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Space Nuclear Safety Program

December 1982

MASTER

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Los Alamos, New Mexico 87545

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S. E. Bronisz

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SPACE NUCLEAR SAFETY PROGRAM

DECEMBER 1982

Compiled by

S. E. Bronisz

ABSTRACT

This technical monthly report covers studies related to the use of $^{238}\text{PuO}_2$ in radioisotope power systems carried out for the Office of Special Nuclear Projects of the US Department of Energy by Los Alamos National Laboratory. Most of the studies discussed here are ongoing. Results and conclusions described may change as the work continues.

I. GENERAL-PURPOSE HEAT SOURCE

A. Phosphorus Effects Experiment (D. Pavone)

Aging of the four fueled clads was completed, as planned, after 6 months at a clad temperature of 1310°C .

The four fueled clads involved were identified as PEF-44, PEF-45, PEF-48, and PEF-49. PEF-44 contained a vacuum-outgassed fuel pellet of the nominal Savannah River Laboratory composition. PEF-45 contained an unoutgassed pellet of the nominal composition. PEF-48 contained a vacuum-outgassed fuel pellet that had been doped with phosphorus. PEF-49 contained a vacuum-outgassed pellet that had been doped with both phosphorus and cationic impurities.

Photographs of the aged fueled clads are shown in Fig. 1. In general, all the iridium clads appeared bright and metallic. Differences in external appearance among the four units were limited to the vent area. A small amount of vent effusate can be seen on the exterior of the vent of PEF-44 (Fig. 1a). The vent of PEF-45 was essentially clean (Fig. 1b) and it was possible to see the filter element through the vent hole with a 7X magnifier.

A moderate quantity of dark-gray effusate was present on the exterior of the iridium surrounding the vent hole of PEF-48 (Fig. 1c). The greatest quantity of effusate was observed on PEF-49 (Fig. 1d). This material did not spread laterally to any great extent, but instead collected in a conical mound, as shown in Fig. 1e. This mound was separated from the vent and retained for possible chemical analysis.

B. Overpressure Tests

1. **Shock-Tube Tests (C. M. Seabourn).** We are in the final stages of preparation for shock-tube overpressure testing of General-Purpose Heat Source modules. The modules will be preheated to 1091°C (the launch temperature) in the shock tube. The test module is centered between graphite blocks of the same size and this stack is suspended in a resistance furnace. After the assembly has been equilibrated at the desired test temperature and immediately before the explosive charge is detonated, the furnace will be dropped to expose the stack to the shock wave. The first test will be conducted at 1.3 MPa (200 psi).

2. **Pre-DIRECT COURSE** (C. M. Seabourn and R. E. Tate). A meeting to discuss the results of the pre-DIRECT COURSE test was held at Kirtland Air Force Base, Albuquerque, New Mexico, the week of December 13, 1982. We presented the results of our experiments* and listened to the results of the other experiments. Of most interest to us was the description of the pre-DIRECT COURSE explosion. It was not radially uniform and the shock wave was poorly defined. The explosion was still occurring when the sphere had expanded to the 4-m location where our sample was. The shock front did not become well defined until it had decayed to 1.9-2.6 MPa (300-400 psi). This means that our test was carried out at an unknown pressure. The same problems will occur in next September's DIRECT COURSE explosion test.

II. LIGHT-WEIGHT RADIOISOTOPE HEATER UNIT (C. M. Seabourn)

Two heater units mounted in holders identical to those on the Galileo magnetometer boom were impacted with 18-g, 50-cal aluminum alloy bullets.

*S. E. Bronisz, Comp., "Space Nuclear Safety Program, October 1982," Los Alamos National Laboratory report LA-9715-PR (March 1983), p. 10.

The first unit (SN 005) was impacted with a 661-m/s (2170-f/s) bullet. The boom holder and the graphite components were destroyed. The fuel capsule was deformed but apparently unfailed.

The second unit (SN 008) was hit off center by a 773-m/s (2535-f/s) bullet. Again the holder and the graphite components were destroyed. The capsule was not touched by the bullet. The test will be repeated.

III. HELIUM RELEASE FROM PLUTONIA (D. E. Peterson)

We continued to analyze data from previous experiments on the release of helium from plutonia. Results from the current measurements were compared with published data taken at Los Alamos, Oak Ridge, and other sites. The magnitudes and temperature dependences of the diffusion constants are in excellent agreement for many of the results. Analyses of the release of helium from the General-Purpose Heat Source and the Light-Weight Radioisotope Heater Unit systems are under way. A new model, which includes the effects of grain boundary trapping of the helium, was also worked on this month.

(a)

(b)

(c)

(d)

(e)

Fig. 1. Postexposure photographs of the fueled clads from the Phosphorus Effects Experiment. 1.5X.

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