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Monthly Progress Report
Heat Source Technology Programs

April 1995

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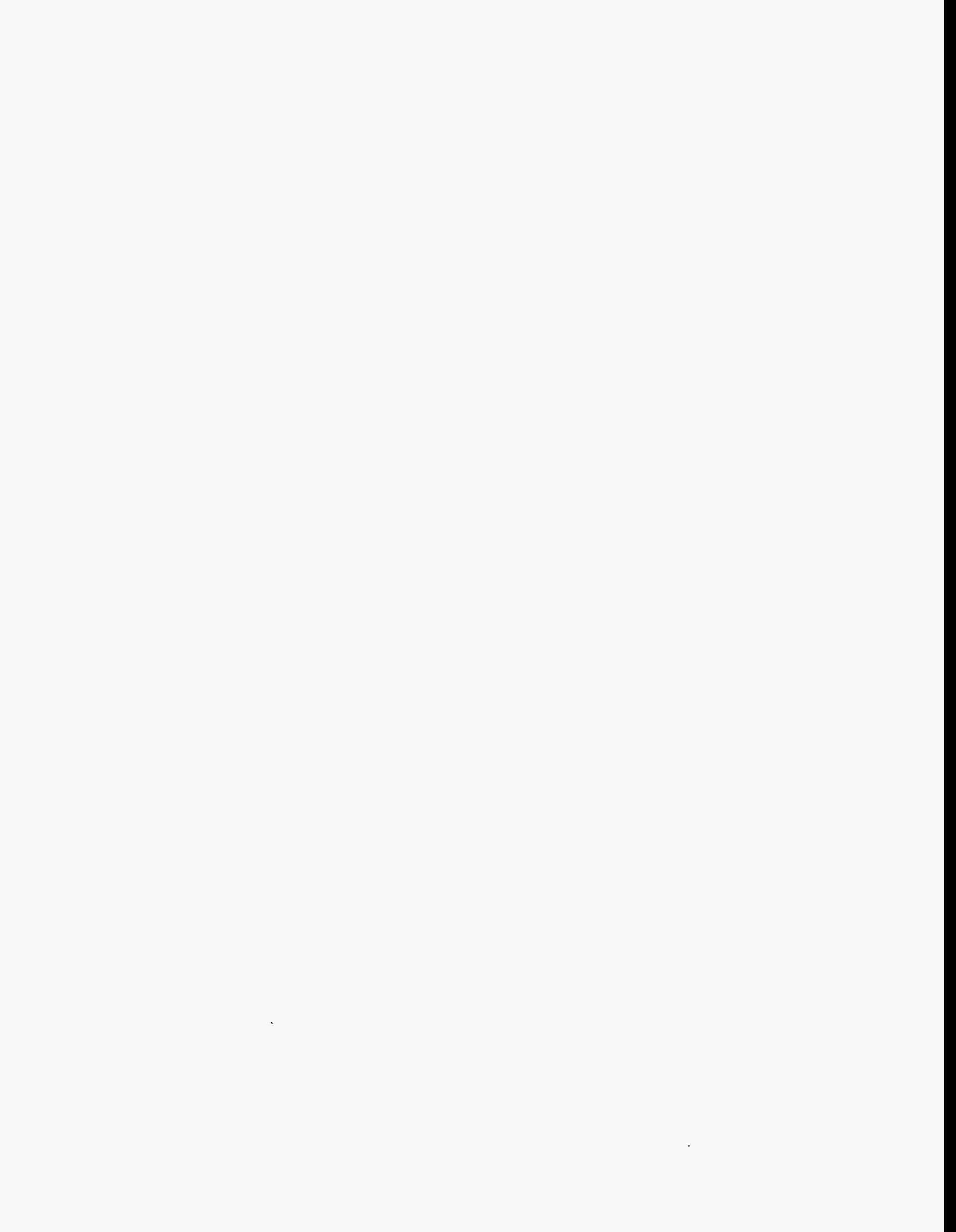
