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RECIP.NAME RECIPIENT AFFILIATION
CLARK,R.A. Operating Reactors Branch 3

SUBJECT: Submits interim response to NRC 830216 ltr re containment purge valve operability. Henry Pratt Co commissioned to prepare rept for purge valves using present conservative metholoay. Rept will address out-of-plan upstream elbow.

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FLORIDA POWER & LIGHT COMPANY

March 31, 1983
L-83-203

Office of Nuclear Rector Regulation
Attention: Mr. Robert A. Clark, Chief
Operating Reactors Branch #3
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Clark:

Re: St. Lucie Unit 1
Docket No. 50-335
Containment Purge Valve Operability

This letter contains Florida Power & Light Company's interim response to your letter of February 16, 1983 concerning St. Lucie Unit 1 containment purge valve operability. Attachments 1, 2, and 3 of this letter contain our assessment of the operability of the Pratt purge and vent valves. Based on the evaluations contained in the attachments, we consider this transmittal as acceptable information demonstrating purge valve operability. We intend to continue operating the subject valves in conformance with our interim position previously described to you and as modified below (i.e., limited purging and limited valve opening angle).

Although the evaluation contained herein demonstrates valve operability on its own merit, we have commissioned the Henry Pratt Company to prepare a report for the St. Lucie Unit 1 purge valves, using its present conservative methodology. Specifically, the report will address an out-of-plane upstream elbow. Discussions with Pratt personnel indicate that their evaluation will result in a maximum blocked angle between 40° and 50°. The results of this Pratt evaluation will be provided to you on or before July 15, 1983. In the meantime, as a conservative measure, modifications will be made to the purge valves during the current refueling outage to reduce the maximum blocked angle from 50° to 40°.

A034

In our letter of July 30, 1982, we committed to install debris screens on the inside of each set of containment purge supply and exhaust valves during the spring 1983 refueling outage. The design of the debris screens is complete and the screens are scheduled for installation during the current refueling outages, as we committed.

Very truly yours,

Robert E. Uhrig
Vice President
Advanced System & Technology

REU/PKG/js

Attachments

cc: Mr. James P. O'Reilly, Region II
Harold F. Reis, Esquire
PNS-LI-83-240-1

ATTACHMENT 1

In response to NRC letter of February 16, 1983, concerning the operability of large diameter Pratt butterfly valves (Type R1A or NR1A) following a DBA-LOCA, the following is offered:

The first portion of the letter discusses the NRC's interim position with regard to Henry Pratt butterfly valves used for containment purge and vent isolation during plant operation. Since FPL complied with this NRC position, this portion of the letter does not require discussion or comment.

The second portion of the letter states, ". . . recent information concerning the operability of large diameter Pratt butterfly valves (of the generic family R1A or NR1A) in the event of a DBA-LOCA has raised concern whether your justification for operability provides the required assurance that these valves will close. Enclosure 1 provides the background information and the basis for our concerns." FPL was requested to provide its assessment as to the operability in Enclosure 1 and whether or not it would seal closed its purge and vent valves in accordance with Standard Review Plan 6.2.4, II.6.f.

After reviewing Enclosure 1, referred to above, we note that the Henry Pratt analysis for Turkey Point Units Nos. 3 and 4 was specifically mentioned. The analysis was considered to be inadequate because the NRC did not believe that the presence of an out-of-plane upstream elbow, which would increase fluid dynamic torque on the valve disc and hence increase stresses in the shaft and related components, was considered. Furthermore, the NRC stated that the margins of safety for the stresses in the shaft were not sufficient to offset the neglect of an out-of-plane upstream elbow. Florida Power & Light Company responded to the NRC concerns on the Turkey Point dockets (50-250 and 50-251) in a letter dated March 4, 1983. The letter explained that Revision 1 of the Henry Pratt Company Stress Reports (which were not previously submitted) did consider non-uniform approach flow due to an upstream 90° elbow. The case considered in the reports was the worst case condition as determined by the Henry Pratt Company. FPL considered the March 4, 1983, submittal to contain acceptable information demonstrating valve operability. The NRC staff review of this submittal is ongoing. Please note that the balance of this letter addresses the St. Lucie Unit 1 purge valves only.

As background information, please consider the following: The containment purge system as used on St. Lucie Unit No. 1 employs three valves in series on both the intake and purge sides of the containment. These valves are connected (purge or make-up side) by piping rather than ductwork. The piping and the valves are seismically supported. Debris screens that are qualified to withstand a worst case DBA-LOCA are being installed during the present refueling outage at the inlet to each set of valves. Two of each set of three valves are on one Class 1E electrical train, while the other of each set is on a separate Class 1E electrical train.

