

AEOD/E910

ENGINEERING EVALUATION REPORT

POTENTIAL FOR GAS BINDING OF HIGH HEAD SAFETY INJECTION PUMPS
RESULTING FROM INSERVICE TESTING OF VCT OUTLET ISOLATION VALVES

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Office for Analysis and Evaluation
of Operational Data
U.S. Nuclear Regulatory Commission

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SUMMARY

Trojan nuclear plant personnel discovered that by opening one manual "bypass" valve around the volume control tank (VCT) outlet isolation valves during inservice testing, both high head safety injection pumps could potentially be rendered inoperable due to hydrogen gas binding, if a safety injection signal occurred while the bypass valve was open. Upon completion of testing, should the manual bypass valve be inadvertently left in the open position, both trains of high head safety injection could be unknowingly rendered inoperable for an extended period of time.

DESCRIPTION OF OCCURRENCE

On October 30, 1989, during inservice testing of the VCT outlet isolation valves at the Trojan nuclear plant, plant personnel discovered that the procedurally specified opening of one manual "bypass" valve around the motor operated VCT outlet isolation valves could render both high head safety injection pumps inoperable if a safety injection signal occurred while testing was in process (Ref. 1). Upon completion of testing, should the manual bypass valve be inadvertently left in the open position, both trains of high head safety injection could be unknowingly rendered inoperable for an extended period of time.

The test procedure involved timed opening and closing of VCT outlet isolation valves MO-112B and MO-112C (see Figure 1). In order to maintain charging pump suction from the VCT during testing to permit normal plant operation, the test procedure specified opening manual isolation valve 8484. With this valve open, upon receipt of a safety injection signal, the VCT would remain aligned to the high head safety injection pumps. If VCT hydrogen cover gas pressure was sufficiently high, pump suction could be preferentially provided from the VCT, even though the pump suctions were aligned to the refueling water storage tank. Hydrogen gas could then be entrained into the high head safety injection pumps, rendering both of them inoperable.

ANALYSIS AND EVALUATION

At the Trojan plant, three charging pumps have the capability of taking suction from the VCT. One pump is a positive displacement pump (PDP) which can be used to perform reactor coolant system hydrostatic testing, and normally functions to automatically maintain pressurizer level and reactor coolant pump seal injection. The other two pumps are high head centrifugal charging pumps which provide the same normal function as the PDP, but also are engineered safeguards components, providing high head safety injection during a loss of coolant accident or main steam line break. Upon receipt of a safety injection signal, both high head centrifugal charging pumps are started, the normal charging path isolates, and flow from the charging pumps is aligned to the boron injection tank with seal injection flow to the reactor coolant pumps still being maintained. Additionally, valves MO 112D and MO 112E open to supply charging pump suction from the refueling water storage tank, and valves MO 112B and MO 112C close to isolate the VCT from the charging pumps.

Valve 8484 is normally locked closed, and valve 8482 is normally open to provide a flow path for the reactor coolant pump seal water return heat exchanger. During performance of Periodic Operating Test (POT) 2-3 at Trojan, valve 8484 is opened to provide a flow path around the VCT outlet isolation valves. This alignment allows valves MO-112B and MO-112C to be timed open and closed while charging pump suction remains supplied from the VCT. However, this valve configuration also defeats the

automatic capability to isolate the VCT upon receipt of a safety injection signal. If VCT hydrogen cover gas pressure was sufficiently high, suction to the pumps could be preferentially provided from the VCT, even though the pump suctions were aligned to the refueling water storage tank. Hydrogen gas could then be entrained into the high head safety injection pumps, rendering both of them inoperable. For a large break LOCA, with an initial VCT pressure of 15 to 45 psig, the licensee calculated the pumps would become inoperable within 1 to 19 minutes of initiation of the safety injection signal.

