OFFICE OF INSPECTION AND ENFORCEMENT
DIVISION OF INSPECTION PROGRAMS

Report No.: 50-313/86-01

Licensee: Arkansas Power & Light Company
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Docket No.: 50-313 License No.: DPR-51

Facility Name: Arkansas Nuclear One, Unit 1

Inspection Conducted: January 6 - 31, 1986

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SCOPE: This special, announced team inspection involved 756 inspection hours to perform an in-depth assessment of the operational readiness of the emergency feedwater system.

RESULTS: The licensee's operational readiness and management controls were reviewed in six functional areas, primarily as they related to the emergency feedwater system. The functional areas reviewed were:

- Design Changes and Modifications
- Maintenance
- Surveillance Testing
- Operations
- Quality Assurance
- Training

Training is not addressed separately in this report; rather, it is incorporated within the other functional areas as appropriate. Eleven potential enforcement findings, identified in this report as Unresolved Items, and five Open Items will be followed up by the NRC Region IV.

I. INSPECTION OBJECTIVE

The objective of the team inspection at Arkansas Nuclear One - Unit 1 was to assess the operational readiness of the emergency feedwater (EFW) system by determining whether:

- The system was capable of performing the safety functions required by its design basis.
- Testing was adequate to demonstrate that the system would perform all of the safety functions required.
- System maintenance (with emphasis on pumps and valves) was adequate to ensure system operability under postulated accident conditions.
- Operator and maintenance technician training was adequate to ensure proper operations and maintenance of the system.
- Human factors considerations relating to the EFW system (e.g., accessibility and labelling of valves) and the system's supporting procedures were adequate to ensure proper system operation under normal and accident conditions.

II. SUMMARY OF SIGNIFICANT INSPECTION FINDINGS

This section summarizes the safety effects of the more significant findings on the operational readiness of Arkansas Nuclear One (ANO)-Unit 1 emergency feedwater system. Section III provides the detailed findings pertaining to the major functional areas evaluated.

A. Safety Effects on the Emergency Feedwater (EFW) System

1. The inspection team identified design concerns regarding the ability of the EFW system to perform its safety function during abnormal events.

   a. For steam line break accident scenarios, given a single active failure within the electrical power system (i.e., vital power), the emergency feedwater initiation and control (EFIC) subsystem did not have the capability to isolate the affected steam generator (SG) from the unaffected SG. It appeared that this could result in the loss of all EFW flow to both SGs. For a nonisolable steam line break in SG A with a concurrent loss of offsite power, the EFW system and EFIC subsystem rely on onsite power sources. If the loss of "red" ac power is assumed as the single active failure (i.e., failure of "red" diesel to start, fault on bus, etc.), the EFW motor-driven pump is unavailable and motive power is lost to operate CV-2667 (the isolation valve between SG A and the EFW turbine-driven pump). As a consequence, CV-2667 could not be closed and EFIC would have unsuccessfully attempted to isolate SG A from SG B. Instead, the unaffected SG B would have been cross-connected to the affected SG A through CV-2667 and CV-2617. As a consequence, both SGs could have depressurized through the nonisolable break, and the steam supply to the turbine-driven EFW pump may have been insufficient, causing a complete loss of EFW. In addition, the blowdown of two SGs through a nonisolable break inside the containment building was outside the design basis for the containment building (See figure 1, page 6).

      Subsequent to the inspection, the licensee provided information indicating that, for the main steam line break accident postulated above, sufficient steam would have been available to the EFW turbine until SG pressure dropped to approximately 80 psia.

   b. No design analysis was found evaluating the consequences of high-energy line breaks (such as a main steam line break within the penthouse area) on the EFW system concurrent with a single active failure even though the steam supply piping and valve arrangement was modified. Likewise, the team found no design analysis performed to assess the impact of high-energy breaks within the EFW steam supply piping on other safety-related equipment.

   The team found that the EFW system will function properly in response to anticipated transients such as loss of offsite power concurrent with a turbine trip and loss of main feedwater events. However, as evidenced by the deficiencies identified above, the team found that the system may not have been adequately protected from abnormal events such as high-energy line breaks and earthquakes (see observation II.B.2).

2. The team identified the following safety concerns with the licensee's program for maintenance and testing of EFW system motor-operated valves (MOVs).

   a. Licensee personnel were generally unaware that EFW MOV torque switches for ANO-Unit 1 were only bypassed during initial valve movement and that, as a consequence, improper torque switch operation could prevent the EFW system from completing its safety function. This lack of understanding was apparently due to a design difference in MOVs between Unit 1 and Unit 2. In ANO-Unit 2, MOV torque switches are typically bypassed for full valve travel.

   b. Torque switch settings were made without reference to the minimum recommended values provided by the vendor. The team reviewed selected MOV torque switch settings and found them to be set low; in one case, the setting was below the minimum value used for manufacturer testing.

   c. MOV limit switches appeared to be set to bypass torque switches for an insufficient amount of initial valve travel. The purpose of these limit switches was to bypass the torque switch until the valve was fully off its shut seat, thereby providing some assurance that the torque switch would not prematurely stop valve motion.

   d. EFW system MOVs located in the pump discharge piping were not tested under flow conditions to ensure that they would operate as expected in emergency situations.

   e. Several discrepancies in the MOV maintenance procedures were identified. These discrepancies could cause confusion among personnel performing maintenance.

   In summary, the licensee could not verify, by test results, engineering evaluation or vendor input that current torque switch and limit switch settings were adequate to permit proper MOV operation under expected flow conditions for all operating scenarios. Most EFW system MOVs are not required to reposition under normal circumstances for EFW initiation. However, EFW system MOVs would be expected to operate against design differential pressure if a steam generator isolation signal was received during EFW operation, if EFW water supply sources were required to be shifted from the condensate storage tank to service water, or if EFW initiation occured during system flow testing.

3. In addition to the concerns described above relating to the testing of motor-operated valves, the inspection team identified other electrical and mechanical equipment in the EFW system that had not been tested.

   a. The condensate storage tank (CST) level indication transmitter, LIT-4203, had apparently not been calibrated after installation during the 1984 refueling outage. The licensee also had no routine surveillance procedure to ensure that this instrument is periodically

calibrated. This instrument is used by operators to make the determination to manually shift EFW pump suction from the non-safety-related CST to the safety-related service water backup.

b. Eight valves in the EFW system that required routine in-service testing were not periodically tested. These valves included four check valves in the EFW pump suction line from the CST, one check valve in each EFW pump minimum recirculation line, and one 3-way valve downstream of each EFW pump that allows recirculation flow when the EFW pump is discharging at high pressure. The proper operation of these valves apparently cannot be verified without the installation of additional instrumentation.

B. Effects on Other Safety Systems

In addition to the specific concerns discussed above that relate directly to the operational readiness of the EFW system, the team also identified several general concerns that have the potential to affect the proper operation of other safety systems.

1. Problems were noted in the ANO-1 mechanical design-change process. The team identified instances where modifications were done without significant mechanical design activities being performed, completed, or documented. The team believes that these oversights should have been corrected during the design verification and supervisory reviews. The fact that these omissions were not detected indicated an apparent lack of design experience and/or a lack of supervisory attention.

2. ANO-Unit 1 did not routinely consider the effect of equipment that is not designed to meet maximum design basis earthquake requirements (seismic Class 2) on equipment that is designed to meet maximum design basis earthquake requirements (seismic Class 1). The team determined that evaluations of potential seismic interaction, seismic Class 2 over Class 1 situations, were not being routinely considered when preparing the civil portions of design-change packages. The lack of consideration for seismic interaction could have a significant effect on the operability of all safety systems at ANO-Unit 1 during a seismic event. Seismic Class 1/Class 2 interaction is apparently fully considered at ANO-Unit 2.

3. The team found several samples of controlled design documents with incorrect or misleading information. Based on the number and types of discrepancies, the team believes that the implementation of configuration control activities was weak.

III. DETAILED INSPECTION FINDINGS

A. Design Changes and Modifications

The inspection team examined design aspects of design-change package (DCP) 82-D-1050. This design change was to replace the EFW pump 7A turbine driver,

to add new steam admission valves, to reroute the turbine steam supply piping, and to modify the turbine pump suction and discharge piping. In addition, DCP 80-1083B was examined. This modification was to replace the discharge piping of the EFW pumps, and to add modulating control valves, automatic recirculation control features, and a full flow test loop, and to change selected valve actuators from ac to dc power. The following observations were made:

1. The team determined that the implementation of DCP 82-D-1050 failed to ensure that it met the single-failure criterion. Specifically, for steam line break scenarios, given a single failure within the electrical power system (vital power), the emergency feedwater initiation and control system (EFIC) would not have the capability to isolate the affected steam generator (SG) from the unaffected SG. It appeared that this could result in the loss of all EFW flow to both SGs.

   Figure 1 on page 6 illustrates the main steam system supply configuration to the EFW turbine pump at the time of the inspection. The steam supply to EFW pump 7A is supplied from both SGs through normally open ac motor-operated control valves CV-2617 (SG B) and CV-2667 (SG A). Like the motor-driven pump, the EFW turbine pump supplies feedwater to either or both SGs depending on the EFIC vector signals. For a steam line break, the EFIC system will isolate the depressurized SG in order to isolate that affected SG from its associated main steam and main feedwater lines. If isolation of the affected SG does not isolate the break, the EFIC system will provide EFW only to the intact SG. For a nonisolable steam line break in SG A with a concurrent loss of offsite power, the EFW system relies on onsite power sources. If the loss of "red" ac power is assumed as the single active failure (i.e., failure of "red" emergency diesel to start, fault on bus, etc.), the EFW motor-driven pump is unavailable and motive power is lost to CV-2667. As a consequence, EFIC would have unsuccessfully attempted to close CV-2667, and therefore the unaffected SG B would have been cross-connected to the affected SG through CV-2667 and CV-2617. Both SGs would have then depressurized through the nonisolable break and the steam supply to the turbine-driven EFW pump could have been insufficient, causing a complete loss of EFW.

