Docket No.: STN 50-483

OCT 2 6 1984

Mr. D. F. Schnell
Vice President - Nuclear
Union Electric Company
P. O. Box 149
St. Louis, Missouri 63166

Dear Mr. Schnell:

Subject: Containment Purge and Vent Valve Operability

By letter dated January 6, 1984, Union Electric submitted the information necessary to demonstrate the operability of the purge and vent valves at the Callaway Plant, Unit 1. The staff has reviewed this information and determined that it is acceptable. Our detailed evaluation is enclosed.

If you should require any additional information, please contact the Callaway project manager.

Sincerely,

B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing

Enclosure:
As stated

cc: See next page

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WASHINGTON, D. C. 20555

OCT 26 1984

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# WOLF CREEK GENERATING STATION AND CALLAWAY PLANT
## DOCKET NOS. 50-482 AND 50-483

## DEMONSTRATION OF CONTAINMENT PURGE AND VENT VALVE OPERABILITY

### 1.0 Requirement

Demonstration of operability of the containment purge and vent valves, particularly the ability of these valves to close during a design basis accident, is necessary to assure containment isolation. This demonstration of operability is required by BTP-CSP 6-4 and SRP 3.10 for containment purge and vent valves which are not sealed closed during operating conditions 1, 2, 3, and 4.

### 2.0 Description of Purge and Vent Valves

The 36-inch large volume, shutdown purge valves are closed during operating modes 1, 2, 3, and 4 as required by the plant technical specifications thus are not a subject of this review. The 18-inch mini-purge valves listed below, which are subject to review, are manufactured by the Fisher Controls Company, Type 9200, and are equipped with G. H. Bettis air open-spring return actuators, Model Number T416B-SR3-12.

| Valve | Size (Inches) | Use | Location |
|---|---|---|---|
| GT-HZ-04 | 18 | Supply | Outside containment |
| GT-HZ-05 | 18 | Supply | Inside containment |
| GT-HZ-11 | 18 | Exhaust | Inside containment |
| GT-HZ-12 | 18 | Exhaust | Outside containment |

### 3.0 Demonstration

3.1 Operability demonstration information has been provided for the Wolf Creek Generating Station and the Callaway Plant in the following submittal:

- SNUPPS letter dated January 16, 1984 from N. A. Petrick to H. R. Denton (NRC).

3.2 The containment conditions utilized in predicting the $\Delta P$ across the valves were extracted from the analysis for the large LOCA which results in the peak containment pressure.

The containment pressure rises from approximately 14 psig to 22.9 psig during the closure stroke of the valve. However, the pressure drop at incremental valve positions was calculated at the higher pressure of 22.9 psig.

The containment pressure during the closure cycle was assumed to be a constant 22.9 psig which corresponds to the pressure at the time that the valve is fully closed (T = 6 seconds). The lag time between the receipt of the signal to close at 3 seconds from LOCA start and the initiation of valve motion has been taken into account. Tests have verified that closure is accomplished within the required 3 seconds from receipt of the closure signal.

The valves are equipped with spring-return actuators. The unpressurized side of the piston actuator is vented to local ambient conditions. During valve closure, the pressure side is also vented to the same local ambient conditions. Therefore, no pressure differential will exist across the piston as a result of a surrounding local pressure rise. The spring will drive the actuators to the fail safe (closed) position and maintain that position.

3.3 The following table is a comparison of torque available to torque required as presented in the submittal.

| | | Case 1 Closure During Transient Design Case | | | Case 2 Closure at Peak Calculated Pressure | | |
|---|---|---|---|---|---|---|---|
| Angle of Opening | Torque Avail. in-lb | Max.* Predicted ΔP | Torque Req. at ΔP=22.9 in-lb | Ratio Avail./Req. Torque | Max. Predicted ΔP | Torque Req. at ΔP=47.2 in-lb | Ratio Avail./Req. Torque |
| Closed | 29,900 | 22.9 | 6,220** | 4.8 | 47.2 | 6,220** | 4.8 |
| 10 | 25,600 | 22.9 | 1,785 | 14.5 | 47.2 | 3,239 | 7.9 |
| 20 | 23,000 | 22.8 | 2,223 | 10.4 | 47.2 | 3,961 | 5.8 |
| 30 | 21,700 | 22.7 | 2,223 | 9.8 | 46.8 | 3,96[illegible] | 5.5 |
| 40 | 21,400 | 22.2 | 2,223 | 9.6 | 45.8 | 3,961 | 5.4 |
| 50 | 22,100 | 21.0 | 2,728 | 8.0 | 44.0 | 4,791 | 4.6 |
| 60 | 23,900 | 18.2 | 3,412 | 7.0 | 39.2 | 5,918 | 4.0 |
| 70 | 27,200 | 12.8 | 3,662 | 7.4 | 30.8 | 6,330 | 4.3 |
| 80 | 33,000 | 7.3 | 3,581 | 9.2 | 16.1 | 6,197 | 5.3 |
| 90 | 43,000 | 4.3 | 3,581 | 12.0 | 9.9 | 6,197 | 6.9 |

*During the 3-second closure period, the containment pressure rises from 14 psig. All predicted ΔPs are based on flow conditions at 22.9 psig at the inlet to the purge piping.

