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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

**Subject: Beaver Valley Power Station, Unit No. 1 and No. 2**
**BV-1 Docket No. 50-334, License No. DPR-66**
**BV-2 Docket No. 50-412, License No. NPF-73**
**Response to Request for Additional Information on Generic Letter 96-05**

By letters dated November 18, 1996, and March 17, 1997, Duquesne Light Company (DLC) provided 60-day and 180-day responses to Generic Letter (GL) 96-05, "Periodic Verification of Design-Basis Capability of Safety Related Motor-Operated Valves," dated September 18, 1996. In these letters, DLC stated that Beaver Valley Power Station (BVPS), as a member of the Westinghouse Owners Group (WOG), was participating with the Joint Owners Group (JOG) Program in response to GL 96-05. Subsequently, in their Safety Evaluation Report (SER) dated October 30, 1997, the NRC requested that utilities participating in the JOG Program in response to GL 96-05 resubmit their commitment to the latest revisions of the JOG Program documents. By letter L-98-072, dated April 13, 1998, DLC resubmitted its commitments to the latest revisions of the JOG Program documents and had included noted exceptions. By letter dated January 14, 1999, the NRC requested additional information (RAI) from DLC concerning GL 96-05.

Attached is the BVPS response to the RAI.

If there are any questions concerning this matter, please contact Mr. Mark S. Ackerman, Manager, Safety & Licensing Department at 412-393-5203.

Sincerely,

Sushil C. Jain



Attachment

c: Mr. D. S. Collins, Project Manager
Mr. D. M. Kern, Sr. Resident Inspector
Mr. H. J. Miller, NRC Region I Administrator

Duquesne Light Company
Beaver Valley Power Station Units 1 and 2
Response to Request for Additional Information on Generic Letter 96-05

1. "In NRC Inspection Report No. 50-344 & 412/95-12, the NRC staff closed its review of the motor-operated valve (MOV) program implemented at the Beaver Valley Power Station, Unit Nos. 1 and 2 (BVPS-1 and BVPS-2), in response to Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." In the inspection report, the NRC staff discussed certain aspects of Duquesne Light Company's (DLC's) MOV program to be addressed over the long term. For example, the inspectors noted that (1) DLC's periodic verification program will gather additional data to support the use of a 10% load sensitive behavior margin; (2) DLC planned to increase the thrust margin for the Unit 1 Quench Spray Pump Discharge valves prior to the end of the next refueling outage; (3) DLC relied on available valve factors in some cases where the assumed valve factors did not have strong support; and (4) DLC's periodic verification program will gather additional data to determine if stem lubricant degradation is occurring. Please describe the actions taken to strengthen group valve factor assumptions and address the specific long-term aspects of the MOV program at BVPS-1 and BVPS-2 noted in the subject NRC inspection report."

Response:

1 - 1) Load sensitive behavior (LSB) is determined by comparing the thrust produced at the same torque values between static and dynamic testing, including running loads at control switch trip (CST). Since the NRC closure of GL 89-10 Program in 1995, DLC has reviewed an additional 12 dynamic tests. This increases the total tests reviewed to 70 tests. A review of all the data using the average value of LSB as a bias error and the two-sigma value as a random error included in the Square Root of the Sum of the Squares (SRSS), shows that the overall error value continues to be consistent with the design assumed value of 10 % of the thrust at CST. As more dynamic test data becomes available, they will be evaluated with the existing data.

1 - 2) The Unit 1 Quench Spray Pump Discharge valves MOV-QS-101A and B are normally maintained closed with a safety function to open. Currently the valves are considered High Margin at values over 50 %. The thrust margin for both MOV-QS-10[illegible] A and B was increased through various methods including:

- Installation of a 5 second time delay of the QS-P-1A and B pumps after th[illegible]ive a Containment Isolation Phase B (CIB) signal. The MOVs also receive the same CIB signal to open. This was to reduce the demand on the actuator during unseating.

- The 15 HP motors were replaced with 25 HP motors and appropriately sized thermal overload heaters to increase the actuator capabilities.

- The reach rods were replaced from the first universal joint to the valve handwheel, and the Yoke/Stem Nut Bushing was modified to include roller bearings. This improved the material condition of the reach rods and increased the torque to thrust conversion from the reach rods to the valve stem.

