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May 28, 1986

REGION V

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Mr. John B. Martin, Regional Administrator  
U. S. Nuclear Regulatory Commission  
Region V Office  
1450 Maria Lane, Suite 210  
Walnut Creek, CA 94596-5368

Dear Mr. Martin:

Subject: Docket No. 50-206  
San Onofre Nuclear Generating Station, Unit 1

On May 22, 1986, an enforcement conference was held at the San Onofre site pursuant to Mr. D. F. Kirsch's letter to the undersigned, dated May 14, 1986. The purpose of this letter is to summarize the actions we are taking, as discussed in the attachment hereto, which are related to three items of apparent violation discussed at the enforcement conference and noted in NRC Inspection Report 50-206/86-07. This inspection report was forwarded by Mr. A. E. Chaffee's letter to Mr. K. P. Baskin dated May 16, 1986.

A detailed discussion of the results of our investigation of the November 21, 1985, water hammer event at San Onofre Unit 1, and of actions we are taking to prevent recurrence, is provided in a report forwarded to Mr. Chaffee by Mr. Baskin's letter of April 8, 1986. This report provides a brief description of work we are performing to ensure a high standard of material condition is established and maintained at Unit 1. This work is described as the Material Condition Review Program (MCRP).

As discussed at the enforcement conference, in addition to the MCRP, we have initiated a separate review to ensure that those safety related areas not specifically addressed during the ongoing outage by the MCRP are adequately addressed by other measures, with respect to verification of material condition. If you would like additional information concerning the MCRP or this additional review, please let us know.

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Mr. John B. Martin

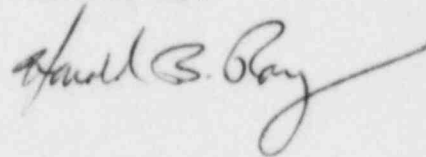
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May 28, 1986

In summary, Southern California Edison is committed to meeting a continuously rising standard of performance that is based on thorough analysis of our experience and on comprehensive and effective corrective action, where warranted. We will not be satisfied with only meeting minimum requirements, and we accept full responsibility for taking whatever action is necessary to ensure that our units are operated in accordance with the highest standards of safety.

We appreciate the thoroughness with which the NRC has evaluated the Unit 1 water hammer event, and our plant operations generally. If you have any questions or comments concerning the information included in the attachment hereto, or if you would like additional information, please let us know.

Sincerely,



Attachment

cc: David J. Fogarty  
L. T. Papay  
Kenneth P. Baskin  
F. R. Huey - NRC Resident Inspector Office

## Attachment

### SUMMARY OF ACTIONS BEING TAKEN BY SOUTHERN CALIFORNIA EDISON CONCERNING ITEMS DISCUSSED AT THE MAY 22, 1986, ENFORCEMENT CONFERENCE

#### PURPOSE

This document summarizes the actions being taken by Southern California Edison concerning three items of apparent violation, as discussed at the May 22, 1986, NRC enforcement conference held pursuant to Mr. D. F. Kirsch's letter to Mr. H. B. Ray dated May 14, 1986. These items are summarized in the NRC Inspection Report forwarded by Mr. A. E. Chaffee's letter to Mr. K. P. Baskin dated May 16, 1986.

#### DISCUSSION

Mr. Chaffee's letter identified three apparent violations. For convenience, separate discussion is provided for each apparent violation.

##### Apparent Violation #1

On page 2 of Inspection Report 50-206/86-07, the apparent violation is described as follows:

"Failure to implement an inservice testing program that was adequate to detect failures in safety related equipment. These undetected equipment failures resulted in the loss of capability to provide automatic auxiliary feedwater to steam generators as required by Technical Specifications and resulted in extensive water hammer to the feedwater system (paragraph 3)."

On page 7 of the Inspection Report, this apparent violation is summarized in the Conclusions as follows:

"The inservice testing program implemented by the licensee did not meet the requirements of 10 CFR 50, Appendix B, Criterion XI, in that it did not detect safety related component failures in the feedwater system. These failures resulted in failure of the auxiliary feedwater system to perform satisfactorily when required. In particular, the licensee's program did not properly consider prior equipment history associated with components covered in the program."