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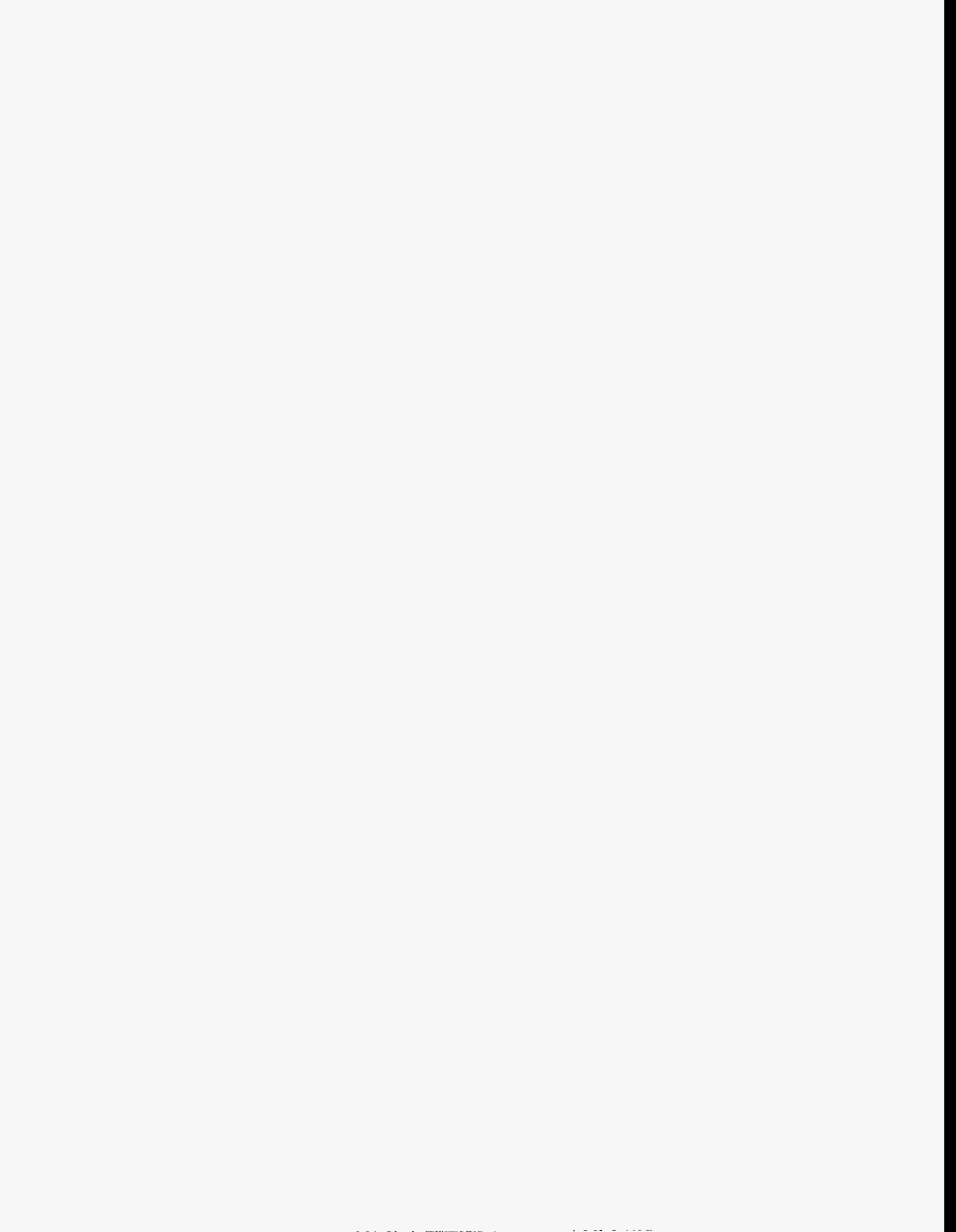
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MONTHLY PROGRESS REPORT
HEAT SOURCE TECHNOLOGY PROGRAMS

