LOFT TECHNICAL REPORT LTR 115-34

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RATIONALE FOR SECONDARY COOLANT SYSTEM
PRESSURES, TEMPERATURES, AND HEAT REMOVAL CAPACITY

D. H. Stevenson

MASTER

EG&G Idaho, Inc.

IDAHO NATIONAL ENGINEERING LABORATORY

DEPARTMENT OF ENERGY

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Pressures, Temperatures, and Heat Removal Capacity		
AUTHOR	GWA NO.	
D. H. Stevenson <i>DK</i>		
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SUMMARY

This LTR documents the rationale used in selecting the following Secondary Coolant System design parameters:

- (1) Pressure
- (2) Temperature
- (3) Heat removal
- (4) System flow rates.

This document was originally Appendix C of SDD 1.1.5B.

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1. Pressures

1.1 High-Pressure Portion

The high-pressure portion of the Secondary Coolant System includes the steam generator and associated piping and valves out to and including the main steam control valve, main feedwater pump, and makeup and auxiliary feedwater pumps. All other lines from the steam generator are considered as high pressure up to and including the second isolation valve from the steam generator. The design pressure is 1100 psia which is typical of LPWR steam generator and is the design pressure of the GFE steam generator. The design pressure of 1100 psia is adequate for LOFT service as shown below:

Maximum operating conditions	1020 psia
(Main steam control valve relieving point following reactor trip)	
Operating allowance band	69 psia
+1% relief valve control band	11 psia
<hr/>	
Relief valve setpoint and selected design pressure	1100 psia

1.2 Low-Pressure Portion

The low-pressure portion of the main secondary loop extends from the main steam control valves to the suction of the main feedwater pump. This pressure is based upon maintaining feedwater temperatures typical of LPWR's and is accomplished by condensing at a temperature typical of LPWR steam generator feedwater injection temperatures. Utilizing this scheme negates the need for feedwater preheaters used in LPWR's because of the vacuum steam condenser. A temperature of 400 - 450°F is typical of LPWR feedwater injection temperatures. Therefore, a nominal operating pressure of 300 psia has been chosen that yields a feedwater injection temperature for LOFT of approximately 407°F, which includes the 10°F subcooling from the subcooler. The selected design pressure is 400 psia, which provides a 75-psia margin from the maximum expected operating pressure of 325 psia.

2. Temperature

2.1 High-Temperature Portion

The high-temperature portion of the system is defined as the steam generator and associated piping out to and including the main steam control valve and feedwater control valve. Blowdown, sampling, and instrumentation lines from the steam generator are included in the high-temperature portion of the system. A temperature of 600°F has been selected as the high-temperature design. This yields a 32°F margin from the maximum transient saturation temperature of 568°F associated with the maximum transient pressure of 110% of design (1210 psia) allowed by ASME Code Section III for Class A pressure vessels.

2.2 Low-Temperature Portion

The remainder of the system is classified as low temperature. A rounded-off temperature of 450°F has been chosen corresponding to a saturation pressure of 400 psia as justified in 1.2 of this appendix.

3. Heat Removal Capacity

The Secondary Coolant System must be able to remove the total heat produced within the Primary Coolant System.

Nominal fuel power	55 MW
Physic uncertainties to achieve	
19.5 kW/ft - 8%	4.4 MW
Radiation heating - 5%	2.8 MW
Instrumentation accuracy	1.9 MW
Pump heat	0.5 MW
Total	64.6 MW

Selected design power 65 MW

4. Secondary System Flow Rates

$$\text{Max power} = 65 \text{ MW} = \frac{3413 \text{ Btu}}{\text{kW-hr}} \times 65,000 \text{ kW} = 2.22 \times 10^8 \frac{\text{Btu}}{\text{hr}}$$

$$\text{Steam enthalpy at average pressure of 650 psia} = 1203 \frac{\text{Btu}}{\text{lb}}$$

$$\text{Feedwater enthalpy } 407^\circ\text{F at 650 psia} = 381 \frac{\text{Btu}}{\text{lb}}$$

$$\text{Enthalpy gained per lb of steam produced} = 1203 - 381 = 822 \frac{\text{Btu}}{\text{lb}}$$

$$\text{Lb of steam required at 100\% quality} = \frac{2.22 \times 10^8 \text{ Btu/hr}}{822 \text{ Btu/lb}} = 2.70 \times 10^5 \frac{\text{lb}}{\text{hr}}$$

$$\text{Nominal flow rate at 65 MW} = 2.70 \times 10^5 \frac{\text{lb}}{\text{hr}}$$