SOUTHERN CALIFORNIA
EDISON
An EDISON INTERNATIONAL Company

February 3, 1997

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Gentlemen:

Subject: **Docket Nos. 50-361 and 50-362**
120 Day Response to Generic Letter 96-06: "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions"
San Onofre Nuclear Generating Station
Units 2 and 3

Reference: Letter from J. L. Rainsberry (Edison) to the Document Control Desk (NRC), dated October 30, 1996, Subject: Response to Generic Letter 96-06: "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," San Onofre Nuclear Generating Station Units 2 and 3

This letter provides the 120-day response to Generic Letter (GL) 96-06 for San Onofre Nuclear Generating Station (SONGS) Units 2 and 3. Southern California Edison (Edison) has performed the actions as requested by GL 96-06. Based on calculations that are in the final verification and approval process, Edison has determined that:

1) Operability assessments conclude that SONGS systems are operable,

2) Containment Emergency Cooling Units (ECUs) are not susceptible to either waterhammer or two-phase flow conditions during postulated accident conditions. However, a design change to delay the restart of the ECUs following a safety injection actuation signal has been implemented in Unit 2 and will be implemented in Unit 3 during the Cycle 9 refueling outage, which is scheduled to begin on April 12, 1997.

A072 1/1

P. O. Box 128
San Clemente, CA 92674-0128

3) Control Element Drive Mechanism Cooling Units and Reactor Coolant Pump Motor Coolers are susceptible to either waterhammer or two-phase flow conditions following a Loss of Coolant Accident. Enhancements to the Emergency Operating Instructions for both Units 2 and 3 will be implemented prior to returning Unit 2 to service from the current refueling outage,

4) Eighty seven of the 92 containment penetrations and their piping systems are not subject to an overpressure condition that requires physical modifications,

5) Four of the remaining five penetrations and their respective piping systems, although they are demonstrated to be operable based on accumulated leak rate testing data, require changes in insulation to eliminate the need to take credit for valve leakage. These modifications will be completed in Unit 2 prior to the return to service from the current refueling outage and will be completed in Unit 3 during the next refueling outage, which is scheduled to begin on April 12, 1997.

6) The remaining penetration and its respective piping system are operable based on expected leakage past an elastomeric seal. A relief valve will be added to eliminate the need to take credit for this leakage. This modification will be completed in Unit 2 prior to the return to service from the current refueling outage and will be completed in Unit 3 during the next refueling outage, which is scheduled to begin on April 12, 1997.

7) Procedural changes are being made to ensure that containment penetrations are not isolated from credited relief paths without compensating actions. The procedures for both Units 2 and 3 will be revised prior to returning Unit 2 to service from the current refueling outage. These procedures will be fully implemented at Unit 2 prior to returning Unit 2 to service from the current refueling outage. The Unit 3 procedures that require containment entry, or are associated with design changes, will be implemented by the end of the next refueling outage, which is currently scheduled to start on April 12, 1997.

8) Relief valves that are being credited to protect penetrations from overpressure will be added to the Inservice Testing (IST) program by the end of the next Unit 3 refueling outage, which is scheduled to begin on April 12, 1997. All required testing in accordance

with the IST program will be complete at Unit 2, as practical, prior to the return to service from the current refueling outage and at Unit 3 during the next refueling outage, which is scheduled to begin on April 12, 1997.

A summary report is enclosed which provides the information requested by GL 96-06. As stated in the report, Edison will approve all calculations prior to returning Unit 2 to service from the current refueling outage. These calculations will be maintained onsite, available for review. We will inform the NRC if our conclusions or our proposed corrective actions change.

If you have any questions or would like additional information, please let me know.

Sincerely,

J. L. Rainsberry
J. L. Rainsberry
Manager, Plant Licensing

State of California
County of San Diego
On 2/3/97 before me, Mariane Sanchez, ~~personally~~ personally appeared J.L. Rainsberry, personally known to me ~~(or proved to me on the basis of satisfactory evidence)~~ to be the person whose name is subscribed to the within instrument and acknowledged to me that he executed the same in his authorized capacity, and that by his signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument.

WITNESS my hand and official seal.

MARIANE SANCHEZ
COMM. # 1033763
Notary Public — California
ORANGE COUNTY
My Comm. Expires OCT 14, 1998

Signature Mariane Sanchez

Enclosure

cc: L. J. Callan, Regional Administrator, NRC Region IV
K. E. Perkins, Jr., Director, Walnut Creek Field Office, NRC Region IV
J. A. Sloan, NRC Senior Resident Inspector, San Onofre Units 2 & 3
M. B. Fields, NRC Project Manager, San Onofre Units 2 and 3

Summary Report

Response to Generic Letter 96-06 for San Onofre Units 2 & 3

EXECUTIVE SUMMARY

Southern California Edison (Edison) is completing an assessment of Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions" for San Onofre Nuclear Generating Station (SONGS) Units 2 and 3. Operability assessments have been completed for both Units 2 and 3. Both units are operable based on current plant design and configuration. SONGS' safety related containment air cooling water systems are not susceptible to either waterhammer or two-phase flow which may occur during postulated accident conditions. Non-safety related containment air cooling water systems may be susceptible for a period of time following a LOCA, however, administrative controls are in place to keep them isolated to prevent them from affecting any safety related systems. Eighty-seven of the ninety-two piping systems that penetrate the containment do not need physical modifications for protection from an overpressure condition as described in the generic letter. The remaining five piping systems that penetrate containment were determined to be susceptible to the overpressurization described in this generic letter. Design changes will be implemented during both Cycle 9 refueling outages to specifically address issues identified by Generic Letter 96-06 for these five remaining piping systems. Procedural changes are being made to ensure that containment penetrations are not isolated from credited relief paths without compensating actions, and to ensure that credited relief valves are incorporated into the inservice testing program. Piping systems inside containment, which are required to perform a safety function following a Design Basis Main Steam Line Break (MSLB) or Loss of Coolant Accident (LOCA), were also evaluated and are not susceptible to the overpressure condition described in the generic letter.

