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Public Service of New Hampshire

New Hampshire Yankee Division

SEABROOK STATION
Engineering Office

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United States Nuclear Regulatory Commission
Washington, DC 20555

Attention: Mr. George W. Knighton, Chief
Licensing Branch No. 3
Division of Licensing

References:
(a) Construction Permits CPPR-135 and CPPR-136, Docket Nos. 50-443 and 50-444
(b) USNRC Letter, dated October 1, 1982, "Request for Additional Information (PSB and EQB)," J. Kerrigan to W. C. Tallman
(c) USNRC Letter, dated January 24, 1983, "Request for Information (Containment Purge and Vent Valve Operability)," G. W. Knighton to W. C. Tallman

Subject: Response to RAI 271.12; Containment Purge and Vent Valve Operability

Dear Sir:

Enclosed please find our responses to the subject RAI that you forwarded via Reference (b) and supplemented by Reference (c). Please do not hesitate to contact us if you require any additional information.

Very truly yours,

John DeVincentis, Director
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Enclosure

cc: Atomic Safety and Licensing Board Service List

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RAI 271.12

Demonstration of operability of the containment purge and vent valves and 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 NUREG-0737, "Clarification of TMI Action Plan Requirements," II.E.4.2 for containment purge and vent valves which are not sealed closed during Operational Conditions 1, 2, 3 and 4.

1. For each purge and vent valve covered in the scope of this review, the following documentation demonstrating compliance with the "Guidelines for Demonstration of Operability of Purge and Vent Valves" (Attachment 2) is to be submitted for staff review:

   A. Dynamic Torque Coefficient Test Reports (butterfly valves only) - including a description of the test setup.

   B. Operability Demonstration or In-Situ Test Reports (when used).

   C. Stress Reports.

   D. Seismic Reports for valve assembly (valve and operator) and associated parts.

   E. Sketch or description of each valve installation showing the following (butterfly valves only):

      (1) Direction of flow.

      (2) Disc closure direction.

      (3) Curved side of disc, upstream or downstream (asymmetric discs).

      (4) Orientation and distance of elbows, tees, bends, etc. within 20 pipe diameters of valve.

      (5) Shaft orientation.

      (6) Distance between valves.

   F. Demonstration that the maximum combined torque developed by the valve is below the actuator rating.

2. The applicant should respond to the "Specific Valve-Type Questions" which relate to his valve.

   ATTACHMENT 1

   RAI 271.12 - Specific Valve-Type Questions

   The following questions apply to specific valve types only and need to be answered only where applicable. If not applicable, state so.

A. Torque Due to Containment Backpressure Effect (TCB)

For those air-operated valves located inside containment is the operator design of a type that can be affected by the containment pressure rise (backpressure effect) (i.e., where the containment pressure acts to reduce the operator torque capability due to TCB). Discuss the operator design with respect to the air vent and bleeds. Show how TCB was calculated (if applicable).

B. Where air-operated valve assemblies use accumulators as the fail safe feature, describe the accumulator air system configuration and its operation. Discuss active electrical components in the accumulator system and the basis used to determine their qualification for the environmental conditions experienced. Is this system seismically designed? How is the allowable leakage from the accumulators determined and monitored?

C. For valve assemblies requiring a seal pressurization system (inflatable main seal), describe the air pressurization system configuration and operation including means used to determine their qualification for the environmental condition experienced. Is this system seismically designed?

D. Where electric motor operators are used to close the valve, has the minimum available voltage to the electric operator under both normal or emergency modes been determined and specified to the operator manufacturer to assure the adequacy of the operator to stroke the valve at accident conditions with these lower limit voltages available? Does this reduce voltage operation result in any significant change in stroke timing? Describe the emergency mode power source used.

E. Where electric motor and air operator units are equipped with handwheels, does their design provide for automatic re-engagement of the motor operator following the handwheel mode of operation? If not, what steps are taken to preclude the possibility of the valve being left in the handwheel mode following some maintenance, test, etc., type operation?

F. For electric motor-operated valves, have the torques developed during operation been found to be less than the torque limiting settings?

3. Analysis, if used, should be supported by tests which establish torque coefficients of the valve at various angles. As torque coefficients in butterfly valves are dependent on disc shape, aspect ratio, angle of closure flow direction and approach flow, these things should be accurately represented during tests. Specifically, piping installations (upstream and downstream of the valve) during the test should be representative of actual field installations. For example, nonsymmetric approach flow from an elbow upstream of a valve can result in fluid dynamic torques of double the magnitude of those found for a valve with straight piping upstream and downstream.

4. In-situ tests, when performed on a representative valve, should be performed on a valve of each size/type which is determined to represent the worst case load. Worst case flow direction, for example, should be considered.

5. For two valves in series where the second valve is a butterfly valve, the effect of nonsymmetric flow from the first valve should be considered if the valves are within 15 pipe diameters of each other.