APRIL 1995

Compiled by

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 U.S. 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

During this month a shipment of eight fueled clads was made to EG&G Mound Applied Technologies (EG&G MAT).

Fuel shipment 487 was received and unpacked in the second half of the month. Shipment 486 was released for processing, and with the exception of one item shipment 485 was also released.

Unpacking of a Russian fuel shipment was completed during the first half of the month. Calorimetry of items received in the shipment continued throughout the month.

II. IRIDIUM HARDWARE SHIPMENTS AND INVENTORY

No shipments of iridium hardware were received in this month. The LANL inventory of General-Purpose Heat Source (GPHS) hardware, as of 30 April, is shown in Table I.

Table I. LANL Inventory of GPHS Iridium Hardware as of April 30, 1995

<u>Type of Hardware</u>	<u>Category</u>	<u>Number of Items in Inventory</u>
PICS*	Prime	222
PICS	Restricted Use	41
Type II Weld Shields	Prime	265

*PICS = postimpact containment shell.

III. FACILITIES

A. General

Radiological Control Technician (RCT) coverage for ^{238}Pu activities at TA-55 was generally consistent, and did not impede heat source production activities.

B. Launcher Relocation

1. Construction Activities

Construction of the launcher addition continued throughout April. However, in the second half of the month, electricians required to complete several construction activities were temporarily reassigned to other tasks. Assignment schedules provided by the contractor indicated that electricians would subsequently alternate work assignments, with two weeks devoted to launcher construction and two weeks scheduled for other LANL projects.

2. Administrative Activities

Work continued to identify required modifications to facility operational documents (emergency plans, operating procedures, etc.) to reflect the existence of the launcher addition.

C. TA-35 Launcher Facility

Plans for conducting the last test in the Cold-Process Verification test series (using urania fuel simulant) were finalized at the beginning of the month. However, in early April both the Los Alamos and Albuquerque DOE offices (LAAO and ALO, respectively) reached agreement that the resumption of any test operations at TA-35 would be delayed pending approval of a current facility safety analysis report (SAR) and completion of a National Environmental Policy Act (NEPA) operational review.

IV. GENERAL-PURPOSE HEAT SOURCE (GPHS) PROGRAM

A. Cassini Fueled-Clad Production

Eight fuel lots were introduced into the glovebox line during April. Additional fuel introductions were constrained at the start of the month by the need to avoid exceeding area limits for special nuclear material (SNM). However, this situation eased later in the month as the opening and calorimetry of the Russian fuel shipment was completed. A summary of Cassini production to date is presented in Table II.

Table II. Cassini Production As of 30 April, 1995

<u>Activity</u>	<u>Number of Units</u>
^{238}Pu Introduced Into LANL Process Line (cumulative, kg)^a	>17
GPHS	
Clads shipped to EG&G MAT ^b	37
Clads welded to date	97
Fuel pellets pressed to date	124
LWRHU	
Capsules Shipped to KSC ^c	0
Capsules welded to date	0
Fuel pellets pressed to date	180

^a From Program Start In January 1994.

^b EG&G Mound Applied Technologies.

^c Kennedy Space Center.

B. Production Support Activities

1. Fueled-Clad Weld Evaluation

Metallographic examinations of 29 weld and wall sections removed from 14 GPHS capsules (plutonia- and urania-fueled) were completed in this month. Weld parameters and initial observations for each capsule, as well as the location of sections removed for metallography, are listed in Table III. Metallographic examination of all 29 weld sections did not reveal any significant defects or anomalies. However, the overlap weld removed from capsule FC0075 did contain a slight offset, or step, between the vent and weld-shield cups.

Table III. Summary of GPHS Weld Evaluations

<u>Clad ID</u>	<u>Weld Current (amps)</u>	<u>Sample Location (deg)*</u>	<u>Avg. Thickness (mm)</u>	<u>Remarks</u>
FC0053	112-114	30	0.79	Rejected by standard UT; indications of a 7.6 equiv.-mil reflector, \approx 4 mm in length centered at 31 deg.
FC0055	112-114	355 180	0.55 0.78	Bulged weld; capsule would not pass ring gage.
FC0057	112-114	180	0.79	Bulged weld; capsule would not pass ring gage.
FC0059	112-114	355 180	0.58 0.84	Bulged weld; capsule would not pass ring gage.
FC0069	112-114	180	0.84	Bulged weld; capsule would not pass ring gage.
FC0075	111-112	0 180	0.77 0.77	Capsule rejected for high fuel impurities. UT evaluation revealed no significant reflectors \geq 3.1 equiv.-mils
FC0085	115-116	0 180	0.57 0.85	Bulged weld; capsule would not pass ring gage.

*The weld start corresponds to an angular location of 0 deg.

