LICENSEE EVENT REPORT (LER)

Form Rev 2.0

Facility Name (1)	Docket Number (2)	Page (3)
Dresden Nuclear Power Station, Unit 2	0 5 0 0 0 2 3 7	1 of 1 0

Title (4) Reactor Scram During Power Operation Due to Low Reactor Water Level Resulting From an Unanticipated Closure of the 2B Feedwater Regulating Valve

Event Date (5)			LER Number (6)			Report Date (7)			Other Facilities Involved (8)	
Month	Day	Year	Year	Sequential Number	Revision Number	Month	Day	Year	Facility Names	Docket Number(s)
									N/A	0 5 0 0 0
0 7	1 7	8 7	8 7	0 2 3	0 1	1 0	2 5	8 8	N/A	0 5 0 0 0

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10CFR (Check one or more of the following) (11)			
POWER LEVEL (10)	0 8 4	___ 20.402(b)	___ 20.405(c)	X 50.73(a)(2)(iv)	___ 73.71(b)
		___ 20.405(a)(1)(i)	___ 50.36(c)(1)	___ 50.73(a)(2)(v)	___ 73.71(c)
		___ 20.405(a)(1)(ii)	___ 50.36(c)(2)	___ 50.73(a)(2)(vii)	___ Other (Specify in Abstract below and in Text)
		___ 20.405(a)(1)(iii)	___ 50.73(a)(2)(i)	___ 50.73(a)(2)(viii)(A)	
		___ 20.405(a)(1)(iv)	___ 50.73(a)(2)(ii)	___ 50.73(a)(2)(viii)(B)	
		___ 20.405(a)(1)(v)	___ 50.73(a)(2)(iii)	___ 50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

Name	TELEPHONE NUMBER AREA CODE
Michael Moy, Technical Staff Engineer Ext. 421	8 1 5 9 4 2 -2 9 2 0

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS
X	J B	D C C	B 0 4 5	Y					
X	S J	F S V	A 6 0 9	Y					

SUPPLEMENTAL REPORT EXPECTED (14)		Expected Submission Date (15)	Month	Day	Year
___ Yes (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

ABSTRACT (Limit to 1400 spaces, i.e, approximately fifteen single-space typewritten lines) (16)

On July 17, 1987 at 2328 hours with Unit 2 descending in power at a conservative average rate of 10 MWe/hour via recirculation flow, the reactor scrammed from 84% rated thermal power on a low reactor water level signal of plus eight inches water level. The root causes of the event were four Feedwater Regulating Valve (FWRV) component failures, and feedwater level control system difficulties. To determine the root cause of the system difficulties a task force was formed and a root cause analysis performed. Several major contributing factors were identified as being the cause of this and other similar previous events. Consequently, several modifications were initiated and will be completed during the upcoming 1988 Unit 2 refueling outage. In addition 24 operating procedures are being revised to include updated operating guidelines for feedwater and condensate system operation.

Corrective actions entailed maintenance repairs and replacements for the component failures, extensive feedwater level control testing, the implementation of numerous pre-startup directions and precautions, and additional Operator training. The safety significance was minimal since all emergency core cooling systems were available; however, no actuation was necessary, the feedwater level control system remained capable of manual control of reactor level at all times and the reactor scrammed at the specified conservative setpoint. Five previous occurrences were reported by Licensee Event Reports #87-13 and #87-12 and #84-10 on Docket 050249 and #87-16 and #84-9 on Docket #050237.

IE22

PLANT AND SYSTEM IDENTIFICATION:

General Electric Boiling Water Reactor - 2527 MWt rated core thermal power. Energy Industry Identification System (EIIS) codes are identified in the text as [XX].

EVENT IDENTIFICATION:

Unit 2 Reactor Scram During Power Operation Due to Low Reactor Water Level Resulting from an Unanticipated Closure of the 2B Feedwater Regulating Valve.