6. If the applicant takes credit for closure time versus the buildup of containment pressure, he must demonstrate that the method is conservative with respect to the actual valve closure rate. Actual valve closure rate is to be determined under both loaded and unloaded conditions (if valves close faster at all angles of opening under loaded conditions, no load closure time may be used as conservative), and periodic inspection under Technical Specification requirements should be performed to assure closure rate does not increase with time or use.

Response

The following response pertains only to the 8" containment on-line purge and vent butterfly valves (COP-V1, V2, V3 and V4) which are maintained partially open during normal operation. The containment pre-entry and refueling purge isolation valves (CAP-V1, V2, V3 and V4) are normally closed during operational conditions and are opened for refueling. There are no other butterfly valves used for containment isolation at Seabrook.

1. A. The dynamic torque coefficient values for purge and vent valves (COP-V1, V2, V3 and V4) were calculated by the valve manufacturer, Posi-Seal International, Inc. Tests were performed to verify these values.

   B. An operability demonstration was performed, and the results of the tests will be made available for inspection during the SQRT/PVORT audits to be conducted at Seabrook Station, November 4-8, 1985 (Reference FP 97786-01).

   C. A complete valve stress analysis, including the effects of seismic loadings, has been prepared by the vendor.

   D. The required seismic report on the valves will be made available for inspection during the SQRT/PVORT audits to be conducted at Seabrook Station, November 4-8, 1985 (Reference FP 93610-03).

   E. Drawings 9763-F-604111 and 9763-F-604113 depict the direction of flow, the shaft orientation, distance between in-line valves and the orientation and configuration of the piping components. The disc closure direction is shown on Drawing No. FP 91012-06. These drawings will be made available for inspection during the SQRT/PVORT audits to be conducted at Seabrook Station, November 4-8, 1985.

F. The actual maximum combined torque developed by the valve at LOCA pressure (17 psig) is 2,568 in-lbs in the preferred direction and 2,088 in-lbs in the nonpreferred direction. A containment pressure of approximately 29 psig will cause the maximum flow (sonic flow); and if the valve would have to close against this pressure, the actual maximum torque required is 2,208 in-lbs.

The torque output of the operator with the valve fully closed is 3,260 in-lbs, which is far in excess of the valve requirements.

2. Attachment 1 on Specific Valve-Type Questions.

A. The increased pressure inside containment during a LOCA will not effect the operation of the COP valves. The operators are equipped with quick exhaust valves which permit fast opening by exhausting the cylinder directly to atmosphere. When containment is not pressurized, the initial pressure differential across the actuator piston is 60 psi. When containment is pressurized, the differential is reduced by 17 psi; consequently, the actuator spring has less of a force to overcome in order to close the valve.

B. This question is not applicable since accumulators are not used in the system.

C. This question is not applicable since the valves do not have inflatable seals.

D. Electric motor operators are not used; therefore, this question is not applicable.

E. The air operators are not equipped with handwheels; therefore, this question does not apply.

F. This question is not applicable since electric motor operators are not used.

3. The operability demonstration was performed with the actual valves in a piping configuration which accurately represented the actual field installation.

4. This question is not applicable, since valve operability is demonstrated by means of bench testing and analysis.

5. The operability demonstration accurately simulated the effect of nonsymmetric flow caused by the first valve closing.

6. No credit is taken for closure time versus containment pressure buildup. The closing times under both loaded and unloaded conditions has been determined by test. A periodic inspection/stroking program will be implemented to assure that the closure rate does not increase with time or use.

Response

1. The valve closure rate is essentially constant.

2. The direction of flow across the valves is shown on Drawings 9763-F-604111, 9763-F-604113 and the Valve Drawing FP 91012.

   The P across the valve is 10.46 psi when the containment pressure is 17 psig.

3. The worst case occurs during a single valve closure outside containment.

4. Containment backpressure causes no noticeable effect on valve closure time.

5. Accumulators are not used; therefore, this question is not applicable.

6. Torque limiting devices are not used for the valve operators.

7. The effect of piping upstream of the butterfly valves has been considered in evaluating operator performance as follows:

   Elbows upstream of the valve but less than 10 valve diameters away can result in turbulence leading to unbalanced forces on the valve disc when it is partially closed. These dynamic forces diminish as the valve closes, reaching a maximum effect when the valve closure angle is 72^{o}. The unbalanced reaction of this flow will not approach the closing or opening torque of 2,568 in-lbs required for operation at maximum LOCA pressure. Configuration of the ducting downstream of the valves will obviously have even less than upstream configuration. The effects of both upstream and downstream configuration on valve closing torque are insignificant when compared to torque capacity of the valve operator.

   The piping configuration upstream and downstream of the valves during the operability tests was identical to the actual plant arrangement.

8. As the valve disc moves from full-open to full-closed position, the dynamic effects of the flowing air mixture increase to a maximum at about 72^{o} of closure and thereafter decrease to zero at 0^{o} or full closure. The static pressure effects increase from zero at full-open position to a maximum of 52 psi at 0^{o}. The dynamic effects result in a small increase in torque. The static effects are balanced on either side of the valve shaft and result in a small increase in friction in the valve shaft bearings.

