LA-8749-PR

Progress Report

C.3

Space Nuclear Safety and Fuels Program

December 1980

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Compiled by

S. E. Bronisz

ABSTRACT

This formal monthly report covers the studies related to the use of $^{238}PuO_2$ in radioisotopic power systems carried out for the Space and Terrestrial Systems Division of the U. S. Department of Energy by the Los Alamos National Laboratory.

Most of the studies discussed here are of a continuing nature. Results and conclusions described may change as the work continues. Published reference to the results cited in this report should not be made without the explicit permission of the person in charge of the work.

SPACE NUCLEAR SAFETY AND FUELS PROGRAM

DECEMBER 1980

Compiled by
S. E. Bronisz

I. GENERAL-PURPOSE HEAT SOURCE

A. Impact Tests (R. Zocher)

An additional impact test series, the impact attitude sensitivity (IAS) series, of the General-Purpose Heat Source (GPHS) will be carried out prior to the final safety verficiation tests. There are three reasons for completing these tests. 1) The iridium failures seen in the 90° tests in the design verification make it imperative that we determine how wide an orientation spread yields the same damage. 2) The prior impact tests have all been performed with fuel pellets made at Los Alamos or Savannah River Laboratory and had microstructures somewhat different from the production pellets made by Savannah River Plant , making it desirable that the production pellets be impacted as early as possible. 3) The most recent thermal calculation have shown that some change must be made in the design of the module to increase the impact temperature, necessitating tests at the new temperature.

A test plan for the IAS tests was issued (CMB-5-C-80-83, December 3, 1980) that calls for three tests using full GPHS modules made to the new design with flight-quality iridium capsules fueled with production pellets. Prior to impact, the fueled clads will be aged for 2000 h at the operating temperature of the GPHS heat source. The first impact will be at 90° to provide a comparison with the prior tests, IRG-88 and IRG-90, of the design verification series. The second IAS impact will be at an orientation of 63°, a 27° rotation around the short axis of the module. The third orientation will be selected after the results of the first two tests are known.

The grapite components for the three IAS tests were machined at Los Alamos. A typical component array is shown in Fig. 1. Flight certified FWPF and POCO graphites were used for the impact and aeroshell assemblies, while the CBCF insulation pieces were nonflight quality material supplied by the Oak Ridge National Laboratory. The components shown are complete except that the ablation equivalent has not been removed from the outer surfaces of the aeroshell and the final machining of the aeroshell-impact shell interface has not been done. Both steps will be completed as soon as the correct dimensions are supplied by General Electric Company (GE).

B. Reentry Test (D. Pavone, C. Frantz, D. Peterson, J. Starszynski, F. Schonfeld)

During a preconditioning reentry heat treatment to 1700°C, capsule IRG-58 was deformed by internal pressure (March 1980 monthly report). Our investigations strongly suggested that the vent operated as designed, but that it had been swamped by the helium release from the one-year-old fuel pellet

(August 1980 monthly report). The thermal history of IRG-58 was not typical of an operational heat source, so a second reentry-like exposure was carried out using a more realistic simulation.

The new test sample was IRG-62, a GPHS fueled clad containing a 21-month-old Los Alamos fuel pellet, GP-19. After welding the capsule was heated to the launch-pad operating temperature and then subjected to a reentry heat pulse. During the heat treatments, the helium emissions from the fuel were monitored.

The simulation of the launch-pad operating condition consisted of holding IRG-62 in argon at a clad temperature of 1133° for five days (the minimum pre-launch, in-shuttle time). The aging treatment was conducted in a closed-system equipped to collect the gases evolved and to measure the pressure as a function of time. A schematic diagram of the apparatus is shown in Fig. 2. The test assembly was in an ATJ graphite container enclosed in a welded tantalum can connected by a tantalum tube to a manifold external to the furnace tank. The manifold consisted of a Wallace and Tiernan pressure gauge, a ballast volume, a gas sampling bulb, and associated valves and fittings. A clad Pt/Pt-10 Rh thermocouple with the junction in contact with the iridium capsule was used to measure the capsule temperature.

The initial pressure of argon in the system was 155 mm. The capsule temperature was increased to the 1133°C test temperature over a period of nearly 4 h to simulate the temperature rise of the heat source after its removal from the storage container. Figure 3 is a plot of the total pressure and capsule temperature vs time for the experiment. The maximum pressure observed was 498 mm at 32.83 h of exposure. The pressure gradually declined to 473 mm at 120 h. The reaction of carbon monoxide with the tantalum container probably was responsible for the decrease in pressure.

The analysis of the gas mixture at the conclusion of the test exposure was as follows:

Helium	- 44 mol%
Carbon Monoxide	- 21 mol%
Argon	- 35 mol%

The helium in the mixture was equal to 115 scc, or 86% of the helium generated in the pellet since its final sintering treatment.

The dimensions of the iridium clad were essentially unchanged by the aging treatment, as indicated in Table I. These data indicate that the vent was not plugged, and that the flow rate of the vent was adequate to accommodate the release of helium from the plutonia without pressurization of the capsules in the launch-pad operating mode. The inner surface of the graphite container that had been opposite the capsule's vent contained a single pit, evidence that an oxidizing species had been vented during the exposure.

After the exposure at 1133°C, the capsule was subjected to the GPHS minimum-gamma reentry pulse supplied by GE, Fig. 4. The helium released from the pellet was measured with a calibrated helium detector attached to the reentry furnace. The maximum release rate observed was 7×10^{-3} sccm and the total helium released during the pulse was 0.5 sec, somewhat less than the ~1 scc that was generated in the pellet between the end of the aging treatment and the reentry. After the reentry exposure, samples of the fuel were analyzed and were found to contain 4.5 scc of helium (4.4 scc should have been generated between the end of the reentry exposure and the analysis).

The post-reentry dimensions of IRG-62 are also given in Table I. The larger dimensions shown in the last column are thought to be a routine measuring difference caused by the change in operators, not by actual swelling of the iridium capsule. This belief is supported by the lack of pattern in the dimensional differences. If swelling had occurred from internal pressure, the center height measurement would have shown the greatest growth.

The capsule is shown in Fig. 5, after it had been removed from the reentry furnace. Other than the normal marks that result from handling, the capsule appears to be unaffected by its thermal exposures.

The capsule was sectioned circumferentially and the vent end was removed to reveal that the fuel was cracked and broken, as can be seen in Fig. 6. The fueled capsule had been radiographed before and after the 5-day, 1133°C exposure and after the reentry exposure. In each case the fuel pellet was seen to contain cracks, which were somewhat more extensive after the 5-day aging and unchanged by the reentry. The changes were relatively small and probably had no great significance to the experiment.

