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SYSTEMATIC EVALUATION PROGRAM REVIEW OF NRC SAFETY TOPIC VII-1.A ASSOCIATED WITH THE ELECTRICAL, INSTRUMENTATION, AND CONTROL PORTIONS OF THE ISOLATION OF THE REACTOR PROTECTION SYSTEM FROM NON-SAFETY SYSTEMS FOR THE GINNA NUCLEAR POWER PLANT

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SYSTEMATIC EVALUATION PROGRAM
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ASSOCIATED WITH THE ELECTRICAL, INSTRUMENTATION, AND CONTROL PORTIONS OF THE ISOLATION OF THE REACTOR PROTECTION SYSTEM FROM NON-SAFETY SYSTEMS FOR THE GINNA NUCLEAR POWER PLANT

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ABSTRACT

This report documents the technical evaluation and review of NRC safety topic VII-1.A, associated with the electrical, instrumentation, and control portions of the isolation of the reactor protection system (RPS) from non-safety systems for the Ginna Nuclear Power Plant, using current licensing criteria.

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

Non-safety systems generally receive control signals from the reactor protection system (RPS) sensor current loops. The non-safety sensor circuits are required to have isolation devices to insure electrical independence of the RPS channels. Operating experience has shown that some of the earlier isolation devices or arrangements at operating plants may not meet current criteria. The safety objective is to verify that operating reactors have RPS designs which provide effective and qualified isolation of non-safety systems from safety systems to insure that the safety systems will function as required.

This report reviews the RPS EI&C design features at Ginna Nuclear Power Plant to insure that the non-safety systems electrically connected to the RPS are properly isolated from the RPS, and that the isolation devices or techniques meet the current licensing criteria detailed in Section 2 of this report. The qualification of safety-related equipment is not within the scope of this report and is discussed in NRC Safety Topic III-12 [Ref. 1] and NUREG-0458 [Ref. 2].

2. CURRENT LICENSING CRITERIA

GDC 24 [Ref. 3], entitled "Separation of Protection and Control Systems," states that:

> The protection system shall be separated from control systems to the extent that failure of any single control system component or channel, or failure or removal from service of any single protection system component or channel which is common to the control and protection system leave intact a system satisfying all reliability, redundancy, and independence requirements of the protection system. Interconnection of the protection and control systems shall be limited so as to assure that safety is not significantly impaired.

IEEE Std-279-1971 [Ref. 4], entitled "Criteria for Protection Systems for Nuclear Power Generating Stations," states in Section 4.7.2 that:

> The transmission of signals from protection system equipment for control system use shall be through isolation devices which shall be classified as part of the protection system and shall meet all the requirements of this document. No credible failure at the output of an isolation device shall prevent the associated protection system channel from meeting the minimum performance requirements specified in the design bases.
>
> Examples of credible failures include short circuits, open circuits, grounds, and the application of the maximum credible ac or dc potential. A failure in an isolation device is evaluated in the same manner as a failure of other equipment in the protection system.

3. REVIEW GUIDELINES

The following NRC guidelines were used for this review:

(1) Verify that the signals used for RPS safety functions are isolated from control or non-safety systems. Identify and describe the type of isolation devices employed. (GDC 24, IEEE Std-279-1971 Section 4.7.2).

(2) Identify the related NRC safety topics in an appendix to the report.

4. SYSTEM DESCRIPTION

4.1 GENERAL

The FSAR for Ginna Nuclear Power Plant [Ref. 5] states in Section 7.2.3 that the design basis for protection (safety system) and control (non-safety system) permits the use of a sensor for both protection and control functions. All equipment common to both the protection and control circuits is classified as part of the protection system. Isolation amplifiers prevent a control system failure from affecting the protection system.

4.2 PRESSURIZER PRESSURE

Four pressurizer pressure channels are used for high-and low-pressure protection, and for overpower-overtemperature protection. Isolated output signals from these channels are used for pressure control; compensating signals are used for control rod motion.

