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Technical Evaluation of the Electrical, Instrumentation, and Control Design Aspects of the Low Temperature Overpressure Protection System for the San Onofre Nuclear Power Station, Unit 1

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Lawrence Livermore Laboratory

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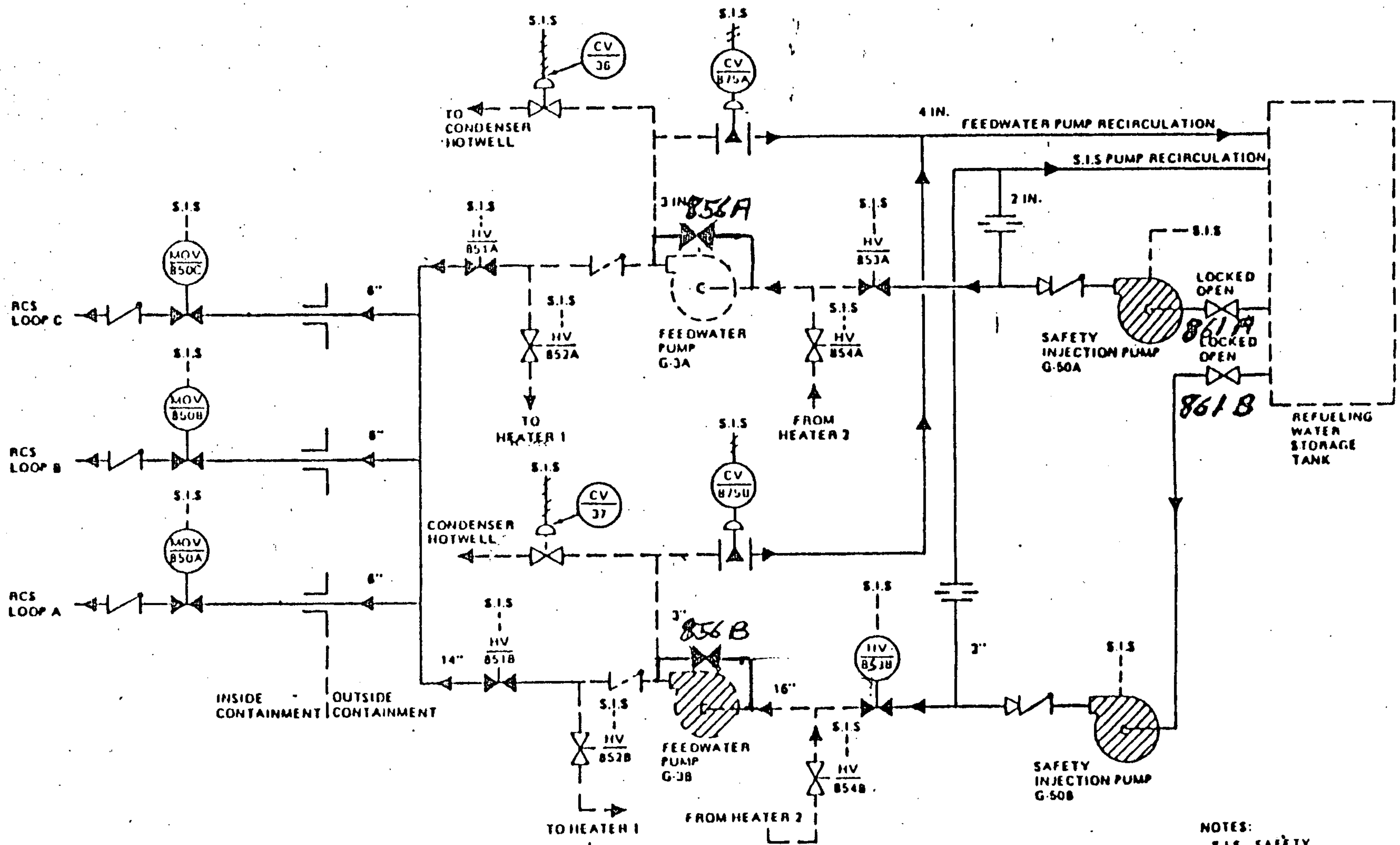

Figure 1 Simplified schematic of Songs-1 safety injection system

estimate of the PORV setpoint overshoot. The following assumptions were made when performing the analysis:

1. One PORV was assumed to fail.

2. The RCS was assumed to be rigid with respect to expansion.

3. Conservative heat transfer coefficients were assumed for the steam generator.

Parameter	Value and/or reference
Initial RCS pressure	50 psig
RCS volume	6752 ft^3
RCS temperature	100°F
PORV relief setpoints	500 psig
Charging pump delivery	110 gpm
PORV relief flow per valve	C_v = 31 gpm/psi
PORV opening time	2 seconds
PORV closing time	1.5 seconds

The PORV setpoint overshoot was determined to be 21 psi. With a relief valve setpoint of 500 psig, a final pressure of 521 psig is reached for the worst case mass input transient. The limit given in Technical Specification 3.1.3, which covers 40 Effective Full Power Years (EFPY) of operation, is 555 psig for a temperature of 100°F.

The licensee performed a plant specific analysis to determine the appropriate PORV setpoint (Ref. 12). Based on the heatup and cooldown curves for 27 effective full power years of operation, the licensee calculated a steady state limit of 543 psig for the limiting case of 100°F. To assure that this limit is not exceeded based on the limiting case of a mass input at 100°F, the licensee reduced the limit to 522 psig to account for the 21 psig pressure overshoot. The licensee also stated that the PORV setpoint will be adjusted as may be determined to be warranted based on additional parametric calculations being performed by Westinghouse.

