U. S. NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
REGION IV

Report No. 50-368/78-25

Docket No. 50-368

Construction Permit No. CPPR-89/
License No. NPF-6

Licensee: Arkansas Power and Light Company
P. O. Box 551
Little Rock, Arkansas 72203

Facility Name: Arkansas Nuclear One (ANO), Unit 2

Inspection At: ANO Site, Russellville, Arkansas

Inspection Conducted: September 19-21, 25-28, October 2-6, 1978

Inspectors: T. F. Westerman, Reactor Inspector — 8-20-78 Date

J. E. Gagliardo, Reactor Inspector — 10/24/78 Date

R. G. Spangler, Reactor Inspector — Oct 30, 1978 Date

Approved By: G. L. Madsen, Chief, Reactor Operations and Nuclear Support Branch — 10/24/78 Date

Inspection Summary
Inspection on September 19-21, 25-28 and October 2-6, 1978 (Report No. 50-368/78-25)
Areas Inspected: Unannounced inspection related to the events resulting from a trip of Unit 1 at the ANO site on September 16, 1978 and the subsequent Engineered Safety Systems Actuation on ANO Unit 2. The inspection involved 42 inspector-hours on-site by two (2) regional inspectors and 56 inspector-hours on-site by the resident inspector at ANO.
Results: One item of noncompliance related to the failure to establish test and surveillance procedures was identified (paragraph 6.e).

Sequence of Events for September 16, 1978

Preceding Event	1A Main Steam Stop Solenoid failed and the valve failed closed.
13:19:04	Unit 1 RPS Channel A&C High Reactor Power and Turbine Trip.
13:19:04	Unit 1 auxiliary load transfer to the Startup Transformer #1.
13:19:13	The 500/161-22 Kv Auto-transformer "C" phase overcurrent relay tripped and the auto-transformer lockout relay actuated. This lockout relay tripped OCB B1025 and 1026 which supply startup transformer #1 and #3, respectively. It was later determined that this auto-transformer had not been set up for two unit operation.
13:19:13	The Unit 1 and Unit 2 auxiliary loads transferred to startup transformer #2. AP&L Company Transmission Dispatcher Center received an overload alarm for startup transformer #2. This is a 45 MVA transformer and is not designed to carry full auxiliary loads for both Units. Operator personnel stated that the 4160 voltage dipped as low as 3300 volts.
13:19:21	Undervoltage relay 27-1/2B5 tripped the 4.16 Kv ESF ACB 2A309. This is the Unit 2 under voltage sensor for bus 2A3 which is set at a nominal 92% of normal voltage.
13:19:21	Undervoltage relay 27-1/2B6 tripped 4.16 Kv ESF ACB 2A409. This is Unit 2 undervoltage sensor for bus 2A4 which is also set at a nominal 92% of normal.
13:19:21	A channel 3 CPC High Local Power Density trip occurred. This trip indicated that the output from inverter 2Y13 failed (no output voltage).
13:19:21	A channel 2 CPC High Local Power Density trip occurred. This trip indicates that the output from inverter 2Y22 failed (no output voltage). Concurrent with this second inverter failure, full actuation of all engineered safety features occurred (SIS, MSIS, RAS, CSAS, and CIAS) in Unit 2.

13:33:03 Trip of all four reactor coolant pumps Unit 1. This was concurrent with the start of Unit 2 Circulating Water Pump. All but one of the Unit 2 reactor coolant pumps were then stopped by the Unit 2 operators.

For reasons which are unexplainable at this time, only the initial Unit 2 computer sequence of events was available. This covered only the initial 22 seconds of the event. If the CPC, PPS and ESF panel were reset at about 3-4 minutes into the event as was stated, there should have been a reinitiation of the sequence of events printout. Also for reasons unknown, there was no alarm printout for Unit No. 2. The licensee is evaluating the computer programming to determine if changes need to be made to assure that the call up of pertinent data will occur in the event of similar events.

