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L-99-162

Beaver Valley Power Station, Unit No. 2
Docket No. 50-412 License No. NPF-73
LER 97-001-02

United States Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

In accordance with Appendix A, Beaver Valley Technical Specifications, the following Licensee Event Report supplement is submitted:

LER 97-001-02, 10 CFR 50.73(a)(2)(iv), "Reactor Trip Due to Main Transformer Ground Protection Relay."

This LER supplement updates the cause and corrective actions of the event.

K. L. Ostrowski

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Division Vice President
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Attachment

IE22

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NRC FORM 366 (6-1998) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

APPROVED BY OMB NO. 3150-0104 EXPIRES 06/30/2001

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TITLE (4)
Reactor Trip Due to Main Transformer Ground Protection Relay

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 NAME	DOCKET NUMBER
									N/A	
01	06	97	97	001	02	10	28	99	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	1
POWER LEVEL (10)	98

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	20.2201(b)		20.2203(a)(2)(v)		50.73(a)(2)(i)		50.73(a)(2)(viii)
	20.2203(a)(1)		20.2203(a)(3)(i)		50.73(a)(2)(ii)		50.73(a)(2)(x)
	20.2203(a)(2)(i)		20.2203(a)(3)(ii)		50.73(a)(2)(iii)		73.71
	20.2203(a)(2)(ii)		20.2203(a)(4)	X	50.73(a)(2)(iv)		OTHER
	20.2203(a)(2)(iii)		50.36(c)(1)		50.73(a)(2)(v)		
	20.2203(a)(2)(iv)		50.36(c)(2)		50.73(a)(2)(vii)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
R. D. Hart, Senior Licensing Supervisor	(412) 393-5284

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

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
B	EL	59	G182	Y						
X	EL	DIF	G182	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 15 single-spaced typewritten lines) (16)

On 1/6/97, at approximately 0556 hours, while in Mode 1 at approximately 98% power, Unit 2 experienced a reactor trip caused by a turbine trip due to operation of Main Transformer (MT) Ground Protection Relay 59-202G, which actuated MT Auxiliary Relay 87-202X1. Post-trip control and protection systems functioned correctly, plant parameters were established within normal control bands, and the plant was placed in shutdown. NRC 4-hour notification of this event was made, at approximately 0616 hours (same day). The root cause of this event is inadequate design implementation of relay 59-202G, which was in service during operation other than MT backfeeding, since initial Unit startup. Actuation of relay 59-202G is attributed to an arc to ground in the Main Unit Generator (MUG) when one of the air diffuser screens on the MUG 'B' phase Flexible Links Compartment (FLC) became detached, due to failed support welds, and momentarily contacted the MUG 22 kilo-volt (KV) isophase bus. Relay 59-202G was functionally tested and found acceptable. Other protective relays which could have actuated in response to an actual 22 KV ground fault were tested with no anomalies noted. The relay setting sheet and operating procedures for relay 59-202G were revised to ensure the relay is only in service during MT backfeeding. The corresponding Unit 1 relay setting sheet and procedures were reviewed and determined to be correct. The failed air diffuser screen was reattached with bolting and the other Unit 2 air diffuser screens were fastened with similar bolting. Unit 1 utilizes a different design for the MUG isophase leads box air diffuser screens. During the next Unit 1 refueling outage, the Unit MUG FLC will be inspected to ensure no loose components in the compartment.

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PLANT AND SYSTEM IDENTIFICATION

Westinghouse Pressurized Water Reactor

Main Transformer Ground Protection Relay 59-202G {EL/59/G182}*

Main Generator Backup Ground Protection Relay 50-201G {EL/50/W120}*

Main Generator Primary Ground Protection Relay 59-201G {EL/59/G182}*

Main Generator Backup Ground Protection Relay 51-201G {EL/51/G182}*

Main Transformer Auxiliary Relay 87-202X1 {EL/87/G080}*

Main Generator Potential Transformer 2GEN-PT-CUB {EL/XPT/G080}*

Main Generator Isophase Bus Compartment Door Air Diffuser Screen {EL/DIF/G080}*

* Energy Industry Identification System (EIIS) Plant System, Component, and Manufacturer Codes are identified in the text as {EIIS:XX/XX/XXXX}.

CONDITIONS PRIOR TO EVENT

Unit 1: Mode 1, approximately 99% Reactor Power

Unit 2: Mode 1, approximately 98% Reactor Power

This LER updates the cause and corrective actions of this event.

EVENT DESCRIPTION

On January 6, 1997, at approximately 0556 hours, while in Mode 1 at approximately 98% power, Beaver Valley Power Station Unit 2 experienced a reactor trip due to a turbine trip. The turbine trip resulted from operation of Main Transformer Ground Protection Relay 59-202G, ASEA Brown-Boveri Type ITE-59G, Model 211E1175 {EIIS:EL/59/G182}, which actuated Main Transformer Auxiliary Relay 87-202X1 {EIIS:EL/87/G080}. Plant parameters were established within their normal control bands shortly after the turbine trip and the plant was placed in a safe, shutdown condition in accordance with

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EVENT DESCRIPTION (continued)

procedures. NRC notification of this event was made, at approximately 0616 hours (same day), pursuant to the requirements of 10CFR50.72(b)(2)(ii). An Event Response Team (ERT) was formed (same day), to conduct a review of this event in accordance with plant procedures.

