

Technical Evaluation Report  
Brookhaven National Laboratory

WATTS BAR UNITS 1 AND 2, DOCKET NO. 50-390 AND 50-391  
DEMONSTRATION OF CONTAINMENT PURGE AND VENT VALVE OPERABILITY

TMI ITEM II.E.4.2

(Revisions 0, 1 and 2)

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WATTS BAR NUCLEAR PLANT UNITS 1 AND 2  
DOCKET NOS. 50-390, 50-391

DEMONSTRATION OF CONTAINMENT PURGE AND VENT VALVE OPERABILITY

(Rev. 0)

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

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

<u>Valve No.</u>	<u>Size (Inches)</u>	<u>Use</u>	<u>Location</u>	<u>Model No.</u>
30-40	8	Not given	Not given	1144
30-37	8	Not given	Not given	1144
30-19	12	Not given	Not given	1144
30-20	12	Not given	Not given	1144
30-58	12	Not given	Not given	1144
30-59	12	Not given	Not given	1144
30-72	4	Not given	Not given	1134
30-82	4	Not given	Not given	1134
30-92	4	Not given	Not given	1134
30-10	24	Not given	Not given	1134
30-14	24	Not given	Not given	1134
30-15	24	Not given	Not given	1134
30-16	24	Not given	Not given	1134
30-17	24	Not given	Not given	1134
30-50	24	Not given	Not given	1134
30-51	24	Not given	Not given	1134
30-52	24	Not given	Not given	1134
30-53	24	Not given	Not given	1134
30-56	24	Not given	Not given	1134
30-57	24	Not given	Not given	1134

The valves are all butterfly valves manufactured by Posi-Seal International, Inc., of North Stonington, Connecticut.

The 24-inch valves are ASME class 150/150 with operator Model Number 33082-SR60 supplied by MATRYX. There are two styles of 24-inch valves included in the listing above. One is a bolted flange and is shown on Posi-Seal Drawing Number 12408, Rev. A, and the other is a welded flange type as shown on on Posi-Seal Drawing Number 12407, Rev. A.

The 12-inch valves are ASME Class 150 with operator Model Number 26062-SR60 supplied by MATRYX. There are also two styles of 12-inch valves included in the listing above. One is a bolted flange and is shown on Posi-Seal Drawing Number 12040, Rev. B and the other is a welded flange type shown on Posi-Seal Drawing Number 12396, Rev. C.

The 8-inch valves are ASME Class 150 with operator Number 26061-SR60 supplied by MATRYX. Again, there are two styles of 8-inch valves included in the listing above. One is a bolted flange and is shown on Posi-Seal Drawing Number 12422, Rev. E, and the other is a welded flange type as shown on Posi-Seal Drawing Number 12421, Rev. D.

The applicant's submittal does not give a correlation between plant designated valve numbers and vendor drawing numbers. However, although there are two different types of valves for each valve size, the internal components are identical for each size valve which results in identical stresses on the critical parts such as shear pins and stem. The only part which experiences different stresses due to the different configuration is the valve neck. These stresses in the neck are generally low except for one configuration of the 8-inch valves, where they are approximately 90% of allowable.

### 3.0 Demonstration of Operability

The following documents were examined for this review:

- A. Letter of December 6, 1983 from L. Mills, Tennessee Valley Authority to E. Adensam, Division of Licensing, U.S. Nuclear Regulatory Commission.
- B. Posi-Seal International, Inc. Report Number N3M-652 dated March 8, 1982, entitled "Nuclear Seismic and LOCA Analysis," Rev. A, for Watts Bar.
- C. "Effect of Fluid Compressability on Torque in Butterfly Valves," F. P. Hartman, ISA 1968 Annual Conference, ISA Transactions, Vol. 8, No. 4, pg. 28.

The applicant's submittals did not contain a description of the complete containment purge and vent system, and a review of the FSAR for this plant did not reveal either a description or schematics for this system.

Reference A is a response to an NRC letter dated October 5, 1982, requesting additional information regarding purge and vent valves for Watts Bar, and contains an enclosure which responds to the particular questions of the letter of October 5, 1982. Most of the answers refer to portions of Reference B which was submitted as Appendix 1 to Reference A. Reference A gives the valve numbers, manufacturer's model numbers and operator manufacturer and model numbers for all the containment purge and vent valves used at Watts Bar, but without further description it is not possible to ascertain where these valves are located or what their use is (i.e., supply, exhaust, bypass, etc.). Reference A clearly states (in the response to question 9 on page 5 of the enclosure), that the 8- and 12-inch valves will be operated fully open and that the 24-inch valves will be restricted to 70° open (90° being fully open).

