NRC Research and/or Technical Assistance Rept

EGG-EA-5963

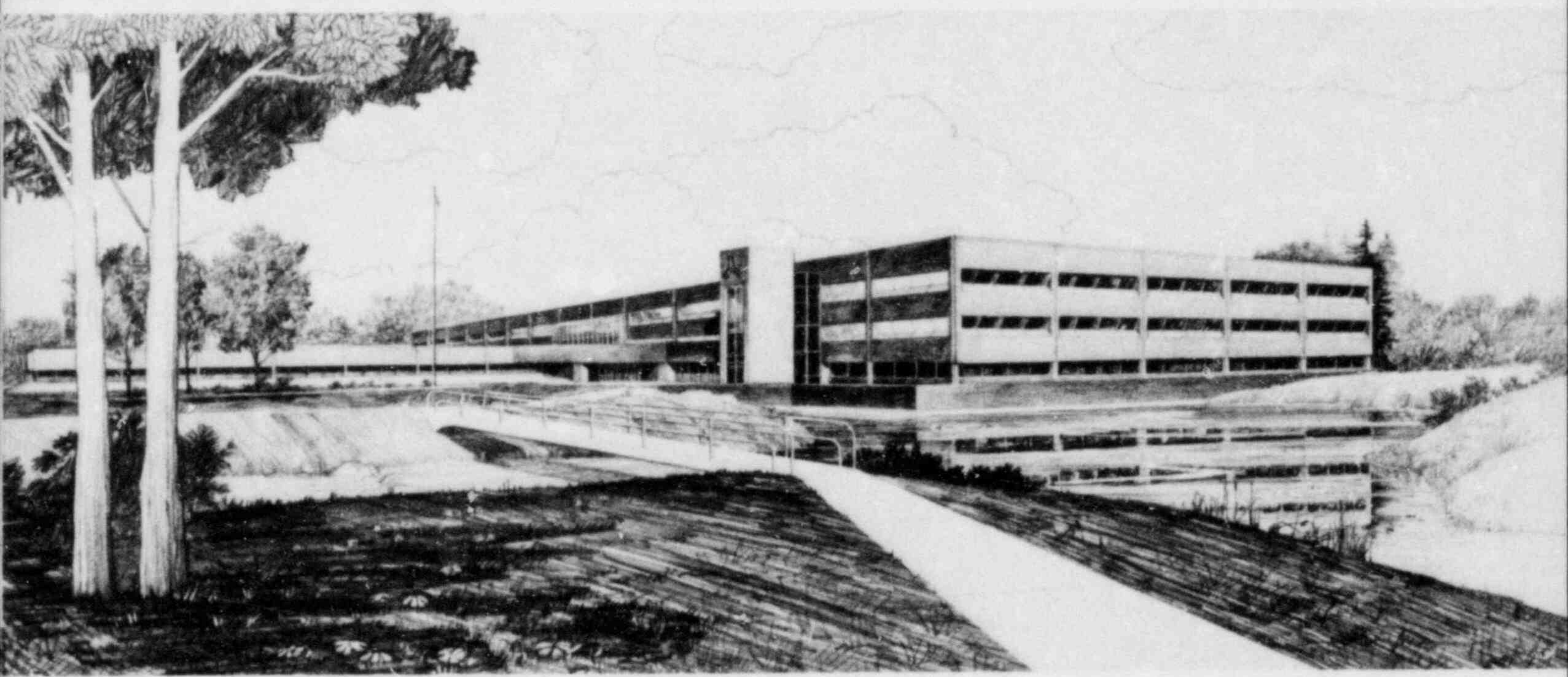
July 1982

PDR
LPDR
NSIC
NTIS
CF

SYSTEMATIC EVALUATION PROGRAM, TOPIC VII-1.A
ISOLATION OF REACTOR PROTECTION SYSTEM FROM NON-SAFETY SYSTEMS, BIG ROCK POINT PLANT

D. J. Morken

U.S. Department of Energy
Idaho Operations Office • Idaho National Engineering Laboratory



This is an informal report intended for use as a preliminary or working document

Prepared for the
U.S. Nuclear Regulatory Commission
Under DOE Contract No. DE-AC07-76ID01570
FIN No. A6425

EG&G Idaho

8211030236 820731
PDR RES
8211030236 PDR

EG&G Idaho, Inc

FORM EG&G-398
(Rev. 03-82)

