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Director, Office of Nuclear Reactor Regulation
Attention: Mr. George E. Lear, Director
PWR Project Directorate No. 1
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

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

By letter dated, June 5, 1986, the NRC staff requested that we review their evaluation of certain technical issues related to the November 21, 1985 Water Hammer Event. This review has been completed and our comments are provided in the enclosure.

If you have any questions or desire additional information, please contact me.

Sincerely,

M O Medford

Enclosure

cc: Mr. J. B. Martin, Regional Administrator, NRC, Revion V
Mr. A. E. Chaffee, Regulatory Projects Branch, Region V
Mr. Gary Zech, Office of Inspection and Enforcement
Mr. F. R. Huey, NRC Senior Resident Inspector, SONGS 1, 2&3

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SCE COMMENTS

NRC Evaluation of Technical Issues
Related to the November 21, 1985 Event
San Onofre, Unit 1

1. Page 7, Paragraph 1, states that for "a complete Loss of Offsite Power (LOP), only one operator action is required to manually restore on-site AC power to the Class IE bus in order to supply power to the motor driven auxiliary feedwater pump." This statement is not completely correct. If a complete loss of AC power is experienced (due to the loss of the grid for example), then one additional action needs to be completed prior to energizing the safety related buses from the diesel generators. This additional action is to reset the LOP/LOB circuit at the sequencer panel in the control room.

2. Page 12, Paragraph 1, there are words missing in the first line. Also, this section describes the motor driven AFW pump rated design flow to be 208 gpm. This flow rate is in fact the "calculated flow" rate used for the pump in the safety analysis and is based on flow control valve preset positions and the safety valve pressure setpoint. The rated design flow for this pump is 235 gpm.

3. Page 12, Paragraph 2, states that a requirement exist to verify that the motor driven AFW pump delivers 375 gpm at 700 psig discharge pressure. The 375 gpm requirement is based on the flow requirements for a feedline break. The 700 psig discharge pressure is an approximate pressure at 375 gpm based on the original pump curve which was informally transmitted to the NRC staff during a telephone discussion. The pump has been completely refurbished during this outage. A new pump curve has been determined by testing at the factory. The testing program was conducted with a motor equivalent to the actual motor which drives the pump in the plant. The motor used has the same brake horsepower rating and was run at the same rpm. Measurements were obtained for efficiency, brake horsepower, net positive suction head and rpm.

   The test program included as the last point on the new pump curve a point at 405 gpm and 561 psid. This point was determined to be a stable point before runout and it is therefore expected that the pump can operate at this point indefinitely, if necessary. The vendor was asked how much margin this point had to the runout condition. In response the vendor informally stated that runout can be defined in several ways, but in general a pump in good condition would be expected to have problems with reliability above 150% of peak efficiency flow. From the new factor generated curve produced after complete rebuild of the pump in the vendors facility, the peak efficiency point is 282 gpm. Therefore, above 423 gpm the pump would be expected to encounter possible cavitation and runout.

In addition to testing performed at the factory, the pump was tested in the plant using the emergency flow path for auxiliary feedwater. The test measured suction pressure, discharge pressure and flow rate. Multiple data points were obtained including a point at 385 gpm (to the steam generators) achieved at 510 psig discharge pressure. This point is consistent with the new pump curve obtained at the factory and includes consideration of flow diversion due to pump recirculation and seal water supply. The pump low discharge pressure trip has been reset to 500 psig.

It should be noted that this pump capacity is adequate since the 375 gpm flow is required only for accidents involving a feedline break during which the steam generators are depressurized to approximately atmospheric conditions. Under these circumstances, the operators will manually throttle flow to establish the desired auxiliary feedwater flow rate.

4. Page 13, Paragraph 3, "ensuring" should be ensueing.

5. Page 17, Paragraph 2 states that "the EOI's should be modified to direct the operators to take action to initiate the third AFW train and place it in a standby mode immediately upon indication of abnormal conditions requiring AFW flow." As a result of further discussions with the NRC staff, agreement was reached on the use of the third pump and this approach is explained below.