Reference B is a detailed analysis of all the valves supplied by Posi-Seal for the Watts Bar purge and vent system. It does not describe the total system, but does give an analysis of the specific case of a valve with an upstream elbow.

The analysis provided by Reference B is divided into the following major sections:

- Results and conclusions,
- LOCA analysis (includes derivation of torque equations),
- Seismic analysis,
- Computer input sheets.

Six enclosures to the report contain the actual data and calculations used to arrive at the conclusions. They are as follows:

1. Calculation of various input parameters,
2. Seismic and LOCA computer calculations,
3. Valve assembly drawings,
4. Posi-Seal Technical Bulletin No. 6 of August 1, 1976,
5. Posi-Seal Technical Bulletin No. 2 of October 1980,
6. Posi-Seal Technical Bulletin No. 1A of October 1980.

In addition, two addenda were included with Reference B, entitled as follows:

Addendum A - "Hydrodynamic Torques of High Performance Trunnion Valves" describes the vendors hydrodynamic tests and presents test data for valves (up to 12 inches in diameter).

Addendum B - "Effects of Having an Elbow Upstream of a Posi-Seal 24-inch 150/150 Containment Isolation Valve."

The conclusions reached in this report (Reference B) are summarized as follows:

1. All valves are capable of closing from the full open position under combined LOCA and seismic loads if they are mounted in the preferred direction with no elbows or bends upstream.
2. The 24-inch valves should be limited to 70° opening (90° is full open) in order to insure their closing if installed with an elbow upstream.
3. Although the 8-inch and 12-inch valves will close in any direction relative to flow, it is recommended that they also be mounted in the preferred direction. Upstream elbows do not produce excessive torques on valves in this size range.

The calculation of aerodynamic torques is based on hydrodynamic tests (water) on smaller valves (up to 12 inches). The Posi-Seal report assumes that for the same size and class of valve, the coefficients of lift and drag for any given valve angle are the same regardless of fluid, flow, or temperature. Based on this assumption, the coefficients of lift and drag which are derived from the hydrodynamic tests are used to calculate aerodynamic torques under

the conditions predicted for the DBA/LOCA scenario chosen. The DBA/LOCA chosen results in an upstream pressure of 33.2 psig, with a steam/air mixture at 100% relative humidity and a temperature of 250 F flowing through the valves. These conditions are held constant for this analysis.

Stresses on all the critical valve components were calculated based on the conditions described above and 3-g seismic loads. These stresses were compared to a listing of "allowable" stresses. These "allowable" stresses were based on the allowables given in Section III of the ASME Boiler and Pressure Vessel Code.

Addendum B to Reference B presents an analysis of the increased torque expected on the 24-inch valves due to an upstream elbow. This analysis assumes the aerodynamic torques are the same as for the straight pipe case, and adds an additional "impact" torque due to the unsymmetrical flow. The analysis results in a recommendation to limit the opening of the 24-inch valves to 70° (90° is full open).

#### 4.0 Evaluation

4.1 The derivation of the aerodynamic torque for these valves during a LOCA is based entirely on the assumption that coefficients of lift and drag are independent of flow media (fluid), flow, or temperature. Using this premise and the data from hydrodynamic testing on similar valves up to 12 inches in diameter, the vendor has derived some general expressions for coefficients of lift and drag, and for the calculation of aerodynamic torques based on the hydrodynamic data.

This assumption is only valid for compressible flow at low Mach numbers (less than 0.3). For Mach numbers approaching 1 (over 0.8), the coefficient of drag increases exponentially. For Mach numbers between 0.3 and 0.8, the coefficients of lift generally increase as a function of Mach number. The rate of increase is dependent on the shape of the airfoil. While the applicant has not submitted any velocities for review in this submittal (Reference B), previous submittals from other licensees using Posi-Seal valves have included velocity data which indicate that for the conditions that these valves will be subjected to, the Mach numbers will be over 0.3 and approaching 0.5. For this reason, the assumption that coefficients of lift and drag are the same as those calculated from the water tests for a 12-inch valve, is not acceptable to the reviewers. Even at low Mach numbers, the coefficients of drag are a function of Reynolds number and should only be transposed between fluids if the Reynolds numbers are equal. For these reasons, the calculation of aerodynamic torques based on hydrodynamic data is not acceptable to the staff.

