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August 5, 1983

Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Limerick Generating Station, Units 1 and 2 Additional Information for Equipment Qualification Branch

Reference: Letter from NRC (A. Schwencer) to Philadelphia Electric Company (E. G. Bauer, Jr.), dated June 27, 1983

File: GOVT 1-1 (NRC)

Dear Mr. Schwencer:

The referenced letter asked 4 questions related to NUREG-0737 Item II.D.1 arising from the staffs' review of report NEDE-24988-P. The responses to these questions are attached.

Sincerely,

Eugene J. Bradley

Eugene J. Bradley

JTR/gra/67

Attachment

Copy to: See Attached Service List

B001
1/1

cc: Judge Lawrence Brenner (w/enclosure)
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Docket and Service Section (w/enclosure)

Docket Nos. 50-352
50-353

**Attachment**
**Limerick Generating Station**
**NUREG-0737, Item II.D.1**
**NRC QUESTION 1**

The test program utilized a "rams head" discharge pipe configuration. Limerick utilizes a "tee" quencher configuration at the end of the discharge line. Describe the discharge pipe configuration used at Limerick and compare the anticipated loads on valve internals in the Limerick configuration to the measured loads in the test program. Discuss the impact of any differences in loads on valve operability.

**RESPONSE TO QUESTION 1**

The safety/relief valve discharge piping configuration at Limerick utilizes a "tee" quencher at the discharge pipe exit. The average length of the fourteen SRV discharge lines (SRVDL) is 132' of 12" diameter pipe and the submergence length in the suppression pool is approximately 18-6". The SRV test program utilized a ramshead at the discharge pipe exit, a pipe length of 112', a diameter of 10" and a submergence length of approximately 13'. Loads on valve internals in the Limerick configuration are within acceptable limits for the following reasons.

1. No dynamic mechanical load originating at the "tee" quencher is transmitted to the valve in the Limerick configuration because there is at least one anchor point between the valve and the tee quencher.

2. The length of the first segment of piping downstream of the SRV in the test facility was selected to result in the test program having a bounding dynamic mechanical load on the valve. The Limerick SRVDL piping configuration differs from the test facility in that the first line segment does not terminate in a 90° elbow and the pipe size increases in the first segment. An

assessment of the Limerick configuration has confirmed that the mechanical loads imposed on the Limerick valves by the low pressure water flow are enveloped by the high pressure steam loads.

3. Dynamic hydraulic loads (backpressure) are experienced by the valve internals in the Limerick configuration. The backpressure loads may be either (i) transient backpressures occurring during valve actuation, or (ii) steady-state backpressures occurring during steady-state flow following valve actuation.

   (a) The key parameters affecting the transient backpressures are the fluid pressure upstream of the valve, the valve opening time, the fluid inertia in the submerged SRVDL and the SRVDL air volume. Transient backpressures increase with higher upstream pressure, shorter valve opening times, greater line submergence, and smaller SRVDL air volume. The transient backpressure in the test program was maximized by utilizing a submergence of 13' and a pipe length of 112'. The Limerick configuration differs from the test facility with offsetting parameters of greater submergence and larger SRVDL air volume. An evaluation of these differences has confirmed that the test facility and the Limerick configuration have comparable backpressures. The maximum transient backpressure occurs with high pressure steam flow conditions. The transient backpressure for the alternate shutdown cooling mode of operation is always much less than the design for steam flow conditions because of the lower upstream pressure and the longer valve opening time.

   (b) The steady-state backpressure in the test program was maximized by utilizing an orifice plate in the SRVDL above the water level and before the ramshead. The orifice was sized to produce a backpressure greater than that calculated for any of the Limerick SRVDL's.

An additional consideration in the selection of the ramshead for the test facility was to allow more direct measurement of the thrust load in the final pipe segment. Utilization of a "tee" quencher in the test program would have required quencher supports that would unnecessarily obscure accurate measurement of the pipe thrust loads.

The differences in the line configuration between the Limerick plant and the test program as discussed above result in loads on the Limerick valve internals which are within acceptable limits.

## NRC QUESTION 2

The test configuration utilized no spring hangers as pipe supports. Plant specific configurations do use spring hangers in conjunction with snubber and rigid supports. Describe the safety relief valve pipe supports used at Limerick and compare the anticipated loads on valve internals for the Limerick pipe supports to the measured loads in the test program. Describe the impact of any differences in loads on valve operability.