1 - 3) Our closure basis for non-testable MOVs relied on demonstration in the BVPS Closure report that the methods employed in the BVPS MOV program resulted in reliable operation of the GL 89-10 MOVs. The design assumptions for valve factor, load sensitive behavior, and stem coefficient of friction were combined with other uncertainties to show that the methodology resulted in reliable valve setups. The MOV testing that BVPS has conducted since the NRC closure of the GL 89-10 program in 1995 continues to demonstrate the validity of this approach.

DLC computed 'available valve factors' for non-testable MOVs at the time of the inspection at the NRC's request to provide an additional relative measure of each valve's margin. The available valve factors that were calculated for this effort showed good correlation with the DLC closure approach, in that most valves demonstrated rather high available valve factors. Similarly, those valves showing a relatively low available valve factor were among the lower margin valves in the closure assessment.

NRC Inspection Report 50-334/95-12; 50-412/95-12, states on page 5 and 6, "Only the Unit 1 Quench Spray Pump Discharge valves were identified as having minimal available valve factor margin. The licensee had previously identified these valves as having small capability margin and had planned to evaluate these valves for possible corrective action....The closure document stated that the selected corrective action would be implemented prior to the end of the next refueling outage. The inspectors concluded that the licensee had adequately supported the present design-basis capability for all GL 89-10 MOVs."

The Unit 1 Quench Spray Pump Discharge valves mentioned in the Inspection Report are MOV-QS-101A & B. Both of these valves were modified to significantly increase their margin (see discussion above in response to question 1-2).

Whenever dynamic testing is conducted, BVPS continued to evaluate the measured valve factor, as well as load sensitive behavior and stem coefficient of friction to ensure that the assumptions for non-testable valves remain valid. To date, we have uncovered no new information which would invalidate the closure basis for non-testable valves.

1 – 4) MOV testing procedures include provisions to obtain as-found/as-left test data for scheduled tests for periodic verification per GL 89-10 and GL 96-05. A review of all the test data does not indicate any observed stem lubrication degradation. The data has shown a decreasing trend in the average Coefficient of Friction (COF). Test dates span as much as approximately 5 years with an 18 month lubrication frequency.

2. "In a letter dated November 18, 1996, DLC stated its commitment to implement the Joint Owners Group (JOG) Program on MOV Periodic Verification in response to GL 96-05. The JOG program specifies that the methodology and discrimination criteria for ranking MOVs according to their safety significance are the responsibility of each participating licensee. In a subsequent letter dated April 13, 1998, DLC stated that risk ranking of MOVs at BVPS-1 and BVPS-2 for application of the JOG interim MOV static diagnostic testing program will be based on guidance provided in Westinghouse Owners Group (WOG) Engineering Report V-EC-1658-A (Revision 1), "Risk Ranking Approach for Motor-Operated Valves in Response to Generic Letter 96-05," with some stated exceptions. For example, DLC stated that (1) MOVs were only ranked based on Core Damage Frequency (CDF) importance measures, (2) only MOVs not modeled in the probabilistic risk assessment (PRA) were reviewed by the expert panel, (3) the PRA analyst used his judgment to review the quantitative ranking based on PRA CDF importance measures, and (4) MOVs that were only modeled as passive failures were ranked based on CDF, and then qualitatively reassessed by the PRA analyst. These exceptions do not appear to reflect the importance of the expert panel as described by WOG Engineering Report V-EC-1658-A and the NRC safety evaluation dated April 14, 1998. DLC should describe the composition and duties of the expert panel in risk ranking MOVs at BVPS-1 and BVPS-2. With respect to each of its specific exceptions, DLC should justify that its MOV risk-ranking approach is consistent with the guidance contained in WOG Engineering Report V-EC-1658-A and the NRC safety evaluation. In light of its exceptions to the WOG MOV risk-ranking approach, please discuss consideration of the example list of risk-significant MOVs provided by the WOG in the engineering report."