4.2 Reference C describes another method for predicting aerodynamic torque using torque relationships developed for incompressible flow. It is of interest here not because of the method presented, but because it describes a test program which compared the results of torque calculations with test results for similar valves using air and water. The data presented in Reference C indicate that for low pressure drops across a valve (less the 5% total pressure) the resultant torque is essentially equal for both air and water. For higher

Pressure drops, the resultant torques decrease for air at a rate of approximately 4% decrease in torque per 1% increase in pressure drop. This rate of decrease continues until a pressure drop of 15% is reached. Above 15% pressure drop, the decrease in aerodynamic torque compared to hydrodynamic torque is exponential.

If these relationships are used, we would expect that the torques calculated by Posi-Seal in Reference B for large angles of valve opening to be closer to the hydrodynamic values shown in Technical Bulletin 1A (enclosure 6 of Reference B).

Since the analysis of Addendum B to Reference B also uses the aerodynamic torques developed for the 24-inch valves from hydrodynamic data, the conclusions reached regarding the recommendation limiting the valves to 70° open, are unacceptable to the staff for the reasons cited above.

For angles less than 60° where the pressure drops are much higher, the torque values predicted by Posi-Seal are closer to what would be expected, and are generally low such that they do not generate high stresses in any of the critical valve components. Therefore, the staff would find it acceptable if the licensee proposed to operate the 24-inch valves with an opening limitation of 50°.

4.3 For the 12-inch valves, the stress generated by the aerodynamic torques is low and even if the torques calculated in Reference B are doubled, the stresses generated are still below allowable for all angles of opening. For this reason, the staff finds that the applicant has demonstrated the operability of the 12-inch valves.

4.4 For the 8-inch valves, the applicant should demonstrate whether or not the stresses in the valve neck are affected by the aerodynamic torque experienced by the valve internals. If these stresses are only a function of the seismic loading, then, by the same reasoning cited in Section 4.2 above, the 8-inch valve operability would be acceptably demonstrated. Until this is demonstrated however, the staff would treat the 8-inch valves in a manner similar to the 24-inch valves, and accept an opening limitation of 50°.

## 5.0 Summary

The staff has completed its review of the information submitted to date concerning operability of the 8-inch, 12-inch, and 24-inch valves used in the containment purge and vent system for the Watts Bar Nuclear Plant Units 1 and 2. The staff finds that the information submitted for the 8-inch and 24-inch valves did not demonstrate that these valves have the ability to close against the buildup of pressure in the event of DBA/LOCA from the full open position. Sections 4.1, 4.2, and 4.4 are the basis for these findings.

The staff finds that the information submitted demonstrated the ability of the 12-inch valve to close from a full open position against the buildup of pressure in the event of a DBA/LOCA. Section 4.3 gives the basis for this finding.

The applicant should confirm that all of the valves have been installed in the "preferred" orientation as described by the valve manufacturer.

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2  
DOCKET NUMBERS 50-390, 50-391

DEMONSTRATION OF CONTAINMENT PURGE AND VENT VALVE OPERABILITY

(Rev. 1)

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

Tennessee Valley Authority (TVA) has submitted operability demonstration information for the following valves identified as the containment isolation valves in the purge and vent system at Watts Bar Nuclear Plants Units 1 and 2.