   Subsequent to the inspection, the licensee provided information indicating that, for the main steam line break accident postulated above, sufficient steam would have been available to the EFW turbine until SG pressure dropped to approximately 80 psia.

   Review of DCP 82-1050 (the design change to install the new EFW turbine, new dc steam admission valves, and to modify EFW suction and discharge piping) indicated that a single-failure analysis was not performed. Specifically, question 15 of the DCP asked, "How was the impact of failure of the systems, components, and structures considered in the design?" In response, the Project Engineer indicated that the question was not applicable by answering "NA." This response was checked and approved without comment. Procedure 1032.01, "Design Control," Revision 7, required an independent reviewer to verify that responses to the Design Evaluation Questions had been properly addressed and that the discipline portion of the design change was complete and technically accurate.

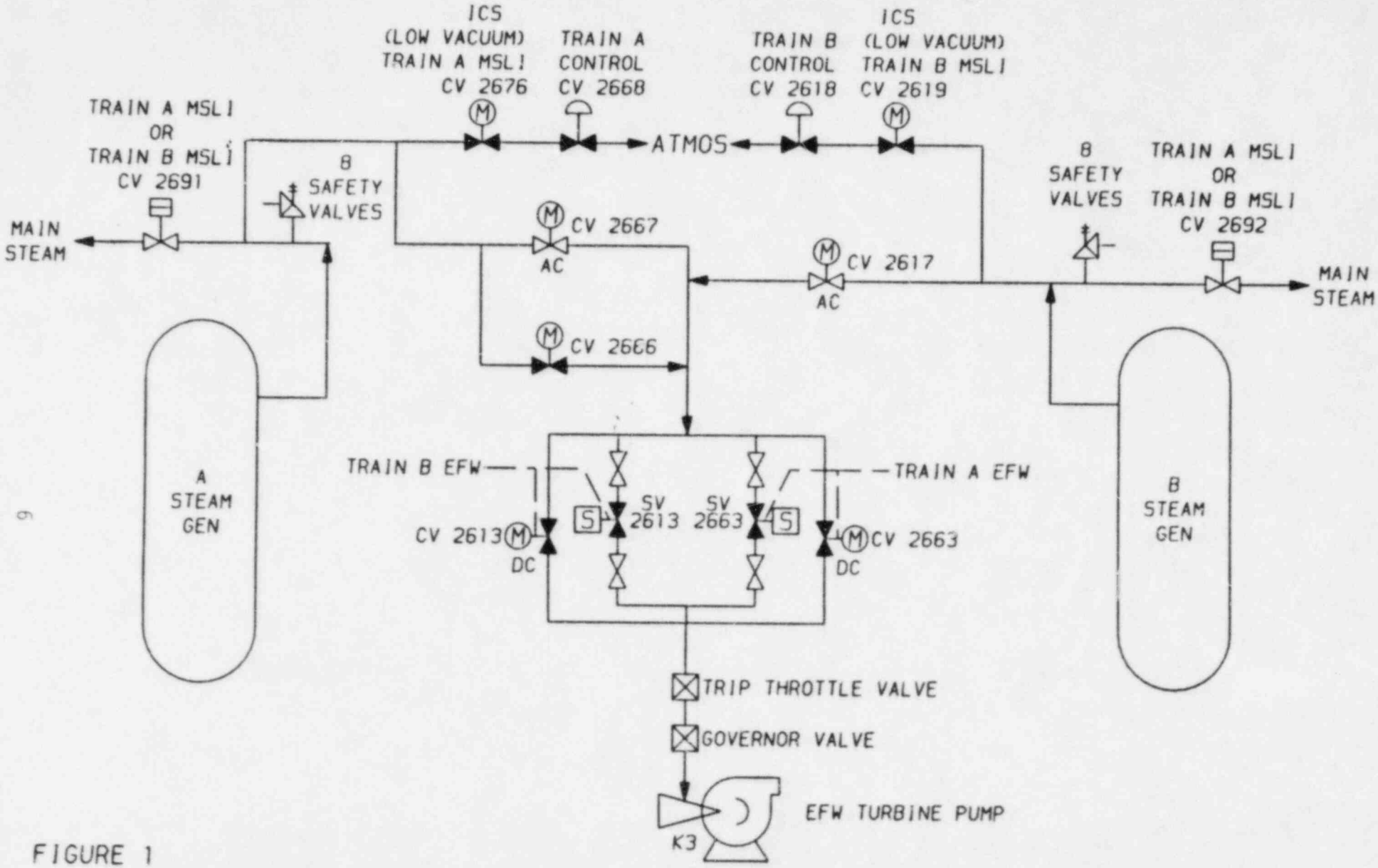

FIGURE 1
ANO-1 MAIN STEAM SUPPLY
TO EMERGENCY FEEDWATER TURBINE PUMP

The team noted that the final design of the EFW system upgrade was submitted to the NRC for approval by an AP&L letter dated December 1, 1981. The design described in that letter and subsequently approved by the NRC contained check valves to prevent blowdown of the unaffected SG through the affected SG. However, because a similar application of steam check valves had not proven reliable, the licensee subsequently decided to eliminate the check valves from the design and did not perform an adequate 10 CFR 50.59 review to determine if an unreviewed safety question existed. At the completion of the onsite inspection activities, the licensee was in the process of installing check valves in the steam supply lines to the EFW turbine to correct this deficiency.

Contrary to the requirements of 10 CFR 50, Appendix A, General Design Criterion 34, the EFW system did not have suitable redundancy in components and features and isolation capabilities. Assuming a single failure, no assurance was provided for proper safety system function for onsite electric power system operation (assuming offsite power is not available) and for offsite power system operation (assuming onsite power is not available). In addition, contrary to the requirements of 10 CFR 50.59, the licensee failed to perform an adequate analysis to determine the existence of an unreviewed safety question.

This item was discussed with the licensee and will remain unresolved pending followup by NRC Region IV (50-313/86-01-01).

2. The licensee had not routinely considered the effect of equipment that is not designed to meet maximum design basis earthquake requirements (seismic Class 2) on equipment that is designed to meet maximum design basis earthquake requirements (seismic Class 1) at ANO-Unit 1 when preparing the civil portions of design change packages. The team was informed by the licensee's engineering personnel that no requirements existed to perform seismic Class 2-over-1 evaluations, either as part of the ANO-Unit 1 design change process or original design. In scope, licensee Procedure CEQN-00002-0 indicated that all ANO-Unit 2 DCPs are evaluated for potentially hazardous seismic Class 2-over-1 interactions but that Unit 1 design changes are evaluated only at the direction of the lead engineer. This approach appears to be contrary to FSAR commitments. The FSAR states in a description concerning the design of seismic Class 1 piping systems that:

> "Where Class 1 seismic structures are directly connected to or in close proximity to Class 2 seismic equipment and piping systems, the failure or excessive movement of the Class 2 seismic systems are restrained in such a way as not to cause a failure of Class 1 structures."

The licensee had interpreted this statement to mean that seismic Class 2 equipment and piping systems will not interfere with seismic Class 1 <u>structures</u>. The licensee did not consider safety-related seismic Class 1 systems and components to fall under the domain of seismic Class 1 <u>structures</u>; therefore the licensee did not routinely consider seismic Class 2-over-1 interaction.

The team observed no documentation of instances where seismic Class 1/ Class 2 interactions were evaluated, with the exception of minor statements in response to DCP Design Evaluation Questions and redesign of the support system for the EFW pump room chiller (DCP 80-1083B). The inspection team considered a seismic Class 1/Class 2 evaluation of service water piping located in the EFW pump room to be inadequate because it appeared to assume that the initiating event was a pipe break and not a seismic event. The potential for pipe movement (i.e., seismic shake space) or hanger pullout considering dead weight and seismic accelerations was not addressed. The analysis concluded, without documented justification, that two hangers provided at both ends were adequate to support the weight of the pipe.

The lack of consideration for seismic interaction will remain unresolved pending clarification of the requirements for ANO-Unit 1 (50-313/86-01-02).

3. Civil design calculations of structures with multiple degrees of freedom did not always consider the effects of seismic forces acting simultaneously. Specifically, the team found that the seismic support design of the EFW pump room chiller was a structure with two degrees of freedom in the horizontal direction but, in the analysis (Calculation 80-D-1083B-01), it was assumed that seismic movement can only occur in one direction at a time. The following discrepancies and errors also were noted:

   a. The calculation did not combine the maximum values of responses for each of the two applicable orthogonal spatial components of an earthquake to obtain a combined representative maximum value. In addition, a nonconservative section modulus was used because of an assumption to consider seismic movement in only one degree at a time. The analysis used a section modulus of 1.07 from the AISC Steel Construction Manual for the angle iron used the support design; however, transformation about the principal axis was apparently not considered to evaluate bending stress. The team determined that the correct section modulus would be approximately 0.714, indicating a less conservative design.

   b. The analysis did not include a design evaluation of the connection between the angle iron and the frame of the chiller. The team was informed that the connection was welded and that the design adequacy of the connection was performed by inspection without documentation.

   c. In conducting the design verification of the calculation, the checker performed an alternate calculation which applied inappropriate design equations. The checker used AISC Steel Construction Manual equation 1.5.1.4.5.2 which dealt with struts in compression and not angles in compression and/or tension.

   d. Design input was incorrectly stated and, in one instance, an incorrect reference was identified. A critical damping value of 2 percent was used in the calculation instead of 0.5 percent as indicated. Additionally, the reference identified as the source of the maximum peak vertical acceleration was incorrect because it referred to a seismic response spectrum for horizontal accelerations.

