Attachment 5

PVNGS Engineering Study 13-NS-C089, Revision 0

PRA Evaluation of LPSI Pump Failing to Trip on RAS

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DOCUMENT TITLE SHEET

Title / Description: **PRA Evaluation of LPSI Pump Failing to Trip on RAS**

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0	Original Issue	R C Lindquist Jr, Robert C (Z60942)	R C Lindquist Jr, Robert C (Z60942)	N/A	N/A	N/A	N/A	N/A	Hulet, Mark A(Z52238)	N/A
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Executive Summary

The purpose of this study is to determine the potential additional risk posed by the failure of a Low Pressure Safety Injection Pump to trip on a Recirculation Actuation Signal, which may result in enough air drawn into the suction of the Emergency Core Cooling and Containment Spray Pumps to render them unavailable. This is done in support of CRDR 2835132, which will change the licensing basis regarding the Refueling Water Tank design basis. The results of the analysis show that even a conservative estimation yields additional risk well below acceptance guideline values. No operator action is credited to close the RWT supply valves to the ECCS and CS headers.

10 CFR 50.59 Applicability Determination

A 10 CFR 50.59 Screening is not required for this study since it does not constitute a credited evaluation or method of evaluation as defined in NEI 96-07 Rev 1, *Guidelines for 10CFR50.59 Implementation*, Section 3.10, "Methods of Evaluation", in accordance with 93DP-0LC17 Rev 5 *10 CFR 50.59 and 72.48 Guidance Manual*, Section 2.1.6, "Qualifying Changes to Studies, Calculations and Analyses". This document does not result in a change to a design output of any Engineering/NFM design basis analysis or calculation.

As a result of this evaluation, no design output document or design process documents will be changed. This study is not intended for alteration, impact or change of any design functions as stated in the Licensing Basis. This study is not intended to be used as design output, design input or design process documentation. As such, there is no impact to the design functions stated in the Licensing Basis. Therefore, a 10CFR 50.59 screening and evaluation are not necessary.

This screening was performed by R.C. Lindquist.

Table of Contents

1.0 Introduction

PRA performed a risk analysis to support a license amendment regarding a statement in the UFSAR regarding single failures associated with Recirculation Actuation Signal (RAS). Of concern is the induction of air due to vortexing at the entrance to the headers supplying Emergency Core Cooling System (ECCS) and Containment Spray (CS) pumps. Specifically, a concern arose that if a Low Pressure Safety Injection (LPSI) pump failed to trip upon RAS, RWT level could be drawn down enough to result in air entrainment in the pump suction before the available head from the containment sump would result in closure of the check valve in the RWT headers (CHAV306 and CHBV305). In 2005 Westinghouse, with support from Fauske Associates, performed a hydraulic analysis showing that with just the HPSI and CS pumps operating after RAS (per design), insufficient air gets far enough into the header to have any effect on the pumps (Ref. 5.1) for the full spectrum of LOCA break sizes and even down to -3 psig in the containment. Though the analysis did not examine the LPSI pump failing to trip, it can be inferred that there is a higher potential for air induction due to the higher velocity of fluid in the RWT suction headers. However, failure of a LPSI pump to trip is a train-specific failure mechanism; there is no cross-train effect, since there is no communication between the two trains. Although operator action could be credited to close the RWT supply valves to the ECCS and CS suction headers before air is drawn in, it is conservatively neglected in this analysis. Additionally, this failure mechanism is not of concern in the Small Break LOCA range, since RCS pressure remains high enough that sub-cooling is not lost, which means that there is no flow from LPSI.

This study supports CRDR 2835132 and was done under ACT 3361768.

2.0 Requirements

A contractor (Exponent) performed a fault tree analysis to determine the probability of a LPSI pump failing to trip on RAS. Their report (Ref. 5.2) used failure data from the PRA data study, Ref. 5.3. Their analysis of the control circuit was thorough and includes all contacts and relays that need to function properly to achieve LPSI pump trip. There is a slight difference in Train A vs. Train B values, because the control circuit for Train B includes the additional Control Room remote disconnect switch for 10CFR50 Appendix R compliance. The 95th percentile values were determined in the Exponent study:

- LPSI-A 2.98E-3
- LPSI-B 3.13E-3

The range of break size of concern from (Ref. 5.4) is less than 0.5 sq-ft. However, as mentioned in Section 1, it also is of no concern in the Small Break LOCA range, because there will be no LPSI flow to the RCS, and even minimum flow recirculation is stopped on RAS. Therefore, the failure will be modeled as only applying to Medium and Large LOCAs.

The Rev. 16 combined internal events and fire model was used.

3.0 Methodology

To estimate the additional potential risk associated with a LPSI pump failing to trip, a new basic event was added to fail a train of ECCS and CS in the recirculation mode. Conservatively, the 95th percentile value, rounded up to 3.2E-3, was used.

In addition a common-cause failure was added using a conservative 0.1 screening value. The common-cause failure probability is then 3.2E-4.

A new parameter, MP-FT, was created having a probability of 3.2E-3 (rounding up the 95th percentile failure probabilities determined by Exponent).

A new parameter, MP-FT-CC was created with a probability of 3.2E-4.

New basic events, both of which use the parameter MP-FT were created:

4SIAP01----MP-FT, 4SIBP01----MP-FT

A third basic event for common-cause failure is 4SIXP01-CC-MP-FT using the parameter MP-FT-CC.

Fault trees SUMPA1 and SUMPB1 were modified as shown in Figures 1 and 2. House event IE-LMLOCA causes the additional fault only to be applied for Medium and Large LOCAs.

