OFFICE OF NUCLEAR REACTOR REGULATION

EVALUATION OF OVERPRESSURE MITIGATION SYSTEM

FOR

SAN ONOFRE UNIT 1

DOCKET NO. 50-206

1.0 INTRODUCTION

Incidents identified as "pressure transients" have occurred in pressurized water reactors where the pressure limit in the Technical Specifications for a given temperature is exceeded. These incidents generally occur at relatively low temperatures where the reactor vessel material toughness, i.e., resistance to brittle fracture, is reduced from that which exists at normal operating temperature and where the primary system is completely filled with water, i.e, in a "water-solid" condition.

The "Technical Report on Reactor Vessel Pressure Transients" in NUREG-0138 (Ref. 1) summarizes the technical considerations relevant to this matter, discussed the safety concerns and existing safety margins of operating reactors, and describes the regulatory actions taken to resolve this issue by reducing the likelihood of future pressure transient events at operating reactors.

By letter dated August 11, 1976 (Ref. 2), the U. S. Nuclear Regulatory Commission (NRC) requested Southern California Edison Company (SCE) to submit (1) an evaluation to determine the susceptability of San Onofre Unit No. 1 to overpressurization events, and (2) an analysis of these possible events. The letter also requested SCE to propose interim and permanent modifications to the systems and procedures to reduce the likelihood and consequences of such events. NUREG-0224, "Reactor Vessel Pressure Transient Protection for Pressurized Water Reactors" (Ref. 24), with appended Branch Technical Position RSB-5-2 (Ref. 25) states the acceptance criteria established by the NRC staff for the overpressure mitigating system.

SCE participated as a member of a Westinghouse owner's group which provided a reference mitigating system and analyses to verify the adequacy of the system (Ref. 23). SCE modified the reference mitigating system and proposed their Overpressure Mitigating System (OMS) along with administrative procedure modifications and operator training (Ref. 8, 9, 12, and 19). The OMS is designed to mitigate the consequences of an overpressurization event and the additional operator training and the administrative procedure modifications are intended to reduce the probability of the occurrence of an overpressurization event.

This evaluation includes (1) the physical and operational aspects of the San Onofre low temperature OMS (Section 3.1), and (2) the electrical, instrumentation, and control aspects (Section 3.2).

2.0 DISCUSSION

The San Onofre Unit 1 OMS consists of two separate trains, each containing a power-operated relief valve (PORV), an isolation valve and associated circuitry. When in the low pressure mode the system provides a low pressure setpoint of 522 psig for both PORV trains. When the system is enabled, it will terminate all analyzed pressure transients below the Appendix G limit by automatically opening the PORVs. A manual switch is used to enable and disable the low setpoint of each relief valve. An enabling alarm which monitors system pressure is provided to alert the control room operator to enable the overpressure mitigating system when system pressure drops to a predetermined point. In addition, an alarm is provided in the control room to indicate when an overpressure transient is occurring.

The power-operated relief valves (PORVs) are spring-loaded-closed, air-required-to-open valves, which are normally supplied by plant instrument air. To assure operability of the valves upon loss of

plant instrument air, a redundant pneumatic source is automatically provided. The backup source (station nitrogen system) is independent such that a failure of the instrument air system will not result in a loss of nitrogen to the PORVs. Similarly, a failure in the station nitrogen system will not affect the air supply to the valves. Either system provides sufficient pneumatic capacity to handle PORV cycling for the duration of a pressure transient with the number of relief cycles conservatively estimated at 45. Both systems have a pressure switch monitoring header pressures. These provide alarms in the control room to notify the operator if instrument air or station nitrogen supply is unavailable to the PORVs.

3.0 EVALUATION

3.1 Physical and Operational Aspects of the OMS

A. System

1. Testability

Testability is provided for the San Onofre Unit 1 OMS. SCE has stated (Ref. 26) that a channel functional test shall be performed prior to entering Mode 5 on cooldown and that the operability of the system shall be tested prior to returning to a "water solid" condition following a cold shutdown with the reactor coolant system depressurized. We have requested the licensee to modify the proposed Technical Specifications as contained in Proposed Change No. 71 dated October 20, 1978 to include these surveillance tests.

We conclude that with this addition to the Technical Specifications, the testing requirements will be met.

2. Single Failure Criteria

The specified single failure criteria for the overpressure mitigating system is that it should be designed to protect the vessel given a single failure in addition to the failure that initiated the pressure transient.

SCE was asked to address this concern and responded that there are no credible single failures which would both initiate a pressure transient and disable one of the redundant PORV trains (Ref. 27). Therefore, the San Onofre Unit 1 OMS meets the single failure criteria.

In addition to the OMS, SCE indicated that, during all of the normally encountered plant cooldown and heatup conditions, there would be either a vapor space in the pressurizer or the RHR system would be in service. The vapor space in the pressurizer would provide a buffer against overpressurization of the RCS.

