Pu-238 FUEL FORM ACTIVITIES

JANUARY 1-31, 1982

Published: March 1982

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FOREWORD

This monthly report for ^{238}Pu Fuel Form Activities has two main sections: SRP-PuFF Facility and SRL Fuel Form Activities. The program status, budget information, and milestone schedules are discussed in each main section.

The SRP portion of this monthly report summarizes production of $^{238}\text{PuO}_2$ fuel forms for use in radioisotopic thermoelectric generators (RTGs) in the Plutonium Fuel Form (PuFF) Facility at the Savannah River Plant. The PuFF Facility was started up in December 1978 producing iridium-encapsulated, 100-watt $^{238}\text{PuO}_2$ spheres for MHW (multihundred watt) RTG's. This program was completed in April 1980. The PuFF Facility is now producing iridium-encapsulated, 62.5-watt $^{238}\text{PuO}_2$ right circular cylinders for GPHS (General Purpose Heat Source) RTS's.

The SRL portion of this program is aimed at the development of technology to support production in the PuFF Facility of ^{238}Pu fuel forms for isotopic heat sources. Components of the program include direct technical support to the production effort, improvement and refinement of existing processes to manufacture fuel forms, and demonstration and adaptation of processes for new isotopic heat sources in the PuFF Facility. In support of these development efforts, the Alpha Materials Facility (AMF) is operated to conduct small-scale fabrication and characterization studies of ^{238}Pu master materials. In addition, the Plutonium Experimental Facility (PEF) is operated to conduct fabrication studies of full-scale fuel forms. Areas of emphasis in the experimental program include technical support of PuFF for the production of GPHS fuel forms, development of processing techniques to minimize fracture in fuel forms, and characterization of the behavior of impurities in fuel forms.

The Work Breakdown Structure (WBS) for this program is shown in Figure 1.

This program is funded under B&R AE-15-20. Starting with the January 1981 issue, the number of the ^{238}Pu Fuel Form Activities monthly report was changed to DPST-year-133-month from DPST-year-129-month.

FIGURE 1. Work Breakdown Structure for Pu-238 Fuel Form Activities

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HIGHLIGHTS

SRP-PuFF FACILITY

Thirty-one GPHS pellets were hot pressed during January.

Thirty-one GPHS pellets were encapsulated in iridium.

Nineteen fueled clads were ultrasonically inspected for cracks. All nineteen were less than the rejection level established by a 3-mil-deep by 50-mil-long standard.

Thirty-seven fueled clads were shipped to the Mound Facility.

Five fueled clads were shipped to Los Alamos National Laboratory.

SRL FUEL FORM ACTIVITIES

SEM examination of multiple quenches on clad vent sets (CVS) of cups from DOP-26 alloy batches L, M, and N confirmed more severe weld cracking in M batch cups than L batch cups.

Eight additional impact ductility specimens have been identified for future testing. ORNL has been funded to carry out these tests to broaden the impact ductility data base.

ORNL has announced that they have demonstrated a discriminatory weldability test and that this test showed similar cracking differences between L and M batch material that have been observed at SRP.

SRL has demonstrated that an acid solution of 3.5M HNO_3 + 6.4M HF is effective in decontaminating iridium and can be neutralized with a calcined montmorillonite clay and $\text{Ca}(\text{OH})_2$.

The SRL recommendation to hold hot press pressure at maximum load during cooldown in the fabrication of production $^{238}\text{PuO}_2$ pellets appears to be increasing the number of integral GPHS pellets.

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SRP-PuFF FACILITY (WBS 1.1)

PuFF FACILITY PRODUCTION (WBS 1.1.1)

GPHS Production (WBS 1.1.1.1)

Objective

The objective of this work is to produce 62.5-watt GPHS fuel forms for use in space and/or terrestrial energy systems.

Milestones and Budget

The Milestone Schedule and Status Report for GPHS Production is shown in Figure 2; the milestone log is given in Table 9.

The Contract Management Summary Report is given in Figure 3.

Narrative

Summary

Thirty-one GPHS pellets were hot pressed during January.

Thirty-one GPHS pellets were encapsulated in iridium.

Nineteen fueled clads were ultrasonically inspected for cracks. All nineteen were less than the rejection level established by a 3-mil-deep by 50-mil-long standard.

Thirty-seven fueled clads were shipped to the Mound Facility.

Five fueled clads were shipped to Los Alamos National Laboratory (LANL)

See Table 1 for the current PuFF GPHS status.

