492-8930

E. Butcher

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON D. C. 20555

MEMORANDUM FOR: D. G. Eisenhut, Assistant Director for Operational Technology, Division of Operating Reactors

FROM: W. R. Butler, Chief, Plant Systems Branch
Division of Operating Reactors

SUBJECT: REVIEW OF I&E INSPECTIONS OF OPERATING PWRs RELATED TO THE FOLLOW-UP ACTIONS IDENTIFIED IN NUREG-0138 ISSUE NO. 4, "LOSS OF OFFSITE POWER SUBSEQUENT TO MANUAL SAFETY INJECTION RESET FOLLOWING A LOCA"

1.0 Introduction

Many of the current PWR control system designs include a safety injection signal (SIS) reset feature that, if actuated, will prevent automatic resequencing of engineered safety feature equipment in the event of a subsequent loss of offsite power. If the diesel generator cooling and air intake and ventilation systems were among the systems that did not automatically restart, the diesel engines could fail if the operator did not take prompt manual action.

A detailed discussion of all the concerns related to SIS reset and subsequent loss of offsite power is included as Issue No. 4 in NUREG-0138, "Staff Discussion of Fifteen Technical Issues Listed in Attachment to November 3, 1976 Memorandum from Director, NRR to NRR Staff." In the discussion of Issue No. 4, we stated that the Office of Inspection and Enforcement would review the emergency diesel generator loading at operating PWRs and that we would take follow-up actions to ensure that: (a) the diesel generator cooling water and air intake and ventilation systems start and continue to run whenever the diesel generators start; (b) that plant operating procedures set forth the necessary corrective operator actions after SIS reset with a subsequent loss of offsite power to assure manual restart of the required engineered safety features; and (c) that plant operating procedures do not permit SIS reset by operator action earlier than ten minutes after a LOCA signal unless it can be shown that such action is required in the interest of safety.

At our request (Memorandum, V. Stello to D. Thompson, dated December 28, 1976), the Office of Inspection and Enforcement conducted inspections of all the operating PWRs to determine the extent to which the above features exist in the control system designs and emergency operating procedures.

The purpose of this memorandum is to report on the results of the I&E inspections and to identify the necessary NRR follow-up actions.

2.0 Inspection Results and Evaluation

A summary of our review of the I&E inspection reports is provided in this Section. The first three items were identified in Issue No. 4, NUREG-0138.

2.1 Diesel Engine Auxiliaries Auto Start

We have confirmed that all of the operating PWRs have design features to ensure that the cooling water and air intake and ventilation systems start and continue to run whenever the diesel generators start regardless of the status of the SIS reset relays. This resolves our concern regarding potential diesel generator failures as a result of SIS reset with subsequent loss of offsite power.

2.2 Operating Procedures for Loss of Offsite Power After SIS Reset

Based on our review of the inspection reports, we are unable to verify that any of the operating reactors have plant procedures established to set forth the necessary corrective operator actions after SIS reset with a subsequent loss of offsite power. We are able to verify, however, that at least 14 do not have the desired operating procedures.

Write memo to get I&E to correct the procedures.

We have concluded that plant operating procedures should be modified to include consideration of this sequence of events because prompt manual action may be required to restart emergency equipment in the event of a loss of offsite power after SIS reset. However, due to the low probability associated with the initiating events, we do not believe that any immediate action by the NRC is necessary at this time. Instead, we propose to advise the licensees of this potential problem and to ensure that the required procedures are adopted on a timely basis as part of our continuing review of the need for a ten-minute delay for SIS reset (see Item 2.3 below).

2.3 Ten Minutes SIS Reset Delay

We have determined that the licensees for 26 of the 36 operating PWRs reviewed do not have procedures to prohibit SIS reset by operator action earlier than ten minutes after a LOCA signal. The average delay for SIS reset is one to two minutes, which is controlled by an adjustable time delay relay. The licensees generally do not favor a ten-minute delay for SIS reset. Enclosure 1 is a summary listing of statements that were made to I&E inspectors by licensees to support their position.