4.2.1 Channel I

Pressurizer pressure channel I (designated RED) originates at pressure transmitter PT-429 and provides isolated output to the control system via Foxboro isolation device Model M/66BR-OH, circuit symbol PM-429A [Ref. 6, drawing BD-10]. The control system provides signals to the pressurizer heaters, spray valves, and power relief valves. In addition, the control system provides input to the computer through another stage of isolation, Foxboro isolation device Model M/66BR-OH, circuit symbol PM-429C [Ref..6, drawing BD-13]. Pressure transmitter PT-429 provides an unisolated signal to the loop A1, $\Delta T\text{-}T_{avg}$ protection system where it is combined

with reactor coolant system (RCS) temperature and nuclear instrumentation system (NIS) protection signals to generate the signal ΔT SP1. The signal ΔT SP1 is isolated from the pen recorder, control board indicator, and computer by Foxboro isolation device Model M/66BR-OH, circuit symbol TM-405D [Ref. 6, drawings BD-2 and BD-15].

4.2.2 Channel II

Pressurizer pressure channel II (designated WHITE) originates at pressure transmitter PT-430 and provides isolated output to the control system via Foxboro isolation device Model M/66BR-OH, circuit symbol PM-430A [Ref. 6, drawing BD-10]. The control system provides signals to the pressurizer heaters, spray valves, power relief valves, and to the computer [Ref. 6, drawing BD-13]. Pressure transmitter PT-430 provides an unisolated signal to the loop A2, $\Delta T\text{-}T_{avg}$ protection system where it is combined with RCS temperature and NIS protection signals to generate the signal ΔT SP1. The signal ΔT SP1 is isolated from the pen recorder, control board indicator, and computer by Foxboro Isolation device Model M/66BR-OH, circuit symbol TM-406D [Ref. 6, drawings BD-3 and BD-15].

4.2.3 Channel III

Pressurizer pressure channel III (designated BLUE) originates at pressure transmitter PT-431 and provides isolated output to the control system via Foxboro isolation device Model M/66BR-OH, circuit symbol PM-431A [Ref. 6, drawing BD-10]. The control system provides signals to the pressurizer heaters, spray valves, and power relief valves. In addition, the control system provides input to the computer through another stage of isolation, Foxboro isolation device Model M/66BR-OH, circuit symbol PM-431C [Ref. 6, drawing BD-13]. Pressure transmitter PT-431 provides an unisolated signal to the loop B1, $\Delta T\text{-}T_{avg}$ protection system where it is combined with RCS temperature and NIS protection signals to generate the signal ΔT SP1. The signal ΔT SP1 is isolated from the pen recorder, control board indicator, and computer by Foxboro isolation device Model M/66BR-OH, circuit symbol TM-407D [Ref. 6, drawings BD-4 and BD-15].

4.2.4 Channel IV

Pressurizer pressure channel IV (designated YELLOW) originates at pressure transmitter PT-449 and provides isolated output to the control system via Foxboro isolation device Model M/66BR-OH, circuit symbol PM-449A [Ref. 6, drawing BD-10]. The control system provides signals to the pressurizer heaters, spray valves, power relief valves, and to the computer [Ref. 6, drawing BD-13]. Pressure transmitter PT-449 provides an unisolated signal to the loop B2, ΔT-T_{avg} protection system where it is combined with RCS temperature and NIS protection signals to generate the signal ΔT SP1. The signal ΔT SP1 is isolated from the pen recorder, control board indicator, and computer by Foxboro isolation device Model M/66BR-OH, circuit symbol TM-408D [Ref. 6, drawings BD-5 and BD-15].

4.3 PRESSURIZER LEVEL

Three pressurizer level channels are used for high-level reactor trip. Isolated output signals from these channels are used for volume control and for increasing or decreasing water level.

4.3.1 Channel I

Pressurizer level channel I (designated RED) originates at level transmitter LT-426 and provides isolated output to the control system via Foxboro isolation device Model M/66BR-OH, circuit symbol LM-426A [Ref. 6, drawing BD-11]. The control system provides signals to the charging pumps and control board indicators. In addition, the control system provides input to the computer through another stage of isolation, Foxboro isolation device Model M/66BR-OH, circuit symbol LM-426B [Ref. 6, drawing BD-14].