The microstructure of GP-19 is shown in Fig. 7. The mixture of large and small fragments is always observed in fuel made by the "GROG-process", but its character is quite pronounced in this pellet. For comparison, the microstructure from the center region of GP-17, which had been heated to 1700°C, without the prior long-term heat treatment, as part of IRG-58, is shown in Fig. 8. Its microstructure is much less open than that of GP-19. It is unlikely that the short time at the higher temperature could have caused this difference.

The fuel recovered from IRG-62 was subjected to a partial size analysis and the results are given in Table II.

The capsule vent was subjected to the standard bubble test (ΔP = 13.8 kPA) and passed helium as evidenced by the numerous small bubbles that immediately formed over the whole exposed surface of the frit. Metallographic examinations of the vent structure showed it to be unaffected by the thermal tests, Fig. 9.

A typical microstructure of the iridium capsule from IRG-62 is shown in Fig. 10. The grain structure and size are what was expected for the low-temperature aging and the short-term reentry.

This test has shown that we can expect most of the stored helium to be released from the fuel during its residence in the shuttle bay prior to launch, without damage to the capsule. The data obtained showed that no helium remained in the fuel after the reentry pulse and that little or no helium above the amount generated between heat treatments was released during the reentry pulse, but that only 86% of the helium generated during the 21-month storage was released during the 5-day, 1133°C aging. We are attempting to resolve this apparent discrepancy.

II. SYSTEMS SUPPORT

A. Stirling Isotope Power Systems (D. Pavone)

The accumulated exposure time at 800°C for this system was 26,422 h on January 1, 1981. During the next reporting period, the exposure will be terminated and the postmortem examination of this sample will be started. The information obtained from this sample will be used to assess the probability of success of the Mound Facility (MF) proposed storage treatment for GPHS.

B. Multi-hundred Watt (D. Pavone, C. Frantz)

The aging heat treatments of fuel sphere assemblies MHFT-74 and -75 were started. The aging duration will be 30 days, after which the spheres will be impacted in orbit-decay reentry simulations.

A simulated Multi-hundred Watt fuel sphere assembly was subjected to five reentry-like pulses. The temperatures of both the iridium shell and the safety can were measured. The data were provided to Applied Physics Laboratory, where it will be used to calibrate the calculations they make in support of our testing program.

III. LIGHT-WEIGHT RADIOISOTOPIC HEAT UNIT (LWRHU)

A. Specification (R. A. Kent)

The Specification Document, CMB-11-RDH-80-105, "The Specification for Fabrication and Encapsulation for LWRHU Pellets and Assembly of Heater Units," has been approved by DOE/STS.

B. Encapsulation (R. A. Kent)

During December, MF shipped 23 sets of Pt-30 Rh developmental hardware and 58 sets of prime hardware to Los Alamos. All 58 sets of prime hardware were loaded with $^{238}PuO_2$ RHU pellets and welded. Three sets of developmental hardware were used for example welds. The welding operation were observed by Quality Assurance personnel from both Los Alamos and Sandia National Laboratory.

After the capsules were welded and decontaminated, the dimensions were measured and the welds were checked with dye-penetrant. The helium leak and neutron emission rates were then measured. Pellet and capsule identities and dimensions, together with the welding box atmospheres, are listed in Tables III-V. The results for the nondestructive testing of these capsules are listed in Tables VI-VIII. These last three tables will be updated monthly as the calorimetry measurements are made.

C. Acceleration Forces (R. E. Tate)

The high-g load testing of the LWRHU in a centrifuge at about 425 g was discussed with James Bear and Charles Sain of Sandia in Albuquerque. Sandia can do the testing envisioned on one or two weeks' notice. GE is redesigning the LWRHU holding fixtures for the Galileo Probe. These fixtures are needed for the g-loading test and Jet Propulsion Laboratory (JPL) will arrange to supply two of these units for the test. JPL has also promised to supply very specific assembly instructions and the g-loading and test duration specification.

D. Cement Outgassing (R. E. Tate)

NASA-Ames has requested that the graphite cement, Union Carbide UCARC-34, be tested for Total Mass Loss (TML) to satisfy any concerns about the release of volatile material within the probe. The applicable procedure is documented in ASTM-E595-77. The procedure involves heating small (100-300 mg) test specimens of cured cement at 125°C for 24 h in a vacuum of at least 5×10^{-5} torr and then reweighing the specimens. An appropriate piece of test equipment at Los Alamos has not yet been identified. The UCARC-34 cement is the material previously used for radioisotope heater units and it is doubtful if an alternative commercial produce more suitable for the aeroshell cementing application would be available if it proves unsatisfactory.

E. Safety Testing (C. M. Seabourn)

Internal job orders for the explosion overpressure tests and the fragment impact tests were issued. The calibrations and calculations required for these tests have been started. The LWRHU holding fixtures for these tests have been ordered.

IV. SAFETY TECHNOLOGY

A. Helium Release (D. Peterson, J. Starszynski)

A rough draft of a program plan for the study of helium release from plutonia was completed this month. The final draft will be issued next month.

The release behavior of IRG-62 and RHU 027 are the subjects of modeling attempts using the data that are available. The degree of success of these attempts will guide us in determining the future experiments and their priorities.

B. Enhanced Ductility Fuel (D. Pavone)

Three additional pellets were made from $^{239}PuO_2$ that had been doped with 1.3 m/o Nb_2O_5. The pellets were made by cold pressing with Carbowax binder and sintering in air for 24 h at 1350°C.

V. FUEL PROCESSING

Residues and Shipments (R. A. Kent)

Six containers have been loaded with plutonia-containing residues (1.44 kg plutonium) to be reprocessed at Savannah River will be shipped when Residue Declaration RS-238-62 is approved and transport is available.

