ENCLOSURE

HOT SAFE SHUTDOWN
SYSTEMS INTERACTION REVIEW

SAN ONOFRE NUCLEAR GENERATING STATION
UNIT 1

SOUTHERN CALIFORNIA EDISON COMPANY

REVISION 1

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TABLE OF CONTENTS

1.0 INTRODUCTION

As part of the NRC review of the San Onofre Unit 1 Return-to-Service (RTS) Program, an evaluation of the possible interactions resulting from a 0.67g seismic event between Out-of-Scope Safe Shutdown/Accident Mitigation (OSSS/AM) components and Hot Safe Shutdown (HSS) components (upgraded to 0.67g). Interaction of HSS components with non-safety related and safety related components not part of the current seismic upgrade program, are not evaluated herein. This report describes criteria and methodology used to identify these postulated component failures and summarizes the results of this evaluation.

This HSS system interaction review evaluated the following interactions: seismically induced falling items, flooding, and high energy line break (pipe whip and jet impingement). OSSS/AM components were considered as potential hazard "sources" and HSS components were considered as potential "targets". Categories of interactions were excluded from further evaluation if the source had been previously upgraded or if target failure was unlikely for the specific interaction (e.g., falling instruments were considered to have insufficient mass to damage pipes). For the remaining interaction categories, HSS components were reviewed by plant walkdowns to identify and further evaluate possible interactions. Each of the remaining interactions resulting from the walkdowns was evaluated for acceptability within the RTS program scope and criteria.

2.0 SUMMARY OF RESULTS AND CONCLUSIONS

The majority of identified possible interactions between OSSS/AM components and HSS systems were eliminated by application of criteria developed in Sections 3.1, 3.2, and 3.3 of this report, and by plant walkdowns. The remaining items were then analyzed by application of the RTS criteria defined in the SCE letter to the NRC dated December 23, 1983.

The HSS system interaction review concludes that the postulated failure of OSSS/AM components has no significant adverse impact on HSS systems under a 0.67g seismic event and that the required HSS systems safety functions will not be impaired.

3.0 PROGRAM DESCRIPTION

The HSS system interaction review program was defined to evaluate potential impacts on HSS systems resulting from the postulated failure of OSSS/AM components induced by a design basis earthquake. The hazards evaluated were falling items, flooding, and high energy line breaks. The following bases were applied in this study:

1. The initiating failure is seismically induced.
2. No other concurrent Design Basis Events are postulated.
3. Offsite power is not available, but emergency onsite power is available.

3.1 Seismically Induced Falling Items

3.1.1 Approach and Criteria

The OSSS/AM components were categorized and reviewed as sources for potential interaction as noted below:

(1) Electrical components: The anchorages of electrical and control panels and cabinets have been previously upgraded or analyzed and found to meet the 0.67g seismic requirements (Reference 1). As for the electrical raceway support systems, reference (2) describes the reevaluation and upgrading plan which is being implemented as a part of the return to service. Therefore, these components were not considered to be sources.

(2) Heating and air conditioning (HVAC): OSSS/AM components in this category are located in the control building (e.g., control room, 4 KV and 480V switchgear room) or associated with containment penetration portions of the containment ventilation system (i.e., approximately 2 to 3 feet of HVAC ducting between the containment penetration and the sphere enclosure building) and their supports have been previously upgraded or analyzed and found to meet the 0.67g seismic requirements. Therefore, they are not hazard sources.

(3) Mechanical components: This category includes pumps, tanks, heat exchangers, filters, and other large items and their supports. Sources in this category were reviewed by plant walkdown for impact on HSS targets. Walkdown procedures and evaluations findings are described in Sections 3.1.2 and 3.1.3.

(4) Instruments and sensing lines: Because of their small mass, falling instruments will only damage other instruments or small sensing lines. Since both the source and the target have small cross sections, damaging interactions will be highly improbable. Therefore, instruments are not considered to be potential sources. Sensing lines were excluded as sources due to their small mass.

(5) Structures: The majority of walls, beams, and columns in safety-related plant areas have been previously upgraded or analyzed and found to meet the 0.67g seismic requirements (References 3, 4, 5 and 6). The rest of the structures were reviewed and found to have no adverse impact on HSS system safety functions. Therefore, structures are not hazard sources.

