Post Fire Safe Shutdown Analysis Unresolved Items

Wolf Creek Nuclear Operating Corporation

January 15, 2009

Meeting Agenda

- Introductions/Purpose of Meeting
- Fire Induced Closure of Reactor Coolant Pump Seal Injection Valves
- Method Used for Cable Analysis of Pressurizer Power Operated Relief Valves (PORVs)

Purpose of Meeting

- Describe WCNOC's intent to request approval to change the Post Fire Safe Shutdown Analysis Method for Two Fire Induced Failures

- Obtain NRC comment and feedback whether presented methods are reasonable

Reactor Coolant Pump Seal Injection Valves

- Describe WCNOC's intent to pursue operation with the Reactor Coolant Pump (RCP) Seal Injection Valves de-energized in the open position
  - Provide a description of the design and operation of the RCP Seal Injection Valves
  - Provide a description of the analysis supporting RCP Seal Injection Valves operability
  - Discuss associated Technical Specification compliance

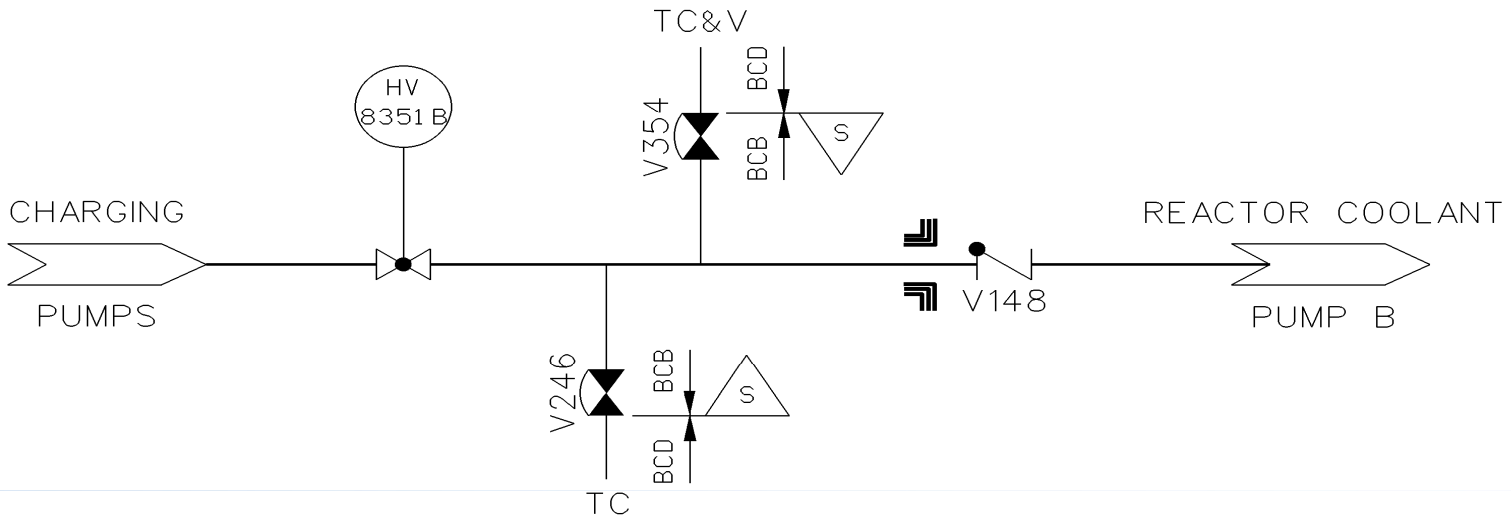
Reactor Coolant Pump Seal Injection Valves (cont)

- WCNOC intends to pursue opening the electrical breakers with the RCP seal injection containment isolation valves in the open position during normal operation
- Certain fires at WCGS could cause spurious closure of these valves with resulting loss of RCP seal injection, increasing risk of RCP seal damage

Reactor Coolant Pump Seal Injection Valves (cont)

- Operators must diagnose and mitigate the spurious closure of the RCP seal injection valves in a timely manner
- Diagnostic instrumentation is available, but difficult to recognize
- Compensatory measures are in place

Simplified Schematic of RCP Seal Injection Penetrations



Seal Injection Valves Description and Operation

- One Motor Operated Valve (MOV) installed in each of the four seal injection penetration lines (outboard)
- These valves are considered remote-manual containment isolation valves
- One Check Valve is installed in each of the four seal injection penetration lines (inboard) to provide containment isolation valves
- RCP seal injection valves have no automatic closure function (essential penetration) (Westinghouse Systems Standard Design Criteria 1.14 and NUREG 0881)