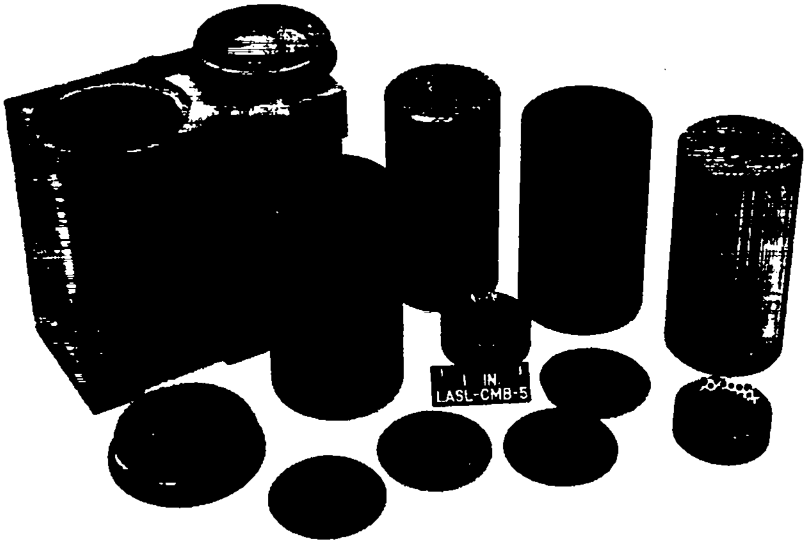


Fig. 1.
The IAS graphite components have been fabricated for all three tests.

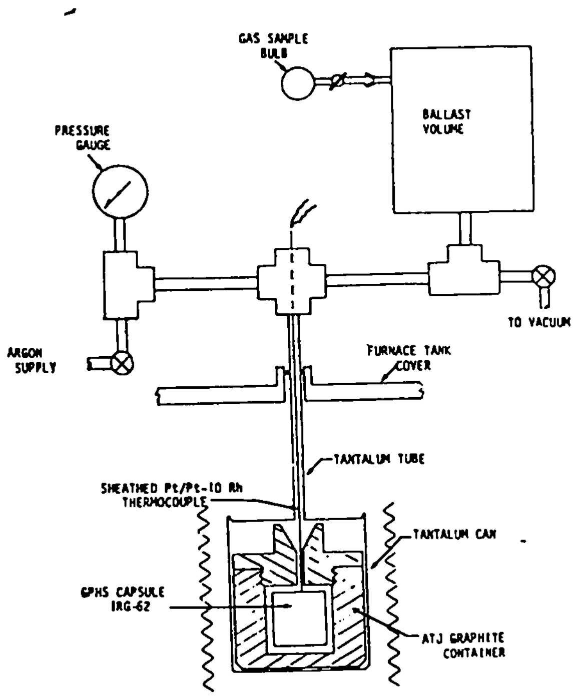


Fig. 2.
Schematic diagram of gas collection apparatus.

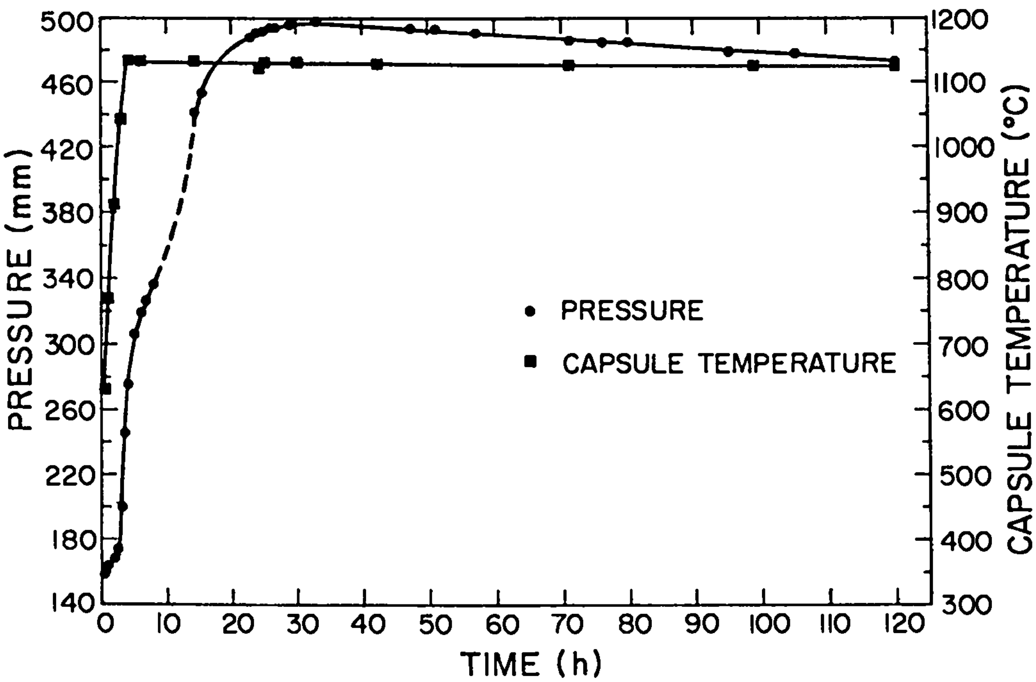


Fig. 3.
The pressure over IRG-62 increased to a maximum after 32 h.