INTERIM REPORT

Accession No. ______

Report No. EGG-EA-5963

Contract Program or Project Title:

Electrical, Instrumentation, and Control Systems Support for the Systematic Evaluation Program (II)

Subject of this Document:

Systematic Evaluation Program, Topic VII-1.A, Isolation of Reactor Protection System from Non-Safety Systems, Big Rock Point Plant

Type of Document:

Informal Report

Author(s):

D. J. Morken

Date of Document:

July 1982

Responsible NRC Individual and NRC Office or Division:

R. F. Scholl, Jr., Division of Licensing

> This document was prepared primarily for preliminary or internal use. It has not received full review and approval. Since there may be substantive changes, this document should not be considered final.

EG&G Idaho, Inc.
Idaho Falls, Idaho 83415

Prepared for the
U.S. Nuclear Regulatory Commission
Washington, D.C.
Under DOE Contract No. DE-AC07-76ID01570
NRC FIN No. A6425

INTERIM REPORT

SYSTEMATIC EVALUATION PROGRAM

TOPIC VII-1.A
ISOLATION OF REACTOR PROTECTION SYSTEM
FROM NON-SAFETY SYSTEMS

BIG ROCK POINT PLANT

Docket No. 50-155

July 1982

D. J. Morken

Reliability and Statistics Branch
Engineering Analysis Division
EG&G Idaho, Inc.

7-22-82

ABSTRACT

This SEP technical evaluation, for the Big Rock Point Plant, reviews the isolation of the reactor protection system from controls and non-safety systems.

FOREWORD

This report is supplied as part of the "Electrical, Instrumentation, and Control Systems Support for the Systematic Evaluation Program (II)" being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Licensing, by EG&G Idaho, Inc., Reliability and Statistics Branch.

The U.S. Nuclear Regulatory Commission funded the work under the authorization B&R 20-10-02-05, FIN A6425.

Electrical, Instrumentation, and Controls Support
for the
Systematic Evaluation Program (II)
FIN No. A6425

CONTENTS

SYSTEMATIC EVALUATION PROGRAM

TOPIC VII-1.A
ISOLATION OF REACTOR PROTECTION SYSTEM
FROM NON-SAFETY SYSTEMS

BIG ROCK POINT PLANT

1.0 INTRODUCTION

The objective of this review is to determine if non-safety systems which are electrically connected to the Reactor Protection System (RPS) are properly isolated from the RPS and if the isolation devices or techniques used meet current licensing criteria. The qualification of safety-related equipment is not within the scope of this review.

Non-safety systems generally receive control signals from RPS sensor current loops. The non-safety circuits are required to have isolation devices to ensure 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 licensing criteria.

2.0 CRITERIA

General Design Criterion 24 (GDC 24), entitled, "Separation of Protection and Control Systems," requires 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 systems, leaves intact a system that satisfies 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.[1]

IEEE-Standard 279-1971, entitled, "Criteria for Protection Systems for Nuclear Power Generating Stations," Section 4.7.2, states:

> 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.[2]

3.0 DISCUSSION AND EVALUATION

3.1 General

The Reactor Protection System (RPS) includes the sensors, signal conditioners, logic, power sources and supporting equipment essential to the monitoring of selected nuclear power plant conditions. It must reliably effect a rapid shutdown of the reactor if any one or a combination of parameters deviate beyond pre-selected set points to mitigate the consequences of a postulated design bases event.

The RPS parameters identified in the Big Rock Point Technical Specifications[3] and reviewed here are as follows:

High Reactor Building Pressure
Low Reactor Water Level
Low Steam Drum Water Level
High Reactor Pressure
Main Steam Line Valve Closed
High Condenser Pressure
High Scram Dump Tank Level
Recirculation Line Valves Closure
High Neutron Level Flux
Short Reactor Period
Manual Scram
Protection Against Picoammeter Circuit Failure
RPS Bus Undervoltage

3.2 RPS Logic

The RPS logic is comprised of two redundant logic channels. Each channel receives an input signal from two or more sensors (with the exception of the RPS bus undervoltage) for each of the monitored RPS channels. The input signals from each set of redundant sensors feed a logic gate which changes state (turns off) upon loss of either input signal. The logic gates for each of the monitored parameters are connected together to drive the channel trip relays.[4] A trip signal by any sensor will initiate a channel trip in a one-out-of-two logic with the exception of the neutron level flux system. The neutron level flux power range system has three monitors with their trip signal arranged in a two-out-of-three logic trip. Each parameter, with the exception of the nuclear flux monitors, is monitored by bistable sensors. The neutron flux monitors are analog systems each with a bistable trip output to the channel two-out-of-three trip logic.[5]

The RPS logic requires a trip of both channels to cause a reactor scram. The scram logic operates in a normally energized, fail safe mode. Loss of power will initiate a reactor scram signal.

