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SYSTEMATIC EVALUATION PROGRAM REVIEW OF NRC SAFETY TOPIC V-11.B ASSOCIATED WITH THE ELECTRICAL, INSTRUMENTATION, AND CONTROL PORTIONS OF THE RESIDUAL HEAT REMOVAL SYSTEM FOR THE GINNA NUCLEAR POWER PLANT

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ABSTRACT

This report documents the technical evaluation and review of NRC safety topic V-11.B, associated with the electrical, instrumentation, and control portions of the residual heat removal (RHR) system for the Ginna nuclear power plant. Current licensing criteria are used to evaluate the overpressure protection and independence of the RHR system.

FOREWORD

This report is supplied as part of the Systematic Evaluation Program being conducted for the U.S. Nuclear Regulatory Commission by Lawrence Livermore National Laboratory. The work was performed by EG&G, Energy Measurements Group, San Ramon Operations for Lawrence Livermore National Laboratory under U.S. Department of Energy contract number DE-AC08-76NV01183.

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1. INTRODUCTION

A number of plants have residual heat removal (RHR) systems in which the design pressure rating is lower than the reactor coolant system (RCS) pressure boundary to which the system is connected. The RHR system normally is located outside of primary containment and has motor-operated valves (MOVs) which isolate it from the RCS. There is, therefore, a potential that these systems would be subjected to pressure stresses in excess of their design rating if the isolation MOVs were opened inadvertently while the RCS was above the RHR system design pressure rating. This could result in a LOCA outside containment and a loss of reflood capability since the coolant inventory could be lost. Generally, interlocks are provided to prevent isolation MOVs from opening under high RCS pressure conditions.

It is important to incorporate features into the system design which will prevent overpressurizing the low pressure-rated RHR systems which interface with the reactor coolant pressure boundary. The current licensing criteria requires redundant, diverse interlocks to prevent opening of the isolation MOVs when RCS pressure exceeds RHR pressure design

limits. The current licensing criteria also requires automatic closure of the isolation MOVs when RCS exceeds RHR pressure design limits.

The objective of this review is to ensure that the plant has adequate measures to protect a low pressure-rated RHR system that interfaces with the RCS from failures due to excessive pressure and that such protection is suitably redundant and diverse.

This review applies to the interlocks associated with the isolation MOVs of the RHR system. Other protection schemes such as double-testable check valves are discussed in reports on other NRC Safety Topics.

2. CURRENT LICENSING CRITERIA

Branch Technical Position ICSB-3 [Ref. 1], entitled "Isolation of Low Pressure Systems from the High Pressure RCS," states that:

> The isolation MOVs should have independent and diverse interlocks to prevent opening unless the primary system pressure is below the subsystem design pressure. Also, the isolation MOV operators should receive a signal to close the valves automatically when the primary system pressure exceeds the subsystem design pressure.

Branch Technical Position RSB 5-1 [Ref. 2], entitled "Design Requirements for the Residual Heat Removal System," states that:

> Isolation shall be provided by at least two power-operated valves in series, and the valves shall have independent diverse interlocks to prevent the valves from being opened unless the RCS pressure is below the RHR system design pressure. The valves shall have independent, diverse interlocks to protect against one or both valves being open during an increase above RHR system design pressure. If the RHR system discharge line is used for an emergency core cooling system (ECCS) function, the power-operated valve is to be opened upon receipt of a safety injection signal once the reactor coolant pressure has decreased below the ECCS design pressure.

3. REVIEW GUIDELINES

The NRC guidelines used in this review are as follows:

(1) Identify the valves which isolate the RHR system from the reactor coolant pressure boundry. (Refer to NRC memorandum from B. L. Siegel, RSB, to P. A. Di Benedetto, SEP; which is enclosure 3 of a letter from Crutchfield NRC, SEPB, to Dittmore, LLNL, dated 6-10-80 [Ref. 3]).

(2) Evaluate the design features which provide protection against the overpressurization of the RHR system.

(3) Identify the related topic reviews in an appendix to this report.

(4) Compile a list of the major EI&C systems that are necessary for DBE and for safe shutdown of the plant. Submit the compilation of necessary items for safe shutdown as an appendix to NRC Safety Topic VII-3, entitled "Systems Required for Safe Shutdown."

(5) If power is locked-out to the RHR isolation MOVs, review to determine if any functions of the interlocks or permissives are adversely affected. (The report on NRC Safety Topic VI-7.C, among others, states which values have power locked out).

4. SYSTEM DESCRIPTION

The RHR loop consists of two pumps, two heat exchangers, and the necessary valves, piping, and instrumentation. During plant cooldown, coolant flows from the RCS to the RHR pumps, through the tube side of the RHR heat exchangers and back to the RCS. The single inlet line to the RHR loop commences at the hot leg of reactor coolant loop A, through two redundant pumps and their associated heat exchangers, and back to the cold leg of reactor coolant loop B via a single header.

The RHR pumps and heat exchangers serve dual functions. Although the normal duty of the RHR pumps and heat exchangers is performed during periods of reactor shutdown, this equipment is aligned during the injection phase after a loss-of-coolant-accident (LOCA) to perform the low-head safety injection (LPSI) function. In addition, during the recirculation phase of a LOCA the capability may be divided between the core-cooling function and the containment-cooling function as a part of the containment spray system.

5. EVALUATION AND CONCLUSIONS

The suction line of the RHR system is isolated from the loop A hot leg of the RCS by MOV-700 and MOV-701 in series. The discharge line of the RHR system is isolated from the loop B cold leg of the RCS by MOV-720 and MOV-721 in series. [Ref. 4, drawing 33013-436-A].

