ECCS Gas Voiding

GE BWR/4 Technology Course
R-504B – 4.4

Objectives

1. Recognize the potential consequence of voiding in Emergency Core Cooling Systems (ECCS) piping.
2. Identify potential causes of voiding in ECCS piping.
3. Identify the industry strategies for detecting, eliminating and/or minimizing the consequences of voided ECCS piping.
4. Recognize the regulations that apply to ECCS piping voiding, including Technical Specification requirements.

Five Consequences of gas binding

1. Inadvertent actuation of relief valves
2. Damage to valves, pipe supports
3. Pump cavitation
4. ECCS pump failure
5. Increased times from actuation of ECCS systems until system injection

Seven Causes of Gas Binding

1. Leakage from accumulators into ECCS discharge pipes (PWR)
2. Leakage from the reactor into ECCS discharge pipes,
3. Out gassing in ECCS piping from water in the condensate storage tank (CST) or the suppression pool

Seven Causes of Gas Binding

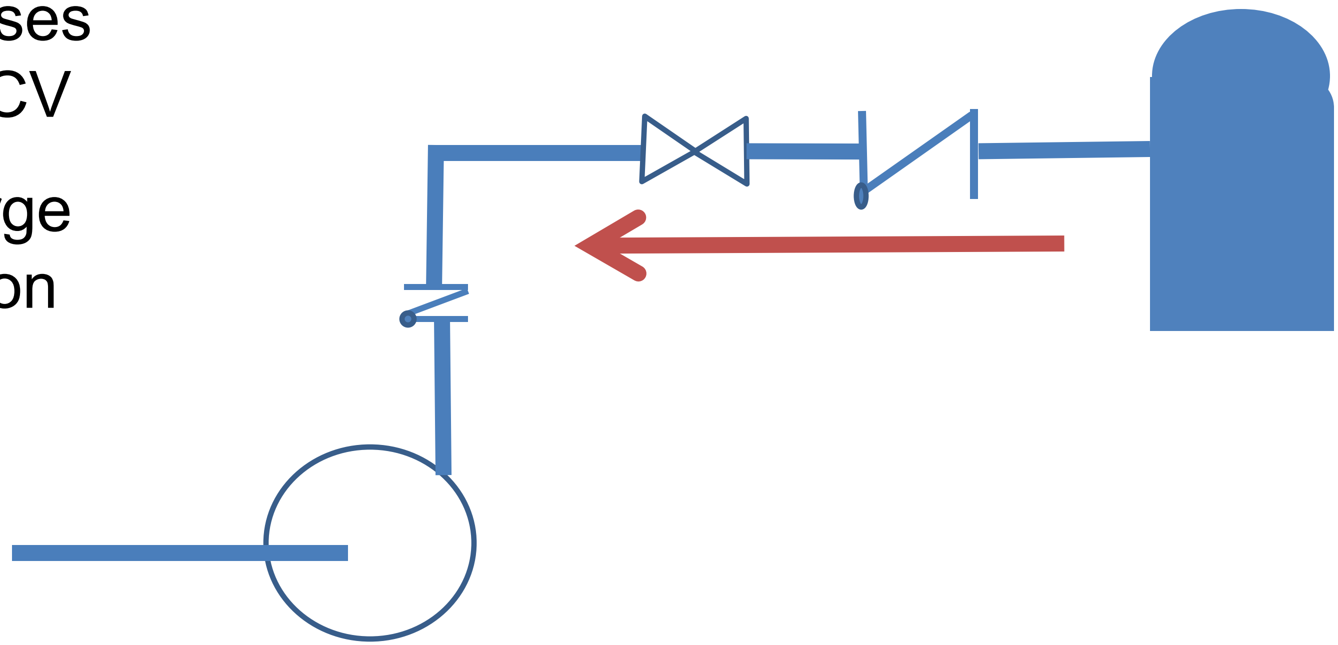
4. Introduction of gas during system draining, filling, realignments, and maintenance
5. System leakage from drain or check valves
6. System design leaving “dead” legs that cannot be vented
7. Line fill (keep fill) system failures