In our letter dated March 24, 1982, we provided the NRC staff with the Henry Pratt stress report for the 48" R1A butterfly valves installed in St. Lucie Unit 1. Though the stress report did not address non-uniform approach flow, the following conservative assumptions were made:

1. Assume sonic flow at the worst possible angle regardless of the fluid dynamics of the situation warranting it or not.

2. Assume the presence of only one valve closing against a LOCA, and ignore the presence of the other two valves and debris screen. Even the presence of two valves locked open at the maximum blocked angle is ignored.

In order to get an idea of the amount of conservatism in the Henry Pratt Analysis, the following was performed:

1. Probabilistic risk analysis (see Attachment 2) that demonstrates that the probability of a worst case DBA-LOCA without any precursor signals to occur while purging operations were taking place is much less than 10^{-7} per year. Also considered was the worst case DBA-LOCA, without any precursor signals, while purging operations were taking place and simultaneously there is a failure of the CIAS train which causes two out of three valves in series to remain open at the maximum blocked angle. This scenario will be called the worst case scenario. Attachment 2 shows it has a probability by less than 10^{-11}/year.

2. A RELAP5 analysis of the worst case scenario, described above, was performed. This is described in Attachment 3. By reviewing the most recent Henry Pratt Turkey Point Unit Nos. 3 and 4 purge valve reports, estimates of empirical coefficients used by Pratt in its current methodology were developed. From this it is possible to determine the maximum fluid dynamic torque that would tend to close the valve by replacing the overly conservative assumptions of the Henry Pratt analysis methodology by input from the worst case scenario RELAP5 model. This should give a more realistic picture of what should occur. Table 1 compares the Pratt prediction with what follows from a RELAP model.

Based on Table 1 and on the above statements, the following can be concluded:

1. A worst case DBA-LOCA which is caused by an instantaneous break in a pipe large enough to cause a pressure rise of magnitude and rise rate sufficient to preclude a large Henry Pratt purge valve from closing against a LOCA is unlikely (much less than 10^{-7} per year).

2. The Henry Pratt methodology is extremely conservative. There is at least a 100% safety margin between the Henry Pratt determination of the fluid dynamic range torque as compared to a RELAP5 worst case scenario determination. Furthermore, the RELAP5 worst case scenario is highly unlikely (less than 10^{-11} per year). It is more likely that three valves will close against the LOCA. Since the Pratt methodology only considers one valve closing against a LOCA, the margin of conservatism used by Pratt is increased much beyond the 100% value cited above; i.e., 170/74 is greater than a factor of two.

3. While it is believed that a worst case DBA as described is unlikely and the Pratt methodology is exceedingly conservative, and hence the present blocked angle of 50° should be acceptable, Henry Pratt has been commissioned to prepare a report for the St. Lucie Unit No. 1 purge valves using its present methodology. Specifically, it would include an out-of-plane upsteam elbow. It will close the valve from an angle such that the maximum fluid dynamic torque is less than the allowable actuator torque. It will provide a stress analysis for valve closure from this allowable maximum angle which will be submitted to the NRC by July 15, 1983. It is expected from verbal communication with Pratt personnel that the new maximum blocked angle will be angle between 40° and 50°. Plant modifications will be made during the present refueling outage to limit the maximum blocked angle of the valves to 40°.

In view of items 1 and 2 above, sufficient justification for purging during normal operations is provided until NRC review of the revised analysis to be submitted by July 15, 1983 is complete.

TABLE 1

COMPARISON OF VALVE EVALUATION METHODOLOGIES

	Henry Pratt Methodology		Value Determined RELAP5 Worst Scenario Model
	July 1980 Report See Notes 1,2	Recent Determination See Notes 1,2,3	
Max. ΔP across any valve at 50°	19.79 psid	-	8.03 psid
Max. flow rate through the valve	27256 lb/min	-	6477.6 lb/min
Flow rate through the valve at 50° open	27256 lb/min	-	5927.8 lb/min
Max. Fluid Dynamic Torque	137031 in.-lb	170270 in-lb	74258.0 in.-lb

Notes:

1. For comparison purposes, values from the St. Lucie Unit No. 1 Henry Pratt report corresponding to valve opening angles less than 50° full open were considered.

2. In the stress analysis portion of the aforementioned Henry Pratt Report, the maximum possible fluid dynamic torque was used in evaluating stresses in the valve shaft and related components. This value was 230296 in.-lb., which corresponds to a valve opening angle of 75°. This torque also exceeds the actuator allowable of 125 in.kips. The stress analysis showed that the shaft and key may have overstressed by less than 25%. Since the present valves are blocked to 50° and the Pratt analysis is demonstrated to be very conservative it is not expected that an overstressed condition will occur.

