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HIGH PRESSURE RELIEF VALVE QUENCHING

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LOFT TECHNICAL REPORT LOFT PROGRAM

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SUMMARY

In response to additional needs developed during a review of the LOFT Technical Specifications, two more pressure reduction and decontamination sump volume vs. initial temperature data points were calculated in order to adequately quench steam generator relief blowdown. The two additional points chosen were for 10,000 gallons (based on ECC requirements) and for 120°F (NPSH limit maximum temperature).

The results are that for 10,000 gallons in the sump the maximum initial temperature is 110°F and for 120°F initial temperature, a volume of 14,000 gallons is required in the sump. Calculations are shown on page two of this report. The maximum final PR & DS temperature was set at 140°F to preclude the vibrational effects discussed in LTR 115-9 and its referenced operational experience reports.

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High Pressure Relief Valve Quenching

Initial Conditions:

Steam Generator (SG)

$$\begin{aligned}\text{Volume (V}_{\text{sg}}) &= 130 \text{ ft}^3 \\ \text{Pressure} &= 1100 \text{ psig} \\ \text{Sat. Temp} &= 556^\circ\text{F} \\ \text{Spec Vol (V}_{\text{fsg}}) &= 0.022 \text{ ft}^3/\text{lb}\end{aligned}$$

Decontamination Sump (DS)

$$\begin{aligned}&= 1336 \text{ ft}^3 (10,000 \text{ gal}) \\ &= \text{Atmospheric} \\ \text{Temp Initial} &= X^\circ\text{F} \\ &= 0.016 \text{ ft}^3/\text{lb} \\ \text{Temp Final} &= 140^\circ\text{F}\end{aligned}$$

$$\frac{\text{Energy SG} + \text{Energy DS}}{\text{Mass SG} + \text{Mass DS}} = 140^\circ\text{F}$$

$$\begin{aligned}\text{Energy DS} &= \left(\frac{1336 \text{ ft}^3}{0.016 \text{ ft}^3/\text{lb}} \right) X^\circ\text{F} \\ &= 8.35 \times 10^4 X^\circ\text{F}\end{aligned}$$

SG Data From LTR 115-9

$$\frac{3.28 \times 10^6 \text{ lb}^\circ\text{F} + 8.35 \times 10^4 X \text{ lb}^\circ\text{F}}{5.91 \times 10^3 \text{ lb} + 8.35 \times 10^4 \text{ lb}} = 140^\circ\text{F}$$

$$\frac{3.28 \times 10^6 \text{ lb}^\circ\text{F} + 8.35 \times 10^4 X \text{ lb}^\circ\text{F}}{8.94 \times 10^4 \text{ lb}} = 140^\circ\text{F}$$

$$3.28 \times 10^6 + 8.35 \times 10^4 X = 9.2 \times 10^6$$

$$\underline{X = 110^\circ\text{F}}$$

So for 10,000 gallons in sump initially, T_{init} can be as high as 110°F and still quench a blowdown

For Temperature of 120°F initially in sump (Max NPSH temperature), what is amount of water needed for quenching?

$$\begin{aligned}\text{Energy}_{\text{DS}} &= (V_{\text{DS}} / 0.016 \text{ ft}^3/\text{lb}) 120^\circ\text{F} \\ E_{\text{DS}} &= 7.5 \times 10^3 X \text{ lb}^\circ\text{F}\end{aligned}$$

$$\frac{3.28 \times 10^6 \text{ lb}^\circ\text{F} + 7.5 \times 10^3 X \text{ lb}^\circ\text{F}}{5.91 \times 10^3 \text{ lb} + 62.5 X \text{ lb}} = 140^\circ\text{F}$$

$$3.28 \times 10^6 \text{ lb}^\circ\text{F} + 7.5 \times 10^3 X \text{ lb}^\circ\text{F} = 8.35 \times 10^5 \text{ lb}^\circ\text{F} + 8.8 \times 10^3 X \text{ lb}^\circ\text{F}$$

$$X = 1.9 \times 10^3 \text{ ft}^3$$

$$\underline{= 14000 \text{ gal}}$$

for T_i = 120, Volume Req = 14000 gal