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Monthly Progress Report
Heat Source Technology Program
May 1993

Los Alamos
NATIONAL LABORATORY

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Compiled by
T. G. George

MONTHLY PROGRESS REPORT
HEAT SOURCE TECHNOLOGY PROGRAM

MAY 1993

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MONTHLY PROGRESS REPORT

HEAT SOURCE TECHNOLOGY PROGRAM

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T. G. George

ABSTRACT

This monthly report describes activities performed in support of Cassini fueled-clad production and studies related to the use of $^{238}\text{PuO}_2$ in radioisotope power systems carried out for the Office of Special Applications of the US Department of Energy (DOE) by Los Alamos National Laboratory (LANL). Most of the activities described are ongoing; the results and conclusions described may change as the work progresses.

I. HEAT SOURCE AND FEED POWDER SHIPMENTS

At the beginning of the month, LANL requested that Sandia National Laboratories: Albuquerque (SNLA) prepare a PAT-1 container for use in shipping a fuel sample from Westinghouse Savannah River Company (WSRC) to LANL.

In mid-May, LANL received a PAT-1 cask that contained six Soviet fuel samples. The fuel samples were analyzed to verify that the stated quantities of nuclear material were correct. By the end of the month, all verification measurements were complete. In June, the samples will be submitted for additional analyses to determine the degree of conformance with General-Purpose Heat Source (GPHS) fuel powder specifications.

II. FACILITIES

A. Launcher Relocation

During May, work continued on construction of an addition to PF-4 to house the relocated launcher and on a number of related procurements.

1. Construction Activities

The second level of the launcher addition's interior and exterior walls were poured (to the 18-ft level). Some gang forms were removed from the newly poured walls, but most were left in place to serve as scaffolding for the rebar and support steel required for the next two levels. At the same time, work began on assembly of gang forms for the third level walls. Expansion joint material for the third level was also installed between the launcher addition and PF-4.

Installation of electrical services for the heating, ventilation, and air conditioning (HVAC) system was temporarily suspended in mid-May, pending the resolution of issues associated with integrating these services into the PF-4 central control and distribution system.

By the end of the month, the architecture and engineering (A&E) contractor had nearly completed design work on a suspension system for the launcher.

2. Procurements

LANL's Materials Management (MAT) Division previously issued a purchase request (PR) for blast doors to cover both entryways from PF-4 into the launcher addition. Before bids on the PR had been received, a number of potential vendors raised questions related to the technical specifications. As a result, the technical specifications were revised and a modified PR, with a 17 May bid deadline, was released at the end of April. Although the bid due date was extended to 21 May, only one bid was received. At the end of May, this bid was under review, and a purchase agreement was expected to be issued by the end of June.

Previously, the vendor selected for procurement and installation of the bridge crane provided shop drawings of the proposed crane. However, examination of these drawings revealed that the crane's travel would not meet the requirements described in the original purchase agreement. In this month, the vendor redesigned the crane to meet the original travel requirements and provided new shop drawings. A review of these drawings by the A&E contractor was expected to be complete by mid-June.

Technical specifications for the filter train that will be used in the launcher addition's HVAC system were approved by the A&E contractor. The PR for the filter train was then forwarded to MAT for placement.

Bids from system integrators for fabrication of the Supervisory Control System (SCS) that will control launcher operations were reviewed in February. However, the original technical specification was revised to clarify items questioned by potential vendors. The bid deadline for the modified PR was 27 April. Unfortunately, the issuance of a purchase agreement was delayed by a federal audit of MAT operations.

B. Glovebox for GPHS Encapsulation Welding

Installation of the glovebox designed for GPHS encapsulation welding was completed in May 1992. A Safety and Technical Assessment for Readiness of Technology (START) review of the welding operation was completed in mid-September 1992 and approval for process start-up was received on 21 September. However, because LANL may not be in compliance with current National Emissions Standards for Hazardous Air Pollutants (NESHAPS), a temporary limit was imposed that permitted welding only six fueled-clads per month.

The results of legal and managerial reviews completed in April indicated that a maximum of 2.5 kg of ^{238}Pu could be processed each month without exceeding the established TA-55 baseline. On this basis of this finding, it was determined that there are no NESHAPS implications for welding up to 16 fueled-clads per month.

