InfoGram

Westinghouse

February 25, 2015 IG-15-1

ELEVATED TRANSIENT PRESSURE IN REACTOR COOLANT PUMP NO. 1 LEAK-OFF LINE FOLLOWING A LOSS OF ALL SEAL COOLING

DESCRIPTION

The purpose of this InfoGram is to share information that may aid licensees when performing evaluations impacted by reactor coolant pump (RCP) seal leak-off line conditions. The evaluations may include FLEX (Diverse and Flexible Coping Strategies) commitments, loss of all seal cooling events and Appendix R analysis.

Previous Westinghouse communications (References 1 and 2) identified that a loss of RCP seal cooling event may result in a pressure increase in the No. 1 seal leak-off line that could exceed the value used in the design analysis. The communications identified above stated that the licensee was responsible for evaluating the structural integrity of the leak-off line piping; however, Westinghouse did not identify the pressure value that should be used in this evaluation.

A review of the hot thermal shock test that was performed at the Montereau test facility (Section 7 and Appendix B of Reference 3) indicated that a short duration transient pressure spike occurred in the leak-off line following the loss of seal cooling. The test identified that the pressure in the No. 1 leak-off line peaked at a value of 2030 psig and lasted a few minutes (exact duration is not critical). The transient pressure spike was caused by the introduction of hot fluid (536°F in the test) on the No. 1 seal and on the previously sub-cooled fluid in the leak-off line.

DISCUSSION

Licensees with standard Westinghouse No. 1 seals that do not utilize the SHIELD® reactor coolant pump passive thermal shutdown seal, may deem it appropriate to investigate the impact of a transient pressure spike on the integrity of RCP No. 1 leak-off line piping. If so, it is recommended that the piping, fittings, components, and pipe supports be evaluated for a pressure of 2030 psig and a maximum reactor coolant system (RCS) cold leg temperature (560°F to 582°F depending on the steam generator design).

The evaluation of this condition for the structural integrity of the piping should take into account loadings, including pressure, dead weight, and thermal. The following discussion provides optional guidance for a simplified method to approach the analysis. Note that this methodology only addresses structural integrity of the piping following a loss of seal cooling, and does not address other design analysis concerns and it is not a full ASME Boiler and Pressure Vessel Code Section III analysis. It supports the evaluation of a one-time faulted event and demonstrates that the piping would not rupture in the event that seal cooling is lost and the leak-off line experiences a pressure spike. Other analysis methodologies can be used if desired by the licensee, including assuming a seal leakage flow rate if the piping was to break.

1. The pressure stresses in the current piping analysis will be modified for a pressure of 2030 psig.
2. The dead weight stress in the current piping analysis remains the same as the previously analyzed value.
3. The thermal stress in the current piping analysis will be modified based on the ratio between the new maximum RCS temperature and the currently analyzed temperature. Note that the ratio of the thermal stress is only appropriate if no additional interferences between the piping and other equipment would occur, due to increased thermal expansion.

$$\sigma_{Tnew} = \sigma_{Told} \times \frac{T_{new} - 70°F}{T_{old} - 70°F}$$

Where:

σ_{Tnew} = new thermal stress, in psi
σ_{Told} = current thermal stress, in psi
T_{new} = maximum RCS temperature, in °F
T_{old} =currently analyzed temperature, in °F

4. The sum of pressure + dead weight + thermal stresses can be compared to the ultimate tensile strength of the material, taken at the appropriate maximum RCS temperature, to determine if the piping will maintain structural integrity.

APPLICABILITY

This InfoGram is applicable to all Westinghouse NSSS plants with standard 8-inch No. 1 Westinghouse RCP seals that do not utilize SHIELD shutdown seals.

REFERENCES

1. Westinghouse Technical Bulletin NSD-TB-91-07, Revision 1, "Overpressurization of RCP #1 Seal Leakoff Line," June 18, 1992.

2. Westinghouse Nuclear Safety Advisory Letter NSAL-14-1, Revision 1, "Impact of Reactor Coolant Pump No. 1 Seal Leakoff Piping on Reactor Coolant Pump Seal Leakage During a Loss of All Seal Cooling," September 8, 2014.

3. Westinghouse Report WCAP-10541, Revision 2, "Westinghouse Owners Group Report Reactor Coolant Pump Seal Performance Following a Loss of All AC Power," November 1986.

If you have any questions, please contact Leah Gussenbauer, gussenlr@westinghouse.com or (412) 374-5316.

Author:
John T. Crane
Regulatory Compliance

Reviewer:
Steven T. Slowik
Regulatory Compliance

Manager:
James A. Gresham
Regulatory Compliance

Verifier:
Leah R. Gussenbauer
Systems and Equipment Engineering

Verifier:
Benjamin A. Leber
Piping Analysis and Fracture Mechanics