Response:

- **Description of the composition and duties of the expert panel in risk ranking motor operated valves (MOVs) at BVPS-1 and BVPS-2:**

The composition of expert panel assembled for the purpose of ranking the GL 96-05 MOVs primarily consisted of personnel from the Maintenance Rule Expert Panel supplemented with the System and Performance Engineering Department (SPED) engineer, responsible for implementing the GL 96-05 program. The following table lists the primary GL 96-05 expert panel members, their group and their duties or area of expertise.

| Group | Duties/Expertise |
|---|---|
| System & Performance Eng. | Maintenance Rule Coordinator |
| System & Performance Eng. | Expert Panel Coordinator |
| System & Performance Eng. | GL 96-05 MOV Coordinator |
| System & Performance Eng. | Performance Engineering |
| System & Performance Eng. | System Engineering |
| Nuclear Engineering | Risk Analysis |

| | |
|---|---|
| Nuclear Operations | Plant Operations |
| Nuclear Safety | Nuclear Safety/Regulatory Affairs |

Since this GL 96-05 expert panel used the Maintenance Rule Expert Panel supplemented with the SPED engineer, responsible for implementing the GL 96-05 program, it was knowledgeable on the risk ranking process, as well as the approach using relevant deterministic and probabilistic issues and concerns to achieve a final risk ranking. Each expert panel member was furnished with a copy of WOG Engineering Report V-EC-1658 to provide guidance on the GL 96-05 MOV risk ranking process. As stated in the DLC letter dated April 13, 1998, and addressed below, this expert panel reviewed only those MOVs that were not modeled in the PRA program. The GL 96-05 MOV Coordinator provided documentation for why the valves were in the GL 96-05 MOV program and prepared MOV ranking worksheets similar to those provided in the WOG report. The risk analysis member provided preliminary MOV risk rankings based on PRA findings and judgment, and the reason why an MOV was not modeled in the PRA for each of the MOV worksheets. The plant operations representative reviewed these completed MOV worksheets prior to the expert panel review. The Expert Panel Coordinator assembled the MOV worksheets and sent them out to the expert panel members for review, prior to any scheduled meetings. In addition, the Expert Panel Coordinator was responsible for scheduling the expert panel meetings, and for documenting the expert panel discussion and final rankings for each of the MOVs reviewed at these meetings.

- **Clarification and justification of DLC stated exceptions to the guidance contained in WOG Engineering Report V-EC-1658-A and the NRC safety evaluation:**

**Stated Exception 1.** MOVs were only ranked based on Core Damage Frequency (CDF) importance measures. This is based on the fact that the Level 2 top event failures at Beaver Valley that lead to large early releases are based on containment phenomena (e.g., consequences of high pressure melt ejections) resulting from Level 1 system failures. Therefore, Large Early Release Frequency (LERF) importance measures were judged not to be relevant.

**Justification of Exception 1.** In developing the basic event importance measure report, only Level 1 CDF importance measures (based on internal and external initiating events) were used, since basic event importance measures based on LERF could not be readily calculated at the time. However, this was judged not to be of great concern since the containment systems of interest, according to Section 3.3 "Containment Performance (Level 2) Impact" of the WOG Engineering Report V-EC-1658-A, were modeled in the Level 1 plant response event trees; i.e., containment sprays and containment isolation systems. This section states that if importances based on LERF cannot be readily calculated a qualitative assessment of the importance of the MOVs to containment isolation to prevent a large release can be provided. As addressed in the BVPS IPE Summary Reports, large preexisting containment failures are not credible at BVPS due to the fact that the containment pressure is required to be maintained at subatmospheric conditions during normal operation and large failures of the containment boundary would preclude the ability to achieve this requirement. Therefore, all core melt sequences with containment isolation failures leaving the Level 1 event trees are mapped to small early releases. As stated in the DLC letter dated April 13, 1998, and restated in the exception above, Level 2 top event failures at Beaver Valley that lead to large early releases are based on containment phenomena and not containment spray or isolation systems failing. This can be demonstrated by the following tables showing LERF contributions:

| **BVPS-1 COMPARISON OF MAJOR CONTRIBUTORS TO LERF** | |
|---|---|
| **Percent Contribution to LERF** | **Accident Scenario Class** |
| 44.0% | Large containment bypass failure prior to core damage, due to an interfacing system LOCA |
| 41.0% | Reactor in-vessel steam explosion that fails containment |
| 9.3% | Induced RCS hot leg or surge line failure resulting in an early hydrogen burn, which overpressurizes and fails containment, due to the operation of the containment spray systems causing a de-inerted containment atmosphere |
| 5.2% | Large containment bypass failure due to induced steam generator tube rupture |
| 0.5% | High pressure melt ejection at RCS pressures > 2000 psia that overpressurizes and fails containment, given that containment sprays have failed |

