation of Criterion V of Appendix B to 10 CFR Part 50 was identified.

A second issue of accounting for instrument uncertainties and inaccuracies was identified as another concern of Unresolved Item 50-313; -368/9909-04.

c.3 Licensee personnel failed to appropriately evaluate the closure of manual valves in the emergency diesel generator keep-warm systems as a permanent change to the plant. A violation of Criterion III of Appendix B to 10 CFR Part 50 was identified.

E4 Engineering Staff Knowledge and Performance (93809)

a. <u>Inspection Scope</u>

a.1 The team reviewed Calculations 92-E-0079-01, "Determination of SW-Cooled Room Heat Loads Under Various Operating Conditions," Revision 0, and 94-E-0095-20, "Room 2010 Heat Load Evaluation," Revision 1, to evaluate the ability of the safety-related room coolers supplied by the service water system to perform their design functions.

a.2 The team reviewed Calculation 95-E-0046-03, "Reactor Building Cooler Minimum Service Water Flow," Revision 0, to evaluate the licensee's engineers' performance upon the identification of an inoperable reactor building cooler.

a.3 The team reviewed test reports for the testing of Unit 1 heat exchangers to evaluate both the performance of the heat exchangers, as well as, the performance of the licensee's engineers.

a.4 The team reviewed an engineering evaluation of the net-positive suction head for replacement service water pumps and compared the results to the previous calculation.

b. Observations and Findings

b.1 Room Cooler Calculations

The team noted, during review of Calculation 92-E-0079-01, that, for the Unit 2 shut down cooling room coolers and the high pressure safety injection room cooler, the heat loads, calculated for the intermediate loss-of-coolant accident and shutdown cooling, appeared to exceed the design capacity of the room coolers. However, in order to reduce the projected heat load, the licensee's engineers considered heat losses from the three rooms. Heat losses were assumed through the floor, the ceiling, and walls to areas of lower temperature. The team noted that, through the consideration of the additional heat removal paths, the heat exchangers would be capable of performing their design functions.

The calculation did not address the effect of the additional heat on the rooms to which the heat was transferred. The licensee's engineer stated that the only rooms affected by the increase in heat load were the charging pump rooms. The licensee's engineer stated that the charging pump room coolers had sufficient margins and could easily remove the small addition in heat loads.

The team noted, during review of Calculation 94-E-0095-20, "Room 2010 Heat Load Evaluation," Revision 1, that Assumption 3.7 stated that Calculation 92-E-0079-01 had neglected heat loads from cable trays within the rooms when determining room heat loads. This calculation was later revised to adjust the room heat loads by adding heat from the cable trays.

Additionally, Calculation 94-E-0095-18, "Room 2007/2009 Heat Load Evaluation," Revision 1; 94-E-0095-14, "Room 2051 Heat Load Evaluation," Revision 1; 94-E-0095-15, "Room 2052 Heat Load Evaluation," Revision 1; and, 94-E-0095-16, "Room 2053 Heat Load Evaluation," Revision 1, added heat loads from small pumps. The team determined that, because not all heat loads were accounted for, the calculations were inconsistent in the determination of maximum room heat loads, and that Calculation 92-E-0079-01 was not conservative in its heat load determinations since it did not consider cable tray heat loads or small pump heat loads.

The team noted that a licensee's engineer issued Engineering Request 981224, dated February 25, 1999, instead of a condition report. This engineering request identified that service water cooled room heat loads in Calculation 92-E-0079-01 did not include heat from cable trays and stated that this calculation should be revised to include heat from cable trays. However, the team noted that Calculation 92-E-0079-01 had not been revised to account for the cable tray heat loads, even though this discrepancy had been identified in February 1999. Had a condition report been initiated, the corrective actions most likely would have also identified the failure to include the heat loads from the small pumps.

The team observed that Procedure 1000.104, "Condition Reporting and Corrective Actions," Revision 15, defined a condition report as a document used for identification, classification, reporting, and correction of conditions that could impact the safe operation of the plants. An adverse condition is defined as an event, defect, characteristic, state or activity which prohibits or detracts from the safe operation of the station. In addition, the procedure defines a nonconformance as a deficiency in characteristic, documentation, or procedure which renders the quality of an item unacceptable or indeterminate. Attachment A of Procedure 1000.104 contains guidelines for the identification of conditions to be reported. One of the examples in Appendix A that should be reported is an item which does not conform to the design or licensing basis.

Criterion XVI of Appendix B to 10 CFR Part 50 requires, in part, that measures shall be established to assure that conditions adverse to quality, such as failures, deficiencies, and deviations are promptly identified and corrected. The failure to write a condition report upon the licensee's discovery, on February 25, 1999, that the cable tray heat loads were not included in Calculation 92-E-0079-01, and the failure to identify a condition adverse to quality upon the discovery, during this inspection, that the heat loads from the pumps were not included in the calculation were identified as violations of Criterion XVI of Appendix B to 10 CFR Part 50.

These are Severity Level IV violations (second and third examples) of Criterion XVI of Appendix B to 10 CFR Part 50 and are being treated as noncited violations (50-313; -368/9909-02) consistent with Appendix C of the NRC Enforcement Policy. These violations are in the licensee's corrective action program as Condition Report CR-ANO-2-1999-0560.

b.2 Reactor Building Coolers

Licensee maintenance personnel identified, on May 7, 1995, that the thrust bearings in the Unit 1 Reactor Building Cooler VCC-2C fan motor failed. The cooler was declared inoperable. Licensee maintenance personnel installed a blind flange on the cooling coils to Cooler VCC-2C so that the total flow in that train would be diverted to Cooler VCC-2D, in the same train. Subsequent testing found that the total flow in the train through one cooler instead of two was less than that allowed by the surveillance requirement of 4524 Lpm [1200 gpm] in Technical Specification 4.5.2.1.2.

The licensee submitted a technical specification change request on May 15, 1995, to revise the minimum flow from 4524 Lpm [1200 gpm] to 3028 Lpm [800 gpm] for each train. The NRC denied this request in favor of a temporary change to the surveillance requirement until July 14, 1995, or until the fan motor was replaced. Licensee maintenance personnel replaced the motor and operability was restored.

The team noted that Calculation 95-E-0046-03, "Reactor Building Cooler Minimum Service Water Flow," Revision 0, showed that the coolers were operable with a total flow as low as 3028 Lpm [800 gpm]. The team found that the calculation was listed as pending on the cover sheet; however, in the documentation system, the calculation was listed as active. A licensee representative issued Condition Report CR-ANO-1-1999-0223, dated August 8, 1999, to track and correct this error.

Criterion III of Appendix B to 10 CFR Part 50 requires, in part, that measures shall be established for the identification and control of design interfaces. These measures shall include the establishment of procedures among participating design organizations for the review, approval, release, distribution, and revision of documents involving design interfaces. The failure to control the calculation as a pending calculation was identified as an example of a violation of Criterion III of Appendix B to 10 CFR Part 50.