By application dated October 28, 1978, the licensee proposed a setpoint of ≤ 522 psig for two PORVs with appropriate surveillance criteria to verify that the overpressure protection systems will respond promptly and properly if required. Based on our review, we conclude that the San Onofre Unit 1 OMS performance is acceptable for mass input transients. We further conclude that the proposed Technical Specifications are acceptable. The issuance of these proposed Technical Specifications will be the subject of a separate licensing action.

2. Heat Input Case

An inadvertent startup of a reactor coolant pump with a primary to secondary temperature differential across the steam generator of 50°F, and with the plant in a water-solid condition, was selected as the limiting heat input case. For the heat input case, Westinghouse provided the licensee with a series of curves based on the LOFTRAN analysis of a generic plant design to determine the PORV setpoint overshoot as a function of RCS volume, steam generator area, and initial RCS temperature. For this transient, the following assumptions were used in the analysis:

Parameter	Value and/or reference
Initial RCS pressure	300 psig
RCS volume	6752 ft^3
Initial RCS temperature	100, 140, 180 and 250°F
RCS/Steam generator ΔT	50°F
Steam generator heat transfer area	27,700 ft^2
PORV relief setpoint	500 psig
PORV opening time	3 seconds
PORV flow capacity per valve	C_v = 31 gpm/psi

The analyses results for the heat input transient depend on the initial RCS temperature; the results for the various initial temperatures are given below.

RCS temperature (°F)	$P_{max} - P_{setpoint}$ (psi)	Maximum RCS pressure (psig)	RCS pressure limit[a] (psig)
100	18	518	555
140	34	534	584
180	58	558	634
250	99	599	834

[a]Determined from 0°F/hr cooldown rate pressure-temperature limits curve from the San Onofre Unit 1 Technical Specification 3.1.3. (0-40EFPY)

The above analysis used a differential temperature of 50°F between the Reactor Coolant System and the secondary side of the steam generator.

Other analyses show that if the pressurizer water level is less than 80% while the RCS pressures ≤ 400 psig this 50°F temperature limit is not needed. Therefore, the Technical Specifications should be revised to state that if the water level in the pressurizer is > 80%, or if the initial RCS pressure is greater than 400 psig (when low temperature overpressure protection in needed) the temperature differential between the secondary side of the steam generator and the reactor coolant system shall be verified to be no greater than 50°F before a reactor coolant pump is started. We have requested the licensee to modify the proposed Technical Specifications as contained in Proposed Change No. 71 dated October 20, 1978 to include this verification.

With this addition to the Technical Specifications, we conclude that the Appendix G limits should not be exceeded and, therefore, the performance of the San Onofre Unit 1 OMS will be adequate for heat induced transients.

C. Administrative Controls

Reactor coolant system temperature gradients are precluded by continuous operation of a reactor coolant pump until the final cold shutdown reactor coolant system temperature is achieved. A charging/letdown mismatch is precluded by maintaining multiple relief paths open through the normal letdown lines and the residual heat removal inlets. These operator actions shall be in accordance with stated Technical Specifications.

An overpressure transient due to an inadvertent initiation of safety injection is precluded by establishment of two positive barriers between the safety injection system and the reactor coolant system during cold shutdown conditions. An overpressure transient during the testing of the SIS is precluded by doing this testing at a low pressure. During this time pressure in the SIS is less than the pressure in the RCS. A Technical Specification is required for ensuring that these two positive barriers are in place during cold shutdown conditions.

When the RCS pressure is $\leq$ 400 psig and the pressurizer water level is greater than 50%, a maximum of one of the two centrifugal charging pumps shall be operable. By letter dated October 20, 1978, the licensee proposed modifications to the Technical Specifications that would (1) establish that a maximum of one charging pump be operable under these conditions, and (2) establish when the overpressure position system is to be enabled and tested. We conclude that the proposed Technical Specifications are acceptable. The issuance of these Technical Specifications will be the subject of a separate licensing action.

With the addition of the above stated Technical Specifications we find the administrative measures at San Onofre Unit 1 acceptable.

D. Conclusions

The administrative controls and plant modifications proposed by Southern California Edison Company provide protection for the San Onofre Nuclear Generating Station, Unit 1 pressure transients at low temperatures by reducing the probability of initiation of a transient and by limiting the pressure of such a transient to below the limits set by 10 CFR 50 Appendix G. We find that with the addition of Technical Specifications, as stated above, the San Onofre Unit 1 overpressure mitigating system meets GDC 15 and 31 and that SCE has implemented the guidelines of NUREG-0224. We conclude that the San Onofre Unit 1 overpressure mitigating system is an acceptable solution to the problem of low temperature, overpressure transients.

3.2 Electrical, Instrumentation, and Control Aspects

Our consultant, Lawrence Livermore Laboratory, has reviewed the licensee's submittals (3, 4, 5, 7, 8, 9, 10, 11, 12, 14, 16, 17, 18, 19, 20, 21 and 23) and prepared the enclosed technical evaluation of the electrical, instrumentation, and control design aspects of the low temperature overpressure protection system for San Onofre Unit 1. Lawrence Livermore Laboratory (LLL) made the following three recommendations which have been implemented by the licensee:

1. LLL recommended that the licensee install a wide range pressure recorder. The licensee has informed the NRC staff that the subcooling meter recorder installed as part of the TMI related modifications includes wide range pressure capability.

2. LLL recommended that all alarms be of the audio/visual type. In particular, LLL indicated that San Onofre Unit 1 will meet the NRC staff position on PORV open alarm if one of the proposed direct indicators is provided with an audio/visual alarm.

   The licensee has installed direct valve indication switches on each PORV as indicated in the staff's Safety Evaluation dated November 6, 1981 supporting License Amendment No. 58. Each limit switch has a position indicator in the control room. Alarms are provided in the control room to indicate if either PORV is open.