TABLE 1

PuFF GPHS Status

	<u>Current Month</u>	<u>FYTD</u>
Pressed	31	118
Heat treated	27	114
Vacuum outgassed	30	-
Usable for encapsulation	25	101
Recycled	7	39
Before vacuum outgas	5	34
After vacuum outgas	2	5
Encapsulated	31	99
Flight quality	31	97
Evaluation use only	0	2
Nondestructive examination	19	133
Fueled clads shipped	42*	103*
Flight quality	37	97
Evaluation use only	5*	6*

* Includes five fueled clads shipped to LANL.

GPHS Fabrication

Production. 6.6 kg of $^{238}\text{PuO}_2$ feed powder was received from HB-Line for processing in January. 1.6 kg of scrap PuO_2 was returned to HB-Line for recovery. During January, 55 runs were oxygen-exchanged, 57 runs were ball milled, 67 runs were sintered, 31 pellets were hot pressed, 27 pellets were final heat treated, and 30 pellets were vacuum outgassed.

Process. Processing in the oxygen-exchange furnace was returned to four runs per furnace cycle after the repaired oxygen-exchange furnace rack was returned to service.

Thirty-one GPHS pellets were hot pressed during January (1-GF-273 through 1-GF-303), see Table 2. All pellets were within specification limits for hot pressing. Two pellets broke into several pieces during removal from the die.

Pellet cracking after final heat treatment continued to be a problem. Nine of the pellets final heated treated this month were found broken. However, only three were broken too severely to encapsulate. Possible methods of increasing the sintering of the low-fired shards, such as sintering in an argon atmosphere, are being investigated. Thirty pellets were vacuum outgassed this month, see Table 3.

The nominal hot press die charge weight was reduced from 150.5g to 150.0g beginning with 1-GF-282. This reduction in pellet weight will maintain the overall F-1 generator wattage at the nominal level.

Verification Pellets. Pellet 256 was sampled for verification analysis, bringing the total to four verification pellets. One in every 35 pellets is subjected to chemical and physical analyses per GPHS specifications. Four samples from each pellet are analyzed for carbon before shipment. No sample has exceeded the 200 ppm limit for carbon, see Table 4.

Equipment

Sintering Furnace. The sintering furnace hearth broke where the adaptor piece is pinned to the hearth. A new hearth was installed and dried out. The 7 micron filter on the inlet line to the furnace was replaced because of pluggage.

Final Heat Treatment Furnace. The final heat treatment furnace developed a vacuum leak in January. The furnace work tube gasket had deteriorated and cracked. A new work tube and gasket were installed.

Hot Press. A leak in the hot press vacuum system developed in January. Extensive leak checking of the entire hot press vacuum system was completed. The hot press high vacuum valve was disassembled and the o-rings on the valve seat sealing surface were replaced. The hot press roughing valve was also replaced. Oil in the mechanical pumps and diffusion pump was changed twice during the month. The thermocouple gages, Hastings gage, and ionization gage were replaced during January. The hot press chamber door quad-ring was replaced twice.

TABLE 2

GPHS Pellets Hot Pressed During the Period 1/1/82 through 1/31/82

<u>Pellet No</u>	<u>Hot Press Date</u>	<u>Pellet Weight, grams</u>	<u>Physical Conditions</u>
273	1-1	150.4	Integral
274	1-1	*	4 pcs**
275	1-2	150.4	Integral
276	1-11	150.6	Integral
277	1-12	150.3	Integral
278	1-13	150.1	2 pcs
279	1-14	*	4 pcs**
280	1-15	150.3	2 pcs
281	1-15	150.3	Integral
282†	1-15	149.6†	Integral
283	1-15	149.9	Integral
284	1-17	150.0	Integral
285	1-17	149.9	Integral**
286	1-18	*	4 pcs**
287	1-18	150.0	2 pcs
288	1-18	150.1	6 pcs**
289	1-19	150.1	Integral
290	1-19	149.9	Integral
291	1-19	150.0	Integral
292	1-21	149.9	Integral
293	1-22	150.0	Integral
294	1-22	150.0	2 pcs
295	1-23	149.9	Integral
296	1-23	150.0	5 pcs
297	1-24	150.4	Integral
298	1-24	149.9	Integral
299	1-29	150.1	Integral
300	1-30	150.1	Integral
301	1-30	150.2	Integral
302	1-30	*	5 pcs
303	1-31	149.9	Integral

* Pellets fractured during removal from hot press die.

** Fractured in several pieces. Recycled.

† Reduced die charge initiated.