Although the team found the design of the EFW pump room chiller seismic supports to be adequate when the two horizontal degrees of freedom were considered, the team was concerned that similar seismic calculation errors may exist for the design of other seismic supports. This item will remain open pending further NRC review of the licensee's method for performing seismic calculations (50-313/86-01-01).

4. Post-modification testing in the form of an adequate service test was not performed on the recently replaced station batteries to conclude that these batteries had sufficient capacity under design conditions to perform their safety function. The following observations pertain:

   a. DCP 83-1032 was issued to replace the Class 1E station batteries. As part of this replacement, the design change included the requirement to perform a 2-hour service test using the duty cycle from calculation GE-83D-1032-01. In response to this requirement, a service test was performed for battery D07 under ANO Job Order 058396 on March 24, 1984. The team reviewed the test data and determined that this initial service test did not include all the necessary design requirements, such as corrections for minimum design temperature. In addition, it did not appear that the test discharge current was corrected for the average cell electrolyte temperature at the start of the test. Temperature affects the response of the battery so that test temperature must be accounted for in order to have a common reference point. Additionally, the team could not confirm what the actual test current was because the test data sheet did not record the actual test current but instead referred to a specific sheet of the battery sizing calculation for the test profile. The calculation sheet that was referenced for both the D07 and D06 batteries did not contain any test profile.

      Another problem with the test currents was that the licensee measured battery voltage at half-hour increments, completely missing the critical discharge period at 1 minute into the test where the battery sizing calculation indicated the voltage would be most limiting. The test results indicated less than one-half volt difference in battery voltage during the test. A discharge voltage profile calculation for the latest duty cycle (which was similar to the original duty cycle for the first 30 minutes) indicated voltages should be 5 to 12 volts below what the test results showed.

   b. DCP-83-119 was issued to modify the dc system components, including removal of two cells from each of the station batteries to reduce the dc system voltage. The newly configured battery was then tested per Special Work Plan 1409.29 using a performance discharge test to meet the Technical Specifications requirements for battery testing. During the performance of this test, the average battery temperature was determined to be 82°F. To determine the actual test discharge current, the battery current for an 8-hour discharge was corrected for temperature. However, the team had the following concerns:

(1) The temperature correction factor used was not for 82°F. The procedure permits the use of battery room temperature if many hours have passed since the average electrolyte temperature was determined. The data sheet did not record if room temperature was used or what that value was.

(2) The temperature correction factor that was used was incorrectly applied by multiplying the rated discharge current by this factor to give, in this case, a lower test current. This method was in disagreement with industry standard IEEE 450-1980, which was included as a referenced document. IEEE 450-1980, Section 5.3, states that the rated discharge current should be divided by the temperature correction factor. This would have increased the required discharge current instead of decreasing the current, resulting in a lower capacity in the battery than what was determined in the performance test.

ANSI N18.7-1976, "Administrative Control and Quality Assurance for the Operational Phase of Nuclear Power Plants," Section 5.2.19.3, requires that modifications that affect functioning of safety-related systems or components be inspected and tested to confirm that the modifications or changes reasonably produced expected results and that the change does not reduce safety of operations. Contrary to the above, the modification acceptance tests for the station batteries did not confirm the expected results because the tests included incorrect discharge currents and the service test did not have an appropriate acceptance criteria (i.e., it failed to measure the voltage at the critical period). This issue was discussed with the licensee and will remain unresolved pending followup by NRC Region IV (50-313/86-01-03).

5. In some cases, mechanical design change packages were found to be reviewed and approved without completion of all design calculations or design evaluations for critical design attributes. The following examples pertain:

a. No design analysis was performed to evaluate the consequences of high-energy line breaks when DCP 82-D-1050 was reviewed and approved. Although this design package modified and extended the boundary between high- and low-energy conditions, the consequences of high-energy line breaks (such as a main steam line break within the penthouse area) on the EFW system concurrent with a single active failure were not analyzed. Similarly, the team found no design analysis performed to assess the impact on other safety-related equipment of high-energy line breaks within the EFW steam piping. In response to this observation, the licensee showed the team a March 12, 1981, letter to the NRC, written before the design package was prepared. Without apparent design analysis, this letter concluded that a break in the steam supply piping for the turbine-driven EFW pump would not adversely affect other critical

EFW components and that once the break is isolated, the plant could be brought to a safe shutdown condition, assuming a concurrent failure of the motor-driven EFW pump by using the normal feedwater system or the high-pressure injection system. The team concluded that the design configuration being assessed by the licensee in the March 1981 letter was not the same as that described in the actual design package (i.e., check valves not installed, see observation 1 of this section). The single failure postulated by the licensee may not have been the most severe (i.e., loss of bus resulting in loss of motive power to isolate the break and loss of the motor-driven pump). The team also concluded that the assessment did not address the consequences to EFW piping and components of other high-energy line breaks.

b. Although the EFW system was upgraded to be safety-related by the design change packages reviewed, design analysis was not performed nor was an engineering review of original architect engineering analysis performed to determine if safety-related room cooling was required while both EFW pumps were operating. In response to the team's concern, the licensee provided design analysis used to establish the environmental equipment qualification pressure and temperatures. Review of these analyses indicated that they are for three high-energy line breaks outside containment. These breaks are two letdown line breaks and a main feedwater line break. Although the consequences of high- energy line breaks outside of containment need to be considered in developing equipment environmental conditions for qualification purposes, those consequences may not be the most severe condition under which safety-related EFW equipment must operate.

The lack of design analysis in the cases cited above appears to be contrary to the requirements of ANSI N45.2.11, Sections 4.1 and 4.2, which require that design analysis be performed in a planned, controlled, and correct manner and that there exist traceability from design input through to design output. This item was discussed with the licensee and will remain unresolved pending followup by the NRC Region IV (50-313/86-01-04).

6. Numerous calculations and design analyses reviewed failed to meet the design control requirements of ANSI N45.2.11 by not documenting inputs and assumptions, by not ensuring a correct methodology was used, and by not ensuring that the calculations were sufficiently completed to permit verification without recourse to the originator. The following examples pertain:

a. Calculation GE-83D-1032-01, dated January 25, 1984, established an emergency duty cycle for the station batteries and determined the battery size required to replace the existing batteries. This calculation referenced industry standard IEEE 485 for sizing large lead storage batteries; however, it only included a correction factor for aging and neglected any correction factors for operation at minimum temperature. Procedure 1307.006, "DO7

Quarterly Surveillance," monitors cell electrolyte temperature and contained an acceptance criteria of 60°F as the minimum battery temperature. Manufacturers normally rate their batteries at 77°F. This 17°F temperature difference would result in a loss of capacity of approximately 11% according to the industry standard referenced in the calculation. This calculation concluded that the battery was sufficient for an 8-hour discharge. The following additional weaknesses were observed in this calculation:

(1) No justification was included in the calculation to permit the reduction of the safety-related inverter loads from 75 amperes to 10 amperes after 30 minutes into the design discharge.

(2) MOV starting currents had not been considered as part of the first minute discharge loads.

The team reviewed the battery sizing performed by the manufacturer on March 17, 1984, and noted:

(1) The manufacturer's sizing calculation used cell discharge current capabilities that were substantially lower than those for the same size battery cell used by the licensee in both the 1983 or 1984 calculations.

(2) The manufacturer's calculations were based on a different 4-hour profile than what was used by the licensee.

(3) The manufacturer's calculation noted that no correction factors were included for temperature compensation because no minimum operating temperature requirement was specified by AP&L.

b. Calculation 83D-1032-05, dated July 9, 1985, revised the battery sizing calculation (discussed in observation 6.a) to include a dc power panel load study, a revised inverter dc load demand based on actual measured inverter loads, and MOV motor inrush currents. The calculation again concluded that the batteries would adequately supply an 8-hour duty cycle. The team noted that temperature correction again was not included in the calculation of the required cell size. The following weaknesses were noted with the determination of the new inverter loads:

(1) These loads were based on a measured inverter loading during normal plant operation and did not appear to consider maximum design values.

(2) The dc loads were not measured but calculated from the inverter output ac load using assumed inverter efficiencies. These calculated dc loads were 20 to 30 amperes less than the values the team read from the inverter dc input current ammeters while the plant was in a normal shutdown mode. The licensee initially stated that the team's readings were in error because of the inaccuracies of the inverter dc meter

but then agreed that the assumed inverter efficiencies were in error.

c. Battery sizing calculation 83-1032-06, dated January 24, 1986, was developed in response to the team's concerns and was performed to verify that the ANO batteries would meet the Unit-1 FSAR minimum requirement for a 2-hour discharge.

The team noted that a new manufacturer's cell discharge characteristic curve (D-699-1A, 6/84) was attached to this calculation to justify the latest cell discharge capability. These new cell capabilities were greater than those used by the manufacturer in the 1984 calculation but less than those used by AP&L in its 1983, 1984, and 1985 calculations. This most recent calculation also included the correction factors for aging and minimum operating temperature. The inverter load values used were based on a measurement taken during plant shutdown without justification as to why a margin should not be used for meter inaccuracy or increased load during a design-basis event.

d. Calculation 80-1083A-02, dated January 14, 1986, was developed to determine the voltage at the terminals of newly installed dc motor-operated valves. This calculation assumed that the voltage available for operating the valve motor was solely a function of the capacity removed from the battery; no consideration was given to any loss of the battery's capability because of aging or minimum acceptable operating temperature. This calculation was superseded by Calculations 80-1083A-04 and 83D-1032-07, both dated January 24, 1986, and prepared in response to the concerns of the inspection team. These calculations correctly developed a battery voltage profile based on the corrected rate of discharge and the actual capacity removed from the battery. The voltage drop from the batteries to the motor control centers had also been factored into the calculation of motor terminal voltage. New feeder lengths, based on the cable pull slips from the motor control centers to the valves (longer than those used in the original calculation, 80-1083A-02) were also included.