Check Valve Leakage

Rx pressure passes through leaking CV

Can heat discharge piping to saturation

Can pressurize discharge piping



Water hammer on the pump start

<u>or</u>

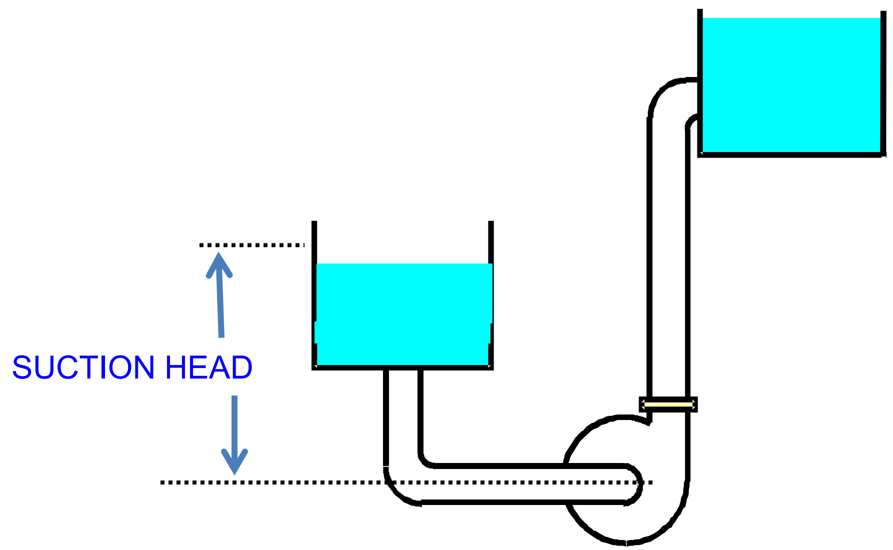
Relief valves lift draining pipe

Suction Gas Voiding

As CST or SP level drops, less NPSH for the pumps

Level drops to low, gas enters pump suction

Gas in the pump causes high vibration and or impeller damage

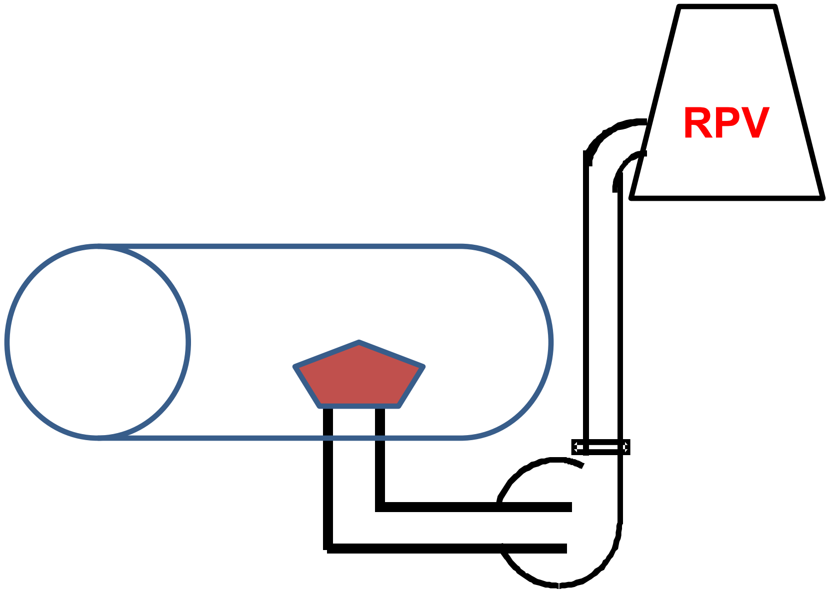


Strainer Fouling

SP suction strainer clogs

Insufficient water to the pump

Pump overheats or vibration damage

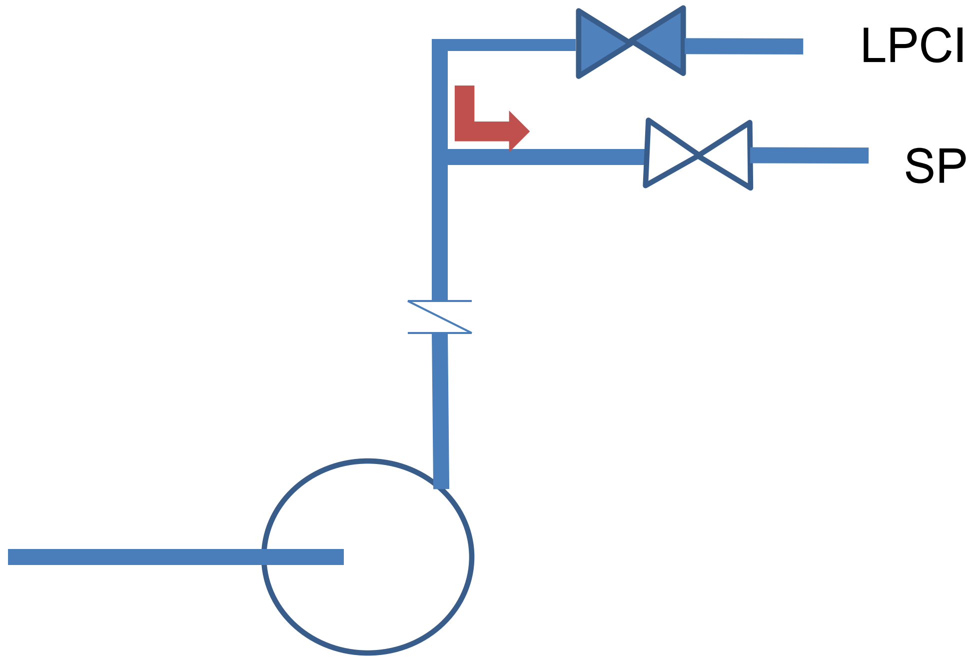


Vacuum drag

Flow through the SP test line

Vacuum drags water from LPCI or CS line

LPCI initiation signal cause water hammer due to voids

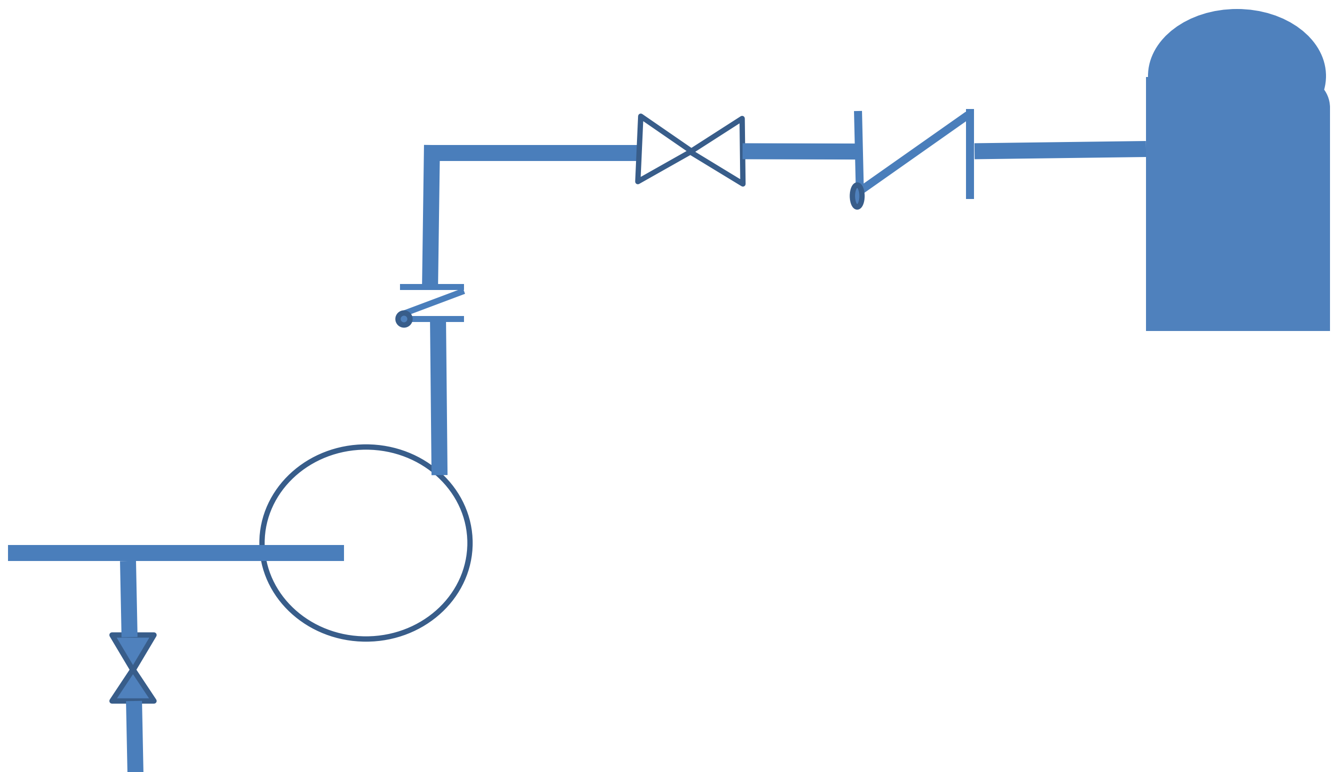


Drain/Relief Valve leakage

Drain valve leaks to floor or RW

Drains part of the pump casing and suction piping

Water hammer on the pump start



4 Industry Strategies

1. Keep Fill systems
   – Maintains a positive pressure on the system,
2. Refill and venting post maintenance or operation and on a periodic basis.
   – Removes air pockets after they form,
3. Ultrasonic testing (UT) on a periodic basis.
   – Verifies the size and location of air pockets
4. Analyses of acceptable gas volumes in a system.
   – Found air, is it OK?

SER 02-05

- Review gas binding piping configurations
- Identify list of susceptible systems for periodic venting and vent them.
- Ensure modifications don't impact gas intrusion
