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GENERAL ELECTRIC COMPANY

PLANT HATCH UNITS 1 AND 2

ANALYSIS TO SUPPORT SURVEILLANCE TEST INTERVAL EXTENSION FOR SCRAM DISCHARGE VOLUME LEVEL SWITCHES

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GENE 770-25-1092-1
CLASS I

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TABLE OF CONTENTS

1.0 SUMMARY

This report provides the technical basis for extending the current quarterly channel functional test intervals for Plant Hatch Scram Discharge Volume (SDV) float type level switches to once per 18 months. The analysis indicates that the frequency of failure to scram due to the SDV level switch test extension increases from 3.41E-10 per year to 1.53E-09 per year for the most limiting postulated SDV blockage. This small increase in scram failure frequency is negligible and is offset by the expected reduction in personal radiation exposure from 6 man-rem to 1 man-rem per refueling outage for both Hatch plants.

2.0 INTRODUCTION

Currently the channel functional tests for scram discharge volume float type level switches C11-N013A, B, C, D, E, and F are conducted on a quarterly basis at Plant Hatch. Personnel are required to perform the functional tests near the SDV which involves personnel exposure to radiation. Plant operating experience at Plant Hatch Units 1 and 2 indicates that each of these tests results in on the average a total of 0.5 man-rem per test. Quarterly tests result in 3 man-rem per 18 month refueling outage for a total of 6 man-rem for both Hatch Plants per refueling outage. Georgia Power Company requested GE to assess the feasibility of testing these scram discharge volume level switches only once per refueling outage so as to reduce personnel exposure from six to one man-rem per refueling outage for both Plant Hatch Units. Scram discharge volume level switches C11-N660A, B, C, and D and their companion level elements C11-N060A, B, C, and D would still be tested on a quarterly basis.

3.0 METHODOLOGY

A fault tree model of scram failure potential due to SDV high water level was developed for Plant Hatch Units 1 and 2 to evaluate the effect of test interval extension for the float type SDV level switches. Model input values (failure rates) from the Georgia Power Company Plant Hatch Units 1 and 2 Individual Plant Examination (IPE) basic event file were used wherever applicable. Test intervals for the SDV float type level switches (C11-N013A, B, C, and D) were varied from 3 months to 18 months. The failure rates for these switches were taken from IEEE 500 1984 (Reference 1) and are discussed further in Appendix B. The effect of the failure to scram on SDV high level logic was evaluated using the CAFTA computer code.

The above technical basis uses similar methodology as has been applied in the BWR Owners' Group program for extending the BWR instrumentation surveillance test intervals and allowed outage times and has been approved by the NRC in Reference 2.

The fault tree has been modeled as a failure to scram on demand due to SDV high water level. The presence of a water source is the initiating event and has been assigned a frequency of once per year.

4.0 SCRAM DISCHARGE VOLUME DESCRIPTION

The scram discharge volume is the volume created by a large U-shaped line leading from each of the hydraulic control banks on each side of the reactor. These large pipe manifolds are designed to have enough volume to be able to accept all the water discharged from each individual control rod drive, with ample margin. The instrument volume provides the means for detecting water accumulation in the discharge volume and automatically scramming the reactor should the discharge volume start to fill.

During normal reactor operation the discharge volume is open to atmospheric pressure. When a scram is initiated the air operated drain valves and vent valves close and the volume accepts reactor water discharged from each of the control rod drives. Reactor startup is prevented by the scram discharge volume level instrumentation until the volume is drained.

There are four level sensors in each side of the scram discharge volume that initiate scram. In each side of the scram discharge volume, two of the four sensors are float type level indicators. The other two level sensors are temperature sensors and give a scram signal when hot reactor water comes into contact with the temperature element. In addition, there are two level switches in the SDV that indicate high water level below the scram setpoint. One level switch causes a rod block when the trip point is reached. The other level switch causes an alarm in the control room when the trip point is reached.

In order to have a failure to scram due to the scram discharge volume, an undetected water source that fills the SDV must be present, there must be a failure to drain the scram discharge volume, and the full scram discharge volume must go undetected. The presence of a water source is the initiating event and has been assigned a frequency of 1.0 per year. A water source could include a prior test or scram, scram valve leakage, maintenance, and/or a drain line water source.

Two SDV scram failures were considered in the analysis. The first failure case is blockage of the scram discharge volume due to failure of the drain or vent

valves or a blockage in the piping such that both sides of the scram discharge volume would fill (i.e., Case 1 involves both sides of the scram discharge volume filling with reactor water). The second failure case considers a blockage where only one side of the scram discharge volume fills. In the second case, only four scram level sensors in the affected instrument volume would detect the level rise instead of the entire eight sensors for Case 1. Case 2 will therefore be more sensitive to test interval extensions.