This is a Severity Level IV violation (sixth example) of Criterion III of Appendix B to 10 CFR Part 50 and is being treated as a noncited violation (50-313; -368/9909-01) consistent with Appendix C of the NRC Enforcement Policy. The violation is in the licensee's corrective action program as Condition Report CR-ANO-1-1999-0223.

b.3 Heat Exchanger Testing

The team, during review of the Unit 1 Report Numbers 93-R-1035-01 (Refueling Outage 1R11), 93-R-1035-02 (Refueling Outage 1R12), and 93-R-1035-03 (Refueling Outage 1R13), "Unit 1 Service Water System Performance Analysis," found that there were examples of service water flow not meeting the acceptance criterion in Refueling Outage 1R11. However, in the two most recent outages, there was only one example of not meeting the acceptance criterion. The team determined that the Unit 1 room coolers and other heat exchangers cooled by service water, with the exception noted below for Refueling Outage 1R13, were meeting their minimum flow requirements.

The Unit 1 reactor building room coolers have a minimum flow rate of 4542 Lpm [1200 gpm] for a pair of coolers, or through a single cooler with the second cooler isolated. During the Refueling Outage 1R13, in October 1996, the as-left corrected flow for Coolers VCC-2A and -2B, was 4526 Lpm [1196 gpm]. Licensee personnel discovered this on July 15, 1999, when Condition Report CR-ANO-1-1999-0200 was initiated. The condition report documented the incorrect consideration of instrument error used when measuring the flow rate of the reactor building coolers.

This discrepancy led to an unrecognized flow test failure during Refueling Outage 1R13, when a flow rate of 4809 Lpm [1270 gpm] was determined. The licensee operators had considered this flow acceptable on the basis of the reactor building cooling unit system acceptance curve, provided in Procedure 1104.033, "RB Cooling Units Flow Test," Revision 56. The team noted that the curve was a plot of differential pressure versus flow. The operators determined that the coolers were above the minimum required flow rate. However, in July 1999, licensee engineers determined that this curve was not conservative and determined that the actual flow was 4526 Lpm [1196 gpm], not 4809 Lpm [1270 gpm], as previously thought. Therefore, the as-left flow rate was less than the minimum allowable. The team determined that the as-left flow was sufficient to remove the required heat with the environmental conditions existing at the time of the testing.

The procedure utilized a 3 percent uncertainty for the flow, but did not include a differential pressure uncertainty. A licensee engineer issued Condition Report CR-ANO-2-1999-0544, dated August 14, 1999, to evaluate this issue for Unit 2.

Criterion XI of Appendix B to 10 CFR Part 50 requires, in part, that a test program shall be established to assure that all testing required to demonstrate that components will perform satisfactorily in service is identified and performed in accordance with written test procedures which incorporate the requirements and acceptance limits contained in applicable design documents. The failure to provide an adequate acceptance limit was identified as a violation of Criterion XI of Appendix B to 10 CFR Part 50.

This Severity Level IV violation is being treated as a noncited violation of Criterion XI of Appendix B to 10 CFR Part 50 (50-313;-368/9909-08) consistent with Appendix C of the NRC Enforcement Policy. This violation is in the licensee's corrective action program as Condition Reports CR-ANO-1-1999-0200 and CR-ANO-2-1999-0544.

While this particular issue was identified as a non-cited violation, it further emphasizes the need for further NRC review of the licensee's consideration and application of instrument uncertainties, as identified above, as Unresolved Item 50-313; -368/9909-04.

b.4 Service Water Pump Net-Positive Suction Head Engineering Evaluation

The team reviewed an engineering evaluation of the current net-positive suction head, which was prepared for the replacement service water pumps, and the prior net-positive suction head calculation. The team determined that the licensee's engineers had intended to convert an engineering evaluation (Information Request Form 6964) into a new calculation, to replace the previous calculation; however, this action was not taken. The licensee wrote Condition Report CR-ANO-1-1999-0219 to address the need for a revised calculation.

The team reviewed the evaluation and the previous pump calculation. The team found that the maximum pump flow of 30283 Lpm [8000 gpm] could be exceeded during operation of the service water system with only one pump operating during a normal plant shutdown. To address this concern Condition Report CR-ANO-1-1999-0254 was prepared by licensee engineers to perform additional evaluation. Without the additional evaluation, the licensee was not able to demonstrate that the verification of the adequacy of the design was acceptable, as required by Criterion III of Appendix B to 10 CFR Part 50. The potential for a service water pump not having adequate net-positive suction head, as a result of being required to supply more flow than it was designed for, was identified as an unresolved item, pending NRC review of the completed evaluation for Condition Report CR-ANO-1-1999-0219 (50-313/9909-09).

c. Conclusions

Engineering performance was found to be acceptable; however, examples identifying a need for improvement are noted below.

c.1 A violation of Criterion XVI of Appendix B to 10 CFR Part 50 was identified for the failure to write a condition report when the cable tray heat load assumptions used for calculations were found to be inaccurate. Another violation of Criterion XVI of Appendix B to 10 CFR Part 50 was identified for the failure to identify the omission of small pump heat loads from a calculation as a condition adverse to quality.

c.2 A violation of Criterion III of Appendix B to 10 CFR Part 50 was identified for the failure to control a pending calculation, thus allowing the calculation to be made active with unapproved data.

c.3 A violation of Criterion XI of Appendix B to 10 CFR Part 50 was identified for the failure to provide an adequate acceptance criterion for reactor building cooler tests.

c.4 An unresolved item was identified, pending NRC review of the licensee's evaluation, to determine if adequate net-positive suction head would be available during a normal plant shutdown to a single operating service water pump.

E7 Quality Assurance in Engineering Activities (93809)

E7.1 Review of Unit 1 Decay Heat Removal Cooler and Emergency Diesel Generator Jacket Water Cooler Thermal Performance Testing

a. Inspection Scope

The team reviewed the results of heat exchanger thermal performance testing for the Unit 1 decay heat removal coolers and the Unit 1 emergency diesel generator jacket water coolers from the past three refueling outages.

b. Observations and Findings

The team identified a systematic treatment of heat exchanger test results for the Unit 1 decay heat removal coolers and the Unit 1 emergency diesel generator jacket water coolers that resulted in the failure to take the appropriate corrective action when these heat exchangers demonstrated the inability to remove the required heat loads at design conditions.

The Unit 1 decay heat removal coolers were originally specified with a non-conservative fouling factor for their intended application at ANO. Generic Letter 89-13 recommended a heat exchanger testing program to demonstrate that components cooled by service water were capable of performing their design function. The licensee performed thermal performance testing of these heat exchangers in accordance with their commitments in response to Generic Letter 89-13.