<u>Valve No.</u>	<u>Size (Inches)</u>	<u>Use</u>	<u>Location</u>	<u>Model No.</u>
30-40	8	Pressure relief	Accumulator Rm 4	1144
30-37	8	Pressure relief	Accumulator Rm 4	1144
30-19	12	Purge Supply	Instrument Rm	1144
30-20	12	Purge Supply	Instrument Rm	1144
30-58	12	Purge Exhaust	Instrument Rm	1144
30-59	12	Purge Exhaust	Instrument Rm	1144
30-7	24	Purge Supply	Upper Compartment	1134
30-8	24	Purge Supply	Upper Compartment	1134
30-9	24	Purge Supply	Upper Compartment	1134
30-10	24	Purge Supply	Upper Compartment	1134
30-14	24	Purge Supply	Lower Compartment	1134
30-15	24	Purge Supply	Lower Compartment	1134
30-16	24	Purge Supply	Lower Compartment	1134
30-17	24	Purge Supply	Lower Compartment	1134
30-50	24	Purge Exhaust	Upper Compartment	1134
30-51	24	Purge Exhaust	Upper Compartment	1134
30-52	24	Purge Exhaust	Upper Compartment	1134
30-53	24	Purge Exhaust	Upper Compartment	1134
30-56	24	Purge Exhaust	Lower Compartment	1134
30-57	24	Purge Exhaust	Lower Compartment	1134

The valves are all butterfly valves manufactured by Posi-Seal International, Inc., (PSI) of North Stonington, Connecticut.

The 24-inch valves are ASME class 150/150, equipped with air to open/spring to close actuators manufactured by Matrix model number 33082-SR60. There are two styles of 24-inch valves indicated in the submittal. One is a bolted flange and is shown on Posi-Seal Drawing Number 12408, Rev. A, and the other is a welded flange type as shown on Posi-Seal Drawing Number 12407, Rev. A.

The 12-inch valves are ASME Class 150, equipped with air to open/spring to close actuators manufactured by Matrix model number 26062-SR60. There are

also two styles of 12-inch valves indicated in the submittal. One is a bolted flange and is shown on Posi-Seal drawing number 12040, Rev. B and the other is a welded flange type shown on Posi-Seal drawing number 12396, Rev. C.

The 8-inch valves are ASME Class 150, equipped with air to open/spring to close actuators manufactured by Matryx number 26061-SR60. Again, there are two styles of 8-inch valves indicated in the submittal. One is a bolted flange and is shown on Posi-Seal drawing number 12422, Rev. E, and the other is a welded flange type as shown on Posi-Seal drawing number 12421, Rev. D.

### 3.0 Demonstration of Operability

3.1 TVA has submitted the following documents in demonstration of purge and vent valve operability:

- A. Letter of October 25, 1984 from L. M. Mills, Tennessee Valley Authority (TVA) to E. Adensam, Division of Licensing, U.S. Nuclear Regulatory Commission (NRC).
- B. Letter of December 6, 1983 from L. M. Mills, Tennessee Valley Authority (TVA), to E. Adensam, Division of Licensing, U.S. NRC.
- C. Posi-Seal International, Inc. Report Number N3M-652 dated March 8, 1982 entitled "Nuclear Seismic and LOCA Analysis," Rev. A, for Watts Bar.
- D. "Effect of Fluid Compressability on Torque in Butterfly Valves," F. P. Hartman, ISA 1968 Annual Conference, ISA Transactions, Vol. 8, No. 4, pg. 28.

Reference A is a response to an NRC Safety Evaluation Report (SER) identifying open issues regarding the demonstration of operability of the 8 and 24-inch purge and vent valves. Addressed are the concerns regarding the 8-inch valves and the 24-inch valves located in the upper compartments. TVA states that the information addressing the NRC concerns regarding the operability of the 24-inch valves in the lower compartment will be provided prior to fuel loading of Unit 1.

Note: TVA has previously demonstrated operability of the 12-inch valves as indicated in the NRC Safety Evaluation Report dated July 1984.

3.2 PSI assumes that for the same size and class of valve, the coefficients of lift and drag for any given valve angle is the same regardless of fluid, flow, or temperature. Based on this the coefficients of lift and drag, which are derived from hydrodynamic test, are used to calculate aerodynamic torques for the conditions predicted for DBA/LOCA. The hydrodynamic test, or model testing, performed are on valves ranging from 1-1/2 inch through 14-inch for both preferred and non-preferred installation configurations, the results of these tests are used to calculate dynamic torques for all sizes and classes of valves. Based upon the flow testing performed at PSI, the following general observations concerning hydrodynamic torque of trunnion valves can be made:

1. For preferred flow, the hydrodynamic torque will always tend to close the valve.
2. For non-preferred flow, the hydrodynamic torque will, through 70° to 80° of valve rotation (the exact location varies with valve class), tend to close the valve. Above 80° of valve rotation, the hydrodynamic torque will want to open the valve.
3. Except for the 90° valve opening where the hydrodynamic torque factors are of equal magnitude for both preferred and non-preferred flow, but of opposite sign, the non-preferred hydrodynamic torque factors are considerably less in magnitude than those for preferred flow.