**The 6,200 in-lb torque required based on 60 psig, which is the containment/valve design pressure. The maximum calculated LOCA pressure is 47.2 psig.

Case 1 provides the calculated pressure drops across the valve for each 10° of valve position. These pressure drops were calculated based on the installed piping system resistances (pressure drops), assuming that the redundant purge valve in the same line has failed in the open (least resistance) position. The predicted pressure drops are all calculated at 22.9 psig, which is the maximum pressure that would exist prior to valve closure. Data also presented for Case 1 includes the actuator torque available and the ratio of torque available to torque required at the corresponding positions. The ratio of excess torque varies from 7.0 to 14.5 for all opening positions.

Case 2 provides data for the worst possible case wherein the valve closure is assumed to be delayed until the peak calculated containment pressure of 47.2 psig is attained. This is not a design case, but is provided to demonstrate the large margins available to ensure valve closure. As can be seen from the data provided, excess torque margins of 4.0 to 7.9 exist even for this worst case. As with the design case, all pressure drops are calculated with 47.2 psig at the inlet to the purge line and the redundant valve in the line failed in the open position.

3.4 A summary of stress in critical parts is presented as follows:

| Stress Consideration | Allowable[a] Stress[b] ksi | Calculated Stresses, ksi | | |
|---|---|---|---|---|
| | | Closed | Case 1[d] at 70° | Case 2[d] at 70° |
| 1. Shaft at disc hub (1.5S) (bending and torsion) | 52.5 | 4.7 | 2.3 | 4.3 |
| 2. Shaft at disc hub (0.75S) (torsion and transverse shear) | 26.25 | 6.1 | 3.1 | 5.7 |
| 3. Shaft at pin connection (0.75S) | 26.25 | 5.8 | 3.7 | 6.3 |
| 4. Shaft at key connection (0.75S) | 26.25 | 5.3 | 3.1 | 5.4 |
| 5. Bushing | 8.5[e] | 1.9 | 0.7 | 1.5 |

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[a] These allowables were derated to 98% of that shown to account for the 320°F design temperature.

[b] Based on ASME Code Section III values (S) of 35 ksi for 17-4PH, condition H1100 (Table I-7.1, Appendix I). The allowable stress of 35 ksi is a conservative figure since an (S) value of 36.2 is allowed by the code for H1075 shaft material.

[c] Closed position stresses based on 60 psid across valve.

[d] Refer to Section 3.3 for the definitions for Cases 1 and 2. Stresses are reported for 70° open since they are the maximum for opening angles 10-70°.

[e] Graphite-filled bronze.

The shaft considered to be the most critical valve component under most conditions, since the pins and keys are selected to be stronger than the shaft. Therefore, separate calculations for pins and keys are not necessary. Stress concentration factors are considered when evaluating the shafts at the pins and keyways. The maximum disc load occurs when the disc is in the closed condition and acceptable disc strength values have been established based on testing and experience.

The stresses reported above are based on dynamic loadings due to the LOCA pressurization transient. Shaft loadings which result from the seismic event are not specifically calculated or combined with LOCA loadings because the events are independent and not postulated to occur simultaneously. The purge valves are Seismic Category I and have been tested for operability during and after a seismic event.

## 4.0 Evaluation

4.1 In demonstrating operability, the accident condition considered was a large LOCA which results in a peak-containment pressure of 47.2 psig. A containment pressure response curve is provided that also indicates the time the valves receive a signal to close and the time the valves would be fully closed, a total of 6 seconds. (The 6 seconds accounts for a 3-second lag time and a 3-second closure time. The applicant reports that tests have ensured that closure is accomplished within the required 3 seconds from receipt of the closure signal.) This corresponds to a pressure of 22.9 psig. Thus, the applicant conservatively has considered at each incremental valve position, a maximum $\Delta P$ of 22.9 psig across the valve (Case 1 as discussed in Section 3.3).

Additionally, the applicant has provided analysis results for the peak containment pressure of 47 psig (Case 2). This was provided to demonstrate the large margins available to ensure valve closure.

4.2 Throughout the submittal the applicant has not combined LOCA and seismic loadings either in the stress analysis (discussed in Section 4.4 or when developing resulting torques, discussed in Section 4.3). The NRC has historically required that the structural/mechanical responses due to various accident loads and loads caused by natural phenomena (such as earthquakes) be combined when analyzing structures, systems, and components important to safety.

A telephone conference call was held on September 7, 1984, with representatives from Wolf Creek, Callaway, SNUPPS and the NRC staff. The telephone conference call focused on two items. Firstly, the applicant (licensee) says there is no requirement to combine the seismic and dynamic loads. Secondly, a significant margin exists (factor of 7 minimum) between the allowable stresses and the calculated stresses. Because the seismic loading is less than or equal to the LOCA loading, if the loadings are combined, the margin is halved at most and still remains significant (factor of 3.5 minimum). This latter information appears on page 12 of the January 6, 1984 submittal from N. A. Petrick to H. R. Denton.