Five out of the last six thermal performance tests performed on the Unit 1 decay heat removal coolers indicated that the coolers were not capable of removing the required accident heat load at the minimum design service water flow. The licensee's engineers addressed this issue by back-calculating the actual service water flow that would have been required to remove the accident heat load. This value was then compared to the most recent service water flow test to ensure that sufficient flow was available. This evaluation was then incorporated into the engineering document that evaluated the heat exchanger test results. The measured service water flow was at least 644 Lpm [170 gpm] higher than the actual flow needed to remove the accident heat load based on the documents reviewed by the team. However, although the licensee's engineers entered this condition into the corrective action system, they did not recognize this test failure as a degraded condition and did not take the appropriate corrective actions required to prevent recurrence of this condition.

The licensee's engineers attempted to resolve this discrepancy following Refueling Outage 1R13 by issuing a change to Procedure 1309.013, "Unit 1 Service Water Flow Test," Revision 6, which increased the minimum service water flow acceptance criterion from 6057 Lpm [1600 gpm] to 6246 Lpm [1650 gpm]. This change was insufficient to resolve the degraded condition as both heat exchanger tests performed during Refueling Outage 1R14 failed to demonstrate that the decay heat removal coolers could remove the required heat load with a service water flow of 6246 Lpm [1650 gpm]. The team found that the licensee's engineers had sufficient information to reasonably conclude that increasing the minimum required service water flow by 189 Lpm [50 gpm] would not correct the condition, as results from previous testing demonstrated that a service water flow of greater than 6246 Lpm [1650 gpm] would be required to remove the accident heat load. Failure to document this condition in the corrective action system and the failure to treat the change in the minimum design service water flow to the decay heat removal coolers as a design change may have contributed to the licensee's engineers' inability to take the appropriate corrective action to resolve this degraded condition, once identified.

Criterion XVI of Appendix B to 10 CFR Part 50 requires, in part, that measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. The team found the failure to take the appropriate corrective actions for degraded conditions identified during thermal performance testing to be a violation. This is a Severity Level IV violation (fourth example) of Criterion XVI of Appendix B to 10 CFR Part 50 and is being treated as a noncited violation (50-313; -368/9909-02) consistent with Appendix C of the NRC Enforcement Policy. This violation is in the licensee's corrective action program as Condition Report CR-ANO-1-1999-0250.

A second example of ineffective corrective action was identified with the handling of the analyses for the Unit 1 emergency diesel generator jacket water coolers. Calculation 88-E-0074-01, Revision 1, specifies the minimum required service water flow to the jacket water cooler as 1514 Lpm [400 gpm]. This value had been included in Procedure 1309.013 as the acceptance criterion for the minimum service water flow to this component. Condition Report CR-ANO-1-1998-0138 documented that the heat exchanger test results evaluated under Engineering Report 93-R-1035-03 documented flow greater than 1514 Lpm [400 gpm] was required to remove the design basis heat load. The test results also showed that there was adequate flow (3028 Lpm [800 gpm]) to remove the design heat loads. Engineering Evaluation 980310-E101 was generated to address this concern.

Engineering Evaluation 980310-E101 concluded that the heat exchanger had never been capable of removing the required heat load at 1514 Lpm [400 gpm] and that thermal performance testing should be conducted at 1987 Lpm [525 gpm]. However, this evaluation failed to consider this increase in the minimum required flow as a change in design. In addition, this engineering report inappropriately determined that the design basis calculation and the service water flow acceptance test criterion need not be changed. At the time of the inspection, Procedure 1309.013, specified a minimum flow acceptance criterion of 1514 Lpm [400 gpm]. Therefore, the team determined that the corrective actions taken by the licensee were not appropriate for the condition described in the condition report. Engineering Request 991915 was written to evaluate a change to the design basis service water flow requirements for the Unit 1 emergency diesel generator jacket water coolers.

Criterion XVI of Appendix B to 10 CFR Part 50 requires, in part, that measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. The team found the failure to take the appropriate corrective actions for degraded conditions identified during thermal performance testing to be a violation. This is a Severity Level IV violation (fifth example) of Criterion XVI of Appendix B to 10 CFR Part 50 and is being treated as a noncited violation (50-313; -368/9909-02) consistent with Appendix C of the NRC Enforcement Policy. This violation is in the licensee's corrective action program as Condition Report CR-ANO-1-1999-0250.

c. Conclusions

Licensee personnel failed to take the appropriate corrective actions for degraded conditions identified during thermal performance testing for the Unit 1 decay heat removal coolers and the Unit 1 emergency diesel generator jacket water coolers. Two violations of Criterion XVI of Appendix B to 10 CFR Part 50 were identified.

E8 Miscellaneous Engineering Issues (92903)

E8.1 (Closed) Licensee Event Report 50-313/98-001: Once-Through Steam Generator Tube Left in Service with a Flaw Exceeding the Technical Specification Limit as a Result of Failure to Identify That a Tube End Flaw Extended into the Pressure Boundary.

On April 17, 1998, licensee personnel identified that tubes, with flaws exceeding the technical specification limit, in a once-through steam generator had been left in service following the previous refueling outage (Refueling Outage 1R13). Technical Specification 3.1.6.3.b limited the leakage through tubes in one steam generator to 568 liters per day (394 ml per minute) [150 gallons per day (0.104 gpm)]. The licensee placed this event in its corrective action program as Condition Report CR-ANO-1-1998-0217.

A formal root-cause analysis was completed and issued on May 15, 1998. Licensee staff attributed the leak test failures of two tubes, one in each steam generator, to primary water stress corrosion cracking. The leak test failures were subsequently correlated to eddy current signals from a rotating pancake probe. Licensee staff accepted these indications in one of the tubes (only one was inspected on a sampling basis) and many other tubes inspected during Refueling Outage 1R13 because the licensee's engineers believed the indications were not in the pressure boundary area. The indications were in the seal weld heat-affected zone and/or the expansion zone.

Before the Refueling Outage 1R13, eddy current inspections had not been conducted with a rotating pancake probe. However, the leak testing, later analysis, and eddy current testing during Refueling Outage 1R14 proved that the assumption on the location of the indications to be incorrect. Corrective actions were to re-roll the tubes in question, Tube 151-1 in Steam Generator A and Tube 89-55 in Steam Generator B. In addition, 1850 tubes in Steam Generator A and 1048 tubes in Steam Generator B were re-rolled because of eddy current indications found during Refueling Outage 1R14.