4.0 Results and Conclusions

CDF1 = 4.979E-6/yr	LERF1 = 2.282E-7/yr
CDF0 = 4.952E-6/yr	LERF0 = 2.282E-7/yr
Delta CDF = 2.7E-8/yr	Delta LERF = 0

Where CDF1 and LERF1 are the calculated values resulting from the changes above, and CDF0 and LERF0 are the documented combined internal event and fire CDF and LERF from the current PRA model, Rev. 16.

Since this is associated with a change to the licensing basis, the guidance in Ref. 5.5 can be used to judge the significance of this additional failure mechanism. It states that a change in CDF of less than 1E-6/yr and a change in LERF of less than 1E-7/yr are acceptable. Therefore, this potential additional risk is not significant, even without crediting operator action to close the RWT supply valve (CHAHV531 or CHBHV530).

5.0 References

5.1 FAI-05/107, *The Potential for Air Intrusion Following RAS*

5.2 Engineering Study 13-EN-A037, *Fault Tree Analysis and Reliability Evaluation for Low Pressure Safety Injection (LPSI) Pump Trip at the Recirculation Actuation Signal (RAS)*

5.3 Engineering Study 13-NS-B063, *PVNGS At-Power PRA Study for Generic and Bayesian Updated Reliability Data Analysis*

5.4 Westinghouse evaluation DAR-OA-07-2 (SDOC N001-1501-00008), *Emergency Operating Procedure (EOP) Report to Support Early Termination of One Containment Spray Train*

5.5 Regulatory Guide 1.174 Rev. 1, *An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis*

Figure 1 - Train A Sump

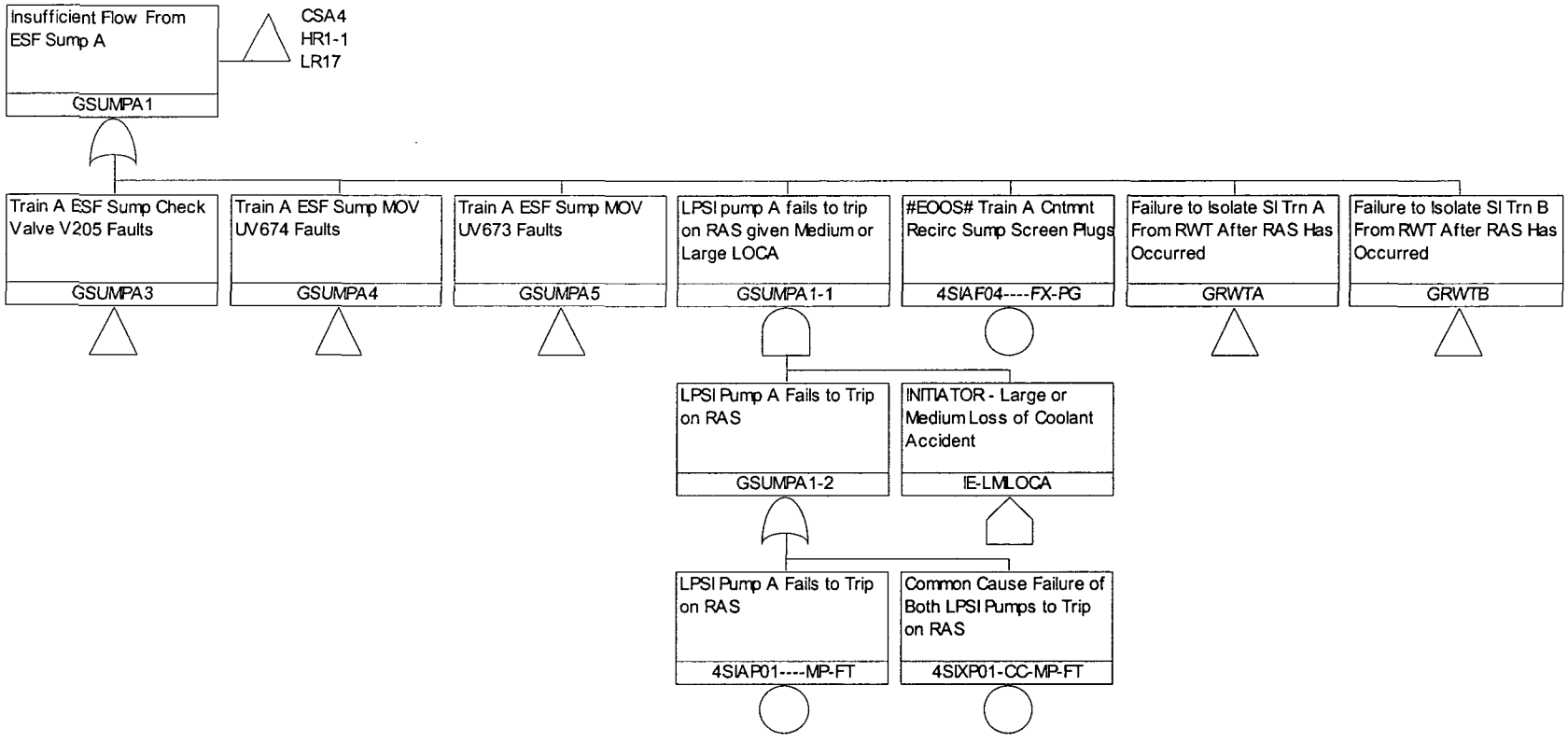

Figure 2 - Train B Sump