All permissive interlocks associated with the RHR system isolation MOVs are designed to open the valves; there are no permissive interlocks associated with isolation MOV closure.

Section 4.1 of the SEP review of Safe Shutdown Systems [Ref. 5] states that the permissive interlocks required to open the four RHR system isolation valves are as listed below:

MOV-700....RCS pressure must be less than 410 psig.
RHR suction valves MOV-850A and MOV-850B from the containment sump must be closed.

MOV-701....The valve is operated by a key switch.
RHR suction valves MOV-850A and MOV-850B from the containment sump must be closed.

MOV-720....No interlocks exist; valve operated by key switch.

MOV-721....RCS pressure must be less than 410 psig.

The RHR system discharge line is not used for an ECCS function that would require MOV-720 or MOV-721 to open; however, a branch of the RHR discharge line provides low pressure safety injection (LPSI) to the reactor vessel via parallel lines. Isolation between the RHR system and LPSI injection into the reactor vessel is provided by two separate paths from the RHR discharge line, with each path containing an MOV and check valve. MOV-852A and check valve 853A provide isolation in one path, while MOV-852B and check valve 853B provide isolation in the other path [Ref. 4, drawing

33013-436-A; Ref. 6, drawing 33013-432-A]. The LPSI isolation MOVs open on a SI signal regardless of RCS pressure; there are no interlocks associated with closure of the LPSI isolation MOVs, although key switch closure capability is provided.

Section 4.1 of the SEP review of Safe Shutdown System [Ref. 5] states in part that:

> A branch of the RHR discharge line provides low pressure safety injection (LPSI) to the reactor vessel via parallel lines with one normally closed motor-operated valve (MOV) and one check valve in each line. The MOV position indication is provided in the control room and these valves receive an open signal coincident with the safety injection (SI) signal. The MOVs in the LPSI lines open on an SI signal before RCS pressure drops below RHR design pressure.

The plant complies to all EI&C aspects of the "RHR Interlock Requirements" review criteria listed in Section 2 of this report except for the following:

(1) The plant RHR system does not satisfy BTP ICSB 3 [Ref. 1] and BTP RSB 5-1 [Ref. 2] because the RHR discharge and suction isolation MOVs do not have independent diverse interlocks to prevent opening the valves until RCS pressure is below 410 psig. Only the inboard valves MOV-700 and MOV-721 have this interlock.. The outboard valves MOV-701 and MOV-720 are manually controlled with key-locked switches. By procedure, MOV-701 and MOV-720 are not opened until RCS pressure is less than 410 psig.

(2) The plant RHR system does not satisfy BTP ICSB 3 [Ref. 1] and BTP RSB 5-1 [Ref. 2] because all RHR isolation MOVs lack an interlock feature to close them when RCS pressure increases above the RHR design pressure.

(3) The plant RHR system does not satisfy BTP ICSB 3 [Ref. 1] and BTP RSB 5-1 [Ref. 2] because the isolation MOVs in the LPSI lines (MOV-852A and MOV-852B) open on an SI signal before RCS pressure drops below RHR design pressure.

6. SUMMARY

The plant RHR interlock system fails to satisfy current licensing criteria for the following reasons:

(1) The RHR suction and discharge isolation MOVs do not have independent diverse interlocks to prevent opening the isolation MOVs until RCS pressure is below 410 psig.

(2) All RHR isolation MOVs lack an interlock feature to close them when RCS pressure increases above RHR design pressure.

(3) The isolation MOVs in the LPSI lines open on an SI signal regardless of RCS pressure.

The resolution of items 1, 2 and 3 are presented in Sections 3.1 and 3.2 of SEP Topic V-11.A.

REFERENCES

1. U.S. Nuclear Regulatory Commission, Branch Technical Position ICSB 3, "Isolation of Low Pressure Systems from the High Pressure Reactor Coolant System."

2. U.S. Nuclear Regulatory Commission, Brancn Technical Position RSB 5-1, "Design Requirements of the Residual Heat Removal System."

3. NRC (D. M. Crutchfield) letter to LLNL (M. H. Dittmore), dated June 10, 1980.

4. Ginna drawing, 33013-436-A, "Auxiliary Coolant System".

5. SEP Review of Safe Shutdown Systems for the R.E. Ginna Nuclear Power Plant, Revision 1, undated.

6. Ginna drawing, 33013-432-A, "Safety Injection System."

APPENDIX A
NRC SAFETY TOPICS RELATED TO THIS REPORT

1. III-1, "Classification of Structures, Systems and Components."
2. III-10.A "Thermal Overload of MOVs."
3. V-10-.B, "RHR System Reliability."
4. V-11.A, "Requirements for Isolation of High and Low Pressure Systems."
5. V1-7.C "ECCS Single Failure Criterion and Requirements for Locking Out Power to Valves Including Independence of Interlocks on ECCS Valves."
6. VIII-3, "Systems Required for Safe Shutdown."
7. XVI, "Technical Specifications".

REQUEST FOR ADDITIONAL INFORMATION ON SEP TOPIC VI-7.C.1 FOR R. E. GINNA

1. For each of the seven automatic transfers from one dc train to the other, provide the short circuit analyses and the protective device coordination curves. Short circuit analyses should be provided for each of the following initial conditions:

    a. Full battery charge with equilizing charge in progress

    b. Battery near discharge with chargers not available.

2. Describe the methods used to assure that fault interrupting devices remain within the curves provided in response to Question 1. Your answer to this question should address breaker test frequency used vice that recommended by the breaker manufacturer and production lot verification of fuse characteristics.

3. Provide electrical schematics from load to dc bus for each transfer and the other drawings given in References 4 and 5 of Enclosure 2 to your letter of March 27, 1981.