A. CONDITIONS PRIOR TO EVENT:

Unit: 2 Event Date: July 17, 1987 Event Time: 2328 Hours

Reactor Mode: N Mode Name: Run Power Level: 84%

Reactor Coolant System (RCS) Pressure: 985 psig

The 2A and 2B reactor feedwater pumps [SJ] were in service with the 2B Feedwater Regulating Valve (FWRV) [SJ] controlling reactor water level in single element control based on input from the A reactor level instrument. The 2A FWRV was isolated from service due to previous mechanical operation problems encountered at 1815 hours on July 17, 1987.

B. EVENT DESCRIPTION:

On July 17, 1987 at 1815 hours with Unit 2 in the run mode with reactor power steady at approximately 2372 megawatts thermal (91% power), the Unit 2 Nuclear Station Operator (NSO) observed a rapid increase in reactor water level. FWRV AO-2-642A was controlling reactor level in the automatic mode when the NSO also observed that feedwater level control system [JB] demand was zero. With a zero demand feedwater level control signal, the 2A FWRV should have closed to lower reactor level. However, the 2A FWRV did not respond and reactor water level continued to increase. The NSO then began to close the 2A FWRV isolation valve MO-2-3206A, located downstream of the 2A FWRV, to control reactor level. When level was under control, the NSO placed low flow FWRV AO-2-643 in the automatic mode to control level oscillations.

The Unit 2 Operating Shift Foreman was immediately dispatched to the feedwater regulating station to inspect the 2A FWRV and discovered that the manual handwheel for the valve was fully engaged preventing the valve from closing. The Foreman also discovered that the valve was stuck at approximately 90% open with a full close signal of 100 pounds air pressure being supplied to it.

From the Control Room, the NSO began to throttle open 2B FWRV AO-2-642B while manually throttling closed motor operated valve MO-2-3206A (2A FWRV 2-642A isolation valve). Control of reactor level was successfully achieved with the 2B FWRV in manual, the low flow FWRV in automatic, and the 2A FWRV isolation valve fully closed. After the 2A FWRV was isolated by MO-2-3206-A, several attempts were made to cycle the 2A FWRV. Position changes of less than 90% were successfully achieved; however, the valve would not fully close, stopping at approximately 50-55% open. The air supply to the 2A FWRV was locally equalized across the valve operator and then locally isolated. This resulted in low supply air pressure and a subsequent FWRV lock-out. A lock-out condition occurs when a FWRV controller output signal is lost (below 1 milliamp) or when the supply pressure to the air dump valve is low (below 75 psig).

Either of these conditions causes a solenoid operated valve to deenergize, thus interrupting and bleeding off the air to a dump valve. See Figure 1. The air dump valve is spring loaded and when spring tension overcomes air pressure (65 psig), the air dump valve exhausts air from the air lock valves. The air lock valves then reposition closed to interrupt any air signal from the positioner and locks-out the air in the valve operator preventing any position change. The Instrument Maintenance Department inspected the feedwater level control circuitry; however, no problems were discovered. Subsequently, the 2B FWRV and the low flow FWRV were placed in the automatic mode of operation.

Following instructions from daily orders prepared by the Unit 2 Operating Engineer, the Unit 2 NSO began reducing power at an average rate of 100 MWe/hour to reduce thermal input to the station cooling lake. While descending in power, the NSO observed the 2B FWRV responding sluggishly and at 2122 hours the valve automatically locked-out. The lock-out condition was immediately reset and the decision was made to reduce power at a slower rate of 10 MWe/hour via reactor recirculation flow. At 2328 hours, a loss of air to FWRV AO-2-642B alarm (alarm F-10 on panel 902-6) initiated and was followed by an immediate reactor scram on reactor low water level of plus 8 inches above vessel instrument zero. The scram signal was initiated by the Reactor Protection System [JE]. The reactor scrammed at a reactor power of 2135 megawatts thermal (84% power) with the feedwater level control system in single element control and the 2B FWRV still in the automatic mode maintaining reactor vessel level. Vessel level reached a minimum recorded level of -37.5 inches (105.5 inches above top of active fuel) and remained at this point for approximately one minute. During this time the NSO reviewed indications on all four feedwater control system digital controllers (master controller, 2A FWRV and 2B FWRV controllers, and low flow FWRV controller). Contrary to the actual reactor low water level condition, all four controllers were transmitting full closed signals to the 2B FWRV and the low flow FWRV. Also, the "High Process Level Alarm" lights on the controllers were lit indicating high reactor water level. Additionally, there was no indication of feedwater flow or FWRV movement on any of the four controllers' vertical or horizontal bar scales, respectively. Upon realizing that there was no feedwater flow to the reactor and that a low reactor water level condition of -30 inches existed, as indicated by medium range level instruments 2-263-23A, B [IG], the NSO immediately placed the minimum flow FWRV controller in manual and demanded full open at maximum demand rate. This action was successful in supplying feedwater flow. At approximately 2331 hours, the NSO cleared the 2B FWRV air lock-out condition and the valve immediately responded open. Reactor level recovered rapidly and increased to +55 inches at 2332 hours, tripping both the 2A and 2B reactor feedwater pumps on high reactor water level. The scram signal was reset at 2342 hours and reactor level was restored to the normal +30 inches at 2345 hours. The low flow FWRV controller remained in the automatic mode with the 2B FWRV controller in the manual mode.

