MAY 25 1982

MEMORANDUM FOR: Gus C. Lainas, Assistant Director for Safety Assessment
Division of Licensing

FROM: Themis P. Speis, Assistant Director for Reactor Safety
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SUBJECT: GENERIC RECOMMENDATIONS FROM THE DSI (RSB/ICSB/CSB) REVIEW OF NUREG-0909

In the May 3, 1982 memorandum (H. Denton to the NRR Directors) we were requested to review the Task Force report (NUREG-0909, "NRC Report on The January 25, 1982 Steam Generator Tube Rupture on R. E. Ginna Nuclear Power Plant") for the development of generic recommendations.

Enclosed are Reactor Systems Branch (RSB), and Instrumentation and Control Systems Branch (ICSB) recommendations for generic action based on their review. There are no generic recommendations from Containment Systems Branch (CSB).

Original Signed By
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Enclosures

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GENERIC RECOMMENDATIONS FROM DSI (RSB/ICSB/CSB) REVIEW OF NUREG-0909

1. Recommendation - Letdown Isolation

A containment isolation signal redundant to that being provided to the letdown control valve (LCV) should be provided to each of the three letdown orifice valves. A safety grade air source, such as an accumulator, should be provided to assure the capability to close the letdown control valve on a containment isolation signal. This will provide redundant isolation of the letdown steam from the relief valve to ensure the pressure boundary. Licensees should perform an evaluation of their letdown control system to determine if it can be isolated by redundant means to maintain pressure system integrity during containment isolation.

Discussion

As described in Section 3.3.5 and 7.4.2 of NUREG-0909, the letdown control valve did not provide complete letdown isolation during the containment isolation phase, since it was dependent upon the operability of instrument air which is isolated by containment isolation. The outside containment isolation valve closed allowing the pressure to build to the relief valve setpoint thereby discharging into a pressurizer relief tank.

Rochester Gas and Electric (RG&E) proposed a modification to prevent the pressure build-up from recurring by providing a containment isolation signal to the LCV inside containment. The LCV has an interlock which will automatically close the three letdown orifice valves. If the LCV fails to close (for whatever reason) then there is no guarantee that the orifice valves will close to provide isolation of the pressure boundary.

The implementation of this recommendation should be such that the resetting of the isolation signal does not automatically reopen the letdown isolation valves. Reopening of the letdown isolation valves should be a deliberate operator action.

2. <u>Recommendation - Cooling Faulted SG</u>

Licensees should perform an evaluation of their SGTR procedures to confirm that a formal method is outlined in the procedures for cooling the affected steam generator. Systems used should be of sufficient capacity and capability for cooling the steam generator until the residual heat removal system is placed in service and assuming offsite power unavailable.

<u>Discussion</u>

As a result of the review of the Ginna steam generator tube rupture (SGTR) event, the task force determined that the licensee's procedure did not include formal instructions for cooling the affected steam generator following closure of its MSIV. Oral instructions developed by the Technical Support Center, directed the operators to feed the steam generator with auxiliary feedwater, up to a level of about 60% of narrow range and reduce primary side pressure by spraying the pressurizer to an indicated pressure of about 25 psi below the secondary side pressure. The secondary water was allowed to flow through the tube break back into the primary side in order to accomplish the desired cooling.

3. Recommendations - Pump Operation

Pump Trip

Licensees should perform a formal study to find a method for keeping the RCPs operational during SGTR events such as occurred at Ginna. This study should consider, among other things, additional HPI capacity, more discriminating criteria for RCP trip, or, if RCP trip cannot be avoided, a qualified auxiliary spray capability.

Pump Restart

Licensees should perform a study, in conjunction with the RCP trip study, to determine the criteria for RCP restart following RCP trip. The criteria should not jeopardize plant safety or result in operator confusion. In particular, the study should address:

- The need for a bubble in the pressurizer prior to restart.
- The minimum volume of water needed in the pressurizer prior to restart, considering the maximum volume of steam that could potentially exist in the vessel head.
- The need for a system subcooling margin prior to restart, and the effects of bulk system flashing if the pressure drop due to head bubble collapse following RCP restart drops the system pressure below saturation.

