Commonwealth Edison
1400 Opus Place
Downers Grove, Illinois 60515

February 18, 1994

Dr. T.E. Murley, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Attn: Document Control Desk

Subject: Zion Nuclear Station Units 1 & 2
NUREG 0737 Item II.D.1
Performance Testing of Relief and Safety Valves
NRC TAC Nos. M44630 and M44631
Docket Nos 50-295 and 50-304

Reference: February 28, 1989 Chandu Patel letter to H.E. Bliss

Dear Dr. Murley,

The reference letter transmitted to Commonwealth Edison Company (CECo) a Technical Evaluation Report (TER) which provided the results of EG&G, Idaho's review of CECo's response to the subject issue. The TER identified several apparent deficiencies in the CECo response.

CECo has reviewed the referenced TER and is providing as an enclosure to this letter our response to the identified deficiencies.

Please direct any questions to this office.

Sincerely,

Terrence W. Simpkin
T.W. Simpkin
Nuclear Licensing Administrator

Enclosure

cc: J.B. Martin - Administrator, Region III
C.Y. Shiraki - Project Manager, NRR
J.D. Smith - Senior Resident Inspector, Zion

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NRC TER

Item 3: Item 3, which requires the forces on the safety and relief valves to be maximized, was not met. This is because the Licensee did not provide the results of an analysis of the system for the PORV discharge or combine valve discharge loads with seismic loads. Therefore, it could not be concluded the forces were maximized.

Zion Response

There are two parts to this item:

1. Analysis of the system for PORV discharge loads.

2. Combination of safety valve discharge loads with seismic loads.

For part #1:

This issue has been previously addressed in reference F. The portions of reference F which pertain to the analysis of the system for PORV loads are presented below:

Zion Relief Valve Piping Thermal Hydraulic Model

The Zion pressurizer is equipped with two power-operated relief valves that are designed to limit system pressure. The relief valves can be operated automatically or by remote manual control and have a setpoint pressure of 2,349.7 psia. The operation of these valves serves to limit the use of the safety valves. The layout of the relief valve piping is shown schematically in the attached diagram labeled Exhibit 3.

Modeling Details

A model of the relief valves, pressurizer, discharge piping, header and relief tank was developed for RELAP5/MOD1 in a manner similar to the model for the safety valve piping system. The nodalization consists of 158 volumes and 158 junctions. Highlighted features are provided below:

* The relief valves are a Copes-Vulcan Model D100-160 - 2-1/2 operator with a 3-inch inlet and outlet, which have a rated flow of 210,000 lbm/hr at a setpoint pressure of 2,349.7 psia. The valves have a 316W/Stellite plug and 17-4 PH cage. During the EPRI tests performed on this type of valve, an average opening time of 0.60 seconds was observed for tests with saturated steam. An average valve opening time of 0.53 seconds was observed for saturated steam tests of Copes-Vulcan valves with a 17-4 PH plug and cage. A conservative valve opening time of 0.40 seconds was used in this analysis. The flow area was assumed to be a linear function of the opening stroke of the valve. The valve throat area was taken as 0.0246 ft^2 and the corresponding valve flow coefficient (C_v) as 50 gal/min $(lbf/in^2)^{1/2}$.

* The pressurizer was modeled as an infinite source of saturated steam at the relief valve setpoint pressure of 2,349.7 psia. The piping components between the pressurizer and relief valves were set at this same initial condition.

* The block valves used to provide isolation for the power-operated relief valves were modeled as piping components with a loss coefficient of 0.144.

* The piping arrangement of the Zion plant is such that no loop seal exists for the relief valve piping; therefore, only a steam blowdown case was investigated.

* The relief valve discharge piping analysis is based on the simultaneous actuation of the two relief valves.

Thermal Hydraulic Results

The peak and final pressures produced by the actuation of the relief valves are markedly lower than the pressures produced by the safety valve actuation. This is the result of several factors: the lower setpoint pressure of the relief valves, the lower flow rate of the relief valves and the absence of a loop seal upstream of the relief valves.

The attached diagram labeled Exhibit 21 is a plot of the mass flow rate through the relief valves. The steady-state flow rate through the relief valves (junctions 1100 and 2300) is shown to be 288,000 lbm/hr. This corresponds to 137% of the manufacturer's rated flow. The RELAP5/MOD1 valve flow rate is also greater than the average flow rate of 241,200 lbm/hr measured during the EPRI/Wyle and EPRI/Marshall tests on Copes-Vulcan 316W/Stellite plug and 17-4 PH cage valves. The higher flow rate used in the analysis will predict higher loads and is therefore conservative for analytical considerations that address valve functionability and the structural integrity of the piping system.