C. CAUSE OF EVENT:

This event is being submitted to comply with 10 CFR 50.73(a)(2)(iv) which requires the reporting of any event or condition that resulted in manual or automatic actuation of an Engineered Safety Feature [JE], including the Reactor Protection System.

The root cause of failure of the 2A FWRV was component failure. Investigation revealed that the manual handwheel stop had broken allowing the handwheel to freewheel and become fully engaged in the closed position with the valve greater than 55% open. This condition allowed full open travel of the 2A FWRV stem and stem coupling, but prevented travel of less than 55% open due to mechanical interference.

Testing of the 2A FWRV by the Instrument Maintenance Department revealed further problems. Both the valve positioner and the booster relay for the regulating valve were discovered faulty resulting in production of signaling errors and unsatisfactory valve operation. The valve positioner was determined to be supplying air to the booster relay at a supply pressure approximately 25 pounds lower than desired as specified by the manufacturer. Further investigation revealed the positioner to be out of adjustment apparently due to vibration and the inability of a stability adjustment screw to perform its intended function. The air booster relay was discovered incorrectly venting to atmosphere a percentage of the air supply to the 2A FWRV air operator lower cylinder. Investigation revealed improper booster relay valve diaphragm seating apparently caused by age or wear as no evidence of foreign material was found.

The root cause of failure of the 2B FWRV was also component failure. Testing, again performed by the Instrument Maintenance Department, for valve stroke time and position accuracy disclosed several intermittent 2B FWRV lock-out occurrences as the regulating valve was cycled open. Each lock-out occurrence was individually reset. The lock-out occurrences were concurrent with valve positioner output signal step changes of approximately 10 milliamps. The root cause of the intermittent lock-out occurrences was attributed to a partial air restriction in air supply/isolation solenoid valve SO-2-655-B. The partial air restriction prevented air supply demand from increasing at the rate necessary to prevent low supply air pressure to the 2B FWRV air dump valve thus creating a lock-out condition. However, once the lock-out condition occurred, enough time elapsed for the air supply pressure to recover allowing reset of the lock-out condition and further opening of the FWRV until air supply demand once again exceeded the partially restricted air solenoid valve's capabilities. The apparent cause for partial air restriction within the solenoid was determined as wear for no evidence of foreign material was found and the lock-out conditions occurred intermittently, dependent on the number of times the air solenoid valve was exercised.

Previous to this July 17, 1987 event, Dresden Unit 3 scrammed from 25% rated core thermal power on July 11, 1987. The root cause of the event was attributed to feedwater system instabilites which occurred while the feedwater level control systems was being operated in the three element mode of operation (reference License Event Report #87-012-0; Docket #050249). A task force was formed as corrective action to further investigate this event and make recommendations to preclude recurrence. As part of the task force investigation, a Bailey diagnostic computer was acquired to assist in monitoring of the Unit 3 FWLC system parameters.