## RESPONSE TO QUESTION 2

The Limerick safety-relief valve discharge lines (SRVDL's) are supported by a combination of snubbers, rigid supports, and spring hangers. These supports were designed to accommodate combinations of loads resulting from piping, dead weight, thermal conditions, seismic and suppression pool hydrodynamic events, and a high pressure steam discharge transient. Each SRVDL at Limerick has 2-5 spring hangers, all of which are located in the drywell.

The dynamic load effects on the piping and supports of the test facility due to the water discharge events (the alternate shutdown cooling mode) were found to be significantly lower than corresponding loads resulting from the high pressure steam discharge event. As stated in NEDE-24988-P, this finding is considered generic to all BWR's since the test facility was designed to be prototypical of the features pertinent to this issue. Furthermore, assessment of a typical Limerick SRVDL configuration has confirmed the applicability of the generic statement to Limerick.

During the water discharge transient there will be significantly lower dynamic loads acting on the snubbers and rigid supports than during the steam discharge transient. This will more than offset the small increase in the dead load on these supports due to the weight of the water during the alternate shutdown cooling mode of operation. Therefore, design adequacy of the snubbers and rigid supports is assured as they are designed for the larger steam discharge transient loads.

This question addresses the design adequacy of the spring hangers with respect to the increased dead load due to the weight of the water during the liquid discharge transient. As was discussed with respect to snubbers and rigid supports, the dynamic loads resulting from liquid discharge during the alternate shutdown cooling mode of operation are significantly lower than those from the high pressure steam discharge. The spring hangers have been reviewed for the deflections resulting from the steam discharge dynamic event and found to be acceptable. In addition, the spring hangers have been evaluated for the increased dead load due to a water filled condition. Both the spring hangers and piping stresses were acceptable. Furthermore, the effect of the water dead weight load does not affect the ability of SRVs to open to establish the alternate shutdown cooling path since the loads occur in the SRVDL only after valve opening.

## NRC QUESTION 3

The purpose of the test program was to determine valve performance under conditions anticipated to be encountered in the plants. Describe the events and anticipated conditions at Limerick for which the valves are required to operate and compare these plant conditions to the conditions in the test program. Describe the plant features assumed in the event evaluations used to scope the test program and compare them to plant features at Limerick. For example, describe high level trips to prevent water from entering the steam lines under high pressure operating conditions as assumed in the test event and compare them to trips used at Limerick.

## RESPONSE TO NRC QUESTION 3

The purpose of the S/RV test program was to demonstrate that the Safety Relief Valve (S/RV) will open and reclose under all expected flow conditions. The expected valve operating conditions were determined through the use of analyses of accidents and anticipated operational occurrences referenced in Regulatory Guide 1.70, Revision 2. Single failures were applied to these analyses so that the dynamic forces on the safety and relief valves would be maximized. Test pressures were the highest predicted by conventional safety analysis procedures. The BWR Owners Group, in their enclosure to the September 17, 1980 letter from D. B. Waters to R. H. Vollmer, identified 13 events which may result in liquid or two-phase S/RV inlet flow that would maximize the dynamic forces on the safety and relief valve. These events were identified by evaluating the initial events described in Regulatory Guide 1.70, Revision 2, with and without the additional conservatism of a single active component failure or operator error postulated in the event sequence. It was concluded from this evaluation that the alternate shutdown cooling mode is the only expected event which will result in liquid at the valve inlet. Consequently, this was the event simulated in the S/RV test program. This conclusion and the test results applicable to Limerick are discussed below.

The BWR Owners Group identified 13 events by evaluating the initiating events described in Regulatory Guide 1.70, Revision 2, with the additional conservatism of a single active component failure or operator error postulated in the events sequence. These events and the plant-specific features that mitigate these events, are summarized in Table 1. Of these 13 events, only nine are applicable to the Limerick plant because of its design and specific plant configuration. Four events, namely 5, 6, 10 and 13 are not applicable to the Limerick plant for the reasons listed below:

(a) Events 5 and 10 are not applicable because Limerick does not have a High Pressure Core Spray system.

(b) Event 6 is not applicable because Limerick does not have RCIC head sprays.

(c) Event 13 is not applicable because large breaks will not be isolated at Limerick.