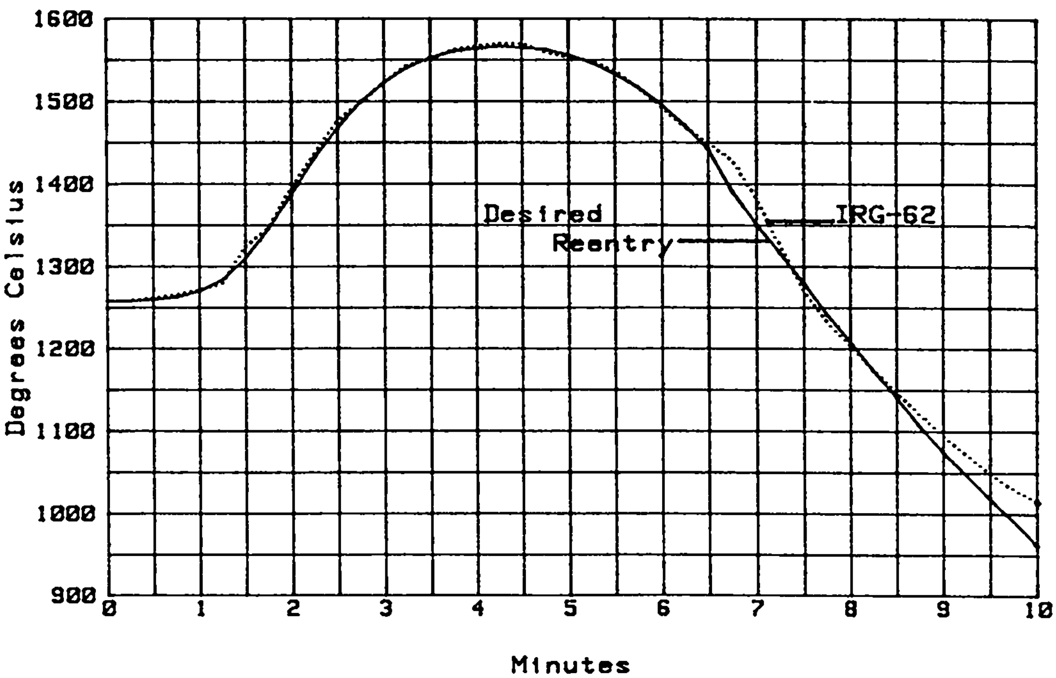
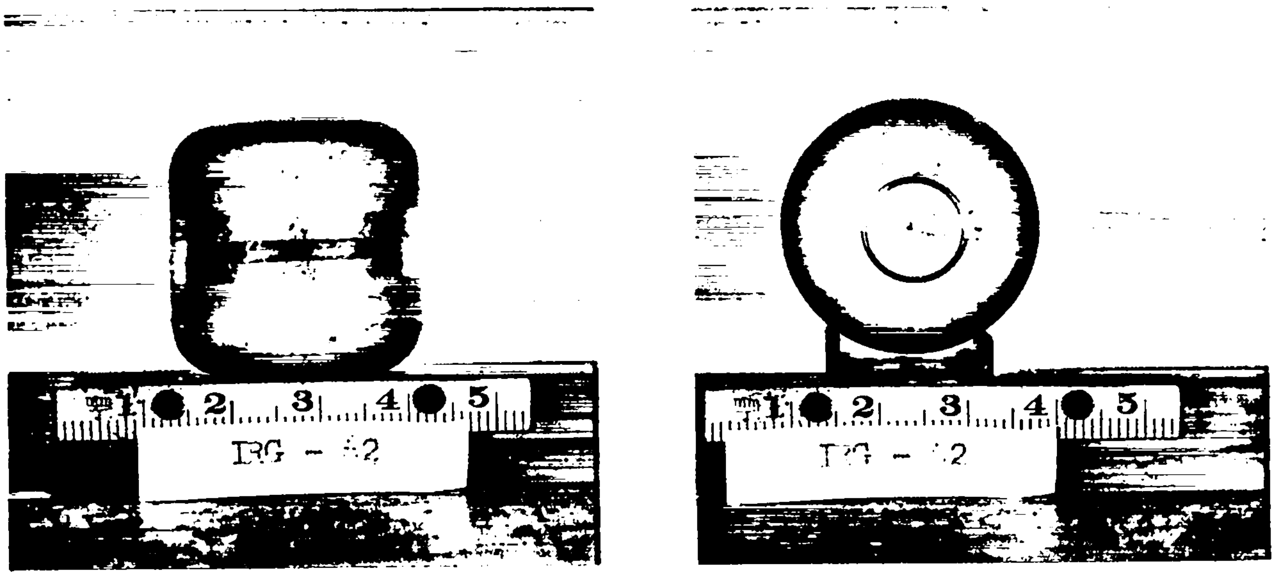
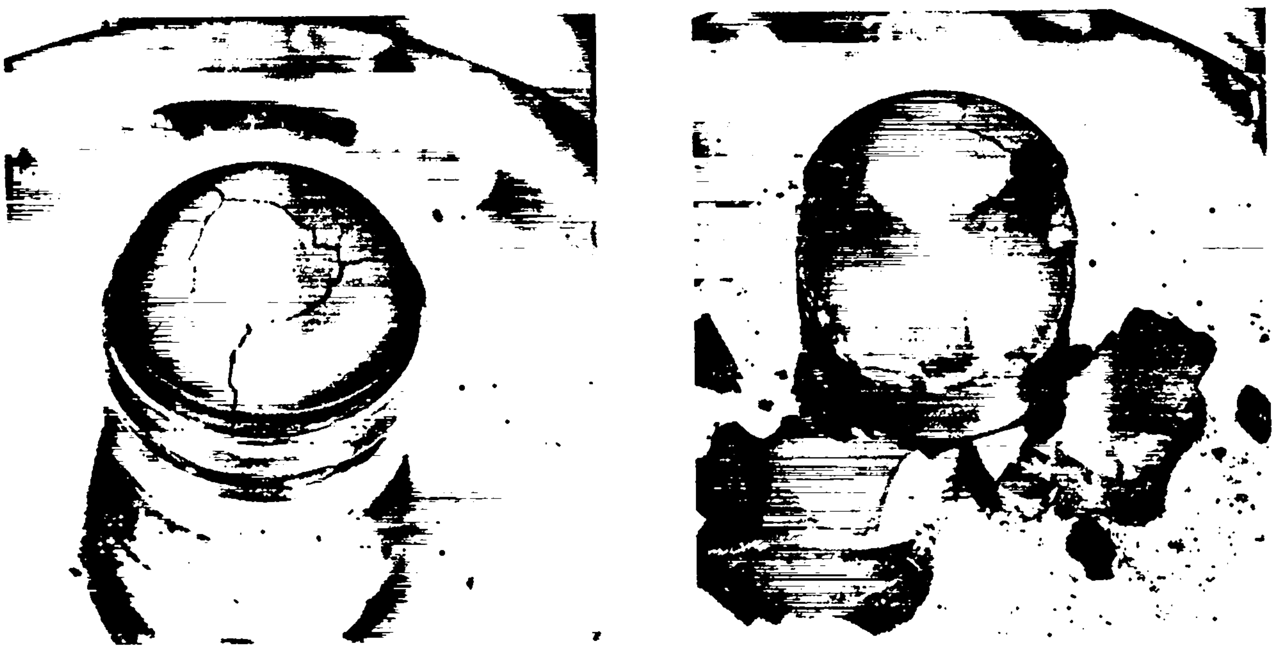


Fig. 4.
GPHS reentry pulse on IRG-62.



(a) (b)

Fig. 5.
Capsule IRG-62 appeared to have been unaffected by the aging and reentry thermal exposures.



(a) (b)

Fig. 6.
Fuel pellet GP-19 was found to be broken when the iridium capsule was removed; a) with the top of the capsule removed, and b) after removal from the capsule.