On August 7, 1987, significant oscillations in Unit 3 feedwater and condensate system pressures were experienced as were other operating difficulties resulting in a manual reactor scram (reference Licensee Event Report #87-013-0; Docket #050249). This event, in addition to the previous two events on July 11, 1987 and July 17, 1987 led to the development of an in-depth feedwater system operability test program to collect feedwater system operating data during the Unit 3 startup following the August 7, 1987 shutdown. Since operation of the Unit 2 feedwater system is in principle the same as Unit 3, the information collected during the testing program was to be applied to Unit 2 as appropriate.

The Unit 3 feedwater operability testing was completed on October 8, 1987. From the observations made during the testing and the subsequent "root cause analysis", the following were identified as the major contributing factors to the cause of the transient events:

The design of te dual ported plug configuration of the 3A FWRV in conjunction with a piston type air operated actuator assembly allowed the valve to be susceptible to flow induced oscillatory movement at certain valve lift and feedwater flow conditions.

The reactor feed pump discharge header pressure was observed to be very high on Unit 3 at low flow conditions (below 6000 gpm feedwater flow). Present operating procedures and present settings of the pump minimum flow valve controls resulted in the reactor feed pumps being operated for sustained periods during normal shutdowns at flows less than desirable for maintaining stable flow through the pumps.

The condensate/condensate booster pumps were also frequently operated for extended periods in potential cavitation conditions when the unit is being shutdown prior to the opening of any feedwater or condensate booster pump minimum flow recirculation valves.

The procedures for feedwater and condensate system operations did not provide the operator with sufficient detailed instructions to prevent operation of the unit in conditions which were detrimental to the plant piping and equipment.

D. SAFETY ANALYSIS:

Although the 2B FWRV and the low flow FWRV did not open in the automatic mode in response to the low reactor water level condition, the NSO was able to open the valves under manual control to maintain water level. Also, while the conditions for which the reactor scrammed did not warrant any automatic or manual operation of the Emergency Core Cooling Systems (ECCSs), i.e., high pressure coolant injection [BJ], low pressure coolant injection [BO], core spray [BM], and automatic depressurization system [SB], the systems were available to provide an alternate means for reactor water makeup and for reactor cooling. ECCS actuation occurs at -59 inches (84 inches above top of active fuel) and at no time did reactor vessel level decrease below -37.5 inches (105.5 inches above top of active fuel). Further, the reactor scrammed at a conservative reactor water level. Technical Specification 2.1.C. "Limiting Safety System Setting" states that the reactor low water level scram setting shall be greater than or equal to 144 inches above the top of active fuel in the vessel at normal operating conditions. This corresponds to a reactor vessel level of +1 inch indicated. Level differences inside and outside the reactor dryer skirt vary from 0 inch difference at 0% steam flow to 7 inch difference at 100% steam flow, therefore the actual scram setpoint is set at +8 inches indicated level. Also, the Reactor Protection System functioned as designed in response to the low water level scram condition. For these reasons, the safety significance of this event was considered minimal.

E. CORRECTIVE ACTIONS:

To prevent future handwheel interference problems with the 2A FWRV, the handwheel was removed under Modification M12-2-87-26. The 2B FWRV, being a different type of regulating valve, did not warrant handwheel removal. The handwheels for both Unit 3 FWRVs were also removed under Modification M12-3-87-26. Justification for removal of the handwheels was based not only on the prevention of future interference problems, but also due to a lack of practicality in attempting to manually control reactor vessel level. The amount of time required to manually change position of a FWRV is much greater than the amount of time required to respond to vessel level control demands.

To correct the faulty signalling errors produced by the 2A FWRV valve positioner and booster relay, both the valve positioner and booster relay were replaced, like for like, in accordance with work instructions contained in Work Request 67156.

To correct the intermittent air lock-out occurrences for the 2B FWRV, the air supply/isolation solenoid valve was replaced under Work Request 67073. Subsequent testing of the regulating valve resulted in smooth valve operation and no further air lock-up.

