UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

DEMONSTRATION OF CONTAINMENT PURGE AND VENT VALVE OPERABILITY

COMMONWEALTH EDISON COMPANY

IOWA-ILLINOIS GAS AND ELECTRIC COMPANY

DRESDEN NUCLEAR POWER STATION, UNIT NOS. 2 AND 3

QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-237/249/254/265

1.0 INTRODUCTION

1.1 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.

1.2 Description of Purge and Vent Valves

The valves identified as the containment isolation valves in the purge and vent system are as follows:

Dresden Station Units 2 and 3

Unit No.	Valve Number	Size (Inches)	Valve Type	Location
2	AO-2-1601-21	18	Butterfly	Outside containment
2	AO-2-1601-22	18	Butterfly	Outside containment
2	AO-2-1601-23	18	Butterfly	Outside containment
2	AO-2-1601-24	18	Butterfly	Outside containment
2	AO-2-1601-56	18	Butterfly	Outside containment
2	AO-2-1601-60	18	Butterfly	Outside containment
2	AO-2-1601-63	6	Butterfly	Outside containment
2	AO-2-1601-55	4	Butterfly	Outside containment
3	AO-3-1601-21	18	Butterfly	Outside containment
3	AO-3-1601-22	18	Butterfly	Outside containment
3	AO-3-1601-23	18	Butterfly	Outside containment
3	AO-3-1601-24	18	Butterfly	Outside containment
3	AO-3-1601-56	18	Butterfly	Outside containment
3	AO-3-1601-60	18	Butterfly	Outside containment
3	AO-3-1601-63	6	Butterfly	Outside containment
3	AO-3-1601-55	4	Butterfly	Outside containment

Quad Cities Station Units 1 and 2

Unit No.	Valve Number	Size (Inches)	Type Type	Location
1	AO-1-1601-21	18	Butterfly	Outside containment
1	AO-1-1601-22	18	Butterfly	Outside containment
1	AO-1-1601-23	18	Butterfly	Outside containment
1	AO-1-1601-24	18	Butterfly	Outside containment
1	AO-1-1601-56	18	Butterfly	Outside containment
1	AO-1-1601-60	18	Butterfly	Outside containment
1	AO-1-1601-63	6	Butterfly	Outside containment
1	AO-1-1601-55	4	Gate	Outside containment
1	AO-2-1601-21	18	Butterfly	Outside containment
1	AO-2-1601-22	18	Butterfly	Outside containment
1	AO-2-1601-23	18	Butterfly	Outside containment
1	AO-2-1601-24	18	Butterfly	Outside containment
1	AO-2-1601-56	18	Butterfly	Outside containment
1	AO-2-1601-60	18	Butterfly	Outside containment
1	AO-2-1601-63	18	Butterfly	Outside containment
1	AO-1-1601-55	4	Gate	Outside containment

The 18-inch butterfly valves at Dresden and Quad Cities are Model 2F11 valves manufactured by Henry Pratt Company and are equipped with Pratt operators (8-inch diameter cylinders).

The 6-inch diameter butterfly valves are also Pratt Model 2F11 valves equipped with Pratt operators (3-1/4inch diameter cylinders). The 4-inch diameter wafer sphere butterfly valves are Jamesbury Model 8126 equipped with type ST-60MSB operators. The 4-inch diameter gate valves are Crane Model No. 47-1/2V valves equipped with Chicago Fluid operators (8-inch diameter cylinders).