### Discussion of Apparent Violation #1

The facts and circumstances concerning this apparent violation are summarized in paragraph 3 of the Inspection Report. In particular, although the feedwater check valves had experienced prior failures, Edison believed that the cause of the prior failures had been corrected by modifications made in 1977, as confirmed by subsequent inspection. Also, Edison relied upon the performance of the ASME B&PVC Section XI program (IST program) to satisfy the testing requirements of 10 CFR 50, Appendix B, for these valves.

However, it is apparent that extended operation at reduced power increased the severity of service for the check valves, and this was not recognized or considered in the implementation of the IST program. Thus, the program, as implemented, was not adequate to detect the failures which occurred.

### Corrective Action for Apparent Violation #1

Early in the investigation and development of corrective action following the water hammer event, Edison implemented a comprehensive review and upgrade of the IST program. The review includes an evaluation of component histories and the results of inspections conducted during the ongoing outage. It will also include evaluation of those areas where equipment histories and inspection results may be very limited, or nonexistent, due to system design and/or operating characteristics.

This review and upgrade is ongoing at this time. Results to date include the following:

- o The feedline to each steam generator has been modified to include two check valves, instead of one as provided previously. Provision has been included to individually leak check each valve separately. Previously, the drain connection provided for IST of the single valves was located so as to preclude accurately measuring seat leakage.
- o Although only verification of closure was required, the IST program will now require measurement and trending of seat leakage for the new feedwater system check valves. This will permit early identification of any valve degradation. Also, within 6 months, a review will be completed to determine if other check valves warrant periodic measurement and trending of seat leakage. Any such valves will then be subject to this procedure.



- o The IST program will now require that at least 25% of the valves which require cold shutdown to perform their IST will be tested each Mode 5 outage. The goal will be to test all valves if time permits, and administrative measures will require that valves with the highest priority for testing be tested first.
- o All safety related check valves will be subject to periodic inspection, or to an adequate reverse flow operability test, as part of the IST program.
- o A complete review is being made of all valves potentially subject to IST requirements in order to identify means of testing more valves with the unit in operation, and means of testing some valves which have not previously been subject to IST. Where complete IST is not practical due to system design or operating limitations, provision will be included in the computer-based maintenance program for periodic inspection and verification of valve operability. This work will be completed within 6 months.
- o Representative examples of the 8 check valves, which were installed during the current outage to replace the 5 feedwater system check valves found to be deficient following the water hammer, will be disassembled and inspected for indications of degradation at the next refueling outage. Based on the results of these inspections, a determination will be made regarding future inspections.
- o Edison is actively evaluating a test program to develop a correlation between accelerometer or acoustic emission signals and known valve defects for future inservice use. This correlation is intended to be determined as a function of flowrate. Industry interest in participation in such a program will be sought.

In addition, following earlier development of procedures for implementation of the IST program, Station Management had transferred it from the Technical Division to the Operations Division. This transfer increased the efficiency with which the program was implemented, and has resulted in testing more valves than may have been tested otherwise. However, it also significantly reduced the ongoing technical input to the program. As a result of the water-hammer experience, the responsibility for implementation of the program has been returned to the Technical Division, where it will remain. An

enhanced, computer-based administrative program has been developed to manage the program, and all related data, in the future. This program is in use now and backfit of historical test failure data will be completed in 6 months.

#### Apparent Violation #2

On page 2 of the Inspection Report, the apparent violation is described as follows:

"Failure to implement effective actions to correct malfunction of safety related equipment following identification of equipment deficiencies several months prior to the event (paragraph 4)."

On page 7 of the Inspection Report, this apparent violation is summarized in the Conclusions as follows:

"The licensee failed to take effective corrective actions following indications of a possible safety related check valve malfunction, as required by 10 CFR 50, Appendix B, Criterion XVI. Furthermore, the licensee did not inspect or test the valve during subsequent plant outages."

#### Discussion of Apparent Violation #2

As discussed in paragraph 4 of the Inspection Report, Edison took a number of actions in response to a noise heard in one of the three feedwater lines in June 1985. These actions included radiography, piping vibration and stethoscope measurements, formal evaluation by the Onsite Safety Review Committee (OSRC), and review in accordance with the offsite safety evaluation program. Much of this review and evaluation was focused on the downstream block valve; the apparent source of the noise.