3. Recently Henry Pratt performed a dynamic analysis with their current methodology to determine the fluid dynamic torque versus valve opening angle starting from a maximum blocked angle of 50° and including an upstream elbow. The value of 170270 in.-lbs. quoted in the table above was transmitted to Ebasco verbally by Henry Pratt personnel. It is understood that a copy of the computer output will be sent to Ebasco shortly.

Attachment 2

PROBABILISTIC ARGUMENTS FOR ST LUCIE UNIT 1 CONTAINMENT PURGE VALVES BEING PERMITTED TO OPERATE DURING REACTOR OPERATION

As stated in the FSAR, the containment purge system is operated following reduction of iodine and particulate activity by the containment airborne radioactivity removal system. When only short term access to the containment is required, the system is not operated. FPL has committed to limiting purging during plant start up and power operation to 90 hours per year, and to continuing the FPL policy of not routinely purging at power.

In order for a potential failure of an open purge valve to close normally to be contributory to a significant radioactive release, several conditions must be simultaneously met. These would be represented as inputs to an "AND" gate in a fault tree, with their independent probabilities multiplied together to produce an overall probability. Assuming a plant normal operation time per year of 7000 hours (corresponding to a 80% utilization factor), the probability of purging during reactor operation is .0129.

One necessary condition for such a significant radioactive release is a major leak into the containment from the primary coolant system; i.e., a LOCA is also necessary. However, should a precursor event, such as leakage from a pipe crack, be observed prior to the LOCA, purging operations would cease and the valves closed. In this case, leakage would release radioactivity into the containment and increase containment pressures and temperatures. These events would trigger a Containment Isolation Signal that would automatically close any open purge valves before any DBA type LOCA pressure pulses would exist. Manual closing of purge valves for any other type of pipe break precursor events would also be expected. Only those LOCA's without precursors can therefore be considered as contributory events to a significant radioactive release during purging.

The median probability of developing a large (greater than 6 inch) pipe rupture as the initiating event for a LOCA is given in WASH-1400 (the "Rasmussen Report") as 10^{-4} per plant per year. The Rasmussen Report indicates the probability that a pipe rupture will occur without intermediate leakage or breakage precursors is about .05. However, not all large LOCA's result in sufficient containment pressurization prior to closure of the purge valves to potentially affect such closure. The highly conservative analysis performed by Henry Pratt Co. of July 1980 can be used to show that at least a 10 psi containment pressure rise is necessary to impair closure of the valves. Allowing a 1.5 second instrument delay after post-LOCA containment pressure reaches .5 psig and assuming three seconds are necessary for full closure of the valves from their 50° open position, the minimum instantaneous LOCA break size which produces such a 10 psi containment pressure rise prior to completion of valve closure is 2.0 ft^2, as shown in FSAR Figure 6.2-10A. A slot break or double ended guillotine break of this area would require an internal pipe diameter of 13.5 in. Only a break without precursors of this size or greater could impair closure of an open purge valve.

Of the systems for which a pipe rupture would result in a LOCA, only about 62% of the linear feet of piping with greater than 6 inch diameter has greater than a 13.5 inch diameter. Consequently, the 10^{-4} median probability for a large pipe rupture LOCA should be multiplied by this fraction.

St Lucie Unit 1 has three purge valves in series for each of the two containment purge valve penetrations. During purging, each of these valves would be blocked open to a maximum angle of 50^{o}. Should at least two of these valves in series start to close following a DBA-type LOCA, the magnitude of the pressure wave would be sufficiently diminished by the other valve so that containment isolation would still be effected.

However, two out of the three valves in series on each of the purge inlet and discharge systems are on one of the two CIS trains, with the third valve on the other CIS train. Thus, an assumed post-LOCA failure in the CIS train which causes the two out of three valves to remain open at their 50^{o} blocked position (should purging be conducted at the time of an instantaneous LOCA) would result in only one of the three series valves attempting to close (from the CIS signal received from the other train). This one closing valve would be subject to the large break LOCA induced flows and torques. The only apparent single active failure which would result in two of the valves to not receive the CIS signal to close is a CIS relay failure. The probability of "Failure to Energize on Demand" for such a relay is given in WASH-1400 as 10^{-4}. Other single active failures, such as valve solenoid failure upon receipt of the CIS signal, result in at least two of the valves in each penetration completely closing.