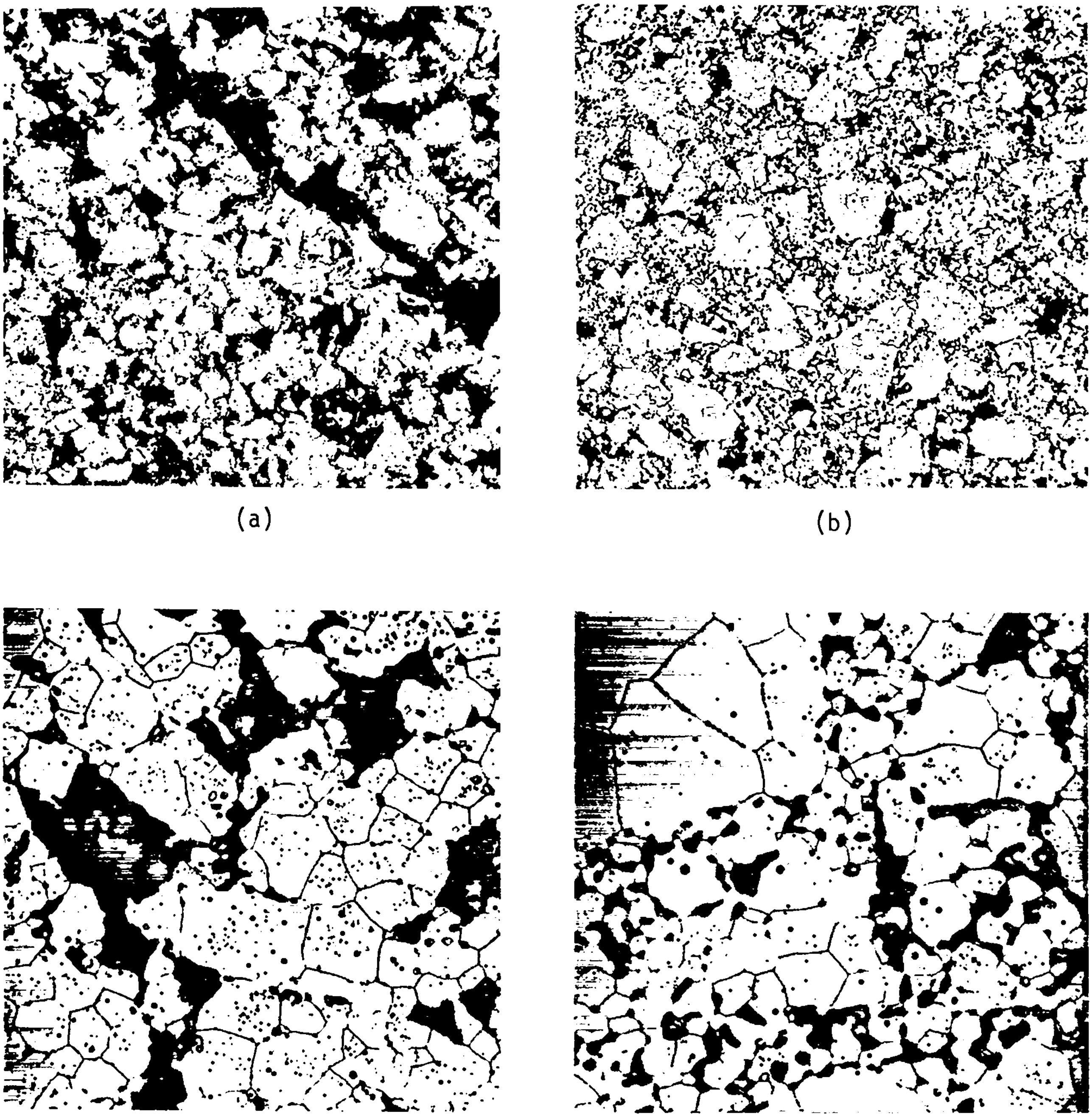
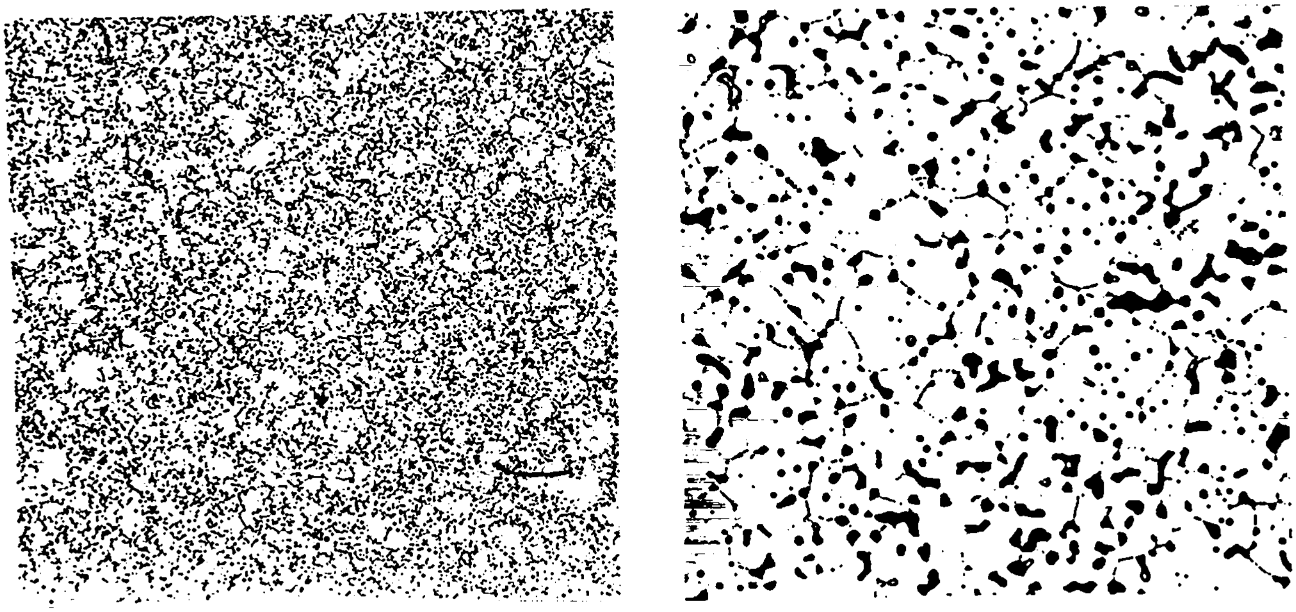


Fig. 7.
The microstructure of GP-19 showed the duplex structure characteristics of the "GROG process"; a) outer region, 50X; b) outer region, 250X; c) center region, 50X; and d) center region, 250X.



(a) (b)

Fig. 8.
The center-region microstructure of fuel pellet GP-17 was much less open, after it had been exposed to a reentry-like heat pulse to 1700°C, than that of GP-19. a) 50X and b) 250X.