Licensees should also examine the procedures to require the earliest possible restart of a RCP, if the RCPs are to continue to be tripped under existing criteria.

Discussion

The staff has been studying the issue of RCP trip and restart since the TMI-2 accident. The issue has also been extensively discussed with both the utilities and the PWR vendors. The above recommendations, while reflecting specific conclusions drawn from the Ginna SGTR event, will be superceded by more specific, generic guidance from the staff that is now in final preparation.

Thus, if these specific recommendations are forwarded to the industry, they should be properly clarified as specific concerns resulting from Ginna, and that they probably will be superceded with a generic resolution guidance letter which will incorporate all of the elements of the RCP trip and restart concern.

4. Recommendation - Cooling Intact SG

Licensees should evaluate the need for and consequences of securing the condenser as a means of removing energy from the intact steam generator, and utilizing only the atmospheric relief valve on the intact steam generator.

Discussion

The decision to secure the condenser and use only the ADV relieving directly to atmospheric during the Ginna event may have reduced some in-plant equipment contamination, but it added to offsite releases and removed the normal means of plant cooldown. Also, the decision to break vacuum on the condenser removed this means as a back-up means of energy removal should a problem have occurred with the intact SG ADV, or its control equipment.

5. Recommendation - Overfilling Faulted SG

Licensees should evaluate the potential for and consequences of overfilling the damaged steam generator, including the effects on the safety valve.

Discussion

Overfilling of the damaged SG can result from excess feedwater addition due to untimely feedwater isolation, or from sustained primary-to-secondary leakage. During a Ginna-type event, sustained leakage can be caused by excessive primary pressure, or a decrease in the secondary pressure due to maloperation of the safety valve, atmospheric relief valve, main steam isolation valve (or its bypass) or the blowdown system. The consequences of overfilling the SG can be severe. The excess weight may damage the steam line and result in continued releases and a loss of primary coolant and RWST water outside containment. Also, filling the damaged SG can result in challenges to its safety or relief valves, and releases offsite. The iodine partitioning is also affected by the amount of water in the SG. Generally, more iodine is in the water than in the steam or vapor above it. If water releases out the safety or relief valves occur, the radiological consequences would be more severe, than if steam releases occurred.

6. Recommendation - Operator Guidance

Licensees should provide additional guidance for operator action in the event of real or suspected void formation in the reactor vessel upper head.

Discussion

Several events including the Ginna SGTR, St. Lucie Cooldown and the TMI accident have produced voids in the upper head which proved difficult to eliminate and were, in varying degrees, unexpected. RG&E in their SGTR submittal requested further guidance on RCS management when bubbles are present. During an SGTR, there is a need to depressurize the RCS to minimize leakage to the steam generator and to the atmosphere. Since void formation may occur, and operators may perceive the void to be a threat to core cooling, more positive guidance should be given on bubble management and condensation. This is clearly generic in nature and is an offshoot of owner's group work on operator guidelines. This should include detailed TH analyses verifying the behavior of voids formed in the RCS.

7. Recommendation - Achieving Cold Shutdown

Based on the high frequency of SGTR events and our evaluation of the requirements for achieving cold shutdown, licensees should evaluate the plant systems' capacity and capability for achieving cold shutdown following the SGTR event. Conservative assumptions should be made regarding the amount of primary and secondary inventory lost through a failed open SG safety valve, conservative times for achieving shutdown and loss of offsite power.

Description

Cold shutdown of the Ginna Power Plant was achieved approximately 33 hours following the SGTR event. Auxiliary feedwater was used for decay heat removal for about 20 hours prior to initiation of RHR cooling. Therefore, in the event of a continuous leakage of primary or secondary coolant through a failed open steam generator safety valve or other malfunction, coolant inventory could have been depleted to unacceptable levels before achieving cold shutdown.