Table III. Summary of GPHS Weld Evaluations (continued)

<u>Clad ID</u>	<u>Weld Current (amps)</u>	<u>Sample Location (deg)*</u>	<u>Avg. Thickness (mm)</u>	<u>Remarks</u>
SC0044	116	0	0.69	Example weld.
		90	0.75	
		180	0.79	
		270	0.87	
SC0053	112-114	0	0.68	Example weld.
		90	0.85	
		180	0.73	
		270	0.80	
SC0055	112-114	0	0.68	Example weld.
		180	0.82	
SC0056	112-114	0	0.83	Example weld.
		180	0.83	
SC0057	111-112	0	0.84	Example weld.
		180	0.79	
SC0058	115-116	0	0.77	Example weld.
		180	0.84	
SC0063	115-116	5	0.74	Example weld.
		180	0.91	

2. Fueled-Clad Ultrasonic Testing (UT)

Ultrasonic evaluation of fuel capsules welded in March and April continued throughout the month. Ultrasonic evaluation of thirty four uranium-fueled (^{235}U -depleted) clads was also completed. Four of eight engineering-use capsules, and twenty five of twenty six capsules fabricated with prime hardware, passed UT.

Software to facilitate communication between the GPHS UT system and ICEPAK artificial intelligence software was received and installed at the end of the month.

C. Safety Test Program

1. End-On RTG Impact Tests

A Quick-Look report on the ENG-1 test was sent to DOE/NE-50, DOE/ALO, MMAS, and OSC on 4 April. Video copies of the high-speed photography of the test and video coverage of initial test operations were also provided to OSC and MMAS.

The first end-on RTG impact test (TA-1) was performed 13 April. The converter section impacted a block of Kennedy Space Center (KSC) concrete at 57.6 m/s and 1071°C. There was no release of uranium. The test components were packaged at SNLA and then shipped to LANL on 21 April. Initial examination of the impacted capsules did not reveal any breaching cracks. Calculated capsule strains are listed in Table IV.

2. Side-On RTG/Fragment Tests

A side-on conceptual test was conducted in the first week of January. During the test, the aluminum fragment dislodged from the rocket sled at a sled velocity of approximately 182 m/s. Post-test analyses suggested that aerodynamic forces acting on the aluminum fragment pulled it out of the hold-downs attached to the rocket sled. Additional work on side-on fragment impacts was postponed, pending programmatic guidance regarding tradeoffs between more robust fragment hold-downs and fragment release mechanisms.

D. Research and Development

1. Cold Process Verification (CPV) Tests

EG&G MAT personnel identified graphite hardware with simulated ablation for the CPV-12 module impact test. Uranium pellets for the module were encapsulated, and the module was assembled.

2. High-Silicon Fuel Study

GIS A and B: GIS A (FC0007 and FC0010) was loaded into a half module that had been machined to simulate reentry ablation, and will be impact tested at a future date. By 30 April, GIS B (FC0006 and FC0008) had been in the aging furnace for 123 days. The furnace pressure was 9×10^{-9} Torr and the GIS surface temperature was 1412°K. The scheduled date for GIS removal from the furnace is September 23.

GIS C and GIS D: The module containing GIS C (FC0019 and FC0026) and GIS D (FC0033 and FC0035) was removed from the MRMF chamber after 54 days and placed in an aging furnace. By

the end of this month, the module had been in the furnace for 43 days. The furnace pressure was 1×10^{-9} Torr and the module surface temperature was 1347°K. The scheduled date for module removal from the furnace is December 9, 1995 (270 d) unless otherwise directed by DOE.

Table IV. TA-1 Capsule Strains*

GPHS Clad No.	Module	Location	Calculated Strains (%)				Axial
			Diametral				
			Vent Cup		Shield Cup		
			Max.	Min.	Max.	Min.	
SC0077	1	A GIS, Open End	12.1	-15.4	10.2	-4.7	8.3
SC0076	1	A GIS, Blind End	20.0	-17.5	15.4	-11.7	19.5
SC0079	1	C GIS, Open End	8.9	-2.5	5.8	-4.2	5.8
SC0078	1	C GIS, Blind End	11.2	-9.0	9.9	-5.6	5.9
SC0081	2	A GIS, Open End	5.9	-6.9	3.6	-1.5	2.1
SC0080	2	A GIS, Blind End	12.8	-8.2	7.9	-6.3	8.7
SC0083	2	C GIS, Open End	4.4	-4.4	4.4	-3.8	4.9
SC0082	2	C GIS, Blind End	6.5	-8.3	4.3	-1.6	2.9
SC0085	3	A GIS, Open End	1.2	-4.8	0.9	-0.9	2.3
SC0084	3	A GIS, Blind End	2.9	-4.4	2.0	-2.2	1.8
SC0088	3	C GIS, Open End	0.9	-4.5	0.5	-2.2	1.4
SC0087	3	C GIS, Blind End	0.4	-2.8	0.5	-2.0	1.0
SC0065	4	A GIS, Open End	0.1	-2.4	0.3	-2.2	1.6
SC0064	4	A GIS, Blind End	1.0	-5.4	0.9	-4.3	2.0
SC0067	4	C GIS, Open End	0.3	-3.4	1.5	-2.8	1.0
SC0066	4	C GIS, Blind End	1.7	-3.5	1.5	-4.0	2.3
SC0069	5	A GIS, Open End	-0.2	-0.3	-0.2	-0.3	0.0
SC0068	5	A GIS, Blind End	0.0	-0.4	-0.2	-0.2	-0.1
SC0071	5	C GIS, Open End	0.0	-0.2	-0.0	-0.3	-0.9
SC0070	5	C GIS, Blind End	0.0	-0.3	-0.0	-0.3	-0.1