3. LLL recommended that the PORV's be instrumented and alarmed in the control room in such a way as to have direct indication of the valves positions. As stated above, the PORVs are instrumented to give direct indication of the valve positions.

   The staff has reviewed the LLL evaluation and concur in its basis and findings; the staff further finds that the three recommendations made by LLL have been implemented at San Onofre Unit 1.

Based on a review of the enclosed Technical Evaluation Report and the discussion presented in Section 3.1 of this evaluation, the NRC staff finds that the San Onofre Unit 1 overpressure protection system meets the following design basis criteria applied in evaluating the electrical, instrumentation, and control aspects:

1. Operator Action. No credit for operator action is taken until 10 minutes after the operator is aware, through an action alarm, that an overpressure transient is in progress.

2. Single Failure Criterion. The OPS shall be designed to protect the reactor vessel given a single failure which is in addition to the failure that initiated the pressure transient.

3. Testability. The OPS must be testable on a periodic basis prior to dependence on the OPS to perform its function.

4. Seismic Category I and IEEE Std-279-1971 Criteria. The OPS should satisfy both the seismic Category I and IEEE Std-279-1971 criteria. The basis objective is that the OPS should not be vulnerable to a failure mode that would both initiate a pressure transient and disable the low temperature overpressure protection system. Events such as loss of instrument air and loss of offsite power must be considered.

Accordingly, we conclude that the overpressure protection system is acceptable.

Attached:
Technical Evaluation by
Lawrence Livermore Laboratory

Date: October 28, 1982

REFERENCES

1. "Staff Discussion of Fifteen Technical Issues Listed in Attachment G, November 3, 1976 Memorandum from Director NRR to NRR Staff." NUREG-0138, November 1976.

2. NRC letter (Schwencer) to Southern California Edison Company (SCEC), dated August 11, 1976.

3. SCEC letter (Haynes) to NRC (Schwencer), dated September 2, 1976.

4. SCEC letter (Baskin) to NRC (Schwencer), dated October 29, 1976.

5. SCEC letter (Baskin) to NRC (Schwencer), dated December 30, 1976.

6. NRC letter (Schwencer) to SCEC (Moore), dated January 10, 1977.

7. SCEC letter (Haynes) to NRC (Schwencer), dated April 11, 1977.

8. SCEC letter (Baskin) to NRC (Schwencer), dated April 22, 1977.

9. SCEC letter (Baskin) to NRC (Schwencer), dated May 2, 1977.

10. SCEC letter (Baskin) to NRC (Schwencer), dated June 2, 1977.

11. SCEC letter (Moore) to NRC (Schwencer), dated August 29, 1977.

12. SCEC letter (Baskin) to NRC (Schwencer), dated October 12, 1977.

13. NRC Memorandum (Baer to Goller), dated November 16, 1977.

14. SCEC letter (Baskin) to NRC (Schwencer), dated December 2, 1977.

15. NRC letter (Schwencer) to SCEC (Drake), dated December 7, 1977.

16. SCEC letter (Baskin) to NRC (Schwencer), dated January 26, 1978.

17. SCEC letter (Baskin) to NRC (Schwencer), dated January 27, 1978.

18. SCEC letter (Ottoson) to NRC (Engleken), dated February 27, 1978.

19. SCEC letter (Baskin) to NRC (Ziemann), dated March 17, 1978.

20. SCEC letter (Baskin) to NRC (Ziemann), dated April 13, 1978.

21. SCEC letter (Baskin) to NRC (Ziemann), dated May 3, 1978.

22. SCEC letter (Drake) to NRC (Denton), dated October 20, 1978.

23. "Pressure Mitigating System Transient Analysis Results", prepared by Westinghouse for the Westinghouse user's group on reactor coolant system overpressurization, dated July 1977.

24. Zech, G.; Reactor Vessel Pressure Transient Protection for Pressurized Water Reactors; U. S. NRC NUREG-0224; September, 1978.

25. U. S. NRC; Standard Review Plan; NUREG-0800; pages 5.2.2.7 & 5.2.2.8; July, 198.

26. Telecom SCE June 29, 1982.

27. Telecom J. Hammond, SCEC, E. Lantz, NRC and C. Ransom, EG&G Idaho, Inc., April 27, 1982.

28. SCEC letters; June 15 & 24, 1982.

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ABSTRACT

This report documents the technical evaluation of the electrical, instrumentation, and control design aspects for the low temperature overpressure protection system of the San Onofre Nuclear Power Station, Unit 1. Design basis criteria used to evaluate the acceptability of the system included operator action, system testability, single failure criterion, and seismic Category I and IEEE Std-279-1971 criteria.

FOREWORD

This report is supplied as part of the Selected Electrical, Instrumentation, and Control Systems Issues (SEICSI) Program being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Operating Reactors, by Lawrence Livermore Laboratory, Engineering Research Division of the Electronics Engineering Department.

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TECHNICAL EVALUATION OF THE ELECTRICAL, INSTRUMENTATION, AND CONTROL DESIGN ASPECTS OF THE LOW TEMPERATURE OVERPRESSURE PROTECTION SYSTEM FOR THE SAN ONOFRE NUCLEAR POWER STATION, UNIT 1

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1. INTRODUCTION

By letter to the Southern California Edison Company (SCEC) dated August 11, 1976 [Ref. 1], the U.S. Nuclear Regulatory Commission (NRC) requested an evaluation of system designs to determine susceptibility to overpressurization events and an analysis of these possible events, and proposed interim and permanent modifications to the systems and procedures to reduce the likelihood and consequences of such events. By letter dated September 2, 1976 [Ref. 2] and subsequent letters [Refs. 3 through 21], the Southern California Edison Company submitted the additional information requested by the NRC staff, including the administrative operating procedures and the proposed low temperature overpressure protection system. The system hardware includes sensors, actuating mechanisms, alarms, and valves to prevent a reactor coolant system (RCS) transient from exceeding the pressure and temperature limits of the Technical Specifications for San Onofre, Unit 1 as required by the Code of Federal Regulations, Title 10, Part 50 (10 CFR 50), Appendix G.

