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November 9, 1982
EF2 - 60,291

Mr. L. L. Kintner
U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Licensing
Washington, D. C. 20555

Dear Mr. Kintner:

References: (1) Enrico Fermi Atomic Power Plant, Unit 2
NRC Docket No. 50-341

(2) Letter NRC to Detroit Edison, "Operability of Safety Relief Valves for Fermi 2", May 27, 1982

Subject: Additional Information to Verify the Applicability of Generic SRV Test Results to Fermi 2

The Reference 2 letter requested that Detroit Edison supply additional information to verify the applicability of generic safety relief valve (SRV) test results to the Fermi 2 plant. This information is supplied in the attachment.

It should be noted that for Fermi 2 the alternate shutdown cooling mode of passing water through the safety relief valves to the suppression pool is not an anticipated operating condition. The Fermi 2 design includes a parallel flow path for shutdown cooling inside containment employing a normally closed, remote manual isolation valve powered from the alternate division emergency power supply. This is discussed in Section 5.4.2 of the Fermi 2 Safety Evaluation Report. In any case, the Fermi 2 SRVs would be available and can accommodate adequate water passage for shutdown cooling in the extremely unlikely event that the normal shutdown cooling path and its backup are unavailable.

Should you have any further questions, please contact Mr. L. E. Schuerman, (313) 649-7562.

Sincerely,

Harry Tauber

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cc: Mr. B. Little

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NRC QUESTION 1

The test program utilized a "rams head" discharge pipe configuration. Fermi 2 utilizes a "tee" quencher configuration at the end of the discharge line. Describe the discharge pipe configuration used at Fermi 2 and compare the anticipated loads on valve internals in the Fermi 2 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 Fermi 2 utilizes a "tee" quencher at the discharge pipe exit. The average length of the fifteen (15) SRV discharge lines (SRVDL) is approximately 101 feet and the submergence length in the suppression pool is approximately eleven (11) feet. The SRV test program utilized a ramshead at the discharge pipe exit, a pipe length of 112' and a submergence length of approximately 13'. Loads on valve internals during the test program are larger than loads on valve internals in the Fermi 2 configuration for the following reasons:

1. No dynamic mechanical load originating at the "tee" quencher is transmitted to the valve in the Fermi 2 configuration because there is at least one anchor point between the valve and the tee quencher.

2. The first length of the segment of piping downstream of the SRV in the test facility was longer than the Fermi 2 piping, thereby resulting in a bounding dynamic mechanical load on the valve in the test program due to the larger moment arm between the SRV and the first elbow. The first segment length in the test facility is 12 ft. whereas this length is five (5) ft. in the Fermi configuration.

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3. Dynamic hydraulic loads (backpressure) are experienced by the valve internals in the Fermi 2 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 backpressues are the fluid pressure upstream of the valve, the valve opening time, the fluid inertia in the submerged SRVDL and the SRVDL air volume. The 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', which is greater than Fermi 2. In addition, the SRVDL air volume for Fermi 2 is larger than that of the test facility due to employing a larger average diameter SRV discharge pipe. 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 Fermi 2 SRVDLs.

The differences in the line configuration between the Fermi 2 plant and the test program as discussed above result in the loads on the valve internals for the test facility which bound the actual Fermi 2 loads. 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. For the reasons stated above, differences between the SRVDL configurations in Fermi 2 and the test facility will not have any adverse effect on SRV operability at Fermi 2 relative to the test facility.

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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 suports. Describe the safety relief valve pipe supports used at Fermi 2 and compare the anticipated loads on valve internals for the Fermi 2 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 Fermi 2 safety-relief valve discharge lines (SRVDLs) are supported by a combination of snubbers, rigid supports, and spring hangers. The locations of snubbers and rigid supports at Fermi 2 are such that the location of such supports in the BWR generic test facility is prototypical, i.e., in each case (Fermi 2 and the test facility) there are supports near each change of direction in the piping routing. Additionally, each SRVDL at Fermi 2 has an average of four (4) spring hangers, all of which are located in the drywell. The spring hangers, snubbers, and rigid 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.