For the nine remaining events, the Limerick specific features, such as trip logic, power supplies, instrument line configuration, alarms and operator actions, have been compared to the base case analysis presented in the BWR Owners Group submittal of September 17, 1980. The comparison has demonstrated that in each case, the base case analysis is applicable to Limerick because the base case analysis does not include any plant features which are not already present in the Limerick design. For these events, Table 1 demonstrates that the Limerick specific features are included in the base case analysis presented in the BWR Owners Group submittal of September 17, 1980. It is seen from Table 1, that all plant features assumed in the event evaluation are also existing features in the Limerick plant. All features included in this base case analysis are similar to plant features in the Limerick design. Furthermore. the time available for operator action is expected to be lone r in the Limerick plant than in the base case analysis for each case where operator action is required due to the conservative nature of the base case analysis.

Event 7, the alternate shutdown cooling mode of operation, is the only expected event which will result in liquid or two-phase fluid at the S/RV inlet. Consequently, this event was simulated in the BWR S/RV test program. In Limerick, this event involves flow of subcooled water (approximately 31 °F subcooled) at a pressure of approximately 156 psig. The S/RV inlet fluid conditions tested in the BWR Owners Group S/RV test program, as documented in NEDE-24988-P, are 15° to 50° subcooled liquid at 20 psig to 250 psig. These fluid conditions envelope the conditions expected to occur at Limerick in the alternate shutdown cooling mode of operation.

As discussed above, the BWR Owners Group evaluated transients including single active failures that would maximize the dynamic forces on the safety relief valves. As a result of this evaluation, the alternate shutdown cooling mode is the only expected event involving liquid or two-phase flow. Consequently this event was tested in the BWR S/RV test program. The fluid conditions and flow conditions tested in the BWR Owners Group test program conservatively envelope the Limerick plant-specific fluid conditions expected for the alternate shutdown cooling mode of operation.

## NRC QUESTION 4

Describe how the values of valve Cv's in report NEDE-24988-P will be used at Limerick. Show that the methodology used in the test program to determine the valve Cv will be consistent with the application at Limerick.

## RESPONSE TO NRC QUESTION 4

The flow coefficient, Cv, for the Target Rock 2-Stage safety relief valve (SRV) utilized in Limerick was determined in the generic SRV test program (NEDE-24988-P). The average flow coefficient calculated from the test results for the Target Rock Valve is reported in Table 5.2-1 of NEDE-24988-P. This test value has been used by Philadelphia Electric Company to confirm that the liquid discharge flow capacity of the Limerick SRV's will be sufficient to remove core decay heat when injecting into the reactor pressure vessel (RPV) in the alternate shutdown cooling mode. The Cv value determined in the SRV test demonstrates that the Limerick SRV's are capable of returning sufficient flow to the suppression pool to accomodate injection by the RHR or CS pump.

If it were necessary for the operator to place the Limerick plant in the alternate shutdown cooling mode, he would assure that adequate core cooling was being provided by monitoring the following parameters: RHR or CS Flow rate, reactor vessel pressure and reactor vessel temperature.

The flow coefficient for the Target Rock valve reported in NEDE-24988-P was determined from the SRV flow rate when the valve inlet was pressurized to approximately 250 psig. The valve flow rate was measured with the supply line flow venturi upstream of the steam chest. The Cv for the valve was calculated using the nominal measured pressure differential between the valve inlet (steam chest) and 3' downstream of the valve and the corresponding measured flowrate. Furthermore, the test conditions and test configuration were representative of Limerick plant conditions for the alternate shutdown cooling mode, e.g. pressure upstream of the valve, fluid temperature, friction losses and liquid flowrate. Therefore, the reported Cv values are appropriate for application to the Limerick plant.