The original MOV terminal voltage calculation acceptance criteria was based on a telecon between AP&L and the valve actuator manufacturer. These latest calculations (80-1083A-04 and 83D-1032-07) did not reference any new acceptance criteria but concluded that the resulting lower torque developed was still sufficient even with the lower voltage at the valve motors. The team noted that these latest calculations showed the torque developed at valve CV-2870 was 7.32 ft-lbs and that the acceptance criteria used in the original calculation for this valve was 10 ft-lbs. The team requested confirmation that the acceptance criteria referenced in the original calculation was sufficient to operate the ANO valves under design requirements. AP&L was not able to produce a valve-actuator sizing analysis during the inspection to confirm the required motor starting torque.

e. Calculation 83D-1032-02, dated February 17, 1984, was prepared to show the acceptable short circuit withstand capability of the existing dc distribution system components with the new larger batteries. This calculation justified a potential problem that the power panels that were rated only for 10,000 amperes could potentially experience a short circuit slightly higher than rating. The team identified other dc components, such as the battery chargers, that were not included in the analysis but could add to the short circuit. The licensee noted that the calculation did not include consideration of the existing fuses or additional cabling to the new battery disconnect switches that would ensure that current would remain below the panel rating.

f. Calculation 84E-0083-12, dated November 19, 1985, included a protective relay study for breaker A311 feeding the EFW pump motor. This calculation failed to document the source of the safe stall time, starting time, or locked rotor current used in the calculation.

g. No calculations were performed by the licensee to determine motor-operated valve overload heater sizing. The team noted that the heaters that were installed for the dc motor-operated valves were selected by the motor control center vendor, apparently based upon a continuous duty motor. The dc motors used on the ANO-1 valve actuators are short-duty-rated motors. The team estimated that heaters selected in accordance with the valve actuator manufacturer's recommendations could be approximately five sizes smaller than those presently installed at ANO. These smaller heater sizes would still permit a valve stroke time approximately twice the acceptance time required by the valve surveillance procedures.

Calculations did not consistently identify inputs and assumptions or provide sufficient detail to permit technical review and verification without recourse to the originator. These calculation deficiencies, as discussed in subparagraphs 6.a through 6.g, above, appear to be contrary to the design control requirements of ANSI N45.2.11, Section 4.2. Similarly, contrary to the design control requirements of Section 6.2, the verification process did not consistently confirm that inputs were correctly selected, that assumptions were reasonable and appropriate, and that an appropriate design method was used. This item will remain unresolved pending followup by NRC Region IV (50-313/86-01-05).

7. A large number of controlled design documents and drawings contained errors and omissions. Based on the number and type of discrepancies identified, the implementation of configuration control activities were considered weak. The following examples pertain:

a. Piping and instrumentation diagrams were found to have incorrect valve positions, incomplete locked positions indicated, and missing instrumentation bubbles.

The following deficiencies pertain to drawing M-204, Sheet 3 of 4, "Piping & Instrument Diagram, Emergency Feedwater," Revision 2:

(1) Manual valve CS-2802C was indicated as normally open; however, the valve was actually normally closed.

(2) Manual valves FW-11A and FW-11B in the pump recirculation lines to EFW pumps 7A and 7B were shown as normally open valves; however, these valves were actually locked open valves.

The following deficiencies pertain to drawing M-206, Sheet 1 of 2, "Piping & Instrument Diagram, Steam Generator Secondary System," Revision 45:

(1) EFW turbine steam supply valves CV-2617 and CV-2667 were indicated as normally closed; however, these valves were actually normally open.

(2) CV-2619 and CV-2676, block valves for atmospheric dump valves associated with steam generators B and A, respectively, were indicated as normally open; however, the valves were actually normally closed.

(3) When CV-2617 and CV-2667 were changed from normally closed to normally open valves, Note 4 of the P&ID was not revised or deleted. Note 4 states, with respect to the bypass valve around CV-2667, that a "single failure analysis requires only one bypass valve. A bypass around CV-2617 is not required."

The following deficiencies pertain to AP&L Drawing M-202, "Piping & Instrument Diagram, Main Steam," Revision 33:

(1) Instrument bubbles were not shown for the handswitch and selector switch for CV-2613 and CV-2663 (EFW turbine steam admission valves).

(2) CV-2613 and CV-2663 were shown as normally open valves; however these valves are actually normally closed.

The following deficiencies pertain to AP&L Drawing M-212, Sheet 1 of 2, "Piping & Instrument Diagram, Plant Makeup Domestic Water Systems," Revision 29:

(1) Condensate storage tank supply isolation valve CS-19 was shown as a normally open valve; however it was actually a locked-open valve.

(2) CV-4201, the heating steam supply valve to the condensate storage tank, was shown as normally open when it was actually normally closed.

b. The piping design specification for ANO-Unit 1, M-84, "Piping Class Drawing," Revision 22, contained errors and was not adequately controlled. The following deficiencies pertain:

(1) DCP-80-1083B identified that a revision to the piping design specification was required to add a new piping classification identified as Class DBD. Drawing control records did not indicate that a change was in progress as would be indicated by assignment of a modified drawing revision number for the affected pages as required by AP&L Design Document Control Procedure 1032.11.

(2) Pages 1 and 1a, the list of effective pages, of the pipe design specification M-84 were compared with the Document Control copy of M-84. Eight errors were identified corresponding to missing pages or incorrect revision numbers. The team also found an uncontrolled copy of M-84 in use which differed from the controlled copy by one page.

c. The Instrument Index, a controlled design document, contained errors and omissions. In particular, the document omits approximately 22 safety-related EFW instruments and does not identify 30 other items as safety-related. The following safety-related EFW instruments were not listed in the Instrument Index:

CV 2869, CV 2870, FO 2800, FO 2801, HS 2869, HS 2870, I/P 2618 I/P 2668, SS 2613, SS 2617, SS 2619, SS 2620, SS 2626, SS 2627, SS 2663, SS 2667, SS 2670, SS 2676, ZS 2613-1, ZS 2663-a, ZS 2869, and ZS 2870.

The following safety-related EFW instruments were in the Instrument Index but were not identified as safety-related:

CV 2613, CV 2619, CV 2626, CV 2627, CV 2663, CV 2666, CV 2676, CV 3850, CV 3851, HS 2619, HS 2676, HS 2800, HS 2802, HS 2805, HS 3850, HS 3851, SV 2613, SV 2663, ZS 2617, ZS 2619, ZS 2626, ZS 2627, ZS 2667, ZS 2676, ZS 2800, ZS 2802, ZS 2803, ZS 2806, ZS 3850, and ZS 3851.

The team noted that the licensee was currently in the process of identifying all safety-related plant equipment on a component level basis to create a new Q-list. This effort appeared to be extensive and should resolve any future concerns of safety-related component classification.

d. The following drafting errors or incorrect information were noted on controlled drawings.

(1) On drawing M-206, Sheet 1 of 2, "Piping & Instrumentation Diagram, Steam Generator Secondary System," revision 45, a cloud around a portion of the drawing that was previously revised was not removed (see H-7 of the drawing). The licensee used clouds on drawings to indicate the area of the drawing that was last changed.

(2) Drawing M-402, Sheet 3 of 4, "Functional Description & Logic Diagram Condensate Feedwater System," Revision 14, contained the following incorrect statement: "Suction lines are furnished with 5 motor-operated valves, CV-2800, CV-2801, CV-2802, CV-2803, and CV-2806, and a solenoid operated valve CV-2804." However, CV-2801 and CV-2804 did not exist in the current system configuration.

(3) The logic diagram for CV-2869 was described as "Emergency F.W. Pump 7A Auto Recirc Valves" when in fact it was the EFW pump 7B full-flow test isolation valve. Auto recirculation valves were FW-10A (pump 7A) and FW-10B (pump 7B).

(4) Drawing M-402, Sheet 3, "Logic Diagram Condensate Feedwater System," Revision 15, showed a seal-in feature for EFW valves CV-2620 and CV-2627. This did not agree with schematic E-293, Sheet 1, Revision 8, which showed this seal-in feature deleted.

(5) Drawing M-402, Sheet 3, "Circuit for EFW Pump Suction Valves," incorrectly showed the indicating light at the full travel position in disagreement with all other circuits and the schematic E-296. This drawing also did not include a seal-in circuit around the momentary switches in disagreement with the schematic E-296.

(6) Drawing M-404, Sheet 3, "MS ATMOS Dump Valve Logic," Revision 3, showed seal-in around manual switch HS 2676 which did not agree with schematic E-442, Revision 5. This drawing also incorrectly showed a high closing torque switch shown in opening circuit.

(7) Drawing E-442, "MS ATMOS Dump Valve Schematic," Revision 5, incorrectly references drawing E-84, Scheme A, which was for a 480-Vac reversing starter with no engineering safeguards relays.

(8) Drawing E-86, Sheet 1, "Schematic Diagram EFIC Trip Relay Assembly," Revision 0, incorrectly identified the right scheme as a 1E to 1E trip module assembly, it should be 1E to non-1E.

(9) Drawing E-293, Sheet 1, "Schematic Diagram EFW Steam Generator Isolating Valves (DC)," Revision 0, referenced E-96 for internal wiring of the dc reversing starter. The wire numbers shown did not agree between the drawings for the negative leads for the series winding or the remote indicating lights so that one cannot determine if the remote lights will indicate an open thermal overload relay contact (device 49). The hand switch contact development did not indicate the reference circuit for the switch contacts. This was typical of most circuits reviewed by the team.

(10) Drawing E-293, Sheet 2, "Schematic Diagram EFW Steam Generator Isolation Valves (AC)," Revision 1, incorrectly referenced drawing E-96 for internal wiring of this ac reversing starter. Drawing E-96 was for dc starters.

