Commonwealth Edison
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DcO

March 2, 1990

Mr. A. Bert Davis
Regional Administrator
U.S. Nuclear Regulatory Commission
Region III
799 Roosevelt Road
Glen Ellyn, IL 60137

Subject: Dresden Unit 2
Response to Confirmatory Action Letter
CAL RIII-90-01
NRC Docket No. 50-237

Reference: (a) Confirmatory Action Letter from A.B. Davis to C. Reed (CAL RIII-90-001) received January 17, 1990

(b) Letter dated January 25, 1990 from A.B. Davis to Cordell Reed confirming items discussed during January 22,1990 conference call.

Mr. Davis:

Reference (a) confirmed Commonwealth Edison's intent to perform a comprehensive root cause investigation of the following equipment problems which occurred during a reactor scram event on January 16, 1990:

1. The fire in the 2D Condensate/Condensate Booster pump motor.

2. The apparent failure of the 2B Condensate/Condensate Booster pump to automatically start.

3. The Reserve Auxiliary Transformer TR 22 unexpected failure.

4. The premature closure of the 2C outboard Main Steam Isolation Valve (MSIV).

5. The 2-203-3B Electromatic Relief Valve (ERV) open indication lamp socket failure.

6. The potential failure of the main generator to trip properly on reverse power circuitry.

7. The failure of 2B Shutdown Cooling pump discharge valve MO2-1001-4B to open electrically.

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In parallel with the Commonwealth Edison investigation, the NRC assembled an Augmented Inspection Team (AIT) to assess the root cause investigation as well as to review any other failures which may have been identified during the investigation. The affected components were placed in quarantine until released by the AIT staff, in order to insure that the AIT members had full access to the components, repair packages, and repair activities.

Reference (b) provided confirmation of a telephone conference which reviewed the results of Commonwealth Edison's investigation, the agreement to allow restart of Unit 2 and to provide a written report of the investigation. Attachment 'A' provides the results of the root cause investigation to date. Further investigation is currently underway and the results of these investigations will be provided, when complete. Attachments 'B' and 'C' provide short and long term corrective actions, respectively. Finally Attachment D provides a summary of the review concerning Operator intervention during the event.

Please direct any questions to the Nuclear Licensing Department.

Very truly yours,

T.J. Kovach
Nuclear Licensing Manager

Attachments

cc: W. Shafer, Region III
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Attachment A

INVESTIGATION AND
ROOT CAUSE SUMMARIES

1. Fire in the 2D Condensate/Condensate Booster pump motor.

The initial investigation of the motor fire indicated that an internal fault occurred within the motor windings. Removal of the motor end bells on January 19, 1990, supported this conclusion. A maintenance history review indicated that electrical meggering and polarization tests had been performed on the 2D pump motor in July, 1987. The polarization index results, based on motor meggering, was 1.9. This data was classified as slightly below the 2.0 index which is considered normal; however, the megger data recorded was well above the minimum acceptable megger values. The motor was considered satisfactory for further service in accordance with IEEE Standard 43, Recommended Practices for Testing Insulation Resistance of Rotating Machinery. Therefore, replacement of the 2D pump motor was judged to be not appropriate in July, 1987.

Review of maintenance and system history records indicated that previous Condensate/Condensate Booster pump motor failures have occurred at the Dresden Station in 1981 and 1987. The 1981 event involved a bearing failure, and the 1987 event involved a motor internal fault. The Electrical Maintenance Department had instituted cleaning of the Condensate/Condensate Booster pump motors. Two of the four Unit 3 pumps and three of the four Unit 2 pumps (all except the 2D pump) had been cleaned under this program prior to this event. Additionally, a thermography program is currently under development by the station Technical Staff to assist with predictive maintenance. Vendor demonstration thermography data gathered in November, 1989 indicated that the 2D pump motor windings were operating at a slightly higher temperature than the other Condensate/Condensate Booster pumps. Periodic vibration monitoring data taken by the Technical Staff did not indicate any abnormalities.

