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SHEBA OPERATING EXPERIENCE

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The Solution High Energy Burst Assembly (SHEBA) is a critical assembly fueled with a solution of 5% enriched Uranyl Fluoride, $U(5\%)O_2F_2$. The fuel is stored in critically safe storage containers and then pumped into the "Critical Assembly Vessel" where the solution becomes critical. The system was designed to achieve criticality in a cylindrically symmetric configuration. The SHEBA facility also incorporates a shielding pit into which the entire assembly can be lowered to provide shielding for elevated power runs.

The major goals of the SHEBA assembly project are to study the behavior of nuclear excursions in a low-enrichment solution, to evaluate accidental criticality alarm detectors for fuel-processing facilities, to provide radiation spectra and dose measurements to benchmark calculations on a low-enrichment solution system, and to provide radiation fields to calibrate personnel dosimetry. SHEBA is also being used to provide a neutron flux test bed to benchmark calculations. Rather than providing the details of these particular projects, this paper summarizes the "free-run" operating experience obtained as a result of the projects.

A "free run" consists of establishing an initial reactor period and then the assembly is allowed to operate itself (or free run). The free run experiments began with very slow initial periods to reproduce some of the free runs done with the original SHEBA. In one example, the initial period was 83 seconds and the system reactivity decreased with increasing temperature for a smooth rise, and subsequent smooth fall in power level.

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Subsequent free runs gradually increased the initial reactor period. At an initial period of about 40 seconds, evidence of radiolytic gas production was first seen. Subsequent runs with faster initial periods dramatically increased the effect of radiolytic gas. Figure 1 shows a plot of four typical free runs with 20 second, 14 second, 5 second and 1 second initial periods. The fast initial periods produce multiple peaks.

During the free runs the reactor power level, temperature and fuel height are recorded. Comparison of these data indicate that the rise in power is initially terminated by the rising temperature and then, on the down slope of the run, the radiolytic gas appears and drops the power rapidly for some period of time. The evolution of radiolytic gas is first seen as a dramatic rise in fuel height and then considerable noise on the level sensor indicating an initial large bubble of gas with subsequent frothing. The faster initial period runs create multiple peaks and multiple releases of radiolytic gas. Both the initial bubble and the subsequent frothing were observed using a periscope and camera during the free run with a 14 second initial period.

To date, there has been one anomalous free run. This free run started with a 10 second initial reactor period. For the first time, the radiolytic gas was produced so quickly that the free run ramp was terminated by the gas production and not the temperature rise. Figure 2 is a plot of the power level and fuel height of SHEBA during this free run. At the start of radiolytic gas production, the power level of the machine dropped nearly two orders of magnitude in a few seconds. Then the system continued to outgas for several minutes, at which time the power jumped back up an order of magnitude and then decayed at the same decay rate seen in the previous free runs. These dramatic power fluctuations were seen again in SHEBA during what was intended to be a steady-state operation.

