UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION REGARDING DEMONSTRATION OF CONTAINMENT PURGE AND VENT VALVE OPERABILITY

POWER AUTHORITY OF THE STATE OF NEW YORK JAMES A. FITZPATRICK NUCLEAR POWER PLANT

DOCKET NO. 50-333

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 CSB 6-4 and SRP 3.10 for containment purge and vent valves which are not sealed closed during operational conditions 1, 2, 3, and 4.

2.0 Description of Purge and Vent Valves

Valve Number	Size (Inches)	Location	Use
27 AOV-111	24	Outside containment - drywell	Not given
27 AOV-112	24	Outside containment - drywell	Not given
27 AOV-113	24	Outside containment - drywell	Not given
27 AOV-114	24	Outside containment - drywell	Not given
27 AOV-115	20	Outside containment - wetwell	Not given
27 AOV-116	20	Outside containment - wetwell	Not given
27 AOV-117	20	Outside containment - wetwell	Not given
27 AOV-118	20	Outside containment - wetwell	Not given

The 20-inch and 24-inch valves are butterfly-type Model 9222 manufactured by Fisher Controls Company and are equipped with G. H. Bettis Company model 733C-SR80 and 732C-SR80 operators, respectively. The valves are equipped with mechanical stops to limit the disc angle opening to 50° (90°=full open). PASNY proposes in Reference G to further limit the 24-inch valve numbers 27 AOV-111, 112, and 113 to 40° open.

3.0 Demonstration of Operability

3.1 The Power Authority of the State of New York (PASNY) has provided operability demonstration information for the purge and vent system isolation valves at their James A. Fitzpatrick Nuclear Power Plant in the following submittals:

A. PASNY letter dated May 12, 1981 from J. P. Bayne (PASNY) to T. A. Ippolito (NRC).

B. PASNY letter dated June 13, 1980 from J. P. Bayne (PASNY) to T. A. Ippolito (NRC).

C. PASNY letter dated May 6, 1980 from P. J. Early (PASNY) to T. A. Ippolito (NRC).

D. NRC letter dated January 13, 1984 from D. G. Eisenhut (NRC) to J. P. Bayne (PASNY).

E. PASNY letter dated February 24, 1984 from J. P. Bayne (PASNY) to D. B. Vassallo (NRC).

F. NRC letter dated October 9, 1984 from D. G. Eisenhut (NRC) to J. P. Bayne (PASNY).

G. PASNY letter dated November 26, 1984 from J. P. Bayne (PASNY) to D. B. Vassallo (NRC).

H. PASNY letter dated May 3, 1985 from J. P. Bayne (PASNY) to D. B. Vassallo (NRC).

3.2 PASNY's approach to operability demonstration is based on the following assumptions:

a. Single valve operation, i.e., redundant in-series valve is to have failed open.

b. Pressure losses due to inlets, piping/ducting, filters, etc. are neglected.

c. For valves with asymmetric discs, flow is assumed toward the hub side for purposes of predicting dynamic torques.

Dynamic torque (T_D) predictions stem from coefficients developed by bench tests on model valves representing the design of the in-service valves. Analytical techniques involving scaling are used to determine T_D for the actual valve sizes. The I.S.A. paper entitled, "Effect of Fluid Compressibility on Torque in Butterfly Valves," gives the basis for Fisher's approach to T_D prediction.

Fisher's approach to evaluating critical valve parts in this valve design is to determine maximum allowable ΔPs across the valve at a given disc angle. This maximum allowable ΔP is based on the weakest operating part of the valve but does not include the operator and associated mounting hardware. The maximum allowable ΔP for each disc angle (10° increments) is compared to the operating pressure condition. From this, the maximum disc-opening angle is selected.

The Fisher developed computer program used to establish the maximum opening angle is described as follows:

1. For a given valve at some angle of opening, the program begins by calculating the loading. This includes a hydrostatic load on the disc, seating torque, bushing, and packing torque and dynamic torque.

2. After the loading is determined, the program calculates stresses in the shaft, key, pin, and bushing for a specific ΔP. These calculated stresses are compared to the allowable stresses. For the ferritic steel shaft which is the weakest member, the design (allowable) stress intensity (Sm) from Section III of the ASME Boiler and Pressure Vessel Code is taken as 1/3 of the minimum ultimate tensile strength at room temperature. Fisher uses a value of 0.75 Sm for an allowable shear stress.

3. The program calculates stress and changes ΔP iteratively until the allowable stress matches the calculated stress. This determines the maximum allowable pressure drop for that angle of opening based on the stress at a single point. This process is done for cases 1, 2, 3, 4, and 5 (as defined below) for each angle of opening.

   Case 1 - Stress in the shaft at the disc hub due to bending and torsion.
   Case 2 - Stress in the shaft at the disc hub due to torsion and transverse shear.
   Case 3 - Stress at the pinned disc-shaft connection.
   Case 4 - Stress at the keyed actuator-shaft connection
   Case 5 - Stress at the shaft bushing.

4. The program output shows a ΔP which is calculated at each point for each angle of opening, including two ΔPs for Case 1 (one based on maximum shear stress and one based on maximum tensile stress) for a total of six ΔPs. The smallest ΔP of these six is then repeated as the allowable ΔP at the bottom of the column. The actuator torque for the lowest ΔP (allowable ΔP) is also listed.