As preliminary corrective action in determining the cause of the feedwater level control instabilities, a series of tests were performed on the digital feedwater control system. The tests were conducted by the Instrument Maintenance Department and a Bailey Controls technical representative. The tests included simulation of the scram event with various faulted input signal conditions such as loss of reactor level, loss of individual valve controllers, high reactor vessel level conditions, and low reactor vessel level conditions. The testing also included testing of system power supplies, circuit boards, and modules, verification of manual control capability in the event of a digital system failure and verification that normal reactor water level changes will not lock-out the 2B FWRV.

None of the tests were successful in duplicating control system faults. Therefore, an eight pen recorder was installed on the feedwater level control system to monitor the following parameters during normal unit operation:

1. A and B reactor water level channels.

2. A and B reactor pressure; 0-1200 psig for reactor level compensation.

3. 2A FWRV and 2B FWRV demand.

4. 2A FWRV and 2B FWRV position.

Prior to Unit 2 startup on July 20, 1987, the following actions were taken:

1. An extra NSO and Instrument Maintenance Foreman were assigned to monitoring of the feedwater control system performance from reactor heatup to approximately 50% power.

2. The operator selected alarms for reactor high and low water level were set at plus 35 inches and plus 25 inches, respectively.

3. Operating Order #37-87, "Reactor Feedwater Regulation Valve Operation", was issued stating the appropriate FWRV mode of operation during startup and subsequent operation. This Operating Order was reissued as #11-88 on July 1, 1988.

4. Feedwater level control system performance was evaluated during the 12 hour xenon soak by Instrument Maintenance Department personnel and Operating Department personnel. No operational problems were noted.

5. Orders that if any abnormalities were observed with the level control system at any time, the reactor would be brought to a stable steady state mode of operation and a thorough evaluation of the problem by station management be conducted prior to resuming power ascension.

6. The event was incorporated into training and was discussed in Instrument Maintenance and Operations Department tailgates.

Based on the Unit 3 root cause analysis and subsequent modifications performed during the 1988 Unit 3 refueling outage, several modifications are being implemented for the Unit 2 feedwater regulating valves. The actuator for the 2A FWRV was replaced with an air operated hydraulically dampened actuator under Modification M12-2-88-04 during the week of May 16, 1988. This actuator was designed to help stabilize the 2A FWRV, with no change to the valve's internal trim design, by providing resistance to fast-acting position changes. Partial Modification M12-2-88-13C was initiated to change the internal valve trim with an improved design. The control accessories and actuator will also be changed as necessary. However, this partial modification and related accessory changeout is not expected to begin until modification testing of the 3B FWRV is completed. Modification testing of the 3B FWRV should be completed during the fourth quarter of 1988.

The internal valve trim for the 2B FWRV is also scheduled for replacement with an upgraded disk stack (the 2B FWRV is a drag valve) in an attempt to achieve stable operation to 100% reactor power. This work will be performed under partial Modification M12-2-88-13A. Additionally, the existing air operated actuator on the 2B FWRV will be replaced with an electrohydraulic actuator, including all power and control accessories under partial Modification M12-2-88-13B. Both of these partial modifications are tentatively scheduled for the upcoming 1988 Unit 2 refueling outage.

Also during the August 7, 1987 Unit 3 feedwater event two small bore tap lines had broken at their main header connection to the feedwater system. Consequently, 44 small bore lines were inspected and evaluated for adequate support. Eleven lines were evaluated as needing modification.

This work was performed under partial Modification M12-3-88-3B during the 1988 Unit 3 refueling outage. Similarly for Unit 2, 32 lines were identified as requiring an engineering evaluation for adequate support. Twenty-seven lines were evaluated as needing support modifications. This work will be performed during the upcoming 1988 Unit 2 refueling outage under partial Modifications M12-2-88-3A, B, C, D.

Finally, 24 feedwater system related procedures were reviewed as part of the root cause analysis and are currently under revision to incorporate recommended changes to prevent flow induced system transients. The procedures affected are the Dresden General Procedures for unit startup and shutdown, the feedwater system specific operating procedures and the Dresden Operating Abnormalities procedures. The intention of the procedure changes are to better define the operating limits of the reactor feedwater pumps and the condensate/condensate booster pumps to prevent pump vibration and excessive pump discharge pressures. These changes will also help to reduce system pressure by providing guidance for better condensate demineralizer bed differential pressure control. The feedwater regulating valve operation procedures were revised as part of the modification packages for the feedwater regulating valves.