Seal Injection Valves Description and Operation (cont)

- RCP seal injection valves have no required closure time (Westinghouse Systems Standard Design Criteria 1.14)
- RCP seal injection valves can be remote-manually closed by operator when charging pump has completed its safety function. (Westinghouse Systems Standard Design Criteria 1.14)
- RCP seal injection valves are tested per Appendix J, type C testing (USAR Fig. 6.2.4-1, pages 18, 29, 30 and 31)

Seal Injection Valves Description and Operation (cont)

- Reactor Coolant Pump Seals
  - Among most vulnerable components in a PWR (Generic Safety Issues 23 and 65)
  - Seals require cooling to avoid failure and possible unisolable seal LOCA
  - Seal Injection from charging pump provides one method of cooling the seals
  - Thermal Barrier Cooling provides a second method of cooling the seals

Seal Injection Valves PSA review

- WCGS PSA models the RCP Seal Injection Valves only for a failure in the closed position
  - Spurious closure is possible due to fire damage on control cables
  - Spurious closure has minimal impact on risk of CDF due to existence of thermal barrier cooling
  - Same fire can cause thermal barrier cooling to be lost
    - Simultaneous loss increases risk of CDF (half order of magnitude increase above baseline at-power CDF)
  - PSA does not model the RCP seal injection valves as containment isolation valves

Seal Injection Valves Design Basis

- Containment isolation valves in the Chemical and Volume Control System (CVCS) are selected, tested and located in accordance with the requirements of 10CFR50, GDC 55 and Appendix J (USAR Section 9.3.4.1.1)
- CVCS is able to continuously supply filtered water to each reactor coolant pump seal, as required by the reactor coolant pump design and as specified in USAR Table 9.3-8 (USAR Section 9.3.4.1.2)
- Seal water supply flow rate, for all four reactor coolant pumps, nominal, 32 gpm (Table 9.3-8)

Seal Injection Valves Design Basis(cont)

- Westinghouse Systems Standard Design Criteria 1.14 states that the seal injection line penetrations are a special case for plants where charging pumps are used for safety injection (i.e., WCGS)
  - Flow to the RCP seals will be provided by the charging pumps following an accident
  - Due to the high pressure inflow, there is no need to provide trip valves in the seal injection lines

Seal Injection Valves Design Basis(cont)

- WCGS SER - NUREG 0881 (by reference to the Callaway SER) states:
  - RCP seal water supply lines are classified as essential and provisions have been made to detect possible leakage from these lines outside containment, thereby allowing remote-manual instead of automatic isolation valves
  - Staff finds that the containment isolation provisions for the specific penetration is an acceptable alternative to the requirements of GDC 55

Seal Injection Valves Design Basis(cont)

- USAR Table 18.2-2 identifies the containment penetrations for the seal injection valves as essential
- Essential is defined as those systems required to have isolation valves open for either post accident safe shutdown or mitigation of the consequences of an accident
- CVCS piping inside and outside containment is designed to ASME Boiler and Pressure Vessel Code, Section III, class 2 requirements (Same design requirements as piping in the containment penetration piping)

VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
BBHV-8351B	2/2	OUTSIDE	IN	GLOBE	MOTOR	4	NONE	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	C
BBV-354	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
BBV-246	3/4/3/4	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
BBV148	2/2	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	OPEN	OPEN	N/A	OPEN	CLOSED	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

FLUID CONTAINED: WATER

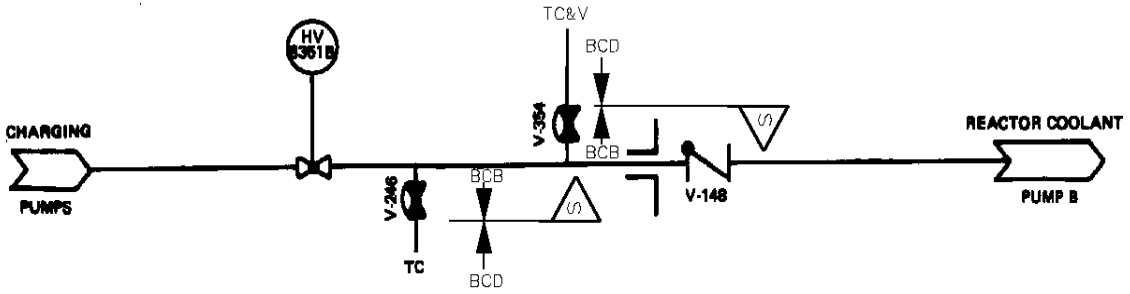
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 11.7ft.