The staff recommends that seismic and dynamic loads be combined. The basis for this is NUREG-0800, Section 3.10, Seismic and Dynamic Qualification of Mechanical and Electrical Equipment, Revision 2, July 1981, which states on page 3.10-3 that

> "Acceptable load combinations and methods for combining dynamic responses for mechanical equipment are defined in SRP 3.9.3. The same criteria is acceptable for electrical equipment."

NUREG-0800, Section 3.9.3, ASME Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures, Revision 1, July 1981 under item I.1, Loading Combinations, System Operating Transients, and Stress Limits states

> "The design and service loading combinations (e.g., design and service loads, including system operating transients, in combination with loads calculated to result from postulated seismic and other events). . . Internal parts of components, such as valve discs and seats and pump shafting, subjected to dynamic loading during operation of the component should be included."

The remainder of SRP Section 3.9.3, including Appendix A, provides appropriate guidance with regard to load combinations. Thus, the staff does not agree with the applicant's (licensee's) position that there is no requirement to combine the seismic and dynamic loads acting on the valve. This requirement is rooted in Appendix A, 10 CFR 50 as General Design Criteria 2 which calls for an appropriate combination of the effects of events to be reflected in the design basis of safety related equipment.

The staff accepts the applicant's (licensee's) position that had the loads been combined, the calculated stresses would not have exceeded the allowable stresses. This is an instance of the applicant (licensee) not following guidance but still satisfying the requirement.

4.3 The submittal stated the following regarding dynamic torque:
Dynamic torque factors used in butterfly valve sizing were developed from test data obtained from models with similar disc configurations and flow characteristics. The dimensionless aspect ratio (defined as the ratio of the disc diameter to the thickness) was judged to be a significant parameter for evaluation of dynamic torques at various opening angles. Therefore, a series of water flow tests was conducted with a group of 4-inch and 6-inch butterfly valve models constructed with various aspect ratios, ranging from 3:1 to 14: (such as 3:1, 8:1, 11:1, and 14:1), in various disc configurations (conventional, offset, cammed), and in both flow directions.

The tests were conducted using the Fluid Controls Institute (FCI) specifications for test arrangement and conduct, per FCI paper 58-2.

The basis followed by the vendor (Fisher) in using incompressible (water) flow model tests to establish dynamic torque coefficients applicable to large diameter valves in compressible flow service is presented in the ISA Transactions article "Effects of Fluid Compressibility on Torque in Butterfly Valves" by Floyd P. Harthun.

Application of the conclusions from the ISA paper was presented in Attachment 2, selection Figures 1 and 2 of the submittals: "Torque Pressure Drop Relationships Used in Dyanamic Torque Coefficients Selection," which are representations of the Figure 5 curves from the ISA paper. These show how the torque values for compressible flow are conservatively determined and related to incompressible flow torques. It should be noted that the compressible flow curve reaches a critical flow condition at larger $\Delta P$ values, resulting in a maximum torque value ($T_c$) that cannot be exceeded, regardless of how large $\Delta P$ becomes.

The available actuator torques and the required torques at the valve for each 10° of opening are shown in Section 3.3. The model valve bench test program used to develop dynamic torque coefficient are configured with straight pipe inlets that produce uniform approach flow to the test valves. Testing did not include inlet piping configurations involving tees and elbows upstream of the valves. Valve installation details provided indicate upstream elbows and tees that should be accounted for in developing dynamic torques.

Based on information derived from other valve manufactuers' model tests, the staff accepts a factor of 3.0 times the $T_D$ predicted stemming from straight pipe or uniform approach flow developed dynamic forque coefficients for an "elbow-shaft out-of-plane" configuration and a factor of 1.5 for the "elbow-shaft in-plane" configuration. Therefore, applying a factor of 3 assuming worst case configuration, to the torque required in the table of Section 3.3, the ratio of available to required torque are 2.3 to 4.78.

The results of the analysis performed by the applicant when coupled with the factor of 3, to account for the worst case loading of "elbow-shaft out-of-plane," demonstrated that the valves will close from the 90° position (fully open) due to dynamic loads only.

4.4 The stress analysis was based on three conditions: closed, Case 1, and Case 2 (see Section 3.3 for clarification of Case 1 and 2). The results of this analysis is summarized in Section 3.3. Consistent with other licensee/applicant submittals, the maximum stresses have occurred at the 70° position with the most critical valve component being the shaft/disc/pin interface. Significant margin exists between the allowable stress and the calculated stresses for design Class I. The stresses reported are based on dynamic loadings due to the LOCA pressurization transient.

4.5 The submittal does not address the structural integrity of the actuator and actuator/valve interface. It is concluded, however, that since the actuator is capable of delivering forces that exceed the dynamic torques, the structural integrity of the actuator under fluid dynamic conditions is not of concern (see Section 4.2).

## 5. Summary

The staff has completed the review of information submitted to date concerning the operability of containment purge and vent valves at Wolf Creek and Callaway. Sections 4.2, 4.3, 4.4, and 4.5 are the basis for the conclusions drawn by the staff. The staff finds the information submitted demonstrates the ability of the valves to close against the buildup of containment pressure in the event of a DBA/LOCA.