FINDINGS AND CONCLUSIONS

- The potential exists for a common mode failure to disable both high head safety injection pumps, by opening a manual "bypass" valve around the VCT outlet isolation valves during testing.
- This situation can be exacerbated by inadvertent failure to close the valve after testing is completed. Should the manual bypass valve be inadvertently left in the open position, both trains of high head safety injection could be unknowingly rendered inoperable for an extended period of time.
- Inservice test procedures, surveillance test procedures, and operating procedures should be reviewed to determine if precautions should be added to inform plant personnel of the potential to disable the high head safety injection pumps when opening the manual "bypass" valve around the VCT outlet isolation valves. Alternately, the procedures could be modified to assure pump suction is taken from the refueling water storage tank, rather than from the VCT through the bypass valve.

REFERENCES

1. Trojan Nuclear Plant Licensee Event Report 89-21 "High Head Safety Injection Inoperable on Loss of Volume Control Tank Isolation Capability Due to Procedural Error," Docket No. 50-344, Portland General Electric Company, November 29, 1989.

CHARGING OVERVIEW

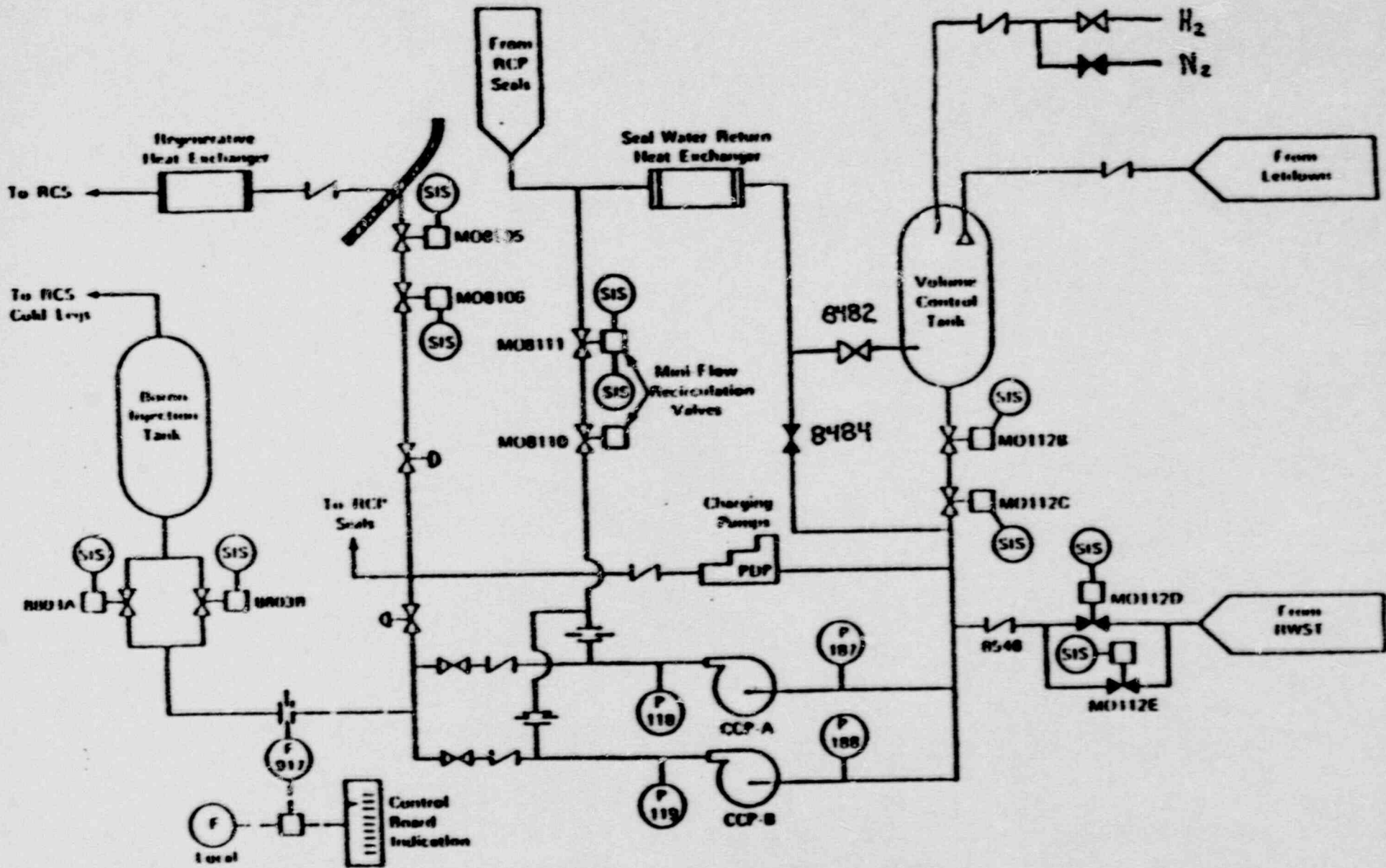


FIGURE 1

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

January , 1990

NRC INFORMATION NOTICE NO. 88-23, SUPPLEMENT 2: POTENTIAL FOR GAS BINDING OF
HIGH-PRESSURE SAFETY INJECTION
PUMPS UPON RECEIPT OF A SAFETY
INJECTION SIGNAL.

Addressees:

All holders of operating licenses or construction permits for pressurized water reactors (PWRs).

Purpose:

The purpose of this information notice is to alert addressees to potential problems resulting from transport of hydrogen from the volume control tank (VCT) to the safety related high pressure safety injection pumps during testing of VCT outlet isolation valves, potentially rendering both trains of high head safety injection inoperable. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

On October 30, 1989, during inservice testing of VCT outlet isolation valves at the Trojan nuclear plant, plant personnel discovered that the procedurally specified opening of one manual "bypass" valve around the motor operated VCT outlet isolation valves could render both high head safety injection pumps inoperable if a safety injection signal occurred while testing was in process. Should the manual bypass valve inadvertently be left in the open position after completion of surveillance testing, both trains of high head safety injection could be unknowingly rendered inoperable for an extended period of time.