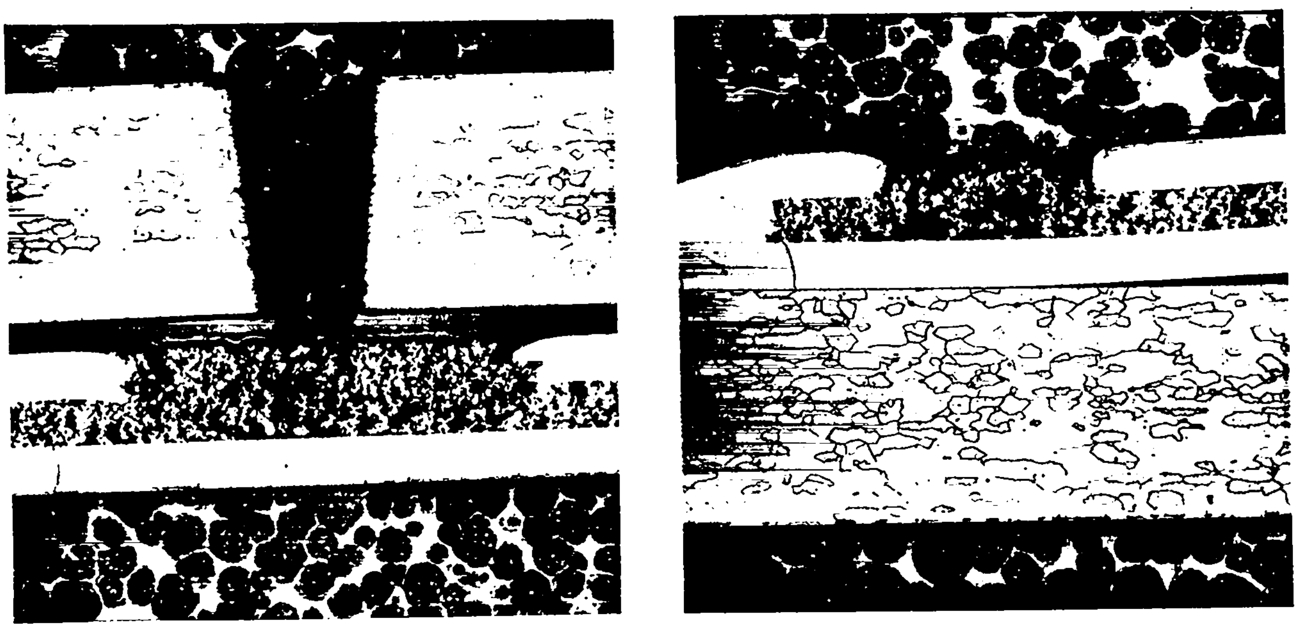


Fig. 9.
The vent in IRG-62 was unaffected by the thermal test, 50X.

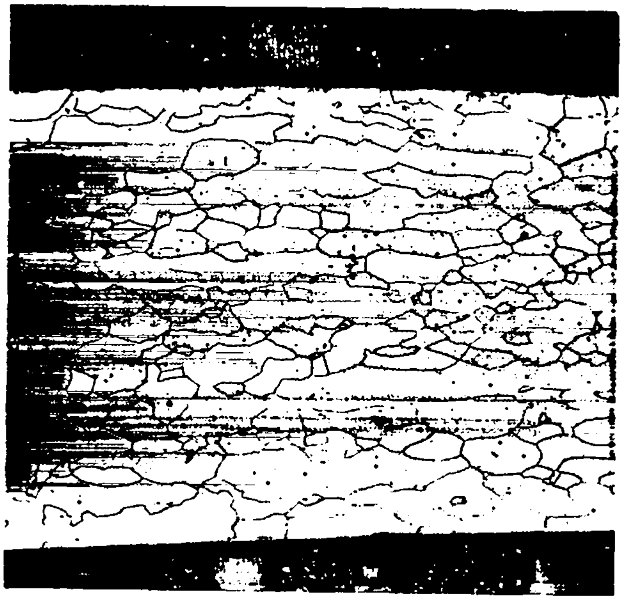


Fig. 10.
The microstructure of the iridium capsule in IRG-62 was typical, 100X.

TABLE I

THE DIMENSIONS OF CAPSULE IRG-62 WERE UNCHANGED BY THE THERMAL EXPOSURES USED IN THE AGING AND REENTRY SIMULATIONS

	Capsule Dimensions, mm		
	Before Aging	After Aging	After Reentry[a]
Diameter			
Vent end	29.72	29.72	29.77
Weld	29.85	29.85	29.90
Shield end	29.69	29.69	29.74
Height			
Center	30.43	30.40	30.46
Edge	30.30	30.30	30.38

[a]The post-reentry measurements were made by a different operator.

TABLE II

FRACTIONAL DISTRIBUTION OF FRAGMENT SIZES OF GP-19

mm	Weight Fraction
+ 6	0.94
+ 2	0.039
+ 0.841	0.0098
+ 0.420	0.0038
- 0.420	0.0064

TABLE III

ENCAPSULATION OF RHU PELLETS-1

Fuel Pellets No.	Fuel Pellets Diam (in.)	Fuel Pellets Length (in.)	Fuel Pellets Weight (g)	Pt-30Rh Capsules No. Body	Pt-30Rh Capsules No. Cap	Pt-30Rh Capsules No. Shim	Pt-30Rh Capsules Dim. (Welded)[a] Diam (in.)	Pt-30Rh Capsules Dim. (Welded)[a] Length (in.)	Welding Box Atmosphere O_2 (ppm)	Welding Box Atmosphere H_2O (ppm)	Comments
-	-	-	-	005	021	-	-	-	0.8	2.5	Example Weld
RU3- 8	0.246	0.363	2.665	021	043	017	0.338	0.497	0.9	2.5	
RU3- 9	0.246	0.368	2.663	022	044	018	0.339	0.497	0.9	2.5	
RU3-10	0.246	0.367	2.665	024	045	019	0.338	0.498	0.9	2.5	
RU3-11	0.246	0.365	2.664	029	046	020	0.339	0.497	0.9	2.5	
RU3-12	0.246	0.364	2.653	031	047	021	0.339	0.497	0.9	2.5	
RU3-13	0.246	0.365	2.663	032	048	022	0.339	0.500	0.9	2.5	
RU3-14	0.246	0.365	2.662	033	049	023	0.339	0.498	0.9	2.5	
RU3-15	0.246	0.365	2.662	042	050	024	0.339	0.499	0.9	2.5	
RU3-16	0.246	0.365	2.661	045	051	025	0.338	0.501	0.9	2.5	
RU4- 3	0.245	0.367	2.656	048	052	026	0.339	0.499	0.9	2.5	
RU4- 4	0.246	0.367	2.670	049	053	027	0.339	0.498	0.9	2.5	
RU4- 5	0.246	0.366	2.663	051	054	028	0.338	0.497	0.9	2.5	
RU4- 6	0.246	0.365	2.666	054	055	029	0.340	0.497	0.9	2.5	
RU4- 7	0.246	0.365	2.666	055	056	030	0.339	0.500	0.9	2.5	
RU4- 8	0.245	0.364	2.668	056	057	031	0.339	0.496	0.9	2.5	
RU4- 9	0.245	0.364	2.663	059	058	032	0.340	0.497	0.9	2.5	
RU4-10	0.245	0.364	2.667	060	059	033	0.339	0.495	0.9	2.5	
RU4-11	0.246	0.364	2.666	061	060	034	0.339	0.496	0.9	2.5	
RU4-12	0.245	0.365	2.666	062	061	035	0.339	0.495	0.9	2.5	
RU4-13	0.245	0.366	2.671	063	062	036	0.340	0.497	0.9	2.5	