3. Initial Analysis of the Event

The loss of power on the 4160 volt ESF buses 2A3 and 2A4 (due to actuation of undervoltage relaying) in conjunction with at least inverters 2Y22 and 2Y13 being on the alternate emergency source resulted in the momentary loss of power to channels B and C of the Plant Protection System (PPS) causing a complete ESF actuation (SIAS, MSIS, CSAS, CIAS, RAS).

This complete PPS actuation caused all associated safeguards equipment to actuate which it did satisfactorily. The PPS functions were reset by a technician and the ECCS pumps were stopped by operator action in the control room. Operators also repositioned the ECCS valves using the "override" feature of valve control.

The PPS actuation resulted in a total of 50,000-60,000 gallons of boric acid solution being transferred from the RWT to the containment building. The licensee estimates that no more than 8,000 gallons of the RWT was pumped into containment by the spray pumps. This estimate is supported by a recorder trace of the stator temperature of one of the spray pumps and the recollections of the operators. This estimate is also substantiated by (1) the apparent degree of wetting of the containment building which was small, (2) the fact that the RWT water was taken from an initial pH of 4.8 to a final pH of 6.5 which indicates minimal (approximately one minute) operation of the sodium hydroxide pumps, and (3) trash from the containment sump had been retained on the inside of the sump screens.

The inspector was unable to contact the Chairman of the Safety Review Committee (SRC) to determine the extent of the committee's involvement. This item will remain open and will be reviewed during subsequent inspections.

The inspector noted and expressed concern that the QC department and the QA department were only marginally involved in following the licensee's cleanup program. Licensee representatives agreed to more closely follow the cleanup and checkout efforts, but no specific commitments were made.

Licensee representatives said that the incident would be reported as a 30-day LER. They agreed to provide in the LER specific information on the cause of the incident, the corrective actions taken to clean up the containment building and check out all safety-related equipment, and the extent of management and committee reviews.

Specific cleanup plans and completion status is as follows:

(a) Surveillance testing was conducted on HPSI, LPSI, NaOH, and containment spray pumps to prove operability. All containment isolation valves inside containment were stroke-tested per operating surveillance procedures covering those valves.

(b) Operational testing of the ECCS pumps per ASME Code Section XI was completed and no discernable degradation was noted on any pump.

(c) The semiannual functional test of both H_2 recombiners was satisfactorily completed with no unusual responses noted.

(d) Applicable sections of the Cold Shutdown Valve Stroke Test and Containment Isolation Valve Stroke Test were run with no discrepancies noted.

(e) Results of sampling done to check for possibility of plugging or partial plugging of the containment spray nozzles from debris picked up from the containment sump indicated low solids content of the water in both trains. No large particles of debris were noted in any of the several samples taken. Hence, the possibility of debris plugging is remote. Based on boron deposition in containment on surfaces wetted by the spray, it is also difficult to concieve of sufficient boron crystallization within the spray nozzles to plug or partially plug them. The maximun crystallization amounted to only a few mils on areas in containment where pools evaporated, concentrating the acid.

(f) Oil residue in the sump area, apparently from the cables of the polar crane and other oily areas, was cleaned up immediately. All floor drains were flushed to the sump and the sump pumped down, and hand cleaned of sludge.

(t) Operation activities included the draindown of the LPSI, HPSI and containment spray systems to restore water quality, operational and visual checks of containment fire protection equipment, and repetition of stroke tests on containment motor operated valves.

(u) The CEA extension shaft coupling tool and RX vessel tensioning tools showed minor rust from the atmospheric conditions. Both were closed.

(v) Other minor items found and corrected on a case-by-case basis included several PAX phones out-of-service, miscellaneous lights out, minor gaitronics problems, and various water spotting and streaking.

(w) Containment Spray Header hangers and snubbers were visually inspected with no evidence of over use or damage.

(x) An inspection was made of specific locations of installed insulation 1) areas around the pressurizer relief valve where insulation was removed for valve repair, 2) inspection under the insulation at the top transition nozzle on each steam generator, 3) inspection under the insulation on each main steam line, and 4) the removal, disassembly, and inspection of a mechanical s[illegible] No problems were found. The remainder of the tempor[illegible]ulation was inspected without any signs of degradation as a result of the spray.