- Provide training on gas intrusion and methods for detection and prevention to key personnel.
- Verify procedures consider gas intrusion and gas removal methods.
- Monitor and trend gas intrusion in systems that periodically require venting.
- Valves that are barriers to leakage into or from safety systems receive PMs to ensure no leaks

GL 98-02

- Looked at the loss of RPV level affecting NPSH to RHR pumps.
  - requested information on common mode ECCS and SDC failures during S/D conditions
  - Looked at SDC configuration control including:
    - identification of drain paths
    - maintenance procedure configuration
    - test and operating procedure configurations
    - configuration control during modifications

GL 2008-001

- Licensee to address gas binding in ECCS, DHR, & Containment Spray systems for the following:
  - Licensing basis
  - Design
  - Testing
  - corrective actions to prevent gas binding
  - actions to be taken when gas is discovered
    - In CAP program?

NRC Actions

- Four Generic Letters, NUREG 0897 and at least 20 information notices have been issued on this problem.
  - Events continue to occur
- Consider inspection opportunities such as:
  - Surveillance procedure verification that all areas of ECCS and decay heat removal piping is verified to ensure no gas voiding?
  - If gas voiding is allowed, is there a calculation to validate the amount of gas that is allowable?
  - Are issues associated with gas voiding researched for common cause failures?