1.3 Demonstration of Operability

Commonwealth Edison (CECO) has provided purge and vent valve operability demonstration information for Dresden, Units 2 and 3 and Quad Cities, Units 1 and 2 in the following submittals:

A. September 30, 1985 letter, J. R. Wojnarowski (CECO) to H. L. Thompson (NRC).
B. July 25, 1985 letter, J. R. Wojnarowski (CECO) to H. L. Thompson (NRC).
C. May 3, 1984 letter, B. Rybak (CECO) to H. R. Denton (NRC).
D. December 21, 1983 letter, B. Rybak (CECO) to H. R. Denton (NRC).
E. November 4, 1983 letter, D. M. Crutchfield (NRC) to D. L. Farrar. (CECO).
F. July 6, 1981 letter, T. J. Rausch (CECO) to G. C. Lainas (NRC).
G. February 27, 1981 letter, R. F. Janecek (CECO) G. C. Lainas (NRC).
H. August 22, 1980 letter, R. F. Janecek (CECO) to G. C. Lainas (NRC).
I. April 1980 NUREG/CR-0891, "Seismic Review of Dresden Nuclear Power Station"

The licensee's dynamic torque (T_D) predictions contained in NUTECH Engineers report COM-83-042 (Reference A) for the 18-inch, 6-inch, and 4-inch butterfly valves at Dresden and Quad Cities are based on Prairie Island valve torque data derived from a torque analysis by the Henry Pratt Company for the same model 18-inch butterfly valve (Model No. 2F11). The Pratt analysis uses dynamic torque coefficients (C_T) based on a test program using a 5-inch diameter model valve disc. For the 6-inch Pratt butterfly valves, the 18-inch torque data is scaled down by the cube of the diameter ratio ($D_{6 inch}/D_{18 inch})^3$. The 4-inch Jamesbury butterfly valve disc does not have the same geometry as the Pratt disc. For this valve, the 18-inch Pratt torque data was modified by two factors. The first factor involved scaling of the 18-inch torque data by the cube of the diameter ratio ($D_{4 inch}/D_{18 inch})^3$. The second factor involved increasing the 4-inch torque data by the ratio of analytically-determined torque coefficients for the Pratt and Jamesbury disc geometry ($C_{T_4 inch}/C_{T_{18} inch}$).

The stress analysis for critical valve parts is contained in the NUTECH Engineers report (Reference A). Stress values are determined for the critical valve parts (shaft, disc pins, keyways) using maximum torque loads combined with design pressure loads. Allowable stresses for the various valve components are taken from ASME Boiler and Pressure Vessel Code, Section III appendices. The largest stress ratio which is defined as the calculated stress divided by the allowable stress was determined to be 0.90 for the Pratt 18-inch diameter valve disc pin.

The actuator torque margin for the valve assemblies is adequate in all cases for the 18-inch, 6-inch, and 4-inch butterfly valves. This is demonstrated by comparing the minimum operator torque with the maximum dynamic torque required to close the valve against the increasing containment pressure during a LOCA.

The Crane 4-inch Gate Valve utilized in the purge and vent system at Quad Cities 1 and 2 is a 150 lbs class valve designed to ANSI B1634 with a design pressure rating of 225 psig at 300°F. The closure analysis for this valve is provided in NUTECH Report No. COM-83-042, dated September 23, 1985 and submitted as an attachment to Reference A.

2.0 EVALUATION

The licensee (Commonwealth Edison) has chosen to use torque data for its 18-inch Pratt Model No. 2F11 butterfly valves from an analysis performed by Henry Pratt Company for the same size and model number valves at another nuclear generating station. The maximum dynamic torque predicted by Pratt for the 18-inch valve is 18,302 in-lbs and includes a factor for the increased dynamic torque resulting from an installation configuration with the valve shaft out of plane with the upstream elbow. Torque coefficients for both sonic and subsonic flow are derived from analysis of experimental test data using a 5-inch test model. Conservative assumptions used in the analysis include:

- Single valve closure with the redundant valve failed in the open position.
- Valve closure against peak containment pressure (65 psig).
- Valve shaft 90° out of plane with an upstream elbow for every valve.

The staff finds the use by the licensee of the Pratt torque data for the 18-inch valves at Dresden-Quad Cities acceptable.

For the 6-inch butterfly valves, the torque of 18,302 in-lbs was scaled down by the ratio of the diameters cubed resulting in a maximum dynamic torque of 678 in-lbs.

