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May 19, 1983
IPN-83-42

Director of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing

Subject: Indian Point Nuclear Power Plant
Docket No. 50-286
Containment Purge And Vent Valves

Dear Sir:

This letter and its Attachment serve to transmit the additional information regarding the ability of the Indian Point 3 purge and vent valves to function against accident containment pressures. The submittal of the attached additional information is in response to your February 8, 1983 letter.

Should you or your staff have any questions regarding this matter, please contact Mr. P. Kokolakis of my staff.

Very truly yours,

J. P. Bayne
Executive Vice President
Nuclear Generation

cc: Resident Inspector's Office
Indian Point Unit 3
U. S. Nuclear Regulatory Commission
P. O. Box 66
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QUESTION

1. PASNY's submittal did not present the results of the stress analysis of the 36.0" and 10.0" valves, valve-operator extended structure and/or associated interfacing hardware under combined operating and seismic loads. Also missing were the g-level(s) used.

   PASNY's July 7, 1982, did contain a Fisher generic analysis report entitled, "Seismic Analysis of Control Valve Assemblies , which describes in part the analysis used to determine stresses in critical areas of the extended structure and bolting under combined loads. A tabulation summarizing the results of this analysis should be provided to demonstrate structural integrity. Expected in the tabulation are the following items:

   - Part name (bolt, bracket, etc.)
   - Stress name (shear, combined, etc.)
   - Material Specification
   - Stress allowable value and source (code or standard)
   - Stress level calculated.

   For the 36.0" valves FCV-1170 and -1171 with the elbow-shaft in plane installation configuration, a factor of at least 1.5 should be applied to the T_D predictions when straight pipe inlet bench tests were used to develop the dynamic torque coefficients.

Response

The results of the stress analysis for the 36" and 10" valves with a disc angle of 60° (90° = full open) are provided in Tables A and B, respectively. The seismic qualifications including g-levels were detailed in Appendix 19.1 of the Authority's July 7, 1982 letter. As stated therein, the seismic qualification for the Containment Purge Valves and extended structure valves was established by testing. The tests determined the fundamental frequency of the valves to be greater than 33 Hz for g-levels of 3g. Additionally, static sideload tests were performed on the valves to verify operability. These tests also verified the closure times and leak tightness for the valves under combined operating and seismic loads.

The seismic qualification for the containment pressure relief valves was established by an analysis which documented the fundamental frequency of the extended structure and determined the stresses developed in the structure due to specified seismic (plus normal) loads/accelerations. Structural and pressure retaining capability was verified by acceptable results from a conservative "g" load static analysis. The stress analysis was determined to be valid as it was performed on a rigid valve (33Hz).

Hardware associated with these valves including air sets, tubing and air storage accumulators are seismically supported.

A computer analysis for determining allowable pressure drop versus angle of opening and actuator torque versus angle of opening was provided by Fisher Controls and can be described as follows:

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.

Subsequent to the determination of loading, the program calculates stresses in the shaft, key, pin and bushing for a specific ΔP and compares these stresses to the material strength. This strength is based on 1.5 x "S". Where "S" is the allowable stress figure found in Sections III and VIII of the ASME Boiler and Pressure Vessel Code, and ASNI B 16.5 (1968).

For valves tag nos.: FCV-1170, 71, 72, 73 (S/N 25530-353; 36"-9220) and PCV-1190, 91, 92 (S/N 170608-610; 10"-9211), "S" is equal to 1/4 of the minimum tensile strength or 2/3 of the minimum yield strength, whichever is less. For shear stresses 0.75 S is used.

The program calculates stress and changes ΔP iteratively until the stress matches the allowable strength. This determines the maximum allowable pressure drop for that angle of opening based on the stress at a single point.

The valve manufacturer's sizing procedures are based on a pressure drop across the valve. The differential pressure across these valves was considered equal to the peak containment pressure (41 psig) at all angles of disc rotation. No credit was taken for the existence of any back pressure produced by down-stream piping. In fact, all gases exhausted must pass through duct work and plenums containing filters and dampers. All of the equipment will produce some degree of back pressure, thereby reducing the actual ΔP across the valves and, hence, the torque required for closure.

The valve manufacturer's sizing data is also based on dynamic torque determination tests performed with uniform flow profiles on valve discs with representative geometrics in order to develop accurate dynamic torque valves. The effect of shaft orientation relative to installed ducting is relevant with respect to dynamic torque that could result under non-uniform flow conditions. The configuration of the installed valves with respect to the installed ducting was reviewed and the following conclusions have been reached:

1. The ducting on the Containment Purge Exhaust and the Containment Pressure Relief are open to the containment atmosphere with no upstream piping other than a short length of ducting extending into containment. This short length of ducting serves to protect the exposed disc when in the open position and further aids pressure equalization across the disc; thus resulting in a uniform flow profile.