(11) Drawing E-294, "Schematic Diagram Emergency FW Motor Driven Pumps," Revision 10, did not indicate an immediate start signal if the offsite power is available through breaker A-309, as indicated in the logic diagram on M-402, Sheet 3. The alarm circuits for this drawing included a pump low-discharge-pressure alarm but not the high-discharge-pressure alarm indicated on logic diagram M-402. Additionally, the setting of the time delay of relay 174-311 of 65 seconds disagrees with the setting of 110 seconds indicated on logic diagram M-402.

(12) Drawing E-295, Sheet 1, "Schematic Diagram EFW Turbine MOVs," Revision 21, referenced motor starter internal wiring scheme A on drawing E-84. Scheme A2 on drawing E-84 referred to this circuit.

(13) Drawing E-295, Sheet 3, "Schematic Diagram EFW Turbine MOV's," Revision 1, included a pump low-discharge-pressure alarm but not the high-discharge-pressure alarm indicated on logic diagram M-402.

(14) Diagram E-295, Sheet 4, "Schematic Diagram EFW Turbine MOVs," Revision 1, was found to be in error. An interlock in the valve open circuit from the 42R auxiliary contact was shown to use terminals 8 and 9. According to drawing E-96, these terminals are actually wired to the 42F auxiliary contact.

(15) Drawing E-295, Sheet 4A, "EFW Turbine MOV's," Revision 0, incorrectly referenced a "green" power supply panel for a "red" circuit. However, the circuit was actually wired correctly. The adapter table for this drawing did not identify the power supplies, and the contact development for relay 42X-M084 failed to identify the applicable circuit for contact 1H-1G.

(16) Drawing E-315, Sheet 1, "Schematic Diagram Steam Generator Isolation Control," Revision 15, had the following errors: The contact for relay 63X1/1 was incorrectly shown as relay 63X/1. The coil for relay 62-3 was incorrectly labeled 63-3. The time delay for relay 62-3 was shown as two different valves on the same sheet. The time delay for relay 62-2 conflicted with the time delay for same relay shown on drawing E-317-3.

(17) Drawing E-318, Sheet 1, "Schematic Diagram EFW Recircuit Test Isolation Valve," Revision 22, 3/5/85, indicated that valve CV-2870 had a 1/3 hp motor. The valve data sheet indicated that CV-2870 had a 0.72 hp motor.

(18) Drawing E-331, Sheet 31, "Schematic Diagram," Revision 1, 1/3/85, incorrectly identifies power panel RS2 as a 120-Vdc power source. This power panel was actually an ac supply.

The team was concerned that inaccurate design drawings could cause design engineers to perform design activities incorrectly. For example, the incorrect depiction of valve position and the lack of correct locked indication can cause a design engineer to perform single failure analyses and safety evaluations incorrectly. In at least one instance, the team noted that drawing errors appeared to have an adverse effect of safety-related activities performed by an AP&L contractor. Specifically, a contractor performing Q-List determinations did not identify instruments SS 2619 and SS 2663 as safety-related apparently because the piping and instrumentation diagram had those instrument bubbles missing from the drawing.

ANSI N45.2.11, Section 7.1, requires that personnel be made aware of and use proper and current instructions, procedures, drawings and design inputs. Design documents and changes to them are to be controlled to ensure that correct and appropriate documents are available for use. Contrary to this requirement, drawings affected by design change packages had not been consistently revised to accurately reflect the as-installed condition. The drawing deficiencies identified above will remain an unresolved item pending followup by NRC Region IV (50-313/86-01-06).

8. The licensee considered the FSAR to be a design document and a suitable source of design input; however, the FSAR was not maintained as a design document and was found to contain errors. Energy Supply Department Procedure 202, "Design Process Procedure," contained a form to be used to ensure that all appropriate design documents were revised to reflect design changes. This form identified the FSAR as a controlled design input document. The team was informed that the FSAR was considered to be a design document suitable as a source of design input for calculations. However, the team determined that the FSAR was only updated yearly and that engineering and design personnel were not in a position to readily know what design changes were pending incorporation between updates.

The team identified the following errors in the FSAR:

a. FSAR Section 7.2.3 described the integrated control system (ICS) and stated in subsection 7.2.3.2.4, "...upon loss of all reactor coolant pumps, and/or both main feedwater pumps, the ICS starts the emergency feedwater pump and positions control valves to control flow to the emergency feedwater header." This incorrect statement should have been revised when the EFIC system was installed as indicated in Amendment 3 of the FSAR.

b. FSAR Section 9.9 described the compressed air system and states, "Tables 9-27 and 9-28 list all the air-operated seismic Category 1 valves and ventilation system dampers." However, Table 9-27 did not include the atmospheric dump valves CV-2618 and CV-2668. These valves were seismic Category 1 and received air from the instrument air header or instrument air accumulators.

c. FSAR Section A.7.2 "MS To Emergency Feedwater Pump Turbine Driver," described the evaluation performed to determine the effects of a high-energy line break in the steam supply to the EFW turbine pump. The piping and valve arrangement described did not account for the modification performed for the EFW system upgrade. Specifically, the arrangement described indicated that CV-2667 and CV-2617 were normally closed isolation valves such that high energy (conditions above 275 psig and 200°F) did not exist downstream. When DCP 82-D-1050 was issued, this arrangement was changed so that CV-2667 and CV-2617 were made normally open causing high-energy line conditions to exist downstream of these valves.

d. FSAR Table 1-1 described design parameters for various components at ANO-Unit 1. In describing the EFW pumps, the design head was listed as 1100 psi and the corresponding design flow was 760 gpm. However, Technical Specification 4.8.1.a indicated that the pumps must produce 500 gpm at 1200 psi discharge head. Design conditions based on Calculation 80-D-1083B-102 indicated that the operating point for EFW pump 7A was 720 gpm at 1295 psi discharge pressure and for EFW pump 7B it was 610 gpm at 1250 psi discharge pressure.

Although the team observed that the FSAR was not normally used as a source of design input, the team was concerned that it was apparently procedurally permitted. The team found one instance where the FSAR was used as a reference for design input instead of appropriate design documents like drawings and design calculations. Calculation MB-1-22, "Emergency Feedwater Pump Switchover To Other Water Sources," Revision 0, referenced the FSAR Section 10 instead of appropriate design analyses or vendor drawings as its source to obtain the condensate storage tank depth when 107,000 gallons are remaining in the tank.

The use of the FSAR as a design document and a source of design input was considered a weakness. The errors in the FSAR identified above were discussed with the licensee. This issue will remain open pending the correction of these errors in the next routine FSAR revision (50-313/86-01-02).

B. Maintenance

1. Several weaknesses were noted with the licensee's program for conducting maintenance and testing on motor operated valves (MOVs) in the emergency feedwater (EFW) system. These weaknesses included:

- Licensee personnel were generally unaware that MOV torque switches for ANO-Unit 1 were only bypassed during initial valve movement and that improper torque switch settings could prevent the EFW system from completing its safety function. This lack of understanding was apparently due to a design difference in MOVs between Unit-1 and Unit-2. In ANO-Unit 2, MOV torque switches are bypassed for full valve travel.

- Torque switch settings were made by licensee personnel without reference to the minimum recommended values provided by the vendor. The team reviewed selected MOV torque switch settings and found them to be set low; in one case, the setting was below the value used for manufacturer testing.

- MOV limit switches appeared to be set to bypass torque switches for an insufficient amount of initial valve travel. The purpose of these limit switches was to bypass the torque switch until the valve was fully off its shut seat, thereby providing some assurance that the torque switch would not prematurely stop valve motion.

- EFW system MOVs located in the pump discharge piping were not tested under flow conditions to ensure that they would operate as expected in emergency situations.

- Five MOVs were found to be missing valve stem housing end caps and a significant amount of debris was found in the stem cavities. This increases the potential for valve binding that could result in premature torque switch actuation to stop valve motion.

- Several discrepancies were identified with the MOV maintenance procedures that could confuse personnel performing maintenance.

Details regarding these weaknesses are provided below:

a. Interviews with licensee personnel revealed that they were generally unaware that torque switches were only bypassed during initial valve movement in an automatic initiation of the EFW system. This is significant because torque switches improperly set with low values could actuate prematurely, causing the MOV to stop in mid-stroke during an automatic initiation. The ANO-Unit 2 auxiliary feedwater system valves appear to have their torque switches bypassed through full valve stem travel during an automatic initiation to ensure that MOVs complete their safety function. However, this was not the case for the ANO-Unit 1 EFW system. Discussions with training instructors, operating personnel, electricians, maintenance engineers and supervisors indicated that this difference was not widely known. This issue was of particular concern because of the other weaknesses discussed below regarding the setting, testing, and bypassing of MOV torque switches.

b. Interviews with licensee personnel revealed that torque switches initially were set by electricians and field engineers during MOV installation and later were adjusted by electricians during valve maintenance. These interviews also revealed that engineering judgement was the basis used to initially set the torque switches and then actual valve operation under no-flow conditions typically became the basis to readjust the settings. Limiter plates were installed to prevent setting torque switches too high and MOV maintenance procedures specifically cautioned against setting torque switches above the upper limit. However, MOV maintenance procedures did not address lower torque switch

limits and vendor recommendations for minimum set points were not referenced when the torque switches were set. The torque switch settings were recorded on Job Order (JO) data sheets and reviewed as part of the normal JO closeout, but lower limits for torque switches settings were not available for the reviewing parties to compare to the actual settings.