TABLE 3

GPFS Pellets Vacuum Outgassed During the Period 1/1/82 through 1/31/82

<u>Pellet No</u>	<u>Outgas Date</u>	<u>Outgas Wt, grams</u>	<u>Physical Condition</u>	<u>Gage Measurements Length/Diameter Inches</u>
260	1/9/82	150.5	3 pcs	*
261	1/9/82	150.1	2 pcs	*
263	1/9/82	150.1	Integral	1.0796/1.0813
264	1/10/82	150.3	Integral	1.0807/1.0792
265	1/10/82	149.3	Integral	1.0842/1.0778
266	1/10/82	150.5	Integral	1.0824/1.0838
267	1/10/82	150.4	Integral	1.0825/1.0815
268	1/10/82	149.2	3 pcs	*
269	1/10/82	150.0	2 pcs	**
270	1/11/82	150.6	Integral	1.0847/1.0837
271	1/11/82	150.4	2 pcs	(1)/1.0788
272	1/11/82	149.7	3 pcs	**
273	1/20/82	150.3	4 pcs	*
275	1/20/82	150.3	3 pcs	*/1.0803
276	1/20/82	150.5	4 pcs	*/1.0788
277	1/20/82	150.4	Integral	1.0803/1.0818
278	1/25/82	150.0	3 pcs	*
280	1/20/82	150.3	2 pcs	*/1.0786
281	1/20/82	150.4	Integral	1.0996/1.0796
282	1/21/82	149.7	Integral	1.0934/1.0792
283	1/21/82	150.0	Integral	1.0760/1.0776
284	1/21/82	150.0	Integral	1.0799/1.0803
285	1/21/82	150.0	2 pcs	†
287	1/21/82	149.9	2 pcs	*/11.0847
289	1/21/82	149.9	4 pcs	*
290	1/25/82	149.8	2 pcs	††
291	1/25/82	149.8	Integral	††
292	1/31/82	150.0	Integral	1.0968/1.0828
293	1/31/82	150.0	Integral	**
294	1/31/82	150.0	2 pcs	*

* Physical condition did not permit gaging. Pellet will be gaged during encapsulation.

** Rejected at welder. Recycled.

† Recycled.

†† Not gaged yet.

TABLE 4**Carbon Analysis for Verification Pellets**

<u>Pellet No</u>	<u>Sample 1 Carbon, ppm</u>	<u>Sample 2 Carbon, ppm</u>	<u>Sample 3 Carbon, ppm</u>	<u>Sample 4 Carbon, ppm</u>	<u>Avg Carbon Content, ppm</u>
64	40	31	69	19	40
156	11	29	19	19	20
216	22	15	23	24	21
256	2	7	<2	<2	<3

Miscellaneous Equipment. The 2-1 manipulator failed in January and was replaced.

The 1-5 manipulator slave was successfully removed from the failed seal tube using a special boom and stand developed for this job. The slave was disassembled and removed from the process cell. The failed seal tube will be removed and inspected to determine the cause of the failure.

Pellet Encapsulation, Decontamination, Packaging, and Shipping

Process. Thirty-one GPHS pellets were encapsulated in iridium.

Twenty-nine fueled clads were decontaminated to less than 1000 d/m smearable alpha contamination during this period. Twenty-two fueled clads were leak checked using a helium leak detector. Four fueled clads have indicated helium leaks, three exceeded the specification limit.

Nineteen fueled clads were ultrasonically inspected for less than weld defects. All nineteen fueled clads had ultrasonic indications less than the threshold limit established by a 3-mil-deep by 50-mil-long standard. See Table 5 for NDE results.

The NDE reject rate has varied from batch to batch of iridium cups. Table 6 lists the reject rates of five batches.

The reject rates can be interpreted as a probability of success for a given batch type. Since the success probability of a matched set is the product of the success probability for each cup, the probability for success for individual cups is the square root of the probability for matched set, see Table 7. That is, the probability of success for unmatched iridium sets is expected to be the product of the respective unmatched success coefficients.

The success rate calculated for welding cups from MER-batch iridium and those from N-batch iridium are in good agreement with that observed in eleven MER-N welds to date, see Table 8.

Twenty-eight fueled clads were welded into fourteen primary shipping containers during this report period. All shipping containers passed the 2.025 in.-ring gage without filing.

Fourteen primary shipping containers were leak checked using a helium leak detector. All shipping containers were leak free.