The relief valve analysis revealed substantially lower loads in the common header piping than the loads calculated during the safety valve analysis. The lower loads are a result of the lower setpoint and flow rate for the relief valves and, more importantly, the absence of a loop seal in the relief valve piping. Therefore, the relief valve actuation was not pursued further for the response to NUREG 0737, item II.D.1, since the safety valve actuation is the bounding transient for the common header piping.

For part #2:

The loss-of-load and locked rotor transients are the design basis events for Zion station which present the limiting conditions since they generate the greatest pressure and highest pressurization rate. The analyses prepared in response to NUREG 0737, item II.D.1 were performed in accordance with the Zion design basis. The TER correctly states that the system was analyzed for faulted conditions which included deadweight, thermal, pressure and safety valve discharge loads. The RCS load combination is described in section 5.4.3.4 of the UFSAR. A closer examination of the UFSAR reveals that the RCS was the only system analyzed for a faulted load combination which included SSE. All other design basis analyses did not combine SSE with postulated accident loads. This approach is consistent with reference C, which states: "Safety-related structures, systems, and components are designed to (1) remain functional during a Safe Shutdown Earthquake (SSE), (2) ensure the integrity of the reactor coolant pressure boundary, and (3) to have the capability to shut down the reactor and maintain it in a safe condition or the capability to mitigate the consequences of accidents.

However, as a design-basis event, the SSE is not assumed to occur simultaneously with the postulated accidents." Since the occurrence of a postulated accident is a required precondition for this event, the SSE loads need not be combined for the analyses.

Zion station maintains that the forces were maximized in accordance with the Zion design basis and applicable regulatory guidance.

NRC TER

Item 7: That part of Item 7 that requires consideration of the effect of as-built discharge piping on safety valve and PORV operability was not met. This is because the pressure drop when the safety valves open is larger than the corresponding values for the test valves. This suggests the Zion 1&2 safety valves may not perform stably. Also, the maximum expected bending moment on the Zion 1&2 PORVs was not supplied. Thus, operability of the PORVs with the maximum expected applied moment could not be assured.

Zion Response

There are two parts to this item:

1. Comparison of our analytical pressure drop across the safety valves with the EPRI test results.

2. The absence of the maximum expected bending moments applied to the PORV's.

For part #1:

The TER states that the Zion analytical safety valve pressure drop is larger than the corresponding value from the EPRI tests. The TER states that this suggests the Zion safety valves may not perform stably and the (800 psi) pressure drop in the pipe feeding the safety valve would cause chattering. Such chattering would reduce the flow rate through the valve below that which we had assumed in our pipe stress calculations. As a result, the dynamic loads on the piping would be less than what was computed, so that the computation would be conservative. In reality, this 800 psi negative spike of pressure is not real; it is predicted because the available model in RELAP is an unrealistic one, and because the valve action was presented in a manner which conservatively predicted the highest possible dynamic loads on the piping. Examination of the predicted valve inlet pressure history in the phase I report does, indeed, bear out the claim that the steady state pressure drop through the piping between the pressurizer and the safety valve is comparable to that in the EPRI tests during those parts of the transients which were predictable by the RELAP model.

The RELAP solution predicts a momentary drop of pressure of 800 psi to 1,700 psi at the inlet to the safety valve, immediately after the assumed opening of the safety valve, followed by a nearly instantaneous positive spike, and then, almost instantaneously, the establishment of a pressure about 200 psi below the pressurizer pressure. This predicted history is attributable to the assumption that the safety valve opens instantaneously while in contact with the water in the loop seal. This assumption then leads to a requirement for the immediate establishment of a very high flow rate through the valve, which, in turn, requires a very high acceleration of the loop seal water to provide the flow rate.

Manual calculations have been performed to verify that a pressure drop of 800 psi is within 30% of what was determined to match the required acceleration of the loop seal water (in a 0.001 second time step) with the flow through the valve. In all likelihood, a more precise calculation would match the RELAP calculation more exactly.

If the analysis were performed today, a more realistic assumption would make the opening of the safety valve a function of the pressure drop across the safety valve, perhaps using a servo valve model within RELAP. This would force a prediction of a more gradual opening of the safety valve. However, this would have no effect on the analytical conclusions. The result would be a less drastic predicted pressure drop through the water column between the pressurizer and the inlet side of the safety valve.

