PALO VERDE NUCLEAR GENERATING STATION

INCIDENT INVESTIGATION REPORT SUPPLEMENTS/REVISIONS

Report Number: 2-1-89-001 Revision Number: 2

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W.E. Ide

INCIDENT INVESTIGATION REPORT
#2-1-89-001
REV. 2

REVISION PURPOSE:

This revision is being done to correct an error that was made in reporting the status of a corrective action (#6.2).

INCIDENT INVESTIGATION REPORT
#2-1-89-001
REV. 1

REVISION PURPOSE:

This revision is being done to provide an update of the corrective actions taken and subsequent events. Since the revision only updates the event description and documents additional action on Issue #1 and Issue #4, Plant Review Board review is not required. There have been no changes to anything in the original Incident Investigation Report regarding the Nuclear Safety Assessment, so there is no impact on PRB review and approval.

INCIDENT INVESTIGATION REPORT
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EXECUTIVE SUMMARY

The Unit 1 Reactor Trip on 03/05/89 was determined to be a Category 2 Event by the Incident Investigation Director. An investigation into the event was completed per the Incident Investigation Category 1 and Category 2 Incidents procedure, 79AC-0IP01.

EVENT DESCRIPTION

At 10:01 on March 5, 1989 PVNGS Unit 1 tripped from 100% reactor power due to a Control Element Assembly Calculator (CEAC) failure. The reactor trip initiated a turbine/generator trip and fast bus transfer of station loads from the Unit Auxiliary Transformer to the Startup Transformers. The fast bus transfer was unsuccessful for 13.8 KV bus NAN-S02 because the normal feeder breaker did not trip as required. This resulted in the loss of power to two Reactor Coolant Pumps (RCPs) and various other plant components. In addition, a fire was observed and subsequently extinguished on the trip coil of the normal feeder breaker for NAN-S02.

The emergency operations procedure was entered and the plant was stabilized in Mode 3. The event was declared as an uncomplicated reactor trip, therefore no emergency classification was required.

Secondary plant shutdown was then initiated along with restoring power to electrical bus NAN-S02. As the main feedwater and condensate systems were placed in long path recirculation, water hammer was observed in the heater drain system. Long path recirculation was secured.

During the reenergization of NAN-S02, damage occurred to the RCP 1B and 2B 286 relay trip coils. Reenergization of the bus was halted until a determination of how the trip coils were damaged was performed.

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EXECUTIVE SUMMARY - (Continued)

SUMMARY OF CAUSES

This event was initiated by a failure of CEAC #2 processor board. The root cause has not been conclusively determined for NAN-S02A failing to trip when required. The most probable causes are either a slight armature linkage misalignment, trip coil degradation or the lack of a general breaker overhaul. The water hammer was caused by placing long path recirculation in service while High Pressure feedwater heaters were still at elevated temperature. The failure of the RCP 286 relay coils was attributed to inadequate procedural guidance, training and the uniqueness of the RCP trip circuit design.

SUMMARY OF CORRECTIVE ACTIONS

The processor board of CEAC #2 was replaced and will be analyzed to determine the root cause of failure.

The trip coil for the normal feeder breaker to NAN-S02 was replaced. In addition, preventive maintenance was performed on the breaker in accordance with the vendor's technical manual. Prior to restart, action will be to cycle the bus feeder and RCP supply breakers. The longer term action includes completion of required Preventive Maintenance on all 13.8 KV breakers during the refueling outage. Additionally, the preventive maintenance procedures will be revised to better reflect the recommendations provided by the vendor.

The affected lines of the secondary systems that experienced water hammer were visually inspected. A design modification that will enhance the affected line's strength will be implemented. Design and procedural enhancements will be pursued to minimize future water hammer.

The RCP 1B and 2B 286 relay coils were replaced. Procedural enhancements and training will be provided to Operations Personnel to ensure that the uniqueness of the RCP trip circuit design is made evident.

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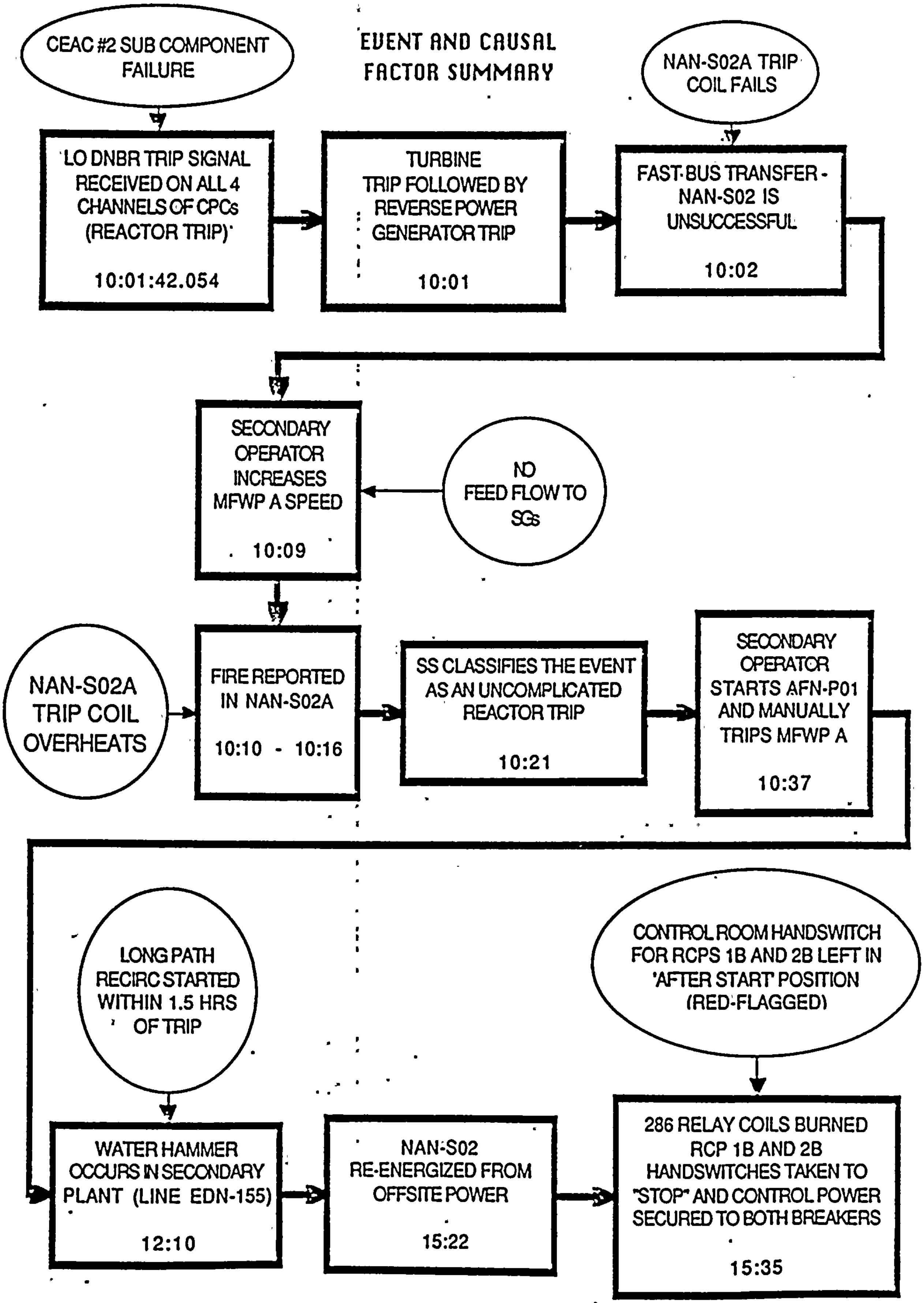

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EVENT DESCRIPTION

On March 5, 1989, Unit 1 was operating in a steady state condition at 100% of rated thermal power. At approximately 10:01 am, Control Element Assembly Calculator (CEAC) #2 experienced a subcomponent. failure which caused it to generate a penalty factor which was then transmitted to the Core Protection Calculators (CPCs). The CPCs compared this information with that provided by CEAC #1. Since CEAC #1 did not transmit a penalty factor, a 10.8 second delay was initiated which is designed to allow time for a spurious deviation to clear. In addition, the difference between the CEAC #2 penalty factor and the data from CEAC #1 was compared to a sensor failure limit. This comparison resulted in all four channels of the CPCs generating a CPC SENSOR FAILURE alarm. After the 10.8-second delay all four channels of the CPCs generated a LO DNBR reactor trip signal resulting in a reactor trip.