TABLE 5

Nondestructive Examination Results

Pellet No	Peak Height	
	In Overlap	Out of Overlap
247	1	2
248	3.8	2
249	3	2
250	8.3	4.6
251	8	2.3
252	4.3	1.6
255	2	1.8
257	2.3	2.3
258	3	4.3
259	2	3.7
260	5.5	3
261	8.5	3.3
263	2.3	1.5
264	3	3.9
265	3.8	1.5
266	1	3.7
267	2.8	1.3
210	2	2
272	1.8	1.7

TABLE 6

Effect of Type Iridium on NDE Reject Rate

Type Ir	Number of Samples	NDE Response					
		>2	>5	>7	>10	>12	>15
All	151	104 64%	36 24%	25 17%	15 10%	10 7%	3 2%
L	41	21 51%	7 17%	3 7%	0 0%	0 0%	0 0%
M	8	6 75%	3 38%	1 12%	0 0%	0 0%	0 0%
MER	11	9 82%	6 55%	4 36%	4 36%	4 36%	1 4%
MER-N	11	8 72%	4 36%	4 36%	3 27%	1 9%	1 9%
N	31	21 68%	8 26%	6 19%	5 16%	2 6%	0 0%
P	23	19 83%	6 26%	5 22%	3 13%	3 13%	1 4%

TABLE 7**Weld Success vs. Iridium Batch**

<u>Iridium Batch</u>	<u>NDE Level for Matched Cups*</u>		<u>Coefficient of Success for Iridium Batch**</u>	
	<5	<10	<5	<10
L	0.83	1.00	0.91	1.00
M	0.62	1.00	0.79	1.00
MER	0.55	0.64	0.74	0.80
N	0.74	0.84	0.86	0.92
P	0.74	0.87	0.86	0.93
Q	0.76	0.90	0.87	0.95

* Determined by process data for welds made with cups from same batch.

** Square root of matched cup success coefficient.

TABLE 8**Success Rate for MER-N Batch Welds**

	<u>NDE Response</u>	
	<5	<10
Calculated (from Table 8)	0.64	0.74
Actual (from Table 7)	0.64	0.73

All fourteen shipping containers were calorimetered and neutron counted in preparation for shipment to the Mound Facility.

GPHS pellet shipment No-6 containing thirty-seven fueled clads was turned over to DOE for transport to the Mound Facility on January 5.

GPHS pellet shipment No-7 containing five fueled clads was turned over to DOE for transport to Los Alamos on January 12.

QA/QC Program

Shipping Casks. The annual inspection and hydrostatic and helium leak test was completed on Shipping Casks 33-36 and 56-57.

Process Equipment: Hot Press Dies. One hundred hot press die sets were received from POCO Graphite, Inc. The die sets were inspected and approved for use. Ten of the die sets were sent to Maintenance at Building 717-A for dimensional verification.

Process Equipment: Furnace Heater Tubes. Astro, Inc., is making the requested changes to the drawings for the furnace shell assemblies on order. The required materials for the two shell assemblies have been received by Astro.

Process Equipment: Furnace Hearths. The ceramic material is still being machined. The expected shipping date for the first hearth is February 19, 1982.

Process Materials: GPHS Primary Shipping Containers. A revised QA/Manufacturing Plan was received from Nuclear Components, Incorporated, for an order of fifty GPHS primary shipping containers.

The order of 100 GPHS primary shipping containers fabricated by Perry Oceanographics had several containers with wall thicknesses below the drawing tolerances. The two worst cases (Serial Numbers 085 and 086) were tested by welding the top caps on the containers, welding high-pressure fittings in one end, and hydrostatically bursting the containers. Serial Numbers 085 and 086 burst in the base metal at pressures of 5500 and 5400 psig, respectively. This compares to a burst pressure of 4900 psi, the basis for the Safety Analysis Report. The burst test assured that the deviant containers are safe to use.

Process Deviations. Deviation 201DN-147 was issued to accept for use Fueled Clads 8112HF247, -248, -249, -250, -251, -252, -253, -255, -257, -258, and -259. Iridium Cups P712-4 and P709-7, used as the example weld for the above listed fueled clads, exceeded the alignment specification.

EFFRB Actions. MRB Actions No N152GPH81SR, N177GPH81SR, and N170GPH82SR: Official concurrence from Mound Facility has been received.

MRB Action No N173GPH81SR: Official response from the Mound Facility has been received with the recommendation that Pellets 8108HF164, 8108HF179, and 8110HF209 be remeasured for helium leakage rate.

MRB Action No N188GPH82SR was issued to accept for use Fueled Clads 8112HF247, -248, -249, -250, -251, -252, -253, -255, -257, -258, and -259. The example weld (Iridium Cups P712-4 and P709-7) exceeded the alignment specification (less than 0.005") with a value of 0.006".