3.3 The stress analysis entitled, "Seismic and LOCA Stress Analysis" for the valve critical parts is presented in Reference C originally and in response to the July SER in Reference A. Based on the results of the analysis, and item 3.5 below, PSI recommends that the 24-inch valves in the upper compartment be restricted to an open angle of 70° and the 8-inch valves may operate from a full open angle of 90°. This valve restriction is accomplished by bolting a stop to the internals of the Matrixx piston cartridge which would limit the stroke of the actuator.

3.4 Reference C additionally presents an analysis entitled, "Determination of Closing Times." This analysis presents a tabulation of available spring torques and dynamic torques at increments of valve closure angle for steam and air.

3.5 Addendum B to Reference C presents an analysis of the increased torque expected on the 24-inch valves due to an upstream elbow. This analysis assumes the aerodynamic torques are the same as for the straight pipe case, and adds an additional "impact" torque due to the unsymmetrical flow. The analysis results in a recommendation to limit the opening of the 24-inch valves to 70° (90° is full open).

#### 4.0 Evaluation

This section will evaluate TVA response to the open issues identified in the July SER. As previously stated, TVA has demonstrated operability of the 12-inch valves and will address the concerns of the 24-inch valves in the lower compartment prior to Unit 1 fuel loading. This evaluation will address the 8 and 24-inch valves in the upper compartment. Item 4.1 will discuss the 8-inch valve while Sections 4.2 through 4.5 will be on evaluation of the 24-inch valve in the upper compartment.

The applicant's submittal does not give a correlation between plant designated valve numbers and vendor drawing numbers. Although there are two different types of valves bolted and welded flange for each valve size, the internal components are identical for each size valve. This results in identical stresses on the critical parts such as shear pins and stem. The only part

which experiences different stresses due to the different configuration is the valve neck. These stresses in the neck are generally low except for one configuration of the 8-inch valves, where they are approximately 90% of allowable.

4.1 The open issues pertaining to the 8-inch valve were (a) the dependency of the valve neck stresses on the aerodynamic torques and their relationship to the code allowables for the material and (b) installation orientation. In response to concern (a), PSI performed a seismic and dynamic torque analysis. The seismic analysis with no torque applied, resulted in a valve neck stress of 23,300 psi. The dynamic torque analysis objective was to determine the amount of torque needed to overstress the valve neck. The results state that "...while the valve neck stresses are not totally independent of the aerodynamic torque, the applied aerodynamic torque would have to be quadrupled for the calculated stress to approach the allowable limitation." The maximum calculated aerodynamic torque in the preferred direction is 842 in-lbs, while the torque required to overstress the valve neck is 3,400 in-lbs.

Thus, with the commitment to install the 8-inch valves in the preferred orientation (see Section 4.5 and the analysis performed), the applicant has demonstrated operability of the valves.

4.2 The open issue pertaining to the 24-inch valves was with the methodology utilized in determining the dynamic torques. The determination by PSI of hydrodynamic torque factors used in predicting valve dynamic loads is based on model testing using test valves ranging in size from 1-1/2 inches to 14 inches in diameter. PSI then derives torque equations for steam and nitrogen using the data from the hydrodynamic model testing program. In the original submittal (Reference C), containment pressure of 18.5 psig was assumed in the torque analysis.

Reference A states that the peak pressure in the upper compartment of the containment is 8 psig. This is due to Watts Bar having an ice condenser containment and the fact that there is no high energy line located in the upper compartment. Since the original aerodynamic torque analysis was based on 18.5 psig, the aerodynamic torque determined was more than twice the actual loads expected. This is based on the rationale that the aerodynamic torque is directly proportional to the pressure drop across the valve. It is concluded that a conservative factor of 2.3 was accounted for when calculating dynamic torques and also inputted into the stress analysis ( $18.5 \text{ psig} \div 8 \text{ psig} = 2.3$ ). Therefore, the concern regarding the methodology utilized in demonstrating operability has been addressed based on this built in conservative factor and since a constant peak containment pressure is assumed in the analysis.