The Control Room Operators entered the Emergency Procedure (41EP-1ZZ01) when the reactor trip occurred. The Control Room Supervisor (CRS) initiated the Diagnostic Flow Chart and during its performance noted that the reactor trip first out annunciator panel did not function as expected. Additionally, the fast transfer of 13.8 KV bus NAN-S02 from the Unit Auxiliary Transformer (UAT) to the Start Up Transformer was not completed..The CRS completed the Diagnostic Flow Chart and correctly diagnosed the event as an uncomplicated reactor trip with a degraded electrical condition. The Emergency Plan was not required to be entered.

When the turbine/generator tripped, a Fast Bus Transfer (FBT) of unit loads from the UAT to the Startup Transformer was initiated. The transfer of 13.8 KV bus NAN-S01 to the Startup Transformer was successful while the transfer of 13.8 KV bus NAN-S02 was not completed due to the feeder breaker from the UAT (NAN-S02A) not tripping. A load shed of NAN-S02 occurred, resulting in the loss of power (LOP) to several plant components. Plant equipment affected by the LOP included Reactor Coolant Pumps (RCP) 1B and 2B, the 'A' Heater Drain Pump, the 'C' Condensate Pump, RMS minicomputer, RU-19, and the 'C' and 'D' Circulating Water Pumps.

EVENT DESCRIPTION - (Continued)

The Seismic Monitoring System and the First Out Annunciator were affected due to the transfer to the alternate power supplies

Rev. 1

At 10:06 the Secondary Operator manually tripped Main Feedwater Pump (MFWP) "B". At 10:09 he observed that feed flow to the steam generators had stopped. Under CRS direction, the Secondary Operator increased the bias on MFWP "A", and restored normal feed flow. At 10:35, the Secondary Operator started the non-essential Auxiliary Feedwater Pump, AFN-P01, and secured MFWP "A". Approximately eight minutes after the MFWP was secured, the Area 2 AO heard "clicking" noises coming from the "B" Condensate Pump breaker cubicle, NBN-S01E caused by intermittent low flow. He immediately notified the Control Room and the Secondary Operator secured the "B" Condensate Pump.

The Control Room was notified of a fire in NAN-S02A at approximately 10:10 by an Auxiliary Operator (AO) and Fire Protection was immediately notified. The Reactor Operator (RO) in the Control Room attempted to trip the breaker, but was unsuccessful. The AO then unsuccessfully attempted to trip the breaker using the local manual trip switch. A second AO then successfully tripped the breaker by opening the breaker cubicle and using the manual trip lever. The fire was then extinguished by the AOs utilizing the CO2 hose reel in the area. Control Room personnel and Fire Protection were notified that the fire was extinguished at approximately 10:16.

The Unit was stabilized in Mode 3 at approximately 10:45 and secondary plant shutdown was begun. Upon placing the condensate and feedwater systems in long path recirculation, water hammer was observed to occur in portions of the secondary plant heater drain system. Long path recirculation was secured to prevent any further water hammer from occurring and secondary plant shutdown was continued to completion.

EVENT DESCRIPTION - (Continued)

Prior to reenergizing the NAN-S02 bus, a visual inspection and megger test were performed by Unit Electrical and Protective Relaying and Control (PR&C) groups. With the exception of breaker NAN-S02A, no damage was noted. Plant Management authorized the reenergization with concurrence form the unit Electrical, Operations and Engineering Evaluations Department personnel. During the reenergization of NAN-S02, damage occurred to the RCP 1B and 2B 286 relay trip coils. Reenergization of the bus was halted until a determination of how the trip coils were damaged was performed.

The event was successfully terminated and power was restored to all plant equipment.

SUBSEQUENT EVENTS

A root cause of failure EER, #89-SA-013, concluded that the CEAC 2 failure was due to a random component failure of an Arithmetical Logic Unit (ALU) on the CEAC 2 processor board. Two processor boards were used during troubleshooting to replace the original failed processor board. The first of these boards experienced an auto-restart due to an illegal instruction. This processor board was removed from the Unit and is currently being tested and evaluated on a test system for root cause of failure EER #89-SA-012. To date, the problem has not been duplicated. The second replacement processor board experienced a failure of a different chip in the ALU section of the processor board. This failure is being evaluated under EER #89-SA-023. A third processor board was pretested on the test system for approximately 1 week and then installed in the Unit. The processor board is scheduled for retesting under W.O. #00349136.

Rev.

CONTROL SYSTEMS EVALUATION:

FEEDWATER CONTROL SYSTEM (FWCS):

The Feedwater Control System operated as designed throughout the event with the exception of Main Feedwater Pump 'A' minimum speed. The Reactor Trip Override (RTO) feature operated to close the Economizer valves and to modulate the Downcomer valves. RCS temperature was controlled with a minimum of 559 degrees. The RTO also reduced MFWP A & B speeds to minimum as designed. MFWP A initially went to approximately 3500 rpm, which is about 300 rpm below the minimum speed required to feed the Steam Generators (SG). This condition was in effect for approximately 2 minutes. The Secondary Operator recognized the problem and inserted a small positive bias to the A MFWP controller to return the A pump to 3800 rpm. Feedwater flow was reinstated to the SG's and a smooth return to the SG level setpoint was completed. A Work Request, #328508 was initiated to calibrate the MFWP Turbine speed governor. This shall be completed on return to service of MFWP A. Feedwater Control System improvements are being evaluated in accordance with EER #88-SF-046.

MFWPs B and A were secured by the operator 4 minutes 47 seconds and 8 minutes 54 seconds respectively, into the event.

PRESSURIZER LEVEL CONTROL SYSTEM (PLCS):

The Pressurizer Level Control System operated as designed throughout the event. The Pressurizer level trended as expected, reached a minimum level of 21.8%, a result of the normal post trip cooldown in the primary and recovered to setpoint within 5 minutes.

PRESSURIZER PRESSURE CONTROL SYSTEM (PPCS):

The Pressurizer Pressure Control System operated as designed throughout the event. Pressurizer heaters were lost when Pressurizer level decreased below 25% and were restored approximately 3 minutes later when level was recovered above setpoint (Heaters are deenergized per design below 25% Pressurizer level to protect them from damage if they become uncovered). RCS pressure was maintained between 1980 psia and 2270 psia during the event and trended as expected.

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CONTROL SYSTEMS EVALUATION: - (Continued)

STEAM BYPASS CONTROL SYSTEM (SBCS):

The Steam Bypass Control System functioned as designed throughout the event. All eight valves Quick Opened in response to the decrease in steam flow and then modulated closed. As secondary pressure rose, valve PV-1001 responded on program to modulate and maintain 1170 psi. No other valves were required to respond in the modulate mode. SBCS valves PV-1007 and PV-1008 opened to atmosphere for approximately 20 seconds during the Quick Open and modulated closed. No other steam was released to the atmosphere during the event.