Final verification and approval of all design calculations is in progress and will be completed prior to the end of the current Unit 2 refueling outage. All design modifications for Unit 2 will be completed by the end of the current Unit 2 refueling outage, and all design modifications for Unit 3 will be completed by the end of the Unit 3 Refueling Outage, which is currently forecast to start on April 12, 1997. A revision to the Emergency Operating Instructions (EOI's), to allow operators to determine if the Component Cooling Water (CCW) non-critical loop should be returned to service following a LOCA, will be issued by the end of the current Unit 2 refueling outage. All other procedures for both Units 2 and 3 will be revised prior to returning Unit 2 to service from the current

refueling outage. These procedures will be fully implemented at Unit 2 prior to returning Unit 2 to service from the current refueling outage. The Unit 3 procedures that require containment entry, or are associated with design changes, will be implemented by the end of the next refueling outage, which is currently scheduled to start on April 12, 1997.

This report addresses each question posed in the "Requested Information" paragraph of the Generic Letter. The report is divided into two parts: Part I addresses the susceptibility of air cooled heat exchangers to waterhammer or two phase flow conditions following a Design Basis MSLB or LOCA. Part II addresses the susceptibility of piping systems that penetrate the containment to overpressurization as a result of thermal expansion of fluid.

I. Susceptibility of Air Cooled Heat Exchangers to Waterhammer or Two-Phase Flow Conditions Following a Design Basis Main Steam Line Break (MSLB) or Loss of Coolant Accident (LOCA)

A. Actions taken in response to the requested actions of GL 96-06

1. A review was performed to identify systems with air cooled heat exchangers inside Containment. Four sets of heat exchangers were identified:

   a. Containment Normal Cooling Units:

      Five non-safety related heat exchangers, which utilize Normal Chilled Water as the cooling medium,

   b. Containment Emergency Cooling Units (ECU's):

      Four safety related heat exchangers, which utilize critical loop Component Cooling Water (CCW) as the cooling medium (the ECU's are located at the highest point in the CCW System),

   c. Control Element Drive Mechanism (CEDM) Cooling Units:

      Two non-safety related heat exchangers, which utilize non-critical loop CCW as the cooling medium.

   d. Reactor Coolant Pump (RCP) Motor Coolers:

      Four (one per RCP motor) non-safety related coolers, which utilize non-critical loop CCW as the cooling medium.

2. Each identified system was reviewed for susceptibility to the conditions identified in GL 96-06:

   a. Containment Normal Cooling Units:

      The Containment Normal Cooling Units are not required following an accident and have no safety functions. Their function has no impact on any safety related system. Therefore, no further evaluation of the Containment Normal Cooling Units is required. Also, the cooling water supply (Normal Chilled Water) is not required post-accident.

The consequences of this water heating up and causing possible overpressure conditions in the piping or the penetration are discussed in Section II.

b. Containment Emergency Cooling Units (ECUs):

At SONGS two conditions potentially expose the ECU's to the issues discussed in GL 96-06:

1) The ECU's are not normally in service but can be running prior to the postulated accident (e.g., for Technical Specification surveillences). Should a Loss of Coolant Accident (LOCA) or Main Steam Line Break (MSLB) occur during testing simultaneous with a Loss of Offsite power (LOOP), fan coastdown time would exceed CCW pump coastdown time which could potentially result in the waterhammer or two-phase flow condition described in the Generic Letter. This condition required further analysis to assess the effects of the post-LOCA or MSLB environment on ECU integrity and performance..

2) A Safety Injection Actuation Signal (SIAS) sequence is such that the ECU fans would start 15 seconds before an idle or a tripped CCW pump would start. This sequence could potentially result in the waterhammer or two-phase flow conditions described in the generic letter and was analyzed further.

c. Control Element Drive Mechanism (CEDM) Cooling Units:

These units are not required following an accident but can affect the performance of systems or components which are required to mitigate an accident. For this reason they were analyzed further.

The CEDM Cooling Units are cooled from the CCW non-critical loop (NCL) and are normally in service. Following an accident which generates a Containment Isolation Actuation Signal (CIAS), the NCL is isolated and CCW flow through the coolers stops, but the cooler fan continues to run. Because operating procedures encourage restoration of the CCW NCL flow (in anticipation of starting a reactor coolant pump) further analysis was required. The analysis evaluated the effects on the CCW critical loop due to re-introduction of fluid from the CCW NCL.

d. Reactor Coolant Pump (RCP) Motor Coolers:

These units are not required following an accident but can affect the performance of systems or components which are required to mitigate the accident. For this reason they were analyzed further.