*Calculated on the basis of nominal pretest capsule dimensions (1.181 in. length.; 1.172 in. diam).

3. Evaluation of Fuel Pellet GF-47

Ceramographic examination of a sample from the interior of fuel pellet GF-47 continued. No anomalies were observed in the as-polished microstructure, and the sample appeared similar to fuel pellets evaluated during the Safety Verification Test (SVT) program. Evaluation of the etched microstructure was delayed as a result of problems associated with the procurement of the etching agent (hydrobromic acid).

E. Project Management

Primavera updates were received from Orbital Sciences Corporation (OSC). The status reports for Cassini and the 60-watt program were submitted on schedule.

HS-NMT9-PP-3-R07, "Feed Introduction Procedure," was distributed for review on March 10, in accordance with the interface working agreement (IWA), requesting response by March 24. By 13 April, all responses had been received and the procedure was in revision.

RHU-NMT9-PP-4-R02, "LWRHU Fueled Clad Welding," the signed document review requests and the completed change request were sent to EG&G MAT in accordance with the IWA, on February 28 with request for disposition by March 17. The procedure was received from DOE/NE-50 on 14 April, and distributed for use.

A revision of SHS-NMT9-PP-14-R03, "O Exchange," which included a number of Class I changes, was distributed for review on 30 March. The distribution was made in accordance with the IWA and requested a response by 14 April. All responses were received and the procedure was submitted for revision. On 25 April, signed document review requests and completed change request forms were forwarded to EG&G MAT with a request for disposition by 12 May.

Revisions of SHS-NMT9-PP-5-R05 ("Product Sintering and Storage"), SHS-NMT9-PP-15-R03 (Ball Milling Process Procedure"), and SHS-NMT9-PP-1-R04 ("Slugging and Screening"), which included a number of Class I changes, were distributed for review on 3 April, with a request for response by 21 April. All responses were received, and all three procedures were revised accordingly. On 25 April, signed document review requests and completed change request forms for SHS-NMT9-PP-125-R03 were forwarded to EG&G MAT with a request for disposition by 12 May.

Revisions of HS-NMT9-PP-13-R15 ("Sampling PuO₂") and SHS-NMT9-PP-21-R02 (Ultrasonic Examination of ²³⁹PuO₂ Fueled Clads"), which included a number of Class I changes, were distributed for review on 10 April, with a request for response by 28 April. As of 26 April, no responses had been received.

V. LIGHT-WEIGHT RADIOISOTOPE HEATER UNIT (LWRHU) PROGRAM

A. LWRHU Weld Development

The moisture and oxygen analyzers on the welding glovebox were installed and calibrated. All problems with the weld system hardware were resolved, and "hot" weld development began and was completed in mid-April. Two sets of LWRHU hardware were welded. Visual examination did not reveal any defects.

Four qualification welds were also performed on 12 April. Each LWRHU capsule contained a plutonia pellet. One clad was intentionally loaded with a plutonia pellet that exceeded the maximum length specification. The pellet easily fit into the capsule, with adequate room for the shim and cap.

After welding, the qualification capsules were submitted for visual examination, decontamination, helium leak check, dimension and weight measurement, gamma and neutron dose rate determination, and calorimetry. By the end of the month, all four clads met specification requirements for nondestructive tests (NDT) that had been performed. At the completion of NDT, the capsules will be sectioned and metallographically examined for weld defects.

B. LWRHU Production

No activity this period.

VI. 1-kW Shipping Container

Welding of product cans and shipping containers for the next shipment continued. A shipment of 1-kW hardware was also received from EG&G MAT at the end of the month. This shipment included: 6 support blocks, 96 product can support cups, 24 product can spacers, 2 graphite filler blocks, 6 cask O-rings, 25 primary container sets, and 16 secondary container sets.