F. PREVIOUS OCCURRENCES:

LER Number/Docket	Title
87-013/050-249	Manual Reactor Scram Due to Reactor Feedwater System Oscillations During Unit Shutdown Due to a Failure of Air Operated Containment Isolation Valve A03-1601-63 to Close During Surveillance Testing.

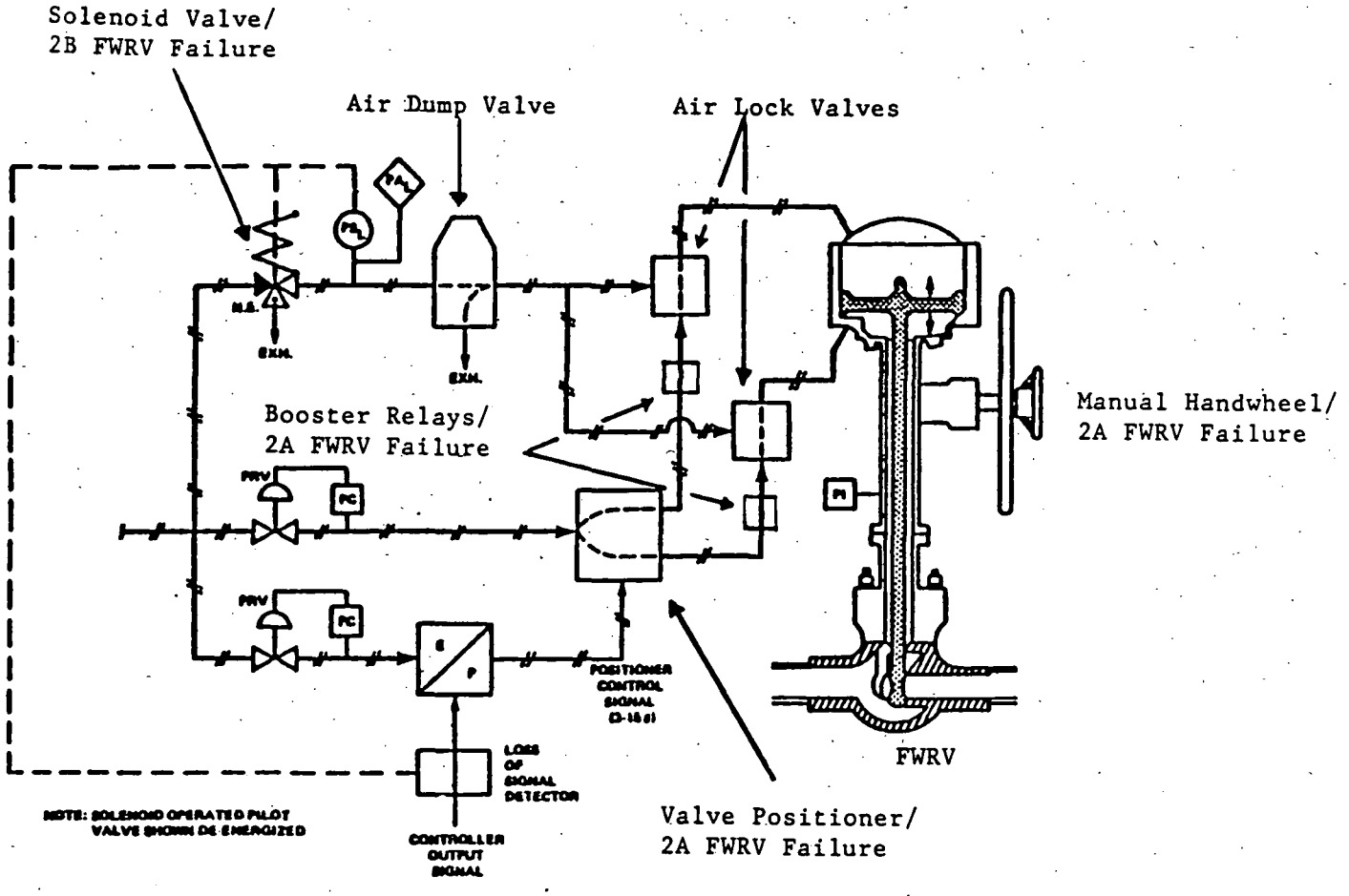
During a Unit 3 shutdown the 3A FWRV lock-out was received in addition to high vibration alarms for the reactor feedwater pumps and feedwater regulating valve station. The piping vibrations caused an instrument line to break on the 3C RFP piping and a drain line on the RWCU system. Unit 3 was manually scrammed to isolate the piping failures. Investigation into the event was initiated and appropriate repairs and corrective actions taken.