TABLE 9

Milestone Log for GPHS Production

Work Breakdown Structure Number	Description	Planned Completion Date	
		Current	Original
1.1.1.1	<u>GPHS Production</u>		
1.1.1.1.1	GPHS Flight Quality Production		
1.1.1.1.1A	Supply 4 GPHS Fueled Clads (FC's) to MF (Mound Facility). (Initial Production Flight Quality Shipment in GPHS Production Program.)	01/82	07/80
1.1.1.1.1B	Supply 14 Process Certification GPHS FC's to MF, including the 4 in WBS 1.1.1.1.1A. Safety Verification Test.	01/82	08/80
1.1.1.1.1C	Supply 3 GPHS Fueled Clads (FC's) to LANL for Impact Attitude Series Tests.	Indefinitely Delayed	02/81
1.1.1.1.1D	Installation and Operation of Vacuum Outgas Furnace.	02/82*	10/81
1.1.1.1.1E	Supply 88 Flight Quality GPHS FC's for GPHS/Galileo Orbiter Flight RTG (F-1).	05/82	05/82
1.1.1.1.1F	Supply 88 Flight Quality GPHS FC's for GPHS/Galileo Orbiter Flight RTG (F-2).	11/82	09/82
1.1.1.1.1G	Supply 88 Flight Quality GPHS FC's for GPHS Backup RTG (F-3).	05/83	01/83

* Will be delayed because of vendor fabrication and material procurement problems.

TABLE 9 (Cont'd)

Work Breakdown Structure		Planned Completion Date	
<u>Number</u>	<u>Description</u>	<u>Current</u>	<u>Original</u>
1.1.1.1.1H	Supply 88 Flight Quality GPHS FC's for GPHS/ISPM Flight RTG (F-4).	11/83	05/83
1.1.1.1.1J	Supply 92 Flight Quality GPHS FC's for GPHS/ISPM Flight RTG (F-5).	06/84	08/83
1.1.1.1.1K	Complete Galileo and ISPM GPHS-FC Requirements, Total Required = 557.	06/84	08/83
1.1.1.1.2	GPHS Evaluation Use Only Production		
1.1.1.1.2A	Supply 88 GPHS FC's (72 EUO and 16 Flight Quality) for GPHS qualification RTG (Q-1)	Completed	06/81

SRP CAPITAL EQUIPMENT (WBS 1.1.2)

Capital costs for the SRP Pu-238 program are shown in Table 10.

TABLE 10

SRP Pu-238 Capital Costs

	<u>Project Number</u>	<u>Budget Amount, \$</u>	<u>Project Approval</u>	<u>Project Amount, \$</u>
FY-1977 Projects				
Miscellaneous Small Projects (<50,000)	S-1711	193,000	12/77	147,000
FY-1978 Projects				
Install Calorimeter	S-2023	65,000	9/78	65,000
Metallograph for AMF (SRL)	S-2032	113,000	9/78	130,000
FY-1979 Projects				
Miscellaneous Small Projects (<50,000)	S-2065	279,000	11/78	279,000
GPHS Welder, PuFF	S-2163	117,000*	7/79	177,000*
Pump Decontamination Control Cabinets	S-2162	65,000	8/79	65,000
FY-1980 Projects				
Minor Projects (<50,000)	S-2211	115,000	11/79	
Water Monitors	S-2199	110,000	11/79	
Furnace Racks	S-2284	75,000	4/80	
Heat Source Transfer	S-1971	- Canceled -		14,500
PuFF Vacuum Furnace	S-2348	250,000	9/80	250,000
FY-1981 Capital Equipment Funds				
Total Capital Funds Available for FY-1981 are \$707,000.**				
Miscellaneous Small Projects (<50,000)	S-2404	225,000	10/80	225,000
GPHS Welder, PuFF	S-1517	100,000	9/81	100,000
Furnace Racks	S-1428	80,000	9/81	80,000
PuFF Vacuum Furnace	S-2348-2	320,000	9/81	320,000

* Includes adjustments of \$17,000 authorized 3/80.

** Includes project overrun from prior years adjustments -
\$18,000 authorized 9/81.

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SRL FUEL FORM ACTIVITIES (WBS 1.2)

SRL PRODUCTION SUPPORT ACTIVITIES (WBS 1.2.1)

The milestone log for this section is shown in Table 11. The Milestone Schedule and Status Report and the Contract Management Summary Report are given in Figures 4 and 5, respectively.

Technical Support - GPHS (WBS 1.2.1.1)

Objective

SRL has developed a process flowsheet based on technology originally developed at LANL for the production of full-scale GPHS fuel forms with a uniform, nearly crack-free microstructure. The objectives of this program are: (1) to support fuel form production operations in the PuFF Facility and (2) to develop technology to help optimize those operations.