Although we do not agree with all of the licensees' reasons for objecting to a mandatory ten-minute delay in SIS reset, some of their statements, e.g.,(b), (c), (d), and (j) appear valid. Based on the limited amount of information available in the inspection reports, we find that the desirability of a mandatory delay in SIS reset may be dependent on the individual plant design. Therefore, we recommend that the minimum ten-minute time delay suggested in NUREG-0138 be considered on a case-by-case basis only after additional detail discussion with individual licensees. This is consistent with our position stated in NUREG-0138 that SIS reset earlier than ten minutes after a LOCA signal would be permitted if it could be shown that such action was in the best interest of safety.

2.4 SIS Reset Single Failure Modes

Some of the plants (at least four) have control system designs which include a single SIS reset button for both redundant ESF trains or two reset buttons (one for each train) which must be pressed simultaneously to achieve SIS reset. This design appears to degrade the degree of independence of the redundant ESF trains. We were unable to perform a complete evaluation of these designs based on the limited information in the inspection reports. Therefore, we will require additional information from the licensees on this subject.

see item 8 of LER 77-05 for Trojan. A single reset button failure may have disabled both recirculation trains.

2.5 SIS Reset and Spurious Control System Action

At least one of the operating reactors has a control system design that causes equipment to change status (e.g., valves move from one position to another) when the SIS is reset. Plants with this design require emergency procedures to ensure that ESF control switches will be placed in the proper position prior to SIS reset. With this design, a single operator error (premature SIS reset) might disable redundant ESF equipment. We are unable to determine from the I&E inspection reports the extent to which this feature exists at other operating reactors. Therefore, we will require additional information from the licensees to complete our evaluation of this item.

2.6 Diesel Generator Auto Start for SIS

Some of the plant control systems (at least two) do not automatically start the diesel generators when a SIS is initiated. The diesel generators are started automatically only on a loss of offsite power. This design results in an unnecessary time delay in restarting ESF equipment if a LOCA event were followed by a loss of offsite power. This time delay, while waiting for the diesel generators to start, would be in addition to the normal

diesel generator loading sequence time delays. The total time that portions of the ESF system are deenergized could be 25 seconds or more, depending on the individual plant design.

In our normal LOCA analyses we assume that a loss of offsite power occurs simultaneously with a LOCA. Although this is a conservative assumption, it may be less conservative and less realistic than assuming that the loss of offsite power is delayed until 15-90 seconds after the LOCA. This sequence is more likely because the effects of the disturbance to the utility grid system resulting from the LOCA do not occur until the main generator inertial energy has been dissipated and it finally trips. It is during this time period that it is necessary to reflood the reactor core following a blowdown of the reactor coolant system. This sequence of events is illustrated in Enclosure 2.

Any significant delay in reflooding the core could increase the peak fuel clad temperature resulting from a LOCA. The time delay in reflooding the core while waiting for the diesel generators to start after a loss of offsite power is shown in Enclosure 2 as the cross hatched area between 30 and 40 seconds. This time delay could be eliminated by automatically starting the diesel generators when an SIS signal is initiated. It should be noted, however, that this would not eliminate the time delay in reflooding the core while waiting for ESF loads to restart when a LOCA is followed by a delayed loss of offsite power.

The ACRS has also considered the question of a delayed loss of offsite power (LOP) following a LOCA and in its letter dated December 12, 1976 stated, "The ACRS believes that a sufficient basis does not now exist to eliminate from consideration the LOP at any time subsequent to the occurrence of a LOCA, and recommends that further studies of the probabilities and consequences of such an event be made by the NRC staff."

Based on these considerations we believe that the NRC staff should perform a sensitivity analysis to verify that short interruptions of cooling water flow to the core during the reflood period for the time necessary to complete the ECCS starting sequence will not have unacceptable consequences. This sensitivity analysis is necessary because the probability of a loss of offsite power as a result of a LOCA is highly sensitive to many variables and conditions and may be highest at about the beginning of the reflood period due to a delayed main generator trip.