3.3 Reference G contains a re-analysis by PASNY based on a revised LOCA containment pressure response curve and a proposed further limitation to a maximum opening angle of 40° for 24-inch valves 27 AOV-111, -112, and -113. These three 24-inch valves have 90° elbows upstream with valve shafts at 90° to the plane of the elbow.

The analysis by PASNY applies a factor of three to the closing torque of the 24-inch valves, with shafts out of plane with the upstream elbow, and is based on analytical methods used by Fisher Control.

Analysis results include the ΔP capability of the valve shaft considered to be the most critical valve component, and the actuator torque margin during closure.

4.0 Evaluation

4.1 In Reference C, PASNY provided information describing accident conditions used by Fisher Controls to assess the subject valves. Fisher makes the assumption that the total containment pressure is the ΔP across each of the

isolation valves from the full open to the full closed position during closure. For valves in lines from the drywell, 39 psi was given as the design pressure. For valves in lines from the wetwell, 22 psi was given as the design pressure. PASNY noted that 39 psi envelopes all drywell pressure values obtained from the most recent drywell response analysis and that 22 psi envelopes all wetwell pressure values obtained in the first 8 seconds based on the wetwell response analysis.

Given that 39 psi is the peak containment pressure predicted for the drywell, the staff finds that using a ΔP of 39 psig as the basis for operability assessment is acceptable. In the case of the wetwell valves, a ΔP of 22 psig is also acceptable.

Fisher's model valve bench test programs used to develop dynamic torque coefficients (C_T) were configured with straight pipe inlets. Testing did not include inlet configurations involving elbows and therefore the effects on C_T can not be quantified for those Fitzpatrick valves which have elbow upstream of the valve.

Information available from other valve manufacturers indicated that for a given valve design at the same conditions, the ratio of C_T (elbow-shaft in plane) to C_T (straight pipe) is greater than one and the ratio of C_T (elbow-shaft out plane) to C_T (straight pipe) is greater than two in some instances. Use of straight pipe developed C_Ts for in service valves with an upstream elbow configuration would result in dynamic torque predictions that are not acceptable.

Based on information available, the staff believes that where bench tests did not include elbows in the piping configuration, a factor of 1.5 times the C_T (straight pipe) for an elbow-shaft in plane valve installation configuration and a factor of 3 times the C_T (straight pipe) for an elbow-shaft out of plane valve installation configuration would yield conservative values of T_D.

4.2 Valve loads for the 20-inch and 24-inch purge and vent valves are predicted by PASNY in the analysis included as part of Reference G. The analysis is based on Fisher Controls developed equations for their 9200 series butterfly valves. Since Fisher does not have data to quantify the effect on C_T (dynamic torque coefficient) of upstream elbows, PASNY applies a torque multiplication factor of three for those valves with upstream elbows and shafts 90° out-of-plane. The staff finds the approach used by PASNY in the prediction of valve torques conservative.

The use of 0.75Sm as the allowable shear stress by Fisher (Section 3.2 of this evaluation) exceeds the generally accepted allowable shear stress of 0.6Sm (ASME Code -NB3227.2) or the AISC allowable shear stress of 0.4Sy (Sy=tensile yield). However, the conservatism in the Fisher analysis results in the

0.6 Sm allowable shear stress not being exceeded. For example, for the valves that constitute the worst case, AOV-111, 112 & 113, that is, there is an elbow upstream and the valve shaft is out of the plane of the elbow, the shaft ΔP capability from Table 1 of Reference G at the 30° valve opening is 27 psi. The ΔP developed at 30° is 19.23 psi, and the ratio of ΔPs is 1.4. Thus, the calculated shear stress does not exceed 0.6Sm (0.75/1.4 = 0.54Sm).

4.3 The capability of the Bettis 732C-SR 80 and 733C-SR 80 actuators to close the valves from the 50° and 40° limited opening positions is shown in curves provided with the analysis contained in Reference G. The curves compare required valve torque developed during closure against the containment pressure ramp with the available actuator spring torque. Adequate torque margins are shown for each valve.

4.4 The structural adequacy of the interfacing hardware (actuator/valve) is demonstrated in the Fisher Controls analysis provided as part of Reference H. The calculated shear stress is shown to be less than the allowable shear stress for the bolt material.

4.5 Seismic qualification for the 20-inch and 24-inch valve assemblies is addressed by the Fisher Controls Company report number CD72-234 dated July 19, 1982.

5.0 Conclusion

We have completed our review of information submitted to date concerning operability of containment purge and vent valves for James A. Fitzpatrick Nuclear Power Plant. Sections 4.1, 4.2, 4.3 and 4.4 are the basis for the conclusion of the staff. We find the information submitted demonstrates the ability of the 20-inch and 24-inch purge and vent valves to close against the buildup of containment pressure in the event of a DBA/LOCA. The 50° opening angle limitation applies to valve numbers 27 AOV-114-, -115, -116, -117, and -118 and the 40° opening angle limitation applies to valve numbers 27 AOV-111, -112, and -113. The Technical Specifications for valves 27 AOV-115, 27 AOV-116, 27 AOV-117 and 27 AOV-118 should reflect a closing time of less than or equal to 8 seconds and the limitation of opening angles as previously described for all valves.

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