SRL is now carrying out a detailed chemical and microstructural characterization of welded GPHS iridium cups that exhibit cracks in the weld overlap region. The objective of this program is to determine the mechanism responsible for weld cracking to provide information on how to control weld cracking.

Narrative

Weld Cracking in DOP-26 Iridium Alloy

Efforts to identify the cause of weld cracking in DOP-26 iridium alloy continue. Cracking severity is being assessed by ultrasonic, dye penetrant, and scanning electron microscopy (SEM) examinations of multiple quenches on clad vent sets (CVS) of cups from DOP-26 alloy Batches L, M, and N. SEM examinations confirmed more severe weld cracking in CVS T-39 (M-batch cups) than in CVS T-38 (L-batch cups). CVS T-39 had more cracks than CVS T-38. Several large centerline cracks were detected in CVS T-39 while CVS T-38 had none. Cracking severity also varied from quench to quench on both CVS T-38 and CVS T-39. Specimens from CVS T-38 and CVS T-39 are being prepared for ion microscopy to determine if cracking severity may be related to differences in elemental concentrations or distributions.

SEM examinations revealed no ridge network porosity on grain surfaces near molten zones on iridium strips heated in argon.

A clad vent set welded by the Mound Facility using an arc pattern shaper is being examined by scanning electron microscopy. Inner and outer weld bead structures at the weld quench will be recorded for comparison to structures of welds made by Engineering Equipment Department (EED) and PuFF using an arc oscillator. Results will be reported by SRP-Separations Technology Department.

Impact Ductility Testing

SRL/SRP-EED will supply specimens for impact ductility testing at ORNL to generate a data base for CVS welds and to correlate ductility with weld properties. The following eight CVS weld specimens have been selected for initial testing:

<u>CVS Specimens</u>	<u>Description</u>
T-29B or C	Production weld parameters (T-29E had 18.9% elongation)
T-26D	Matched chucks, 8 RPM (T-26C had 10.6% elongation)
T-30 (2 specimens)	Minimum chill chucks
T-32 (2 specimens)	Matched chucks, 5 RPM
T-36 (2 specimens)	Production weld parameters (quench taper area)

DOP-26 Iridium Alloy Weldability Test Development

In August 1981 SRP funded ORNL to develop a weld patch test to assess the susceptibility of DOP-26 alloy to cracking under SRP production welding conditions. SRL is coordinating this development effort. ORNL has announced that a discriminatory weldability test has been demonstrated. The test has confirmed SRP observations that M-batch alloy cracks more than L-batch alloy. ORNL, SRP, and SRL personnel will meet soon to discuss how the weldability test can be refined and applied to production welding.

Decontamination Development Studies

The objective of this study is to develop and evaluate improved decontamination techniques for the SRP Production decontamination of the iridium containment shell of the general purpose heat source.

After testing a variety of possible decontamination solutions, an acid solution containing 3.5M HNO_3 + 6.6M HF was recommended. This solution has been used successfully by the Mound Facility and LANL. SRL designed, and had built, a suitable apparatus for use with this acid solution in PuFF. Testing of this apparatus will begin in early February.

A safe and simple procedure has also been developed for disposal of spent acid solution. The procedure is as follows:

- Fill a 1-liter polyethylene wide-mouth bottle with 400 grams of Oil Dry. Oil Dry is the trade name of calcined montmorillonite clay distributed by Martin Distributors of Charlotte, NC.
- Pour in 200 mL of spent acid (or the contents of one decon vessel). Let the contents stand undisturbed for 5 to 10 minutes.
- Cap the bottle and shake it vigorously for a few seconds (4-6) in the direction parallel to the longitudinal axis of the bottle. Uncap the bottle immediately to vent the gases that built up during shaking. A small amount of brown gas will be observed. This is NO_x gas resulting from reaction of the nitric acid with the iron in the clay. After shaking, the bottle will become hot.
- Allow the bottle to stand for about 30 minutes to cool. The Oil Dry will be moist, but no free liquid will be present. The pH of a small amount of Oil Dry in a few milliliters of water will be between 1 and 2.
- Add 50 g of $\text{Ca}(\text{OH})_2$, cap the bottle and shake vigorously for 10-20 seconds. Uncap and scrape the $\text{Ca}(\text{OH})_2$ stuck to the lid into the bottle. Replace the cap and shake again for 10-20 seconds. Again, the bottle will get hot. Uncap the bottle and cool. After this step, the Oil Dry will appear damp and crumbly. The pH of a small amount in a few milliliters of water will be about 6. When the bottle is cool, it is ready to be capped and bagged out as waste.