[a]Diameters are measured across the machined standoffs, lengths across the weld standoffs.

TABLE IV

ENCAPSULATION OF RHU PELLETS-2

	Fuel Pellets			Pt-30Rh Capsules					Welding Box Atmosphere		
				No.			Dim. (Welded)[a]				
No.	Diam (in.)	Length (in.)	Weight (g)	Body	Cap	Shim	Diam (in.)	Length (in.)	O_2 (ppm)	H_2O (ppm)	Comments
-	-	-	-	018	024	-	-	-	0.9	25.0	Example Weld
RU4-14	0.246	0.367	2.668	065	063	037	0.339	0.498	0.6	7.0	
RU4-15	0.246	0.367	2.669	066	064	038	0.339	0.498	0.6	7.0	
RU4-16	0.245	0.367	2.666	067	065	039	0.338	0.496	0.6	7.0	
RU5- 3	0.246	0.366	2.666	068	066	040	0.338	0.497	0.6	7.0	
RU5- 4	0.246	0.368	2.669	069	067	041	0.339	0.498	0.6	7.0	
RU5- 5	0.246	0.365	2.670	070	068	042	0.338	0.498	0.6	7.0	
RU5- 6	0.246	0.366	2.666	071	069	044	0.339	0.497	0.6	7.0	
RU5- 7	0.246	0.368	2.669	073	070	045	0.339	0.499	0.6	7.0	
RU5- 8	0.246	0.369	2.668	075	071	046	0.338	0.497	0.6	7.0	
RU5- 9	0.246	0.368	2.668	076	072	047	0.338	0.497	0.6	7.0	
RU5-10	0.245	0.368	2.668	078	073	048	0.339	0.495	0.6	7.0	
RU5-11	0.246	0.367	2.671	079	074	049	0.339	0.498	0.6	7.0	
RU5-12	0.246	0.368	2.668	084	076	051	0.340	0.498	0.6	7.0	
RU5-13	0.245	0.367	2.668	089	077	052	0.338	0.497	0.6	7.0	
RU5-14	0.246	0.369	2.666	090	078	053	0.338	0.498	0.6	7.0	
RU5-15	0.246	0.368	2.668	091	079	054	0.338	0.497	0.6	7.0	
RU5-16	0.245	0.366	2.658	093	081	055	0.339	0.498	0.6	7.0	
RU7- 2	0.245	0.376	2.660	094	082	056	0.339	0.498	0.6	7.0	
RU7- 3	0.245	0.375	2.665	095	083	057	0.340	0.498	0.6	7.0	
RU7- 4	0.245	0.374	2.664	096	084	058	0.339	0.498	0.6	7.0	

[a] Diameters are measured across the machined standoffs, lengths across the weld standoffs.

TABLE V

ENCAPSULATION OF RHU PELLETS-3

No.	Fuel Pellets Diam (in.)	Fuel Pellets Length (in.)	Fuel Pellets Weight (g)	Pt-30Rh Capsules No. Body	Pt-30Rh Capsules No. Cap	Pt-30Rh Capsules No. Shim	Pt-30Rh Capsules Dim. (Welded)[a] Diam (in.)	Pt-30Rh Capsules Dim. (Welded)[a] Length (in.)	Welding Box Atmosphere O_2 (ppm)	Welding Box Atmosphere H_2O (ppm)	Comments
-	-	-	-	023	025	-	-	-	0.6	7.0	Example Weld
RU7- 6	0.245	0.372	2.665	097	085	059	0.338	0.498	0.6	7.0	
RU7- 7	0.245	0.375	2.664	098	086	061	0.339	0.499	0.6	7.0	
RU7- 8	0.245	0.373	2.663	099	088	062	0.339	0.498	0.6	7.0	
RU7- 9	0.245	0.371	2.663	100	089	063	0.339	0.499	0.6	7.0	
RU7-10	0.246	0.372	2.662	101	090	064	0.339	0.499	0.6	7.0	
RU7-11	0.246	0.373	2.662	102	091	066	0.339	0.499	0.6	7.0	
RU7-12	0.246	0.371	2.662	103	092	067	0.338	0.500	0.6	7.0	
RU7-13	0.245	0.375	2.661	105	093	068	0.339	0.498	0.6	7.0	
RU7-14	0.246	0.375	2.657	107	094	069	0.340	0.499	0.6	7.0	
RU7-15	0.246	0.374	2.661	108	095	070	0.339	0.497	0.6	7.0	
RU7-16	0.245	0.375	2.659	109	096	071	0.339	0.498	0.6	7.0	
RU10-1	0.245	0.369	2.661	110	098	072	0.339	0.500	0.6	7.0	
RU10-2	0.245	0.367	2.660	112	099	073	0.339	0.496	0.6	7.0	
RU10-3	0.245	0.369	2.660	114	100	076	0.339	0.496	0.6	7.0	
RU10-4	0.245	0.367	2.660	115	101	077	0.339	0.500	0.6	7.0	
RU10-5	0.245	0.369	2.663	116	102	078	0.338	0.498	0.6	7.0	
RU10-6	0.245	0.371	2.663	117	103	080	0.339	0.497	0.6	7.0	
RU10-7	0.245	0.372	2.662	118	105	081	0.338	0.498	0.6	7.0	

[a]Diameters are measured across the machined standoffs, lengths across the weld standoffs.