The dynamic load effects on the piping and supports of the test facility due to the water discharge event (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 BWRs since the test facility was designed to be prototypical of the features pertinent to this issue.

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. Therefore, sufficient margin exists in the Fermi 2 piping system design to adequately offset the increased dead load on the spring hangers in an unpinned condition due to a water filled condition. 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

Report NEDE-24988-P did not identify any valve functional deficiencies or anomalies encountered during the test program. Describe the impact on valve safety function of any valve functional deficiencies or anomalies encountered during the program.

RESPONSE TO QUESTION 3

No functional deficiencies or anomalies of the safety relief or relief valves were experienced during the testing at Wyle Laboratories for compliance with the alternate shutdown cooling mode requirement. All of the valves subjected to test runs, valid and invalid, opened and closed without loss of pressure integrity or damage. Anomalies encountered during the test program were all due to failures of test facility intrumentation, equipment, data acquisition equipment, or deviation from the approved test procedure.

The test specification for each valve required six runs. Under the test procedure, any anomaly caused the test run to be judged invalid. All anomalies were reported in the test report. The Wyle Laboratories test log sheet for the Target Rock two stage valve tests is attached as Table 1. This valve is used in the Fermi 2 Nuclear Power Station.

Each Wyle test report for the respective valves identifies each test run performed and documents whether or not the test run is valid or invalid and states the reason for considering the run valid. No anomaly encountered during the required test program affects any valve safety or operability function.

All valid test runs are identified in Table 2.2-1 of NEDE-24988-P. The data presented in Table 4.2-1 for each valve were obtained from the Table 2.2-1 test runs and were based upon the selection criteria of:

(a) Presenting the maximum representative loading information obtained from the steam run date,

(b) Presenting the maximum representative water loading information obtained from the 15°F subcooled water test data,

(c) Presenting the data on the only test run performed for the 50°F subcooled water test condition.

TABLE 1

TEST LOG FOR SRV TR-1

Test No.	Test Media	Load Line Configuration	Test Date	Remarks
301	Steam	I	3/17/81	Acceptable
302	Water	I	3/17/81	GN_2 Regulator failed. Data not acceptable.
303	Water	I	3/17/81	Acceptable
304	Steam	I	3/17/81	Acceptable
305	Water	I	3/18/81	Acceptable
306	Steam	I	3/18/81	Acceptable
307	Water	I	3/18/81	Acceptable
308	Water	I	3/18/81	Special test at elevated temperature and low pressure requested by G.E.

NRC QUESTION 4

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 Fermi 2 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 Fermi 2. 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 Fermi 2.

RESPONSE TO NRC QUESTION 4

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 Fermi 2 are discussed below. The alternate shutdown cooling mode of operation has been described in the response to NRC Question 5.

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 Fermi 2 in the alternate shutdown cooling mode of operation.

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 10 are applicable to the Fermi 2 plant because of its design and specific plant configuration. Three events, namely 5, 6 & 10 are not applicable to the Fermi 2 plant for the reasons listed below.

- o Events 5 and 10 are not applicable, because Fermi 2 does not have a HPCS System.

- o Event 6 is not applicable, because Fermi 2 does not have RCIC Head Sprays.

For these 10 remaining events, the Fermi 2 specific features, such as trip logic, power supplies, instrument line configuration, alarms and operator actions, have been compared to the base 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 Fermi 2 because the base case analysis does not include any plant features which are not already present 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 Fermi 2 plant. All features included in this base case analysis are simlar to plant features in the Fermi 2 design. Furthermore, the time available for operator action is expected to be longer in the Fermi 2 plant than in the base case analysis for each case where operator action is required.

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 Fermi 2, this event involves flow of subcooled water (approximately 15 - 50°F subcooled) at a pressure range of approximately 100 - 170 psig. The test conditions clearly envelope these plant conditions.

