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THE EFFECTS OF TIME AND OTHER VARIABLES ON FISSION PRODUCT RELEASE RATES*

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The releases of krypton and cesium from highly irradiated LWR fuel as measured in tests at Oak Ridge National Laboratory (ORNL) [1–4] have been examined in detail. The main interest has been the effect of time on the rate of release and the effects of heatup and cooldown cycles. The minute-by-minute release rates for fission product ^{85}Kr from commercial fuel irradiated in the H. B. Robinson PWR are shown in Fig. 1. The release rate, fraction per minute, is calculated in the same manner as release rates given in NUREG-0772 [5]; the fission gas, cesium, and iodine release rate curve from that report is also shown in Fig. 1.

Our analysis shows that what appears to be a high release rate during heatup (note direction of arrows in Fig. 1) is partly a release of "embedded" gas [1] that should be accounted for separately. Some is also probably the release of fission gas accumulated at grain boundaries that is sometimes called the "burst release" [2].

The high release on cooldown is typical of most tests. This is usually attributed to cracking of fuel, but is probably in part due to the delay of released material escaping from the open porosity and pellet-to-pellet gap space. The very low release rates observed to occur during the heatup of PBF bundles may be due in large part to this gas-phase mass transfer delay. This release rate is approximated in Fig. 1 as being a factor of 100 lower than the NUREG-0772 release rate curve. Calculations indicate that the high pressure and long fuel rods used in these tests may create delays of the order of tens of minutes for the escape of gaseous and volatile fission products already released from the UO_2 fuel matrix. Examination of fuel heated to liquefaction temperatures at ORNL suggests that the zirconium–UO_2 reaction products tend to form a skin that serves to seal previously open pores and cracks.

The fractional release rates at constant temperature vary from one test to another, which makes it difficult to form a simple mathematical expression of release rate vs time.

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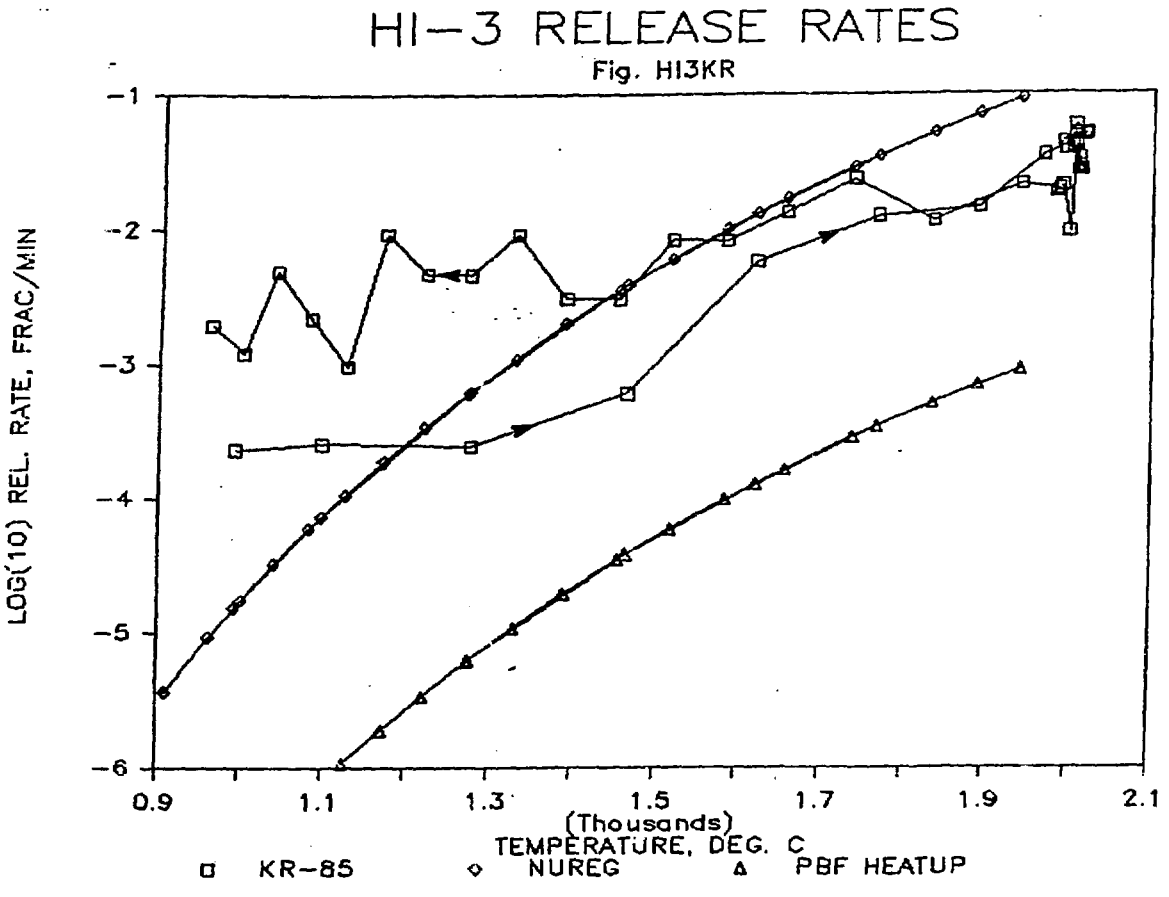

FIG. 1. The rate of release of ^{85}Kr from H. B. Robinson fuel heated in steam to 2000°C (2270 K).

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