(6) Piping and Valves: SONGS 1 safety-related piping above grade is ductile steel. Data available from testing and actual earthquake experience with ductile steel piping has indicated that such piping systems have the capability to withstand dynamic loads three to four times larger than that for which they are designed (Enclosure 2 to Reference 7). Based on the above information, it is concluded that piping systems at SONGS 1 have substantial seismic withstand capability and the possibility of sections of pipe becoming detached (e.g., two double ended ruptures) and falling from their fixed locations to become potential hazard sources is not considered credible. Cast iron piping above or below grade cannot interact with HSS components.

Pipe supports are considered to be credible sources for HSS instruments, sensing lines, remote operated valves and mechanical equipment although the probability of a pipe support severing both its connections to a structural member and the pipe, is considered highly unlikely. However, walkdowns to evaluate the effects of pipe sag due to limited pipe support failures and the effects of pipe supports becoming a falling source were conducted.

3.1.2 Plant Walkdowns

Screening between HSS and OSSS/AM components was performed to identify potential interactions. For each component walked down, an interaction checklist was completed to identify the component being reviewed and any potential sources or targets. Teams consisting of at least 2 people were used in all cases to ensure accuracy of recorded data.

The guidelines used in the Plant Walkdowns are summarized below:

(1) Piping and Manual Valve Targets - HSS piping, 2" NPS and smaller, was walked down to identify potential credible OSSS/AM hazards. Large bore piping is generally not susceptible to damage from falling items and was not evaluated. Where an HSS target pipe of any size is routed near a large piece of mechanical equipment, the case was evaluated. The walkdown team evaluated the possibility of the target to be damaged by the source considering the source and target relative masses, and the existence of intervening or connected structures or components.

(2) Instrument, Remote Operated Valve and Mechanical Equipment Targets - In general, OSSS/AM mechanical equipment, sagging pipes, and falling pipe supports were considered to be credible sources for HSS instruments, sensing lines, remote operated valve and mechanical equipment targets in this category.

(3) Source Failure Modes - Floor mounted equipment were assumed to tip over in any direction. Wall and ceiling mounted sources were assumed to fail and fall down, with approximately a 10° angular zone of influence in any direction from vertical.

3.1.3 Evaluation

Each of the seismically induced falling item interactions resulting from plant walkdowns was evaluated for target interaction within the RTS scope and criteria.

It was found that in the following categories there were no unresolved interactions:

1. OSSS/AM Mechanical equipment sources on HSS electrical component targets (e.g., cable tray, panel, cabinet, etc.).

2. OSSS/AM Mechanical equipment sources on HSS HVAC targets.

3. OSSS/AM Mechanical equipment sources on HSS instrument, sensing line, and conduit targets.

4. OSSS/AM Mechanical equipment sources on HSS mechanical equipment targets.

5. OSSS/AM pipe support failure and resulting pipe sag on HSS instrument, sensing line, remote operated valve and mechanical equipment targets.

The only category that required additional evaluation was OSSS/AM Mechanical equipment sources on HSS Piping/Valve targets.

The OSSS/AM Mechanical equipment sources were further evaluated by using RTS seismic criteria to determine if the "source" components meet the 0.67g seismic requirements and therefore can be eliminated from consideration. The two items of concern (the CCW heat

exchangers and the excess letdown heat exchanger) were both evaluated. The evaluation of the excess letdown heat exchanger verified that equipment anchorage met the upgrade requirements by application of the RTS seismic criteria. The evaluation of the component cooling water heat exchanger indicates that the equipment anchorage does not exceed its ultimate strength under a 0.67g seismic event.

In addition, the effect of piping connections were considered together with the pipe break criteria of 3.1.1 (6). The heat exchangers are connected to the system by means of large diameter pipes connected on opposite sides forming a 6 degree of freedom restraint system. On the basis that a double ended break of these pipes will not occur; and the low probability that all four pipes will break and distort so as to provide clearance for the heat exchanger to fall; the heat exchangers will be locked into position and thus preclude their falling and becoming a source. In addition, there are large pipe support structures between the heat exchangers and HSS potential targets. It is therefore, concluded that the CCW heat exchanger would not turn over and become a hazard source for HSS targets.