   The manufacturer's data sheets give a value of opening torque for an 8" valve at 50 psi to be 976 in-lbs and a hydrodynamic torque (for gases) of 6 in-lbs for each pound per square inch across the valve. In the full-flow condition, the P across the valve is relatively small, so hydrodynamic torque is low. As the valve closes, the flow rate through the restricted orifice is reduced; and so hydrodynamic forces are reduced until in the full-closed position they equal zero.

Demonstration

Demonstration of the various aspects of operability of the containment on-line purge valves has been accomplished by analysis and test.

The evaluation of the stress margins of these valves to withstand loads imposed while closing during or following a design basis accident has been addressed in the combined seismic/LOCA stress analysis (refer to 1.C above). Seismic loadings as well as valve closure loadings have been included in this analysis.

With regard to the sealing integrity after closure and long-term exposure to the accident environment, the valve seat material is identified as Tefzel, a material which is resistant to containment spray chemicals and radiation. Since these seals are intended to be replaced every five years, the cumulative radiation dosage will remain low (on the order of 6×10^5 rads in 5 years. Tefzel is relatively unchanged by radiation doses on the order of 1×10^8 rads.

The 1-year accident dose rate is calculated to be on the order of 1.2×10^6 rads. The combination of a 5-year normal dose plus a 1-year post-accident dose will be on the order of 1.8×10^6 rads, which is well below the resistance level of 1×10^8 rads claimed by the manufacturer for Tefzel.

The long-term effects of ambient temperatures on the sealing characteristics of Tefzel are documented in the literature. Below 200°C, no hardening should occur.

Screens have been included in the elbows upstream of the valves to stop debris from entering the valve seating area. Periodic cleaning of the lines will also reduce the buildup of dust and dirt.

Bench Testing and In-Situ Testing

"Bench Testing" of the COP valves was performed which simulated the actual piping configuration (see 1.B).

ATTACHMENT 2 to RAI 271.12

Guidelines for Demonstration of
Operability of Purge and Vent Valves

Operability

In order to establish operability, it must be shown that the valve actuator's torque capability has sufficient margin to overcome or resist the torques and/or forces (i.e., fluid dynamic, bearing, seating, friction) that resist closure when stroking from the initial open position to full seated (bubble tight) in the time limit specified. This should be predicted on the pressure(s) established in the containment following a design basis LOCA. Considerations which should be addressed in assuring valve design adequacy include:

1. Valve closure rate versus time (i.e., constant rate or other).

2. Flow direction through valve; P across valve.

3. Single valve close (inside containment or outside containment valve) or simultaneous closure. Establish worst case.

4. Containment backpressure effect on closing torque margins of air-operated valve which vent pilot air inside containment.

5. Adequacy of accumulator (when used) sizing and initial charge for valve closure requirements.

6. For valve operators using torque limiting devices, are the settings of the devices compatible with the torques required to operate the valve during the design basis condition.

7. The effect of the piping system (turns, branches) upstream and downstream of all valve installations.

8. The effect of butterfly valve disc and shaft orientation to the fluid mixture egressing from the containment.

Demonstration

Demonstration of the various aspects of operability of purge and vent valves may be by analysis, bench testing, in-situ testing or a combination of these means.

Purge and vent valve structural elements (valve/actuator assembly) must be evaluated to have sufficient stress margins to withstand loads imposed while valve closes during a design basis accident. Torsional shear, shear, bending, tension and compression loads/stresses should be considered. Seismic loading should be addressed.

Once valve closure and structural integrity are assured by analysis, testing or a suitable combination, a determination of the sealing integrity after closure and long-term exposure to the containment environment should be evaluated. Emphasis should be directed at the effect of radiation and of the containment s[illegible]ay chemical solutions on seal material. Other aspects such as the effect on sealing from outside ambient temperatures and debris should be considered.

The following considerations apply when testing is chosen as a means for demonstrating valve operability:

Bench Testing

1. Bench tes[illegible]g can be used to demonstrate suitability of the in-service valve by reason of its traceability in design to a test valve. The following factors should be considered when qualifying valves through bench testing:

   A. Whether a valve as qualified by testing of an identical valve assembly or by extrapolation of data from a similarly designed valve.

   B. Whether measures were taken to assure that piping upstream and downstream and valve orientation are simulated.

   C. Whether the following load and environmental factors were considered:

      (1) Simulation of LOCA
      (2) Seismic Loading
      (3) Temperature Soak
      (4) Radiation Exposure
      (5) Chemical Exposure
      (6) Debris

2. Bench testing of installed valves to demonstrate the suitability of the specific valve to perform its required function during the postulated design basis accident is acceptable.

   A. The factors listed in Items 1.B and 1.C should be considered when taking this approach.

In-Situ Testing

In-situ testing of purge and vent valves may be performed to confirm the suitability of the valve under actual conditions. When performing such tests, the conditions (loading, environment) to which the valve(s) will be subjected during the test should simulate the design basis accident.

Note

Post-test valve examination should be performed to establish structural integrity of the key valve/actuator components.