INSTRUMENTATION

The RMS instrumentation operated as designed throughout the event. The loss of power to NAN-S02 resulted in the RMS minicomputer and RU-19 being down-powered. After power was restored to these components, the RMS minicomputer and RU-19 were restored to service. At this time, it was noted that RU-142 would not communicate to the RMS minicomputer. Troubleshooting under W.O. #346105 revealed that the microprocessor of RU-142 would not respond to any command from the RMS minicomputer or the local keypad, i.e. the monitor was locked up. The I&C technician reinitialized the RU-142 microprocessor via a reset switch that is provided for this purpose on the microprocessor. This action restored communication between the minicomputer and RU-142. RU-142 was declared operable and returned to service. A previous investigation determined that a lock-up of RU microprocessors is due to and expected during a power transient. EER #88-SQ-180 was initiated to investigate feasible methods to automatically restart the microprocessor.

Minicomputer power was lost due to failure of S02. Alternate power to the minicomputer was applied through the transfer switch and it was restarted. The RMS terminal in the control room was reenergized after NAN-S02 was restored. In the interim, an Radiation Protection Technician was stationed at the terminal in the RP office to report alarms to the control room. Plant change DCP #1FE-SQ-058 has been issued to the field. This change will provide class IE power to the minicomputer.

CONTROL SYSTEMS EVALUATION: - (Continued)

INSTRUMENTATION - (Continued)

The Seismic Instrumentation responded as designed to this event. The Seismic Monitoring System is powered from the NAN-S02 bus and will alarm when power is removed. The seismic unit has an internal battery backup, but it is not designed as a fast transfer system. Therefore, when NAN-S02 lost power, the Seismic Monitoring System alarmed as designed. This feature of the Seismic Monitoring System was evaluated per EER 87-SM-002 and was found to perform as designed.

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PERSONNEL PERFORMANCE EVALUATION

The response of the Operating crew to this event was both professional and timely. The event was diagnosed as an uncomplicated reactor trip with a degraded electrical condition present. The Unit was stabilized in Mode 3 and restoration of electrical power was completed.

The Control Room Staff reacted to and mitigated the event in a professional and efficient manner. Communications within the Control Room were effective, although not always formal. Although the Control Room received numerous incoming calls, the Nuclear Operations Technician addressed these calls expeditiously minimizing the impact on the Operations Staff. Overall, communications were hampered by the number of unnecessary people in the Control Room and the less than optimal radios that are utilized. An HPES evaluation was initiated by PRS #00145 to further investigate the impact of these issues.

Initial declaration of the Reactor Trip was made by the Primary Operator. The degraded electrical condition was recognized by the Shift Supervisor. The Control Room Operators entered the Emergency Procedure and successfully maintained the safety functions throughout the event. The event was correctly diagnosed as an Uncomplicated Reactor Trip with a degraded electrical condition. The appropriate procedures for mitigating the event were utilized and the plant was stabilized.

The team work that was displayed by the Operators was good. The third Reactor Operator assisted the Secondary Operator in the maintenance of his safety functions until he was directed to begin the Degraded Electrical Abnormal Operating Procedure. The Shift Supervisor reviewed and concurred with the Primary Operator's recommended actions when normal makeup to the VCT was required and could not be initiated due to the loss of power. Members of the Control Room Staff maintained a high awareness of plant conditions and provided assistance to each other as they noticed plant conditions change. The Auxiliary Operators inspected their assigned areas and performed additional assigned tasks in an efficient manner. In addition, the Auxiliary Operators performed immediate corrective actions which included manually opening the NAN-S02A breaker and extinguishing the fire on that breaker.

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PERSONNEL PERFORMANCE EVALUATION - (Continued)

In addition to the communications problems and the unnecessary crowding of the Control Room noted above, the Operations Crew during their debriefing and self critique identified the following:

- The error in restoration of RCP 1B and 2B during reenergization of NAN-S02 resulting in minor equipment damage (addressed in Action Plan 6).

- The lack of procedural guidance to match a battery charger output voltage to the battery bus voltage after the bus has been in service, i.e., the battery has been supplying the bus (an ICR, #03128 was submitted to Plant Standards addressing this issue).

- The need for a General Operating Procedure (GOP) incorporating the actions of the numerous OPs that are entered following an unplanned reactor trip (An ICR#05511 was submitted to Plant Standards addressing this issue).

Support group personnel were professional and efficient, providing expertise in the identification and resolution of problems. Fire Protection's response was immediate and no problems were noted with access to the Protected Area. Security's response in providing an officer to prevent access to the NAN-S02A breaker was rapid. PR&C, Central Maintenance and Unit Electrical response to restore NAN-S02 and other plant equipment to service was timely. System engineers were readily available to the Operations Crew and assisted in identifying potential problems.

PPS AND NUCLEAR SAFETY ASSESSMENT

The reactor trip occurred due to all four Core Protection Calculators (CPC) calculating a DNBR value below setpoint. The CPC calculations resulted from an abnormally large penalty factor being generated in Control Element Assembly Calculator (CEAC) #2 due to a component failure. (CEAC's monitor all rod positions and generate penalty factors based on rod misalignments.)

There were no ESFAS system actuations during the event and none were required.

The reactor was stabilized in Mode 3 with feedwater provided initially by the RTO circuit and then single element control of the FWCS. SG levels were maintained above 49% wide range throughout the event and no safety limits were challenged. All eight SBCS valves received an initial quick open demand and then closed as the excess stored energy in the SG's and main steam piping was released. SBCS then provided SG pressure control and RCS temperature control with the modulation of SBCS valve PV-1001. The SBCS performed as designed.

RCP's 1B and 2B lost power at 10:01:43 due to their power supply NAN-S02, failing to fast transfer to its alternate supply when the Unit Auxiliary Transformer was tripped. The PVNGS safety analysis assumes a loss of forced circulation involving the loss of all four RCP's from 100% power. The existing situation with a loss of two pumps from a shutdown condition is well within the bounds of the safety analysis.

The failure of the normal feeder breaker to NAN-S02, NAN-S02A, has two other potential areas of nuclear safety concern. This breaker provides backup overcurrent protection for the electrical containment penetration for 13.8 KV loads in containment. If the RCP supply breakers were to fail to trip and the normal feeder breakers also fail, then there would be no overcurrent protection for containment. Prior to a loss of containment integrity, the following would all have to occur simultaneously; electrical failure in the RCP, failure of the primary overcurrent protection breaker and the failure of the backup overcurrent protection breaker.

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PPS AND NUCLEAR SAFETY ASSESSMENT: - (Continued)

The failure of this breaker to trip resulted in the failure of the Fast Bus Transfer and the loss of two RCPs. As all 13.8 KV feeder breakers are the same type, the feeder breakers for NAN-S01 may also be subject to the same failure scenario. The root cause may be determined through destructive examination of the failed NAN-S02A breaker trip coil or further inspection of a 13.8 KV breaker. The corrective actions specified, ensure that the Preventive Maintenance program is evaluated and upgraded as necessary to keep this equipment in good operating condition. With these actions specified, all probable causes are addressed and there is no nuclear safety impact. Rev. 1

The loss of RU-19 which monitors radiation levels in the new fuel storage area is of no safety consequence as the Fuel Building effluent monitor, RU-145, was still in service. Additionally there is no fuel in the new fuel storage racks. The loss of RU-142 which is the high range monitor for the condenser air removal effluent is of no safety consequence in this event as the low range monitor, RU-141, was still in service.

In summary, all required safety systems were available to perform their safety function but none were required. Normal operation of non-class equipment maintained control of safety functions and successfully controlled the event from initiation through plant stabilization.