In the interim, while the sensitivity analysis is being performed, we believe that all operating reactors should have control systems which automatically start the diesel generators on both a loss of offsite power and a SIS, unless the licensee can show that such action is not in the best interest of safety and that the time delay to start the diesel generators will not result in unacceptable consequences from a LOCA. This position should affect only a very few operating reactors and can be implemented on a routine basis as part of the follow-up actions recommended below.

3.0 Recommended Follow-Up Actions

We have indicated in the discussion above that we will require certain additional information from PWR licensees before we can complete our evaluation of Items 2.2 through 2.5. A generic request for additional information is provided in Enclosure 3. This should be forwarded to the Assistant Director for Operating Reactors for transmittal to all of the PWR licensees.

Our evaluation of Item 2.6, Diesel Generator Auto Start for SIS, is complete to the extent that we have determined that changes to some plant diesel generator starting controls may be desirable. A statement of the recommended staff position and request for additional information is provided in Enclosure 3. Enclosure 3 is applicable to both PWRs and BWRs and should be sent to all the licensees.

For the reasons stated in our discussion of Item 2.6, we also recommend that the NRC staff perform a sensitivity analysis to verify that short interruptions of cooling water flow to the core during the reflood period of a LOCA will not result in unacceptable consequences. This analysis should be performed in consultation with the Plant Systems Branch to ensure that all credible interactions of the utility grid system with the plant's onsite power system and ECCS equipment are accounted for. After we have determined the sensitivity of the LOCA analyses to this condition, a decision can be made as to the need for additional analyses by the individual licensees of the probabilities and consequences of such an event.

In summary, we have identified a significant amount of follow-up review effort that is required to resolve the SIS reset issue and our other concerns regarding loss of offsite power. We have discussed this matter with PSB/DSS. They agree with our proposed approach, and have verified that current licensing practice requires D/G start for either SIS or LOP. We believe that this follow-up work should begin as soon as possible. However, due to the low probability of the events under consideration, we conclude that there is no basis for any immediate changes to any operating licenses or to the current staff priorities in considering these issues. Given the existing priority we believe that all of the necessary follow-up review can be completed by the end of 1978.

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The associated memorandum to request the additional information identified in Enclosure 3 from the licensees is being forwarded for your signiture with this memorandum should you agree with our recommendations.

Walter R. Butler, Chief
Plant Systems Branch
Division of Operating Reactors

Contact:
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cc: D. Tondi
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Enclosure 1

Summary Listing of
Licensee Statements Regarding SIS Reset
Made During I & E Inspections

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a. "Before the ECCS can be switched to the recirculation mode the SIS must be reset on many designs. A ten-minute delay in switching to the recirculation mode is undesirable due to the excessive depletion of the Safety Injection Tank resulting from maximum safety injection flow. This would reduce the water inventory available from the Safety Injection Tank for subsequent core cooling."

b. "A ten-minute time delay for SIS reset would not permit the operational flexibility required to deal with small breaks. For example, resetting the SIS permits operation of the charging pumps for small breaks, otherwise the pressure must drop to 1500 psig to achieve cooling with the safety injection pumps. Also operation of low pressure injection pumps should be terminated as soon as possible to prevent over heating from low flow for small breaks."

c. "Preventing or prohibiting SIS reset for ten minutes increases the probability of reactor vessel overpressurization. This is especially significant during heatup or cooldown when the allowable reactor pressure is low and a spurious SIS is most likely."

d. "Preventing or prohibiting SIS reset prior to ten minutes will lengthen recovery to power operation following a spurious SIS due to the complete depletion of the Boron Injection Tank. This delay in recovery is substantial late in core life when the reactor coolant system boron concentration is low."

e. "The high pressure makeup pumps could run out during a large break condition. It would be necessary to reset the SIS to throttle the loop injection valves and eliminate the run out condition."

f. "A ten-minute time delay for SIS reset unnecessarily restricts general operational flexibility to deal with spurious SIS actuations."

g. "A ten-minute time delay for SIS reset may inhibit operators from manual initiation of safety injection equipment if they know they will have to wait ten minutes to resume control of the equipment."

h. "A ten-minute time delay for a SIS reset of an inadvertent initiation is not desirable in order to minimize reactor coolant system component thermal shock."

i. "The SIS signal inhibits other equipment which should be placed into service as soon as possible following a SIS actuation. Examples include the charging pumps, boric acid pumps, and other miscellaneous equipment."

j. "A delay in SIS reset will prevent timely realignment of ECCS equipment to permit isolation of some line breaks and thus achieve early termination of the LOCA."

