TO:      S. E. Beall
FROM:    W. C. Ulrich

SUBJECT: Loss of Cooling Water Flow to MBRE Thermal Shield

With the reactor operating at 10 MW, the MBRE reactor thermal shield was designed to remove 600 kwh (2 x 10^6 Btu/hr) of heat with a cooling water flow rate of 100 gpm, giving a water temperature rise of 40°F.

The weight of the thermal shield empty was estimated to be about 40 tons which includes the 2 in. steel plates added in the top cover. Approximately 70 tons (475 ft^3) steel balls will be added to the cylindrical section. The base will contain only water.

<table>
<thead>
<tr>
<th></th>
<th>Total Volume</th>
<th>Volume of Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylindrical section</td>
<td>480 ft^3</td>
<td>240 ft^3</td>
</tr>
<tr>
<td>Top Cover</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>Base</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>380 ft^3</td>
<td></td>
</tr>
</tbody>
</table>

Normal operating conditions are: 90°F water inlet temperature, 130°F outlet; relief valve set at 20 psig. Saturated steam temperature at 20 psig is 260°F.

The heat capacity of the thermal shield is:

\[
q = (W_c\text{steel} + W_c\text{water}) \Delta t
\]

\[
q = [(220,000 \text{ lb}) (0.12 \text{ Btu/lb} - F) + (380 \text{ ft}^3 \times 62.4 \text{ lb/ft}^3) (1 \text{ Btu/lb} - 0^\circ F)] (260 - 90 + 130) / 2
\]

\[
q = (26,400 + 23,600) (150)
\]

\[
q = 7.5 \times 10^6 \text{ Btu}
\]

Operating time at 10 MW with no cooling water flow = \[ \frac{7.5 \times 10^6 \text{ Btu}}{2 \times 10^6 \text{ Btu/hr}} = 3.75 \text{ hr.} \]

The thermal shield cooling water system is equipped with a 1/2" relief valve set at 20 psig. That should discharge into the vapor suppression system to meet containment requirements.

\[
\text{rate of temperature @ loss of flow} = \frac{2 \times 10^6 \text{ Btu/hr}}{0.5 \times 10^6 \text{ Btu/hr}} = 40^\circ F/\text{hr}
\]

Assuming 50% voids.
In case of a large salt leak inside the thermal shield, it is recommended that a welded sheet-metal pan, similar to the ones in the DT furnaces, be installed on top of the thermal shield insulation. The sides of the pan need only be about 2 ft. high to contain the entire 70 ft$^3$ of fuel salt. A slot in the side of the pan would be required for line 103, but the leakage there would probably be small.

Original Signed by:

W. C. Ulrich

cc: E. S. Bettis
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    R. E. Guymon
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