

TECHNICAL EVALUATION REPORT

**PRIMARY COOLANT SYSTEM
PRESSURE ISOLATION VALVES**

NORTHERN STATES POWER COMPANY
PRAIRIE ISLAND UNITS 1 AND 2

NRC DOCKET NO. 50-282, 50-306

NRC TAC NO. 12932, 12933

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FRC PROJECT C5257

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1.0 INTRODUCTION

The NRC has determined that certain isolation valve configurations in systems connecting the high-pressure Primary Coolant System (PCS) to lower-pressure systems extending outside containment are potentially significant contributors to an intersystem loss-of-coolant accident (LOCA). Such configurations have been found to represent a significant factor in the risk computed for core melt accidents.

The sequence of events leading to the core melt is initiated by the concurrent failure of two in-series check valves to function as a pressure isolation barrier between the high-pressure PCS and a lower-pressure system extending beyond containment. This failure can cause an overpressurization and rupture of the low-pressure system, resulting in a LOCA that bypasses containment.

The NRC has determined that the probability of failure of these check valves as a pressure isolation barrier can be significantly reduced if the pressure at each valve is continuously monitored, or if each valve is periodically inspected by leakage testing, ultrasonic examination, or radiographic inspection. The NRC has established a program to provide increased assurance that such multiple isolation barriers are in place in all operating Light Water Reactor plants designated by DOR Generic Implementation Activity B-45.

In a generic letter of February 23, 1980, the NRC requested all licensees to identify the following valve configurations which may exist in any of their plant systems communicating with the PCS: 1) two check valves in series or 2) two check valves in series with a motor-operated valve (MOV).

For plants in which valve configurations of concern are found to exist, licensees were further requested to indicate: 1) whether, to ensure integrity of the various pressure isolation check valves, continuous surveillance or periodic testing was currently being conducted, 2) whether any check valves of concern were known to lack integrity, and 3) whether plant procedures should be revised or plant modifications be made to increase reliability.

Franklin Research Center (FRC) was requested by the NRC to provide technical assistance to NRC's B-45 activity by reviewing each licensee's submittal

against criteria provided by the NRC and by verifying the licensee's reported findings from plant system drawings. This report documents FRC's technical review.

2.0 CRITERIA

2.1 Identification Criteria

For a piping system to have a valve configuration of concern, the following five items must be fulfilled:

- 1) The high-pressure system must be connected to the Primary Coolant System;
- 2) there must be a high-pressure/low-pressure interface present in the line;
- 3) this same piping must eventually lead outside containment;
- 4) the line must have one of the valve configurations shown in Figure 1; and
- 5) the pipe line must have a diameter greater than 1 inch.

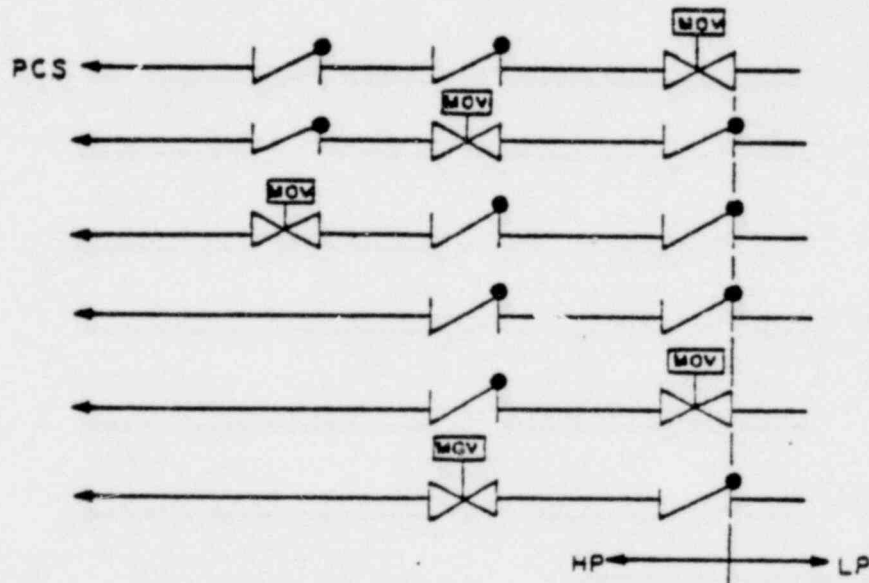


Figure 1. Valve Configurations Designated by the NRC To Be Included in This Technical Evaluation