The 4-inch butterfly valves have a disc geometry dissimilar to the Pratt disc geometry. In order to account for this difference, the NUTEC analysis (Reference A) determined theoretical torque coefficients for both discs then applied the ratio of these coefficients and the diameter ratio cubed to the 18,302 in-lbs maximum dynamic torque from the Pratt analysis for the 18-inch valve.

$$T_{D4\text{-}inch} = 18,302 \times \left(\frac{D_{4\text{-}inch}}{D_{18\text{-}inch}}\right)^3 \times \frac{C_T \text{ Jamesbury}}{C_T \text{ Pratt}}$$

$$= 18,302 \times \left(\frac{4}{18}\right)^3 \times \frac{0.0458}{0.03}$$

$$= 307 \text{ in-lbs}$$

$$\text{Diameter Ratio} = \frac{D_4 \text{ inch}}{D_{18} \text{ inch}}$$

$$\text{Torque Coefficient Ratio} = \frac{C_T \text{ Jamesbury}}{C_T \text{ Pratt}}$$

The staff finds the assumptions and methodology used in torque prediction for the 18-inch, 6-inch, and 4-inch valve acceptable.

The stress analysis for the 18-inch, 6-inch, and 4-inch butterfly valve critical parts is contained in NUTECH Report No. COM-83-042 which is furnished as an attachment to Reference A. Calculated stresses are compared to allowable stresses taken from Section III and Appendices of the ASME Boiler and Pressure Vessel Code. Tables 4.1, 4.2, and 4.3 of the NUTECH report tabulated the stress ratios for the 18-inch, 6-inch, and 4-inch butterfly valve critical parts. The stress ratio is defined as the calculated stress divided by the code allowable stress. The weakest critical part in each valve size has the largest stress ratio. For the 18-inch butterfly valve, the weakest member is the disc pin with a stress ratio of 0.9. The weakest member in the 6-inch

butterfly valve is the disc shaft in the pin region with a stress ratio of 0.43. The weakest member in the 4-inch butterfly valve is the disc shaft in the spline region with a stress ratio of 0.56.

The staff finds the stress analysis results acceptable. Conservative loading assumptions were used and the results demonstrate that the calculated stresses do not exceed stresses allowed by code.

For the demonstration of adequate torque margins, the maximum dynamic torque is compared to the minimum operator torque in the NUTECH analysis. The comparison for each size valve is shown below:

Valve Type	Maximum Dynamic Torque (in-lbs)	Minimum Operator Torque (in-lbs)
18-inch Butterfly	18,302	25,303
6-inch Butterfly	678	2,903
4-inch Butterfly	307	720
4-inch Gate	1,404	2,545

The staff finds that the torque margins for the valves above are adequate and demonstrate the ability of the operator to close the valve against the increased containment pressure during a LOCA. The 150 lbs pressure rating of the valve provides an acceptable margin for structural integrity when compared to the peak containment pressure of 65 psig.

NUTECH furnishes a closure and static pressure analysis for the 4-inch gate valves. The closure analysis determines the force required to close the valve which is created by packing friction and a wedging factor, and compares this with the minimum actuator force. The analysis results show that the actuator has a minimum available spring preload of 2,545 lbs compared to the required force to effect closure of 1,404 lbs. The 150 lbs pressure rating of the valve provides an acceptable margin for structural integrity when compared to the peak containment pressure of 65 psig.

As a valid seismic qualification document is not available, this item must be addressed under Unresolved Safety Issue A-46 (seismic qualification of equipment in operating plants).

3.0 CONCLUSION

We have completed our review of information submitted to date concerning the operability of the 18-inch, 6-inch, and 4-inch containment purge and vent valves at the Dresden Station, Units 2 and 3, Quad Cities Station, Units 1 and 2. We find that the information submitted has satisfactorily demonstrated the ability of the valves to close from the fully open position against the build-up of containment pressure in the event of a DBA/LOCA.

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Dated: February 28, 1986