2. The ducting on the Containment Purge Supply inside containment serves as the upstream piping under accident conditions. This duct layout is such that both wings of the disc, as split by the valve shaft, will be subject to the same flow with respect to time and no additional unbalanced forces will result. Therefore, the factor of 1.5 for dynamic torque coefficient does not apply to the Indian Point 3 36" purge valve nos. FCV-1170 & 1171.

Table A: For valve tag nos. FCV-1170, 71, 72 and 73 with a valve position of 60°.

	Part Name / Stress Name	Max Predicted ΔP(psid)	Max Allowable ΔP Calculated (psid)
1)	Maximum tensile on shaft of hub due to bending & tension	41	120.27
2)	Maximum shear on shaft at hub due to bending & tor.	41	93.40
3)	Maximum shear on shaft at hub due to torsion & transverse shear	41	70.36
4)	Stress at the pinned discshaft connection	41	52.09
5)	Stress at the keyed actuator shaft connection	41	213.71
6)	Stress at the shaft bushing	41	110.35

Table B: For valve tag nos. PCV-1190, 91 and 92 with a valve position of 60°*

	Part Name / Stress Name	Max Predicted ΔP(psid)	Max Allowable ΔP Calculated (psid)
1)	Maximum tensile on shaft to hub due to bending & torsion	41	169.90
2)	Maximum shear stress on shaft at hub due to bending & torsion	41	111.95
3)	Maximum shear stress on shaft at hub due to torsion & transverse shear	41	89.39
4)	Stress at the pinned disc-shaft connection	41	53.65
5)	Stress at the keyed actuator shaft connection	41	206.14
6)	Stress at the shaft bushing	41	254.45

*In the Authority's letter of July 7, 1982 in response to request No. 12, the travel stop installed in the 486U-1-15-60 actuator limits the opening of the valve to 40°. Thus, the data provided above is for the maximum allowable angle the valve can be opened.

QUESTION

2. The 10.0" valves are equipped with a Fisher Model 486 U-1-15-60 air open-air close operator and are also equipped with an accumulator for fail safe operation. PASNY's assessment of operator torque margin capability is based on the condition of 75 psig initial accumulator pressure available, 41 psig containment back pressure and a torque requirement of 6011 in lbf to seat the disc given a Δp of 150 psid (conservative assumption) across the disc. PASNY indicated that the "worst case" pressure differential across the operator's piston is 34 psid (75 psig-41 psig). The 75 psig is the pressure of the accumulator alone at the start of the system's activation. It does not appear that PASNY's analysis has accounted for the volume of the closing side of the operator. This additional volume added to the accumulator volume will reduce the pressure available at the end of stroke. The affect on torque margin due to this added volume must be quantified.

RESPONSE

As outlined in the Authority's letter of July 7, 1982 in response to Request No. 9, the calculated valve torque required (VTR) to shut off the valve to a 0° open against 150 psid is 3420 in-lb_f (including the force required to seat the disc). If a containment pressure of 41 psig existed, the actuator could only experience a "worst case" pressure differential across the operator of 34 psid (75 psig -41 psig =34 psid). At this pressure differential the actuator torque available will be 6011 in-lbs. Taking into consideration the added volume of the closed side of the operator (229 in^3) and using the conservative valve stroke length of 4 1/8" to calculate the the torque available to seat the valve, the torque available is reduced from 6011 in-lbs to 3653 in-lbs. Available torque of 3653 in-lbs was calculated based on an available pressure at the end of stroke of 61.7 psig as compared to 75 psig. The torque available (torque margin) is still greater

than the torque required (3420 in lbs) to seat the valves inside containment against containment pressure. The actuator torque available, assuming 61.7 psig supply and normal ambient exhaust pressure, (as is the condition for the 2 valves located outside containment) is 10,890 in-lbs.

QUESTION

3. PASNY's submittal did not contain information to demonstrate that the operator's critical operating parts were structurally capable of withstanding the resultant torque loads developed during valve closure.

In the case of the 36.0" valves, the Bettis operators typically have limits on their torque absorption capability which vary depending on the stroke (valve disc angle). The limiting part(s) in the Bettis designs have typically been the yoke arm/yoke pin. PASNY should demonstrate that the resultant torques developed during closure are less than the torque rating (allowable) at all disc angles. For 36.0" valves FCV-1170 and -1171 with "elbow-shaft in plane" installation configuration, a factor of at least 1.5 should be applied to T_D predictions where only straight pipe inlet bench tests were used to develop dynamic torque coefficients.

For the 10.0" valves, the torque absorption capability of the Fisher operator's operating parts must also be demonstrated.

