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MASTER

Some Safety Considerations Based on Design Experiences in the BNL Settled Bed Fast Reactor Concept*+

by

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The mechanical design of a fast reactor can greatly effect its safety under a loss of coolant accident. While misinformation on deadlines prevent a more complete discussion, in the five minutes allotted to us, we can discuss one of the dominant safety features of the Settled Bed Fast Reactor concept - a concept that we introduced at this conference last year. This safety feature can be of importance not only for reactors having fuel elements consisting of packed beds of fuel particles in random or ordered arrangement but also for other reactor concepts.

In the SBFR there is a sodium region above the core and each of the axial blankets to provide head room for fluidization. Slide one shows an elevation of one conceptual design. Immediately above and below the core are the sodium regions which are considered here. For both of these regions there is a strong negative reactivity effect when the sodium expands.

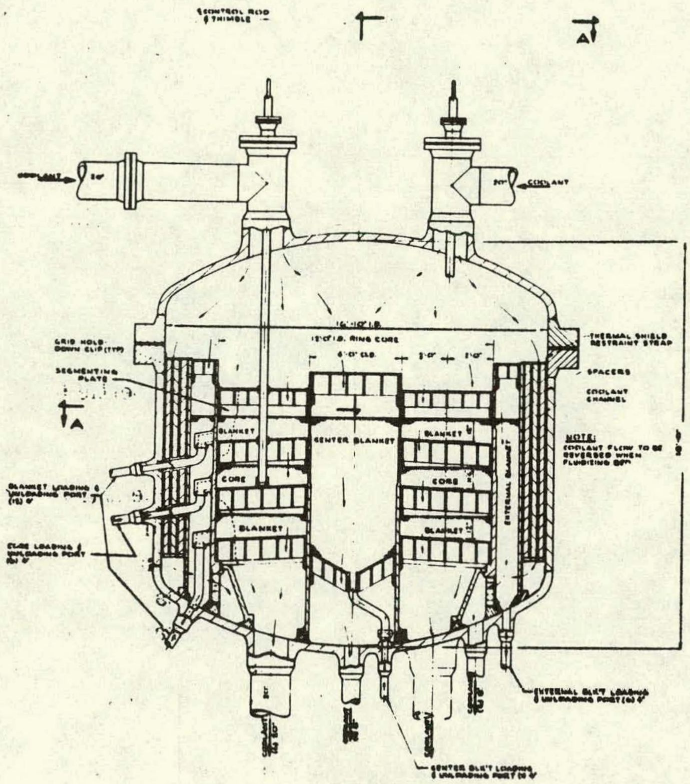
Slide two shows the local sodium expansion coefficient at power as a function of position in this reactor. As in most fast reactors there is a local positive effect at the center of the core, and this becomes negative at the core edge. Here, however, there is a still stronger negative effect as we move into the sodium region. The overall temperature coefficient in this sodium region is many times stronger than the core sodium and Doppler coefficients.

The temperature coefficient in the sodium region is a delayed one - due to the sodium transit time through the core - of the order of magnitude of a 10th of a second. In the present case this is a powerfully stabilizing influence. Slide <u>three</u> shows the time behavior of the reactor power when the inlet sodium temperature is reduced 100^{o}C and maintained at that lower temperature; this corresponds to a reactivity increase of $\sim$\$0.4. Even for this drastic temperature change, the peak power exceeds the original power level by less than 50%. The various turning points of this curve can be related to the passage of the cold front through various regions of the reactor, but our time limit here prevents discussing this. Slide <u>four</u> shows the core sodium temperature at several positions as a function of time for the same perturbation. The peak exit temperature rise exhibited is only 25% above the initial value. The time behavior exhibited here was obtained from a multi-region space and time solution of the reactor equations, which was programmed at Brookhaven National Laboratory.

The sodium regions were introduced into the SBFR because of bed engineering requirements. However, a similar high leakage region might well be of benefit in other reactor designs as well. The location, the size, and the composition of such a region can all be adjusted to obtain desirable stability properties. This might be considered for use in many fast reactor designs. For fuel elements containing ordered arrays of fuel particles such as in the Brookhaven National Laboratory Countercurrent Reactor concept presently under study these parameters of location, size, and composition are set by the fashion in which the individual fuel particles are stacked in the fuel element. Since the ordered bed fuel element can be designed so to be disassembled and reassembled periodically, these parameters can be altered when necessary.