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

THIS PENETRATION PIPING HAS A HIGH PRESSURE WATER INFLOW WHICH PRECLUDES THE NEED FOR AUTOMATIC ISOLATION OF THIS PENETRATION. THE CVCS CHARGING PUMPS SUPPLY REACTOR COOLANT PUMP SEAL INJECTION WATER, AND THERE IS A POTENTIAL FOR DAMAGE TO THE REACTOR COOLANT PUMP IF UNDESIRED ISOLATION SHOULD OCCUR.

THE ISOLATION CAN BE AFFECTED BY REMOTE-MANUAL CLOSURE OF THE MOTOR-OPERATED VALVE BY THE OPERATOR PRIOR TO THE CHARGING PUMPS COMPLETING THEIR SAFETY FUNCTION.



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CONTAINMENT PENETRATION NO. P-22
DESCRIPTION:
RCP SEAL WATER SUPPLY
REACTOR COOLANT SYSTEM

REFERENCE SECTION(S) 5.0
REV. 13

RCP Seal Injection Valves Safety Analysis Review

- Safety Analysis calculations do not model these valves for containment isolation function
- Analyses assume that seal injection is in service and water is flowing into the containment through these essential penetrations
- On loss of power, these valves will fail-as-is
- Under accident conditions, these valves stay open
- There is no specified closure time for these valves in the safety analyses

RCP Seal Injection Valves Safety Analysis Review (cont)

- Four Operations Emergency procedures call for closure of the seal injection isolation valves
  - To allow restart of charging pump following loss of all charging and loss of all seal cooling
  - To avoid thermal shock damage to the RCP seals
  - Meets Westinghouse Emergency Response Guidelines for restoring seal injection

RCP Seal Injection Valves Technical Specifications

- Section 3.6.3, Condition A, states that if one containment isolation valve is inoperable in a penetration flow path, the penetration must be isolated by a closed manual valve, blind flange, or closed and de-activated automatic valve, or a check valve with flow through the valve secured
- Section 1.1 (definitions) states:

  A component…shall be OPERABLE…when it is capable of performing its specified safety function(s) and when all necessary attendant instrumentation, controls, normal or emergency electrical power…that are required for the component to perform its specified safety function… are also capable of performing their related support function(s)

RCP Seal Injection Valves Technical Specifications (cont)

- Based on the Technical Specification definition of OPERABLE/OPERABILITY, removing electrical power to the RCP seal injection valves would make the valve inoperable
- Operation with the power removed to the seal injection valves is an acceptable approach, as a safe plant condition will be maintained
- Plant Operators can energize the breakers and remote-manually close the valves when specified in procedures

RCP Seal Injection Valves Conclusion

- Proposed change to TS 3.6.3, “Containment Isolation Valves” will be submitted to allow operation with the RCP seal injection containment isolation valves in the open position and power removed from them
- This would prevent a fire from causing the valves to spuriously close
- Operators will not need to take actions to avoid seal LOCA due to fire
- No other impacts to operation of plant

