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MEMORANDUM FOR: Carlyle Michelson, Director
Office for Analysis and Evaluation of Operational Data

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SUBJECT: REVIEW OF INFORMATION ON PURGE VALVES

These comments are based on a review of the information attached to the March 6, 1981 note from John Austin. The information forwarded to us was applicable to purge and vent valves for Farley Units 1 and 2. Although specific aspects of these units are the bases for questions and comments, the comments are believed to apply in a general sense to purge valve operability.

Information on Specific Valves and Operating Conditions

The valves in question are 18 inch H. Pratt butterfly valves used in each minipurge system of Farley 1 and Farley 2. The main purge system has 48 inch valves that are to be maintained closed during Modes 1, 2, 3, and 4. A valve assembly consists of valve body, operator, and pilot solenoid valve manufactured by H. Pratt, Bettis, and ASCo, respectively. The operator is the type with air to open - spring to close. Additional information concerning operation is as follows:

- Valve closure in six seconds (one second signal delay and five second close stroke).
- Dynamic torque coefficient developed with a 5" scale model valve with air flow.
- Maximum containment pressure is about 46 psig after 290 seconds.
- Minimum torque margin was identified as occurring at or near closure (0°).
- These valves are presently permitted to be full open (not blocked at some angle) during plant operation (Farley 1 was estimated to have been open 6984 hours from 1/1/80 to 12/1/80).

Discussion and Comment of Technical Issues

The primary technical issues relate to demonstration of valve assembly operability during expected accident conditions and potential problems that may develop if the valve closure (isolation) signal is delayed.

Valve assembly operability, as distinct from pressure integrity, can be affected by many aspects related to construction, materials, and the environment in which it operates. The basic items of concern for operability relate to the contributors to torque that resist closure torque supplied by the valve operator. The information we received addresses some items but for only certain portions of the valve disc motion from open to close. Some areas of interest are as follows:

1. Contributors to Torque

   The information identifies dynamic torque, combined seating torque, bearing torque, and hub seal torque as important items. Combined seating, bearing, and hub seal torques are mentioned as major aspects near zero degrees (the valve is almost closed) where the valve has the minimum positive torque margin (the difference between operator torque and resisting torque is smallest). However, there is no information relative to the behavior of these items over the range of valve closure from 90° to zero. Also, these torques are apparently determined by calculation rather than test. The dynamic torque coefficient was determined by test with a 5 inch scale model valve with air flow of unspecified velocity. The dynamic torque was then calculated by formula with containment pressure of 24 psig (based on containment pressure at six seconds). Experience has shown that this torque may oppose or assist valve closure and the maximum opposing value is believed to occur between 90° and 70° (0° is full close and 90° full open). Again, the information does not indicate the behavior of dynamic torque as a function of angle. The approach used to determine the dynamic torque coefficient is apparently common within the valve industry. It is also stated that the torque coefficient is independent of valve size.

   It would seem that certain aspects related to torque should receive more attention. For example, the reason that dynamic torque coefficient is independent of valve size is not clear. Since this should be related to flow characteristics, one might expect the dynamic torque coefficient could at least vary with angle of closure, valve size, internal design, and flow media, velocity, and direction effects. Also, flow direction effects to be considered should address such items as reverse flow on inlet valves, differences in torque requirements depending on whether the flat or curved portion of the disc faces the flow direction, and potential flow interaction based on separation distance of adjacent isolation valves. The other resisting torques are apparently determined by calculation rather than test. Since these depend on friction coefficients, it would seem important to have test data to at least support the formula and, in particular, when new materials are introduced or designs are changed. (Although a butterfly valve is quite different from a gate valve, it was an unrealized increase in friction that has resulted in an inability of some gate valves to close against a prescribed differential pressure during recent tests and operational experience.) In addition, it is important to know the value of torque, for each source, as a function of closure angle and the torque margin (difference between operator torque and resistance torque) as a function of closure angle.

2. Demonstration of Operability (Functional Qualification)

Efforts to establish requirements for demonstration of operability have been under development for many years. There are two proposed draft national standards that would be applicable to butterfly valves. One proposed standard addresses functional qualification of a valve assembly as a unit or system and the other is applicable to valve operators. Each proposed standard requires testing of equipment under prescribed accident conditions to demonstrate operability.

The proposed standard for valve assemblies, B16.41, would require testing as the acceptable method to demonstrate operability. It also provides guidelines for extrapolation of results to different size valves with similar design. However, it limits extrapolation of results (successful operation) to valve assemblies that are between one-half and two times the test diameter.

The proposed standard for valve actuators, N41.6, would require testing of some operators (this has been issued as IEEE-382-80). NRC staff members have cast negative ballots based, in part, on the limited number of operators that would be tested and still qualify a family of operators with a very large variation in size and other characteristics important to operability, rather than a dispute with the testing that is required.

The information we received does not indicate extensive testing. It appears that testing was involved to determine the dynamic torque coefficient and that all other aspects are based on calculation. Also, the testing that has been done appears to be inconsistent with the proposed national standard with respect to extrapolation of results to larger sized valves. However, the most critical aspect is that testing to demonstrate operability of a given valve assembly during expected conditions seems to have been neglected (not done or not required). In addition, there is no information about testing of valve operators. Inservice testing under such conditions as no load (or other variations) that may differ significantly from those during accident conditions would not, in general, provide adequate demonstration of continued ability to operate under accident conditions.

3. Other Impacts on Valve Operability

There are other potential areas of concern that do not appear to be addressed in the information we received. Some of these are: (1) effect of possible delay in the containment isolation signal to open a vent valve; (2) should a valve be qualified to close against maximum containment pressure; (3) what conditions result in lowest torque margin for valve closure; and (4) possible impact of adjusting valve closure rate (slower than possible) to protect the valve from damage during rapid closure.

The extent of concern about these items can be highly plant-specific and there was essentially no reference to them in the information we received. In an attempt to provide some explanation, it would appear that any adjustment (especially a slowdown) of valve closure rates would have an impact on eventual valve assembly closure and operability in general. In addition, air contamination problems similar to those discussed in the memorandum from Carlyle Michelson to Harold R. Denton and Victor Stello, "Immediate Action Memo: Common Cause Failure Potential at Rancho Seco - Desiccant Contamination of Air Lines," dated September 15, 1981, could adversely affect air vent valves and subsequent purge valve closure.

The Rancho Seco event illustrates two potential operating problems relevant to purge valve closure. The event is an example of both contaminate blockage of a vent orifice with a 3/16" port diameter and subsequent delay in valve closure time of approximately 2.5 seconds. Based on our understanding that the Farley solenoid vent valves are controlled by needle valves which could be smaller than an orifice hole, I would be concerned that contaminate blockage is potentially more probable just on size alone and that purge valve closure time would subsequently increase. In addition, use of the needle valve could affect operability of the solenoid valves. Also for the Farley units, an increase in time to close the purge valves raises questions about the adequacy of the dynamic torque calculation based on containment pressure of 24 psig at six seconds compared to a peak containment pressure of 46.3 psig reached at a later time. However, there was no information about the value of dynamic torque so it is not clear whether a potential problem exists.

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