The RCP motor is totally enclosed. The cooler is located inside the motor housing. Steam in the containment atmosphere does not have direct access to the cooling coils. In addition, motor housing internal heat (from the motor stator) will cease based on prompt operator action to trip the RCP's due to loss of the NCL. As a result, the consequences of cooling water heating up in these coolers are enveloped by the analysis performed for the CEDM coolers (item c).

3. Analyses performed to evaluate those heat exchangers and systems that were determined susceptible to the waterhammer or two-phase flow conditions described in GL 96-06:

a. Containment Normal Cooling Units:

No analysis required

b. Containment Emergency Cooling Units (ECUs):

A computerized flow network model of the SONGS CCW system was developed, including a portion of the non-critical loop which is inside Containment. The non-critical loop is important to the analysis because the SONGS design basis LOCA scenario assumes a break in the NCL (due to the High Energy Line Break (HELB)) which contributes to CCW critical loop inventory and pressure losses. The model includes both the ECUs and CEDM Coolers. The model was validated by comparison of calculated flowrates for normal conditions against actual flowrates through major components under normal conditions. The model was verified as accurately representing the system.

The analysis considered both MSLB and LOCA conditions. For the LOCA evaluation, both possibilities (loop still intact and postulated lines ruptured due to HELB) regarding the non-critical loop pipe break were considered.

The most critical case was found to be a LOCA due to a Pressurizer Surge line break. In this scenario the failed pressurizer surge line ruptures three, 4" diameter lines in the NCL which provide cooling water to a Reactor Coolant Pump (RCP). This scenario also assumes a loss of offsite power (LOOP), which causes the CCW flow to stop until power to the CCW pumps is restored by the diesel generators. The following conservative assumptions were incorporated into the calculation:

1) The analysis combines inputs from two separate LOCA scenarios. The Design Basis LOCA was the source for the containment heatup profile to maximize the ECU heat transfer rate. The Pressurizer Surge Line LOCA analysis was used to determine the NCL isolation valve closure time. Because the CIAS occurs later for the Pressurizer Surge Line LOCA than for the Design Basis LOCA, the NCL isolation valve closure is delayed, which results in greater CCW critical loop inventory and pressure reduction.

2) The analysis assumes a constant 100% ECU fan flow throughout the event. No credit was taken for the fan coastdown which occurs following the LOOP.

3) The analysis assumes that the CCW flow stops instantly on LOOP.

4) To account for Nitrogen Supply Regulator offset the analysis assumes no nitrogen makeup to the CCW Surge Tank until the offset value is overcome. This equates to having no nitrogen makeup until the Surge Tank pressure drops to approximately 6 psi below the regulator nominal setpoint.

5) A fouling factor of zero was used for the ECU's to maximize heat transfer.

The results of this evaluation are discussed below:

During the interval between event initiation and LOOP, the CCW pump continues to run while water is lost out of the breaks in the NCL inside Containment. Water flows out of the CCW Surge Tank to compensate for the system inventory loss, and nitrogen (from the safety-related backup nitrogen system) is supplied to the CCW Surge Tank to assist in the system pressure recovery. This was done in

accordance with assumption 4) above. System pressures at the ECUs vs time were determined based on the flow network computer model.

During the time interval between LOOP and CCW pump restart, data from the American Air Filter (AAF) "Coolnuc" program was used to estimate the increase in temperature of the stagnant CCW within the ECUs. (American Air Filter is the manufacturer of the ECUs.) The fouling factors were conservatively assumed equal to zero to maximize heat transfer to the stagnant CCW. ECU fan coast down time was ignored. At each timestep the pressure of the stagnant CCW was checked against the saturation pressure.

When LOOP occurs, the CCW pump trips, but water continues to be lost from the CCW system through the break in the NCL until the NCL is isolated from the critical loop by the CIAS. (Valve closure time is approximately 21 seconds.) Backup nitrogen continues to enter the now stagnant critical loop, raising the system pressure toward the original setpoint. At each timestep the saturation pressure was checked against minimum system pressure to determine if voiding could occur. It was confirmed that the minimum CCW system pressure remains above the saturation pressure at the ECUs at each timestep, including during the time of pump re-start, thereby ensuring that waterhammer or two-phase flow will not occur.

c. Control Element Drive Mechanism (CEDM) Cooling Units:

The CEDM Coolers are not credited for post-accident mitigation. The purpose of the analysis was to determine if conditions developed within the CEDM Coolers could adversely affect the CCW critical loop.

The MSLB event was analyzed first. Containment ambient conditions were derived from the Pressure/Temperature (P/T) analysis for the Design Basis Main Steam Line Break. Data from the American Air Filter (AAF) "Coolnuc" program was used to estimate the increase in temperature of the stagnant CCW within CEDM coolers. (American Air Filter is the manufacturer of the CEDM Coolers.) The fouling factors were conservatively assumed equal to zero to maximize heat transfer to the stagnant CCW.

The most critical case for the CEDM Coolers is the scenario where offsite power is not lost (no LOOP). In this scenario the cooler fan continues to run but CCW flow stops when CIAS isolates the non-critical CCW loop.