PuFF $^{238}\text{PuO}_2$ Pellet Fabrication Recommendations

Fracture of PuFF pellets into 2 or more pieces after final heat treatment has been a continuing problem. SRL has made several recommendations to the plant to help alleviate the cracking. One recommendation, to hold the hot press pressure at full load during cooldown of the hot press, was recently implemented by SRP with positive results. Of the 41 pellets fabricated before this change, 34% were fractured after final heat treatment and 24% were recycled. Of the first 29 made after the change through mid-January, only 10% were fractured after final heat treatment and 7% recycled. SRL is continuing to work with SRP to test other recommendations which are expected to further reduce the fracture problem.

Impurities in $^{238}\text{PuO}_2$ (WBS 1.2.1.2)

Objective

Sulfur and phosphorus impurities have been found at the grain boundaries of the iridium cladding of encapsulated $^{238}\text{PuO}_2$ fuel forms. These impurities are considered to be detrimental to the impact behavior of iridium. Efforts are being made at SRL to characterize the concentration and transport of these impurities in $^{238}\text{PuO}_2$.

Narrative

Welding of the three remaining compatibility pellets in PuFF has been rescheduled by SRP for early February. Welding of these pellets must be done around the SRP production welding runs. Once welded, these encapsulated pellets will have to be decontaminated and packaged for shipment. All of these processes are done in the production facility, and each operation must be fitted into the schedule after production runs are completed.

Samples of the last three compatibility pellets have been received by ORNL for spark source spectrographic analysis. Results of these analyses are expected during February.

Helium Aging Studies (WBS 1.2.1.3)

Objective

DOE has requested that SRL participate in a coordinated effort with Mound Facility (MF) and LANL to characterize the

release of helium from GPHS pellets. The objective of the SRL program is to characterize the microstructure of sections of GPHS pellets that have been aged at ambient temperature for times up to 48 months and then heated at different temperatures to release stored helium.

Narrative

Gas collected from a helium release sample was analyzed. The analysis detected only traces of decay helium (^4He). Large amounts of argon were present in the gas sample. This showed that the collection chamber leaked, permitting the decay helium to escape. The sample from which the gas was collected was the control in a paired set of samples designed to test the effect of intermittent heating on preventing microstructural damage from release of decay helium. The control sample had been stored for 17 months and had a theoretical helium inventory of $\sim 2.283 \text{ cm}^3$ at 20°C . Most of this should have been released at the test temperature (1400°C). If the gas collection system had been leak tight, $\sim 0.220 \text{ cm}^3$ of decay helium should have been present in the gas sampling bomb. In addition, none of the argon gas surrounding the sample chamber in the furnace should have been detected. The initial composition of the gas in the sample bomb was $>99\%$ ^3He . At the end of the test, the composition of the gas in the sample bomb was 40.8 mol% ^3He , 58.8% Ar, 22 ppm ^4He , and the remainder O_2 and N_2 . This is equivalent to 0.011 cm^3 of ^4He , or about 20 times less than expected. The large quantity of argon detected and the large loss of ^3He show that the system leaked considerably, permitting the ^4He to escape.

Two other helium release samples scheduled for heating in conjunction with the above control sample were heated with no attempt to collect decay helium. It was considered more important to maintain the timing of the heatings than to take the time to build a better gas collection system. Work is continuing on possible collection systems that do not require large investments of money and time to install new equipment in PEF that may have only limited application.

Safety Analyses (WBS 1.2.1.4)

Objective

SRL has the responsibility for carrying out safety analyses of both production and laboratory facilities. In addition, SRL has the responsibility for writing technical standards to ensure

the safe operation of these facilities. The objective of this program is to prepare safety analyses and technical standards for facilities involved in the ^{238}Pu Fuel Form Program.

Narrative

The SRL Safety Technology has initiated its review of the PuFF Safety Analysis Report (SAR) as a part of the overall F-Area review.

1. Contract Identification SRL Production Support Activities		2. Reporting Period 01 JAN 82 through 31 JAN 82		3. Contract Number 1.2.1																														
4. Contractor (name, address) E. I. du Pont de Nemours & Co. Aiken South Carolina				5. Contract Start Date																														
				6. Contract Completion Date																														
7. Identification No.	8. Reporting Category (e.g. contract line item or work break down structure element)	9. Fiscal Years and Months												10. Percent Complete																				
		FY 1982																																
		O	N	D	J	F	M	A	M	J	J	A	S	1983	1	2	3	4	1984					1985					1986					
0.1	Tech Support-GPHS																											47						
0.2	Impurities in ²³⁸ PuO ₂													47	78																			
0.3	He Aging Studies																											47						
0.4	Safety Analysis													47	57																			
11. Remarks																																		
12. Signature of Contractor's Project Manager and Date														13. Signature of Government Technical Representative and Date																				