The team reviewed actual torque switch settings for eight EFW system MOVs. The significant data from this review is provided below:

Valve No.	Description	Operator	Actual Torque Switch Settings	
			Open	Close
CV-2613	P7A Stm Admission	SMB-000	1.5	1.5
CV-2617	OTSG B Stm Supply	SMB-000	3.5	3.0
CV-2620	P7A to S/G B Isol.	SMB-000	2.0	2.0
CV-2626	P7B to S/G B Isol.	SMB-00	1.5	1.5
CV-2627	P7A to S/G A Isol.	SMB-000	1.5	2.5
CV-2869	P7B Test Recirc Isol.	SMB-00	1.5	1.5
CV-2870	P7A Test Recirc Isol.	SMB-00	1.5	1.5
CV-3851	Loop II SW Supply	SMB-000	2.0	2.0

The torque switch adjustment scale ranged from a minimum of 1.0 to a maximum of 5.0. As illustrated by the data in the above table, the torque switch settings were typically set at the low end of the scale for the EFW system valves. This was a particular concern for the EFW discharge valves (CV-2620, CV-2626, CV-2627, CV-2670, CV-2869, CV-2870). During the onsite inspection, the licensee was unable to provide recommended minimum torque switch settings for these MOVs.

After completion of the onsite inspection, the licensee provided the following manufacturer test data for the selected valves:

Valve No.	Test Press	Manufacturer's Torque Switch Setting	
		Open	Close
CV-2613	1100 psig	1.5	1.5
CV-2617	1050 psid	2.0	2.0
CV-2620	1792 psig	2.0	2.0
CV-2626	1792 psig	1.25	1.25
CV-2627	1792 psig	2.0	2.0
CV-2869	1792 psig	1.5	1.5

It is not clear that all the manufacturer's test data was obtained under flow conditions because the test pressure was recorded in psig for several valves and the motor run current measurements were inconsistent with licensee test data obtained when the valves were installed. However, it does appear from these data that the CV-2627 torque switch open setting was set

below the manufacturers testing set points. Additionally, no manufacturer test results were available for CV-2870 and CV-2851 because the operators and valves were connected by the licensee without vendor recommendations for minimum and maximum torque switch set points. The apparent failure of the licensee to translate the vendor-supplied MOV design basis data into applicable controlling documents appeared to be contrary to 10 CFR 50, Appendix B, Criterion III. This issue will remain an unresolved item pending followup by NRC Region IV (50-313/86-01-07).

IE Information Notice 84-10, "Motor-Operated Valve Torque Switches Set Below The Manufacturer's Recommended Value," raised issues that were similar to the findings outlined above. The inspection team reviewed the licensee's internal memorandum regarding this notice. It stated that this issue was not a problem at ANO because torque limiter plates were used; additionally, any changes to torque switch settings were reviewed in the JO closeout process. This reasoning appears inadequate because the limiter plates did not prevent setting torque switches too low and the licensee did not maintain a list of recommended minimum torque switch set point values for comparison at JO closeout.

c. Interviews with licensee personnel and a review of the MOV maintenance procedures revealed that limit switches were set to bypass torque switches for only a minimal amount of initial valve travel. Licensee procedures for operator models SMB-00 and SMB-000 directed that the limit switches should be set 1-2 turns off the fully open or closed position. This minimal amount does not appear to be adequate to compensate for the effects of coast or backlash in the operator. This could result in excessive valve backseating or the limit switch actuating before the initial starting torque is fully removed from the operator, which could cause the torque switch to prematurely stop the valve motion. The licensee stated that this issue was currently under review as part of their response to IE Bulletin 85-03, "Motor Operated Valve Common Mode Failures During Plant Transients Due To Improper Switch Settings," but no short-term actions had been initiated to correct this potential deficiency.

d. Interviews with licensee personnel, reviews of maintenance and periodic testing procedures, and inspection of post-modification test packages revealed that not all EFW system MOVs have been tested to ensure they will operate properly under flow conditions. During the 1984 outage, new steam admission and pump discharge MOVs were installed as part of DCP 80-1083. It appeared that no tests were conducted to verify proper MOV operation during flow conditions nor were any engineering evaluations conducted to verify that torque and limit switch settings were adequate. An exception to this was the EFW turbine steam admission valves (CV-2613, CV-2663) which were tested routinely under system flow conditions during both manual and automatic EFW system initiation.

However, the EFW pump discharge valves (CV-2620, CV-2626, CV-2627, CV-2670, CV-2869, CV-2870) had apparently never been fully tested under system flow conditions either by post-modification tests, post-maintenance tests, periodic surveillance checks, or by actual system initiation. The EFW steam generator isolation valves (CV-2620, CV-2626, CV-2627, CV-2670) and the full-flow test isolation valves (CV-2869, CV-2870) are not normally repositioned for EFW system initiation. These valves are expected to operate against full-flow conditions only when an EFW initiation occurs during system flow testing or if a steam generator isolation signal is received during EFW system operation.

10 CFR 50, Appendix B, Criterion XI, requires that components be tested to demonstrate that they will perform satisfactorily in service. This testing shall include proof tests prior to installation, pre-operational tests, and operational tests, as appropriate. The apparent failure to adequately test the EFW system discharge piping MOVs under flow conditions either by pre-installation, post-modification, periodic surveillance, or post-maintenance tests was considered to be contrary to 10 CFR 50, Appendix B, Criterion XI. This issue will remain an unresolved item pending followup by NRC Region IV (50-313/86-01-08).

e. During the walkdown of the EFW system, the team identified five MOVs that were missing stem housing end caps. Three valves (CV-2617, CV-2667, CV-2870) appeared to be missing the screw cap, and two valves (CV-2800, CV-2802) had their end caps sheared off. A significant amount of dirt and foreign material was observed in the stem cavities of these valves. Debris in the stem cavity could work down into the operator and foul gears or affect bearings, preventing proper valve operation.

f. The team reviewed three MOV maintenance procedures: Procedure 1402.160, "Limitorque Motor Operated Valve SMB-000 Maintenance," Revision 3; Procedure 1402.161, "Limitorque Motor Operated Valve SMB-00 Maintenance," Revision 1; and Procedure 1402.71, "EIM Motor Operated Valve Maintenance," Revision 2. The following inaccuracies were noted with these procedures:

(1) All three procedures referenced drawing E-195 for a description of the MOV limit switch (LS) operation. This drawing did not show the Limitorque LS contact scheme and the EIM LS scheme incorrectly showed contact "LSO/G" as being closed continuously throughout valve travel.

(2) The procedures failed to identify CV-2663, CV-2620, and CV-2870 as dc-powered MOVs. Further, the procedures failed to include CV-2663, CV-3850, CV-3851, CV-2627, CV-2626, CV-2869 and CV-2870 as Q-listed valves. (See Design Changes, observation 7.c for further discussion of the licensee's Q-list.)

(3) Procedures 1402.160 and 1402.161 had an incorrect drawing showing a reversed position of the open and closed adjustments for torque switches.

(4) Procedure 1402.161 incorrectly listed CV-385. and CV-2620 as model SMB-00 operators when they were actually model SMB-000.

(5) All three procedures incorrectly stated that closed limit switches should be set to operate off the shut seat to allow for coastdown. This was incorrect because in the closing direction the motor is stopped by the torque switch and the limit switch should be set to provide adequate bypass of the torque switch when unseating the valve or to indicate valve position.

(6) Procedure 1402.71 incorrectly stated that CV-3850 can be modulated when the valve was actually designed with a seal-in feature to prevent throttling.

(7) Procedure 1402.71 had no requirement for independent verification of removal of a test jumper. The test jumper, when installed, bypassed the seal-in feature of the MOV and would interfere with normal valve operations.

At the exit meeting the licensee stated that these procedures were in the process of being corrected. This item will remain open pending inspector review of the licensee's corrective action (50-313/86-01-03).

Collectively, the weaknesses described in observations 1.a through 1.f were evidence of an inadequate program for maintenance and testing of MOVs. Based on the information available to the team during the inspection, the licensee could not verify by testing or engineering evaluation that the current limit and torque switch set points for MOVs in the EFW system were adequate to permit proper valve operation under flow conditions.

2. The team reviewed mechanical and electrical maintenance training and on-the-job training (OJT) for technicians who worked on EFW/EFIC components. The emphasis of this review was on MOV training. Mechanical maintenance training consisted of generic pump and valve training with no special emphasis on EFW components. Electrical maintenance training was conducted in a laboratory where hands-on motor control center and MOV work could be accomplished. The electrical maintenance laboratory had eight MOV actuators installed (Limitorque, Rotork, and Electrodyne), six of which were wired and operable. Technicians were able to gain hands-on practice in setting limit and torque switches and in making other actuator adjustments and settings. Maintenance training was considered good overall; the presence of operable actuators in the electrical maintenance laboratory was considered a strength.

The licensee was in the process of initiating a new OJT program for maintenance technicians. At the time of the inspection first-line supervisors in the electrical maintenance shop were using the records from the old OJT program to record and determine technician qualifications for assignment to a maintenance task. Both the old and the new OJT program appeared adequate for this purpose.

3. The team noted weaknesses with the maintenance and testing of EFW system pump P7A conducted at the conclusion of the 1984 outage. During a 1-month period the pump was disassembled and reassembled three times as follows:

December 23, 1984 - Pump P7A was reassembled after outage maintenance and testing (JO 76916).

January 7-8, 1985 - Pump P7A thrust bearing was replaced after overheating during surveillance testing (JO 81212).

January 11, 1985 - Pump P7A balance drum shims were replaced at the direction of the mechanical maintenance superintendent (JO 75648).

The following deficiencies were noted with the maintenance and testing of EFW pump P7A during this sequence:

a. A new thrust bearing and balance drum shims were installed as part of JO 76916; however, the steps of Section 7.2 of Procedure 1402.09, "Emergency Feedwater Pump Maintenance," Revision 1, which described this process, were marked N/A by the maintenance technician. It appeared that the prescribed maintenance procedure was not followed for this involved maintenance activity.

b. The post-maintenance testing conducted on pump P7A during this period appeared incomplete. Procedure 1402.09 provided detailed guidance for taking post-maintenance vibration readings in the horizontal, vertical, and axial directions and required that they be compared to a set of pre-maintenance vibration results. Despite this detailed guidance, the following post-maintenance testing deficiencies were identified:

(1) The testing documented for the December 1984 maintenance (JO 76916) was not conducted until January 17, 1985. These data were not representative of the pump configuration after JO 76916 since the thrust bearings and balance drum shims were replaced again before testing was conducted.