For a postulated MSLB, it was determined that the non-critical loop is not subject to waterhammer or two-phase flow. Due to the short duration of the transient and relatively high system pressures, voiding will not occur. When the NCL isolation valves are re-opened the CCW pressure in the NCL remains above the saturation pressure at all times during the MSLB scenario. Therefore, restoration of CCW flow to the RCPs can be made anytime within the thirty minute time period stipulated by plant procedures.

Based on that analysis, an assessment was made of the LOCA scenario. Because of the higher, sustained, temperature plateau predicted for the LOCA event and the indeterminate time that the CEDM Coolers could be exposed to that condition without CCW flow, it was determined that there is a period of time when the CEDM Coolers may be susceptible to the waterhammer or two-phase flow conditions discussed in the generic letter. For this reason administrative controls have been put in place to keep the NCL isolated following that event.

d. Reactor Coolant Pump (RCP) Motor Coolers:

The analysis performed for the CEDM Coolers envelopes this equipment.

*B. **Conclusions that were reached relative to susceptibility to waterhammer or two-phase flow***

a. Containment Normal Cooling Units:

These units are not required to be operable for any accident scenario and are not cooled from the CCW System. Waterhammer or two-phase flow in these units does not affect the plant accident response. No further action is required.

b. Containment Emergency Cooling Units (ECUs):

The ECU's are not susceptible to either waterhammer or two phase flow during a postulated LOCA or MSLB event. This conclusion is

valid for LOOP and non LOOP conditions. The analysis also shows that the ECU's may be running prior to the postulated accident without becoming susceptible to the waterhammer or two-phase flow conditions.

The most significant factors responsible for SONGS' ECU immunity to the conditions described in the GL 96-06 are the following two design features:

1) the CCW Surge Tank Backup Nitrogen Supply System, which provides surplus pressure at the ECU's, raising the saturation point,

2) the throttle valves downstream of the ECU's, at a lower elevation, which increase backpressure at the ECUs during a transitory loss of system inventory through a break in the NCL piping.

c. Control Element Drive Mechanism (CEDM) Cooling Units:

Based on the analysis, system pressures are sufficiently high to ensure that SONGS CEDM coolers are not susceptible to either waterhammer or two-phase flow conditions during a postulated MSLB event.

In certain circumstances, and for a specific period of time, the CEDM Coolers may be susceptible to the waterhammer or two-phase flow conditions described in the generic letter following a LOCA event. This is a result of the higher, sustained, temperature plateau predicted for the LOCA event and the indeterminate time that the CEDM Coolers could be exposed to that condition without CCW flow. If the NCL was restored to service during this temperature transient, the conditions in the CEDM Cooler could impact one train of critical loop CCW. To prevent this, Operations has been instructed not to restore the NCL for this accident scenario. Formal revisions of the applicable Emergency Operating Instructions (EOI's) are in progress and will be completed by the end of the current Unit 2 refueling outage.

d. Reactor Coolant Pump (RCP) Motor Coolers:

Based on the enveloping analysis performed for the CEDM coolers, the RCP Motor coolers are not susceptible to either waterhammer or two-phase flow conditions during a postulated MSLB event.

For the LOCA event, the susceptibility of the RCP Motor Coolers to waterhammer or two-phase flow is enveloped by the analysis performed for the CEDM Coolers. The operating instructions and the EOI revisions, referred to in c. above, apply.

C. *Basis for continued operability of affected systems and components*

a. Containment Normal Cooling Units:

These units are not required to be operable for any accident scenario. They do not interact with any systems that are required to be operable post-MSLB or LOCA.

b. Containment Emergency Cooling Units (ECUs):

The ECU's are not subject to the conditions described in the Generic Letter for either a MSLB or LOCA. The ECU's are operable as-is.

SONGS' ECU's are presently operating under modified instructions which were issued when GL 96-06 was initially evaluated. Until the calculations are verified and approved, these modified instructions will remain in effect. The procedures restrict ECU testing to the CCW train which does NOT have the noncritical loop aligned to it (this eliminates the possibility of inventory loss from that CCW train due to the postulated break in the non-critical loop) and require that conservative CCW Surge Tank level and nitrogen pressure be maintained during the test.

c. Control Element Drive Mechanism (CEDM) Cooling Units:

These coolers are not required to be operable to mitigate the consequences of a MSLB or LOCA. They do not affect the operability of any other systems or components that are required to be operable for a MSLB because analysis showed that they are not subject to the waterhammer or two-phase flow conditions. They do not affect the operability of any other systems or components that are required to

be operable for a LOCA because the station technical advisors (STA's) and the plant operators have been instructed not to restore the NCL for this event. Formal revisions of the applicable Emergency Operating Instructions (EOI's) are in progress and will be completed by the end of the current Unit 2 refueling outage.

d. Reactor Coolant Pump (RCP) Motor Coolers:

These coolers are not required to be operable to mitigate the consequences of a MSLB or a LOCA. They do not affect the operability of any other systems or components that are required to be operable for a MSLB because the enveloping analysis for the CEDM Coolers showed that the RCP Motor Coolers would not be subject to the waterhammer or two-phase flow conditions discussed in GL 96-06. They do not affect the operability of any systems or components that are required to be operable for a LOCA because the station technical advisors (STA's) and the plant operators have been instructed not to restore the NCL for this event. Formal revisions of the applicable Emergency Operating Instructions (EOI's) are in progress and will be completed by the end of the current Unit 2 refueling outage.