The short reactor period system is comprised of two channels monitoring neutron flux. The sensors are compensated ion chambers which input an analog signal to the log-N and period amplifiers. The system operates in a range of approximately 10^{-5}% to rated power and provides analog output signals for period trips, annunciation, remote meters and recorders. Each period amplifier has a trip unit which provides a trip signal to both RPS logic channels in a one-out-of-two configuration. Placement of any two-out-of-three High Level Neutron Flux ranges switches in the power range position will bypass the period trip feature.

The High Neutron Flux System is comprised of three channels monitoring neutron flux in the power range. Each channel consists of a power supply, a compensated ion chamber and a picoammeter. The picoammeters each have two up scale trip units and one down scale trip unit. One upscale trip unit provides the trip signal to one input of the two-out-of-three logic inputs to the RPS logic channels. It also provides a trip signal to the neutron flux hi scram annunciator. The second upscale trip unit provides a high flux warning alarm. The down scale trip unit initiates a down scale interlock. Any two-out-of-three high neutron flux channel trip signals will trip both logic channels, initiating a reactor scram. The picoammeters also supply analog signals to local meters, remote meters and recorders.

Each RPS sensor, with the exception of the RPS undervoltage relays, in addition to feeding an OR gate in the channel trip logic, feeds separate RPS relays. Contacts of these relays provide output signals to the event recorder and annunciators.

Sensors for each logic channel, with the exception of the Low Reactor Water Level sensors, are dedicated to the RPS. The Low Reactor Water Level sensors feed two sets of logic gates, one set for the scram logic and the other set for the engineered safety features (ESF). (See SEP Topic VII-2[6] for an evaluation of this system.)

A reactor operation mode switch provides control and bypass for an RPS logic channel. The four position switch has a run, bypass dump tank, refuel, and shutdown position to accommodate the different reactor conditions. Inclusion of the mode switch in the logic channel is by switch contacts.

3.3 RPS Power[7]

Power to the RPS and the nuclear instrumentation is supplied from three 120V AC sources. Two motor generator (MG) sets, MG-1 and MG-2, fed from 480V AC buses 1A and 2A respectively, supply power to RPS bus No. 1 and RPS Bus No. 2. A solid state inverter with 125 DC input from the 125V DC Distribution Panel No. 1 feeds 120 VAC to the Reactor Protection System bus No. 3. RPS bus No. 3 feeds the rod position indicating system and Neutron Monitoring Channels.

Upon the loss of power supplied by one of the MG sets, an alternate 120 volt supply from panel 1Y can be switched to either of the two protection buses or to the neutron monitoring bus No. 3. The alternate power supply is interlocked so that only one of these three buses can be supplied at any one time from Panel 1Y.[8] Loss of 480 V power to either MG results in an alarm in the control room.

Protection for each RPS bus and MG set consists of an overload relay which provide annunciation in the control room and an undervoltage and overvoltage relay for each MG which alarms in the control room and also interrupts the MG exciter field current causing the MG to trip with a consequent loss of voltage to the RPS channel. The MG sets each have voltage regulators for output voltage control but do not have frequency control, relying on the stability of the plant 480 V frequency plus inertia flywheels for minor frequency disturbances.[9]

RPS buses 1 and 2 have under voltage relays set at 52 $\pm$ 20 volts[3] which open the circuits to their respective scram pilot valve solenoids, the master scram solenoid and other solenoid valves essential to a reactor scram.[8]

3.4 Evaluation

Based on the review of the referenced documents, that portion of the RPS comprised of instrument bistable sensors, logic gates, relays, and manual switch logic is adequately isolated from control and non-safety systems.