The licensee's staff revised Procedure, 5120.500, "Steam Generator Integrity Program Implementation," Revision 8, and the steam generator eddy current inspection guidelines, HES-27, "ANO-1 Steam Generator ECT Examination Guidelines," Revision 6, so that these indications would be considered within the pressure boundary. In the root-cause analysis, the licensee's engineers concluded the degradation to be inactive. However, as a result of reviewing Topical Report, BAW-2346P, "Alternate Repair Criteria for Tube End Crack-Tubesheet Roll Joint of Once-Through Steam Generators," April 1999, the licensee's engineers subsequently identified this failure mechanism as active. Further inspections during the Refueling Outage 1R15 are planned by the licensee's engineers to definitely establish whether the failure mechanism is active or not.

Because the requirements of Technical Specification 3.1.6.3.b were not met during the Refueling Outage 1R13, and the actions required by the technical specification were not performed (i.e., shutdown the plant), the team identified a violation of regulatory requirements. This Severity Level IV violation is being treated as a noncited violation of Technical Specification 3.1.6.3.b (50-313/9909-10) consistent with Appendix C of the NRC Enforcement Policy. The team verified that the corrective actions identified in this licensee event report and condition report had been completed.

E8.2 (Closed) Licensee Event Report 50-313/98-005: Two Manual Reactor Trips and a Manual Actuation of the Emergency Feedwater System Due to Reduced Circulating Water Flow to the Main Condenser Caused by Unusually Large Intrusions of Fish Exceeding the Removal Capability of the Traveling Screens.

On December 25 and 28, 1998, operations personnel manually tripped the reactor due to reduced circulating water system flow caused by an unusually large build-up of fish on the traveling screens. The circulating water system is nonsafety-related and not a technical specifications-related system. This event had no impact on the service water system. Licensee personnel documented this event in Condition Report CR-ANO-1-1998-0748. A root-cause analysis was done and the report issued February 18, 1999.

Corrective actions were implemented to improve the fish removal capability by, upgrading the traveling screen drive motors, breakers, and overload circuits. Also, shad seines upstream of the intake structure and nets at the mouth of the intake canal were installed. The team verified the corrective actions were completed. No violation of regulatory requirements was identified.

E8.3 (Closed) Licensee Event Report 50-368/98-008: Entry into Technical Specification 3.03 Caused by Failure of the Pressure Controller for One Control Room Emergency Chiller While the Other Train Was Removed from Service for Maintenance.

On December 15, 1998, one control room emergency chiller was discovered to be inoperable while the chiller in the other train was out of service for planned maintenance. Licensee staff documented this event in Condition Report CR-ANO-C-1998-0326. A root-cause analysis was issued on December 29, 1998. The licensee's personnel identified the root cause to be a shift in the setpoint of the pressure controller. The failed component was replaced and returned to the manufacturer for fault diagnosis. The manufacturer could not duplicate the problem. Plexiglass covers were installed over controllers of both trains to prevent inadvertent contact, since inadvertent contact was considered as a possible cause of this event. The team verified the corrective actions were completed. No violation of regulatory requirements was identified.

E8.4 (Closed) Unresolved Item 50-313/97201-14: Molded Case Circuit Breaker Testing.

During an architect engineering inspection, NRC inspection personnel raised a question related to the testing of molded case circuit breakers in Unit 1. In particular, the inspectors questioned the lack of electrical testing of the containment penetration protection breakers.

The inspectors stated that the only testing requirements tied to a regulatory requirement was a statement in the Unit 1 Final Safety Analysis Report, Section 8.3.1.4, which states that the Class 1E power system is designed to meet IEEE Standard 308-1971. Table 2, "Illustrative Periodic Tests," and Section 6.3 of IEEE Standard 308-1971 provide guidance on the periodic testing of electrical components not exercised during normal plant operation.

At issue was whether or not the commitment made in Section 8.3.1.4 applied to the testing of the molded case circuit breakers. The safety analysis report states only that the Class 1E power system was *designed* to meet IEEE Standard 308-1971. It does not state that the Class 1E power system would be tested in accordance with the IEEE standard. As such, the team found no violation of regulatory requirements. However, as a result of the architect engineering inspection, the licensee's management committed to perform a limited scope program to test the Unit 1 reactor building penetration molded case circuit breakers.

The team noted that 10 containment penetration breakers were randomly selected and tested in accordance with Job Order 970931 (3 safety-related 480 Vac, 4 nonsafety-related 120 Vac, 2 safety-related 125 Vdc, and 1 nonsafety-related 125 Vdc). All breakers passed the testing satisfactorily. The team noted that all but one of the tested breakers were reinstalled. One breaker was replaced for a stripped connection that was not related to the testing.

The team noted that there were 81 penetration protection breakers for Unit 1. Not all breakers were included in the testing during Refueling Outage 1R14. Thirteen breakers were excluded from the testing for reasons such as recent replacement. Sixteen breakers were tested during Refueling Outage 1R14: the 10 tested to meet the licensee's commitment, and all 6 120 Vac breakers. The 6 120 Vac breakers were a subset of the 149 total 120 Vac molded case circuit breakers tested during Refueling Outage 1R14.

Of the penetration breakers tested, there were three failures to trip within the acceptance range. All the failures were 120 Vac breakers; however, each had a backup protection device, even though Unit 1 was not licensed with a requirement to have redundant protective devices. There were no failures of the 480 Vac molded case circuit breakers used for electrical protection of containment penetrations. None of the failed breakers would have resulted in the failure of the electrical containment penetration.

Of the remaining 120 Vac breakers, there were 10 additional failures to trip within the acceptance range. The loads supplied by these breakers are: engineered safeguards actuation system Digital -1 Panels C86 and C87; emergency feedwater isolation control Channel A Panel C37-1; emergency feedwater isolation control Channel B Panel C37-2; emergency feedwater isolation control Channel D Panel C37-4; emergency feedwater isolation control trip interface Panels C512 and C514; emergency feedwater isolation control alarm Controller C545; B reactor protection system Cabinet C42; containment radiation monitor RE-8061 and T-41 Level LIT-4203 in Cabinet C486-4; control room isolation Cabinet C141 and Valve CV-3804 (SV-3804); and, control room isolation Cabinet C141B and Valve CV-3805 (SV-3805). While any of these breakers would be required to trip on an electrical fault of its load, the team found that there was adequate coordination such that only the panel supplying these loads would be lost. In no case would multiple panels be affected.

From a review of the Unit 1 containment penetration breakers, the team noted that only 4 of the 81 breakers did not have additional protection such as fusing (16), thermal overload protection (50), or field cables smaller than the penetration feed-through (11). While the team found that the consideration of the size of field cables with respect to the size of the feed-through cables was not ideal for protecting the penetrations, this team acknowledged that the configuration was in accordance with the license requirements.

The team found, therefore, that the licensee had developed and implemented a testing program for the Class 1E molded case circuit breakers. During the implementation of this testing program, the licensee appropriately identified and corrected the test failures.