C. Metallography and Ceramography Glovebox Lines

All of the gloveboxes in the metallography and ceramography lines have been installed and wired for electric power. A bench-top metallographic facility for "cold" (uncontaminated) specimens was activated previously and has been used to support fueled-clad weld-process development.

In early November 1992, work on a facility ventilation upgrade (to service open-front hoods in both lines) was stopped by the Laboratory's quality assurance (QA) organization as a result of concerns with seismic qualification and duct welding procedures. Issues associated with duct welding were resolved by early December, and the issue of seismic qualification was resolved by the end of January. Work on the ventilation upgrade resumed on 22 February and was expected to be complete by 15 June.

D. Sieve Analysis Gloveboxes

Two gloveboxes designed to house the sieving and particle size analysis operations were previously installed and prepared for use. The Heat Source Technology group (NMT-9) requested a START review of these gloveboxes on 9 April, and a START review team convened on 30 April. On the basis of an inspection, the START review team identified 11 findings that would have to be addressed before the gloveboxes are approved for use. By the end of May, actions had been taken to close out 10 of the 11 findings; the remaining finding was expected to be closed by mid-June.

E. Fuel-Processing Glovebox Line

In this month we concentrated on replacing the connecting rings, spools, and gaskets used to access three fuel-process gloveboxes (GB-218, GB-221, and GB-222). On 1 March 1993, a minor contamination incident was traced to degradation of the gasket between GB-221 and dropbox 7 (DB-7). Subsequent inspection of other fuel-processing gloveboxes revealed that the gaskets between GB-221 and GB-222, and between GB-218 and DB-6, were similarly affected. All of these gaskets had been in use for the approximately 15 years that building PF-4 has been operational. In addition, gloveboxes GB-218 and GB-221 are used for ball-milling $^{238}\text{PuO}_2$ powders, which is the harshest environment present in the ^{238}Pu laboratories. As a result of these inspections, the leaking gasket on GB-221, which is normally covered by external radiation shielding, was temporarily sealed, and work on a plan to replace the gaskets and connecting hardware was initiated.

After several meetings between NMT-9 and HS-1 personnel, a replacement plan was developed, a temporary plastic tent to minimize the spread of contamination was designed and constructed under a radiation work permit (RWP), and standard and custom parts were designed and fabricated as needed. Four practice sessions were held in the TA-55 training center practice laboratory; full-face respirators were worn during the last session. As a result of these meetings and practice sessions, an RWP with step-by-step instructions for the connecting ring changeout, with a detailed description of anticipated radiological conditions and protective clothing requirements, was finalized.

By 19 May, the hardware used to connect GB-221 to DB-7 and to GB-222 had been replaced. No significant release of contamination occurred as a result of these replacements.

On 24 May, work began on replacing the connection between GB-218 and DB-6. During removal of the connecting ring gasket from GB-218, a portion of the gasket stuck to the box and flexed when a worker attempted to push the gasket inside the glovebox. Consequently, the replacement of this connection resulted in a contamination incident. However, by 28 May, new connection hardware was in place and decontamination of the room was in progress.

III. GENERAL-PURPOSE HEAT SOURCE

A. Preproduction Activities

1. Operational Readiness Evaluation (ORE)

A Cassini Production ORE was conducted at LANL on 16–20 November 1992. Also present was a DOE EH audit/review team that acted in an oversight capacity. The ORE was closed out on 20 November, with six findings to be resolved prior to the start of Cassini heat source production. By the end of May, the work required to close all six findings had been completed.

2. GPHS Fuel Powder, Pellet, and Fueled-Clad Specifications

The $^{238}\text{PuO}_2$ fuel powder acceptance specification, the GPHS fuel pellet specification, and the GPHS fueled-clad specification were previously distributed to the Office of Special Applications (OSA), EG&G MAT, General Electric Astro Space (GE-ASTRO), Martin Marietta Energy Systems-Oak Ridge National Laboratory (MMES-ORNL), and WSRC for review, as required by the Interface Working Agreement (IWA). Only six organizations/individuals provided comments on the draft specifications by the deadline of 7 May. These comments will be addressed in subsequent specification revisions.

3. Development of Process Procedures

Two compilations of procedures, titled "Quality Assurance Procedures for Flight Quality Cassini Fueled-Clads" and "Fabrication Procedures for Flight-Quality Cassini Fueled Clads," were previously distributed on controlled-copy bases internally and externally as required by the IWA. Both compilations will be updated to reflect subsequent procedure revisions only after DOE/OSA approval.