Following the AIT exit, further investigation of the 2D pump motor was conducted by SEED and System OAD Engineers. The disassembly and inspection determined that the failure occurred between the top and bottom coil where the coils exit the core iron. This resulted in flashover to a compression finger. The failure was located at approximately the 330-degree position, when facing the connections inside the winding. Significant dirt was observed throughout the vent openings, which would have resulted in decreased air flow throughout the windings. However, further inspections of the failure area will be required in order to pinpoint the root cause of failure.

2. Apparent failure of the 2B Condensate/Condensate Booster pump to automatically start.

At the time of the event, the 2B Condensate/Condensate Booster pump was selected as the standby pump and, as such, would have been expected to start upon failure of the 2D pump. The standby pump autostart logic is designed to provide automatic start of the standby Condensate/Condensate Booster pump on decreasing Reactor Feed Pump (RFP) suction header pressure or trip of any running Condensate/Condensate Booster pump. The standby pump logic system, including feed breaker logic and suction pressure instruments, was functionally tested satisfactorily.

It was concluded that the 2B Condensate/Condensate Booster pump did, in fact, start upon failure of the 2D pump. This was not observed by Control Room Operations personnel during the approximate two-minute period before failure of Reserve Auxiliary Transformer TR 22, which caused loss of feed to all the Condensate/Condensate Booster pumps and RFP's, and may have been due to the many required Operator actions in progress during this period. No alarm printer line item is provided for start of the standby pump. Approximately two seconds after failure of the 2D Condensate/Condensate Booster pump, the running RFP's tripped, apparently on low suction pressure, even though the standby 2B Condensate/Condensate Booster pump had started. The selected standby 2B RFP then automatically started; an Operator also restarted the 2A RFP. The RFP's continued to run and, therefore, adequate RFP suction pressure was supplied by the 2A, 2B, and 2C Condensate/Condensate Booster pumps. This supports the conclusion that the selected standby 2B Condensate/Condensate Booster pump had previously started, since three Condensate/Condensate Booster pumps would be necessary to supply adequate suction for two running RFP's.

3. <u>Unexpected failure of Reserve Auxiliary Transformer TR 22.</u>

Oil sample analyses indicate that significant insulation breakdown had occurred. Preliminary investigation by Operational Analysis Department (OAD) and Station Electrical Engineering Department (SEED) personnel indicates that the failure was apparently incipient. Further investigation is underway to determine the specific failure cause including any relationship to the motor fault on the 2B Condensate/Condensate Booster pump.

4. <u>Premature closure of the 2C outboard Main Steam Isolation Valve (MSIV).</u>

Outboard MSIV 2-203-2C was observed to spuriously close approximately three minutes into the event, immediately after the main generator field breaker opened. Investigation revealed that the DC solenoid for MSIV 2-203-2C had failed due to an open coil.

The MSIV's are equipped with normally energized AC and DC solenoids. The deenergization of both solenoids is required to cause MSIV closure. In this event, failure of Reserve Auxiliary Transformer TR 22 (coincident with separation of the main generator) resulted in a momentary loss of onsite AC auxiliary power while the Unit 2 and 2/3 Emergency Diesel Generators (DG's) automatically loaded onto the emergency buses. This momentary loss of AC power coupled with the failed DC solenoid caused the spurious closure of the outboard MSIV. The MSIV DC solenoids are replaced on a preventive maintenance interval of every third refuel outage. The 2-203-2C MSIV DC solenoid was last replaced on February 11, 1989.

5. <u>Failure of the 2-203-3B Electromatic Relief Valve (ERV) open indicator lamp socket.</u>

Upon placing the 2-203-3B ERV control switch to the MANUAL position, its open indicator lamp shorted. The intent of opening the ERV was to assist in the control of reactor pressure. The Operator returned the control switch to the AUTO position to close the valve, and proceeded to open the 2-203-3C ERV. Review of ERV temperature recorder data verified that the 2-203-3B ERV did open and close properly. The failure of the socket assembly could have resulted from foreign material within the socket.