E8.5 (Closed) Violation 50-313/9721-02: design calculation deficiencies. The team verified the corrective actions described in the licensee's response letter, dated March 9, 1998, to be complete.

E8.6 (Closed) Violation 50-313; -368/9714-01: failure to comply with requirements of criteria used to qualify bobbin coil eddy current examination sizing technique. The team verified the corrective actions described in the licensee's response letter, dated December 18, 1997, to be reasonable and complete. No similar problems were identified.

V. Management Meetings

X1 Exit Meeting

The team leader presented the results to members of licensee management on November 8, 1999. The licensee representatives acknowledged the findings presented.

The team leader asked the licensee representatives whether any materials examined during the inspection should be considered proprietary. The licensee representatives stated that no proprietary information was provided to the team. The licensee representatives did not provide any comments on the findings as presented.

Mr. C. Randy Hutchinson made a commitment to replace the Loop 1 service water piping on the Unit 2 emergency diesel generator during the mid-cycle outage being conducted in November 1999.

ATTACHMENT 1

SUPPLEMENTAL INFORMATION

PARTIAL LIST OF PERSONS CONTACTED

Licensee

G. Ashley, Licensing Supervisor
R. Bement, Plant Manager - Unit 2
M. Chisum, Manager, Unit 2 System Engineering
M. Cooper, Licensing Specialist
B. Day, Manager, Engineering Programs
R. Hutchinson, Vice President, Operations
T. Ivy, Unit 2 System Engineer
D. James, Manager, Licensing
R. Lane, Director, Design Engineering
D. MacPhee, Design Engineer, Mechanical, Civil, Structural
D. Phillips, Supervisor, Unit 1 System Engineering
M. Smith, Manager, Engineering Programs
M. Stroud, Assistant Manager, Design Engineering
C. Turk, Manager, Design Engineering
J. Vandergrift, Director, Nuclear Safety

NRC

R. Bywater, Senior Resident Inspector

INSPECTION PROCEDURES USED

IP 37001	10 CFR 50.59 Safety Evaluation Program
IP 93809	Safety System Engineering Inspection

ITEMS OPENED AND CLOSED

Opened

50-313;-368/9909-01	NCV	Six examples of inadequate design controls (Sections E1b.1, E1b.2, E2b.4, E3b.2, E3b.3, and E4b.2).
50-313;-368/9909-02	NCV	Five examples of failure to correct conditions adverse to quality (Sections E1b.1, E4b.1 and E7.1).
50-368/9909-03	URI	Evaluation of combined effects on Unit 2 emergency diesel generators of under-predicting the maximum heat load and microfouling (Section E1b.3).
50-313;-368/9909-04	URI	Lack of consideration of instrument uncertainties (Sections E2b.2, E3b.2, and E4b.3).

50-313;-368/9909-05	NCV	Four examples of failure to implement procedures (Sections E2b.3, E3b.1, and E3b.2).
50-313;-368/9909-06	URI	Evaluation of excessive service water flow (Section E2b.4).
50-313; -368/9909-07	URI	Evaluation of combined effects of a throttled butterfly valve with a clean heat exchanger (Section E3b.2).
50-313;-368/9909-08	NCV	Failure to provide adequate acceptance criterion (Section E4b.3).
50-313/9909-09	URI	Evaluation of available net-positive suction head with one service water pump operating during normal plant shutdown (Section E4b.4).
50-313/9909-10	NCV	Violation of Technical Specifications 3.1.6.3.b because actions were not taken for leakage from a steam generator that exceeded 0.104 gpm (Section E8.1).

Closed

50-313; -368/9714-01	VIO	Failure to comply with requirements of criteria used to qualify bobbin coil eddy current examination sizing technique (Section E8.6).
50-313/9721-02	VIO	Design calculation deficiencies (Section E8.5).
50-313/97201-14	URI	Molded Case Circuit Breaker Testing (Section E8.4).
50-313/98-001	LER	Once through steam generator tube left in service with a flaw exceeding a Technical Specification limit as a result of failure to identify that a tube end flaw extended into the pressure boundary (Section E8.1).
50-313/98-005	LER	Two manual reactor trips and a manual actuation of the emergency feedwater system due to reduced circulating water flow to the main condenser caused by unusually large intrusions of fish exceeding the removal capability of the traveling screens (Section 8.2).
50-368/98-008	LER	Entry into Technical Specification 3.03 caused by failure of the pressure controller for one control room emergency chiller while the other train was removed from service for maintenance (Section 8.3).
50-313; -368/9909-01	NCV	Six examples of inadequate design controls (Sections E1b.1, E1b.2, E2b.4, E3b.2, E3b.3, and E4b.2).

50-313; -368/9909-02	NCV	Five examples of failure to correct conditions adverse to quality (Sections E1b.1, E4b.1 and E7.1).
50-313; -368/9909-05	NCV	Four examples of failure to implement procedures (Sections E2b.3, E3b.1, and E3b.2).
50-313; -368/9909-08	NCV	Failure to provide adequate acceptance criterion (Section E4b.3).
50-313/9909-10	NCV	Violation of Technical Specifications 3.1.6.3.b because actions were not taken for leakage from a steam generator that exceeded 0.104 gpm (Section E8.1).

LIST OF DOCUMENTS REVIEWED

Procedures

PROCEDURE NUMBER	TITLE	REVISION
STM 1-42	System Training Manual Service and Auxiliary Cooling Water	4
STM 2-42	System Training Manual Service Water and Auxiliary Cooling Water Systems	11
1000.028	Control of Temporary Alterations	22
1000.104	Condition Reporting and Corrective Action	15, 18
1000.131	10 CFR 50.59 Review Program	2
1000.153	Engineering Request Process	Change 004-03-0
1015.035	Valve Operations (Attachment E)	Change 006-03-01
1052.019	Chemistry Inspections of Plant Systems and Heat Exchangers	2
1104.029	Service Water and Auxiliary Cooling System	Change 052-02-0
1104.029	Unit 1 Service Water and Auxiliary Cooling System	52
1104.033	RB Cooling Units Flow Test	56
1203.012I	Annunciator K10 Corrective Action	38