TABLE 1 - EVENTS EVALUATED

| PLANT FEATURES | #1 FW Cont. Fail., FW L8 Trip Failure | #2 Press. Reg. Fail. | #3 Transient HPCI, HPCI L8 Trip Failure | #4 Transient RCIC, RCIC L8 Trip Failure | #5 Transient HPCS, HPCS L8 Trip Failure | #6 Transient RCIC Hd. Spr. | #7 Alt. Shutdown Cooling, Shutdown Suction Unavailable | #8 MSL Brk OSC | #9 SBA, RCIC, RCIC L8 Trip Failure | #10 SBA, HPCS, HPCS L8 Trip Failure | #11 SBA, HPCI, HPCI L8 Trip Failure | #12 SBA, Depress. & ECCS Over., Operator Error | #13 LBA, ECCS Overf Brk Isol |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| High Water Level 7 Alarm | X / S | | X / S | X / S | X / NA | | | | X / S | X / NA | X / S | X / S | X / NA |
| High Drywell Pressure Alarm | | | | | | | | | | | | | |
| FW Level 8 Trip | X / S | X / S | | | | | | | | | | | |
| RCIC Level 8 Trip | | | X / S | X / S | X / NA | | | | X / S | X / NA | X / S | | X / NA |
| HPCS Level 8 Trip | | | | X / NA | X / NA | | | | X / NA | X / NA | | | X / NA |
| HPCI Level 8 Trip | | | X / S | X / S | | | | | X / S | | X / S | | X / NA |
| HPCI/S and RCIC Initiation on Low Water Level | X / S | X / S | X / S | X / S | X / NA | X / NA | | X / S | X / S | | | | X / NA |
| HPCI/S initiation on High Drywell Pressure | | | X / S | X / S | | | | | X / S | X / NA | X / S | X / S | X / NA |
| RCIC Initiation on High Drywell Pressure | | | | | | | | | | | | | X / NA |

## TABLE 1 - EVENTS EVALUATED

| PLANT FEATURES | #1 FW Cont. Fail., FW L8 Trip Failure | #2 Press. Reg. Fail. | #3 Transient HPCI, HPCI L8 Trip Failure | #4 Transient RCIC, RCIC L8 Trip Failure | #5 Transient HPCS, HPCS L8 Trip Failure | #6 Transient RCIC Hd. Spr. | #7 Alt. Shutdown Cooling, Shutdown Suction Unavailable | #8 MSL Brk OSC | #9 SBA, RCIC, RCIC L8 Trip Failure | #10 SBA, HPCS, HPCS L8 Trip Failure | #11 SBA, HPCI, HPCI L8 Trip Failure | #12 SBA, Depress. & ECCS Over., Operator Error | #13 LBA, ECCS Overf Brk Isol |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Low Pressure ECCS Initiation on High Drywell Pressure | | | | | | | | | | | | X / S | X / NA |
| Low Pressure ECCS Initiation on Low Water Level | | | | | | | | | | | | | X / NA |
| FW Pumps Trip on Low Suction Pressure | X / S | | | | | | | | | | | | |
| HPCI Trip on High Backpressure | | | X / S | | | | | | | | X / S | | |
| RCIC Trip on High Backpressure | | | | X / S | | | | | X / S | | | | |
| Turbine Trip on Vessel High Level | X / S | X / S | | | | | | | | | | | |
| MSIVs Closure on Low Turbine Inlet Pressure | X / S | X / S | | | | | | X / S | | | | | |
| MSIVs Closure on High Steam Flow | | X / S | | | | | | X / S | | | | | |
| MSIVs Closure on High Steam Tunnel Temperature | | | | | | | | X / S | | | | | |

TABLE 1 - EVENTS EVALUATED

| PLANT FEATURES | #1 FW Cont. Fail., FW L8 Trip Failure | #2 Press. Reg. Fail. | #3 Transient HPCI, HPCI L8 Trip Failure | #4 Transient RCIC, RCIC L8 Trip Failure | #5 Transient HPCS, HPCS L8 Trip Failure | #6 Transient RCIC Hd. Spr. | #7 Alt. Shutdown Cooling, Shutdown Suction Unavailable | #8 MSL Brk OSC | #9 SBA, RCIC, RCIL L8 Trip Failure | #10 SBA, HPCS, HPCS L8 Trip Failure | #11 SBA, HPCI, HPCI L8 Trip Failure | #12 SBA, Depress. & ECCS Over., Operator Error | #13 LBA, ECCS Overf Brk Isol |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MSIV Closure on High Radiation | | | | | | | | X / S | | | | | |
| Reactor Scram on Turbine Trip | X / S | X / S | | | | | | | | | | | |
| Reactor Scram on Neutron Flux Monitor | | X / S | | | | | | | | | | | |
| Reactor Scram on MSIVs Closure | | X / S | | | | | | | | | | | |
| Reactor Scram on High Radiation | | | | | | | | X / S | | | | | |
| Reactor Scram on High Drywell Pressure | | | | | | | | | X / S | X / NA | X / S | X / S | X / NA |
| Reactor Scram on Low Water Level | | | | | | | | | | | | | X / NA |
| Reactor Isolation on Low Water Level | | | | | | | | | | | | | X / NA |

KEY: X - Feature considered in Base Case Analysis
S - Feature in Plant Specific Design
NA - Not Applicable