4.3.2 Channel II

Pressurizer level channel II (designated WHITE) originates at level transmitter LT-427 and provides isolated output to the control system

via Foxboro isolation device Model M/66BR-OH, circuit symbol LM-427 [Ref. 6, drawing BD-11]. The control system provides signals to the computer, charging pumps, and control board indicators [Ref. 6, drawing BD-14].

4.3.3 Channel III

Pressurizer level channel III (designated BLUE) originates at level transmitter LT-428 and provides isolated output to the control system via Foxboro isolation device Model M/66BR-OH, circuit symbol LM-428A [Ref. 6, drawing BD-11]. The control system provides signals to the charging pumps and control board indicators. In addition, the control system provides input to the computer through another stage of isolation, Foxboro isolation device Model M/66BR-OH, circuit symbol LM-428B [Ref. 6, drawing BD-14].

4.4 COOLANT TEMPERATURE (T_{avg})

Four T_{avg} channels are used for overtemperature-overpower protection. Isolated output signals for all four channels are averaged for automatic control rod regulation of power and temperature.

4.4.1 Loop A1

The loop A1 T_{avg} signal is generated by a dual-current source device, circuit symbol TT-401, as a product of temperature element TE-401A, TE-401B, TE-405A and TE-405B inputs. The T_{avg} signal is isolated from the control system by Foxboro isolation device Model M/66GR-OW circuit symbol TM-401C [Ref. 6, drawing BD-2]. The control system provides signals for control rod regulation and control board indication. In addition, the control system provides input to the computer through another stage of isolation, Foxboro isolation device Model M/66BR-OH, circuit symbol TM-401W [Ref. 6, drawing BD-17]. The control system also provides input to recorder TR-401 through another stage of isolation, Foxboro isolation device Model M/66BR-OH, circuit symbol TM-401G [Ref. 6, drawing BD-15].

4.4.2 Loop A2

The loop A2 T_{avg} signal is generated by a dual-current source device, circuit symbol TT-402, as a product of temperature element TE-402A, TE-402B, TE-406A and TE-406B inputs. The T_{avg} signal is isolated from the control system by Foxboro isolation device Model M/66GR-OW, circuit symbol TM-402C [Ref. 6, drawing BD-3]. The control system provides signals for control rod regulation and control board indication. In addition, the control system provides input to the computer through another stage of isolation, Foxboro isolation device Model M/66BR-OH, circuit symbol TM-402W [Ref. 6, drawing BD-17]. The control system also provides input to recorder TR-401 through another stage of isolation, Foxboro isolation device Model M/66BR-OH, circuit symbol TM-401G [Ref. 6, drawing BD-15].

4.4.3 Loop B1

The loop B1 T_{avg} signal is generated by a dual-current source device, circuit symbol TT-403, as a product of temperature element TE-403A, TE-403B, TE-407A and TE-407B inputs. The T_{avg} signal is isolated from the control system by Foxboro isolation device Model M/66GR-OW, circuit symbol TM-403C [Ref. 6, drawing BD-4]. The control system provides signals for control rod regulation and control board indication. In addition, the control system provides input to the computer through another stage of isolation, Foxboro isolation device Model M/66BR-OH, circuit symbol TM-403W [Ref. 6, drawing BD-17]. The control system also provides input to recorder TR-401 through another stage of isolation, Foxboro isolation device Model M/66BR-OH, circuit symbol TM-401G [Ref. 6, drawing BD-15].

4.4.4 Loop B2

The loop B2 T_{avg} signal is generated by a dual-current source device, circuit symbol TT-404, as a product of temperature element TE-404A, TE-404B, TE-408A and TE-408B inputs. The T_{avg} signal is isolated from the control system by Foxboro Isolation device Model M/66GR-OW, circuit symbol

TM-404C [Ref. 6, drawing BD-5]. The control system provides signals for control rod regulation and control board indication. In addition, the control system provides input to the computer through another stage of isolation, Foxboro isolation device Model M/66BR-OH, circuit symbol TM-404W [Ref. 6, drawing BD-17]. The control system also provides input to recorder TR-401 through another stage of isolation, Foxboro isolation device Model M/66BR-OH, circuit symbol TM-401G [Ref. 6, drawing BD-15].

