PM Note: This was handed out by NEI at the Jan. 15, 2009, GSI-191 meeting for the staff to review and consider. With this submittal, NEI is asking on behalf of PWR licensees who have not, at the time of this submittal, completed their sump analysis, to credit the initial containment pressure in their ECCS pump NPSH margin calculations. Joe Golla, DPR/PGCB, PM for GSI-191

Credit for Initial Dry Air Partial Pressure

Inherent in the Reg Guide 1.83 calculation methodology used to determine NPSH is conservatism from not crediting the presence of air in containment prior to a design basis accident. The standard methodology assumes the sump water is at saturation temperature corresponding to the minimum pre-accident containment pressure. A more realistic but still conservative approach is identified in NEI 04-07, Section 6.4.7.1, based on the law of partial pressures. Section 6.4.7.1 states it is reasonable to assume that the total pressure in containment is the sum of the partial pressure of water vapor corresponding to the sump saturation pressure, and the dry air partial pressure which remains constant at the pre-accident value.

The dry air pressure prior to the event is to be calculated assuming 100% relative humidity at a containment temperature corresponding to the maximum normal operational temperature experienced at the plant. The recognition of the pre-event air pressure acknowledges the thermal-hydraulic condition of containment prior to the event without crediting containment overpressure based on the accident scenarios.

Application

The Hydraulic Institute Standard ANSI/HI 1.1-1.5-1994 defines NPSH as the total suction head in feet absolute, determined at the suction nozzle and corrected to datum, less the vapor pressure of the liquid in feet absolute. It is an analysis of energy conditions on the suction side of a pump to determine if the liquid will vaporize at the lowest pressure point in the pump. The typical equation governing the calculation of available NPSH is given as:

$$NPSH_A = H_P + H_{El} - H_{VP} - H_F$$

Where:

H_P = absolute pressure head at the pump suction pressure

= $(P_{gage}) \times \rho/144 in^2/ft^2$

ρ = fluid density (lbs/ft^3)

H_{El} = Elevation head

H_{VP} = Vapor pressure at prevailing water temperature converted to head

= $(P_{vapor})\ \rho/144 in^2/ft^2$

H_F = form and frictional head losses including through the sump screen, entrance losses and piping losses

Crediting the initial dry air partial pressure involves setting the pressure head term (H_P) equal to the minimum partial pressure of air in containment at the start of the event plus the vapor pressure at the prevailing sump temperature. This method limits the contribution of air pressure to the minimum present at the start of the event and ignores any increase in air pressure resulting from heatup during the event.

Set $H_P = H_{amin} + H_{VP}$

$$NPSH_A = H_P + H_{El} - H_{VP} - H_F$$

$$= H_{amin} + H_{VP} + H_{El} - H_{VP} - H_F$$

$$= H_{amin} + H_{El} - H_F$$

<u>Example Calculation</u>

Based on an assumed initial containment temperature of 130'F (typically based on maximum allowed by Technical Specifications) and a pressure of -1.0 psig (typically based on minimum allowed by Tech Specs), the minimum dry air partial pressure prior to the event is 11.5 psia.

Conservatively assuming a sump water temperature of 32°F, sump water density would be 62.4 pounds/cubic feet or 0.43 psi/foot, and the minimum partial pressure of air represents a minimum hydrostatic head of 26.7 feet (H_{amin} = 26.7 ft).

$$NPSH_A = H_{amin} + H_{El -} H_F$$

Assume the following typical values:

H_{El} = 17 ft

H_f = 4 ft

$NPSH_A$ = 26.7 + 17 – 4 =39.7 ft