| **BVPS-2 COMPARISON OF MAJOR CONTRIBUTORS TO LERF** | |
|---|---|
| **Percent Contribution to LERF** | **Accident Scenario Class** |
| 39.8% | Induced RCS hot leg or surge line failure resulting in an early hydrogen burn, which overpressurizes and fails containment, due to the operation of the containment spray systems causing a de-inerted containment atmosphere |
| 30.0% | Large containment bypass failure prior to core damage, due to an interfacing system LOCA |
| 17.1% | Reactor in-vessel steam explosion that fails containment |
| 12.8% | Large containment bypass failure due to induced steam generator tube rupture |
| 0.2% | High pressure melt ejection at RCS pressures > 2000 psia that overpressurizes and fails containment, given that containment sprays have failed |

As shown in the tables above, failure of containment sprays contribute 0.5% to the LERF at BVPS-1 and 0.2% to the LERF at BVPS-2. Interfacing system LOCAs contribute approximately 44% and 30% to the LERF at BVPS-1 and BVPS-2, respectively, but these are a result of safety injection check valve disc ruptures and not MOV demand failures. Additionally, induced RCS hot leg or surge line failures resulting in an early hydrogen burn, which overpressurize and fail containment, are due to the containment spray systems operating as designed and de-inerting the containment atmosphere. Recently, the ability to calculate LERF basic event importance measures for the MOVs at BVPS-1 was developed. Using these LERF importance measures and applying the same methodology as used in the CDF rankings, the MOVs of interest were ranked once again. This alternate ranking did not result in any changes to the final MOV rankings as previously determined by applying only the CDF rankings, thereby reassuring that MOV risk importance was captured by the CDF rankings.

**Stated Exception 2**. Only MOVs not modeled in the PRA were reviewed using the expert panel approach presented in the WOG report.

**Justification of Exception 2.** The MOVs that were modeled in the PRA had their top event risk significance contribution already considered for initiating events, system response and/or basic events considered in the PRA reviewed by the Maintenance Rule expert panel. Based on this, it was expected that there would not be any significant variation in the risk rankings assigned for the PRA modeled MOVs. Furthermore, over 80 percent of the PRA modeled MOVs that were not reviewed by the expert panel are assigned in the MEDIUM or HIGH risk categories using the PRA analysts' qualitative judgment and the PRA risk ranking process.

**Stated Exception 3**. A quantitative approach using the PRA CDF importance measures was used to preliminarily rank the MOVs. The PRA analyst then used his judgment to assign a qualitative final ranking.

**Justification of Exception 3.** This exception is a statement on how the quantitative CDF importance rankings for the MOVs were conservatively adjusted to arrive at a final qualitative ranking. The basis for adjusting the quantitative CDF importance rankings is that the current PRA models assume that for normally operating systems, equipment on train "A" is running, while equipment on train "B" is in standby. The result of this assumption unfairly biases the importance of one train over the other with respect to MOV demands placed on the system. For example, if train "A" of river water is in service, its pump discharge MOV is already open; therefore, a failure of the MOV to open on demand is not accounted for in the systems' equipment failure combinations (cutsets). Likewise, since river water train "B" is in standby, its pump discharge MOV is closed and is required to open. Therefore, a failure to open on demand is more important on the train "B" MOV than on the train "A" MOV. The PRA analyst applied judgment to equalize the effects of this biasing by conservatively assigning the highest ranking to both trains of the river water pump discharge MOVs. This approach is consistent with Section 3.4 of WOG Engineering Report V-EC-1658-A to evaluate the assessment of interchanging functions of MOVs that can perform the same function.

**Stated Exception 4**. MOVs that were only modeled as passive failures (e.g., MOV transfers closed) in the PRA were ranked based on the PRA CDF importance measures for that passive failure, then qualitatively reassessed by the PRA analyst to determine a final ranking.

