BHO-67-2

MASTER

Refer to: CANH-70-256

October 14, 1970

U. S. Atomic Energy Commission
Brookhaven Area Office
Upton, Long Island, New York 11973

Attention: Mr. Harold L. Bates

Subject: Plant Instrumentation Program, Contract AT(30-1)-67
Quarterly Technical Report

Attachment: Quarterly Technical Report, BHO-67-2, July 1, 1970
to October 9, 1970, dated October 12, 1970, by
W. J. Gallagher

Dear Mr. Bates:

The attached quarterly report details the progress made during the development and fabrication of two isotopic source assay systems (ISAS), under Contract AT(30-1)-67 of the US AEC Plant Instrumentation Program.

Please contact Mr. William Gallagher or myself, for any additional information you may require.

Very truly yours,

Commercial Products Division

Donald B. Gill
Contract Administrator

bl

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FABRICATION AND EVALUATION OF ISOTOPIC SOURCE

NEUTRON INTERROGATION ASSAY SYSTEM

(ISAS)

JULY 1, 1970 TO OCTOBER 9, 1970

QUARTERLY TECHNICAL REPORT

W. J. GALLAGHER

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PREPARED FOR THE U.S. ATOMIC ENERGY COMMISSION
UNDER CONTRACT AT(30-1)-67
PLANT INSTRUMENTATION PROGRAM
OCTOBER 12, 1970

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ABSTRACT

The Gulf Radiation Technology Division of Gulf Energy and Environmental Systems, Inc., under sub-contract to United Nuclear Corporation - Commercial Products Division, New Haven, Connecticut, as part of the USAEC Plant Instrumentation Program, completed the design and fabrication of two Isotopic Source Assay Systems (ISAS).

Preliminary acceptance tests were completed at the Gulf facilities on October 9, 1970 and the ISAS Units were released for shipment to the United Nuclear Corporation. It is planned to ship one ISAS Unit on October 14, 1970, and the second unit on October 21, 1970.

Enriched uranium calibration standards, representing materials commonly found in industry, are being synthesized or prepared by United Nuclear Corporation. These standards will be used with the ISAS Units by UNC personnel.

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PERIOD JULY 1, 1970 THROUGH OCTOBER 9, 1970

Attachment: Isotopic Source Assay System (ISAS), Description and Operation Manual (Preliminary), dated 10/9/70, by T. Gozani, of Gulf Radiation Technology

Note: This report has been submitted to the US AEC Patent Group but has not received patent clearance as of this date.

United Nuclear Corporation under Contract AT(30-1)-67, as part of the US AEC Plant Instrumentation Program, sub-contracted to the Gulf Radiation Technology Division of Gulf Energy and Environmental Systems, Inc. (Purchase Order NHA 72998, dated 4/27/70), the task of designing and fabricating two isotopic source assay systems (ISAS), each capable of separately measuring U₂₃₅ and U₂₃₈. The attached manual includes design and operation details of the ISAS units.

From October 5 through October 9, 1970, preliminary acceptance tests of both ISAS Units were performed at the Gulf Facility in LaJolla, California in the presence of, or by, a representative of United Nuclear Corporation. These tests were satisfactory and both ISAS Units were released for shipment.

The pre-acceptance tests were confined to measuring the U₂₃₅ content of material containing 93% or 97% enriched uranium. Since the response from U₂₃₅ was as much as 30 times greater than that from U₂₃₈, the ISAS Units could not accurately distinguish the fertile material content of the highly enriched uranium standards utilized for the tests. An informal test of ISAS Unit No. 1, using a depleted uranium/aluminum cased, sample (282.6 gms. total U, 0.57 gms. U₂₃₅) resulted in a net signal of 334 counts per 200 seconds with no moderator inserted into the detector moderator cavity, 226 counts per 200 seconds with a one inch thick moderator in the detector cavity, and 118 counts per 200 seconds with a two inch thick moderator in the detector cavity. Tests are scheduled at United Nuclear Corporation to determine the uranium enrichments within which the ISAS Units can accurately measure fertile material.

During the tests, each ISAS Unit was adjusted such that 3 out of the 4 plastic scintillation detectors had to simultaneously detect a neutron and gamma emission from the irradiated sample before a count was recorded by the system. This coincidence counting effectively screened out the neutrons emitted from the ²⁵²Cf source, except for a relatively few random events.