Sets of controlled-copy compilations of the "Fabrication Procedures for Flight-Quality Cassini Fueled Clads" were previously distributed to members of the Cassini Process Readiness Evaluation Review, which occurred on 18–19 May.

Procedure SHS-NMT9-PP-30 ("Cassini GPHS Iridium Control Procedure") was approved for use (at the local level) on 7 May. This procedure reflects recent changes to the design of the GPHS weld-shield; with DOE approval, it will replace SHS-NMT9-PP-24 ("GPHS Clad Vent Set [CVS] Control Procedure").

4. Fueled-Clad Weld Development

The first encapsulation weld over $^{238}\text{PuO}_2$ was performed in September 1992. The capsule (FC0002) was successfully decontaminated and was forwarded for a helium leak check, ultrasonic testing (UT), dimensioning, and neutron emission measurement. Although all test results indicated that the weld was satisfactory, subsequent encapsulations were postponed until the fueled-clad had been destructively examined.

5. Evaluation of Alternate Weld-Shield Designs

On 17 March, LANL and WSRC personnel welded two GPHS capsules (WT-37 and WT-38) using type-II weld-shields and fragmented simulant (lavite) pellets. The lavite pellet used in capsule WT-37 had been fragmented into two pieces, and the WT-38 pellet was broken into four pieces. In both tests, the weld-shields performed as designed and aided the operator in reassembling the fractured pellet in the weld-shield cup. After encapsulation welding and UT evaluation, both capsules were forwarded to WSRC for use in their UT development effort.

6. Fueled-Clad Ultrasonic Test Development

On 15 April, LANL hosted a meeting of the GPHS Welding/UT Working Group. The primary outcome of this meeting, which was attended by representatives from DOE/NE-53, WSRC, EG&G MAT, MMES, Westinghouse Advanced Energy Systems (WAES), GE-ASTRO, and Fairchild Space Company (FSC), was the development of a detailed plan and schedule to ensure that a viable UT system would be in place and operational by 15 July 1993. By the end of May, all of the actions required by this plan were on schedule.

7. Cold Process Verification (CPV) Tests

The CPV test series was designed to verify that the welding process for simulant-fueled ("cold") capsules had been optimized and to quantify the impact responses of the hot-pressed, and cold-pressed and sintered, urania fuel-simulants.

All simulant-fueled clads required for the CPV test series were welded previously. Eight capsules were loaded with hot-pressed urania (^{235}U -depleted) fuel-simulant and seven capsules were loaded with cold-pressed urania. UT examination performed with the existing Panametrics system indicated that the welds in nearly three-quarters of the capsules (11 of 15) contained indications that exceeded the proposed 4.8 equiv.-mils acceptance criterion.

a. CPV-1. On 28 September 1992, the first impact in the CPV series was completed. In this test (CPV-1), capsule SC0011, which had been loaded with a hot-pressed urania pellet, was impacted against a steel plate at 55.0 ± 1.0 m/s and 1092°C . The iridium hardware used for this capsule was Z-batch material produced for the Galileo and Ulysses missions. Postimpact examination of capsule SC0011 revealed that the clad had breached as a result of a fuel fragment push-through. Details of the clad failure, metallographic examination of selected clad sections, and a sieve analysis of fuel retained in the capsule have been documented in previous monthly reports.

In this month, particle sizing of fines released from capsule SC0011 and of the $\leq 45\mu\text{m}$ fraction of the retained fuel-simulant was delayed by a START review of the sieve analysis gloveboxes (see section IID).

b. CPV-2. On 4 December 1992, capsule SC0008, which had been loaded with a hot-pressed urania pellet, was impacted against a steel plate at 55.0 ± 1.0 m/s and 1090°C. The iridium hardware used for this capsule was designated as "Prime" and was from the D2 batch.

Postimpact examination revealed that although the capsule had two small transverse cracks on the cup radii at the edges of the impact face, no urania was released. Details of the clad deformation have been documented in previous monthly reports.

In this month we continued to make progress on the CPV-2 postmortem examination. A sieve analysis of fuel-simulant recovered from the impacted capsule was completed (Table I), and metallographic examination of selected cross sections continued.