6. <u>Potential failure of the main generator to trip properly on reverse power circuitry.</u>

The main generator is equipped with two circuits designed to automatically trip the main generator on reverse power conditions. The first, associated with a primary GGP relay (32G3), is initiated by way of a turbine trip signal and is designed to trip the generator at a real reverse power value of approximately -2.18 MWe after a 5-second time delay. The primary GGP circuit also prohibits the Operator from opening the OCB's, via main Control Room panel 902-8, until the reverse power and time delay setpoints are satisfied. This open-prohibit interlock does not apply to the OCB control switches on the 345 KV switchyard control panel, located in the common area of the Control Room. The second reverse power trip circuit is a secondary GGP relay (92G3) which is designed to trip the main generator at a real reverse power value of approximately -2.18 MWe with a 15-second time delay. The secondary GGP relay, therefore, normally trips the main generator unless a turbine trip signal is present.

Following this event, the generator did not appear to trip within the expected setpoints. The Operator, as directed by the Shift Engineer, attempted to open the OCB's via the panel 902-8 control switches. As this was unsuccessful, the OCB's were then opened via the 345 KV switchyard panel. Reactor Scram procedure DGP 2-3 provides for taking these actions in order to trip the generator, if the generator appears not to trip within the expected setpoints. Opening of the OCB's provided an automatic trip of the generator as expected.

Testing of the reverse power relays was performed on-site by OAD personnel. Following the onsite testing, the primary and secondary GGP relays were taken to the Company's Technical Center for further testing. Initial results of this testing indicated that the relay trip setpoints were, in fact, set in accordance with vendor recommendations. However, the real power values (at which the reverse power trip occurs) were demonstrated in laboratory testing to be biased by significant reactive loads. As the generator was experiencing a significant reactive power loading at the time of the event, it is currently believed that this resulted in biasing of the real power trip setpoints, such that the generator trip did not occur as expected. Further investigation is currently underway.

7. <u>Failure of the 2B Shutdown Cooling (SDC) pump discharge valve MO2-1001-4B to open electrically.</u>

While preparing to align the "B" SDC loop, the 2B SDC pump discharge valve MO2-1001-4B failed to open via its control switch. An Operator was dispatched to open the valve manually, but this required assistance from the Mechanical Maintenance Department because the valve operator disengage arm was not functioning properly.

Disassembly and inspection of the valve motor on January 18, 1990, revealed that the initial cause of failure was shearing of a motor pinion gear key, which effectively uncoupled the operator assembly from the motor. Subsequent disassembly of the operator gear train revealed that a declutch fork mechanism was slightly out of phase. This condition resulted in the manual disengage arm only actuating partially, thereby, preventing proper manual operation of the valve. The valve operator torque switches were verified to be set properly. This valve was last operated electrically following a previous Unit 2 reactor scram which occurred on January 5, 1990.

Attachment B

IMMEDIATE AND SHORT-TERM CORRECTIVE ACTIONS

1. Fire in the 2D Condensate/Condensate Booster pump motor.

The 2D Condensate/Condensate Booster pump motor replacement work was completed on January 26, 1990.

2. Apparent failure of the 2B Condensate/Condensate Booster pump to automatically start.

The standby pump automatic start logic was functionally tested satisfactorily, as described previously in Attachment A. It was concluded that the standby 2B Condensate/condensate Booster pump did, in fact, start properly upon sensing an undervoltage condition after failure of the 2D pump. Therefore, no further immediate corrective actions were needed.

3. Unexpected failure of Reserve Auxiliary Transformer TR 22.

A team of OAD, SEED, and Substation Construction Department personnel was mobilized to replace TR 22 with a spare transformer. On January 22, 1990, the new transformer was in place, connection/testing activities were completed, and the transformer was energized.

4. Premature closure of the 2C outboard Main Steam Isolation Valve (MSIV).

The 2-203-2C MSIV DC solenoid was tested and found to have an internal open. The DC solenoid was then replaced.

5. Failure of the 2-203-3B Electromatic Relief Valve (ERV) open indicator lamp socket.

The 2-203-3B ERV open indicator lamp socket was removed and replaced. Because examination of the removed socket assembly indicated that foreign material in the socket base may have been the cause, the remaining ERV light sockets were vacuumed to remove any accumulated foreign material. Other selected control panel light sockets were also checked for cleanliness.

6. Possible failure of the main generator to trip properly on reverse power conditions.

As described in Attachment A, the reverse power relays were functionally verified to be set in accordance with vendor recommendations. However, the real reverse power trip values were subsequently demonstrated to be biased by significant reactive loads. The following short-term corrective actions were therefore initiated:

a. Until further investigation and testing could be performed, the primary and secondary reverse power relays were assumed to be deficient and were replaced prior to startup.

b. Operator response procedures were reviewed/revised as appropriate prior to startup, in order to provide guidance concerning Operator action to be taken to trip the generator.