4.5 NUCLEAR FLUX

Four nuclear flux channels are provided for overpower protection. Isolated outputs from all four channels are averaged for automatic control rod regulation of power.

4.5.1 Loop A1

Loop A1 receives input from the upper and lower ion chambers of the nuclear instrumentation system (NIS). Loop A1 converts these inputs into a flux difference signal (Δg) that is combined with T_{avg} to generate the signal ΔT SP2. The signal ΔT SP2 is isolated from the pen recorder, control board indicator, and computer by Foxboro isolation device Model M/66BR-OH, circuit symbol TM-401S [Ref. 6, drawings BD-2 and BD-15].

4.5.2 Loop A2

Loop A2 receives input from the upper and lower ion chambers of the NIS. Loop A2 converts these inputs into a flux difference signal (Δg) that is combined with T_{avg} to generate the signal ΔT SP2. The signal ΔT SP2 is isolated from the pen recorder, control board indicator, and computer by Foxboro isolation device Model M/66BR-OH, circuit symbol TM-402S [Ref. 6, drawings BD-3 and BD-15].

4.5.3 Loop B1

Loop B1 receives input from the upper and lower ion chambers of the NIS. Loop B1 converts these inputs into a flux difference signal (Δg) that is combined with T_{avg} to generate the signal ΔT SP2. The signal ΔT SP2 is isolated from the pen recorder, control board indicator, and computer by Foxboro isolation device Model M/66BR-OH, circuit symbol TM-403S [Ref. 6, drawings BD-4 and BD-15].

4.5.4 Loop B2

Loop B2 receives input from the upper and lower ion chambers of the NIS. Loop B2 converts these inputs into a flux difference signal (Δg) that is combined with T_{avg} to generate the signal ΔT SP2. The signal ΔT SP2 is isolated from the pen recorder, control board indicator, and computer by Foxboro isolation device Model M/66BR-OH, circuit symbol TM-404S [Ref. 6, drawings BD-5 and BD-15].

5. EVALUATION AND CONCLUSIONS

Based on a review of the Foxboro drawings [Ref. 6] and the Foxboro Technical Information Bulletins [Refs. 7, 8, 9], we conclude that the reactor protection system is adequately isolated from the non-safety systems and complies to the current licensing criteria listed in Section 2 of this report.

6. SUMMARY

Based on a review of the documentation listed in the reference section of this report, we conclude that the isolation of the reactor protection system (RPS) from non-safety systems satisfies the current licensing criteria detailed in Section 2 of this report.

REFERENCES

1. U.S. Nuclear Regulatory Commission, Safety topic III-12, Environmental Qualifications of Safety Related Equipment.

2. U.S. Nuclear Regulatory Commission, Short-term Safety Assessment on the Environmental Qualification of Safety-related Electrical Equipment of SEP Operating Reactors, NUREG-0458, May 1978.

3. U.S. Nuclear Regulatory Commission, Code of Federal Regulations, Title 10, Part 50, Appendix A (General Design Criteria), 1979.

4. Institute of Electrical & Electronics Engineers, IEEE Std-279-1971.

5. Rochester Gas and Electric Corp., Ginna Final Safety Analysis Report (FSAR), dated April 23, 1975.

6. Foxboro drawings, BD-2 through BD-19 for the Ginna Nuclear Power Station.

7. Foxboro Technical Information Bulletin No. 39-168b, dated March 30, 1965.

8. Foxboro Technical Information Bulletin No. 18-240, dated March 1965.

9. Foxboro Technical Information Bulletin No. 18-241, dated July 1965.

APPENDIX A
NRC SAFETY TOPICS RELATED TO THIS REPORT

1. TOPIC III-1, "Classification of Structures, Systems and Components."

2. TOPIC VI-10.A, "Testing of RTS and ESF including Response Time Testing."

3. TOPIC VII-3, "Systems Required for Safe Shutdown."

4. TOPIC XVI, "Technical Specifications."

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