Multiplying all the above probabilities gives the overall probability of exposing only one closing purge valve in series of three purge valves to containment pressures from a DBA-type LOCA having no precursor detection and worst case CIS signal failure. This probability is (.0129) (.0001) (.05) (.62) (.0001)=4×10^{-12} per plant per year. However, there are order of magnitude uncertainties in the pipe rupture data given in WASH-1400. Therefore, a maximum overall probability of 10^{-11} per plant per year is considered to be conservative.

ATTACHMENT 3

There are three 48" butterfly vavles in the St. Lucie No. 1 purge line and a debris screen is being installed during the present refueling outage at the inlet side, upstream of the first valve. The debris screen and the valves are safety related and seismically qualified. The connections upstream of the debris screen and the ones downstream of the third valve are either not safety-related or seismically qualified. Hence, following a LOCA, the pressure rise inside the containment would be assumed felt upstream of the debris screen. The downstream side of the third valve will be exposed to the pressure of the auxiliary building, namely atmospheric. The consequent pressure gradient will drive a flow through the purge lines. It is to be expected that the fluid dynamic load would be shared by the debris screen and the three valves. By reviewing Henry Pratt's St. Lucie Unit No. 1 Purge Valve report it is known that the torques on the valves could be determined from the relation: $T_D = C_T\, d^3\, \Delta p$, where C_T is the torque coefficient (experimentally determined); d is the diameter of the valve; and, Δp is the pressure difference across the disc.

In order to determine the pressure difference Δp across the valves, a RELAP5 model was developed. The pressure, temperature -time histories in the containment following a LOCA were obtained from FSAR Fig. 6.2-7A, B (worst case). The loss coefficients for the screen was assumed to be 2.5 (lower conservative value). The valves would start closing following the receipt of the containment isolation signals sent from two different bases. In order to account for the loss of signal itself following a LOCA, only valve 1 was assumed to close following a LOCA while valves 2 and 3 are kept open at 50°. The pressure downstream of the third valve was assumed constant and atmospheric. The loss coefficients for the valves as a function of the disc angle were obtained from a Pratt catalog. The differential pressures across each of the valves and the mass flow through the purge line were determined using RELAP5 as a function of time.

In order to determine the torques on the valves, the coefficient C_T (which is part of Pratt's proprietary data) is required. From Ebasco's discussions with Pratt, the C_T's were ascertained to be functions of the disc angle θ and the pressure ratio across the valve; below $\theta = 50°$ (0° closed and 90° full open) the C_T's are practically independent of the pressure ratios and are functions of the disc angle θ alone. The C_T's used to estimate the torques for the Pratt valves were developed from the data in Pratt's analysis for Turkey Point Unit No.'s 3 and 4, Rev. 1, dated 9/15/81. The understanding from Pratt is that the C_T's used for the Turkey Point Unit No.'s 3 and 4 analyses were their latest conservative estimates accounting for elbows upstream of the valve and density factors due to the presence of steam. The torques on the valves were determined using these C_T's. It is seen that valve 1 experiences the highest torques of approximately 75,000 in.-lbs. Pratt performed a revised calculation of the fluid dynamic torque across the Pratt valves for St. Lucie Unit No. 1, with their latest C_T's that account for upstream elbows and steam density factors; they arrived at a torque of 170,270 in.-lbs. at an angle of about 50°. They have not yet communicated their torque values for other angles from the same analysis, however, these values have been estimated by computing the ratio of the torque at 50° from this analysis and the earlier analysis (170,270/137,031). This factor was used to increase the torques from the earlier Pratt analysis, for all of the angles less than 50°.

It is seen that Pratt has overestimated the maximum torque by at least a factor of 2.29. The reason for this is obvious. They have, in their calculations, placed the fluid dynamic load on just one valve, while in reality it is shared by the screen and 3 valves. It is also seen that the maximum torque obtained by the alternate approach (74258.0 in.-lbs.) is much less than the rated torque, 125,000 in.-lbs. for the actuator, and very much less than 230296 in.-lbs., which they used for the stress analysis of the valve.

STATE OF FLORIDA)
) ss.
COUNTY OF PALM BEACH)

Robert E. Uhrig, being first duly sworn, deposes and says:

That he is Vice President of Florida Power & Light Company, the Licensee herein;

That he has executed the foregoing document; that the statements made in this document are true and correct to the best of his knowledge, information, and belief, and that he is authorized to execute the document on behalf of said Licensee.

Robert E. Uhrig

Robert E. Uhrig

Subscribed and sworn to before me this

31st day of March, 1983.

Cheryl I. Fredricks

NOTARY PUBLIC, in and for the County of Palm Beach, State of Florida.

My commission expires: Notary Public, State of Florida at Large My Commission Expires October 30, 1983 Bonded thru Maynard Bonding Agency