The purpose of this report is to evaluate the electrical, instrumentation, and control (EI&C) aspects of the licensee's equipment and procedures based on the information provided [Refs. 3 through 21], and to define how well they meet the criteria established by NRC as necessary to prevent unacceptable overpressurization events [Ref. 22].

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2. EVALUATION OF THE SAN ONOFRE NUCLEAR POWER STATION, UNIT 1

2.1 INTRODUCTION

A review of the San Onofre Nuclear Power Station, Unit 1 low temperature overpressure protection system design by SCEC was begun in 1976 at NRC's request. The proposed overall approach to eliminating overpressure events incorporates administrative, procedural, and hardware controls, with reliance upon the plant operator for the principal line of defense. Preventive administrative/ procedural measures include:

(1) Procedural precautions.

(2) Deenergization (power removed) of essential components which are not required to be operable during the cold shutdown mode of operation.

(3) Maintenance of a non-water-solid reactor coolant system condition whenever possible.

(4) Incorporation of low pressure relief setpoints for the existing power-operated relief valves (PORVs) control logic.

The design basis criteria that were applied in evaluating the acceptability of the electrical, instrumentation, and control aspects of the low temperature overpressure protection system (OPS) are as follows:

(1) Operator Action. No credit for operator action is taken until 10 minutes after the operator is aware, through an action alarm, that an overpressure transient is in progress.

(2) Single Failure Criterion. The OPS shall be designed to protect the reactor vessel given a single failure which is in addition to the failure that initiated the pressure transient.

(3) Testability. The OPS must be testable on a periodic basis prior to dependence on the OPS to perform its function.

(4) Seismic Category I and IEEE Std-279-1971 Criteria. The OPS should satisfy both the seismic Category I and IEEE Std-279-1971 criteria. The basic objective is that the OPS should not be vulnerable to a failure mode that would both initiate a pressure transient and disable the low temperature overpressure protection system. Events such as loss of instrument air and loss of offsite power must be considered.

2.2 SCEC OVERPRESSURE PROTECTION SYSTEM DESIGN

The overpressure protection system (OPS) provided at San Onofre Nuclear Power Plant, Unit 1 will utilize pressurizer power-operated relief valves (PORVs) to prevent a postulated pressure transient from exceeding the limits in 10 CFR 50, Appendix G. The system will use the existing PORVs (CV545 and CV546) with an added low pressure setpoint interlocked with an administratively controlled enable/disable switch. The low pressure setpoint logic is in addition to the existing PORV actuation logic, and will not interfere with existing automatic or manual actuation of CV545 or CV546. Drawing UDS-SK-082277 is a logic flow diagram of the OPS; drawings UDS-SK-082377 and UDS-SK-082477 show the controls and the electrical schematics for the OPS.

Valves CV545 and CV546 are spring-loaded, closed type valves that require plant instrument air to open. The valves are 2-inch control valves with a minimum valve coefficient (C_v) of 31 gpm $\sqrt{psig}$. The opening times of CV545 and CV546 have been measured and are 2 seconds and 1.8 seconds, respectively; the closing times are 1.5 and 1.4 seconds.

The line between the pressurizer and the PORVs includes isolation valves CV531 and CV530. These valves are 2-inch spring-open valves and require plant instrument air to close.

The PT-425 loop will be modified by adding two separate circuits to provide the low pressure setpoint and actuation logic for each of the PORVs. Each of the added actuation logics will include a two-channel pressure control bistable with dedicated power supplies and input/output modules to generate a low pressure setpoint, as well as annunciation signals for PORV control. All of the electronic circuit modules will be installed in available space in existing racks in the main control room.

The pressure transmitter signal (10-50MA) supplied to each channel of the signal converter module (PCS-425-X1, X2) is converted into a zero- to ten-volt control signal. The control signal operates the dual-channel bistable (PC-425-X1, X2) that actuates the valves and the annunciator signals through the contact isolator module (PRD-425-X1, X2).

The electronics and control circuits associated with each of the PORVs will be powered from separate vital buses. The present power supply alignment for the PORVs will be modified to power CV545 and CV546 from separate vital buses also. The power supply for the isolation valves will be aligned with the associated PORVs.

Since overpressure protection is required only during periods of water-solid operation, the low level setpoint is administratively controlled through a double action (requiring both pull and turn motions to actuate) control switch located in the control room. When the control switch is placed in the "Enable" position, the first channel of the bistable provides a valve-open command to the PORV when pressurizer pressure exceeds the low pressure setpoint of 522 psig. (Section 4 in Reference 22 discusses the basis for this setpoint.) The same bistable output also causes an alarm in the control room (annunciator A1 which indicates "TRANSIENT IN PROGRESS") to alert the operator to a pressure transient.

The second channel of the bistable is used as a permissive setpoint to activate annunciator A2 in the control room when the pressurizer pressure is less than or equal to 400 psig. The setpoint pressure of 400 psig encompasses all operating conditions at which the RCS would be expected to be water-solid and susceptible to an overpressure event. Annunciator A2, indicating "ARM PORV," alerts the operator that the low pressure setpoint for PORV actuation is to be enabled by placing the control switch in the "Enable" position. Annunciator A4 alarms in the control room, indicating "PORV CONTROL SWITCH ENABLED," and can be reset (extinguished) only when the control switch is in the "Disable" mode.