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LIST OF ISSUES

1. CPC/CEAC AND RSPT SYSTEMS
2. FIRST OUT ANNUNCIATOR
3. FAILURE OF 1ENANS02A TO TRIP
4. CDN-P01B LOW FLOW
5. WATER HAMMER
6. RCP 1B/2B 286 RELAYS

INCIDENT INVESTIGATION REPORT
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ISSUE #1 - CPC/CEAC AND RSPT SYSTEMS

ACTION PLAN - SUMMARY

- •Record as found conditions
- •Review maintenance activities
- •Review other plants experience
- •Review Engineering design
- •Obtain Vendor support
- •Perform initial data collection and evaluation
    - *Evaluate if CEA deviation existed
    - *Evaluate if there was a position indication failure
    - *Evaluate if there was a CEAC component failure
    - *Evaluate if erroneous input (software error) into CEAC caused a valid trip
- •Perform troubleshooting and evaluate to identify possible causes
- •Verify identified component as cause of event
- •Rework and retest

FACTS:

NO. FACT DESCRIPTION

1. Prior to Trip:
   a) All CPC's operating normally
   b) CEAC #1 operating normally

2. All CPC channels calculated low DNBR, initiating the Reactor Trip.

3. All CPC channel's trip buffers showed normal parameters, except for a penalty factor of 1.26562 from CEAC #2.

4. CPC Failed Sensor Stack Data:
   a) CPC A data was lost when its trip buffer was dumped.
   b) CEAC #1 fail flag received and cleared in CPC C and D
   c) CEAC #1 PF > CEAC #2 PF alarm received and cleared in CPC B and D
   d) CEAC #2 PF > CEAC #1 PF alarm received and cleared in CPC C

ISSUE #1 - CPC/CEAC AND RSPT SYSTEMS - (Continued)

FACTS - (Continued)

5. Ten seconds prior to trip, following alarms recorded by the plant computer:
   a) CEA deviation Channel C (from CEAC #2)
   b) CEA Withdrawal Prohibit
   c) CPC Sensor Fail (all 4 CPC's)

6. Low DNBR trip signals received from CPC D, B, A, and C (in order).

7. Subsequent to trip alarms received:
   a) CEA deviation Channel B (from CEAC #1)
   b) AWP
   c) CPC Sensor Normal (all four CPC's)
   d) CEAC #2 Data Link failed message on Core Monitoring Computer.
   e) CEAC #1 responded to the actual deviation of the CEA's when the trip occurred.

8. After the trip it was discovered that CEAC #2 was operating, but not communicating with operator's module, CEA display or PMS Data Link; passing normal data to CPC's

9. The initial CPC sensor alarms were due to CEAC #2 Penalty factor being greater than CEAC #1's penalty factor.

10. With a penalty factor from one CEAC greater than the penalty factor from the other CEAC, the CPCs will delay 10.8 seconds prior to generating a trip signal, per design.

11. The CEAC #2 processor board was found to be improperly executing some instructions.

12. CEAC #2 memory locations that should have contained addresses to the PMS Data Link, the Operators Module, and the Idle Time Task programs, contained incorrect data. The PMS Data link and the Operators Module programs will not run if the addresses are not correct.

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ISSUE #1 - CPC/CEAC AND RSPT SYSTEMS - (Continued)

FACTS - (Continued)

13. The location of the address to the Idle Time Task program was changed to the Task Dispatcher Program. The Task Dispatcher program then ran more frequently than designed.

14. After the Processor was replaced, retests of the CEAC #2 indicated no additional failures.

15. CEAC #2 trips buffer data shows no deviated raw CEA Positions. Subgroup 9 was indicated as the deviated subgroup after calculation. The deviated subgroup is determined by evaluating CEA positions.

16. The Processor board did not correctly execute several instructions during testing. It was determined that the processor board had a failed Arithmetic Logic Unit (ALU) chip.

17. The first replacement processor board experienced an auto restart due to an illegal instruction error. The board was removed from the Unit and is currently being tested in a test system. The error has not been duplicated.

18. The second replacement board experienced a failure of a different chip in the ALU section of the processor board.

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CONCLUSIONS:

1. No CEA deviation prior to the trip.

   Fact #'s: 1, 3, 7, 15

2. There was no false CEA indication to cause the CEAC #2 to output a penalty factor.

   Fact #: 3, 7, 8, 15

3. All CPC's and CEAC #1 performed as designed.

   Fact #'s: 3, 5, 7, 10

ISSUE #1 - CPC/CEAC AND RSPT SYSTEMS - (Continued)

CONCLUSIONS:

4. CEAC #2 failed, calculating an erroneous Penalty Factor.

   Fact #'s: 8, 9, 11, 12, 13, 15, 16

5. CEAC #2 Penalty Factor (PF) caused the CPC's to generate a Low DNBR trip signal.

   Fact #'s: 2, 3, 4, 5, 6, 10

6. This single component failure did not impact the ability of the DNBR/LPD Calculator System to generate a trip since the other CEAC was still functioning.

   Fact #'s: 1, 4, 7, 16

7. Component failure is the cause of the CEAC #2 processor board failure.

   Fact #'s: 1, 3, 4, 10, 11, 14, 16

8. CPC Failed Sensor Stack data must be recorded prior to printing the trip buffer report to preserve additional trip data.

   Fact #: 4

9. The reliability of replacement parts for CPC/CEACs initially taken out of the warehouse is lower than desired.

   Fact #s: 17, 18

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CORRECTIVE ACTIONS:

1. Replace failed component and retest.

   Conclusion: 7

2. Revise procedure 72MT-XSB01 CPC/CEAC Software Maintenance Procedure to include recording of Failed Sensor Stack Data prior to performing the trip buffer dump.

   Conclusion: 8

3. Perform root cause of failure for the processor board per EER #89-SA-013.

   Conclusion: 7

4. Perform a design review for the CEACs to determine vulnerability to single failure that results in a reactor trip.

   Conclusion: 6, 7

5. Perform a study to determine a suitable method for providing reliable spare parts to the Units. Examples: Hot Spare System; testing parts upon receipt from vendor.

   Conclusion: 9 Rev. 1

RESPONSIBLE ORGANIZATION/DUE DATE:

1. OCS/Complete Rev. 1
2. EED/Reactor Engineering/45 Days
3. OCS/Complete - Attachment JJ Rev. 1
4. NED/12-90
5. OCS/8-31-89 Rev. 1

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ISSUE #2 - FIRST OUT ANNUNCIATOR

ACTION PLAN - SUMMARY

- •Interview control room operator on Alarm indication/Action.
- •Review the maintenance history.
- •Review the Engineering design.
- •Visually inspect the components on related annunciator alarm windows.
- •Troubleshoot and simulate alarm input in various sequences and conditions to observe the effect on the system.

FACTS

NO. FACT DESCRIPTION

1. Alarm could not be reset for several hours after the trip.
2. Flasher reset problems have been recorded in SIMS.
3. 12V Power Supply #2 in bay 5 observed to be failed on 10/25/88 WR# 319813.
4. Inverter output light on Inverter DC-IK-12-AS "Right" was not functional (Transformer T, has physically indicated damage reported 06/10/87 WO # 328150)
5. Backup 117 VAC power supply source is normally from NAN-S02 (Lost during the trip) and is designed to automatically transfer to PGB-L36 (Class 1E power - 200m sec. transfer).
6. Logic card (SFFM) response time is 10 m/sec.
7. Time of alarms:

DNBR-LO	10:01:42:015
LPD-HI	10:01:42:679
SG2-LO Flow	10:02:01:887
SG1-LO Flow	10:02:02:280

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ISSUE #2 - FIRST OUT ANNUNCIATOR - (Continued)

FACTS: - (Continued)

8. NAN-S02 failed at 10:01:47:103. This failure occurred between DNBR, LPD and SG2, SG1 LO Flow alarm.

9. No problem was found during troubleshooting.

10. A stuck flasher reset button with different sequences of alarm input was simulated during troubleshooting. The system did not repeat as described by the Control Room Supervisor.

11. The flasher reset push button on RMN-B04 resets all three annunciator panels.

12. Operator successfully reset alarms on the other annunciator panels with the exception of the reactor trip first-out annunciator.