Table I. Sieve Analysis of Urania Fuel-Simulant in Capsule SC0008*

<u>Particle Size</u> <u>(mm)</u>	<u>Weight</u> <u>Fraction</u>
+5600	0.5293
+2000 to 6300	0.2947
+ 850 to 2000	0.0354
+ 425 to 850	0.1131
+ 180 to 425	0.0135
+ 125 to 180	0.0019
+ 75 to 125	0.0016
+ 45 to 75	0.0016
≤ 45	<u>0.0089</u>
Total:	1.0000

* Weight fractions are calculated on the basis of the recovered pellet weight.

c. CPV-3. On 26 February 1993, capsule SC0004, which had been loaded with cold-pressed and sintered urania fuel-simulant, was impacted against a steel plate at 55.0 ± 0.1 m/s and 1090°C. The iridium hardware used for this capsule was designated as "Prime" and was from the D2 batch.

Postimpact examination revealed that although the capsule contained two small transverse cracks on the cup radii at the edges of the impact face, no urania was released. Details of this initial examination have been documented in previous monthly reports.

In this month we made no progress on the CPV-3 postmortem examination.

d. CPV-4. On 5 March, capsule SC0020, which had been loaded with cold-pressed and sintered urania fuel simulant, was impacted against a steel plate at 55.3 ± 0.2 m/s and 1090°C. The iridium hardware used for this capsule was X- and YR-batch material (vent cup ID: X342-2, shield cup ID: YR421-1) produced for the Galileo and Ulysses missions.

Postimpact examination revealed that capsule SC0020 was breached by several cracks: an axial crack located approximately 120° from the weld start that extended from the shield

cup, through the weld, and into the vent cup; smaller axial weld cracks at 170°, 180°, and 225°; a network of hairline (generally axial) cracks at ~180° that extended from the edge of the grit blast line to the vent cup radius; and small transverse cracks on the cup radii at the edges of the impact face. A small amount of urania was released into the tantalum containment vessel. Details of this initial examination have been provided in previous monthly reports.

In this month we made no progress on the CPV-4 postmortem examination.

e. CPV-5. Capsule SC0017, loaded with cold-pressed and sintered urania, was selected for use in CPV-5. The iridium hardware for this capsule was designated as "Prime" and was from the D2 batch.

8. Production Qualification

This effort cannot be initiated until after fueled-clad weld development has been completed and until LANL receives a shipment of new plutonia fuel.

On 18–19 May, the Cassini Process Readiness Evaluation Team conducted a preliminary review of LANL operations. Previously, LANL completed a review of the 14 April draft readiness plan for the Production Qualification Program and forwarded a copy of this review to the leader of the Process Readiness Evaluation Team.

B. Fueled-Clad Production

There was no activity during May.

C. Safety Test Program

There was no activity during May.

D. Research and Development

1. High-Temperature Mechanical Properties of Urania Fuel Simulant

There was no activity during May.

2. High-Temperature Mechanical Properties of Graphite

There was no activity during May.

E. Project Management

All required weekly status reports were delivered on schedule. The program Project Management System (PMS) monthly status report (which included a data disc) was also delivered to FSC (the operator of the program PMS) on schedule.

IV. LIGHT-WEIGHT RADIOISOTOPE HEATER UNIT (LWRHU)

A. LWRHU Fuel Powder, Pellet, and Fueled Capsule Specifications

A draft version of the LWRHU product index was previously distributed to OSA, EG&G MAT, GE-ASTRO, ORNL, and WSRC, for approval, comment, or information as described in the IWA. A final version of the LWRHU product index has not been released.

B. LWRHU Weld Development

A plexiglass welding chamber designed for "cold" weld process development has been fabricated and is expected to be installed by 15 June 1993.

C. LWRHU Production

Fabrication of urania (^{235}U -depleted) fuel-simulant pellets for two LWRHU vibration tests and for weld development was initiated.

V. MEETINGS AND VISITORS

Members of the MENTOR team selected by DOE/HQ were present on site throughout the month.

A safeguards and security (S&S) review was performed by DOE and contract personnel on 11 May. On 13 May a similar review was conducted by DOE Headquarters S&S personnel.

On 18–19 May, the Cassini Process Readiness Evaluation Team conducted a preliminary review of LANL operations.

On 20 May, a technical exchange meeting held at Teledyne Energy Systems in Timonium, Maryland, was supported by one LANL staff member.

On 27 May, one LANL staff member supported the quarterly program review held in Germantown, Maryland.