Both Plant Hatch Units were analyzed. Only one difference exists between Unit 1 and Unit 2 in relation to modeling the SDV blockage but this difference does not affect the fault tree logic. Unit 2 has the Rod Withdrawal Block level switch C11-N013E and the SDV high level alarm C11-N013F positioned to one side of the SDV whereas they are located below the SDV for Unit 1. Unit 2, case 1 would be annunciated via these sensors whereas Case 2 would not. For Unit 1, these sensor locations are below the postulated blockage in either Case 1 or Case 2, resulting in no indication of high level for either case. This difference is not modeled in the fault tree because four different alarms would have to fail before the operator has no indication of high level in the scram discharge volume. Failure to notify the operator of scram discharge volume high level is therefore negligible and is not modeled.

5.0 RESULTS

Figures 1 through 7 in Appendix A present the top level fault tree for a failure to scram due to the scram discharge volume high water level for both failure cases for Plant Hatch Units 1 and 2.

As can be seen from the following table, for Case 1 where there is a postulated blockage of both sides of the SDV, there is a negligible difference (2%) in the failure probabilities by extending the test intervals from 3 months to 18 months for the C11-N013 level sensors. Case 1 involves both sides of the scram discharge volume blocking resulting in the C11-N013 level sensors modeled in an "AND" gate with the C11-N660 sensors. Therefore, the scram failure results are not very sensitive to the test interval extension.

This is not the case for Case 2 where there is postulated blockage in only one side of the scram discharge volume. There is a reduced redundancy in level indication and the failure probability increases by a factor of 4 1/2 as a result.

SDV HIGH LEVEL SCRAM FAILURE
(Failure Probability per Year)

	3 Month Test Interval	18 Month Test Interval
Case 1	2.48E-10	2.53E-10
Case 2	3.41E-10	1.53E-09

The primary reason for the low probability of failure to scram due to scram discharge volume high level is the fact that two diverse conditions must occur simultaneously, a failure to drain and a failure to detect the drain failure. Even though the drain failure rate has been assumed to be relatively high, adequate redundancy and diversity exist to reliably detect this drain failure and automatically scram the plant before the scram discharge volume becomes full.

An analysis of the Nuclear Power Reliability Data system (NPRDS) data corroborates the use of 6.72E-6 failures/hour taken from industry standards for float type level switches, see Appendix B.

A search of the GE Service Information Letters indicates there are no unusual failure rate trends which affect the extension of the surveillance test interval for the scram discharge volume level switches, see Appendix B.

In the most limiting case, Case 2, the failure to scram probability increases from 3.41E-10 to 1.53E-09. This small increase in scram failure frequency is negligible and is offset by the expected reduction in personal radiation exposure of 5 man-rem per refueling outage for both Plant Hatch units.

6.0 REFERENCES

1. IEEE Std. 500 Reliability Data, 1984

2. "Technical Specification Improvement Analyses for BWR Reactor Protection System", GE Document NEDC-30851P-A, March 1988.

APPENDIX A

RPS SCRAM DUE TO SDV HIGH LEVEL FAILS FAULT TREE

The evaluation to determine the Reactor Protection System failure to scram due to SDV high water level was performed using the inputs from Table 1 for the component unavailabilities and the following assumptions:

1. The possibility of detecting SDV high level by instrumentation channel check has been conservatively neglected.

2. The blockage probability for the drain line where there is the restriction from 8-inch diameter pipe to 2-inch pipe is very conservatively considered the same as the probability of a plugged orifice (3E-4/demand). The same value has been used for Case 1 where the blockage is in the 2-inch drain line.

   The probability of having a blockage in the vent line was assumed equal to the probability of failure to open of a vacuum breaker (1E-5/demand) tested every 3 months.

3. A failure to drain either side of the scram discharge volume was conservatively assumed to cause shutdown failure. If this condition should occur, a failure to fully insert one half of the control rods on one side of the reactor could result. However, reactor hot shutdown may still be possible since the reactor power level would be low and the operator would have more than one-half hour to manually insert control rods or start boron injection.

4. The detection of closure of the drain or vent valves by the position light was neglected.

5. The failure of the SDV high level alarm has been taken as zero. Four alarms have to fail before the operator has no indication of SDV high level:
   a) The SDV high level trip,
   b) the SDV not drained alarm,
   c) the System A trip alarm, and
   d) the System B trip alarm.

The probability of all four alarms failing is negligible compared to that of the operator failing to initiate a scram failure rate of 1.0E-3.