D. Corrective actions that were implemented or are planned to be implemented

a. Containment Normal Cooling Units:

None

b. Containment Emergency Cooling Units (ECUs):

1. The analysis discussed above will be verified and approved by the end of the current Unit 2 refueling outage. A supplemental letter will be submitted to the NRC if the verification or approval results in any change to the conclusions or corrective actions.

2. Although the analysis indicates that the ECU's are not subject to the waterhammer or two-phase flow conditions discussed in the GL, a Design Change Package (DCP) was issued to delay restart of the ECU fans on a SIAS until after the corresponding CCW pump is started. Addition of this time delay will increase the available margin in several key CCW system parameters, such as Surge Tank minimum/maximum level, nitrogen supply setpoints, etc. This

design change has been installed in Unit 2 and will be installed in Unit 3 during the cycle 9 refueling outage, which is scheduled to start April 12, 1997.

c. Control Element Drive Mechanism (CEDM) Cooling Units:

1. The analysis discussed above will be verified and approved by the end of the current Unit 2 refueling outage. A supplemental letter will be submitted to the NRC if the verification or approval results in any change to the conclusions or corrective actions.

2. SONGS Emergency Operating Instructions (EOI's) presently include requirements to verify that there is no break in the NCL prior to restoring that loop to service. The EOI's will be revised by the end of the current Unit 2 refueling outage, to provide enhanced guidelines, based on specific plant parameters, to allow Operators to determine if the NCL should be restored. These parameters will be determined based on the results of the analysis mentioned above.

d. Reactor Coolant Pump (RCP) Motor Coolers:

1. SONGS Emergency Operating Instructions (EOI's) presently include requirements to verify that there is no break in the NCL prior to restoring that loop to service. The EOI's will be revised by the end of the current Unit 2 refueling outage, to provide enhanced guidelines, based on specific plant parameters, to allow Operators to determine if the NCL should be restored. These parameters will be determined based on the results of the analysis mentioned above.

II. Thermal Overpressurization of Piping Systems and Mechanical Containment Penetrations Following a Design Basis Main Steam Line Break (MSLB) or Loss of Coolant Accident (LOCA) .

A. Actions Taken in Response to the Requested Actions in GL 96-06

An analysis was undertaken to determine the potential for thermal overpressurization of piping systems and mechanical containment penetrations due to trapped liquid between isolation valves, subsequent to a Loss of Coolant Accident (LOCA) or a Main Steam Line Break (MSLB) event. The penetration analysis evaluated 92 penetrations in each Unit. The analysis considered the possibility of isolated portions of piping within containment heating and leaking into the penetration pressure boundary and overpressurizing the penetration. The remaining piping systems inside containment, required for safe shutdown, were reviewed for the potential of overpressurization.

1. Mechanical Containment Penetrations.

Throughout this document the term "Penetration" will include the penetration and piping between isolation valves. All penetrations were evaluated against the following screening criteria:

a. Penetrations containing gas, air, or steam were excluded. It was determined by analysis that, due to the compressibility of gases, these penetrations would not experience excessive overpressure conditions.

b. Spare penetrations were excluded. These penetrations are capped, and can be treated similar to those containing gas.

c. Penetrations operating at temperatures higher than the maximum containment transient temperature, at all times throughout Modes 1 through 4, were excluded.

d. Penetrations protected by relief valves installed directly on the penetration with no isolation valves in between them, were excluded.

e. Penetrations with relief paths through check valves and/or normally open valves to systems protected by relieving devices were excluded. Operating Procedures were reviewed to verify that the valves are maintained open during plant normal operation. To prevent these valves from being closed for maintenance activities, the operating procedures will be augmented to ensure these valves will not be closed without providing an alternative relief path.

f. Penetrations that are procedurally maintained empty of water during plant operation were excluded. The potential for and consequence of water in-leakage were considered before penetrations in this category were excluded.

The penetrations that were not excluded by the above screening criteria were evaluated in more detail. The design and operating characteristics of the containment isolation valves for these remaining penetrations were reviewed to determine how these valves will respond to overpressure conditions. If these valves were spring loaded, diaphragm actuated valves, the flow direction, bench set pressure, and packing load were evaluated to determine under what internal pressure the valves will self-relieve. The internal pressure was then combined with other simultaneous design basis primary loads to ensure that the penetration and associated piping between the isolation valves met ASME Section III Code Service Level D stress limits. The valve designs were reviewed to ensure that self-relieving is inherent to the design of these valves.

Where applicable, combinations of features were considered to provide defense-in-depth scenarios to demonstrate structural integrity (e.g., pressure relieving, thermal insulation, and stress analysis). The consequence of single active failures, concurrent with the thermal overpressure conditions, were also considered to ensure containment integrity.

For the penetrations that were identified with potential for thermal overpressurization, thermal/stress transient analyses were performed to determine the maximum pressure (assuming no leakage) and resultant stresses from the most limiting LOCA or MSLB event. The resultant stresses were compared to Service Level D stress limits in accordance with Section III of the ASME Code. Detailed ANSYS-based finite element models were used which included the containment wall, the penetration, and the piping with trapped water between the isolation valves. All of the analyses were comprised of two fundamental steps (thermal transient analysis and elastic stress analysis):

Thermal Transient Analysis

The purpose of this step is to calculate the temperature time history of the penetration, piping, and trapped water following a LOCA or a MSLB event. Axisymmetric models of the penetrations were generated using ANSYS heat transfer elements. Each model included the full penetration, parts of the attached piping inside and outside containment, the contained water, the isolation valves, a section of the containment wall, and the liner plate. Thermal insulation was also included in the model whenever applicable.