The normal source of air supply to the PORVs is through plant instrument air lines which come from a common header that is located approximately 8 feet above the control valves. A pressure switch to monitor the loss of instrument air to the PORVs is installed directly on the air-supply header, and will alarm in the control room to notify the operator if instrument air is lost.

In the event of loss of plant instrument air, the plant nitrogen (N_2) system will automatically provide a redundant pneumatic source for the PORVs. Because the N_2 system is independent, a failure of the instrument air system will not result in loss of N_2 to the PORVs. Similarly, a failure in the N_2 system will not affect the air supply to the valves. A pressure switch is provided on the N_2 header to notify the operator of the availability of the N_2 system to supply the PORVs. Either the instrument air supply or the N_2 system provides sufficient pneumatic capacity to handle PORV-cycling for the duration of a pressure transient. Based on the Westinghouse bounding analysis report [Ref. 23] and the faster closing characteristics of CV545 and CV546, the number of relief cycles is conservatively estimated to be 45.

2.3 EVALUATION OF THE SAN ONOFRE NUCLEAR POWER STATION, UNIT 1 USING DESIGN BASIS CRITERIA

The San Onofre Nuclear Power Station, Unit 1 was evaluated under the guidance of the four design basis criteria stated in Section 2.1 of this evaluation. Specific attention was given to various pertinent NRC staff positions resulting from these criteria. Sections 2.3.1 through 2.3.4 are concerned with the four design criteria.

2.3.1 Operator Action

In each design basis transient analyzed, no credit for operator action was taken until 10 minutes after the initiation of the RCS overpressure transient and after the operator was made aware of the overpressure transient by the low temperature overpressure transient alarm. The criterion for operator action is consistent with that suggested at recent meetings between pressurized water reactor (PWR) owners and the NRC (i.e., when a plant is operated in accordance with established operating procedures, the protection afforded by normal operating procedures is a vital part of the overall plan for protection against overpressurization).

In the analysis of postulated events defined in Appendix G of 10 CFR 50, operator actions to mitigate the consequences of the event are conservatively assumed not to occur for 10 minutes after the event. The operator is alerted to a possible overpressure event by means of the impending transient and by PORV open alarms on the master control board. The rise of sufficient accumulated nitrogen within the seismic portion of each separate train of the OPS provides sufficient volume to operate each PORV during the 10-minute period of operator inaction.

Based on the above features of the OPS at San Onofre, we conclude that San Onofre Nuclear Power Station, Unit 1 satisfies the NRC criterion on operator action.

2.3.2 Single Failure Criterion

The OPS is designed to protect the reactor vessel given a single failure in addition to the failure that initiated the overpressure transient. The single failure criterion has been applied both to initiating events and to the means of mitigating the effects of these overpressurization events. Either a single equipment malfunction or a single erroneous operator control manipulation has been assumed to initiate each of the overpressurization events considered.

The Westinghouse Electric Corporation generic bounding analysis entitled, "Pressure Mitigating Systems Transient Analysis Results," dated July 1977 [Ref. 23] demonstrates that one pressurizer power-operated relief valve is adequate to mitigate potential overpressure conditions from possible inadvertent heat and mass inputs during water-solid operation.

The use of two pressurizer power-operated relief valves controlled by redundant logic trains provides protection against failure of the system to operate due to a single failure in addition to the failure which caused the transient. A failure mode and effects analysis was also performed to demonstrate the effective operation of the OPS in the event of a single failure of any instrument or equipment within the system.

Based on the system description and the information referenced in this section, we conclude that the OPS at San Onofre Nuclear Power Station, Unit 1 satisfies NRC's single failure criterion.

2.3.3 System Testability

There are two aspects associated with the testability of the OPS. The first aspect is concerned with the PORV-testing program for low pressure protection system operability, and has resulted in the following NRC Staff Position: "the control circuitry from pressure sensor to valve solenoid should be tested prior to each heatup or cooldown. The PORVs should be stroked during each refueling. Deviations from this criterion should be justified." Consequently, the testability program for the PORVs will be as follows:

(1) Verification of upstream isolation valves functioning once per cold shutdown.

(2) Performance of a channel functional test of the control circuitry from the pressure sensor to the valve solenoid once per refueling outage.

(3) Performance of a channel calibration of the pressurizer pressure sensors once per 18 months.

At San Onofre Nuclear Power Station, Unit 1, each power-operated relief valve (PORV) is tested to assure its operability in the following manner:

(1) The pressure control bistable setpoint is adjusted such that following a cold shutdown with the RCS depressurized, the PORVs are actuated and the annunciators alarm 31 days prior to returning to a water-solid condition.

(2) Channel calibration on the PORV actuation channel is performed at least once per 18 months.

(3) Position indications on the PORV isolation valves showing that the valves are open are verified at least once per week when the PORVs are being used for overpressure protection.

The surveillance requirement to verify operability of the PORVs provides assurance that the RCS will be protected from pressure transients which could exceed the limits of Appendix G to 10 CFR Part 50 when the initial RCS pressure is less than or equal to 400 psig. Either PORV has adequate relieving capability to protect the RCS from overpressurization due to a design basis transient [Ref. 11].

The second aspect of testability involves plant tests performed during cold shutdown which could result in RCS overpressurization above the minimum operating limit curves. SCEC states [Ref. 7] that tests of components or systems that can potentially cause overpressurization are not conducted in water-solid conditions.

We conclude that the OPS at San Onofre Nuclear Power Station, Unit 1 satisfies the NRC criteria on system testability.