However, Edison did not formally address the potential for the safety function of multiple check valves to be affected, or for their failure to affect the safety function of the Auxiliary Feedwater System. Thus, the actions taken were not effective in ensuring that the noise heard was unrelated to these significant potential problems.

#### Corrective Action for Apparent Violation #2

Edison has consistently provided for a broad participation in its OSRC deliberations, and the discussion of the feedwater line noise was no exception. Nevertheless,

in order to minimize the potential for important safety considerations to not be fully addressed, Edison has retained the services of a consultant, experienced in nuclear plant operation and maintenance, to participate in OSRC meetings for all three units at San Onofre. The consultant normally will provide input to the OSRC chairman, but provision has been made for both regular and exception reporting to the executive level at the site and Edison general offices as well.

As indicated in the discussion of corrective action for apparent violation #1, return of the IST program implementation responsibility to the Station Technical Division will also increase the ongoing technical input to the direction of this important program.

### Apparent Violation #3

On page 2 of the Inspection Report, the apparent violation is described as follows:

"Failure to provide appropriate procedures for the troubleshooting and prompt isolation of faults on 4KV electrical equipment (paragraph 5)."

Paragraph 5 of the Inspection Report includes the following:

"Operating Instructions SO1-9-7 and SO1-9-2, '4160V Systems Operations,' provided precautions on operation of diesel generators in parallel with the C auxiliary transformer, based on potential short circuit currents in excess of the 4160V switchgear rating. These procedures did not provide similar guidance on operation auxiliary A or B transformers in parallel with the auxiliary C transformer. With these transformers in parallel operation, the transformers are able to deliver a total of 263 MVA to a fault on the load side of the bus; however, the bus and circuit breaker ratings are only 250 MVA.

"The A auxiliary transformer is Y-wound with its neutral connected to ground through a high resistance. During the period that the faulted C auxiliary transformer was paralleled to the A auxiliary transformer, this high resistance path to ground increased the leakage current through a known fault in a feeder cable from the C transformer. This resulted in accelerated insulation breakdown and subsequent major short circuiting between phases, causing a loss of the C transformer due to the action of protective relays."

On page 7 of the Inspection Report, this apparent violation is summarized in the Conclusions as follows:

"The licensee did not provide appropriate procedures for troubleshooting and isolation of faults associated with station electrical equipment, as required by 10 CFR 50, Appendix B, Criterion V. In particular, inappropriate operator actions associated with troubleshooting of an apparent ground on a safety related 4KV bus resulted in delayed isolation and de-energization of the C auxiliary transformer. This delay allowed the existing fault conditions to rapidly deteriorate, causing a loss of all offsite power and initiating the water hammer event."

### Discussion of Apparent Violation #3

This apparent violation includes three related issues which pertain to the appropriateness of the operating procedures: (1) the precautions related to protection against exceeding bus and circuit breaker ratings; (2) the extent to which parallel bus operation, with the indication of a ground on one of the feeders to one of the buses, resulted in accelerated insulation breakdown and subsequent failure; and (3) the extent to which inappropriate operator actions resulted in delayed isolation and de-energization of the C auxiliary transformer. Because of its importance to the corrective action taken, Edison's evaluation of each of these issues is addressed separately below.

#### - Protection Against Exceeding Bus and Circuit Breaker Ratings

As indicated in the Inspection Report, the maximum power that can be delivered to any fault with two buses in parallel is 263 MVA. The maximum that can be delivered by either transformer to its associated bus is far below the 250 MVA rating of its feeder breakers. Therefore, no fault can result in the power transferred exceeding the rating of the feeder breakers.

The breakers are set to open at less than 100 MVA. Therefore, the power delivered through either bus to a fault cannot exceed 200 MVA for a period longer than the few cycles required to open the feeder breakers and/or bus tie breakers. The current could momentarily exceed by perhaps 5% the rating of a load breaker serving a fault, but at no time would it exceed the rating of either the feeder or bus tie breakers. In fact, a large margin is provided between the rating of these breakers and the maximum power transfer possible.



The precautions provided in the procedures concerning parallel operation of a diesel generator with the auxiliary transformers are based on a consideration which does not apply to parallel operation of two auxiliary transformers. Specifically, extended duration operation of the loaded diesel generator during surveillance testing, warrants an additional measure of protection which is not otherwise required. Thus, current limiting reactors are inserted by procedure during such operation.