RCP Seal Injection Valves Conclusion

- Questions
- Comments and Feedback

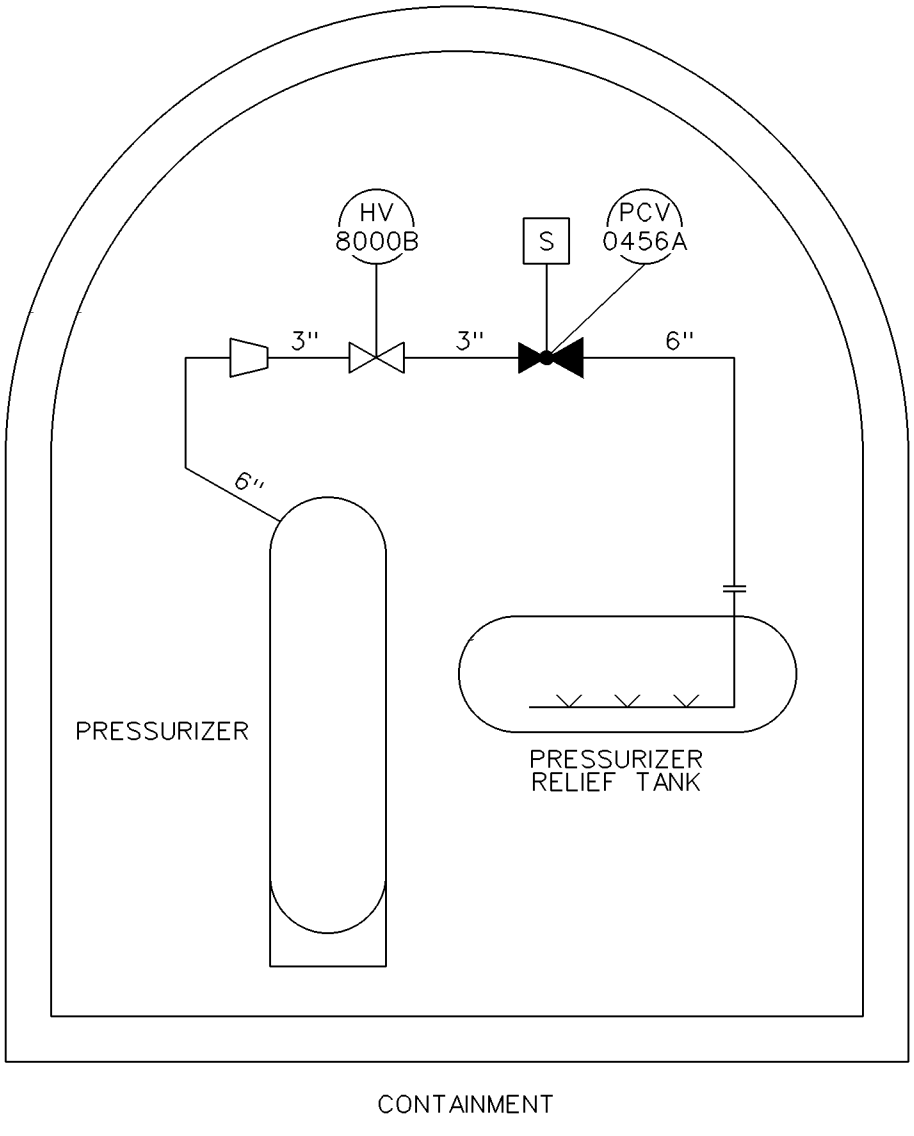
Pressurizer Power Operated Relief Valves (PORV)

- Describe WCNOC's intent to reclassify the PORVs as non high-low pressure interface
  - Provide a description of the design and operation of the PORVs
  - Provide a discussion of the origin of the high-low pressure interface concern
- Proposed change would alleviate burden of operator manual actions following fire induced opening of PORVs
  - Compensatory measures are in place

Pressurizer Power Operated Relief Valves (PORV)

- For post-fire safe shutdown purposes, the PORVs have been classified as high-low pressure interfaces
  - Increases the circuit fault scenarios that can result in a fire induced open PORV
  - Increases burden of operator manual actions
- Based on review, WCNOC does not consider this classification to be correct and desires to re-classify these valves as non high-low pressure interfaces

PORV Simplified Diagram



PORV Description and Operation

- PORVs have electrical solenoid actuators
  - They are operated automatically based on RCS pressure or by remote manual control (USAR Section 5.1.4.f)
- PORVs designed to limit Pressurizer pressure to a value below the fixed high pressure Reactor trip point
- PORVs designed to fail to the closed position on loss of power (USAR Section 5.4.13.1)

PORV Description and Operation (cont)

- PORVs assist administrative controls to prevent violation of pressure limits during low temperature operation (USAR Section 5.2.2.10)
- PORVs provide the safety related means for Reactor Cooling System depressurization to achieve cold shutdown (USAR Section 5.4.13.3)
- Discharged steam from the PORVs is piped to the Pressurizer Relief Tank (inside containment) where it is condensed and cooled by mixing with water (USAR Section 5.1.2)

PORV High-Low Pressure Interface History

- WASH-1400, Reactor Safety Study (NUREG-75/014, October 1975)
  - Identified an intersystem LOCA in a PWR which is a significant contributor to risk from core melt accident (Event V)
  - Investigated piping systems that connect to the RCS and also go through the containment
    - Such connections have the potential to cause a LOCA in which the interior of the Reactor Vessel may communicate to the environment

PORV High-Low Pressure Interface History (cont)

- WASH-1400 (cont)
  - Paragraph 5.3.2.5 discusses interfacing systems LOCA.
    - The concern is stated, "...the break in the system will lead into a safeguards building outside the containment so there will be a direct path for radioactive release to the atmosphere,..."
  - All RCS connections except the low pressure injection system (LPIS) (RHR System) were dismissed due to one or more reasons
    - One reason for dismissal was "Failure of the barriers would involve a LOCA into the containment..." (Appendix I, Paragraph 4.1.6)

PORV High-Low Pressure Interface History (cont)