PROCEDURE NUMBER	TITLE	REVISION
1203.030	Unit 1 Loss of Service Water	11
1305.007	RB Isolation and Misc Valve Stroke Time	27
1306.019	Annual Emergency Cooling Pond Sounding	Change 007-01-0
1306.037	Surveillance Test For U1 Sluice Gates SG1 and SG2	1
1309.013	Unit 1 Service Water Flow Test	6, 7
2104.029	Service Water System Operations	44, 47
2104.033	Containment Atmosphere Control	37
2203.012E	Annunciator 2K05 Corrective Action	25
2203.022	Unit 2 Loss of Service Water	47
2305.005	Valve Stroke and Position Verification	Change 019-03-0
2311.001	Shutdown Cooling Heat Exchanger Thermal Test	02
2311.002	Service Water System Flow Test	11
5010.015	Engineering Calculations	1
5010.017	Control of Engineering Reports	1
5010.036	Component Classification Process	0
5120.500	Steam Generator Integrity Program Implementation	8
6030.005	Control of Modification Work	PC-1
BAW-2346P	Alternate Repair Criteria for Tube End Cracking in the Tube-to-Tubesheet Roll Joint Once-through Steam Generators	April 1999
HES-07	ANO-1 Inservice Testing Program	4
HES-08	ANO-2 Inservice Testing Program	5
HES-17	ANO-1 Inservice Testing Program Bases Document	2
HES-18	ANO-2 Inservice Testing Program Bases Document	3
HES-27	ANO-1 Steam Generator ECT Examination Guidelines	6

Condition Reports

CR-ANO-C-1996-0245	CR-ANO-1-1998-0748	CR-ANO-2-1999-0036
CR-ANO-C-1997-0031	CR-ANO-1-1999-0051	CR-ANO-2-1999-0059
CR-ANO-C-1998-0109	CR-ANO-1-1999-0100	CR-ANO-2-1999-0079
CR-ANO-C-1998-0326	CR-ANO-1-1999-0149	CR-ANO-2-1999-0089
CR-ANO-C-1999-0028	CR-ANO-1-1999-0152	CR-ANO-2-1999-0113
CR-ANO-C-1999-0209	CR-ANO-1-1999-0200	CR-ANO-2-1999-0152
CR-ANO-C-1999-0211	CR-ANO-1-1999-0219	CR-ANO-2-1999-0323
CR-ANO-C-1999-0213	CR-ANO-1-1999-0223	CR-ANO-2-1999-0413
CR-ANO-C-1999-0215	CR-ANO-1-1999-0248	CR-ANO-2-1999-0440
CR-ANO-1-1997-0239	CR-ANO-1-1999-0251	CR-ANO-2-1999-0451
CR-ANO-1-1997-0262	CR-ANO-1-1999-0254	CR-ANO-2-1999-0528
CR-ANO-1-1997-0292	CR-ANO-2-1991-0514	CR-ANO-2-1999-0535
CR-ANO-1-1997-0297	CR-ANO-2-1995-0182	CR-ANO-2-1999-0544
CR-ANO-1-1998-0138	CR-ANO-2-1995-0197	CR-ANO-2-1999-0549
CR-ANO-1-1998-0150	CR-ANO-2-1995-0286	CR-ANO-2-1999-0550
CR-ANO-1-1998-0160	CR-ANO-2-1997-0031	CR-ANO-2-1999-0551
CR-ANO-1-1998-0204	CR-ANO-2-1997-0183	CR-ANO-2-1999-0554
CR-ANO-1-1998-0217	CR-ANO-2-1997-0320	CR-ANO-2-1999-0555
CR-ANO-1-1998-0224	CR-ANO-2-1997-0442	CR-ANO-2-1999-0559
CR-ANO-1-1998-0299	CR-ANO-2-1997-0508	CR-ANO-2-1999-0560
CR-ANO-1-1998-0299	CR-ANO-2-1997-0541	CR-ANO-2-1999-0561
CR-ANO-1-1998-0310	CR-ANO-2-1998-0173	CR-ANO-2-1999-0562
CR-ANO-1-1998-0368	CR-ANO-2-1998-0248	CR-ANO-2-1999-0571
CR-ANO-1-1998-0602	CR-ANO-2-1998-0343	CR-ANO-2-1999-0573
CR-ANO-1-1998-0662	CR-ANO-2-1998-0443	CR-ANO-2-1999-0580
CR-ANO-1-1998-0700		

Calculations

CALCULATION NUMBER	DESCRIPTION	REVISION
IRF 6964	Service Water Pump Net Positive Suction Head Calculation	10/26/93
V-1-00	Design Basis Differential Pressure Evaluations for Unit 1 High Pressure Safety Injection and Emergency Feedwater Valves	0
MB-1-12	Design Change Request 617 - Venturi Flow Calculations	0
G-254-7	Little Rock Data Analysis - Worst Case Periods	1
G-254-18	Cooling Pond Performance Analysis for Unit 2 Safe Shutdown	0

CALCULATION NUMBER	DESCRIPTION	REVISION
G-254-19	Pond Performance Sensitivity Analysis	0
M-4720-1 thru 5	Service Water System Flow Requirements (Superseded or Cancelled)	Various
2-4720-1	Determine required total discharge head and net positive suction head	0
85-EQ-0004-07	Accuracy Analysis for 2PT-1417-1 and 2PT-1423-2	3
85-S-0002-01	Emergency Diesel Loading Profiles	0
86D-1006-11	Determination of Ultrasonic Level Transmitter Alarm Setting for Service Water Bays	0
87-E-0006-04	Decay Heat Vault Post Loss-Of-Coolant-Accident Temperature Profile	2
87E-0071-01	Accuracy Analysis for Flow Loops 3816 and 3817	0
87-E-0071-01	Accuracy Analysis for Flow Loops 3816 and 3817	0
88-E-0032-01	ANO-2 Design Basis Accident Loss-Of-Coolant-Accident Containment Pressure-Temperature Response with Degraded Service Water Flow and Corrected Safety Injection Flow - Various Cases	1
88-E-0074-01	Unit 1 Emergency Diesel Generator Jacket Water Cooler Design Calculation	1
88-E-0074-01	ANO-1 Emergency Diesel Generator Cooling Requirements	1
88-E-0098-05	Essential Cooling Pond Winter Heat Loads	0
88-E-0115-01	ANO-1 Service Water Flow Degradation Design Basis Accident Analysis Impact	April 11, 1989
89-D-2049-01	Unit 2 Service Water System Water Hammer Analysis	0
89-D-2049-03	Code Qualification of 1" Bypass Piping for Control Valves 2CV-1510-1 and 2CV-1511-1	0

CALCULATION NUMBER	DESCRIPTION	REVISION
89-D-2049-07	Time Delay of Containment Cooler Valves After Engineered Safeguards Function Actuation System Actuation and Stroke Times for Valves 2CV-1511-1, 2CV-1510-2, 2CV-1513-2, and 2CV-1519-1	0
89-E-004-02	High Pressure Safety Injection Systems Analysis Work Package	1
90-E-0079-01	ANO-2 Service Water System Water Hammer Analysis	0
91-D-2003-1	Emergency Diesel Generator Capacity Ratings By Coltec Industries, Fairbanks Morse Engine Division	3
91-E-0015-01	Accuracy of Service Flow Indicator Loops for Unit 2 Containment Coolers and Shutdown cooling Heat Exchangers	0
91-E-0050-01	Software Validation of STER (Shell and Tube Exchanger Rating) Version 5.04	4
91-E-0099-10	Emergency Cooling Pond Peak Temperature and Inventory Loss Analysis Summary	1
91-E-0125-05	Ultrasonic Test Data Table for 1991 through 1996 "Summary of Results"	3
91-R-2013-01	Service Water Performance Methodology	0, 3
91-R-2014-01	Service Water Thermal Performance Test Results Analysis	0
91-R-2014-05	2R12 Emergency Diesel Generator Thermal Performance Test	0
91-R-2017-01	Service Water Flow Test Evaluation	1
91R-2017-02	2R9 Service Water Flow Test Evaluation	0
92-E-0079-01	Determination of SW-Cooled Room Heat Loads Under Various Operating Conditions	0
92-D-1092-03	Water Hammer Mitigation Analysis	0