Such a modified calculation is unnecessary, since the assumed sharp opening of the safety valve places a conservatively high slug flow load on the piping. This is the case because, under the sudden opening assumption, the loop seal water is ejected into the downstream piping more rapidly than would be the case if the valve were opened gradually. Similarly, if the valve were to chatter, the mean flow rate of the loop seal water into the downstream piping would be reduced, again leading to a loading reduced below the level used in our reports.

Thus, the problem of the Zion safety valves performing unstably (or chattering) is not significant from the viewpoint of pipe stresses for the following reasons:

1. The aspects of the RELAP solution which appear to lead to a prediction of an excessive pressure drop leading to the possibility of chattering are actually artifacts of the assumptions in the calculations.

2. Actual plant experience and the EPRI tests show that, if the valves are maintained, they will not chatter during a blowdown event.

3. The chattering valve opening will give lower slug flow loads on the piping than would the assumed sudden, maximum opening.

Insofar as the significance of chattering is concerned in real operation, it is important to note that the EPRI tests showed that inspection and maintenance will prevent chattering in real valves; chattering seems to only occur in valves whose seats have been eroded.

For part #2:

As described earlier, the piping system configuration has been previously analyzed (with acceptable results) for PORV actuations. Additionally, neither of the two design basis transients in question (loss-of-load and locked rotor) take any credit for the PORV's. Further, there are block valves available to isolate the PORV's, if necessary (both the Zion design basis and an NRC clarification revision to NUREG 0737, item II.D.1 indicate that isolation of a stuck-open PORV is not required to ensure safe plant shutdown). Based on these facts, PORV operability does not appear to be an issue of concern.

NRC TER

Item 7: Item 7, regarding applicability of the test valves, was not met for the block valves. The test results on the valve/operator combination tested by EPRI are not applicable to the block valve/operator combination at Zion, Units 1 and 2. This is because, based on the information provided by the Licensee, it cannot be concluded the torque output of the plant operators is greater than the minimum torque used in the EPRI tests.

Zion Response

Since the issuance of the TER, Generic Letter 89-10 has been issued regarding motor operated valves. Responding to this generic letter involved analyses and some modifications to MOV's in many areas, one of which was torque values. Commonwealth Edison Company has determined correct switch settings (torque, torque bypass, position limits, overload) for all Generic Letter 89-10 program MOV's for each valve operation (opening, closing) using design basis reviews, thrust calculations and vendor recommendations. Torque switch settings are based upon the target and thrust windows specified in the MOV program. The thrust window identifies the range of thrust values in which the valve operator may safely provide thrust to open or close the valve and are calculated based upon the maximum expected differential pressure that the MOV is expected to operate against. Proper switch settings are verified by diagnostic testing methods for rising stem MOV's. All MOV switch setting shall be controlled by administrative means in accordance with company directives. The Zion station MOV coordinator has verified that all of the Zion PORV block valves have actuator closing torques greater than or equal 100 ft-lbs.

NRC TER

Item 8: Item 8, which requires qualification of the piping and supports, was not met. This is because the Licensee's piping analysis did not analyze the system for PORV discharge or combine valve discharge loads with seismic loads.

Zion Response

Commonwealth Edison maintains that the forces were maximized in accordance with the Zion design basis and applicable regulatory guidance.

Two additional issues were raised by the TER:

1. The Zion operating procedures or licensing documents must be revised to ensure inspection and maintenance (as required) of the pressurizer safety valves following each lift involving loop seal or water discharge. Zion station has revised the applicable procedures and documents to require an inspection of the pressurizer safety valves following each lift.

2. Since the analysis results indicate that during the postulated event, support RCRS-1120 will be overstressed, Zion station has revised the applicable procedures and documents such that if the pressurizer safeties lift, this support must be examined to determine the need for repair or replacement.