REPORTABILITY

This event is applicable to the reporting criteria of 10CFR50.73(a)(2)(iv), as an event or condition that resulted in a manual or automatic actuation of any Engineered Safety Feature (ESF), including the Reactor Protection System (RPS).

CAUSE OF THE EVENT

The root cause of the event is inadequate design implementation of the Transformer Ground Protection Relay 59-202G, which had existed since original Unit 2 startup. Relay 59-202G is designed to monitor voltage swings on an ungrounded system (during Main Transformer backfeeding). Contrary to this, the relay had been in continual service during normal system operation (reactive grounded system). With 59-202G in service during normal system operation, the relay was rendered susceptible to actuation from the reactive grounded system.

Information from relay setting sheet BVT-TM-16 for 59-202G, for the normal system alignment (NSA) of the relay, had not been reflected in the revised Elementary Diagram 12241-E-8BE. Consequently the NSA for the relay had not been used in the development of the associated Operating Manual (OM) procedures 2OM-35.4C, "Power Supply Control Switch List," or 2OM-35.4L, "Backfeed No. 2 Main Transformer" for the relay to be "cut-out" during normal plant operation.

During refueling outage 2R7, routine inspection in the Unit Main Generator isophase leads box diffuser {EL/DIF/G080} was conducted, as part of scheduled preventive maintenance. This inspection revealed that one of the box's 24 diffuser screens (8 screens per phase) had become detached from the 'B' phase flexible link compartment door and was located at the bottom of the isophase leads box cabinet. From this discovery, it has been determined that this diffuser screen, became detached and momentarily struck an arc to ground in the generator. As the 59-202G protection relay was in service, this arc

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CAUSE OF THE EVENT (continued)

to ground caused the relay to actuate. Support for this conclusion is based on the size of the diffuser screen and the clearance of the screen with the 22 kilo-volt (KV) generator isophase leads box.

The detached diffuser screen in the 'B' Phase Flexible Links Compartment resulted from failure of the screen attachment spot welds. The apparent cause of the failed spot welds is mechanical stress and fatigue of the weld material attributed to normal vibration in the isophase bus duct and the turbine generator. The diffuser screens are lightweight perforated mesh aluminum, each with a thickness of 1/8 - inch, and are attached to the Flexible Links Compartment door, which is 3/16 - inch. This difference in the thickness of the two materials combined with the perforated makeup of the diffusers would tend to make the diffusers susceptible to deformation under high pre-heat conditions more easily during the attachment weld fabrication process. The Flexible Links Compartments were vendor field fabricated and made, per Specification F-06 welding process. A contributor to the weld failures is attributed to inadequate vendor review of the welding practices or material during the construction of the Flexible Links Compartment. Consequently, the 40-year life for the welds with normal plant conditions was not assured.

ANALYSIS OF EVENT

The turbine trip resulted from operation of Main Transformer Ground Protection Relay 59-202G, which actuated Main Transformer Auxiliary Relay 87-202X1. The 59-202G relay should be in service to provide ground protection whenever backfeed is established to the Main Transformer from the 345 KV system and the Main Generator links are open. The Unit 2 Operating Manual normal system arrangement and plant electrical drawings indicated this relay had been in service during plant operation since initial startup. In addition, the relay was incorrectly not addressed in the backfeed procedure.

Relay 59-202G is provided for ground fault protection on the 22 KV side (delta side) of the Main Transformer, when the transformer is energized from the 345 KV system (backfeed). Under backfeed conditions, the 22 KV system changes from a "grounded" system to an "ungrounded" system. Under ungrounded (backfeed) conditions, the phase to ground voltages are balanced. During normal system operation (reactive grounded system), the normal zero sequence voltage swings will be amplified. The relay is intended to monitor these zero

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ANALYSIS OF EVENT (continued)

sequence voltages on an ungrounded system. Since these voltages will be amplified in a grounded system, the relay may inadvertently actuate. Review of this protection scheme identified that the relay was not intended to be in service during normal plant operation.

Following the event, Transformer Ground Protection Relay 59-202G was functionally tested and found to be acceptable. The trip was immediate and the trip condition apparently cleared prior to picking up the relay target. A check of the relay input circuit for continuity, grounds and tight connections, revealed satisfactory results. Evidence of vibration-induced wear was noted on the primary contacts of the 22 KV potential transformers. Oil samples obtained from the Main, 2C and 2D transformers were analyzed with normal results, which support that a fault had not occurred in the transformers. Inspection of the potential transformer wiring and contacts revealed some vibration-induced wear on the 22 KV potential transformer primary contacts.