**Justification of Exception 4.** There were some MOVs in the GL 96-05 program that only had passive failure modes associated with them in the PRA models (e.g., MOV transfer closed failures). Since the generic letter was only concerned with MOVs required to change positions, the WOG Engineering report only addressed the "failure to open/close on demand" failure modes in their assessment. Instead of neglecting the CDF importance measures altogether for these MOVs with passive failure modes, they were used as a starting point in order to determine a qualitative risk ranking. This qualitative risk ranking not only accounted for the Fussel-Vesely (FV) and Risk Achievement Worth (RAW) values for a single passive MOV failure, but also included the FV and RAW values for the system in which the MOV was modeled, thereby providing some insight as to what the common cause failure importance measures would be, if they were modeled. Using these quantitative importance measures as a basis, the PRA analyst qualitatively assigned a risk category, keeping in mind that importance measures for components with extremely low failure rates (e.g., transfer closed failures) can provide FV values that are low and might result in a LOW risk categorization, as well as providing RAW values that are high and might be classified in the HIGH risk category. While this approach is not specified in WOG Engineering Report V-EC-1658-A, it follows the same rationale as the surrogate basic event approach noted in Section 3.3 "Implicitly and Explicitly Modeled MOVs" and Section 3.4 "Components Not Modeled in the MOV Program or PSA Model."

- **Discussion of consideration of the example list of risk-significant MOVs provided by the WOG in the engineering report.**

  The general list of risk-significant MOVs provided in WOG Engineering Report V-EC-1658-A, Appendix A was reviewed and assessed in the risk ranking process. Typically, if the BVPS quantitative risk ranking for a valve, which was similar in function to one on the WOG list, was categorized as LOW, the final qualitative risk ranking was changed to the MEDIUM risk category. If the BVPS quantitative risk ranking for a valve, which was similar in function to one on the WOG list, was categorized as MEDIUM, the final qualitative risk ranking remained at the MEDIUM risk category. Likewise, if the BVPS quantitative risk ranking for a valve, which was similar in function to one on the WOG list, was categorized as HIGH, the final qualitative risk ranking remained at the HIGH risk category. Exceptions to these may include normally open MOVs that were quantitatively categorized as LOW and whose safety functions are to remain open (e.g., the BVPS-1 outside recirculation spray pump discharge MOVs). These MOVs would then remain in the LOW risk category since they are not required to change position to perform their safety function. Additionally, the GL 96-05 expert panel also used this example list of risk-significant MOVs as guidance in determining the final risk categories for MOVs that were not modeled as part of the PRA program.

3. "The JOG program focuses on the potential age-related increase in the thrust or torque required to operate valves under their design-basis conditions. In the NRC safety evaluation dated October 30, 1997, on the JOG program, the NRC staff specified that licensees are responsible for addressing the thrust or torque delivered by the MOV motor actuator and its potential degradation. Please describe the plan at BVPS-1 and BVPS-2 for ensuring adequate AC and DC MOV motor actuator output capability, including consideration of recent guidance in Limitorque Technical Update 98-01 and its Supplement 1."

Response:

In anticipation of the issuance of Limitorque Technical Update (LTU) 98-01, later published in NRC Information Notice 96-48, Supplement 1, a preliminary review was done by BVPS concerning the use of running efficiency versus pullout efficiency. Although running efficiency was not routinely applied, there were some applications at BVPS in which its use had been justified. As a result, the "seat side" of two quarter turn valves (MOV-RW-102A2 and MOV-RW-102C2), was reversed to reduce the torque requirements of the operator. This was done prior to startup of Unit 1 after its Twelfth Refueling (1R12) Outage. Subsequent reviews evaluated the effect that the LTU 98-01 would have on the actual field set-ups when compared against the reduced motor output torque available after application of the LTU 98-01 guidelines. The results of these reviews concluded that all GL 89-10 valves were shown to have sufficient capability to ensure operability with the current field set-ups. However, to recover performance margin, BVPS has elected to modify two actuators (2SIS-MOV836 and 2SIS-MOV841) during the BVPS-2 Seventh Refueling (2R07) Outage. Other margin improvements are being considered for additional MOVs in future outages. At this time, all BVPS-2 design torque output calculations have been updated and are in place to support the present 2R07 outage. The BVPS-1 calculation revisions are slated for completion to support the next scheduled BVPS-1 refueling outage (1R13). Margin improvement modifications are also being considered for specific BVPS-1 MOVs during future outages. In general, margin improvements will be pursued where appropriate, through physical modifications, or through application of additional valid analytical information on actuator motor performance.