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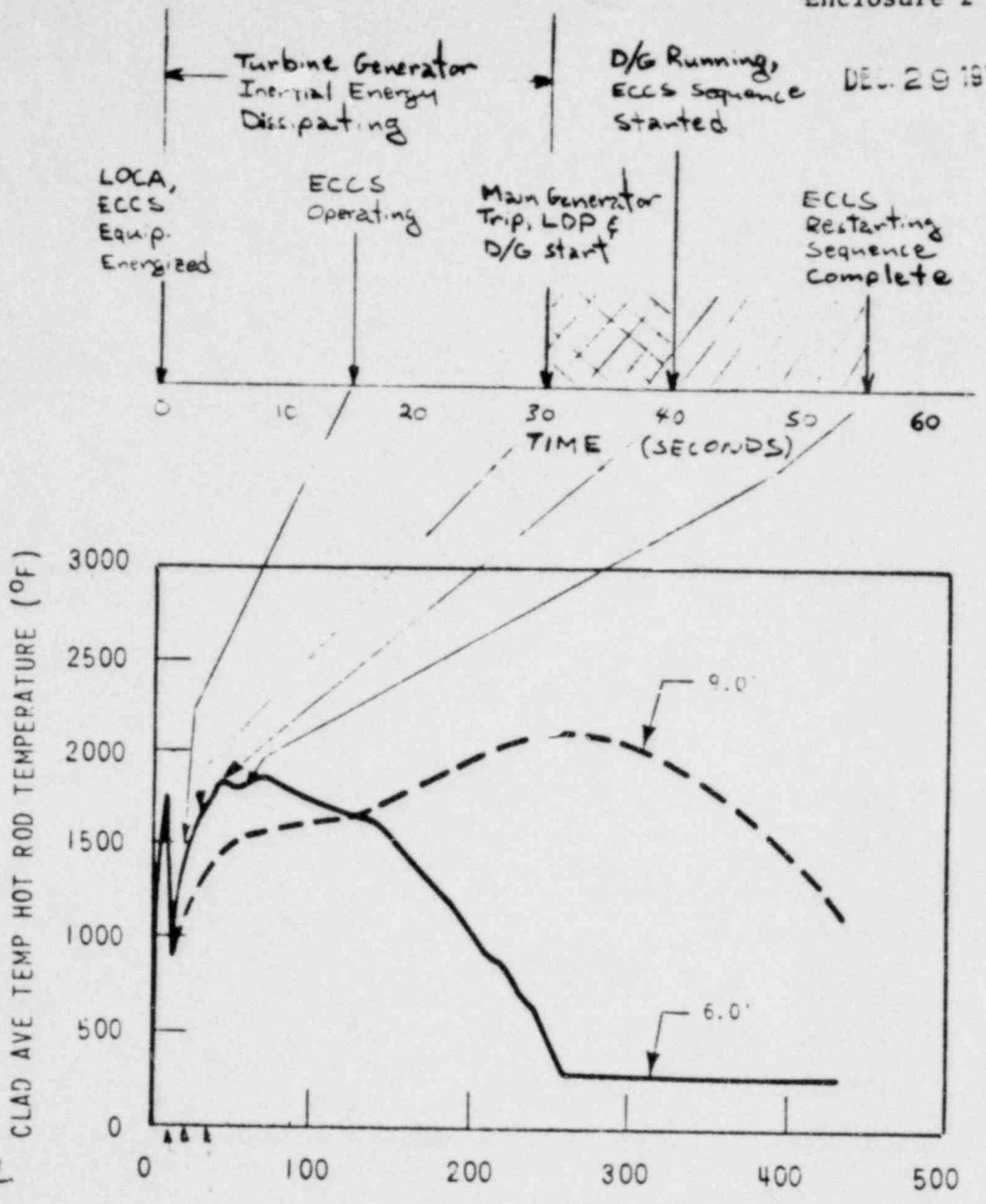