Main Generator Backup Ground Protection Relay 50-201G, Main Generator Primary Ground Protection Relay 59-201G, and Main Generator Backup Ground Protection Relay 51-201G, which could have responded had there been an actual 22 KV ground fault, were tested with no anomalies noted. In addition, during the investigation shortly after the event, the following supported that there was no actual ground on the 22 KV subsystem: results of post-trip startup testing, information from the switchyard fault recorder, the absence of other observed electrical protective circuit actuations, and the results of transformer oil samples from the Main, 2C and 2D transformers. However, at that time the existence of the detached diffuser plate was not known.

Special testing of the 59-202G relay, that included a Surge Withstand Capability, harmonic and a thermal stress test, did not identify any problems with the relay.

Subsequent routine inspection in the Unit Main Generator isophase leads box diffuser {EL/DIF/G080 determined that one of the box's 24 diffuser screens (8 screens per phase) had become detached and struck an arc to ground in the generator causing 59-202G relay to actuate. Support for this conclusion is based on the size of the diffuser screen and the clearance of the screen with the 22 kilo-volt (KV) generator isophase leads box.

The ERT review of this event concluded Operations personnel responded to this event in a conservative manner and diagnosed component

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ANALYSIS OF EVENT (continued)

problems in a timely manner. In addition, the ERT performed an evaluation of secondary plant-related component problems observed prior to the event and during the post-trip recovery and concluded they were unrelated to the cause of the trip.

SAFETY IMPLICATIONS

Post-trip control and protection systems functioned correctly in response to the turbine and reactor trip. Plant parameters were established within their normal control bands shortly after the turbine trip and the plant was placed in a safe, shutdown condition in accordance with procedures. There were no implications to the health and safety of the public as a result of this event.

CORRECTIVE ACTIONS

1. The original 59-202G relay, which initiated the event, was replaced and sent to the Duquesne Light Company Standards Laboratory for special testing. This testing, which included a Surge Withstand Capability, harmonic and a thermal stress test did not identify any problems with the relay.

2. Procedure 2OM-35.3C was revised by January 10, 1997 and procedure 2OM-35.4L was revised by March 27, 1998 such that relay 59-202G will only be in service during main transformer backfeed operations. The output of this relay was cut-out (disconnect switches open) January 10, 1997.

3. Elementary diagram 12241-E-8BE was revised January 7, 1997.

4. The relay setting sheet for relay 59-202G (BVT-TM-16) was revised March 14, 1997 to provide additional clarification that relay 59-202G protection is cut-out except during backfeed.

5. Selected parameters were monitored during plant startup on January 15, 1997 during field flashing of the generator and the power ascension to confirm that there was no 22 KV ground path. This monitoring determined that at that time there was not a ground on the 22 KV system.

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CORRECTIVE ACTIONS (continued)

6. The Main Generator exciter diodes were checked during plant startup on January 15, 1997 and found to be satisfactory.

7. The contacts on the Unit 2 22 KV Regulator potential transformers and the 22 KV Metering and Relay potential transformers were cleaned and lubricated and assessed to be fully functional. These contacts were replaced during refueling outage (2R7).

8. A common Preventive Maintenance Procedure was implemented July 31, 1997 to periodically inspect the contacts of the 22 KV Regulator potential transformers and the 22 KV Metering and Relay potential transformers.

9. An extent of condition review was completed March 14, 1997 for both Units to determine if there are other relay setting sheet conditions that are different than those specified by the controlled drawings. No discrepancies requiring follow-up actions were identified.

10. The relay setting sheet, procedures, and drawings for the Unit 1 ground protection relay comparable to Unit 2 relay 59-202G were reviewed by January 9, 1997 and determined to be correct.

11. The Nuclear Engineering Department issued a Technical Evaluation Report to complete a Design Equivalent Change for the replacement and setpoint change of relays 51-201G and 59-201G, to reduce the potential for inadvertent actuation on the Unit 2 Main Generator Ground Protection Relays April 30, 1997. This action was completed August 12, 1998.

12. During 2R7, the main unit generator (MUG) isophase leads box diffuser screen which had become detached from the leads box diffuser was reattached with appropriate bolting. At that time the remaining diffuser screens in the MUG A, B, and C Phase Flexible Links Compartment on Unit 2 were also fastened with similar bolting. This was done to ensure that the diffusers are adequately fastened and thereby eliminate the potential for future similar diffuser screen attachment failures. Unit 1 utilizes a different design for attachment of the main unit generator isophase leads box air screens.

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CORRECTIVE ACTIONS (continued)

13. By February 16, 2000, the procedure for the once per 18 months inspection of the MUG, 1/2PMP-35-GML/TRF-01E, "Iso-Phase Bus, Main and Unit Transformer Inspection", will be revised (for each Unit) to ensure inspection of the Flexible Links Compartments.

14. During the next Unit 1 refueling/maintenance outage, currently scheduled to commence in February, 2000, an inspection of the Unit MUG Flexible Links Compartment will be conducted to ensure the existence of no loose components in the compartment.

SIMILAR EVENTS

A review of Licensee Event Reports for the prior two years identified no similar events.