Based on the foregoing evaluation, it is concluded that credible seismically induced falling OSSS/AM components would not cause unacceptable impacts to HSS systems.

3.2 Flooding

Flooding from lines in the OSSS/AM scope was also reviewed. In high energy lines, full area double ended ruptures were postulated. For moderate energy lines, the failure mode was assumed to be a critical crack, as defined in branch technical position MEB 3-1.

Inside containment, calculations had been previously performed to define the design basis flood. Since any OSSS/AM breaks are be enveloped by the design basis flood and all HSS components below flood level were qualified for underwater service, a detailed review of these breaks was not required.

Outside containment, in a report titled "Effects of Non-Category A Equipment Failure on Safety-Related Equipment", dated March 1975, flood effects from non-safety related components to safety related components were addressed (References 8, 9 and 10) and found to be acceptable by the NRC (Reference 11). Although the piping failures

addressed in the current study are different than those in the earlier study, conclusions are still applicable here.

The OSSS/AM (safety injection portion) main feedwater lines outside the containment are high energy lines. A postulated pipe rupture at the main feedwater pump discharge would cause flooding at a rate of approximately 10,000 gpm. However, it poses no hazard to the auxiliary feedwater pumps (floor elevation 14'-0") located in the general vicinity of the feedwater pump G-3B (floor elevation 14'-0") for the following reasons:

(1) Break locations for the main feedwater pump G-3B are oriented east and west, and the auxiliary feedwater pumps are located at approximately 20 feet south of the feedwater pump G-3B and behind a shield wall. The water jet/spray resulting from pipe ruptures will not directly spray on the auxiliary feedwater pump and jeopardize the motor operation (for the jet impingement impact see evaluation in section 3.3.3).

(2) The auxiliary feedwater pumps are mounted on foundations 1'-4 1/2" above the floor elevation 14'-0". Ground level flooding due to a seismically induced main feedwater line break

will not reach the foundation height because Elevation 14'-0" level of the turbine building is open to the yard area and there are no impediments to drainage such as curbs that would prevent drainage towards the yard or the condenser bay.

It is, therefore, concluded that a postulated pipe rupture of the OSSS/AM main feedwater piping will not generate unacceptable flooding that would impact the safety function of the auxiliary feedwater pumps.

The remaining OSSS/AM scope piping outside containment are moderate energy lines. The postulated failure mode of these lines is a critical crack, which will result in relatively lower flooding rates compared to those considered in the effects of non-Category A equipment failure (References 8, 9 and 10) and it was therefore concluded that flooding effects due to OSSS/AM components failure outside the containment are enveloped by the previous study.

Based on the foregoing summary, it is concluded that flooding due to failures of OSSS/AM piping would not result in unacceptable flooding interactions with HSS scope components.

3.3 High Energy Line Break Interactions

3.3.1 Approach

Previous studies (References 12, 13 and 14) identified jet impingement and pipe whip interactions from postulated high energy line breaks. There are 37 breaks postulated in OSSS/AM systems inside the containment. Interactions resulting from these breaks were evaluated by walkdowns.

Outside the containment, there are 4 breaks postulated in OSSS/AM systems and were also reviewed by walkdowns for possible targets.

3.3.2 Walkdown

For each postulated break, the break location, jet orientation, and jet dimensions were identified on a zone of influence (ZOI) sketch included in the walkdown packages.

Possible target components, as defined in Section 3.3.1, within the three-dimensional ZOI were listed on the target list included in the walkdown package. For each impacted item, the distance (to the nearest foot) between the break location and the target, measured along a line-of-sight from the break, was also recorded.

Credit was taken for jet impingement protection provided by intervening components or structures (e.g., structural beams and columns, concrete walls, piping with a diameter larger than the broken line). However, smaller or lightweight items (e.g., HVAC duct, conduit, instruments) were assumed to give limited or no protection to components behind them. Conduits flush mounted to walls were not considered as susceptible targets.

3.3.3 Evaluation

It was determined from the plant walkdown that the 4 OSSS/AM breaks outside the containment do not result in jet impingement or pipe whip on HSS targets.