Boundary and initial conditions were applied as follows:

- Condensing heat transfer coefficients, calculated per the guidelines of NUREG-0800, were applied to the model boundary inside containment. The maximum containment vapor temperature was conservatively used throughout the analysis to calculate the heat flux into the penetration.

- The initial conditions used in the analysis were based on the operating temperature for each line. The analysis is, therefore, based on the range of temperature rise in the trapped water due to the postulated accident.

The transient analysis was performed by dividing each accident event into many time steps. Each time step was a complete solution with the final conditions applied to the initial conditions of the next time step. These steps continued to 10^6 seconds (i.e., when containment atmosphere is almost back to pre-accident conditions). Results of this thermal analysis were in the form of temperature distributions at each time step. These results were used to perform the elastic stress analysis described below.

Elastic Stress Analysis

The temperature distribution in the finite element model, calculated in the thermal transient analysis step, was used to calculate the trapped water pressure and the stresses in the piping components as a function of time up to 10^6 seconds. The models used for the stress analyses are identical to the thermal analysis models except that:

- The element types were changed to types suitable for structural stress analysis, and fluid elements were used to model the water in the piping.

- Appropriate displacement boundary conditions were applied.

Water pressure and stresses in the pipe walls were calculated at the end of each time step, and the maximum trapped water pressure was identified. Results of the analysis indicate that a LOCA is more limiting than a MSLB due to the much longer duration of elevated temperatures. The stress due to the trapped water pressure was used, in combination with deadweight and Safe Shutdown Earthquake (SSE) stresses, to demonstrate the adequacy of the piping and the penetration to withstand the accident conditions. Allowable stresses for membrane and membrane plus bending stresses were calculated using the ASME Code.

2. Piping Systems Inside Containment Required for Safe Shutdown.

This evaluation consisted of reviewing all of the fluid piping systems inside containment required for safe shutdown, to eliminate any possibility of thermal overpressurization following a LOCA or MSLB. The systems included in the review were those identified in the Updated Final Safety Analysis Report (UFSAR) Section 3.6.1.2. The systems reviewed were:

- Safety Injection System
- Containment Spray System
- Reactor Coolant System
- Main Steam System
- Main Feedwater System
- Auxiliary Feedwater System
- Charging System
- Shutdown Cooling System

These systems were evaluated using the same Thermal Transient Analysis methods and Elastic Stress Analysis method described above. These analyses were used to determine if there are piping sections that are required for safe shutdown which can become isolated after a LOCA or MSLB and experience thermal overpressurization. The results of this evaluation are summarized in Section B.

B. *Conclusions Regarding the Potential for Thermal Overpressurization*

1. Mechanical Containment Penetrations.

The analyses performed for this purpose concluded that only five penetrations in each unit are susceptible to overpressurization as a result of LOCA or MSLB accidents. The remaining 87 penetrations have adequate features to prevent adverse thermal overpressure conditions. All the 92 mechanical penetrations in each unit were screened or analyzed against susceptibility to thermal overpressurization and are detailed in Table 1, attached. The following is a summary of the screening results for the 92 penetrations:

Number of Penetrations	Criteria
40	Gas/air/spare penetrations that will not overpressurize.
3	Penetrations procedurally kept empty and leakage doesn't pose a concern.
9	Penetrations with direct pressure relief valves.
10	Penetrations with a pressure relief path through a check valve to an overpressure protected system.
10	Penetrations with a pressure relief path through intervening isolation valves to an overpressure protected system
2	Penetrations with a pressure relief path through a spring loaded, diaphragm actuated valve (functioning similar to a relief valve).
4	Penetrations operating at temperatures above accident conditions (they are also connected to pressure relief valves).
9	Qualified by calculations.
5	Required modifications to be qualified by calculations.

Five of the penetrations required physical modification to be qualified by calculations. The details are as follows:

a. Penetrations 42 and 43 (Component Cooling Water System, Non-Critical Loop) credited the addition of 3" thick insulation on 9' sections of piping inside containment including the penetration.

b. Penetrations 45 and 46 (Containment Normal chilled Water System) credited increasing the insulation inside containment from 2" to 3" thick, including insulating the penetrations, and the removal of insulation outside containment, up to and including the containment isolation valve.

c. Penetration 11 (Nuclear Service Water) was provided with a relief valve inside containment.

The purpose of the added insulation is to reduce the heat flux from containment to the trapped water, and removing the insulation outside containment enhances cooling. Under these conditions, analysis results show the ASME Code Level D Service Limits are met

2. Piping Systems Inside Containment Required for Safe Shutdown.

This evaluation consisted of reviewing all the fluid piping systems inside containment which are required for safe shutdown, to determine if there is a potential for thermal overpressurization following a LOCA or MSLB. Some sections of piping were identified that would be isolated and subject to containment atmospheric conditions, however, overpressurization was demonstrated not to occur. Typically, such sections of piping were those between double isolation valves used for venting and draining the system. These are 3/4" schedule 160 lines and can be qualified by comparison to the analysis for sample lines penetrating containment. The ANSYS analysis performed for the various sample line penetrations demonstrates that stresses are within Code allowables for a 3/4" schedule 160, uninsulated line fully exposed to containment atmosphere. This envelopes the case of 3/4" vents and drains, above. However, other instances are detailed below and summarized in Table 2.