No further activities for the Unit 2 containment cleanup are planned.

5. Failure of the Bus Tie Auto-Transformer

The loss of the bus tie auto-transformer offsite power supply was caused by a time delay overcurrent trip on "C" phase which tripped the lockout relay associated with the auto-transformer. This particular trip is designed to protect the auto-transformer from an overload condition, and was apparently set to trip for loads in excess of 58 MW. The auto-transformer itself is rated at 600 MVA and is easily capable of supplying both Unit 1 and Unit 2 auxiliary loads. Operational and maintenance responsibilities for the auto-transformer belong to engineering organizations within AP&L other than the ANO staff. However, no engineering organization within AP&L recognized the necessity of re-evaluating the auto-transformer protective relaying set points. This appears to be an engineering error. The 22 KV tertiary bus overcurrent relays were reset to allow for operation of both Unit 1 and Unit 2 operation on September 26, 1978. The licensee's representatives indicated that this is the only switchyard protective relaying that needs to be reset for two unit operation.

c. Status of the Inverters Subsequent to the Event

The plant operator who was sent to check out the inverters approximately 10 minutes after the event stated that he had found them in the following condition:

2Y22

Both the DC and AC breaker tripped. The inverter was transferred to alternate.

2Y24

Fuse FU2 was blown. The inverter was transferred to alternate.

2Y11

The inverter was transferred to alternate.

2Y13

The inverter was transferred to alternate.

This same condition was again verified by the plant operator and plant electricians at about 30 minutes after the event. At this time 2Y22, 2Y11 and 2Y13 were transferred back to normal supply.

d. Inverter Post Event Testing

Following the incident a service representative (whose final report remains outstanding at this time) and ANO technicians performed a series of tests on the inverters. As a result of this testing, the DC voltage sensing board on 2Y22 was found set incorrectly at 134 volts DC (normally factory set at 104 volts), and the time delay on 2Y22 was found to be set at 0 seconds (normally factory set at 10 seconds). This sensing board will cause the AC and DC breakers on the inverter to open after a given time delay. This would appear to explain why 2Y22 transferred to alternate source following the tripping of the AC/DC breakers. The time delay on 2Y24 was set at 0 seconds; however, the DC voltage sensing board was set properly at 104 volts. 2Y24 will transfer to alternate source due to fuse FU-2 which was found blown; however, there is not direct explanation for the blown fuse. This fuse is on the input into the oscillator/power switching portion of the inverter. The voltage surges that occurred on 2A4 may have blown the fuse. The time delays for 2Y11 and 2Y13 were found to be set at two seconds; however, the DC voltage sensing boards were properly set at 104 volts. No other setting or component operations were reported faulty.

(4) 125 V DC high and low alarm set point verification - verified that the high alarm set point was 141 V DC and the low alarm set point was 120 V DC.

(5) Static switch overcurrent transfer set point verification - verified that the static switch transferred to alternate emergency source when the inverter was loaded to 150 amps AC.

(6) Static switch undervoltage transfer set point verification - verified that the static switch transferred to alternate source at 84 V AC.

(7) The output voltage and frequency at no load and full load was verified for each source - normal rectified AC, battery DC and the alternate emergency AC source. These tests also verified that the inverter transferred to alternate source at 104 V DC input.

The inspector noted that the preoperational procedure did not address or verify any time delay operations of the inverter input breaker trip circuitry. The vendor's manual does not clearly indicate that there are time delay relays in the circuitry and does not specify a time delay although the vendor representative indicated that the delays were supposedly factory set at 10 seconds. Personnel involved in preoperational testing (including the plant staff) were not sufficiently familiar with the equipment to realize that time delay relays were used in the circuitry. The inspector did note that all input voltage relay set points were correctly set during this preoperational test for all inverters. However, the low 108 V AC inverter output trip of the AC-DC breakers CB-1 and CB-3 with a 10 second time delay had not been verified. The testing performed following the event did however verify this set point.