4.3 The maximum allowable design torque of the Matryx 33082-SR80 actuator is 57,955 in-lbs. With the valve restricted to 70° open the maximum torque is 50,652 in-lbs, demonstrating that the structural capacity of the actuator is not exceeded.

4.4 The stress analysis provided compares the calculated stresses versus ASME code allowable for the various critical valve parts (e.g., actuator bolts, bracket bolts, bracket, valve stem and disc pin). A summary of the stress analysis results is presented for straight and upstream elbow configuration, preferred and non-preferred disc installation and for steam and air media. Seismic and LOCA loads are applied simultaneously in the stress analysis. The results of the analysis has demonstrated that the stress allowables are not exceeded for either straight pipe or elbow upstream, regardless of media or disc installation, as long as the valve stem is perpendicular or parallel with the plane of the elbow.

4.5 Regarding valve installation, TVA commits to installing the 8 and 12-inch valves in PSI preferred orientations (valve seal retaining ring downstream relative to LOCA flow) by Unit 1 fuel load and that the 24-inch valves, being restricted to 70° open may be installed in either orientation. The staff in reviewing the submittals, agrees with the recommendation by PSI and the commitments by TVA.

4.6 Seismic qualification is addressed in Reference C, entitled "Nuclear Seismic and LOCA analysis."

#### 5.0 Summary

We have completed our review of the information submitted to date concerning operability of the 8, 12, and 24-inch valves used in the containment purge and vent system for the Watts Bar Nuclear Plant, Units 1 and 2.

We find that the information submitted concerning the 8-inch valves and the 24-inch valves (upper containment) has demonstrated the ability of the 8-inch valve to close from the full open position, and the 24-inch valve to close from a mechanically limited opening position of 70° in the event of a DBA/LOCA. Paragraphs 4.1 through 4.6 are the basis for this determination.

The 12-inch valves were already approved (Reference NRC letter to TVA, dated July 19, 1984) for full open operation. As stated previously, the TVA has committed to provide information demonstrating operability of the valves in the lower compartment prior to fuel loading of Unit 1.

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2  
DOCKET NUMBERS 50-390, 50-391

DEMONSTRATION OF CONTAINMENT PURGE AND VENT VALVE OPERABILITY

(Rev. 2)

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

Tennessee Valley Authority (TVA) has submitted operability demonstration information for the following valves identified as the containment isolation valves in the purge and vent system at Watts Bar Nuclear Plants Units 1 and 2.

<u>Valve No.</u>	<u>Size (Inches)</u>	<u>Use</u>	<u>Location</u>	<u>Model No.</u>
30-40	8	Pressure relief	Accumulator Rm 4	1144
30-37	8	Pressure relief	Accumulator Rm 4	1144
30-19	12	Purge Supply	Instrument Rm	1144
30-20	12	Purge Supply	Instrument Rm	1144
30-58	12	Purge Exhaust	Instrument Rm	1144
30-59	12	Purge Exhaust	Instrument Rm	1144
30-7	24	Purge Supply	Upper Compartment	1134
30-8	24	Purge Supply	Upper Compartment	1134
30-9	24	Purge Supply	Upper Compartment	1134
30-10	24	Purge Supply	Upper Compartment	1134
30-14	24	Purge Supply	Lower Compartment	1134
30-15	24	Purge Supply	Lower Compartment	1134
30-16	24	Purge Supply	Lower Compartment	1134
30-17	24	Purge Supply	Lower Compartment	1134
30-50	24	Purge Exhaust	Upper Compartment	1134
30-51	24	Purge Exhaust	Upper Compartment	1134
30-52	24	Purge Exhaust	Upper Compartment	1134
30-53	24	Purge Exhaust	Upper Compartment	1134
30-56	24	Purge Exhaust	Lower Compartment	1134
30-57	24	Purge Exhaust	Lower Compartment	1134

The valves are all butterfly valves manufactured by Posi-Seal International, Inc., (PSI) of North Stonington, Connecticut.

The 24-inch valves are ASME class 150/150, equipped with air to open/spring to close actuators manufactured by Matrix model number 33082-SR60. There are two styles of 24-inch valves indicated in the submittal. One is a bolted flange and is shown on Posi-Seal Drawing Number 12408, Rev. A, and the other is a welded flange type as shown on Posi-Seal Drawing Number 12407, Rev. A.