7. Failure of the 2B Shutdown Cooling (SDC) pump discharge valve MO2-1001-4B to open electrically.

The MO2-1001-4B valve operator gearbox was rebuilt prior to Unit 2 startup. An improved-type pinion key was installed to prevent future failure, and the declutch mechanism was adjusted to provide proper manual operation.

Attachment C

LONG-TERM CORRECTIVE ACTIONS

1. Fire in the 2D Condensate/Condensate Booster pump motor.

a) The Station Technical Staff will continue with implementation of a thermography program to assist with predictive maintenance activities. Formal implementation of the thermography program is currently scheduled for June 30, 1990.

b) Periodic vibration monitoring of Balance of Plant rotating equipment, such as the Condensate/Condensate Booster pumps, will continue.

c) The Electrical Maintenance Department will clean the remaining Unit 3 Condensate/Condensate Booster pumps (3A and 3D) on an expedited basis.

d) Megger and polarization index tests were performed on the 3A and 3D pumps prior to startup from the current Unit 3 refuel outage (D3R11). The 3A pump megger and polarization index values were 5 E 5 ohms and 3, respectively. The 3D pump megger and polarization index values were also 5 E 5 ohms and 3, respectively. These data are considered to be satisfactory.

e) The Station's Electrical Maintenance Department will revise the meggering/polarization index procedure to clarify the acceptance criteria and review process.

f) The Technical Staff will implement a program for periodic trending of polarization index testing of all 4 KV motors, so that this data can be utilized as a predictive maintenance indicator.

g) The Electrical Maintenance Department is planning to cut out a section of the windings around the failure area in order to perform a more detailed inspection. A formal report will then be issued by SEED to document the conclusion of this investigation.

2. Apparent failure of the 2B Condensate/Condensate Booster pump to automatically start.

As described previously, it is currently believed that the standby Condensate/Condensate Booster pump did start properly after failure of the 2D pump motor. It was noted during the investigation that the undervoltage start signal was a recent modification, which had been implemented following a similar Condensate Booster pump failure on Unit 3 in 1987. The purpose of the modification was to provide more rapid start of the standby pump to support Reactor Feed Pump (RFP) suction pressure, such that automatic trip of the RFP's on low RFP suction pressure would be prevented. The Technical Staff will continue to evaluate the RFP suction header pressure recovery issue in order to determine if further modifications or actions can be taken to prevent automatic trip of the RFP's on low suction pressure in this type of event.

3. Unexpected failure of Reserve Auxiliary Transformer TR 22.

Further investigation concerning the failure of TR 22 is in progress. A formal report will be issued by SEED documenting this investigation and any further recommended corrective actions.

4. Premature closure of the 2C outboard Main Steam Isolation Valve (MSIV).

a. Periodic preventive maintenance replacements of the MSIV solenoids will continue.

b. A surveillance will be developed to test the MSIV solenoids for potential coil failure. This surveillance will be conducted when the unit is in cold shutdown and the test has not been performed in the previous six months.

5. Failure of the 2-203-3B Electromatic Relief Valve (ERV) open indicator lamp socket.

The Station Operating Staff is evaluating the feasibility of periodically vacuuming the control panel light sockets in order to maintain their cleanliness.

6. Potential failure of the main generator to trip properly on reverse power circuitry.

The Operational Analysis Department staff is continuing to investigate this issue and will issue a follow-up report to document any further recommended actions.

7. Failure of the 2B Shutdown Cooling (SDC) discharge valve MO2-1001-4B to open electrically.

A comprehensive Motor Operated Valve (MOV) Improvement Program was underway at the time of this event. The following items were included in this program:

a. Comprehensive revision of MOV maintenance procedures had been completed.

b. All safety-related MOV's had been overhauled in accordance with the upgraded procedures.

c. A schedule for overhaul of non-safety-related Balance of Plant valves (such as MO2-1001-4B) within the next two and one-half years had been established. Additionally, the Maintenance Staff will expedite overhaul of the remaining Unit 2 and 3 SDC pump discharge valve operators containing the original-type pinion keys.

d. Enhanced MOV preventive maintenance frequencies had been established, such that safety-related MOV's are scheduled for inspection at every other refuel outage.