The neutron flux monitor system output signals to the RPS trip modules also feed remote indicating meters and recorders. A 9.65 KΩ resistor located in the picoammeter chassis isolates the signal to the remote process instruments from the RPS trip unit input signal. The process instruments are low impedance current instruments operating on a low (mA) current signal. The signals are derived from the dc amplifier in the picoammeter using a 6201 dual triode vacuum tube in a cathode follower configuration for the signal output. A short or open circuit on a signal lead to the remote instrumentation will have minimal or no effect on the signal to the RPS trip unit operation. A maximum credible voltage that could be applied at the output of the buffer resistor is 120 ac.[9] This condition will cause the trip unit in the effected system (one of three systems) to trip. The trip signal will be indicated in the control room. Using a resistor as an isolation device in the RPS signal circuit will not prevent perturbations of the RPS trip signal for a postulated maximum voltage on the isolator output. However, the perturbation will cause the neutron monitor to trip, which is in the safe direction.

The motor generator sets feeding the RPS buses 1 and 2 are not considered to be Class 1E equipment.[10] The isolation of the RPS bus from the non-Class 1E motor generator is comprised of a thermal overload breaker and an undervoltage relay for each RPS bus. As described in a memorandum by Faust Rosa, Chief, Power Systems Branch, NRC,[11] the capability of the Class 1E Reactor trip system to accommodate the effects of a possible sustained abnormal voltage or frequency conditions from non-Class 1E reactor trip system power supply has been questioned. An Information Memorandum Executive Summary from Harold R. Denton, Director, NRR, to the Commissioners, "Orders and Exemptions for Operating BWR RPS Power Supplies," (Enclosures 2 to Reference 11) describes the Staff's concern that postulated failures of either of the two non-Class 1E power supplies for the RPS could produce power as to preclude automatic and manual scram. A proposed conceptual design modification by GE (Enclosure 1 to Reference 11) has been recommended for implementation by the NRC.

4.0 SUMMARY

Based on current licensing criteria and review guidelines, isolation of the Reactor Protection System from control and non-safety systems complies with all licensing criteria listed in Section 2.0 of this report except for the following:

1. The Motor Generator power supplies for the RPS channels do not qualify as Class 1E equipment. Isolation between each RPS channel and its non-Class 1E power supply is inadequate.

5.0 REFERENCES

1. General Design Criterion 24, "Separation of Protection and Control Systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

2. IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations."

3. Appendix "A", Consumers Power Company Big Rock Point Nuclear Plant Technical Specifications, Appended to Operating License No. DPR-6, as amended through February 25, 1981.

4. "Final Hazards Summary Report Vol. 1 Plant Technical Description and Safeguard Evaluation," Revised March 1, 1962. Consumers Power Company drawing 0740-G30743, sh 2, Rev E, "Reactor Protection System."

5. Consumers Power Company drawing 0740-G30743, sh 2, Rev E, "Reactor Protection System" and 0740-F30760 shs 1 and 2, Rev B, "Neutron Monitoring Systems."

6. SEP Technical Evaluation, Topic VII-2, "ESF System Control Logic and Design, Big Rock Point," dated October 13, 1981.

7. Consumers Power Company drawing 0740-G30743, sh 1, Rev D, "Reactor Protection System."

8. Consumers Power Company letter, R. A. Vincent to NRR, D. M. Crutchfield, "Big Rock Point Plant--SEP Topic VI-10.A, Electrical, Instrumentation and Control Portions of the Testing of RTS and ESF," dated March 29, 1982.

9. Consumers Power Company letter, D. J. VandeWalle to NRR, D. M. Crutchfield, "Big Rock Point Plant--Isolation of Reactor Protection System from Non-Safety Systems, Including Qualification of Isolation Devices," dated June 22, 1982.

10. IEEE Standard 308-1974, "IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations."

11. Memorandum from Faust Rosa, Chief, Power Systems Branch, to J. Stolz, Branch Chief, Light Water Reactors Branch No. 1, DPM, T. Ippolito, Branch Chief, Plant Systems Branch, DOR, and G. Laines, Chief, Power Systems Branch, DOR, "Reactor Protection System (RPS) Power Supplies (Hatch 2 Problem)," dated February 12, 1979.

APPENDIX A

NRC SAFETY TOPICS RELATED TO THIS REPORT

APPENDIX A

NRC SAFETY TOPICS RELATED TO THIS REPORT

1. III-1 Classification of Structures, Components and Systems.
2. VI-10.A Testing of Reactor Trip Systems and Engineered Safety Features, Including Response Time Testing.
3. VII-2 ESF System Control Logic and Design.
4. VII-3 Systems Required for Safe Shutdown.