CALCULATION NUMBER	DESCRIPTION	REVISION
92-R-2037-01	Evaluation of Reduced Service Water Flow to Shutdown Coolers 2E-35A and -35B	0
93-R-1035-01	Unit 1 Service Water Performance Analysis	0
93-R-1035-02	Unit 1 Service Water Performance Analysis	0
93-R-1035-03	Unit 1 Service Water Performance Analysis	0
93-R-2011-10	System Review Report for the Unit-2 Service Water System (SRR-2-SYS-10)	0
94-D-6021-01	Service Water Vacuum Breaker Line Orifice Sizing Calculations	0
94-E-0030-01	Minimum Temperature of Lake Dardanelle Reservoir	0
94-E-0063-01	Verification of Ability to Cool to Cold Shutdown within Times Stated in Safety Analysis Report	0
94-E-0095-12	Room 2024 Heat Load Evaluation	0
94-E-0095-13	Room 2025 Heat Load Evaluation	0
94-E-0095-14	Room 2051 Heat Load Evaluation	1
94-E-0095-15	Room 2052 Heat Load Evaluation	1
94-E-0095-16	Room 2053 Heat Load Evaluation	1
94-E-0095-17	Room 2096 Heat Load Evaluation	0
94-E-0095-18	Room 2007/2009 Heat Load Evaluation	1
94-E-0095-20	Room 2010 Heat Load Evaluation	1
94-E-6021-01	Service Water Vacuum Breaker Line Orifice Sizing Calculation	0
95-E-0046-01	Reactor Building Cooler VCC-1C Thermal Performance	0

CALCULATION NUMBER	DESCRIPTION	REVISION
95-E-0046-03 (Pending)	Reactor Building Cooler Minimum Service Water Flow	0
95-E-0095-15	Room 2052 Heat Load Evaluation	0
97-E-0004-03	Shutdown Cooler 2E-35A Thermal Performance Test	0
97-E-0004-03	Shutdown Cooler 2E-35A Thermal Performance Test	0
97-E-0004-04	2R12 Shutdown Cooling Heat Exchanger Thermal Performance Test	0
97-0034-01	Water Hammer Analysis for Generic Letter 96-06	1
97-E-0034-02	Water Hammer Analysis for Generic Letter 96-06	0
98-R-0004-01	Cathodic Protection Operational Inspection - Unit 2 Waterboxes and Plant Piping	0
98-E-0022-01	DH Cooler 1R14 Thermal Performance Test	0
98-E-0022-02	DH Cooler 1R14 Thermal Performance Test	0
91-R-01018-02	Maximum Flowrate for Service Water Pumps to Prevent Runout/Loss of Net Positive Suction Head	4

Safety Evaluations and Screenings

DCP 95-5010-D101
LCP-94-5022
LCP-94-6035
PC 95-8086
PC 95-8103
PC 96-7014
PC 962027P201
PC 963304P101
PC-962031P201
PC-962031P202
PC-963020P101
PC-974024P101
PC-974106P101
PC-974899P201

Engineering Reports, Action Requests, and Evaluations

2-99-0323
2-99-0551
91-0174
91-R-2013-01
91-R-2014-04
91-R-2017-05
92-R-2009-25
93-R-1035-01
93-R-1035-02
93-R-1035-03
980310-E101
EAR 92-310
ER 981275 N101
ER 974487
ER 980483
ER 981224
ER 991457
ER 991457-E201
ER 991457-E202
ER 991457-E203
ER 991915
ER 991916
ER 991917
ER 991920-E201

Design Change Packages, Limited Change Packages, and Plant Changes

NUMBER	DESCRIPTION	REVISION
DCP 85-2174	Flow Elements for Service Water Pump Tests	November 1986
DCP 88-2105	ANO-2 Flow Element Service Water Pump Test	1
DCP 89-2049	Service Water and Auxiliary Cooling Systems Water Hammer Mitigation	0
DCP 90-2029	ANO-2 Thermal Performance Monitoring	0
DCP 98-2049	Service Water and Auxiliary Cooling Systems Water Hammer Mitigation	0
DCP 95-5010-D101	Service Water System Crossover and Boundary Valve Replacement	0
LCP/PC 97-4024-P101	1R14 Service Water Piping Modifications	0
LCP 91-6021	Rebuild/Repair to 2P-4 Service Water Pumps	1
LCP 93-6013	Emergency Cooling Pond Spillway Modifications	0
LCP 94-5008	Decay Heat Room Cooler (VCU-1 A,B,C,D) Replacement	0
LCP 94-5022	Service Water System Crossover Valves Logic and Fire Protection	0
LCP 94-6035	Service Water Pipe Replacement B Valve Installation	0
PC 95-8086	HPSI Pump Seal Cooler Replacement	0
PC 95-8103	Modification to Valves 2CV-0711-2 and 2CV-0716-1 for Pressure Locking and Thermal Binding	0
PC 96-2027	Modifications to Valve 2CV-1460 SW Squeeze Valve	0

NUMBER	DESCRIPTION	REVISION
PC 96-7014	Resize Orifice FO-3824 to Full Bore Diameter Orifice	0
PC 96-8016	Modifications to Valve 2CV-1460 SW Squeeze Valve	0
PC 96-2031-P201	2R12 Service Water Pipe Replacement	0
PC 96-2031-P202	2R12 Service Water Pipe Replacement (2HBC-85-1)	0
PC 96-3020-P101	1R13 Service Water Piping Modifications	0
PC 97-4024-P101	1R14 Service Water Piping Modifications	0
PC 97-4024-P101	P4C Service Water Pump Discharge Pressure Alarm Wiring Change	0
PC 97-4106-P101	Installation of Flange Connections on Service Water Supply & Return Sides of E-28C	0
PC 97-4899-P201	2R13 Service Water Pipe Replacement	0
TM-95-2-021	Temporary Stem Clamp on Squeeze Valve	December 15, 1995