13. The First Out Annunciator is not used in the decision tree for the Emergency Procedure

14. The expected/observed alarms are:

	Expected	Observed
Hi LPD	Slow Flash	Solid
DNBR Lo	Fast Flash	Fast Flash
SG 1 RC Flow Lo	Slow Flash	Fast Flash
SG 2 Rc Flow Lo	Slow Flash	Fast Flash

CONCLUSIONS:

1. Reactor first-out annunciator functioned as designed. The cause of abnormal indication was momentary loss of power to AC backup to annunciator system when NAN-S02 was lost combined with a failed inverter and 12V power supply.

   Fact #'s 3, 4, 5, 6, 7, 8, 9, 10, 14

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ISSUE #2 - FIRST OUT ANNUNCIATOR - (Continued)

CONCLUSIONS: - (Continued)

2. Failure to reset properly was due to a intermittent failure of the push button interface card.

   Fact #'s: 2, 11, 12, 13

3. Although the reactor trip First Out Annunciator is annotated during the performance of the diagnostic, it does not lead the CRS to a misdiagnosis of the event.

   Fact #: 13

CORRECTIVE ACTIONS:

1. Implement WR #319813 to repair the 12V power supply.

   Conclusion: 1 Rev. 1

2. Implement WO #328150 to repair/replace the Inverter DC-IK-12-AS-Right.

   Conclusion: 1 Rev. 1

3. Replace the push button interface card on RKN-C02 bay 7 logic housing #5 board #4 - part #304342. WR#341328.

   Conclusion: 2 Rev. 1

RESPONSIBLE ORGANIZATION/DUE DATE:

1. Unit 1 Work Control/ Prior to restart following Cycle 3 Refueling (6/15/89)

2. Unit 1 Work Control/ Prior to restart following Cycle 3 Refueling (6/15/89)

3. Unit 1 Work Control/ Prior to restart following Cycle 3 Refueling (6/15/89)

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ISSUE #3 - FAILURE OF 1ENANS02A TO TRIP

ACTION PLAN - SUMMARY:

- Review maintenance activities
- Visually inspect the breaker and the cubicle for physical damage
    - *Evaluate replacement of the breaker
- Repair visually identified damage
- Evaluate breaker lubrication and periodic maintenance
- Retest the breaker
- Contact the vendor

FACTS:

NO.	FACT DESCRIPTION
1.	Turbine trip initiated a generator trip, opening switchyard breaker PL-915 and PL-918
2.	Fast bus transfer initiated
3.	1ENANS01 successfully reenergized from 1ENANS03
4.	1ENANS02 not reenergized from 1ENANS04
5.	Breaker 1ENANS02A failed to trip
6.	Smoke from 1ENANS02A breaker cubicle - from overheated trip coil.

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ISSUE #3 - NAN-S02A FAILURE TO TRIP - (Continued)

FACTS - (Continued)

7. Maintenance history of breaker 1ENANS02A

WO#	TASK#	STATUS	DATE
00326074	051488	Waived	02/27/89
00310881	051488	Waived	11/10/88
00304534	041120	Comp	07/25/88
00295866	051488	Comp	01/10/88
00280603	051488	Waived	06/28/88
00269354	051488	Comp	02/02/88
00235565	051488	Comp	09/18/87
00232667	041120	Comp	11/11/87
00244224	010169	Comp	11/02/87
00200801	010169	Cancel	02/23/87
00139118	010169	Cancel	02/26/86
00137799	010169	Cancel	03/12/86

Startup generic procedure EG-201.1 completed 11/03/83.

Task #051488 - Exercise breaker
Task #041120 - Inspect/adjust breaker (32MT-9ZZ29)
Task #010169 - 60 month containment penetration breaker test

8. Maintenance history of failed trip coils (2 failed on 1ENANS05B, documented on WO #111901 and WO #340160 and 1 failed on 2ENANS06C, documented on WO #118699).

9. WO #340160 has a Root Cause of Failure EER in progress, EER #89-NA-003

10. Visually inspected 1ENANS02A per W.O.# 00346469.

11. Reworked 1ENANS02A per PM WO #00346469.

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ISSUE #3 - NAN-S02A FAILURE TO TRIP - (Continued)

FACTS - (Continued)

12. Contacted G.E. and obtained Breaker Trip Shaft Force requirements. Also learned that pick-up voltages for trip coil should be measured at least once per year. [This is also in Tech Manual E009-207 Section 3 (GEK 7347C)].

13. Pick-up voltage requirements for the trip coil are not listed in the General Maintenance Section of Tech Manual E009-207.

14. Replaced failed trip coil with a new trip coil per WO #00346469.

15. Procedures 32MT-9ZZ29, "Maintenance of Medium voltage circuit breaker" and 32ST-9ZZ06, "60-Month Containment Penetration Conductor 13.8 KV Breaker Inspection, Testing, and PM" do not measure pick-up voltages for the trip coil and closing coil or main contact opening and closing times. (Preventive Maintenance task #041120)

16. Tech manual E009-207, Section 3 for Magne-Blast circuit breakers recommends a maximum maintenance interval of two years, while Preventive Maintenance task #041120 (32MT-9ZZ29) specifies a requirement of 3R (54 months).

17. Procedure 32MT-9ZZ29 contained a statement for measuring and adjusting the trip armature travel which was not consistent with Section 3 of Tech Manual E009-207.

18. Procedure 32ST-9ZZ06, "60-month Containment Penetration Conductor 13.8KV Breaker Inspection, Testing and PM," contains the same inconsistency as fact #17.

19. Surveillance requirement 4.8.4.1.b of the Unit 1 operating license states "At least once per 60 months by subjecting each circuit breaker to an inspection and preventive maintenance in accordance with procedures prepared in conjunction with its manufacturer's recommendations."

ISSUE #3 - NAN-S02A FAILURE TO TRIP - (Continued)

FACTS - (Continued)

20. GE General Maintenance Section of Tech Manual E009-207 does not contain five year maintenance requirements for breakers that do not interrupt arc furnaces or capacitors.

21. Procedure 32ST-9ZZ06 was developed to fulfill surveillance requirement 4.8.4.1.b.

22. Successfully performed trip coil pick-up voltage test as documented by WO #346469 (no problems were identified).

23. Successfully completed 32MT-9ZZ29 (Breaker Retest).

24. "The frequency of the inspection and maintenance operations required should be determined by each operating company and will depend on the application of the breakers and the operating conditions." (Tech Manual E009-207, Section 3)

25. The trip coil for NANS02A failed.

26. The trip coil armature linkage was misaligned.

27. Vendor representative guidance was given that the general breaker overhaul should be performed every five years.

ISSUE #3 - NAN-S02A FAILURE TO TRIP - (Continued)

CONCLUSIONS:

1. The Fast Bus Transfer performed as designed, except for breaker 1E-NAN-S02A. The Fast Bus Transfer failed on NAN-S02 due to failure of 1E-NAN-S02A to trip.

   Fact #s: 1, 2, 3, 4, 5

2. Preventive Maintenance tasks and associated procedures on GE medium voltage circuit breakers do not include the requirements of all sections of the G.E. Tech Manual and G.E.'s verbal recommendations.

   Facts #s: 12, 13, 15, 16, 17, 18, 24

3. Breaker 1E-NAN-S02A is functionally adequate to be placed in service.

   Fact #s: 10, 11, 13

4. The requirements of the Tech Manual are incomplete and ambiguous.

   Fact #s: 13, 20

5. The process for waiving PM tasks is not adequate to assure PMs are performed.

   Fact #: 7

6. The PM tasks for NAN-S02A are not being performed per schedule.

   Fact #: 7

7. The root cause has not been conclusively determined for NAN-S02A failing to trip when required. The most probable causes are either a slight armature linkage misalignment, trip coil degradation or the lack of a general breaker overhaul.

   Fact #: 25

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ISSUE #3 - NAN-S02A FAILURE TO TRIP - (Continued)

CORRECTIVE ACTIONS:

1. 13.8 KV breaker Periodic Maintenance requirements will be evaluated by EED based on a review of the Technical Manual and other information that has been provided by the vendor.