  - Are gas voiding issues documented in the corrective action program?

Technical Specifications

- Current ISTS:
  - Only require venting on discharge piping
  - Only applies to 3.5.1, 3.5.2, 3.5.3 (ECCS and RCIC)

"Verify, for each ECCS injection/spray subsystem, the piping is <u>filled</u> with water <u>from the pump discharge valve to the injection valve</u>."

Technical Specifications

- **TIA 2008-03 to address acceptable gas volume when SR requires “filled”:**

When voids are discovered in piping, if the licensee can establish through an operability determination that there is a reasonable expectation that the system in question will perform its specified safety function, the system piping can be considered filled with water such that the surveillance requirement is met.

Technical Specifications

- TSTF 523, Rev. 2:
  - Requires venting on susceptible locations
  - Added applicability to SDC (3.4.8, 3.4.9, 3.9.8 and 3.9.9) and SP Cooling (3.6.2.3) and SP Sprays (3.6.2.4)

"Verify the [system name] locations susceptible to gas accumulation are sufficiently filled with water.”

Objectives

1. Recognize the potential consequence of voiding in Emergency Core Cooling Systems (ECCS) piping.
2. Identify potential causes of voiding in ECCS piping.
3. Identify the industry strategies for detecting, eliminating and/or minimizing the consequences of voided ECCS piping.
4. Recognize the regulations that apply to ECCS piping voiding, including Technical Specification requirements.