Sequence of Events (sec)

Start LOCA	0.0
Reactor trip signal	1.04
Safety injection signal	0.94
Accumulator injection	13.1
End of blowdown	21.68
Bottom of core recovery	34.9
Accumulators empty	55.9
Pump injection	25.94

station Blacked Out
No ECCS Equipment Available

station Power Restored
ECCS Equipment Sequencing Back On

Modified RESAR 35 Figure 15.4-28. Peak Clad Temperature - DECLG ($C_D = 1.0$)
(NRC Parameters)

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Enclosure 3

xyz Utility

Gentlemen:

Reference: List the reactors for which the utility holds operating licenses

The NRC Office of Inspection and Enforcement has completed a survey of the diesel generator and engineered safety features control systems at operating pressurized water reactors. This survey was conducted as a part of our review of issue number four in NUREG-0138, "Staff Discussion of Fifteen Technical Issues Listed in Attachment to November 3, 1976 Memorandum from Director, NRR to NRR Staff."

As a result of the survey, we have determined that certain changes to the existing control systems or emergency operating procedures at some operating boiling water or pressurized water reactors may be desirable, depending on the individual plant design. In order to complete our review and determine which plants, if any, should be modified, we request that you provide the additional information identified in the enclosure.

The requested information should be provided separately for each licensed facility. Since the enclosure was prepared to cover the broad spectrum of control system designs, you may conclude that some of our requests do not apply to your specific plant or plants. If this is the case your response should so state and set forth the basis for your conclusion.

Please provide the information requested in the enclosure within 45 days of your receipt of this letter.

Sincerely,

Enclosure:
Request for Additional Information

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Request for Additional Information
Diesel Generator and Engineered Safety
Feature Control System Design

1. Provide a copy of the emergency operating procedures that are applicable to all those plant conditions where operator action is required to mitigate the consequences of any transient or accident, including those followed by a loss of offsite power (e.g., loss of offsite power after a safety injection signal (SIS) reset with or without a concurrent LOCA). If emergency operating procedures do not exist for such conditions, provide your basis for not having such procedures or propose new procedures.

2. In the discussion of Issue No. 4, "Loss of Offsite Power Subsequent to Manual Safety Injection Rest Following a LOCA," in NUREG-0138, we stated, "the staff plans to require that... procedures be revised to assure that SIS reset by operator action earlier than ten minutes after a LOCA signal is prohibited, unless it can be shown that such action is required in the interest of safety." Propose emergency procedures which implement this position, or if you have concluded that such procedures would not be in the best interest of safety, provide the basis for your conclusion.

3. We have determined that some plants have control system designs which include a single SIS reset switch for both redundant engineered safety feature train c · two reset switches (one for each train) which must be pressed simultaneously to achieve reset. If your plant has such a design provide an analysis to demonstrate that one single failure will not disable both engineered safety feature trains.

4. We have determined that some operating reactors have control system designs that cause equipment to change status (e.g., valves change position) when the SIS is reset. Plants with this design require emergency procedures to assure that engineered safety feature control switches are placed in the proper position prior to SIS reset. If your plant has such a design, provide a copy of the applicable emergency operating procedure or provide your basis for not having such a procedure.

5. We have determined that some operating reactors have control systems which do not automatically start the diesel generators immediately from an SIS signal. These designs only start the diesel generators for a loss of power to the engineered safety feature buses. This design results in an unnecessary time delay in restarting engineered safety feature equipment if a LOCA were followed by a loss of offsite power. Our position is that such a design is not acceptable unless it can be

shown that the time delay to start the diesel generators anytime during a LOCA will not result in unacceptable consequences from a LOCA. If your plant has such a design, describe any changes you intend to implement or provide an analysis to justify the existing design.

We met with Stello, Ruca, Eisenhut, Butler, Tondi, & Butcher on 3/31/78, to discuss this matter. WB.