2.3.4 Seismic Design and IEEE Std-279-1971 Criteria

2.3.4.1 Seismic Considerations. SCEC states that, as a minimum, those portions of the OPS which interface with or could affect existing seismic Category 1 equipment are designed as seismic Category 1. All other portions of the system are designed at least to seismic Category 2. In view of the very limited time that the plant is actually in a water-solid condition when there is a potential for overpressurization (for a brief time during startup from and shutdown to a cold shutdown condition), the probability of experiencing a design basis earthquake coincident with these conditions is extremely low. In view of this low probability, it is considered unnecessary to design the OPS to seismic Category 1 requirements, with the exception of those portions of the system which could affect existing seismic Category 1 equipment. In this way the OPS provides the required protection against overpressurization without degrading existing plant equipment.

We conclude that the OPS at San Onofre Nuclear Power Station, Unit 1 satisfies the NRC criterion on seismic design.

2.3.4.2 IEEE STD-279-1971. The control circuitry added for the OPS meets all applicable portions of IEEE STD-279-1971. Control of the PORVs and associated isolation valves is through redundant and physically separate systems. Each PORV has the capability for manual control to initiate valve actuation. No single failure within the PORV actuation logic or manual control circuitry will prevent initiation of overpressure protection. The system also has the capability for operational testing.

We conclude that the OPS at San Onofre Nuclear Power Station, Unit 1 satisfies the IEEE STD-279-1971 criteria.

2.4 ALARM SYSTEMS DESIGN AND OPERATION

Specific details concerning the design and operation of acceptable alarm systems for the San Onofre Nuclear Power Station, Unit 1 OPS are described below.

2.4.1 High-Pressure Alarm

The NRC staff position requires that a high-pressure, audio/visual alarm shall be used during low RCS temperature operations as an effective means to provide unambiguous information to the operator that a pressure transient is in progress.

An alarm (annunciator A1) will be provided in the control room at San Onofre, Unit 1. When the control switch is in the low pressure mode, this alarm will annunciate when the RCS pressure reaches the low pressure PORV setpoint. The alarm setpoint will correspond to the PORV setpoint of 522 psig. An annunciator in the control room which receives a signal from pressure sensor PT-425 for the OPS will also alarm.

An alarm will annunciate when the RCS pressure exceeds the PORV setpoint, provided the control switch is in the low pressure mode. Annunciator A4 alarms in the control room to notify the operator that the control switch is in the "Enable" position, and also indicates that the "TRANSIENT IN PROGRESS" annunciator is activated. In this way, the alarm is available during all water-solid operations. The testing provisions described in Reference 23 will ensure proper operation.

We conclude that the design of the OPS at San Onofre Nuclear Power Station, Unit 1 satisfies the NRC staff position on high-pressure alarms.

2.4.2 Isolation Valve(s) Alarm

The NRC Staff Position requires that:

(1) The upstream isolation valves to the PORVs shall be wired into the overpressure protection alarm in such a way that the alarm will not clear unless the system is enabled and the isolation valves are open. Means should be provided to ensure proper alignment of the isolation valves during OPS operation.

(2) The alarms shall be of the audio/visual type and provide unambiguous information to the operator.

The OPS at San Onofre Nuclear Power Station, Unit 1 is designed so that if the low pressure setpoint is activated and the PORV isolation valve is not open, annunciator A3 (indicating "Open CV530" or "Open CV531") in the control room activates.

We conclude, therefore, that the OPS at San Onofre Nuclear Power Station, Unit 1 satisfies the NRC staff position on isolation valve alarms.

2.4.3 Enable Alarm

The NRC staff position requires that

(1) An alarm shall be activated as part of the plant cooldown process to ensure that the OPS is activated before the RCS temperature is less than 350°F. Prior to cooling the RCS below 350°F, operating procedures require the activation of the OPS by setting both keylock permissive switches to the "enable" position.

(2) The alarm shall be of the audio/visual type and provide unambiguous information to the operator.

In the OPS for San Onofre Nuclear Power Station, Unit 1, the second channel of each bistable is used as a permissive setpoint to activate annunciator A2 in the control room when the pressurizer pressure is less than or equal to 400 psig. The setpoint pressure of 400 psig encompasses all operating conditions at which the RCS would be expected to be water-solid and susceptible to an overpressure event. Annunciator A2, indicating "ARM PORV," alerts the operator that the low pressure setpoint for PORV actuation is to be enabled by placing the control switch in the "Enable" position.

We conclude that the OPS at San Onofre Nuclear Power Station, Unit 1 satisfies the NRC staff position on enable alarms.

2.4.4 Disable Alarm

The NRC staff position requires that

(1) An alarm shall be activated as part of the plant heatup process to ensure that the RHR isolation valves are closed when the RCS temperature is greater than 350°F.

(2) The alarm shall be of the audio/visual type and provide unambiguous information to the operator.

In the OPS for San Onofre Nuclear Power Station, Unit 1, when the control switch is placed in the "Enable" position, annunciator A4 alarms in the control room, indicating "PORV CONTROL SWITCH ENABLED". The alarm can be reset (extinguished) only when the control switch is in the "Disable" mode.

We conclude that the OPS at San Onofre Nuclear Power Station, Unit 1 satisfies the NRC staff position on disable alarms.

2.4.5 Power-operated Relief Valve (PORV) Open

The NRC staff position requires that

(1) An alarm shall be activated to alert the operator that a power-operated relief valve is in the "open" position.

(2) An alarm shall be of the audio/visual type and provide unambiguous information to the operator.

An alarm (annunciator A1) will be provided in the control room at San Onofre, Unit 1. When the control switch is in the low pressure mode, this alarm annunciates when the RCS pressure reaches the low pressure PORV setpoint. The alarm setpoint will correspond to the PORV setpoint of 522 psig. The alarm will be from an annunciator in the control room which receives a signal from pressure sensor PT-425 for the interim OPS.