- Task Action Plan Item B-63, “Isolation of Lower Pressure Systems Connected to the Reactor Coolant Pressure Boundary” [NUREG-0471, Sept 78]
  - States, “Each low pressure system connected to the reactor coolant pressure boundary and penetrating the containment will be examined”
  - This issue was resolved and requirements were issued (ref.- NUREG-0933, Prioritization of Generic Safety Issues – 11/83)

PORV High-Low Pressure Interface History (cont)

- 2/23/80 - NRC issued letter to LWR Licensees, "LWR Primary Coolant System Pressure Isolation Valves" (subsequently designated as Generic Letter 80-14)
  - References the WASH-1400 report - Concerned with an overpressurization and rupture of the LPIS (RHR) low pressure piping which results in a LOCA that bypasses containment
  - Requested Licensees to describe the valve configuration and indicate if Event V isolation valve configuration exists (e.g., two check valves in series, or two check valves in series with an MOV)

PORV High-Low Pressure Interface Licensing Basis

- April 1981 - SNUPPS FSAR Question Q280.5 - received as part of review of Appendix 9.5B (SNUPPS final fire hazards analysis) - Information requested:
  - Identify each high-low pressure interface that uses redundant electrically controlled devices
  - Identify each devices essential cabling
  - Identify cable separation

PORV High-Low Pressure Interface Licensing Basis (cont)

- SNUPPS FSAR Question Q280.5 (cont.)
  - Question indicates compliance with BTP RSB 5-1 and BTP ICSB 3
    - BTP RSB 5-1 discusses the design of the RHR System only
    - BTP ICSB 3 discusses over pressurization of the low pressure system and "...loss of integrity of the low pressure system and possible radioactive releases"

      NOTE: Radioactive releases would occur only if containment was penetrated or compromised

PORV High-Low Pressure Interface Licensing Basis (cont)

- SNUPPS FSAR Question Q280.5 (cont.)
  - SNUPPS response of 5/18/81 stated the RHR letdown isolation valves and the Pressurizer PORVs and associated PORV isolation valves are high/low pressure interfaces
  - Stated FSAR Appendix 9.5B (to be submitted in June 1981) demonstrates no single credible fire could cause spurious opening of these valves
  - Question 280.5 and response subsequently incorporated into SNUPPS FSAR and maintained in WCGS USAR

NOTE: as previously shown – the piping downstream of PORVs is wholly contained inside containment

PORV High-Low Pressure Interface Licensing Basis (cont)

- September 1981 – SNUPPS submitted Event V Program (program for testing the isolation between low pressure systems and the reactor coolant pressure boundary)
  - Submitted based on request from NRC at a June 1981 meeting with SNUPPS
  - Identified only two subsystems that satisfy Event V valve configuration – cold leg injection system and hot leg injection system
  - Pressurizer PORVs and isolation valves are not identified as high-low pressure interfaces

PORV High-Low Pressure Interface Licensing Basis (cont)

- April 1982 – NUREG-0881 (WCGS SER) Section 1.8
  - Confirmatory Item B.3 (Section 3.9.6) – have addressed leak testing of only those check valves with an Event V configuration
  - In addition to the above check valves, required that leaktight integrity of the accumulator discharge check valves, the boron injection system PIVs, and the MOVS in the RHR System
- June 1983 -Supplement 2 to NUREG 0881 (WCGS SER) – “After review of the list of pressure isolation valves, we find it acceptably complete and consider the confirmatory item complete”

PORV High-Low Pressure Interface Licensing Basis (cont)

- Generic Letter 87-06, “Periodic Verification of Leak Tight Integrity of Pressure Isolation Valves”
  - Request submittal of list of PIVs and description of periodic tests to assure integrity of the valve
- June 5, 1987 – WCNOC response referred to the listing of PIVs in TS Table 3.4-1 and associated surveillance testing requirements (PORVs and isolation valves not included in TS Table)
- NRC Inspection Report 92-09 – reviewed PIVs in IST Program and the response to GL 87-06 and no issues identified

PORV Conclusion

- PORVs do not constitute a high-low pressure interface as intended by WASH 1400
- PORVs are not identified as a high-low pressure interface in WCGS SER (NUREG 0881)
- Response to FSAR question Q280.5 is in error
- Proposed change will be submitted to the NRC, iaw 10 CFR 50.90, as a change that could adversely affect the ability to achieve and maintain safe shutdown in the event of a fire (License Condition 2.C.(5))
  - PFSSD Analysis of PORVs and isolation valves would utilize less severe methodology

PORV Conclusion

- Questions
- Comments and Feedback