To: File

Subject: Heat Production in Fission Product Deposits in MSBR Piping and Heat Exchanger

February 24, 1967

Information concerning the deposition of noble metal fission products in the MSBR was reported in MSR-67-8. Decay of radioactive isotopes in the deposits will produce heat in the metal walls. If the rate of heat production is high, cooling must be provided for a time after fuel is drained from the reactor. If the decay is slow, maintenance of equipment may have to be done with the temperature above 100°F, with continuous cooling, or after a very long time. Table 1 contains a list of isotopes that are expected to deposit on the walls and to contribute most of the decay energy after about one day of cooling. The yields are for fission of U²³³.

The list in Table 1 includes niobium and iodine in addition to the elements reported in MSR-67-8. Niobium has been found to deposit on metal and graphite in the MSRE. The mass of niobium in the deposits in an MSBR would be negligible in comparison with the mass of the stable molybdenum daughters and was accounted for through the daughters in MSR-67-8. However, the heat produced by decay of niobium is important and must be included here. Tellurium isotopes with long half lives can be expected to deposit and decay on the surfaces in the reactor. I assumed in these calculations that the iodine daughters remain in the deposit, decay, and release their heat there.

The heat production rates in the table neglect the contribution of isotopes with short half lives and should therefore grossly underestimate the total heat production for times up to $10^4$ sec. They should be acceptably accurate for $10^5$ and $10^7$ sec and agree reasonably with calculations based on numbers reported by Arnold in CF-66-9-34.

If most of the yield of most of the isotopes listed in Table 1 deposits on the surfaces in the fuel system, cooling will be required for at least 10 days after shutdown. Removal of the rotary element of a pump and maintenance of a more minor type probably could be undertaken during this time. I doubt whether anything more than preparatory work could be done toward removal of a fuel heat exchanger or a reactor core, but the preparatory work should be expected to take at least 10 days. At some time between 10 and 100 days, it seems likely that a heat exchanger could be removed without special cooling, although the center of the tube bundle might be at several hundred degrees Fahrenheit.
Table 1. Heat Production After Shutdown from Decay of Selected Fission Products at Saturation Levels

<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>β Mev*</td>
<td>γ Mev</td>
<td></td>
<td>0 sec</td>
</tr>
<tr>
<td>95</td>
<td>Nb</td>
<td>0.061</td>
<td>-</td>
<td>90h</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Nb</td>
<td>0.061</td>
<td>0.06</td>
<td>35d</td>
<td>10</td>
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<tr>
<td>99</td>
<td>Mo</td>
<td>0.048</td>
<td>0.37</td>
<td>67h</td>
<td>50</td>
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<tr>
<td>103</td>
<td>Ru + Rh</td>
<td>0.018</td>
<td>0.09</td>
<td>40d</td>
<td>5</td>
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<tr>
<td>105</td>
<td>Rh</td>
<td>0.006</td>
<td>0.17</td>
<td>36h</td>
<td>10</td>
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<tr>
<td>106</td>
<td>Ru + Rh</td>
<td>0.003</td>
<td>1.13</td>
<td>1γ</td>
<td>10</td>
</tr>
<tr>
<td>127</td>
<td>Sb + Te</td>
<td>0.006</td>
<td>0.68</td>
<td>91h</td>
<td>11</td>
</tr>
<tr>
<td>129</td>
<td>Te + Te</td>
<td>0.006</td>
<td>0.44</td>
<td>37d</td>
<td>7</td>
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<tr>
<td>131</td>
<td>Te</td>
<td>0.005</td>
<td>0.37</td>
<td>1.3</td>
<td>5</td>
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<tr>
<td>131</td>
<td>I</td>
<td>0.005</td>
<td>0.20</td>
<td>8d</td>
<td>3</td>
</tr>
<tr>
<td>132</td>
<td>Te + I</td>
<td>0.045</td>
<td>0.52</td>
<td>77h</td>
<td>66</td>
</tr>
</tbody>
</table>

*The β values are 1/3 the total energy of β decay.
The numbers in the table involve only a few fission products and depend directly on the fraction of each fission product that deposits on the surfaces in the reactor. We must obtain as much quantitative information as we can about the behavior of those fission products in the MSRE and in the thermal convection capsule tests.

RBB:alg

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