   Conclusion: 2, 4 Rev. 1

2. Preventive maintenance tasks and procedures should be revised to include all the maintenance requirements that EED has determined to be necessary for 13.8 KV breakers.

   Conclusion: 2, 4 Rev. 1

3. Review the adequacy for waiving PM tasks. When PM tasks are waived, it will require technical justification and the responsible Maintenance management approval, escalated on successive waivings. Rev. 1

   Conclusion: 5, 6 Rev. 1

4. Prior to returning Unit 1 to Critical Operations, the NAN-S01A breaker and the RCP breakers on 1ENANS01 and 1ENANS02 will be cycled a minimum of two times. The alternate supply breakers to 1ENANS01 and 1ENANS02 will be cycled a minimum of two times when the busses are transferred to the UAT. Retest per 32MT-9ZZ29, Section 8.11, Breaker Functional Test.

   Conclusion: 7 Rev. 1

5. Perform root cause of failure on the failed trip coil for NAN-S02A with vendor participation. Additionally teardown and inspect a Unit 1 13.8 KV breaker to determine the need for general breaker overhaul.

   Conclusion: 7 Rev. 1

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ISSUE #3 - NAN-S02A FAILURE TO TRIP - (Continued)

CORRECTIVE ACTIONS: (Continued)

6. Ensure PMs are up to date for all 13.8 KV and 4.16KV breakers prior to restart from the Unit 1 refueling outage.

   Conclusion: 6, 7

7. Unit 2 and 3 to evaluate 13.8 KV and 4.16 KV circuit breaker PM status.

   Conclusion: 5, 6, 7

RESPONSIBLE ORGANIZATIONS/DUE DATE:

1. EED - Electrical/Complete
2. Plant Standards - Electrical/Complete
3. Plant Standards - Electrical/Complete
4. Unit 1 Work Control/Prior to 30% power
5. EED - Electrical/90 days following report approval
6. Unit 1 Work Control/6-15-89
7. Unit 2 Work Control/Complete
   Unit 3 Work Control/Prior to restart following refueling.

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ISSUE #4 - CDN-P01B LOW FLOW

ACTION PLAN - SUMMARY:

•Review maintenance activities
•Review the loop design and Agastat relay for source of clicking
  *Determined to be Agastat relay 462B
•Determine if a low flow condition exists using a loop calibration
  *Recalibrate the loop
  *Determine cause of actual low flow

FACTS:

NO.	DESCRIPTION
1.	An Operator heard a clicking noise emitting from switchgear cubicle 1E-NBN-S01E.
2.	Alarm typer output indicated contact 1J-CDN-FSL-27A cycled at least 135 times during the transient.
3.	Alarm typer output indicated contact 1J-CDN-FSL-27A stopped cycling concurrent with the tripping of Condensate Pump B.
4.	Associated with contact 1J-CDN-FSL-27A is agastat time delay relay 462B also located in 1E-NBN-S01E which also cycled on and off concurrent with 1J-CDN-FSL-27A.
5.	Agastat time delay relay 462B trips the associated Condensate Pump if 1J-CDN-FSL-27A is energized for 20 seconds continuous.
6.	During the time frame of the flow switch cycling, the agastat was not energized for more than 7 seconds continuous.
7.	Calibration for instrument flow loop 27 for condensate pump B was last performed in October, 1987. Calibration was completed successfully.

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ISSUE #4 - CDN-P01B LOW FLOW - (Continued)

FACTS: - (Continued)

8. Frequency of performance for the instrument loop preventative maintenance task is every refueling outage.

9. Work order #00346488 performed 32MT-9ZZ82 on the agastat time delay relay for condensate pump B instrument loop. Testing indicated no problems.

10. Work order #00346547 performed 32MT-9ZZ82 on the agastat time delay relay for condensate pump A instrument loop. Testing indicated no problems.

11. Work order #00346548 performed 32MT-9ZZ82 on the agastat time delay relay for condensate pump C instrument loop. Testing indicated no problems.

12. Work order #00346738 checked as found conditions for loop 26 (condensate pump 'A'). As found calibration was satisfactory except as follows:

    *Flow transmitter 26 was out of calibration .019 MA at the zero point.

Rev.1

13. Work order 00346739 checked as found conditions for loop 27 (condensate pump B). As found calibration was satisfactory except as follows:

    *I/P FY27 was found out of calibration by .03 PSI at the 6 psi position and .01 psi at the 9 psi position.

    *The overall loop was out of calibration 60 gpm high at the 5000 gpm point. (Loop is 0-9000 gpm).

    It was noted during the check that valve 1J-CDN-FV0027 did not stroke smoothly. Stroking did become smoother on second stroke

14. Work order #00346714 checked as found conditions for loop 28 (condensate pump C). As found calibration was satisfactory. It was noted during check that valve 1J-CDN-FV0028 did not stroke smoothly.

ISSUE #4 - CDN-P01B LOW FLOW - (Continued)

FACTS: - (Continued)

15. Work order #00346275 performed recalibration of instrument loop 26 (Condensate Pump A). All recalibration was satisfactory.

16. Work order #00346269 performed recalibration of instrument loop 27 (Condensate Pump B). All recalibration was satisfactory. Rev. 1

17. Work order #0346819 was issued to perform packing rework on valve 1J-CDN-FV0027. Prior to packing work, multiple strokes failed to indicated any further binding problems. Inspection of the valve shaft at the time of the work indicated residue on the operator shaft below the cylinder seal. Residue appeared to be grease mixed with dust.

18. Work order #00346277 performed recalibration of instrument loop 28 (Cond. Pump C). All recalibration was satisfactory. Rev. 1

19. Work order #00346882 was issued to perform packing rework on valve 1J-CDN-FV0028. Prior to packing work, multiple strokes failed to indicate binding problems. Inspection of the valve shaft at the time of the work indicated residue on the operator shaft below the cylinder seal. Valve also is tagged with a maintenance required tag for packing leak.

20. Work order #00346819 was also amended to perform operator rework as applicable on valve 1J-CDN-FV0027. As binding problem was no longer apparent, no work was performed.

21. Work order #00346975 performed dynamic tuning of the instrumentation loop of valves 1JCDNFV0026 & 0027. Tuning was performed with system in long path recirculation mode and resulted in satisfactory response of valves. Rev. 1

ISSUE #4 - CDN-P01B LOW FLOW - (Continued)

FACTS: - (Continued)

22. Work order #00346951 prescribed a retest which simulated, as close as feasible, a rapid decrease in condensate demand. While attempting to perform this test, the following items were identified:

    Valve 1JCDNFV0026 oscillated between 75% and 100% open during the start of pump 'A' ('A' train discharge isolation valve closed-full flow mini-recirculation). Valve oscillation terminated with initiation of long path recirculation flow path.

    Valve 1JCDNFV0028 oscillated between 80% and 100% open during pump 'C' shutdown ('C' train discharge isolation valve closed-full flow mini-recirculation).

    Valve 1JCDNFV0027 failed to open in sufficient time to prevent agastat trip 20 seconds following pump start. Second pump start attempt resulted in the same condition.

23. Work order #00352397 initiated troubleshooting of all instrumentation loops and mini-recirculation valves to identify sources of problems identified in Step 22 above. The following items were documented:

    Observed stroke time for valves 1JCDNFV0026 & 0028 was approximately 13 seconds. Observed stroke time for valve 1JCDNFV0027 was 17 seconds. All stroke times were verified by more than one test.

    Controller output signal was verified against valve position on all three valves and found to be satisfactory in all cases.

    Controllers 1JCDNFIC0027 & 0028 were observed to produce indicated flow fluctuations of up to approximately (+/-) 300 gpm. This condition was observed with pumps B & C operating with discharge isolation valves closed (full mini-recirculation flow indication).