FIGURE 4. Milestone Schedule and Status Report for SRL Production Support Activities

1. CONTRACT IDENTIFICATION SRL Production Support Activities		2. REPORTING PERIOD 01 Jan 82 THROUGH 31 Jan 82		3. CONTRACT NUMBER 1.2.1												
4. CONTRACTOR NAME AND ADDRESS E. I. du Pont de Nemours & Co. Aiken South Carolina				5. CONTRACT START DATE												
				6. CONTRACT COMPLETION DATE												
7. MONTHS	O	N	D	J	F	M	A	M	J	J	A	S	TOTALS		FY 1982	
8. COST STATUS																
THOUSANDS														G1 COST PLAN DATE Oct. 81		
														H1 PLANNED COST PRIOR FYS N/A		
PIA AND R NUMBERS AE-15-20														I1 ACTUAL COSTS PRIOR FYS N/A		
														J1 TOTAL ESTIMATE FY COSTS FOR CONTRACT 1030		
													K1 TOTAL CONTRACT VALUE N/A			
													L1 UNFILLED ORDERS OUTSTANDING N/A			
													M1 ESTIMATE FOR SUBSEQUENT REPORTING PERIOD N/A			
ACCURED COSTS		C1 PLANNED	84	90	98	100	95	90	85	80	80	75	75	78	1030	
		D1 ACTUAL	83	90	98	83									355	
		E1 VARIANCE	1	0	0	17										
		F1 CUR. VARIANCE	1	1	1	18										
16. REMARKS																
13. SIGNATURE OF CONTRACTOR'S PROJECT MANAGER AND DATE								14. SIGNATURE OF THE GOVERNMENT TECHNICAL REPRESENTATIVE AND DATE								

FIGURE 5. Contract Management Summary Report for SRL Production Support Activities

TABLE 11

Milestone Log for SRL Production Support Activities

Work Breakdown Structure Number	Description	Planned Completion Date	
		Current	Original
1.2.1.1	<u>Technical Support - GPHS</u>		
1.2.1.1A	Optimize GPHS Production Operations in the PuFF Facility.	Continuous	12/80
1.2.1.2	<u>Impurities in $^{238}\text{PuO}_2$</u>		
1.2.1.2A	Provide Technical Basis for Setting Impurity Levels in $^{238}\text{PuO}_2$ Fuel Forms.	08/82	02/82
1.2.1.2B	Provide Recommendations for SRP to Control Impurity Levels in $^{238}\text{PuO}_2$ Fuel Forms.	10/82	04/82
1.2.1.3	<u>Helium Aging Studies</u>		
1.2.1.3A	Assess Microstructural Damage According to Test Matrix.	Continuous	
1.2.1.4	<u>Safety Analyses</u>		
1.2.1.4A	Complete Update of PuFF SAR.	06/82	06/82
1.2.1.4B	Complete Update of PEF SAR.	09/82	09/82

SRL CAPITAL EQUIPMENT (WBS 1.2.2)

The milestone schedule and status report for this section is given in Figure 6. The milestone log for AMF renovations is given in Table 12.

AMF Renovations (WBS 1.2.2.1)

Objective

The Alpha Materials Facility (AMF) has been in operation for more than 13 years. To ensure the continued operation of this facility, a general upgrading of the glove box trains in the AMF is essential. The objective of this program is to renovate the MM5 metallograph in the AMF in conjunction with the AMF upgrading activities being funded by other SRL programs.

Narrative

Renovation activities continue in the AMF with the arrival of the water-extended polyester (WEP) barrier wall molds from the vendor. Construction is making final shaping preparations on this barrier prior to installation in the AMF.

The new glove boxes are scheduled to be brought into the AMF once the WEP wall is installed. Once the boxes are set in place, the emergency exit doors will be put into place.

Design and working prints for the WEP $^{238}\text{PuO}_2$ storage fort, the Halon fire suppression systems, and the Pivot apparatus for the Pt-Ph furnace are complete.

[illegible]

Figure 6. Milestone Schedule and Status Report for SRL Capital Equipment

TABLE 12**Milestone Log for AMF Renovation**

Work Breakdown Structure Number	Description	Planned Completion Date	
		Current	Original
1.2.2.1	<u>AMF Renovation</u>		
1.2.2.1A	Complete Renovation of MM5 Metallograph	01/82	09/81
1.2.2.1B	Complete Acceptance Testing of Upgraded Facilities.	04/82	01/82

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