Slide 1

Axial Flow Settled Bed Reactor



VERTICAL SECTION

<u>Slide 2</u>

Sodium Temperature Coefficient vs. Position in Axial Flow Reactor

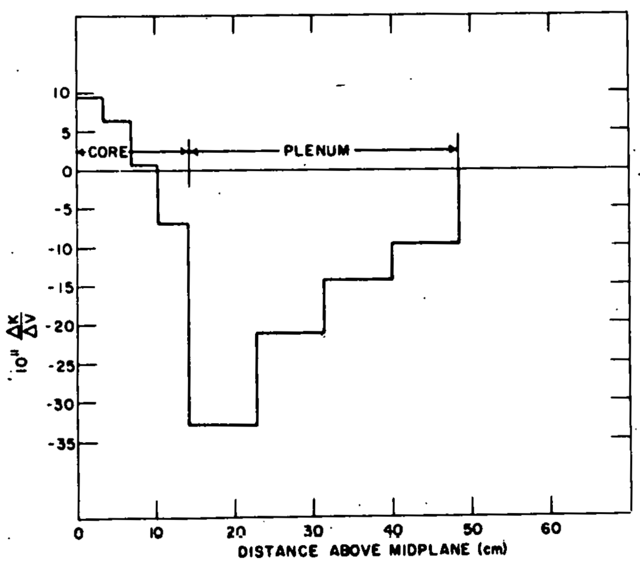


FIG. 3 POWER TRANSIENT DUE TO A PERMANENT DROP OF 100 °C IN REACTOR INLET SODIUM TEMPERATURE

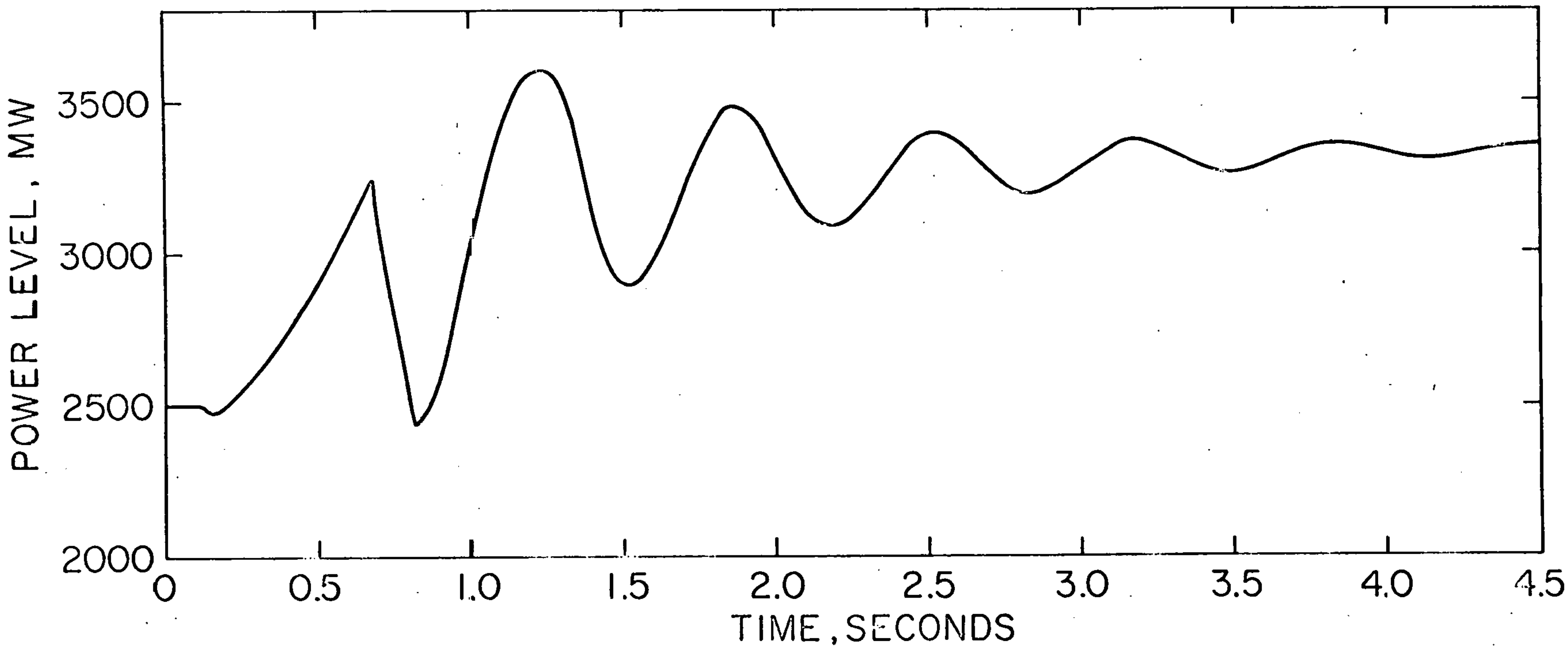


FIG. 4 VARIATION OF LOCAL CORE SODIUM TEMPERATURES AFTER 100 °C DROP IN REACTOR INLET SODIUM TEMPERATURES