(2) The testing documented on JO 81212 was missing some axial measurements and there were no pre-maintenance data for comparison. A note at the end of the test data sheet stated that operations personnel had conducted the test as a surveillance test and axial readings were omitted because they were not required for the surveillance test.

(3) There were no post-maintenance test data recorded on JO 75648 for maintenance conducted on January 11, 1985.

Interviews with licensee maintenance personnel revealed that there may be inadequate coordination of post-maintenance and surveillance tests. The surveillance tests were conducted in all cases to determine operability; but post-maintenance tests apparently were not always performed in accordance with procedural guidance. The team was concerned that post-maintenance testing

requirements may not always be satisfied by surveillance tests and that both test programs should be accomplished to ensure equipment reliability. The apparent failure by the licensee to follow procedures for the maintenance and testing of EFW pump P7A will remain an unresolved item pending followup by NRC Region IV (50-313/86-01-09).

4. The inspection team conducted a detailed walkdown of the EFW system to verify that the system layout was as depicted in the system drawings (P&IDs), that the system was aligned as required by licensee procedures, and to evaluate the material condition and cleanliness of the system. The following references were used:

   - System Drawings (P&IDs):

     M-202, "Main Steam," Revision 33
     M-206, "Steam Generator Secondary System," Revision 45
     M-204, "Emergency Feedwater," Revision 2

   - Procedures:

     1106.06, "Emergency Feedwater Pump Operation," Revision 25
     1102.01, "Plant Preheatup and Precritical," Revision 32

   The team found that the system layout was as depicted in the system drawings and that the system was aligned as required by the procedures. The team considered plant cleanliness and material condition to be generally acceptable. However, several weaknesses were noted during the walkdown:

   a. Inconsistencies were found between the system drawings and Procedure 1106.06 concerning the position of four valves:

Valve No.	Position Per Procedure 1106.06	Position Per P&IDs M-202, M-206
CV-2613	Shut	Open
CV-2663	Shut	Open
CV-2617	Open	Shut
CV-2667	Open	Shut

      The valves were found in their correct positions as specified in Procedure 1106.06. Additionally, the system drawing (M-202) identified one steam trap as "ST-75" instead of "ST-60" as identified by the component label plate and the valve lineup procedure.

   b. The team noted the following as related to material condition and cleanliness:

      (1) A significant amount of dirt and foreign material was noted in the steam cavity of several MOVs as discussed in maintenance observation 1.e.

(2) Valves CS-2803 and CS-2804B had missing operator handwheels.

(3) Numerous vent and drain valves had no pipe caps.

(4) Valves MS-6886, MS-6872, and MS-1053 had no label plate identification.

(5) Valve HV-166 was mislabeled as HV-160.

(6) Valve MS-1053 had a body-to-bonnet steam leak. This condition was not previously documented by the licensee.

(7) The cleanliness of the penthouse room containing the EFW system main steam piping was poor in comparison to the generally good appearance of other spaces containing EFW system components.

c. Several of the concrete expansion anchor bolts associated with these seismic pipe supports in the EFW system were noted to be nonperpendicular to the surface into which they were installed. Additionally, the washer on an installed concrete expansion anchor on pipe support 3-EFW-116-H20 was noted to be so loose that it would rotate easily by hand. A later review of this pipe support installation by the licensee revealed that seven of the concrete expansion anchors had less than the required imbedment depth. The details of these issues regarding concrete expansion anchors will be followed up by NRC Region IV and documented in NRC inspection report 50-313/86-02.

C. Surveillance Testing

1. The licensee was unable to provide the team with calibration data documenting the initial post-installation calibrations and functional checkout of condensate storage tank (CST) level indication transmitter LIT-4203. A determination of the set point and set point accuracies for the CST low level annunciation function of CST level indicator switch LIS 4203 also was not available. Additionally, surveillance procedures were not developed to periodically calibrate condensate storage tank (CST) level instrumentation. This instrumentation is used by the licensee to verify that greater than 16.3 feet of water is available in the CST as required by Technical Specification (TS) 3.4.1.3. It also provides indication that alerts the control room operators to manually switch-over the EFW water supply from the CST to the service water system, if necessary. The CST level instruments were installed by DCP 80-1083 and DCP 84-1045 as part of recent EFW upgrade modifications and were considered by the licensee to be functional following the 1984 refueling outage.

Subsequent to these findings, the licensee conducted calibrations on all CST level instruments and initiated Plant Engineering Assistance Request 86-301 to determine set point and set point accuracies for LIS-4203. The apparent failure to calibrate the CST level indicator after installation is contrary to 10 CFR 50, Appendix B, Criterion XI, which requires that testing be performed to demonstrate that components will perform satis-

factorily in service. This issue was discussed with the licensee and will remain an unresolved item pending followup by NRC Region IV (50-313/86-01/10).

2. Several components were identified by the inspection team for which 18-month test requirements were not incorporated into surveillance test procedures. However, in all examples (except for the CST level instrumentation discussed in observation 1, above) post-installation functional testing performed at the completion of the 1984 refueling outage and before restart constituted sufficient initial surveillance testing. The licensee had no apparent administrative controls to ensure the incorporation of these surveillance requirements. The team considered that the licensee's failure to maintain administrative tracking of omitted 18-month surveillance requirements constituted a programmatic weakness that could result in the incomplete surveillance testing of EFW components during the next refueling outage. Specific weaknesses with EFW component surveillance procedures were found in the following areas:

   a. Surveillance procedures were not developed to functionally verify that the steam admission valves (CV-2667 and CV-2617) to the turbine-driven EFW pump actuate to the required position on an emergency feedwater initiation and control (EFIC) vector logic valve command. These vector logic valve commands function to isolate a faulted steam generator and to align EFW to the good steam generator. Adequate testing of this function was conducted by Special Work Plan (SWP) 1409.44 during post-modification testing of the EFW system upgrades; however, the licensee had not written a surveillance procedure to periodically perform this functional demonstration as part of the surveillance test program.

   b. Surveillance procedures were not developed to functionally demonstrate the adequacy of steam generator isolation valve responses to an EFIC main steam line isolation signal. An EFIC generated main steam line isolation signal results in closure of the main steam line isolation valves and the main feedwater isolation valves. Testing of these responses at least once every 18 months is required to demonstrate component operability pursuant to TS 3.4.1.5. A review of approved periodic surveillance procedures revealed that the response of these valves to an EFIC isolation signal was not tested. Post-installation functional testing of the EFIC system performed in accordance with SWP 1409.44 before unit restart following the 1984 refueling outage provided a sufficient initial demonstration of these functions. Retesting of these functions was not required until the next refueling outage.

   The weaknesses in the surveillance testing program discussed in this observation will remain open pending followup by NRC Region IV (50-313/86-01-04).

3. Additional instrumentation testing and calibration weaknesses were noted in regard to EFW system components. The following items pertain:

   a. Instrumentation and Control Periodic Test, 1304.05 "Emergency Feedwater Pressure and Flow Instrumentation," Revision 3, did not

verify that control room annunciators PAL-2811 and PAL-2812 (EFW discharge pressure low) annunciate when EFW discharge pressure indication switches PIS-2811 and PIS-2812, respectively, are actuated at the low pressure set point. The test procedure instructed the technician to remove the pressure indication switch from service before calibrating the indicator; as a result, the annunciator was not verified to respond when the switch low-pressure contacts change state during the calibration.

b. The licensee had not developed a procedure to routinely functionally test HS-2646, the Appendix 'R' disconnect switch. HS-2646 is located in the lower south electrical penetration room and provides a method for operators to remove dc power from CV-2646 and CV-2648. This ensures that a method is available to remove power from CV-2646 and CV-2648, when required for an alternate shutdown, thereby failing these valves to the open position to ensure an EFW flowpath to the steam generators.

c. The monthly and the 18-month calibration surveillances of EFIC use an internal, hardwired self-test to demonstrate proper operation of the following control module functions:

- Steam generator pressure of 1020 psig
- 31-inch low range level with reactor coolant pumps (RCPs) running (forced flow)
- 312-inch full range level with no RCPs running (natural circulation)
- 378-inch full range level for reflux boiling
- variable steam generator fill rate based on steam generator pressure

The team considered that this self-test constituted an appropriate monthly functional verification of control module operability. However, there was no provision for periodic validation of self-test adequacy. Although the self-test was hardwired into the individual control module, the circuit was composed of components that may be subject to instrument drift or incorrect setting. Because this internal test circuitry represents measuring and test equipment, the licensee must provide a means to periodically validate the test results.

Additionally, the team did not consider the self-test to be an adequate 18-month channel calibration of the EFIC control module. In response to this concern, the licensee committed to develop a more conventional 18-month calibration procedure that will input test signals to the EFIC control module and verify appropriate control module responses. Furthermore, after this calibration method has been completed, the self-test will be performed to validate its acceptability for continued use as a monthly functional verification of control module operability.

The weaknesses discussed in observations 3.a, 3.b, and 3.c will remain an open item pending followup by NRC Region IV (50-313/86-01-05).