REFERENCES

A. C.Patel Letter to H.Bliss dated 2/28/89

B. Zion NTS Item 295-123-89-07370

C. NRC Inspection and Enforcement Manual, Part 9900, STS Section 1, dated 5/12/86

D. J.Norris Letter to D.Farrar dated 3/31/87

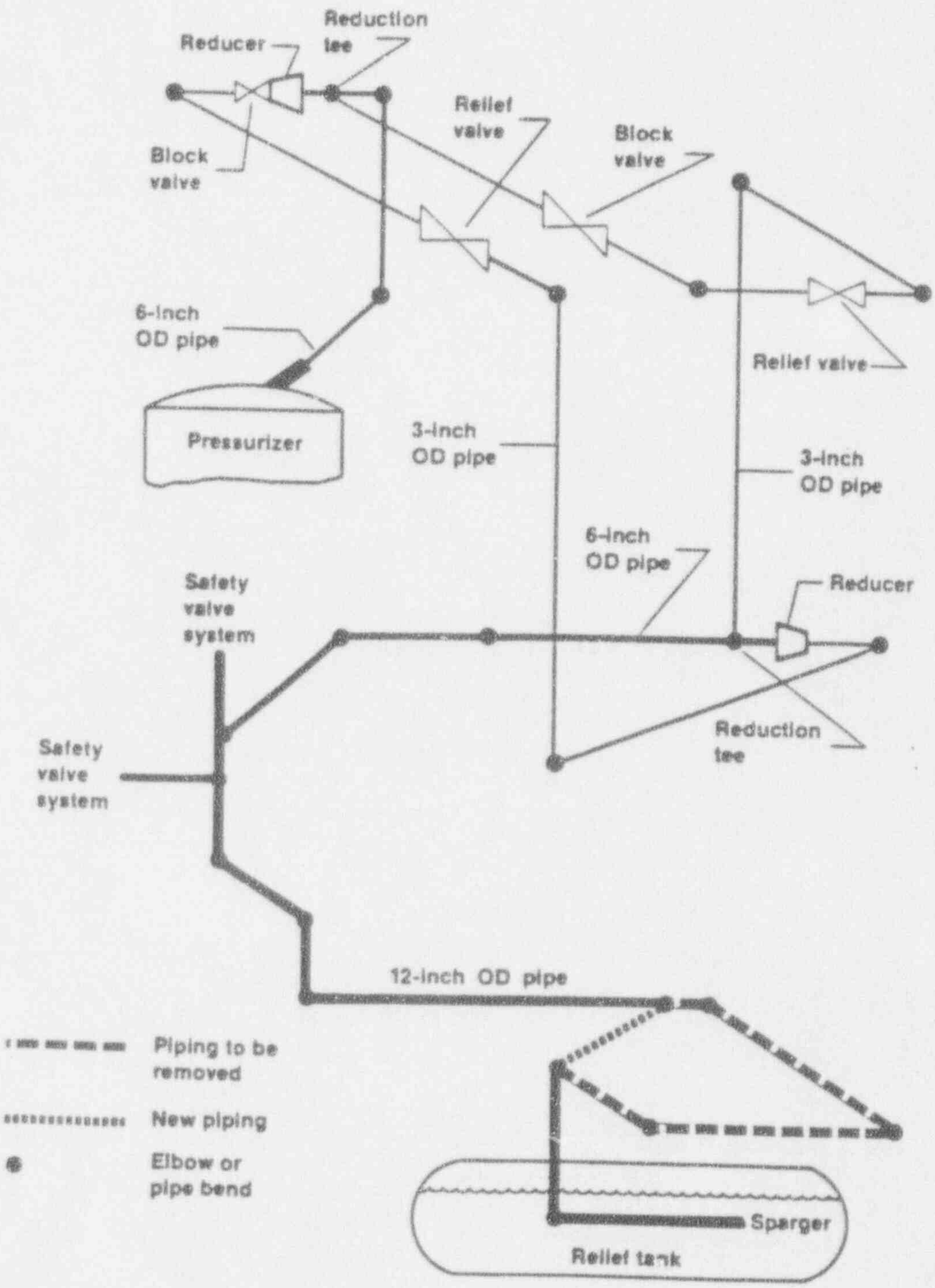
E. P.Leblond Letter to NRC Document Control Desk dated 11/19/87

F. Sargent & Lundy Summary Report SL-4283 dated 5/2/84

SARGENT & LUNDY
ENGINEERS
CHICAGO

EXHIBIT 3
SL-4283
05-02-84

SCHEMATIC OF MODEL FOR RELIEF VALVE PIPING SYSTEM



TYPICAL MASS FLOW RATES (RELIEF VALVE ANALYSIS)

RELAP5/MOD1/014 REACTOR LOSS OF COOLANT ANALYSIS PROGRAM

ZION S/RV DISCHARGE TRANSIENTS-CASE 2 25/11/82