Edison does not consider it necessary for procedures concerning parallel bus operation to require insertion of the current limiting reactors. Although such insertion would not have created a problem, it would not have prevented or mitigated the loss of offsite power which occurred on November 21, 1985, and it could add unnecessary complication to the actions required by the operators in promptly locating and isolating a ground indication.

- Acceleration of Insulation Breakdown and Subsequent Failure

The high resistance path to ground identified in the Inspection Report, which was provided when the 1C bus was paralleled to the 1A bus, was in the form of the ground detector connected to the neutral point of the A transformer. Buses 1A, 1B, 1C and 2C, and their associated transformers, are all ungrounded. Bus 1C is provided with a ground detector, and parallel operation with Bus 1A introduced a second ground detector. The maximum possible increase in the current to ground resulting from the second ground detector is 10 ma. This is the limiting current that would flow through the detector from a fully faulted 4KV source.

The 1A and 1C buses were paralleled for 6 minutes in order for a test technician to check the possibility that the ground was in the synchronizing potential transformer. The C auxiliary transformer was isolated, due to a fault on the feeder to the 1C bus, about an hour after this parallel bus operation had ended. Therefore, during the 6 minutes of parallel bus operation, the increase in the current to ground resulting from the second ground detector was far less than the 10 ma maximum.

Edison has carefully evaluated the sequence of events involved in this case and concludes that the 6 minutes during which a second ground detector was in parallel with the ground on the feeder to the 1C bus did not contribute in any

significant manner to the development of a fault on that feeder about an hour later. Further, the associated parallel bus operation should not be precluded, since it provides the needed flexibility to the operators to deal in the safest manner possible with the multitude of circumstances which cannot be anticipated in advance. Accordingly, an appropriate procedure would not prohibit such operation during electrical ground troubleshooting.

- Inappropriate Operator Actions Resulting In Delay

Actions by the operators which were not appropriate, and which resulted in delay in isolation and de-energization of the C auxiliary transformer, are not detailed in Inspection Report 50-206/86-07. However, the NRC IIT report, NUREG 1190, includes the following:

"Once the electrical ground was located on the feeder from auxiliary transformer C to bus 1C, the operators did not aggressively pursue isolating the auxiliary transformer. Instead, they opted to leave the transformer energized while technicians performed inspections that did not require the transformer to be energized."

The report of Edison's investigation into the November 21 event is forwarded by Mr. K. P. Baskin's letter to Mr. A. E. Chaffee dated April 8, 1986. As indicated in Section 6.2.4 of that report, Edison concludes that:

"The root cause of the auxiliary transformer C isolation has been determined to be that the ground was not isolated as soon as it could have been. This, in turn, contributed to the development of the ground into a fault."

The actions which were being taken by the operators while the transformer remained energized, and their rationale for these actions, are also described in the report (e.g., pages 6-230 and 6-231).

Corrective Action for Apparent Violation #3

Section 6.2.4 of the Edison report describes actions being taken to ensure that any future electrical grounds are isolated as quickly as practical. In addition, Edison is installing a "bus parallel alarm" to annunciate after the 4KV buses have been paralleled longer than 10 seconds. However, following thorough consideration, it has been concluded that appropriate procedures should not include a time limit on parallel bus operation.

As was illustrated when the 4KV ground appeared in this instance, and the operators were required to maneuver the plant in an abnormal condition due to a preexisting salt leak in the main condenser, Edison concludes that appropriate procedures should not include unnecessary restrictions on the flexibility of the operators to maintain the plant in the safest condition possible. Since the C auxiliary transformer provides the source of immediately available offsite power to Unit 1, its isolation requires careful consideration and should be justified by elimination of other options for maintaining it in service. Consideration continues to be given to procedure revisions which would promptly isolate the C transformer and place the unit into an orderly shutdown sequence following identification of a potential for loss of the transformer, however, the ability of experienced supervision to exercise judgement based on the existing, specific facts is considered essential.

#### CONCLUSION

Action has been, or is being, taken by Edison in the areas of the three apparent violations discussed above which will minimize the possibility of a recurrence at San Onofre Unit 1 of an event such as occurred on November 21, 1985. In addition, comprehensive programs have been developed and implemented to address the underlying causes of this event which are related to the material condition of plant systems and equipment.