   The third AFW pump, presently powered from the dedicated shutdown system diesel generator, is a full capacity AFW pump which discharges to the AFW header similarly to the other two AFW pumps. Until the third AFW pump is upgraded, during the next refueling outage, to an automatically initiated pump, it must be manually started by first starting the diesel generator and then energizing its associated 4 kV bus. After starting the pump, its discharge valve, located at the pump, is manually opened, which then places it in parallel operation with the other two AFW pumps.

   To initiate the use of the third AFW pump during off-normal events, the EOI's are being revised to include the direction that the third AFW pump be placed in service upon the demand for auxiliary feedwater flow, coincident with the unavailability of any of the main feedwater pumps or the AFW pumps such that only one of these four normal sources of feedwater remains available. This action is to be taken upon placing and ensuring the plant is in a stable condition not requiring the services of the operator required to place the third AFW pump and diesel generator in service. If both AFW pumps were to fail, the priority for placing the third AFW pump in service would be elevated appropriately.

6. Page 29, Paragraph 1, states "The licensee acknowledges that the labels on the vital bus availability lights are not large enough to read from all areas of the control room, but states that this deficiency is not considered to be an immediate safety concern."

To more accurately reflect the SCE position, this sentence should be replaced with the following sentence.

> "The licensee is aware that the indication for the vital buses is of concern, however the size of the labels are not an immediate safety concern."

The basis for this position is as follows:

> The vital bus labels appear to be difficult to read from a distance across the control room but it is possible to determine that all vital buses are, or are not, energized from all areas in the control room. However the actions of the operating staff to promptly identify the loss of the vital bus and take corrective action within 20 seconds demonstrates that the operating staff is familiar with the location of the lights on the control board and the size of the labeling did not delay response during the event. The layout of the control panel does not permit the indication for the vital buses to be readily altered without affecting the electrical mimic bus, or meter indication which is adjacent to the vital bus lights. The licensee considers the relocation of the vital bus indication to another location on the control panel inappropriate as it would alter the relationship of the vital bus indication to other electrical system indications.
>
> Increasing the size of the vital bus indication has an impact on the other instruments and the mimic panel on the electrical control panel. A modification of this nature must be given careful consideration to ensure it is properly integrated into the overall design of the control panels. Since the indication proved to be adequate during the event, redesign of the vital bus indicating lights is not immediately required to restart with the understanding that SCE will include an evaluation of the vital bus indication in the Control Room Design Review. The Control Room Design Review Team will confirm that no short term enhancement of the labels for the vital bus availability lights is possible.

7. Page 31, Paragraph 2, states that the UPS for vital bus 4 will be installed during the next refueling outage. Subsequent to the issuance of the NRC evaluation it appeared that this modification might be completed prior to return to service. Recent implementation difficulties have occurred, however, which prohibit completion of this modification prior to startup. The modification schedule will therefore remain as stated in the evaluation (i.e., next refueling outage).

8. Page 39, Paragraph 1, states that the results of the study of the means to enhance the availability of the second source of offsite power will be provided by June 30, 1986. As previously discussed with the NRC staff, this date will be delayed to July 30, 1986.

9. Page 50, Paragraph 1, states "This alarm will alert operators of a pending loss of trending information." This statement is not entirely correct in that the alarm will not be heard in the control room. Identification of a loss of power to the computer would occur only after an entry is made into the technical support center. Since the software changes to automatically reset the computer after a power interruption have been completed and, as discussed in Item 10 below, the hardware modification to provide a UPS for the computer have also been completed, the need for this alarm is not critical.

10. Page 50, Item 2, states that the UPS for the TSC Fox III Computer will be installed by no later than July 15, 1986 if not installed by return to service. This modification has been completed.

11. Page 54, Paragraph 2, states "During the loss of offsite power event of November 21, 1985, the auxiliary transformers 'A' and 'C' were paralleled for time periods beyond the time-limits stated for startup conditions for trouble-shooting of a ground fault on the 4360 volt system."