TABLE VI

NDT FOR ENCAPSULATED RHU PELLETS-1

Fuel Pellet No.	Fuel Pellet Weight (g)	Capsule Body No.	α Swipe (Count/min)[a]	Helium Leak Rate (cm^3/s)	Neutron Emission Rate (n/s-g ^{238}Pu)	Calorimetry (Watts)	Comments
RU3- 8	2.665	021	0	$< 9\times10^{-10}$	5 215		
RU3- 9	2.663	022	0	$< 9\times10^{-10}$	5 889		
RU3-10	2.665	024	0	$< 9\times10^{-10}$	5 612		
RU3-11	2.664	029	0	$< 9\times10^{-10}$	5 803		
RU3-12	2.653	031	0	$< 9\times10^{-10}$	5 613		
RU3-13	2.663	032	0	$< 9\times10^{-10}$	5 460		
RU3-14	2.662	033	0	$< 6\times10^{-10}$	5 539		
RU3-15	2.662	042	0	$< 6\times10^{-10}$	5 547		
RU3-16	2.661	045	0	$< 6\times10^{-10}$	5 293		
RU4- 3	2.656	048	0	$< 6\times10^{-10}$	4 775		
RU4- 4	2.670	049	0	$< 6\times10^{-10}$	4 843		
RU4- 5	2.663	051	0	$< 6\times10^{-10}$	4 785		
RU4- 6	2.666	054	0	$< 6\times10^{-10}$	4 923		
RU4- 7	2.666	055	0	$< 6\times10^{-10}$	4 991		
RU4- 8	2.668	056	0	$< 6\times10^{-10}$	4 946		
RU4- 9	2.663	059	0	$< 6\times10^{-10}$	4 636		
RU4-10	2.667	060	0	$< 6\times10^{-10}$	4 616		
RU4-11	2.666	061	0	$< 6\times10^{-10}$	4 738		
RU4-12	2.666	062	0	$< 6\times10^{-10}$	4 725		
RU4-13	2.671	063	0	$< 6\times10^{-10}$	4 691		
RU4-14	2.668	065	0	$< 9\times10^{-10}$	4 763		
RU4-15	2.669	066	0	$< 9\times10^{-10}$	4 785		
RU4-16	2.666	067	0	$< 9\times10^{-10}$	4 775		

[a]The specifications are:

α Swipe,	<220 counts/min
Helium Leak Rate,	$<1\times10^{-6}$ cm^3/s
Neutron Emission Rate,	<6000 n/s-g ^{238}Pu
Calorimetry,	1.10 ± 0.03 watts

TABLE VII

NDT FOR ENCAPSULATED RHU PELLETS-2

Fuel Pellet							
No.	Weight (g)	Capsule Body No.	α Swipe (Count/min)[a]	Helium Leak Rate (cm^3/s)	Neutron Emission Rate (n/s-g ^{238}Pu)	Calorimetry (Watts)	Comments
RU5- 3	2.666	068	0	$< 9\times10^{-10}$	4 626		
RU5- 4	2.669	069	0	$< 9\times10^{-10}$	4 632		
RU5- 5	2.670	070	0	$< 9\times10^{-10}$	4 674		
RU5- 6	2.666	071	0	$< 9\times10^{-10}$	4 723		
RU5- 7	2.669	073	0	$< 9\times10^{-10}$	4 739		
RU5- 8	2.668	075	0	$< 9\times10^{-10}$	4 674		
RU5- 9	2.668	076	0	$< 9\times10^{-10}$	4 292		
RU5-10	2.668	078	0	$< 9\times10^{-10}$	4 259		
RU5-11	2.671	079	0	$< 9\times10^{-10}$	4 377		
RU5-12	2.668	084	0	$< 3\times10^{-10}$	4 398		
RU5-13	2.668	089	0	$< 3\times10^{-10}$	4 350		
RU5-14	2.666	090	0	$< 3\times10^{-10}$	4 449		
RU5-15	2.668	091	0	$< 3\times10^{-10}$	4 492		
RU5-16	2.658	093	0	$< 3\times10^{-10}$	4 458		

[a]The specifications are:

α Swipe,	<220 counts/min
Helium Leak Rate,	$<1\times10^{-6}$ cm^3/s
Neutron Emission Rate,	<6000 n/s-g ^{238}Pu
Calorimetry,	1.10 ± 0.03 watts

TABLE VIII

NDT FOR ENCAPSULATED RHU PELLETS-3

Fuel Pellet No.	Fuel Pellet Weight (g)	Capsule Body No.	α Swipe (Count/min)[a]	Helium Leak Rate (cm^3/s)	Neutron Emission Rate (n/s-g ^{238}Pu)	Calorimetry (Watts)	Comments
RU7- 2	2.660	094	0	$< 3x10^{-10}$	4 252		
RU7- 3	2.665	095	0	$< 3x10^{-10}$	4 240		
RU7- 4	2.664	096	0	$< 3x10^{-10}$	4 532		
RU7- 6	2.665	097	0	$< 3x10^{-10}$	4 527		
RU7- 7	2.664	098	0	$< 3x10^{-10}$	4 492		
RU7- 8	2.663	099	0	$< 3x10^{-10}$	4 468		
RU7- 9	2.663	100	0	$< 3x10^{-10}$	4 329		
RU7-10	2.662	101	0	$< 3x10^{-10}$	4 343		
RU7-11	2.662	102	0	$< 1x10^{-10}$	4 411		
RU7-12	2.662	103	0	$< 1x10^{-10}$	4 498		
RU7-13	2.661	105	0	$< 1x10^{-10}$	4 495		
RU7-14	2.657	107	0	$< 1x10^{-10}$	4 395		
RU7-15	2.661	108	0	$< 1x10^{-10}$	4 504		
RU7-16	2.659	109	0	$< 1x10^{-10}$	4 508		
RU10-1	2.661	110	0	$< 1x10^{-10}$	4 722		
RU10-2	2.660	112	0	$< 1x10^{-10}$	4 686		
RU10-3	2.660	114	0	$< 1x10^{-10}$	4 917		
RU10-4	2.660	115	0	$< 1x10^{-10}$	5 042		
RU10-5	2.663	116	0	$< 1x10^{-10}$	4 939		
RU10-6	2.663	117	0	$< 1x10^{-10}$	4 918		
RU10-7	2.662	118	0	$< 1x10^{-10}$	4 981		

[a]The specifications are:

α Swipe,	<220 counts/min
Helium Leak Rate,	$<1x10^{-6}$ cm^3/s
Neutron Emission Rate,	<6000 n/s-g ^{238}Pu
Calorimetry,	1.10 ± 0.03 watts

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