2.2 Periodic Testing Criteria

For licensees whose plants have valve configurations of concern and choose to institute periodic valve leakage testing, the NRC has established criteria for frequency of testing, test conditions, and acceptable leakage rates. These criteria may be summarized as follows:

2.2.1 Frequency of Testing

Periodic hydrostatic leakage testing* on each check valve shall be accomplished every time the plant is placed in the cold shutdown condition for refueling, each time the plant is placed in a cold shutdown condition for 72 hours if testing has not been accomplished in the preceding 9 months, each time any check valve may have moved from the fully closed position (i.e., any time the differential pressure across the valve is less than 100 psig), and prior to returning the valve to service after maintenance, repair, or replacement work is performed.

2.2.2 Hydrostatic Pressure Criteria

Leakage tests involving pressure differentials lower than function pressure differentials are permitted in those types of valves in which service pressure will tend to diminish the overall leakage channel opening, as by pressing the disk into or onto the seat with greater force. Gate valves, check valves, and globe-type valves, having function pressure differential applied over the seat, are examples of valve applications satisfying this requirement. When leakage tests are made in such cases using pressures lower than function maximum pressure differential, the observed leakage shall be adjusted to function maximum pressure differential value. This adjustment shall be made by calculation appropriate to the test media and the ratio between test and function pressure differential, assuming leakage to be directly proportional to the pressure differential to the one-half power.

2.2.3 Acceptable Leakage Rates:

- Leakage rates less than or equal to 1.0 gpm are considered acceptable.
- Leakage rates greater than 1.0 gpm but less than or equal to 5.0 gpm are considered acceptable if the latest measured rate has not exceeded the rate determined by the previous test by an amount

*To satisfy ALARA requirements, leakage may be measured indirectly (as from the performance of pressure indicators) if accomplished in accordance with approved procedures and supported by computations showing that the method is capable of demonstrating valve compliance with the leakage criteria.

that reduces the margin between the measured leakage rate and the maximum permissible rate of 5.0 gpm by 50% or greater.

- Leakage rates greater than 1.0 gpm but less than or equal to 5.0 gpm are considered unacceptable if the latest measured rate exceeded the rate determined by the previous test by an amount that reduces the margin between measured leakage rate and the maximum permissible rate of 5.0 gpm by 50% or greater.
- Leakage rates greater than 5.0 gpm are considered unacceptable.

3.0 TECHNICAL EVALUATION

3.1 Licensee's Response to the Generic Letter

In response to the NRC's generic letter [Ref. 1], the Northern States Power Company (NSP) stated [Ref. 2] that, "Event V isolation valve configurations exist within the Class I boundary of the high-pressure piping connecting the Primary Coolant System (PCS) to low-pressure piping outside containment in the case of the Low-Pressure Safety Injection (LPSI/RHR) system. This configuration is also used to isolate the Safety Injection (SI system) and accumulators from the PCS. SI system piping on the discharge side of the pumps is rated for full PCS pressure."

The licensee further stated, "Leakage rate of isolation valves connecting RHR, SI, LPSI, and the accumulators to the PCS will be measured during the leakage test of the PCS. Continuous surveillance of the LPSI/RHR pressure isolation valves is accomplished with pressure indication and alarm in the control room."

It was discovered by FRC that a crossover piping line between the Loop B cold-leg Accumulator and the Low-Pressure Safety Injection System also contains a valve configuration of concern for Units 1 and 2.