With the completion of preoperational testing, the responsibility for operational maintenance of the inverters was transferred from the startup organization to the ANO plant electrical maintenance group. On September 20 the inspector found the incomplete Job Orders 4590, issued July 3, 1978, and 5028, issued July 24, 1978, in the shift supervisor's active Job Order Log. Job Order 4590 was issued as a result of the following trouble reports:

TR0769, dated 4/20/78, "Numerous alarms in and will not clear 2Y22, also both Sync and Out-of-Sync lights on."

TR0779, dated 4/23/78, "2Y22 alarm will not clear."

TR3062, dated 7/1/78, "2Y22 alarms will not clear."

expeditiously complete these job orders and the readjustment of the low voltage DC set point form 104 volts to 134 volts, indicating improperly controlled maintenance practices, materially contributed to at least the failure of inverter 2Y22.

7. Degraded Power Operation

With the transfer of both Units 1 and 2 auxiliary loads to the No. 2 Startup Transformer, the rating (45 MVA) of this transformer was exceeded. The combined loads of Unit 1 and Unit 2 were stated by plant personnel to run about 50 MVA. Alarms from the switchyard ranged from 60.3 to 86.4 MVA. The low voltage levels on the secondary of this transformer triggered further relay operation within the Unit 2 plant auxiliary system. The low voltage on the secondary triggered the Unit 2 trip of the 2A3 and 2A4 4160/480 volts essential buses on undervoltage at 92% of normal voltage. The 4160 voltage was stated by the operators to have dropped as low as 3300 V. This is well below the 92% set point noted above. The 92% trip of the Unit 2 essential buses comes about as the result of the Millstone degraded voltage problem. Concurrent with the trip of the essential buses, the initiation of Engineered Safety Features System occurred due to the inverter malfunction described in paragraph 6 of this report. Also, due to the Millstone degraded voltage problem, the initiation of the Safety Injection Actuation Signal in Unit 2 (with the plant lined up to off-site power) sheds all non-Engineered Safety Feature loads except the Unit 2 Reactor Coolant Pumps. From this point in time, (13:19:21 until 31:33:03) various Unit 2 loads were restarted on Startup Transformer No. 2 in addition to the Unit 2 Reactor Coolant Pumps. At 13:33:03, the Unit 2 operators attempted to restart a Unit 2 Circulating Water Pump. This resulted in an apparent under-voltage trip of the Unit 1 Reactor Coolant Pumps on under voltage (71.5% of 6.9 KV). Plant personnel stated that the load on Startup Transformer No. 2 was recognized as a potential problem. Steps were then taken to reduce the load by stopping all but one of the Unit 2 Reactor Coolant Pumps. Only two of the Unit 1 Reactor Coolant Pumps were restarted. It is also probable that the reactuation of the Engineered Safety Features at 13:24 to 13:26 shed all Unit 2 non-essential loads that may have been started after the initial event.

The degraded voltage levels that occurred during the event are not recorded by any recorder. The inspector did review the motor winding temperatures for the Unit No. 1 makeup pump, service water pumps and circulating water pumps which were on line at the time. The maximum winding temperature increase observed was less than 20°F. Oil and

c. The licensee is to take chloride swipes of exposed stainless steel piping in the containment to determine chloride levels. Further action may be dictated based on the conclusions of this testing.

d. The licensee is to also evaluate the Unit 1 instrument inverters in view of the problems experienced on Unit 2.

e. The licensee is to submit individual 30-day reports for each of the degraded LCO modes the plant operated in during the September 16, 1978 event. These reports are to be forwarded under a cover letter which describes the September 16, 1978 sequence of events and the corrective aciton taken to prevent recurrence.

10. Exit Meeting

Exit meetings were conducted on September 21 and 28, and October 4, 1978 with Mr. Miller and other members of the plant staff. The inspectors discussed the scope of the inspection and summarized the inspection findings which are detailed in this report.