LER Number/Docket	Title
87-012/050-249	Dresden Unit 3 Main Turbine Trip on High Reactor Water Level and Subsequent Reactor Scram Due to Malfunction of the 3A Feedwater Regulating Valve. Root cause of this event was feedwater system instabilities which occurred while operating the feedwater level control system in three-element mode at low power levels. Corrective actions to prevent recurrence included procedural changes and evaluation of new instrument rack designs.
87-016/050237	Dresden Unit 2 Reactor Scram Occurred While at 31% Power Due to an Automatic Reactor Feed Pump Trip on High Reactor Water Level and Subsequent Level Decrease to the Low Level Scram Setpoint. This resulted from a feedwater regulating valve locking up in the full open position during testing of the feedwater level control system. A firmware change to the feedwater level control circuitry was implemented to help prevent future recurrence. The firmware change was also planned for Dresden Unit 3 and has since been implemented.
84-10/050249	Dresden Unit 3 Reactor Scram During Normal Operation Due to Low Reactor Water Level Caused by "A" Feedwater Regulating Valve Closure Due to Vibration. Corrective actions were to drill holes into the regulating valve coupling block and install set screws to secure the stem and valve operator to the coupling block.
84-9/050237	Dresden Unit 2 Reactor Scram Due to Reactor Low Water Level Caused by "A" Feedwater Regulating Valve Failing Closed Due to Vibration. Corrective action was to reconnect the valve operator and stem with sheet metal locktabs to prevent the locknuts from vibrating loose.

G. COMPONENT FAILURE DATA:

Manufacturer	Nomenclature	Model Numbers
Copes-Vulcan Inc.	2A FWRV	P-200-12
Babcock and Wilcox	2B FWRV	B209-12-18P9-13NJ41
Controlled Components Inc.	2B FWRV	18" x 18", 900# Offset Globe
ASCO	Solenoid Valve	WP830069F
Moore Products Co.	Valve Positioner	HF/R 74
Moore Products Co.	Valve Booster	61H

An industry-wide NPRDS data search was conducted for failures of Copes-Vulcan valves over a one year period. A total of 81 failures were identified, four of which were failures of the model P-200. The failures were attributed to FWRV valve positioner operating abnormalities. The positioner was either recalibrated or replaced in each case. An industry-wide NPRDS data search was also conducted for failures of Babcock and Wilcox valve operators. The search revealed six failures. Five of the failures were solenoid valve related. In each case, the solenoid valve was replaced. The sixth failure was attributed to excessive grease in the valve operator spring pack. The repair consisted of removing the excess grease.



FWRV Control System

FIGURE 1

Commonwealth Edison
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Morris, Illinois 60450
Telephone 815/942-2920

October 25, 1988

EDE LTR #88-776

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Licensee Event Report #87-023-1, Docket #050237 is being submitted as required by Technical Specification 6.6, NUREG 1022 and 10 CFR 50.73(a)(2)(iv). This revised report is submitted to provide the results of further investigation regarding the cause of this event and corrective actions taken to prevent recurrence.

E.D. Eenigenburg
Station Manager
Dresden Nuclear Power Station

EDE/ade

Enclosure

cc: A. Bert Davis, Regional Administrator, Region III
File/NRC
File/Numerical

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