4. Weaknesses were identified in the in-service testing program for mechanical equipment associated with the EFW system. Specifically, certain check valves listed in Attachment 2 to Procedure 1022.06, "ASME Code Section XI Inservice Testing Program," Revision 4, as requiring in-service testing were not identified in the supplements to Procedure 1106.06, "Emergency Feedwater Pump Operation," Revision 24. Therefore, these check valves were not documented as having been routinely tested. The following deficiencies were noted:

   a. Valves CS-98, CS-99, CS-261, and CS-262 are check valves in the EFW pump suction line from the condensate storage tank (CST). These valves exist two each in parallel lines coming from the CST. Adequate flow has been demonstrated through these valves in routine pump flow tests. However, since these two lines are in parallel, the operability and full stroke response of each individual valve has apparently not been demonstrated.

   b. Valves FW-55A, FW-55B, FW-56A, and FW-56B are check valves in the EFW pump discharge headers. Adequate flow has been demonstrated through these valves during routine pump flow tests. However, routine testing of these valves was not documented.

   c. Valves FW-10A, FW-10B, FW-61, and FW-62 are in the EFW pump minimum recirculation flow paths. FW-10A and FW-10B are three-way recirculation control check valves that function to provide a recirculation flow path when steam generator pressure exceeds pump discharge pressure. Valves FW-61 and FW-62 are check valves installed downstream of FW-10A and FW-10B. Flow and stroke for these valve combinations is not routinely demonstrated.

   The licensee agreed that Procedure 1106.06 will be revised to identify specific testing and documentation for these valves. The failure to provide adequate testing for these valves will remain unresolved pending followup by NRC Region IV (50-313/86-01-11).

D. OPERATIONS

1. The procedures and drawings related to the normal and abnormal operation of the EFW system were reviewed. The following weaknesses were noted:

   a. Procedure 1106.06, "Emergency Feedwater Pump Operation," Revision 24, contained inaccurate guidance regarding the operation of motor-operated valves for steam admission to the P7A pump turbine. Specifically, step 9.3.2 stated that operation of those valves was ". . . the same as the EFW isolation valves." When operating in the manual mode, momentary actuation of the switch in the control room will cause the EFW isolation valves to travel momentarily, but momentary actuation of steam admission valve control switch will cause that valve to operate to full travel as a result of a seal-in feature designed into the motor control circuitry.

   b. During a review and walkdown of Procedure 1203.02, "Alternate Shutdown," Revision 12, nothing was identified that would clearly prevent achieving reactor shutdown, but it was noted that substantial

difficulty would probably be encountered by the operator attempting to control the atmospheric dumps valves (ADVs) for decay heat removal. In some cases communications facilities were located significant distances away from the alternate shutdown components, such as the EFW flow control valves and the ADV station. Additionally, the battery-powered lighting system at the ADV station failed to operate when the test button was pushed. The licensee had corrective action in progress, initiated before and during the inspection, to correct these communications and lighting deficiencies.

2. Procedure 1000.27, "Hold and Caution Card Control," Revision 5, and associated equipment control logs were reviewed. One deficiency was identified: there was no record of an independent verification of equipment status for the initial hanging of tag 11 (breaker 5116) for tagout 86-1-043 (emergency diesel generator). This was found to be an isolated instance and the licensee took prompt corrective action to verify the status of the equipment.

3. During daily tours of the control room, operations crew personnel were observed to be maintaining plant parameters within specified limits according to approved procedures. The overall level of professionalism displayed by the operators was satisfactory, with the exception of relaxed control of nonessential personnel in the control room. On several occasions, non-operations personnel were observed to either remain in the control room after completing official work-related business or were allowed to enter the control room with no apparent work-related reason for being there. This condition was observed with the plant both operating and shutdown. Although no cases were observed of on-watch operators being distracted from their duties, the potential for such distraction was clearly present.

4. Operator training for the EFW system and the EFIC subsystem was combined into one module which comprised the lesson plan (AA-21002-040, Rev. 2), a handout, viewgraphs, a slide presentation and a short video tape explaining operation of the turbine-driven EFW pump. This material was reviewed for adequacy and technical accuracy. Minor weaknesses were noted:

   a. Page 22 of the handout showed a tabular summary of the EFIC vector valve commands which was incorrect. However, an identical table on page 82 was correct.

   b. Figure 66.1 of the handout contained several errors. Valves CV-2646 and CV-2645 were not labeled, CV-2648 was mislabeled as CV-2621, and CV-2647 was mislabeled as CV-2672.

5. The team examined the effectiveness of operator training for alternate shutdown. This training had most recently been conducted as part of operator requalification and initial qualification training in October 1985. The training consisted of 2 hours of classroom instruction, a walk-through of operator actions at each station, and a simulated shutdown with shift operators working at the appropriate stations. Overall, the training for this activity appeared satisfactory. Interviews with operators revealed operational difficulties at some stations (see paragraph 1.b of this section).

6. The team examined shift technical advisor (STA) training. The present STA training program appeared to meet only the minimum requirements. One member of the plant engineering staff was assigned to be STA for both units on a rotating basis. This individual would usually conduct his normal job assignments and respond to control room activities on an on-call basis.

   ANO plans to implement a new STA policy and procedure in mid-1986. The new program will consist of trained, dedicated STAs on shift rotation assigned specifically to Unit 1 or Unit 2. The licensee intends for the STA to have a senior reactor operator license on either Unit 1 or 2. At the time of this inspection, there were 12 engineers in training for these STA positions. A review of the new STA program and training material revealed that it met the NRC requirements for such training. This new STA program is expected to be a significant improvement over the existing program.

E. Quality Assurance

The QA audit program was considered weak in determining the effectiveness of the ANO-Unit 1 QA program. Similar weaknesses to those found in this inspection report were not identified during a review of the more recent licensee audits conducted in the areas of training, operations, surveillance test, design control, corrective action, quality control, and engineering services. Also included in this review were two overview audits of the ANO-1 plant staff and the ANO-1 QA program conducted by Middle South Services.

The following observations were made relative to the QA audit program:

1. Current guidance in the QA audit/activity plan limits the scope of all audits to a review of audit areas for regulatory compliance and program implementation. This guidance appeared to be interpreted by QA through the conduct of the audits to mean program and procedural compliance without emphasis on assessing the quality of the end product.

2. The last two design control audits and an audit of the licensee's corporate engineering staff in Little Rock provided no technical assessments to evaluate the effectiveness of the licensee's design control program. No significant findings were identified by these audits.

3. The training audits consisted of programmatic reviews with specific observations, such as the following, highlighted in the audit reports:

   a. Lesson plans were found to be consistent in format.

   b. Lesson plans are being maintained in locked storage.

   c. The HP Supervisor reviews general employee radiation protection training quarterly.

   No assessments, such as determining the adequacy of the training plans, the effectiveness of any training accomplished, or the capability of the instructors presenting the training, were made.

4. The quality control document management system audit did not provide technical assessments of the QC group's performance.

5. The corrective action audits appeared to have been a superficial review of the adequacy of the actions taken by the plant in response to identified deficiencies. It was not apparent that any assessment of the root causes for the significant deficiencies adverse to quality were performed. The auditors appeared to have focused on the timeliness of the corrective action taken and the ability of the plant to close a backlog of nonconformance reports.

6. Recent staff increases through contractor hirings and permanent staff additions have provided the QA group with important technical and operational expertise that could serve as a foundation for future performance-oriented assessments.

7. The QA staff lacked technical design expertise.

8. The QA manager and QA supervisor exhibited an understanding of the need for performance-oriented assessments and stated that consideration is being given to conducting more performance-oriented assessments.

In summary, the ANO-Unit 1 QA audit program had not provided technical and operational reviews of site quality activities; thus it had not provided plant and corporate management with important feedback on the quality of the activities performed that affect the safe operation of the plant.

IV. MANAGEMENT EXIT MEETING

An exit meeting was conducted on January 31, 1986, at Arkansas Nuclear One. The licensee's representatives are identified in the Appendix. In addition, Mr. James G. Partlow, Director, Division of Inspection Programs, IE, and Mr. James E. Gagliardo, Branch Chief, NRC Region IV, attended the exit meeting. The scope of the inspection was discussed, and the licensee was informed that the inspection would continue with further in-office data review and analysis by team members. The licensee was informed that some of the observations could become potential enforcement findings. The team members presented their observations for each area inspected and responded to questions from licensee's representatives.

APPENDIX

Persons Contacted

The following is a list of persons contacted during this inspection. There were other technical and administrative personnel who also were contacted.

*J. D. Vandergift, Training Manager
*R. Tucker, Electrical Maintenance
*H. Carpenter, Instrumentation and Control Maintenance
*D. Jones, Instrumentation and Control Maintenance
*W. H. Jones, Modification Manager
*J. T. Enos, Manager Nuclear Engineering and Licensing
*D. G. Horton, QA Manager
*G. D. Provencher, QC Supervisor
*A. J. Wrape, Electrical Engineering Supervisor
*D. Howard, Special Projects Manager
*J. Levine, Site Director
*T. Cogburn, General Manager Nuclear Services
*D. B. Lomax, Plant Licensing Supervisor
*C. N. Shively, Plant Engineering Superintendent
*P. Campbell, Plant Licensing Engineer
*B. A. Baker, Operations Manager
*M. Drost, QC Engineering Supervisor
*J. McWilliams, Operations Superintendent
*V. Pettus, Mechanical Maintenance Superintendent
*E. L. Sanders, Maintenance Manager
*R. P. Wewers, Work Control Center Manager
*D. R. Sikes, Engineering Services General Manager
*J. G. Dobbs, Engineering Services Electrical Engineer
*W. Cottingham, I&C Engineer
*V. Bardwaj, Electrical Engineer
*R. W. Howerton, Civil Engineering Manager
*W. Greeson, Civil Engineering Supervisor
*D. Williams, Mechanical Engineering Supervisor
*R. Lane, Mechanical Engineering Manager
*W. M. Cawthon, Electrical Engineering
C. Cole, Surveillance Testing Coordinator
W. Garrison, Operations Technical Staff
S. Burris, Staff Administrative Assistant
S. Capehart, Shift Operator
J. Clement, Shift Operations Supervisor
S. Fullen, Shift Operator
M. Goad, Training Department Instructor
C. Zimmerman, Operations Technical Support

*Attended exit meeting on January 31, 1986.

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