RESPONSE

As outline in the Authority's letter of July 7, 1982 in response to request No. 12, a modification was made to the actuator of valve tag nos.: FCV-1170, 71, 72, 73 (36"-9220) to limit the opening angle to 60°. This modification has since been removed. This does not pose a safety concern as purging is currently allowed only during cold shutdown. The probability of a significant differential pressure developing across the valve during cold shutdown is extremely remote. The valves are administratively maintained closed above cold shutdown. If permission to purge above cold shutdown is granted, the stops will be re-installed, limiting the opening angle to 60°.

In general, for a valve angle of 60° the actuator torque requirement calculations used for sizing an actuator to the valve include dynamic torque such that the maximum torque requirement for the complete valve stroke (both opening and closure) has been determined. In the case of the closure of the valve during accident conditions, the dynamic torque will aid closure of the disc. Therefore, the dynamic torque may be excluded in the determination of opposing torque for valve closure.

Additionally, as stated in the response to question 1 of this submittal, the ducting on the Containment Purge Exhaust (and the Containment Pressure Relief) is open to the containment atmosphere with no upstream piping other than a short length of ducting extending into containment. This short length of ducting serves to protect the exposed disc when in the open position and further aids pressure equalization across the disc; thus resulting in a uniform flow profile.

The ducting on the Containment Purge Supply inside containment serves as the upstream piping under accident conditions. This duct layout is such that both wings of the disc, as split by the valve shaft, will be subject to the same flow with respect to time and no additional unbalanced forces will result. Therefore, the factor of 1.5 for dynamic torque coefficient does not apply to the Indian Point 3 36" purge valves nos. FCV-1170 & 1171.

Fisher's design philosophy for establishing the loads on type 9200 butterfly valves was developed by testing and scaling, in addition to equations and calculations. The testing and scaling of these valves produced the 1.5 multiplier which is applied to the dynamic torque factor when installation results in "flow into the hub" of the valve disc (which is not the case for FCV-1170 and 1171). This was reflected in the determination of the allowable pressure drop versus degree of disc rotation for the critical valve components as outlined in the response to Question No. 1.

The closing torque required, based mainly on packing torque and friction torque, has been determined to be approximately 10,240 in-lb_f for a 41 psid differential pressure. This would be the maximum total required closing torque from 60° open angle until just before the disc seats in the valve. The total torque to seat the valve is 25,570 in-lb_f for the maximum shutoff of 50 psid differential pressure. The Bettis actuator is capable of producing 28,100 in-lbf torque at the shutoff position and 23,082 in-lb_f torque at the 60° angle open which is well within the limits of the torque required.

The critical part for the Bettis operator design is the keyed actuator to shaft connection, where the limiting condition of the 36" valves is the stress at the pinned disc to shaft connection. The maximum allowable ΔP for a 60° valve angle is 213.71 psid at the keyed connection and 52.09 psid at the pinned connection. Both calculated ΔP values are greater than the anticipated 41 psid accident pressure differential.

For valve tag nos. PCV-1190, 91, 92 (10"-9211) the maximum torque required for the 486U-1-15-60 actuator is determined to be 2431 in-lb_f for open valve angles to and including 60° open. The torque is based upon the accident condition of 41 psid pressure differential. This torque requirement value is a worst case condition since it includes dynamic torque as well as packing torque and friction torque. The actuator is capable of producing 17,680 in-lb_f torque which is well within the limits of the required actuator torque at open valve angles. In considering seating torque required, total actuator torque

required to seat the disc in the valve is 3420 in-lb_f for the service condition of 150 psig for which the valve was designed. Again, this requirement is well within the capability of the actuator output. The critical part on the 486U-1-15-60 actuator is the pinned disc to shaft connection. The maximum allowable ΔP calculated for a valve angle of 60° is 53.65 psid which is greater than 41 psid. For a valve angle of 40°, which is the actual setting of the valve, the calculated maximum allowable ΔP for the pinned disc to shaft connection increases to 206.14 psid.

QUESTION

4. Information submitted concerning the 10.0" and 36.0" valve closure times indicated a total time from LOCA start to full valve closure of 4.4 seconds based on the following time increments; 2.0 seconds to reach 3.5 psig (containment pressure sensor signal initiate), 0.9 seconds isolation signal delay and 2.0 seconds valve stroke time. What was not clear was whether the 0.4 second signal delay time and 2.0 second stroke time were assumed values or determined by actual test. While the staff does not expect this to be significant relative to valve structural integrity assessment, it may be significant relative to satisfying the 5.0 second requirement of CSB 6-4. Therefore, actual times as extablished by test should be used for "signal delay time" and "stroke time" to verify conformance to the CSB 6-4 timing requirement.

RESPONSE

The time response of the system for "signal delay time" was obtained from startup test data. The valve closure time, "stroke time" was demonstrated by a factory test and was required by the original valves purchase specification. The valve closure rates were included in the Fisher Controls data package submitted in the Authority's July 7, 1982 letter.