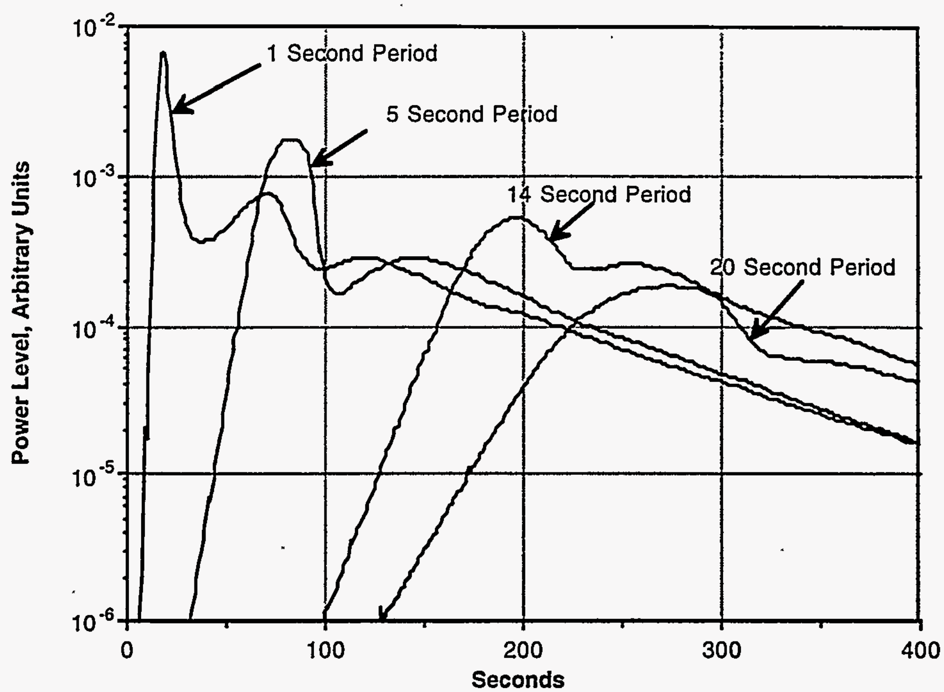

Figure 1. Comparison of four free runs on SHEBA

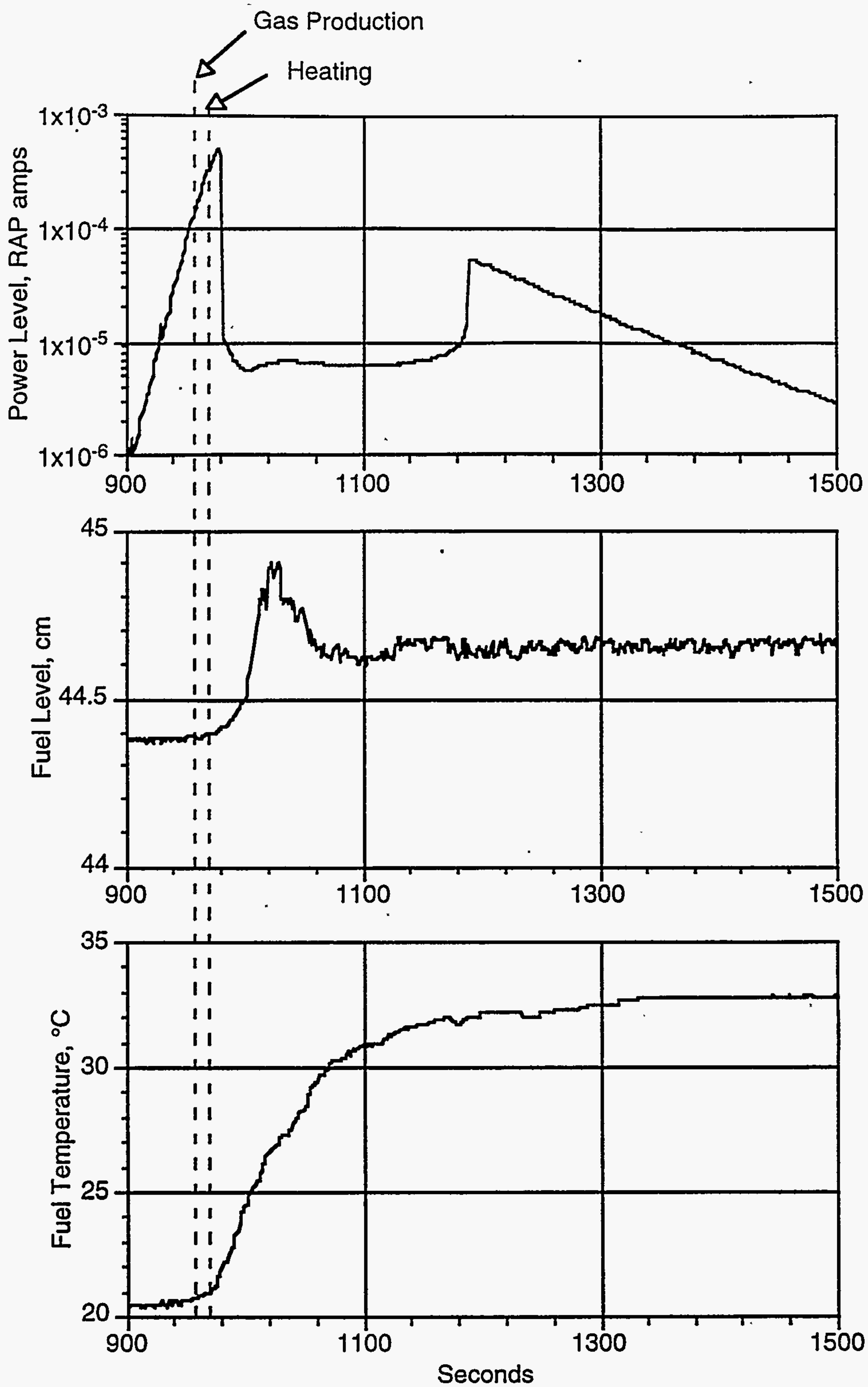

Figure 2. Data from 10 Second Inital Period Free Run