An alarm will annunciate when the RCS pressure exceeds the PORV setpoint, provided the control switch is in the low pressure mode. Annunciator A4 alarms in the control room to notify the operator that the control switch is in the "Enable" position, and also indicates that the "TRANSIENT IN PROGRESS" annunciator is activated. In this way, the alarm is available during all water-solid operations.

In addition to the above annunciators, indication of pressurizer relief valve operation during cold shutdown conditions would be indicated on one or more of the following instruments:

(1) Pressurizer relief tank high level (LC 440A)

(2) Pressurizer relief tank high temperature (TC 440B)

(3) RV-206 high temperature (TIC 1104)

(4) Pressurizer relief header temperature (TIC 433A, B, and C)

We conclude that OPS at San Onofre Nuclear Power Station, Unit 1 will satisfy the NRC staff position on PORV open alarm if one of the proposed direct indicators is provided with an audio/visual alarm.

2.5 PRESSURE TRANSIENT REPORTING AND RECORDING REQUIREMENTS

The NRC staff position is that a pressure transient which causes the OPS to function, thereby indicating the occurrence of a serious pressure transient, is a 30-day reportable event. In addition, pressure-recording and temperature-recording instrumentation are required to provide a permanent record of the pressure transient. The response time of the pressure/temperature recorders shall be compatible with pressure transients that increase at a rate of approximately 100 psig/s.

San Onofre Nuclear Power Station, Unit 1 has a wide-range temperature recorder for Cold Leg Loop A (TR402) in the unit control console in the control room. There is, however, no mention of a wide-range pressure recorder. It is recommended, therefore, that a wide-range pressure recorder, whose characteristics satisfy the NRC Staff Position on pressure transient reporting and recording, be installed at San Onofre Nuclear Power Station, Unit 1.

2.6 DISABLING OF ESSENTIAL COMPONENTS NOT REQUIRED DURING COLD SHUTDOWN

The NRC Staff Position requires the de-energizing of safety injection system (SIS) pumps and the closure of safety injection (SI) header/discharge valves during cold shutdown operations. San Onofre Nuclear Power Station, Unit 1, uses the following procedures for SIS shutdown and testing.

(1) Cold Shutdown Arrangement of Safety Injection System (Operating Instruction S-3-2.21)

This operating instruction describes the procedures for aligning the SIS during cold shutdown of the RCS. The SIS is placed in the cold shutdown arrangement prior to a RCS pressure of 500 psig and is returned to a normal status when the RCS pressure is 1400 psig on plant startup. The only circumstance during cold conditions in which the SIS is removed from the cold shutdown arrangement is for the "no-flow test" (see Item B, Cold Operation Test of the Safety Injection System). This test is not conducted with the RCS water solid.

In accordance with this procedure, two positive barriers are established between the RCS and the SIS. A positive barrier is defined as any one of the following: (1) motor operated valve, when closed and tagged with the safety switch open; (2) pneumatic hydraulic valve, when closed and the hydraulic oil isolaiton valve is closed; or (3) manually operated valve, when locked closed and tagged.

Two alternative valve arrangements are provided for in this instruction. The primary arrangement requires: (1) the following valves are 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 are opened, the fuse blocks removed, and a yellow tag affixed to the breaker; (3) the output breaker for the UPS inverter to MOV 850C is opened with the manual transfer switch aligned to the inverter output breaker, and 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 are closed and tagged.

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 853B; and (4) closing and tagging the hydraulic oil valves on the operators for HVs 853A and 853B.

(2) Cold Operation Test of the Safety Injection System (Operating Instruction S-3-3.4)

This operating instruction describes the procedure for conducting a "no-flow test" of the SIS to demonstrate operability. This test is conducted with the RCS in a cold shutdown condition, with the RCS vented and not water solid. The safety injection pumps and feedwater pumps are not operating and their respective breakers are racked-out to the test position with control power available. At the start of the test the SIS is in the cold shutdown arrangement (see item 1, "Cold Shutdown Arrangement of Safety Injection System"). In order to complete the test, however, the system is temporarily removed from this arrangement under the supervision of the Watch Engineer.

In accordance with this procedure, two tests are conducted: one on the SIAS circuits and one on the Safety Injection Actuation System/Loss of Power (SIAS/LOP) circuits. In the first test, the SIS is changed from the cold shutdown arrangement to the SIAS no-flow test condition. This includes (1) positioning MOVs 850A, 850B, and 850C in the closed position, and (2) positioning HVs 851A and 853B in the closed position with the hydraulic oil isolation valves closed. With this configuration, the SIAS block circuit is tested. The block circuit is then opened, SIAS is generated, and proper system actuation is verified. However, HVs 853A and 853B remain closed and the feedwater and safety injection pumps do not start since their breakers are racked-out.

In the second test, the SIS is aligned in the SIAS/LOP no-flow test condition. This includes positioning MOVs 850A, 850B, and 850C and HVs 851A, 851B, 853A and 853B to the closed position. An SIAS concurrent with LOP is then simulated and proper system actuation is verified. However, the feedwater and safety injection pumps do not start since their breakers are racked-out.

We conclude that the OPS at San Onofre Nuclear Power Station, Unit 1 satisfies the intent of the NRC Staff Position on disabling of essential components not required during cold shutdown.

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3. TECHNICAL SPECIFICATIONS

To ensure operation of the OPS at San Onofre Nuclear Power Station, Unit 1, SCEC has submitted for NRC staff review proposed changes and additions to the Technical Specifications which will be incorporated into the license for San Onofre Nuclear Power Station, Unit 1. These specifications are summarized below.

Technical Specification 3.1.2 will be revised (by adding Specification E) to read:

E. A reactor coolant pump shall not be started with the RCS pressure ≤400 psig unless:

(1) The pressurizer water level is less than 80% or,

(2) The potential for having developed coolant system temperature gradients has been evaluated.