    The previous paragraph describes the normal startup paralleling sequence in which there is no need for any intentional time delay. During the event there was no specific time limit specified in the operating procedures. Specific Items 6.E (pg. 68) and 12.C (pg. 71) require improvement of cautions and limitations of parallel bus operation.

    Since no specific guidance or limit was specified at the time. The phrase "paralleled for time periods beyond the time-limits stated ... for trouble-shooting of a ground fault," is inappropriate.

12. Page 55, Paragraph 2, states "While this current is limited to a low value, it was larger than the ground fault current before this path existed. The staff believes that this ground fault current value became sufficiently large due to the addition of the second ground path so that the existing cable fault was worsened. With one ground on the system, as was the case on transformer 'C', it is not advisable to parallel another grounded source (such as transformer 'A' and 'B') with transformer 'C'."

    The staff's "belief" that the additional ground current caused localized heating in cable accelerating the ultimate failure, cannot be supported by electrical theory or physical evidence. When the 1C bus (with grounded B phase supply cable) was paralleled with the 1A bus on November 21, 1985, a ground loop was created. The ground loop current is limited to 0.030 amps by the impedance of the neutral grounding transformer. The power dissipated by 0.030 amp of circulating current is approximately 120 watts. A 100% ground would mean that the ground contact resistance is very low (less than one ohm). Since the power in the ground loop is dissipated in the portion with the most impedance (i.e., the neutral grounding transformer), the heat dissipated in the cable ground itself is extremely low ($W = I^2R = 0.03^2 \times 1$ or 9×10^{-4} Watts). The temperature rise in the cable due to the heat from 9×10^{-4} watts for 5 minutes was insignificant.

If, as the NRC contends, all 120 watts were to dissipate at the original (B phase) ground fault, then the C phase ground should have occurred near the B phase fault. In actuality, the B and C phase faults were 27" apart and straddled the uninsulated feedwater pipe flange. Pictures of the failed cable both in the plant and during disassembly where given to the IIT team prior to their leaving SONGS.

This portion of the report should be changed to read as follows:

> "Since this additional ground current is limited to a low value, paralleling of 4 kV buses with the ground present did not contribute to the second ground which caused the failure of the cable. Dissassembly and examination of the failed cable showed the failure to be 27" away from the original ground on B phase. The failures on the B and C phases straddled the uninsulated feedwater pipe flange."

13. Page 56, Paragraph 1, states "It would be inappropriate to parallel transformers 'A' and 'B' with transformer 'C' for supplying power to 4360 V safety related switchgear because serious damage could result to the safety related switchgear in case of a fault."

The power plant cannot be shutdown or started up in an orderly manner without paralleling these transformers to transfer buses 1A and 1B supply from the 'C' transformer to transformers 'A' and 'B'. The first paragraph of section 2.0 (Page 53) describes this bus paralleling as a known startup or shutdown evolution.

The above statement needs to be revised to read, "It would be inappropriate to CONTINUOUSLY parallel ...." A bus paralleled alarm Item 6B (Page 68) is being added to alert the operator to the fact the buses are in a non-normal alignment. The alarm response procedure will require corrective action to remove the paralled condition.

14. Page 57, Paragraph 1, states "This situation would result in both offsite sources being lost for a common fault in the 4360 V switchgear, when operating transformer 'C' in parallel with transformers 'A' or 'B'.

This sentence should be changed to read as follows (changes are underlined for clarity):

> "This situation would result in both offsite sources being lost to one electrical train for a common fault in its 4360 V swtichgear, when operating transformer 'C' in parallel with transformers 'A' or 'B'. The second electrical train would remain energized/uneffected by this fault on the opposite train since the fault will result in only the 4360 V bus being deenergized. The A, B and C transformers would not be deenergized by this fault."