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

(Event 7) 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 envlope the Fermi 2 plant-specific fluid conditions expected for the alternate shutdown cooling mode of operation.

PLANT FEATURES

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

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

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

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 Isci
High Water Level 7 Alarm	X / S		X / S	X / S	X / NA				X / S	X / NA	X / S	X / S	X / S
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					X / S		X / S		X / S
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 / S
HPCI/S Initiation on High Drywell Pressure			X / S	X / S					X / S	X / NA	X / S	X / S	X / S
RCIC Initiation on High Drywell Pressure													X / NA

NRC QUFSTION 5

The valves are likely to be extensively cycled in a controlled depressurization mode in a plant-specific application. Was this mode simulated in the test program? What is the effect of this valve cycling on valve performance and probability of the valve to fail open or to fail colsed?

RESPONSE TO NRC QUESTION 5

The BWR safety/relief valve (SRV) operability test program was designed to simulate the alternate shutdown cooling mode, which is the only expected liquid discharge event for Fermi 2.* The sequence of events leading to the alternate shutdown cooling mode is given below.

Following normal reactor shutdown, the reactor operator depressurizes the reactor vessel by opening the turbine bypass valves and removing heat through the main condenser. If the main condenser is unavailable, the operator could depressurize the reactor vessel by using the SRVs to discharge steam to the suppression pool. If SRV operation is required, the operator cycles the valves in order to assure that the cooldown rate is maintained within the technical specification limit of 100°F per hour. When the vessel is depressurized, the operator initiates normal shutdown cooling by use of the RHR system. If that system is unavailable because the valve on the RHR shutdown cooling suction line fails to open, the operator initiates the alternate shutdown cooling mode.

*See cover letter - This mode not anticipated on Fermi 2.

For alternate shutdown cooling, the operator opens one SRV and initiates either an RHR or core spray pump utilizing the suppression pool as the suction source. The reactor vessel is filled such that water is allowed to flow into the main steam lines and out of the SRV and back to the suppression pool. Cooling off the system is provided by use an an RHR heat exchanger. As a result, an alternate cooling mode is maintained.

In order to assure continuous long term heat removal, the SRV is kept open and no cycling of the valve is performed. In order to control the reactor vessel cooldown rate, the operator is instructed to control the flow rate into the vessel. Consequently, no cycling of the SRV is required for the alternate shutdown cooling mode, and no cycling of the SRV was performed for the generic BWR SRV operability test program.

The ability of the Fermi 2 SRV to be extensively cycled for steam discharge conditions has been confirmed during steam discharge qualification testing of the valve by the valve vendor. Based on the qualification testing of the SRVs, the cycling of the valves in a controlled depressurization mode for steam discharge conditions will not adversely affect valve performance and the probability of the valve to fail open or closed is extremely low.

NRC QUESTION 6

Describe how the values of C_v's in report NEDE-24988-P will be used at Fermi 2. Show that the methodology used in the test program to determine the valve C_v will be consistent with the application at Fermi 2.

RESPONSE TO NRC QUESTION 6

The flow coefficient, C_v, for the Target Rock two stage safety relief valve (SRV) utilized in Fermi 2 was determined in the generic SRV test program (NEDE-24988-P). The average flow coefficient calculated from the test results for the Target Rock two stage is reported in Table 5.2-1 of NEDE-24988-P. This test value has been used by Detroit Edison to confirm that the liquid discharge flow capacity [illegible] Fermi 2 SRVs will be sufficient to remove core decay heat when injecting into the reactor pressure vessel (RPV) in the alternate shutdown cooling mode. The C_v determined in the SRV test demonstrates that the the Fermi 2 SRVs are capable of returning the flow injected by the RHR or CS pump to the suppression pool.

If it were necessary for the operator to place the Fermi 2 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.

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The flow coefficient for the Target Rock two stage 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 C_v 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 Fermi 2 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 C_v values are appropriate for application to the Fermi 2 plant.