The 12-inch valves are ASME Class 150, equipped with air to open/spring to close actuators manufactured by Matrix model number 26062-SR60. There are

also two styles of 12-inch valves indicated in the submittal. One is a bolted flange and is shown on Posi-Seal drawing number 12040, Rev. B and the other is a welded flange type shown on Posi-Seal drawing number 12396, Rev. C.

The 8-inch valves are ASME Class 150, equipped with air to open/spring to close actuators manufactured by Matrix number 26061-SR60. Again, there are two styles of 8-inch valves indicated in the submittal. One is a bolted flange and is shown on Posi-Seal drawing number 12422, Rev. E, and the other is a welded flange type as shown on Posi-Seal drawing number 12421, Rev. D.

### 3.0 Demonstration of Operability

3.1 TVA has submitted the following documents in demonstration of purge and vent valve operability:

- A. Letter of March 1, 1985 from R. H. Shell, Tennessee Valley Authority (TVA), to E. Adensam, Division of Licensing (NRC).
- B. Letter of October 25, 1984 from L. M. Mills, Tennessee Valley Authority (TVA) to E. Adensam, Division of Licensing, U.S. Nuclear Regulatory Commission (NRC).
- C. Letter of December 6, 1983 from L. M. Mills, Tennessee Valley Authority (TVA), to E. Adensam, Division of Licensing, U.S. NRC.
- D. "Effect of Fluid Compressibility on Torque in Butterfly Valves," F. P. Hartman, ISA 1968 Annual Conference, ISA Transactions, Vol. 8, No. 4, pg. 28.

In Reference A, TVA provides operability demonstration information for the 24-inch purge and vent valves in the lower compartment. Also, stated in Reference A is the intent by TVA prior to fuel loading, to reorient in the preferred flow direction, the 24-inch valves in both the upper and lower compartments. Also, based on the Posi-Seal International analysis (enclosure 1 of Reference A), TVA proposes to operate the lower compartment valves blocked at a 50° opening angle and the upper compartment valves with no valve opening restrictions.

Note: TVA has previously demonstrated operability of the 12-inch valves as indicated in the NRC Safety Evaluation Report dated July 1984 and the 8-inch valves in the February 25, 1985 NRC Safety Evaluation Report.

3.2 PSI assumes that for the same size and class of valve, the coefficients of lift and drag for any given valve angle is the same regardless of fluid, flow, or temperature. Based on this the coefficients of lift and drag, which are derived from hydrodynamic test, are used to calculate aerodynamic torques for the conditions predicted for DBA/LOCA. The hydrodynamic test, or model testing, performed are on valves ranging from 1-1/2 inch through 14-inch for both preferred and non-preferred installation configurations, the results of these tests are used to calculate dynamic torques for all sizes and classes of valves. Based upon the flow testing performed at PSI, the following general observations concerning hydrodynamic torque of trunnion valves can be made:

1. For preferred flow, the hydrodynamic torque will always tend to close the valve.
2. For non-preferred flow, the hydrodynamic torque will, through 70° to 80° of valve rotation (the exact location varies with valve class), tend to close the valve. Above 80° of valve rotation, the hydrodynamic torque will want to open the valve.
3. Except for the 90° valve opening where the hydrodynamic torque factors are of equal magnitude for both preferred and non-preferred flow, but of opposite sign, the non-preferred hydrodynamic torque factors are considerably less in magnitude than those for preferred flow.

3.3 A seismic and LOCA stress analysis for the valve critical parts by Posi-Seal International is included in Reference A as Appendix E of Addendum C. Based on the results of the analysis, Posi-Seal recommends that the valves be reoriented so that flow is in the preferred direction and valve openings restricted as follows:

- 24-inch valves - lower compartment -  $\Delta P = 18.5$  psi - 50°
- 24-inch valves - upper compartment -  $\Delta P = 8.0$  psi - no restrictions

Valve restriction is accomplished by bolting a stop to the internals of the Maytryx piston cartridge which limits the actuator stroke.

3.4 Addendum C to Reference A also presents a closure time analysis for the 24-inch valves. The computer program entitled, "LOCA-TVA" used for the analysis, determines for increments of valve closure; the dynamic torque, closure time, residual air torque, spring torque, net torque tending to open the valve and the packing, seal, and bearing torques. Both steam and air, are used in the analysis as the fluid media.