ISSUE #4 - CDN-P01B LOW FLOW - (Continued)

FACTS: - (Continued)

23. (Cont.) Transmitters 1JDCNFY0027 & 0028 produced widely fluctuating signals during pump B & C operations with respective discharge isolation valves closed (full flow mini-recirculation). This operating condition is used at pump start and closely simulates conditions following a rapid reduction of condensate flow demand.

24. Work order #00352397 was used to perform the following troubleshooting and corrective action:

Valve 1JCDNFV0027 flapper nozzle clearance was adjusted to achieve valve stroke time comparable to valves 1JDCNFV0026 & 0028. This adjustment provided for successful starts of pump b.

NOTE: The following troubleshooting was performed on loops 27 and 28 but is applicable to all three loops.

Controller signal was conditioned using volume chambers of various sizes to attempt to dampen the response to the indicated flow fluctuations. All attempts to condition the signal were unsuccessful.

Controller response to transmitter signal was conditioned by means of proportional band adjustments. Increased proportional band settings resulted in a positive damping of controller output vs. input signal fluctuation, but resulted in significantly reduced system sensitivity.

Transmitter signal was conditioned using snubbers and various volume chambers to attempt to dampen the response to system flow turbulence. All attempts to condition the signal were unsuccessful.

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ISSUE #4 - CDN-P01B LOW FLOW - (Continued)

FACTS: - (Continued)

25. Testing required by work order #00346951 was satisfied by retesting performed during completion of work order #00352397. Rev. 1

CONCLUSIONS:

1. Calibration error of loop 27 (Condensate pump B) did not contribute to the cycling behavior of FSL-27A as the errors were all high and would not induce an artificially low signal. The zero point error of loop 26 (Condensate Pump A) did not contribute to cycling in the CD system.

   Fact #: 12, 13, 15

2. The agastat time delay relay functioned as designed. Calibration of the agastat was acceptable even after the transient was complete.

   Fact #s: 6 and 9

3. Flow switch contact 1J-CDN-FSL-27A caused the cycling of the agastat and the associated clicking in cabinet 1E-NBN-S01E as well as the numerous flow alarms in the control room for mini-recirculation flow-low.

   Fact #s: 2, 3, 4, 5, and 6

4. Flow switch contact 1JCDNFSL27A cycling was caused by slow response of valve 1JCDNFV0027 to changes in system flow. This response lag resulted from the flapper nozzle clearance preventing proper operator response. This problem was resolved via work order #00352397.

   Fact #s: 2, 3, 13, 22, 23, 24, 25

Rev. 1

ISSUE #4 - CDN-P01B LOW FLOW - (Continued)

CONCLUSIONS: - (Continued)

5. Valve hesitation problem for 1JCDNFV0027 & 0028 was not caused by packing tightness or operator malfunction. Most probable contributing factors are as follows:

   Shaft interference with the operator cylinder seal due to residue buildup on operator shaft.

   Frequency of valve exercise is dependent on plant trip frequency or refuel cycle. Valve can remain idle for up to 18 months before being required to operate.

   Fact #s: 7, 8, 12, 13, 14, 18, 19, 20

6. Valve oscillation problems for all three mini-recirculation valves were caused by widely fluctuating transmitter signals. These signals result from system turbulence at the location of the transmitter pressure taps. The transmitter signals result in controller signal fluctuation and subsequent valve position oscillation. Due to the configuration of piping between pump discharge and the mini-recirculation piping tap, significant turbulence is always present at transmitter tap locations. This turbulence is worst during pump start and rapid flow demand reduction conditions when full flow mini-recirculation is required. This condition accounts for the repetitive miniflow high/lo alarm signals received from various condensate pump loops during transient conditions. Any signal conditioning results in a loss of loop sensitivity which slows the system response to rapid reductions in system demand flow.

   Fact #s: 2, 3, 21, 22, 23, 24

Rev. 1

ISSUE #4 - CDN-P01B LOW FLOW - (Continued)

CONCLUSIONS: - (Continued)

7. The following equipment has been reworked, recalibrated, or otherwise verified functional:

1J-CDN-FV0026
1J-CDN-FV0027
1J-CDN-FV0028
1J-CDN-LOOP 26
1J-CDN-LOOP 27
1J-CDN-LOOP 28
Agastat Relay 462B in cabinets:
1E-NBN-S01E
1E-NBN-S01D
1E-NBN-S02D

Fact #'s: 10, 11, 14, 15, 16, 17, 18, 19, 20, 25 Rev. 1

CORRECTIVE ACTIONS:

1. Evaluate frequency for calibration of instrument loops. (NED #89-CD-008).

   Conclusion: #5

2. Evaluate the need for a PM to clean the operator shaft on a scheduled basis. (EER #89-CD-013)

   Conclusion: #5

3. Evaluate the need for a setpoint change on controllers 1JCDNFIC0026, 0027 & 0028. Present setpoint is 4000 gpm. Recommended setpoint is 4500 gpm. This new setpoint would raise the fluctuation band on the controller above the alarm setpoint. This would result in reduction of nuisance alarms while still providing for adequate pump protection and system response. (EER #89-CD-018)

   Conclusion: #6 Rev. 1

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RESPONSIBLE ORGANIZATION/DUE DATE:

1. NED - I & C / 5-22-89
2. EED - Mechanical / Complete
3. NED - Mechanical / 6-30-89

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ISSUE #5 - WATER HAMMER

ACTION PLAN - SUMMARY:

- Interview witnesses of water hammer to assess location/severity
- Review Engineering design
- Visually inspect pipe hangers on the subject line
- Visually inspect the piping and nozzle on the subject line

FACTS:

NO.	FACT DESCRIPTION
1.	Source of water hammer was located in line EDN-155.
2.	Line EDN-155 was designed for two phase flow.
3.	B Train of HP heaters was out-of-service due to tube leak.
4.	Long path recirculation was established within 1.5 hrs of trip.
5.	No maintenance to repair water hammer damage has been required or performed previously on line EDN-155.
6.	SGN-HV-46 is full open/full close valve, vs. a "jog control" valve.
7.	Visual inspection of line EDN-155 revealed no indication of pipe deformation, structural distortion of restraint members or weld failures. (W.O. #346270)
8.	Installation of reinforcing sleeves per Site Mod 1-M-ED-008 has not been implemented. Installation scheduled for Cycle 3 refueling.
9.	There are limited procedural guidelines for establishing long path recirculation. They do not include specific initial conditions post trip - time related.
10.	Long path recirculation established approximately 6,000 gpm flow of cold condensate through tube side of 'A' train HP heaters on near step change basis.

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ISSUE #5 - WATER HAMMER - (Continued)

FACTS: - (Continued)

11. The present design for the system does not include the ability to gradually initiate flow on long path recirculation to allow for controlled cooldown of HP heater trains.

12. The jog control feature was included in the original design and later deleted due to repeated failures with SGN-HV-046 while throttling.

13. Low flow control of long path recirculation is required to avoid thermal shock and water hammer to the HP heater trains when elevated temperatures are present.

CONCLUSIONS:

1. No physical damage

   There was no physical damage resulting from this or previous events.

   Fact #7

2. Design enhancement for initiation of Long Path Recirculation Required

   Improvements can be made to add margin and reduce the potential for repeated transients.

   Facts #1, 2, 3, 4, 5, 7 and 8

3. Existing procedures lack detailed guidelines for establishing long path recirculation.

   Fact#: 9

ISSUE #5 - WATER HAMMER - (Continued)

CORRECTIVE ACTIONS:

1. Implement Site Mod 1-SM-ED-008 at next refueling outage.

   Conclusion: 2 Rev. 1

2. Evaluate and implement as required, a design change to provide low flow initiation capability for long path recirculation.