During cooldown, the RHR system is normally placed in service prior to collapsing the pressurizer bubble and is not normally removed from service during heatup until after a steam bubble has been established in the pressurizer. The RHR system provides a second letdown flow path and safety Valve RV-206, which has a setpoint of 500 psig and a relief capacity of 470 gpm at 10% accumulation (550 psig). This safety valve is capable of mitigating a pressure transient resulting from any of the initiating events analyzed for San Onofre Unit 1. The RHR system is not automatically isolated at high pressures, therefore, this safety valve should remain available during an overpressure event.

We conclude that the San Onofre Unit 1 OMS meets the single failure criteria.

3. Seismic Design

The specified seismic criteria is that the overpressure mitigating system should be designed to function during an operating basis earthquake (OBE). Those portions of the OMS at San Onofre Unit 1 which interface with or could affect existing seismic Category A equipment are designed as seismic Category A. The PORVs and their operators are seismic Category A as is the backup nitrogen system except for sections that remain as original plant equipment. These sections are now being upgraded to meet NRC's seismic requirements (Ref. 28). All other portions of the system are designed at least to Seismic Category B.

We conclude that with this upgrading, the San Onofre Unit 1 OMS will meet the seismic criteria.

B. Analysis

1. Mass Input Case

The Westinghouse bounding analysis considered two mass input cases: inadvertent safety injection, and inadvertent isolation of letdown while charging to a solid system. SCE proposed to exclude inadvertent safety injection at San Onofre Unit 1, as a design basis event, even though it would be the most limiting mass input case. The San Onofre Unit 1 safety injection system (SIS) pumps have a larger capacity than the PORVs are capable of relieving. SCE states that inadvertent safety injection is precluded by the establishment of two positive barriers between the SIS and the reactor coolant system (RCS) during all cold shutdown conditions. These positive barriers are established during plant cooldown prior to reaching a reactor coolant system pressure of 500 psig and are returned to a normal status when the RCS pressure is 1400 psig during plant startup. Once the positive barriers are established on the safety injection system, they are not removed until plant startup except for the performance of the "no-flow" test. SCE stated that the "no-flow" test is never conducted with the RCS water-solid.

The two positive barriers are established by the plant operating instructions and are required by the plant technical specifications.

A positive barrier is defined as any one of the following: (1) a motor-operated valve, when closed and tagged with the safety switch open, (2) a pneumatic hydraulic valve, when closed with the hydraulic oil isolation valve closed, or (3) a manually operated valve, when locked closed and tagged.

Two alternative valve arrangements are provided for in the San Onofre Unit 1 operating instructions. The primary arrangement requires: (1) the following valves to be closed with a yellow "caution" tag affixed to the remote manual switch: MOVs 850A, 850B and 850C and HVs 851A and 851B, (2) the safety switches (breakers) for MOVs 850A and 850B to be opened, the fuse blocks removed, and

a yellow tag affixed to the breaker, (3) the output breaker from the uninterruptable power supply (UPS) inverter to MOV 850C to be opened with the manual transfer switch aligned to the inverter output breaker; a yellow tag is affixed to the output breaker and the transfer switch, and (4) the hydraulic oil block valves on the operators for HVs 851A and 851B to be closed and tagged. As shown on Figure 1 this will create two positive barriers between the SIS and the RCS. The alternative arrangement requires: (1) closing, locking, and tagging the safety injection pump suction valves 861A and 861B, (2) closing, locking, and tagging the feedwater safety injection bypass valves 856A and 856B, (3) closing HVs 853A and 853B and (4) closing and tagging the hydraulic oil valves on the operators for HVs 853A and 853B. An interlock exists between the HV-854 valves and the HV-851 valves. In order to prevent unborated water from inadvertently being injected following an SI signal, the HV-851 valves do not receive their open signal until the HV-854 valves are closed. Thus, as shown on Figure 1, this will also create two positive barriers between the SIS and the RCS. In the event of a loss of coolant accident, with either of these arrangements, the SIS can still be manually activated through Mode 4.

All plant operating conditions were examined to determine the potential for an inadvertent safety injection leading to RCS overpressurization at San Onofre Unit 1. All potential scenarios which could lead to inadvertent safety injection were identified and evaluated. These scenarios included consideration of operator errors, equipment failures, and combinations thereof. In each case a minimum of three independent operator errors and/or equipment failures was required to create an inadvertent safety injection. Therefore, the probability of such an event occurring is very low.

The mass input case that SCE proposed as a design basis mass input event is an inadvertent isolation of letdown while charging to a water-solid RCS. Westinghouse provided the licensee with a series of curves based on the LOFTRAN analysis of a generic plant design which indicates PORV setpoint overshoot for this transient as a function of system volume, relief valve opening time and relief valve setpoint. These sensitivity analyses were then applied to the San Onofre Unit 1 plant parameters to obtain a conservative