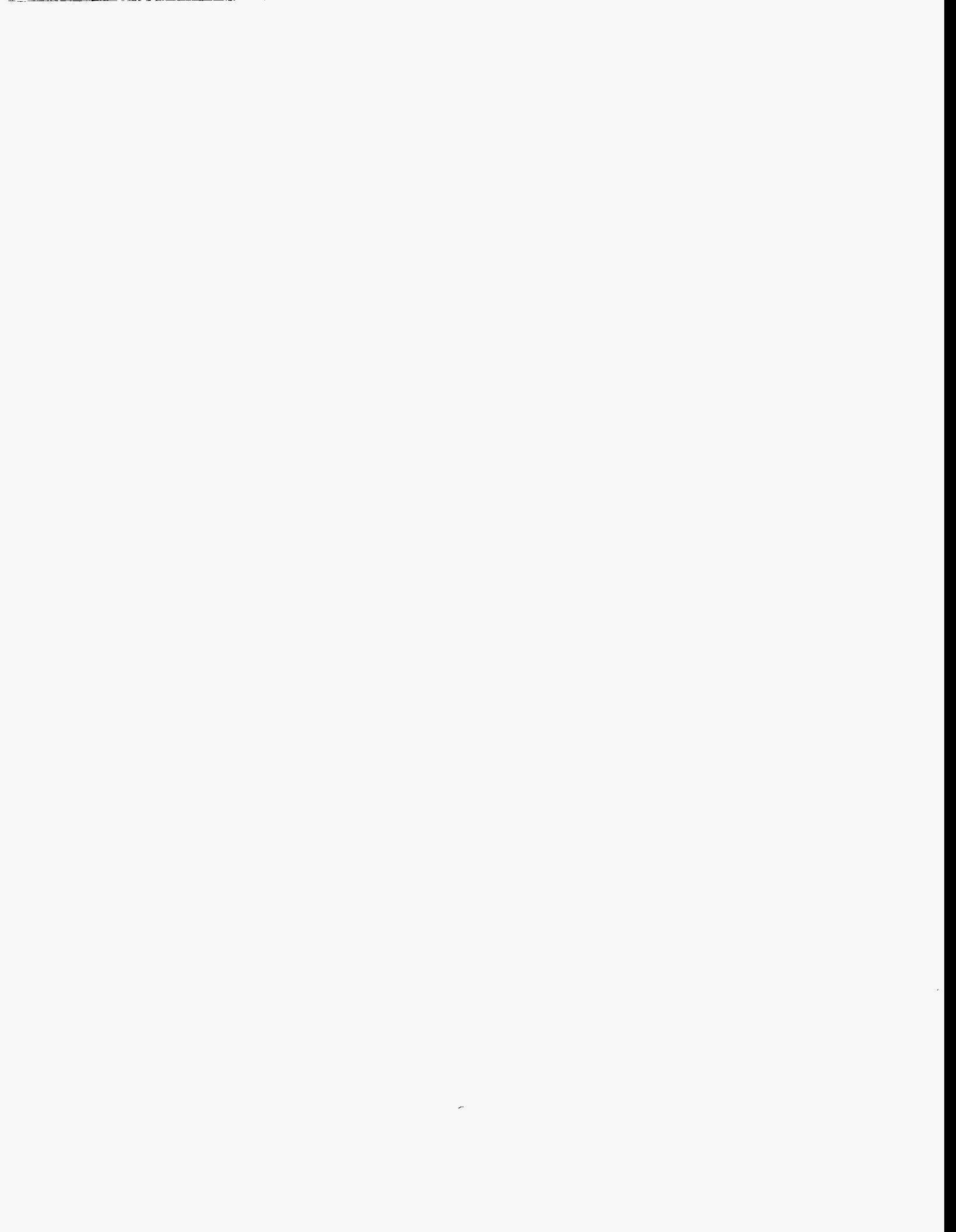
VII. PROGRAMMATIC MEETINGS AND VISITORS

EG&G MAT personnel visited LANL during the week of April 17 to work on the 200-W calorimeter.

DOE/NE-50 personnel were on-site at the beginning of the month.

Personnel from Westinghouse Nuclear Advanced Technology Division (WNATD) were on-site intermittently throughout the month.

The Cassini quarterly status review was held at LANL on 25 April.



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