Miscellaneous Documents

DOCUMENT NUMBER	DESCRIPTION	REVISION
0CAN019012	ANO Response to Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment"	January 26, 1990
0CAN019903	Additional Information Pertaining to Generic Letter 96-06	January 25, 1999
0CAN058114	IE Bulletin 81-03 - Flow Blockage to Safety System Components by Corbicula & Mytilus	May 22, 1981

DOCUMENT NUMBER	DESCRIPTION	REVISION
0CAN079005	Supplemental Information Related to Generic Letter 89-13	July 2, 1990
0CAN129802	Additional Information Pertaining to Generic Letter 96-06	December 16, 1998
2HCC-2003-1	Large Pipe Isometric Emergency Feedwater Pump 2P-7B Inlet from Service Water Header #1	N
ANO-M-2555	Unit 2 Piping Class Sheets	1
CL-1474	Memorandum: Material Selection for Small diameter Piping and Valves for the ANO-2 Service Water System	February 20, 1981
GES-02	Engineering Standard, Configuration Management Program	0
HI-941175	Resolution of Discrepancies in STER Models of ANO Diesel Generator Coolers	0
950824	Job Order to Perform Unit 2 Emergency Diesel Generator Heat Exchanger Thermal Performance Tests During Refueling Outage 2R11	0
950906	Job Order to Perform Unit 2 Emergency Diesel Generator Heat Exchanger Thermal Performance Tests During Refueling Outage 2R11	0
M-2210	Service Water System, Sheets 1, 2, and 3	79, 77, and 80
M-2211	Auxiliary Cooling System	54
M-2217	Emergency Diesel Generator Auxiliary Systems	12
M-2250	Schedule of Water Demand for Aux. Cooling and Service Water System	10
SES-32	Engineering Standard, Piping Minimum Wall Thickness Calculations	0

DOCUMENT NUMBER	DESCRIPTION	REVISION
SRR-2-SYS-10	System Review Report for the Unit-2 Service Water System (CALC-93-R-2011-10)	0
ULD-1-SYS-10	ANO Unit 1 Service Water System	4
ULD-2-SYS-02	ANO-2 High Pressure Safety Injection System	0
ULD-2-SYS-10	ANO Unit 2 Service Water System	4
	Emergency Operating Procedure Technical Guidance Setpoint Documentation for Both Units	

ATTACHMENT 2

LICENSEE WHITE PAPER ON THROTTLING SERVICE WATER FLOW FROM SHUTDOWN COOLING HEAT EXCHANGERS AND CLOSURE OF EMERGENCY DIESEL GENERATOR KEEP WARM SYSTEM CROSS-FLOW VALVE

9-9-99

SSEI Follow-up Issues

Two issues from the SSEI inspection have raised questions regarding the philosophy of the ANO (and EOI) design control process. In one case, it was pointed out that throttling of two Service Water (SW) valves in order to increase the SW supply to the EDG should have been a temporary alteration. In the other, it was noted that changing the U2 EDG cross-flow valve from normally open to a normally closed category E valve should have been done through the formal design change process. Neither of these issues involved a physical alteration to an SSC other than a change in the normal position of valves.

In both cases, ANO personnel complied with the intent of ANO configuration management procedures in place at the time. They also would have been in compliance with EOI's current standard engineering procedures that are presently in the review and approval cycle. In both cases, a design control process was used (Engineering Evaluations or their predecessors).

The ANO Design Control process provides a set of available processes to use in response to a request for engineering technical support (ER) including Engineering Evaluations, Nuclear Changes and Commercial Changes. Prior to implementation of the current "ER" processes, a separate series of procedures governed the design control processes. Because the older processes have not yet been phased out totally, there are in essence two sets of procedures in place. It should be noted however that both are considered to meet the intent of ANSI standard N45.2.11 (reference section 4).

The ANO Engineering Request (ER) process that would result in a formal modification package (i.e. Nuclear or Commercial Change) is typically triggered by a physical modification to an SSC that affects either a system or component level design basis beyond the range of accommodation of design features. Operational changes to a design basis (e.g. valve position or line-ups) would also typically be handled by an Engineering Request to evaluate the ability of the present system configuration to fulfill the new design basis. However, these would normally trigger an Engineering Evaluation-type ER and would include revisions as necessary of appropriate configuration management documentation (including calculations). The changes under discussion are not physical modifications to an SSC but are changes in the position of a design feature (valve open vs. closed or valve throttled vs. more or less throttled) and fall below the threshold of the Nuclear Change. Nonetheless, they still fall under the ER design control process and would be controlled using an Engineering Evaluation.

The first issue concerning the positioning of valves to throttled positions could have been considered "modifications" in accordance with the procedural definition of the older methods (procedure 6000.010). Since this procedure is still active as mentioned before, this matter does lead to confusion and is acknowledged as an area for improvement. The present approach using the more recent ER procedure (1000.153) would allow that an "evaluation" be performed which was in fact done in both cases. It is acknowledged that for one of the two evaluations, a configuration control checklist and resulting 10CFR50.59 safety evaluation was not performed as required (a condition report was initiated to address this oversight). This is considered an individual personnel error (human performance) and not a process deficiency.

Both engineers who performed the Engineering Evaluations of the acceptability of the resulting flows also did not evaluate the impact of the changes with respect to hydrodynamic issues (such as flashing or cavitation). It is relevant to note that even if the engineers, certified to perform safety evaluations, had performed evaluations while processing the changes as a Nuclear Change or a temporary alteration, there is no reason to believe that either would have come to a different conclusion. Therefore, regardless of the process, it is likely that the outcome would most likely not have differed significantly in this case.

The cross-flow valve issue occurred in 1991 and pre-dated the present design control processes. It was handled under a corrective action plan developed with participation of System and Design Engineering management in response to a Condition Report. This action plan defined which calculations to revise, which procedures to revise, actions to determine the long term solution, etc. This approach was and still is allowed under the current procedures. The only negative aspect identified with regard to the cross-flow valve was the creation of a condition that could be considered to be an operator workaround (OWA). Closing of the cross-flow valve was not identified by Operations as an OWA when the OWA program was initiated and has been re-verified by Operations <u>not</u> to be an OWA by their current criteria. No additional operator actions have been required to date as a result of closing the valve nor are they expected to be in the future. The use of the formal design change process to accomplish this change would not have changed the outcome with regard to the chosen configuration and no other differences in the configuration management document revisions or updates have been identified.

In summary, the first issue represents an area where current design processes were considered acceptable but actual implementation was unsatisfactory. As explained above, it does suggest a design process area for improvement. However, the failure to address the hydrodynamic issue of flashing/cavitation is not considered attributable to the type of design control process employed. The second issue is considered an adequate application of design control processes in place at that time and still does not meet the threshold for an OWA as interpreted by ANO personnel.

As a result of the Condition Reports written relating to these issues, additional corrective actions are being considered to address potential improvements in the design process / design control area.