8. Recommendation - PORV Operation

Licensees whose pressurizer PORV is air operated should ensure that they have not crimped or otherwise altered the air system solenoid valve vent path so maloperation of the PORV is not experienced. The potential for blockages in the air supply and vent path should also be examined.

Discussion

Although not conclusively demonstrated, there appears to be a strong possibility that the Ginna event demonstrated that the pressurizer PORV air system vent flow path should not be tampered with to avoid restricting the PORV air operator vent path and causing the PORV to stick open. With the PORV stuck open in any scenario, the operator must rapidly detect, diagnose and correct the problem (isolate the PORV). It is not acceptable that any over-pressure event, like a turbine trip or loss of feedwater, be turned into a small break LOCA due to maloperation of the pressurizer PORV.

9. Recommendation - RCS Pressure Control

The optimal means of controlling and lowering RCS pressure in the SGTR accident should be determined to avoid rapid depressurization, void formations, and continued primary-to-secondary tube leakage.

Discussion

The control of RCS pressure during the SGTR determines, in large part, the tube leakage and therefore, releases out the damaged SG relief or safety valve. Too rapid a depressurization can cause void formation in the upper head and hot legs, especially if the plant is being cooled with natural circulation. In such an eventuality, it may be difficult to reduce system pressure without restarting the RCPs and initiating normal pressurizer pressure control. The use of the PORV as a means to rapidly depressurize the system should be evaluated, as well as the use of auxiliary and normal spray systems. The review should be performed with the goal of minimizing complicating conditions, expeditious plant cooldown and reducing, to the maximum extent possible, offsite consequences.

10. Recommendation - The Single Failure Criterion

NRC should determine if single equipment failures should be assumed in the course of analyzing a SGTR accident. Also, determine if the loss of offsite power should be assumed in a mechanistic manner. That is, should licensees or applicants assume offsite power is retained until the turbine generator has been tripped.

Discussion

The SRP for the analysis of a SGTR does not require applicants to assume a coincident or consequential single failure. The analysis generally assumes the damaged steam generator safety or relief valve is assumed to correctly operate. Based on the steam generator overfill experience (Point Beach and Ginna SGTRs) and the resulting challenges to the safety and relief valves, and the significant impact the failure of the safety or relief valve would have on system cooldown, inventory control, offsite consequences and in general, the operator's ability to cope with the event, it is prudent to consider if single failures should be postulated along with the event.

With respect to offsite power, the loss of offsite power at sometime beyond the initial event may place a more severe restriction on systems and the operators than a concurrent loss of offsite power.

11. Recommendation - Credit For Control Grade Equipment

NRC should determine if credit should still be given for the use of control grade pieces of equipment in the mitigation and recovery from a SGTR.

Discussion

Analyses and procedures for operating plants are performed assuming a number of control grade pieces of equipment. The pressurizer PORV is relied on to lower RCS pressure and the intact SG atmospheric relief valve is used to remove primary energy to cool down the RCS. The PORV quality has been improved after TMI, but the valve control system is basically control grade. Likewise, the steam generator atmospheric relief valve (ARV) on operating plants is not a safety grade piece of equipment, although on newer plants, the ARVs are required to meet RSB BTP 5-1 of SRP Section 5.4.7. NRC needs to determine if credit for control grade pieces of equipment should continue to be given in light of the failures that have been experienced and the frequency of the SGTR event itself. This determination should be made concurrently with items 6, 9, and 11.

12. Recommendation - SGTR Analysis Requirements

NRC determine if the SGTR should be reclassified and the requirements for analysis made more stringent.

Discussion

No other PWR "accident" has occurred as frequently as the SGTR. The Ginna event is the fourth domestic SGTR and, considering the general philosophy that accidents should rarely if ever occur, it is prudent to reconsider the event classification and the SRP assumptions and criteria. It may be appropriate to consider more than a single broken tube as the initiating event, or, an additional single failure, or the offsite consequences must meet the 10 CFR 20 limits rather than the 10 CFR 100 limits.