3.5 Posi-Seal in Reference A provides a comparison of calculated aerodynamic and hydrodynamic torque with Fisher data contained in Reference D.

#### 4.0 Evaluation

This section will evaluate operability demonstration by TVA for the 24-inch purge and vent valves in the upper and lower compartments. TVA has provided satisfactory operability information for the 12-inch valve, and the 8-inch valves in previous submittals which have been reviewed and found acceptable.

4.1 Posi-Seal's approach for determination of dynamic torques for the 24-inch valves is based on model testing using test valves ranging from 1-1/2 inches to 14 inches in diameter. Hydrodynamic torque factors are developed from the test data and then used in torque equations for steam and air media that predict the aerodynamic torques. A constant peak containment pressure of 22.7 psia for the upper compartment 24-inch valves, and 33.2 psia for the lower compartment 24-inch valves is assumed in the analysis. Posi-Seal included in Reference A, a comparison of aerodynamic torques calculated using hydrodynamic torque factors with test data published by Fisher Controls in an ISA

transation (Reference C). The correlation is good with Posi-Seal calculated aerodynamic torques slightly higher then the measured values.

To account for the increased torques produced by an upstream elbow-shaft out of plane configuration, Posi-Seal presents an analysis in Reference B that adds the torque resultant produced by the upstream elbow configuration to the aerodynamic torque developed with a straight pipe configuration.

The staff finds that Posi-Seal has demonstrated the adequacy of the methodology used in predicting valve dynamic loads for the 24-inch upper and lower compartment valves.

4.2 The 66,800 in-lbs structural capability of the Matryx 33082-SR60 actuator for the 24-inch valves provides a large torque margin for both the 24-inch upper and lower compartment valves. The maximum aerodynamic torque developed in the lower compartment 24-inch valves is 33,329 in-lbs with flow in the preferred direction and the valve opening restricted to 50°. With no restrictions on valve opening and flow in the preferred direction, the upper compartment 24-inch valves experience a maximum aerodynamic torque of 25,901 in-lbs.

4.3 The stress analysis provided in Reference A compares the critical valve part calculated stresses versus the allowable stresses from the ASME Boiler and Pressure Vessel Code. Critical valve parts considered in the analysis are the actuator and bracket bolts, bracket, valve neck, stem and disc pin. Stresses taken from Reference A for the disc pins which are the limiting valve part are shown below.

Item	Disc Pin	
	Calculated Stress	Allowable Stress
24-inch Valve Lower Compartment $\Delta P = 18.5$ psi Preferred Direction Valve Opening Restricted to 50° Open	24,884 psi	32,580 psi
24-inch Valve Upper Compartment $\Delta P = 8$ psi Preferred Direction No Restrictions on Valve Opening	19,307 psi	32,580 psi

The results of the stress analysis demonstrate that the allowable stresses are not exceeded during closure under the postulated accident conditions.

4.4 The applicant (TVA) has committed to installing the 8, 12, and 24-inch purge and vent valves in the preferred flow direction as recommended by Posi-Seal (valve seal retaining ring downstream relative to LOCA flow) by Unit 1 fuel load. Additionally, as recommended by Posi-Seal, TVA is limiting the 24-inch lower compartment valves to a maximum opening angle of 50° open. The

staff in reviewing the submittals agrees with the recommendations by Posi-Seal.

4.5 Seismic qualification is addressed in Reference A entitled, "Nuclear Seismic and LOCA Analysis."

#### 5.0 Summary

We have completed our review of the information submitted to data concerning operability of the 8, 12, and 24-inch valves used in the containment purge and vent system at the Watts Bar Nuclear Plant, Units 1 and 2. Operability of the 8-inch and 12-inch valves has been demonstrated by TVA and accepted in previous NRC SERs dated July 19, 1984 and February 25, 1985.

We find that the information submitted concerning the 8, 12, and the 24-inch upper compartment valves has demonstrated the ability of these valves to close from a full open (90°) position against the buildup of pressure in the event of a DBA/LOCA. We also find that the 24-inch lower compartment valves have been demonstrated to be capable of closing under DBA/LOCA conditions, from a 50° mechanically limited position. Paragraphs 4.1, 4.2, 4.3, 4.4, and 4.5 of this evaluation are the basis for this determination.