Specification A.(1) of Technical Specification 3.2 will be revised to read:

(1) One charging pump or the test pump shall be operable. However, when the RCS pressure is ≤400 psig and pressurizer water level is greater than 50%, a maximum of one of the two centrifugal charging pumps shall be operable. The inoperable centrifugal charging pump shall have the motor circuit breaker removed from the electrical power supply circuit and shall be condition tagged.

A new Technical Specification 3.15 will be added to read:

3.15 <u>OVERPRESSURE PROTECTION SYSTEMS</u>

<u>APPLICABILITY</u>: Applies to operability of the overpressurization protection systems.

<u>OBJECTIVE</u>: To preclude the potential for exceeding 10 CFR 50, Appendix G, in the event of a pressure transient while water solid.

SPECIFICATION: A. When the RCS pressure is $\leq$400 psig andd pressurizer water level is greater than 50%, at least one of the following overpressure protection systems shall be operable:

(1) Two power operated relief valves (PORVs) with a lift setting of $\leq$522 psig, or

(2) A reactor coolant system vent(s) of $\geq$1.75 square inches.

B. With one PORV inoperable when required in accordance with Specification A above, either restore the inoperable PORV to operable status within seven days or depressurize and vent the RCS through a 1.75 square inch vent(s) within the next eight hours; maintain the RCS in a vented and tagged condition until both PORVs have been restored to operable status.

C. With both PORVs inoperable when required in accordance with Specification A above, depressurize and vent the RCS through a 1.75 square inch vent(s) within eight hours; maintain the RCS in a vented and tagged condition until both PORVs have been restored to operable status.

D. In the event either the PORVs or the RCS vent(s) are used to mitigate a potential RCS pressure transient, a Special Report shall be prepared and submitted to the Commission pursuant to Specification 6.9.2.b within 30 days. The report shall describe the circumstances initiating the transient, the effect of the PORVs or vent(s) on the transient and any corrective action necessary to prevent recurrence.

APPLICABILITY: Applies to operability of the overpressurization protection systems.

OBJECTIVE: To verify that the overpressure protection systems will respond promptly and properly if required.

SPECIFICATION: A. Each power operated relief valve (PORV) shall be demonstrated operable by:

(1) Adjusting the pressure control bistable setpoint such that the PORVs are actuated and the annunciators alarm within 31 days prior to returning to a water solid condition following a cold shutdown with the RCS depressurized.

(2) Performance of a channel calibration on the PORV actuation channel at least once per 18 months.

(3) Verifying that position indications on the PORV isolation valves indicate that the valves are open at least once per week when the PORVs are being used for overpressure protection.

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4. CONCLUSIONS

The electrical, instrumentation, and control design aspects of the San Onofre Unit 1 low temperature OPS were evaluated using those design basis criteria originally prescribed by the NRC staff and later expanded during subsequent discussions with the licensee.

We conclude that the OPS at SCEC's San Onofre Nuclear Power Station, Unit 1, as described, satisfies most of the NRC criteria, requirements, or staff positions. To ensure that all criteria are satisfied, we make the following recommendations:

(1) We recommend SCEC install a wide-range pressure recorder to satisfy the NRC staff position on recorders.

(2) We recommend that all alarms be of the audio/visual type.

(3) We recommend that the PORVs be instrumented and alarmed in the control room in such a way as to have a direct indication of the valves positions.

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REFERENCES

1. NRC letter (Schwencer) to Southern California Edison Company (SCEC), dated August 11, 1976.

2. SCEC letter (Haynes) to NRC (Schwencer), dated September 2, 1976.

3. SCEC letter (Baskin) to NRC (Schwencer), dated October 29, 1976.

4. SCEC letter (Baskin) to NRC (Schwencer), dated December 30, 1976.

5. NRC letter (Schwencer) to SCEC (Moore), dated January 10, 1977.

6. SCEC letter (Haynes) to NRC (Schwencer), dated April 11, 1977.

7. SCEC letter (Baskin) to NRC (Schwencer), dated April 22, 1977.

8. SCEC letter (Baskin) to NRC (Schwencer), dated May 2, 1977.

9. SCEC letter (Baskin) to NRC (Schwencer), dated June 2, 1977.

10. SCEC letter (Moore) to NRC (Schwencer), dated August 29, 1977.

11. SCEC letter (Baskin) to NRC (Schwencer), dated October 12, 1977.

12. NRC Memorandum (Baer to Goller), dated November 16, 1977.

13. SCEC letter (Baskin) to NRC (Schwencer), dated December 2, 1977.

14. NRC letter (Schwencer) to SCEC (Drake), dated December 7, 1977.

15. SCEC letter (Baskin) to NRC (Schwencer), dated January 26, 1978.

16. SCEC letter (Baskin) to NRC (Schwencer), dated January 27, 1978.

17. SCEC letter (Ottoson) to NRC (Engelken), dated February 27, 1978.

18. SCEC letter (Baskin) to NRC (Ziemann), dated March 17, 1978.

19. SCEC letter (Baskin) to NRC (Ziemann), dated April 13, 1978.

20. SCEC letter (Baskin) to NRC (Ziemann), dated May 3, 1978.

21. SCEC letter (Drake) to NRC (Denton), dated October 20, 1978.

22. "Staff Discussion of Fifteen Technical Issues Listed in Attachment G, November 3, 1976 Memorandum from Director NRR to NRR Staff." NUREG-0138, November 1976.

23. "Pressure Mitigating System Transient Analysis Results", prepared by Westinghouse for the Westinghouse user's group on reactor coolant system overpressurization, dated July 1977.