The test procedure involved timed opening and closing of VCT outlet isolation valves MO-112B and MO-112C (see Figure 1). In order to maintain charging pump suction from the VCT during testing to permit normal plant operation, the test procedure specified opening manual isolation valve 8484. With this valve open, upon receipt of a safety injection signal, the VCT would not be automatically isolated from the suction the high head safety injection pumps. If VCT hydrogen cover gas pressure was sufficiently high, suction of the pumps could be preferentially provided from the VCT, even though the pump suctions were aligned to the refueling water storage tank. Hydrogen gas could then be entrained into the high head safety injection pumps, rendering both of them inoperable.

Discussion:

Opening of one manual "bypass" valve around the motor operated VCT outlet

isolation valves could render both high head safety injection pumps inoperable if a safety injection signal occurred while testing was in process. This situation can be exacerbated by inadvertent failure to close the valve after testing is completed. Should the manual bypass valve be inadvertently left in the open position, both trains of high head safety injection could be unknowingly rendered inoperable for an extended period of time.

Actions taken by licensees to avoid or correct the described situations include reviewing inservice test procedures, surveillance test procedures, and operating procedures to determine if precautions should be added to inform plant personnel of the potential to disable the high head safety injection pumps when opening the manual "bypass" valve around the VCT outlet isolation valves. Alternately, licensee procedures were found to specify that pump suction is to be taken from the refueling water storage tank, rather than from the VCT through the bypass valve during testing.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact the technical contact listed below or the appropriate NRR project manager.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contact: L. Mark Padovan, AEOD
(301) 492-4445