15. In accordance with our comments to this section of the report, the conclusions (Page 57) should be changed to read as follows:

    3.0 Conclusion

    Based on the above evaluation of the SONGS 1 4360 V electrical system, the staff concludes that it is inappropriate to parallel auxiliary transformer 'C' with transformer 'A' or 'B', except momentarily during startup, shutdown or ground fault isolation. Continuously operating the transformers 'C' and 'A' (or 'B') in parallel is inappropriate for the following reasons:

    1. The Class 1E 4360 V switchgear is not rated to handle the maximum fault current (40,325A) which would result when the 4360 V buses are energized from the offsite power through auxiliary transformers 'A' (or 'B') and 'C'.

    2. Although circulating currents between auxiliary transformers 'A' (or 'B') and 'C' do not appear to pose a serious problem, it is not good operating practice to operate these transformers in parallel. The circulating currents would add to the normal current, thus affecting the transformer temperature rise.

    3. The two offsite sources supplying power through the two transformers ('A' and 'C' or 'B' and 'C') to one electrical train could be lost for a given single fault in the 4360 V switchgear.

16. Page 59, Item 7.b, provides the NRC evaluation of operator performance related to the attempts to locate and isolate the ground prior to the November 21, 1985 Event. This evaluation ignores, to a large extent, the equivalent evaluation provide by SCE in Section 6.4 of the Water Hammer Event Report submitted to the NRC on April 8, 1986. The SCE evaluation differs from the NRC evaluation in the area of procedure implementation and the contention that Technical Specification Action Statement were avoided. Additional use of the information provided by SCE regarding operator performance should be considered.

    A specific correction should be made to the sentence on Page 60, Paragraph 2, which states that "there was no sense of urgency. Operator actions demonstrated accelerated response and continuous perserverance to locate the 4 kV ground." The SCE determination regarding a "letdown in the sense of urgency" applies only to the period of time after the ground was located and refers to the attempts to isolate the ground.

17. Page 68, Action 5, Item 3.a.5, provides a recommendation to review further the design of the SLSS remote surveillance panels to possibly identify the deficiency which may have caused the faulty indication. In response to this recommendation, SCE will perform additional testing. During the loss of offsite power test from approximately 25% power the response of the Remote Surveillance Panels and the SLSS itself will be verified. If the November 21, 1985 anomoly does not return, this item will be closed.

18. Page 68, Action 6(e), Item 3.a.6, provides a recommendation to modify operating and emergency procedures to add a caution statement regarding parallel bus operation. This action has been completed as indicated by the following statement which has been included in Procedure SO1-2.6-6:

    CAUTION 4160 V feeder switchgear is not rated to interrupt faults that may occur when a bus is supplied from two transformers in parallel or, one diesel generator and 'A' or 'B' transformer in parallel; therefore, the time two transformers or a transformer and a diesel generator are paralleled must be minimized.

19. Page 69, Action 7, Item 3.a.7, provides a requirement to install larger labels for the vital bus availability lights. In accordance with our comment 6, the requirement should reas as follows:

    "The licensee Control Room Design Review (CRDR) Team shall confirm that no short term enhancement of the labels for the vital bus availability lights is possible. The final CRDR report will include a specific analysis of the vital bus availability lights."

20. Page 71, Action 12(c), Item 7.6, describes an SCE commitment to improve the ground alarm system to provide indication of auxiliary transformer 'C' ground conditions. This item should be deleted.

    Approximately three months ago, earlier in the electrical system analysis, there was a concern that the location of the 'C' transformer ground detectors contributed negatively to the operators performance during the November 21, 1985 event. A commitment was made at the time to move the ground detectors to the transformer side of the incoming breakers, electrically similar to that of the 'A' and 'B' transformers.

    The design change to accomplish this objective was completed and approved. The engineering evaluation concluded that there was no technical improvement made by this change nor was there any gain to be made with respect to the human engineering of the operator's performance since the ground isolation technique is similar with the ground detector in either location. Our human engineering review concluded that the means to significantly improve the operators performance is through procedure upgrade and additional training. These two items were recognized separately and are described by action summary Items 6E (Page 68) and 12A and 12B (Page 71).

    For these reasons, physical modification of the ground detectors on buses 1C and 2C was cancelled.