13. Recommendation - RCS Dilution

Evaluate the potential for and consequences of RCS dilution as the RCS pressure is reduced below the damaged SG pressure and relatively dilute fluid flows back into the RCS.

Discussion

Since the past SGTR events have demonstrated that filling of the steam generator is possible in the cooldown phase following the event, dilution of the RCS can occur. It is not readily apparent that without proper monitoring and chemistry control, recriticality is not a concern. The maximum dilution of the RCS should be determined, and procedural steps taken to ensure operators are cognizant of this phenomena and take the appropriate actions.

14. Recommendation - Upper Head Thermocouples

All PWRs should have thermocouples in the upper head as a valuable aid in diagnosing and managing various cooldown events.

Discussion

For most PWRs the upper head is a rather stagnant location especially after the pumps are tripped. Also for most PWRs, the upper head has relatively high fluid temperatures. Therefore, for those events where depressurization occurs, the upper head would tend to flash prior to other locations in the primary system. Thermocouples located stratigically in the upper head would be extremely valuable in monitoring the approach to saturation and anticipating bubble formation. Ginna happens to be one of the very few PWRs with thermocouples in the upper head. Although not well placed for saturation monitoring, they still proved valuable in following the course of the accident. Obviously thermocouples arranged vertically in the upper head would give the best prediction of incipient saturation. The recommendation for thermocouples is not meant as a substitute for reactor vessel level instrumentation (RVLIs) as required by the TMI Action Plan. Thermocouples cannot provide positive level indication but are meant as a prediction for the onset of bubble formation.

15. Recommendation - Pressurized Thermal Shock

1. Cold Leg Temperature Monitoring

In the long-term, as part of the overall PTS resolution, evaluate the need for supplemental temperature monitoring instrumentation on the RCS cold legs between the reactor vessel and the safety injection inlet nozzle.

Discussion

Currently, cold leg temperature detectors are located on the piping between the safety injection inlet nozzle and the steam generator so that during events where the SI system is actuated, accurate determination of the fluid temperature entering the reactor vessel can't be made. The current location of temperature detectors complicates the analysis of pressurized thermal shock consideration after the event, and gives the operator potentially non-conservative information regarding the cold leg temperatures. Operator actions to control system pressure during a PTS event should be based on the most limiting temperature condition, which would be the fluid temperature downstream of the SI inlet nozzle. Actions based on the current instrumentation may not be suitably conservative.

2. Enhanced Cold Loop Flow

Licensees should review and identify all potential transient and accident scenarios that could produce relatively stagnant flow conditions in a coolant loop, and examine the effect of the operator actions which could draw the cold water into the vessel (e.g., open PORV high point vents, depressurize secondary).

In the near term, for the scenarios identified, review and modify procedures and train operators as necessary to prevent or minimize the flow of cold leg water into the vessel. In the long term, as part of the overall PTS resolution, perform detailed PTS evaluations of the scenarios identified.

Discussions

The staff examined the Ginna scenario to determine if any actions or variations of the scenario could have directed the flow of "cold" HPI water into the vessel. If it is assumed the enhanced flow of cold water away from the vessel was due to the open PORV in the hot leg of the broken generator loop, then the same of this scenario, but with pressuruzer located in the loop with the intact steam generator, needs to be examined. This is because opening the PORV in the hot leg of the loop with the intact steam generator could put the low pressure point in the system in a location such that HPI water would preferentially flow towards the vessel to reach the PORV rather than away for the vessel.

A similar situation could exist if high point venting at the top of the vessel occurred. However, it is not known if high point vents exist on the top of the Ginna vessel. Moreover, the NRR has not yet allowed any licensee to operator high point vents.

The above two scenario describe a general class of events in which one loop is stagnant and cold with respect to the other loop(s). The general concern is that a venting action could draw relatively cold HPI water into the vessel prior to being mixed by a loop circulation flow.