   Conclusion: 2 Rev. 1

   2.1 Ensure approval of the Plant Change Package.

   2.2 Implement the design change package in all three units.

3. Upgrade Operating Procedure to include guidelines for establishing long path recirculation as interim action.

   Conclusion: 3 Rev. 1

RESPONSIBLE ORGANIZATION/DUE DATE:

1.0	Unit 1 Work Control - Prior to restart following cycle 3 refueling / 6/15/89
2.1	EED Manager / 12/90
2.2	Work Control-all Units / First Refueling Outage after 12/90
3.0	Operations Standards / Complete Rev. 1

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ISSUE #6 - RCP 1B/2B 286 RELAYS

ACTION PLAN - SUMMARY

- Interview Auxiliary Operator and Control Room Operator
- Review system design for root cause
- Replace 286 relays of RCP 1B/2B
- Evaluate the adequacy of procedures
- Perform an HPES evaluation on the personnel actions

FACTS

NO. FACT DESCRIPTION

1. Prior to restoring power to NAN-S02, Control Room Operators instructed A.O. to attempt to reset the 286 relays on the RCP breakers.

2. Both 286 relays tripped immediately after being rotated to the reset position.

3. After restoring power to NAN-S02, Control Room Operators requested A.O..to attempt a reset of the speed relays and 286 relays for RCP 1B and 2B.

4. The 286 relay for RCP 1B stayed in the reset position..

5. The 286 relay for RCP 2B tripped once then stayed in the reset position.

6. Operations, EED and an Electrician researched the RCP elementary drawings to determine why the relays overheated.

7. Control Room handswitches for RCP's 1B/2B were in the 'after start' positioning.

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ISSUE #6 - RCP 1B/2B 286 RELAYS - (Continued)

FACTS - (Continued)

8. Internal factors were:
   A. Awareness of inter-relationship between RCP handswitches and 286 lockout relays
   B. Incorrect assumptions were made when 286 relays tripped after being reset
   C. Operations Personnel did not have sufficient specific system knowledge
   D. Not well-practiced with task

9. External factors were:
   A. Unusual plant conditions, i.e., plant trip and loss of NAN-S02

10. Behavior shaping factors were:
    A. Training content did not recognize the potential for this event

11. Written instructions (procedures) were a factor due to:
    A. Procedures did not present the required information
    B. Procedures did not provide adequate instruction to prevent this event
    C. The procedures did not have sufficient technical content
    D. Procedures omitted relevant information

12. Self-checking was not applied to ensure that the intended action was correct before it was performed.

13. Training content was a contributing factor because it did not adequately address the inter-relationship between the Control Room handswitches and resetting 286 lockouts.

14. Operations personnel and Electricians determined that with handswitches in 'after-start', a continuity path existed through the trip coils.

15. Operations personnel initially thought that with degraded battery voltage, the 286 coils drew excessive current.

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ISSUE #6 - RCP 1B/2B 286 RELAYS - (Continued)

FACTS - (Continued)

NO. FACT DESCRIPTION

16. Previous problems have been encountered with 286's when in degraded voltage conditions - relays may not work correctly.

17. Procedures did not contain a warning to ensure CR handswitch in "off" before resetting the 286 relays.

18. The Operations Crew was not aware of any formal guidance regarding the reflagging of components following an automatic actuation of the component..

19. The Operations Crew was unsure if they should flag automatically actuated equipment due to the possibility that the equipment may be quarantined.

CONCLUSIONS

1. The lack of specific system knowledge allowed personnel to attempt the reset of the RCP 286 relays without placing the control room handswitches in "off." The uniqueness of RCP trip circuitry design was not readily apparent to Operations Personnel. Training on RCP operation did not cover the uniqueness of RCP trip circuit design.

   Fact #'s 1, 2, 6, 7, 8, 10, 11, 14, 15

2. The successful resets of the RCP 1B and 2B 286 relays led the Operations Personnel to believe that the subsequent trips of the relays were due to other activities that were concurrent with this event.

   Fact #'s 3, 4, 5, 8, 9, 16, 17

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ISSUE #6 - RCP 1B/2B 286 RELAYS - (Continued)

CONCLUSIONS - (Continued)

3. Procedures did not adequately address the resetting of RCP 286 relays. There are deficiencies in instructional and informational presentation. Technical inaccuracies and the omission of relevant information were key factors in this event.

   Fact #'s 11, 18

4. Formal guidance currently does not exist for reflagging of components that have automatically actuated. In addition, some confusion exists in that following a plant transient, some plant components may be quarantined.

   Fact #19

CORRECTIVE ACTIONS:

1. Provide training to all Operations Personnel concerning the resetting of the RCP 286 relays with the control room handswitches in "after-start" or with a trip signal still present.

   Conclusion #'s: 1, 2, 3

2. Modify existing procedures to provide additional guidance on resetting RCP 286 relays from lessons learned for this event.

   Conclusion #'s: 1, 3

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3. Install caution placards on the RCP breaker doors in all three Units that state "Ensure that control room handswitches for this component are in the "after-stop" position before resetting the 286 relays."

   Conclusion #: 1

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ISSUE #6 - RCP 1B/2B 286 RELAYS - (Continued)

CORRECTIVE ACTIONS: - (Continued)

4. Evaluate plant components to determine if any other plant components are of the same design. Based on this evaluation, modify station procedures to incorporate guidelines for resetting the 286 relays for these components and install Caution placards as necessary.

   Conclusion #'s: 1, 2, 3, 4

5. Provide guidance to Operational Personnel concerning the matching of handswitch flags to component indicators in situations where the component has tripped or has automatically started. In addition, this guidance should also address Management's philosophy concerning the possibility of the actuated component being quarantined.

   Conclusion #: 4

6. Evaluate existing Operations guidelines for resetting 86 lockouts to determine if additional information/guidance is needed.

   Conclusion #: 4

RESPONSIBLE ORGANIZATION/DUE DATE

1. Licensed Training / 5-15-89
2. Operations Standards / 4-15-89 REV. 2
3. Work Control - all Units / Complete
4. EED / 6-15-89
5. Operations Managers & Plant Standards Manager / Complete
6. Operations Standards, PR & C / Complete

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LIST OF ATTACHMENTS:

A. CPC/CEAC ACTION PLAN
B. FIRST OUT ANNUNCIATOR ACTION PLAN
C. NAN-S02A FAILURE TO TRIP ACTION PLAN
D. CDN-P01B LOW FLOW ACTION PLAN
E. 5A HP HEATER WATER HAMMER ACTION PLAN
F. RCP 1B/2B 286 RELAYS ACTION PLAN
G. FINAL EVENTS AND CASUAL FACTORS CHART
H. PERSONNEL STATEMENTS
I. STA LOG
J. CONTROL ROOM LOG
K. UNIT LOG
L. DIAGNOSTIC FLOW CHART
M. FACTS LISTS
N. TDAS PLOTS
O. STRIP CHART RECORDER CHARTS
P. PMS POST TRIP REVIEW LOG
Q. ALARM TYPER PRINTOUT
R. RONAN SOE PRINTOUT
S. CPC/CEAC TRIP BUFFER REPORT
T. DIGITAL FAULT RECORDER PRINTOUT
U. QUARANTINED MATERIALS INVENTORY LIST
W. SEISMIC MONTORING EVALUATION
X. RU19/RU142 EVALUATION
Y. ANALYZED TDAS PLOTS
Z. EBTs
AA. WORK DOCUMENTS
BB. MEMO DOCUMENTING OPERATOR SELF CRITIQUE
CC. INCIDENT INVESTIGATION TEAM ORGANIZATION
DD. EXECUTIVE SUMMARY DOCUMENT
EE. WORK CONTROL SHIFT STATUS
FF. TELEPHONE MEMORANDUM FROM G.E. TO EED
GG. PRS #00145
HH. ENS WORKSHEET
II. UNIT 1 NIGHT ORDER DATED 3/6/89
JJ. EER #89-SA-013

Rev. 1