For OSSS/AM breaks inside the containment, electrical targets identified by plant walkdowns were noted and the effected circuits in the target raceway were then identified by the raceway schedule. An evaluation for acceptability of the target circuit was performed on each circuit identified by application of the RTS scope and criteria. The 29 unresolved HSS system interactions identified in previous High Energy Line Break submittal (Reference 12) were determined to be from breaks located on lines RHR-3000-6", RHR-3001-6", RHR-3015-6", and LDS-2071-2". Analyses were performed by application of the RTS seismic criteria to demonstrate that these lines meet the 0.67g seismic requirements and therefore are precluded from seismically induced failure. Based on the foregoing evaluation, it is concluded that seismically induced breaks in OSSS/AM high energy piping would not result in unacceptable interactions with HSS components.

4.0 RESULTS AND CONCLUSIONS

Potential interactions between OSSS/AM components and HSS systems were first screened to determine possible interactions and then verified by plant walkdowns to show no siginificant interactions. HSS system interactions identified by plant walkdowns were further evaluated for acceptability. The results of these evaluations are summarized below:

1) Falling Items: Equipment anchorage for possible OSSS/AM equipment sources identified by the plant walkdowns were analyzed and found to meet the RTS seismic criteria (i.e., to withstand a 0.67g earthquake) or were shown to have no credible HSS interaction. It was also determined that seismically induced falling items resulting from OSSS/AM component failures would not adversely impact the safety functions of HSS systems.

2) Flooding: HSS system interactions resulting from flooding by OSSS/AM component failures were determined to be enveloped by the design basis floods previously evaluated and therefore would not result in unacceptable HSS system interactions.

3) High Energy Line Break Interactions: HSS system interactions resulting from plant walkdowns were evaluated by performing additional analyses to document that OSSS/AM source piping meet the RTS seismic requirements and therefore would not fail under seismic conditions.

Based on the foregoing summary, it is concluded that there are no unacceptable HSS system interactions resulting from OSSS/AM failures under seismic condition.

5.0 REFERENCES

(1) Enclosure to letter dated April 12, 1982 from K.P. Baskin (SCE) to D.M. Crutchfield (NRC).

(2) Enclosure to letter dated October 2, 1984 from M.O. Medford (SCE) to W.A. Paulson (NRC).

(3) San Onofre Nuclear Generating Station Unit 1, NRC Docket 50-206, Seismic Reevaluation and Modification, April 29, 1977.

(4) Enclosure to letter dated February 8, 1982 from R.W. Krieger (SCE) to D.M. Crutchfield (NRC).

(5) Enclosure to the letter dated December 8, 1981 from K.P. Baskin (SCE) to D.M. Crutchfield (NRC).

(6) Enclosure to the letter dated April 30, 1982 from K.P. Baskin (SCE) to D.M. Crutchfield (NRC), September 30, 1982.

(7) SCE to NRC letter dated October 17, 1984, from K. P. Baskin to H. R. Denton - Subject: Seismic Withstand Capability

(8) SCE to NRC letter dated March 21, 1975, from K. P. Baskin to Karl Goller - Subject: Effects of Non-Category A Equipment Failure

(9) SCE to NRC letter dated May 30, 1975, from K. P. Baskin to Karl Goller - Subject: Effects of Non-Category A Equipment Failure

(10) SCE to NRC letter dated October 28, 1975 from K. P. Baskin to R. A. Purple - Subject: Response to Questions on Non-Category A Equipment Failure

(11) NRC to SCE letter dated March 18, 1981 from D. M. Crutchfield to R. Dietch - Subject: Multi-plant issue B-11 and partial review of SEP Topics III.5.b and VI.7.d

(12) SCE to NRC letter dated October 11, 1983 from R. W. Krieger to D. M. Crutchfield, enclosing HELBA report: High Energy Line Break Analysis Inside Containment

(13) SCE to NRC letter dated March 31, 1983 from K. P. Baskin to D. M. Crutchfield enclosing HELBA report: Supplemental Study Report on Effects of a Piping System Break Outside the Containment

(14) SCE to NRC letter dated October 11, 1983 from K. P. Baskin to D. M. Crutchfield enclosing HELBA Report: Supplemental Study Report on Effects of a Piping System Break Outside the Containment, Addendum 1