6. The operator error has been taken as a demand failure rate of 1.0E-03. This is a reasonable assumption given that the operator should have a considerable time to scram the plant once the high scram discharge volume level is annunciated. The time it takes for the scram discharge volume level to continue to climb above the alarm level to where the volume becomes too full to accommodate the discharge from the control rod drives is the time the operator has to scram the plant.

7. Even should there be a blockage in the scram discharge volume, there needs to be a water source to fill the volume before there is a need to scram the reactor on high scram discharge volume water level. The presence of a water source is the initiating event and is given a conservative probability of 1.0 per year. A water source could include a prior test or scram, scram valve leakage, maintenance, and/or a drain line water source.

TABLE 1: PLANT HATCH SCRAM DISCHARGE VOLUME FAILURE PROBABILITIES

ACRONYM	EVENT	PROBABILITY	F. RATE (/h)	F. RATE (/d)	TEST INT (h)	RESTORE (h)	REF.	HATCH NAME

GENERAL ELECTRIC COMPANY
PROPRIETARY INFORMATION

GENE 770-25-1092-1
CLASS I

ACRONYM	EVENT	PROBABILITY	F. RATE (/h)	F. RATE (/d)	TEST INT (h)	RESTORE (h)	REF.	HATCH NAME

GENERAL ELECTRIC COMPANY
PROPRIETARY INFORMATION

GENE 770-25-1092-1
CLASS I

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Figure 1

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Figure 4
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Figure 5

[illegible]

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Figure [illegible]

[illegible]

APPENDIX B

SDV FLOAT TYPE LEVEL SWITCH FAILURE RATE

A search was made of the Nuclear Power Reliability Data System (NPRDS) and the General Electric Service Information Letters (SILs) so as to check the appropriateness of the failure rate of 6.72E-6 per hour which was used for the scram discharge volume level switches. This failure rate was taken from the IEEE 500 1984, Reference 1, for float type level switches.

Magnetrol International, Inc. Catalog # 5.0-7.51 float level switches are used for the scram discharge volume level switches at Plant Hatch Units 1 and 2. There are 508 Magnetrol switches listed in the NPRDS as being in use at GE BWRs. Seventy-eight of those switches are identified as being in the CRD system.

In the NPRDS, ten failures are associated with the 78 CRD Magnetrol switches. These ten failures occurred at five different plants from 1984 through 1992. Using a very rough assumption that all 78 listed switches have been in use for this eight year span results in a switch failure rate of:

10 failures/[(78 switches)x(8 years)x(365 day/yr)x(24 hrs/day)]
= 10 failures/5,466,240 hours
= 1.8E-6 failures/hour

Another rough estimate can be made from the 508 Magnetrol switches listed in the NPRDS for any system for GE BWRs. There are 104 failures given for these 508 switches. The failures occur as follows:

1975 - 2	1984 - 13	1989 - 17
1977 - 1	1985 - 17	1990 - 12
1980 - 1	1986 - 9	1991 - 9
1982 - 3	1987 - 14	1992 - 1
1983 - 1	1988 - 4	

As can be seen from the above listing, there is a large increase in the number of failures from 1983 to 1984. In order to make a realistic assumption regarding the number of years these 508 switches have been in service, assume the bulk of the switches are 1984 or later, i.e., use a service interval of eight years in the estimation. The eight failures in the proceeding years are retained in the calculation.

104 failures/[(508 switches)x(8 years)x(365 day/yr)x(24 hrs/day)]
= 104 failures/35,600,640 hours
= 2.9E-6 failures/hours

While the preceding is admittedly only a rough estimate, the findings do corroborate the use of 6.72E-6 failures/hour taken from industry standards.

A search for information pertaining to SDV level switches was also made of the GE SILs to ensure operating experience supports the test interval extension. The following is a summary of recommendations from SILs relating to SDV level switches:

SIL 238 8/5/77
Recommends the addition of instrument test vent valves for personnel safety during testing.

SIL 331 Supplement 2 8/28/80
The recommendation is made that float level switches should be tested by filling the float chamber with water and not by merely manually actuating the switch and checking the channel response.

SIL 331 Supplement 3 9/26/80
The recommendation is made that the scram discharge volume float level switches be checked after scrams with reactor pressures exceeding 500 psig so as to detect float collapse.

SIL 531 2/7/91
Recommends the use of improved switches in high temperature applications to avoid spurious trips from saturated steam conditions.

This search of the GE SILs indicates there are no unusual failure rate trends which affect the extension of the surveillance test interval for the scram discharge volume level switches. The recommendations made in these SILs would still apply to the SDV level switches.