Attachment: List of Recently Issued NRC Information Notices

CHARGING OVERVIEW

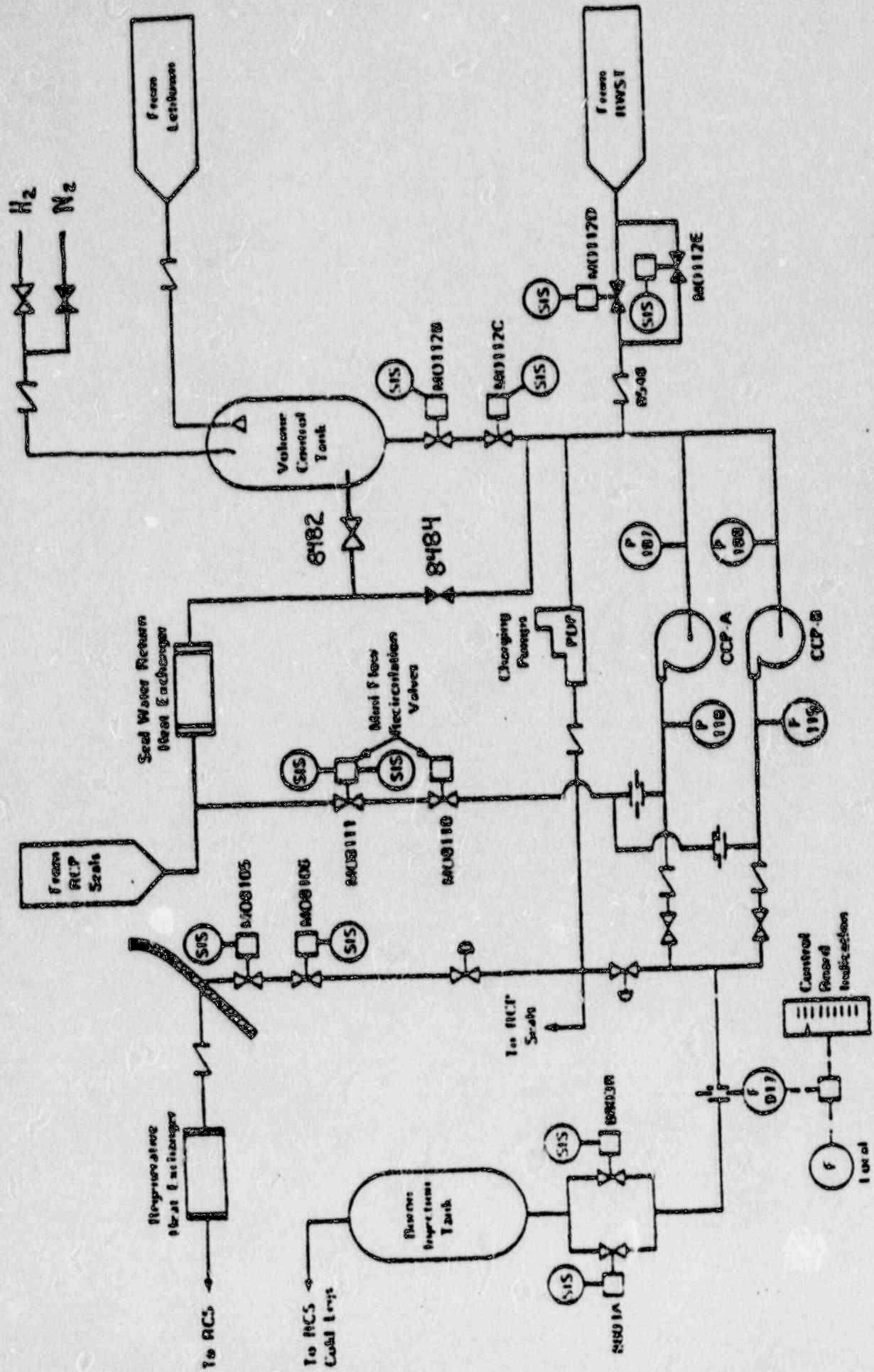


FIGURE 1