It is FRC's understanding that, with NSP's concurrence, the NRC will direct NSP to change its Plant Technical Specifications as necessary to ensure that periodic leakage testing (or equivalent testing) is conducted in accordance with the criteria of Section 2.2.

3.2 FRC Review of Licensee's Response

FRC has reviewed the licensee's response against the plant-specific Piping and Instrumentation Diagrams (P&IDs) [Ref. 3] that might have the valve configurations of concern.

FRC has also reviewed the efficacy of instituting periodic testing for the check valves involved in this particular application with respect to the reduction of the probability of an intersystem LOCA in the Low-Pressure Safety Injection and the Loop B cold-leg Accumulator-LPSI/RHR crossover piping lines for Prairie Island Units 1 and 2.

In its review of the P&IDs [Ref. 3] for the Prairie Island Units 1 and 2, FRC found two following piping systems to be of concern:

The Low-Pressure Safety Injection (LPSIS/RHR) System for Units 1 and 2 is connected directly to the reactor vessel via two separate piping branches A and B. Each branch has a valve configuration of concern consisting of two check valves in series with a motor-operated valve (MOV). The high-pressure/low-pressure interface exists at the upstream side of the MOV.

The crossover line between the loop B cold-leg Accumulator and the Low-Pressure Safety Injection lines contains a configuration of concern consisting of a single check valve in series with a MOV. The high-pressure/low-pressure interface exists also at the upstream side of the MOV. The appropriate valves for both systems are listed below for Units 1 and 2.

Low-Pressure Safety Injection/Residual Heat Removal

	Unit 1	Unit 2
<u>Reactor Vessel</u>		
Branch A		
high-pressure check valve	SI-9-6	2SI-9-6
high-pressure check valve	SI-9-4	2SI-9-4
high-pressure MOV, n.c.	32064	32167
Branch B		
high-pressure check valve	SI-9-5	2SI-9-5
high-pressure check valve	SI-9-3	2SI-9-3
high-pressure MOV, n.c.	32065	32168

Loop B, Cold-Leg Accumulator to LPSI/RHR Crossover Line

	Unit 1	Unit 2
high-pressure check valve	SI-6-2	2SI-6-2
high-pressure MOV, n.c.	32006	32169

In accordance with the criteria of Section 2.0, FRC found no other valve configurations of concern existing in this plant.

FRC reviewed the effectiveness of instituting periodic leakage testing of the check valves in these lines as a means of reducing the probability of an intersystem LOCA occurring. FRC found that introducing a program of check valve leakage testing in accordance with the criteria summarized in Section 2.0 will be an effective measure in substantially reducing the probability of an intersystem LOCA occurring in these lines, and a means of increasing the probability that these lines will be able to perform their safety-related functions. It is also a step toward achieving a corresponding reduction in the plant probability of an intersystem LOCA in Prairie Island Units 1 and 2.

4.0 CONCLUSION

It has been determined that the Low-Pressure Safety Injection/Residual Heat Removal System in Prairie Island Units 1 and 2 incorporates valving in one of the configurations (identified in Figure 1) designated by the NRC as a valve configuration of concern. Moreover, based on the previously docketed information and drawings made available for FRC review, FRC found that the crossover line between the Loop B cold-leg Accumulator and the Low-Pressure Safety Injection/Residual Heat Removal system lines also incorporates a valve configuration of concern. Thus, if the licensee's review of the valving configuration contained in this crossover line confirms FRC's finding, then valve configurations of concern exist in two systems of Prairie Island Units 1 and 2, incorporating the valves listed in Table 1.0.

If NSP modifies the Plant Technical Specifications for Prairie Island Units 1 and 2 to incorporate periodic testing (as delineated in Section 2.2) for the check valves itemized in Table 1.0, then FRC considers this an acceptable means of achieving plant compliance with the NRC staff objectives of Reference 1.