Attachment D

OPERATOR INTERVENTION POLICY REVIEW

Approximately three minutes following failure of the 2D Condensate/Condensate Booster pump, manual Operator action was initiated to start the Unit 2 Diesel Generator (DG). The Operating crew, including the Shift Engineer, were aware that a reactor scram had occurred, that the Reserve Auxiliary Transformer TR 22 had tripped and that the normal AC power would be interrupted upon trip of the main generator. In anticipation of the loss of AC power, the Operator determined that starting the Unit 2 DG was an appropriate preparatory measure. When the trip occurred, the Unit 2 DG closed automatically onto its emergency bus (4160V bus 24-1). Reactor conditions at this time were stable and the parameters of reactor pressure and level were deemed to be within a satisfactory band. The Operator closed the Main Steam Isolation Valves to conserve reactor inventory and initiated manual load shedding in accordance with procedure Dresden General Abnormal Procedure DGA 12, Partial of Complete Loss of AC Power. The manual load shedding procedure included placing the LPCI and Core Spray in the pull to lock position (to prevent their automatic start as the result of increasing drywell pressure due to the loss of the cooling medium to the drywell coolers) to avoid overloading of the DG.

Review of the DG load shedding logic indicates that the purpose for allowing the DG to automatically start and close onto the emergency bus (as opposed to manual initiation) is to prevent the possibility of exceeding the DG load carrying capacity. Procedure DGA 12 directs the Operator to verify the automatic start of the Unit 2 and 2/3 DGs, and the automatic start, by definition, requires taking manual action if the functions do not occur automatically; however, in this case, the Operator initiated the manual action prior to the receipt of the automatic signal. A procedure deficiency was identified with DGA 12 in that no specific precaution against manual DG starts in this type of scenario was provided. Reveiw of this concern with the Station Training Department concluded that further review and training on this topic was required.

The manual start and synchronization of the DG prior to a loss of off-site power could potentially result in an overload of the DG when the feed breaker from the auxiliary transformer to Bus 24 opens on a loss of off-site power. Since Bus 24 is the normal AC electrical feed to Bus 24-1 and if the Unit 2 DG output breaker to Bus 24-1 is closed, the Unit 2 DG could potentially try to carry all the loads on both buses (Bus 24 and Bus 24-1). If the DG were allowed to auto-start, the Bus 24 to Bus 24-1 feed breaker would open, and load shedding on Bus 24-1 would occur. The DG would then be manually loaded with the loads required for safe shutdown and cooldown of the reactor as needed. Operator actions conducted during the event would have mitigated the consequences of a DG overload because of the manual load shedding that was performed per DGA 12.

This potential configuration of DG loads is within the original design basis, and also occurs during routine required monthly DG operability surveillances. During the DG operability surveillances, the DG is started and loaded manually onto its respective emergency bus and functionally verified to carry rated capacity. If design-basis LOCA (coincident with a loss of off-site power) conditions were then to cause automatic start of the LPCI/Core Spray pumps (fed via the emergency bus), potential overload of the DG until trip of its loads could also occur. This would have no effect on the remaining LPCI/Core Spray pumps fed from the opposite emergency bus and is of extremely low probability.

Formal training on this event was initiated by the Training Department on January 22, 1990, including specific clarification that manual action should not be taken to start the DGs in this type of event unless they fail to start upon receipt of an automatic start signal. This training was performed with all Licensed Shift Operations personnel prior to their assuming Shift duties under power operations, and was completed with all Licensed Shift Operations personnel by January 29, 1990. This training is also being performed with individuals holding inactive Licenses on an expedited basis, and will also be included in the Licensed Operator Initial Training program.

The Operations Staff will also review and revise DGA 12 in order to ensure that adequate precautions relative to manual start of the DGs are provided. Dresden Administrative Procedure (DAP 7-12), Conduct of Operations, and Nuclear Operations Directive NOD-OP.1, Conduct of Operations, will be reviewed for consistency in this area.

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