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Technical and Regulatory Aspects of the Use of Containment Accident Pressure in Reactor Safety Analysis

Richard Lobel
Containment and Ventilation Branch
Office of Nuclear Reactor Regulation
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Cavitation

- Cavitation is the formation of vapor in a liquid due to a decrease in the local static pressure followed by an increase in local static pressure which results in the sudden condensation of the vapor.
- Excessive pump cavitation can result in:
  - Erosion of the pump impeller and other pump parts
  - Mechanical damage to seals, bearings, shaft, etc.
  - Decrease in pump flow rate
  - Decrease in pump discharge head
  - Vibration

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Net Positive Suction Head (NPSH)

- NPSH is an indication of pump suction performance with respect to cavitation
- Required NPSH
  - Property of pump
  - Obtained from test
- Available NPSH
  - Property of system
  - Obtained from calculation
- NPSH margin = NPSHA – NPSHR

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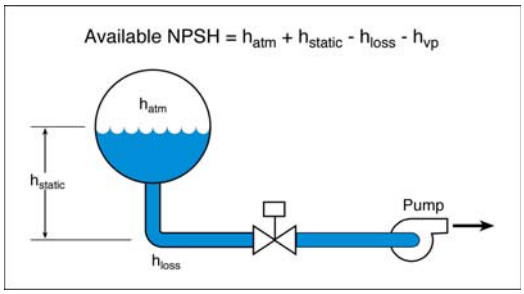
Available NPSH



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Containment Accident Pressure vs. Overpressure

- Staff uses the term *containment accident pressure.*
- Previously, term *containment overpressure* was used
  - No system, structure or component is being overpressurized.
  - *Overpressure* has been given several different definitions
- *Containment accident pressure* is the containment pressure during the postulated accident.

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NRC Guidance on Use of Containment Accident Pressure

- Regulatory Guide 1.1 (1970)
- Regulatory Guide 1.82 Revision 3 (2003)
- Standard Review Plan Section 6.2.2 Revision 5 (2007)
- Letters to BWROG (March 1, 2010) and PWROG (March 24, 2010)

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Staff Guidelines for Use of Containment Accident Pressure

- Based on ACRS recommendations, staff developed guidance for using containment accident pressure in determining available NPSH (ML100550869)
- Transmitted to Boiling Water Reactor Owners' Group (3/01/2010) and Pressurized Water Reactor Owners' Group (03/24/2010)

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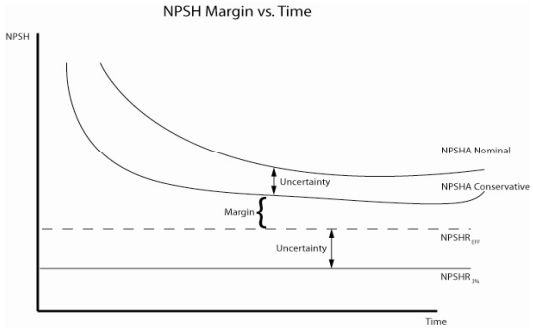
Margin and Uncertainty



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Guidelines-1

- 1. Propose use of $NPSHR_{eff}$ defined as
  - $NPSHR_{eff}$ = (1.0 + uncertainty) $NPSHR_{3\%}$
- 2. A 95/95 lower tolerance limit should be used in determining the available NPSH
- 3. Maximum flow rate chosen for NPSH analyses should be greater than flow rate used for core and containment cooling analyses
- 4. Containment isolation should not be lost due to an Appendix R Fire (associated circuit) or containment venting (required by procedures)

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Guidelines-2

- 5. Operator action to control containment pressure is acceptable if justified by human factors considerations and included in appropriate procedures
- 6. Operation for a limited time with NPSHA<NPSHR is acceptable if justified by testing
- 7.Licensees should have capability to detect and take action for a (pre-existing) containment leakage rate large enough to adversely affect containment capability to retain accident pressure

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Guidelines-3

- 8. Pump operation in the maximum erosion zone should be limited to less than 100 hours
- 9. The mission time of the pump must consider any operation necessary to maintain stable core and containment cooling post-accident.
- 10. To protect the mechanical seal faces from excess entrained air (released during operation at the 3% NPSHR condition), dual mechanical seals with an external cold water flush system (or equivalent) should be provided

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Acceptability of Use of Containment Accident Pressure

- NRC has concluded that use of containment accident pressure is acceptable based on:
  - Requirements and procedures that ensure high reliability of containment leak tightness
  - Robust pump design
  - Low risk

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