The Reactor Coolant System (RCS) drain lines from the cold legs to the RCS Drain Tank also contain portions of pipe isolated by double isolation valves. This piping is 2" schedule 160 pipe, is insulated, and can be qualified by comparison to the analysis of the Letdown line. The ANSYS analysis of the Letdown line (Penetration No. 2) demonstrates that stresses are within Code allowables for a 2" schedule 160,uninsulated line fully exposed to containment atmosphere.This envelopes the RCS drain lines to the RCS Drain Tank.Furthermore, under pre-accident operating conditions, the cold legs are at 553 F and heat conduction from the cold legs would keep this piping well above the initial condition temperatures utilized in the Letdown line analysis.

Excluding vents and drains, there is only one section of potentially isolated process piping in the RCS system of concern: the header which connects the Reactor Vessel Head Vent and Pressurizer Vent lines to the Quench Tank.This is a 1" schedule 160 line, and is not insulated.Pressure relief for this section of piping is credited by reverse flow through one of four solenoid operated valves back to the RCS.In the reverse flow direction these valves allow leakage via pressure under the seat.

C. *Basis for Continued Operability Of Affected Systems and Components*

1. Mechanical Containment Penetrations.

a. An operability assessment was performed for the five penetrations in both Units 2 and 3 requiring modifications.For each of these penetrations the last three Local Leak Rate Test (LLRT) records were reviewed to demonstrate small, quantifiable leakages had been measured across the seats of the containment isolation valves which would be sufficient to prevent a thermal overpressure condition.However, for Penetration 43 in both Units 2 and 3 no leakage was measured during the 1995 LLRT.This penetration has two butterfly valves which utilize a mechanically adjustable elastomeric seat, referred to as a T-Ring seal.As confirmed by the valve manufacturer, a small amount of leakage would be expected to occur once the line pressure increases to a value greater than the pressure used to adjust the elastomer T-Ring seal (typically this is done at 150 psid).Since only a small amount of leakage is required to relieve the pressure, the elastomeric T-Ring seal will return to normal function once the pressure is relieved.Therefore, all five penetrations were determined to be operable either by the LLRT records or by the inherent design of the isolation valves.The operability assessments were documented in nonconformance reports in our Action Request (AR) Program.

b. Operability for the ten penetrations, which were evaluated as being protected against overpressure by crediting a relief path through one or more valves to a pressure protected system, is discussed below.The discussion also covers cases where relief devices are relied on to prevent isolated sectionsof piping from inside containment from pressurizing penetrations through leaking internal isolation valves.

In all cases, the intervening valves are normally open.Procedures were verified that insure that all the intervening valves are open prior to closure of containment after an extended outage.Furthermore, many of the paths are controlled by Technical Specification.For the short term, operator awareness of the importance of keeping the relief path open is being credited to keep the paths from being procedurally closed in Modes 1 through 4 without compensating measures being taken for overpressure protection.For the long term, administrative controls will be implemented.

c. Many of the relief devices credited in the analysis to protect containment penetrations or internal piping systemswere not previously determined to have a safety-related function.As such, they were not included in the ASME Section XI Inservice Testing (IST) program..These valves have been determined to be operable based on the fact that they have been tested for lift pressure and seat leakage,

via another site test program, within the last ten years.These valves will be added to the IST program.

2. Piping Systems Inside Containment Required for Safe Shutdown.

All piping systems inside containment required for safe shutdown are operable.

D. Corrective Actions That Were Implemented or Are Planned for Implementation.

1. Mechanical Containment Penetrations.

The five penetrations in each unit which require modification will be upgraded during each unit's cycle 9 refueling outage. The modifications consist of adding thermal insulation on Penetrations 42 and 43, removing and modifying thermal insulation on Penetrations 45 and 46, and adding a relief valve on the piping inside containment for Penetration 11. These physical changes will be completed at Unit 2 prior to return to service from the current refueling outage and at Unit 3 before the unit is returned to service from the next refueling outage, which is currently scheduled to start on April 12, 1997.

For those penetrations which rely on relieving paths with intervening valves, specific administrative controls will be implemented to ensure that these valves will remain open throughout Modes 1 through 4, or that compensatory measures are taken to provide overpressure protection in the event of their closure. The procedures for both Units 2 and 3 will be revised prior to returning Unit 2 to service from the current refueling outage. These procedures will be fully implemented at Unit 2 prior to returning Unit 2 to service from the current refueling outage. The Unit 3 procedures that require containment entry, or are associated with design changes, will be implemented by the end of the next refueling outage, which is currently scheduled to start on April 12, 1997.

Relief valves that are being credited to protect penetrations from overpressure will be added to the Inservice Testing (IST) program by the end of the next Unit 3 refueling outage, which is scheduled to begin on April 12, 1997. All required testing in accordance with the IST program will be complete at Unit 2, as practical, prior to the return to service from the current refueling outage and at Unit 3 during the next refueling outage, which is scheduled to begin on April 12, 1997.

2. Piping Systems Inside Containment Required for Safe Shutdown.

None.

Table 1, Overpressure Protection Features for Mechanical Containment Penetrations									
PEN NO.	SERVICE	GAS/ AIR	EMPTY	RELIEF VALVES	RELIEF VIA C.V.	RELIEF VIA M.V	DIAPH. VALVE	HIGH TEMP	STRESS CALC
1	Pressurizer vapor space sample								X
2	Letdown								X
3	High pressure safety injection				X				
4	Hot leg sample								X
5	High pressure safety injection				X				
6	SIS drain line								X
7	RCP bleed-off								X
8	Charging line					X			
9	Shutdown cooling line			X					
10A	Containment pressure detector	X							
10B	ILRT pressure sensor	X							
10C	Spare	X							
11	Nuclear service water					X			
12	Pressurizer surge line sample								X
13	Containment sump						X		
14	Fire protection water supply		X						
15	Fuel transfer tube flange		X						
16A	Containment air sample	X							
16B	Containment air sample	X							
16C	Containment airborne radiation monitor	X							
17	Steam generator secondary steam sample								X

Table 1, Overpressure Protection Features for Mechanical Containment Penetrations									
PEN NO.	SERVICE	GAS/ AIR	EMPTY	RELIEF VALVES	RELIEF VIA C.V.	RELIEF VIA M.V	DIAPH. VALVE	HIGH TEMP	STRESS CALC
18	Normal containment purge supply	X							
19	Normal containment purge exhaust	X							
20	Quench tank makeup					X			
21	Service air	X							
22	Instrument air	X							
23A	Nitrogen supply	X							
23B	LLRT Connection	X							
23C	LLRT Connection	X							
24	Spare	X							
25	Refueling canal fill and drain		X						
26	Reactor coolant drain tank discharge						X		
27A	Containment pressure detector	X							
27B	Spare	X							
27C	Containment airborne radiation monitor	X							
28	Steam generator feedwater							X	
29	Steam generator feedwater							X	
30A	Containment airborne monitor	X							
30B	Containment airborne monitor	X							
30C	Reactor coolant drain tank and quench tank gas sample	X							
31	Hydrogen purge	X							
32	Main steam line							X	

Table 1, Overpressure Protection Features for Mechanical Containment Penetrations

PEN NO.	SERVICE	GAS/ AIR	EMPTY	RELIEF VALVES	RELIEF VIA C.V.	RELIEF VIA M.V	DIAPH. VALVE	HIGH TEMP	STRESS CALC
33	Main steam line							X	
34	ILRT test connection	X							
35	Spare	X							
36	Steam generator blowdown					X			
37	Steam generator blowdown					X			
38	Spare	X							
39	High pressure safety injection				X				
40A	Containment pressure detector	X							
40B	Spare	X							
40C	Spare	X							
41	High pressure safety injection				X				
42	Component cooling water-inlet								X
43	Component cooling water-outlet								X
44	Steam generator secondary water sample								X
45	Containment normal A/C chill water								X
46	Containment normal A/C chill water								X
47	Containment waste gas vent header	X							
48	Low pressure safety injection				X				
49	Low pressure safety injection				X				
50	Low pressure safety injection				X				

Table 1, Overpressure Protection Features for Mechanical Containment Penetrations

PEN NO.	SERVICE	GAS/ AIR	EMPTY	RELIEF VALVES	RELIEF VIA C.V.	RELIEF VIA M.V	DIAPH. VALVE	HIGH TEMP	STRESS CALC
51	Low pressure safety injection				X				
52	Containment spray inlet					X			
53	Containment spray inlet					X			
54	Containment emergency sump								X
55	Containment emergency sump								X
56	Containment emergency A/C cooling			X					
57	Containment emergency A/C cooling			X					
58	Containment emergency A/C cooling			X					
59	Containment emergency A/C cooling			X					
60	Containment emergency A/C cooling			X					
61	Containment emergency A/C cooling			X					
62	Containment emergency A/C cooling			X					
63	Containment emergency A/C cooling			X					
64	Spare	X							
65	Spare	X							
66	Spare	X							
67	Hot leg injection					X			
68	Charging bypass line for auxiliary spray					X			
69	Spare	X							

Table 1, Overpressure Protection Features for Mechanical Containment Penetrations									
PEN NO.	SERVICE	GAS/ AIR	EMPTY	PELIEF VALVES	RELIEF VIA C.V.	RELIEF VIA M.V	DIAPH. VALVE	HIGH TEMP	STRESS CALC
70	Auxiliary steam (service air U2)	X							
71	Hot leg injection					X			
72	Spare	X							
73A	Containment pressure detector	X							
73B	Spare	X							
73C	Spare	X							
74	Hydrogen Purge	X							
75	Auxiliary feedwater				X				
76	Spare	X							
77	Nitrogen supply to safety injection tanks	X							
78	Auxiliary feedwater				X				
	TOTALS	40	3	9	10	10	2	4	14

Table 2, Potential for Overpressurization of Piping Systems Inside Containment Required for Safe Shut Down

System	Process Piping	Vents and Drains
Safety Injection System	No	Yes
Containment Spray System	No	Yes
Reactor Coolant System	Yes	Yes
Main Steam (unaffected generator)	No	Yes
Main Feedwater System	No	No
Auxiliary Feedwater System	No	Yes
Charging System	No	Yes
Shutdown Cooling System	No	Yes