It was noted that the four photomultiplier tubes in each ISAS Unit are temperature sensitive and cause the total counts per sample to vary by approximately 2 to 3% as the temperature of the environment varies by approximately 20 degrees. This was compensated for by periodically checking the system with a standard during the extended series of measurements, and normalizing the data to the standard measurements. For the pre-acceptance tests, a small ²⁵²Cf source was used as a standard.

Background measurements of material of similar density and bulk are desirable, especially when measuring samples containing small quantities (less than 10 grams) of U₂₃₅. For example, in Table 1 in the attached manual, background measurements of ISAS Unit No. 1, taken with a can of Aluminum oxide (#CC-B Kgs.) in the detector well over a two hour period, were 1595, 1637 and 1576. A similar empty can placed in the detector well gave a background of approximately 11% less. The background

measurement is subtracted from the signal obtained from irradiation of the sample, to give a net signal.

The spectrometer of each ISAS Unit has a bias adjustment which can be set to screen out specific energy radiation from the irradiated sample. Tests were conducted with and without bias.

Table Number 1 and associated calibration curves, in the attached manual, detail the results of measuring the U_{235} content of six cans (5 inch x 6.75 inch) of $U_3O_8 - Al_2O_3$, with ISAS Unit No. 1. The cans contained 50.32, 100.66, 201.78, 301.98, 402.65, and 603.97 grams of U_{235} respectively. As indicated by the normalized (to Cf) net signals of 0.034, 0.063, 0.107, 0.151, 0.186 and 0.257 respectively, this ISAS Unit produced signals which were in direct proportion to the quantity of U_{235} measured. Repeat measurements indicate the unit does reproduce measurements within statistical limits of error; for example, Sample #C-1, containing 50.32 grams of U_{235} , produced a normalized (to Cf) net signal of 0.035 at 8:46 A.M. and 0.033 at 10:38 A.M. on October 6, 1970.

ISAS Unit No. 2 was tested with glass vials of U_3O_8 , each containing 5 grams of U_{235} . These vials were arranged in layers of 8 on aluminum plates, within a 5-3/4 inch x 11 inch plastic jug. ISAS Unit No. 2 was not fully adjusted for this test and the travel time of the sample carrier differed in the up vs. down movement. The test data net signals were adjusted to reflect this time differential by calculating the net signal in counts per second. ISAS Unit No. 2 produced signals in direct proportion to the quantity of U_{235} present in the samples. Data and calibration curves from this test are attached.

The same glass vials of U_3O_8 were previously measured in ISAS Unit No. 1, by Gulf Radiation Technology personnel, on three different days. The following data illustrates the reproducibility or precision of this assay device:

Experiment 9-29-70					
Grams U_{235}	Net Signal + Stat. Error %			Ratio Using 240 gms. as 1	Ratio Using 401 gms. as 1
40	1884	+	4.6%	0.189	0.113
80	3563	"	2.3	.357	.214
120	5335	"	1.8	.535	.320
160	6892	"	1.5	.691	.413
200	8624	"	1.3	.869	.517
240	9980	"	1.1	1.0	.598
281	11735	"	1.1	-	.709
321	13144	"	1.0	-	.788
361	14950	"	0.9	-	.896
401	16681	"	0.9	-	1.0
441	18110	"	0.8	-	1.086
482	19546	"	0.8	-	1.172
Experiment 9-30-70					
40	1898			0.194	
80	3465			.355	
120	5207			.533	
160	6792			.696	
200	8429			.863	
240	9761			1.0	
281				-	
321				-	

Experiment 9-30-70 (cont'd.)

Grams		Ratio Using	Ratio Using
U-235	Net Signal + Stat. Error %	240 gms. as 1	401 gms. as 1
361		-	
401		-	
441		-	
482		-	

Experiment 10-5-70

40	1829	0.110
80	3609	.218
120	5202	.314
160	6684	.404
200	8214	.503
240	9929	.600
281	11422	.690
321	13342	.807
361	14850	.897
401	16558	1.0
441	17803	1.075
482	19314	1.166

Inconsistencies were encountered when measuring the U₂₃₅ content of synthesized acid insoluble residue standards (beach sand, ZrO₂, filter flock, U₃O₈, aluminum trihydrate) with ISAS Unit No. 1. These standards were measured by the Gulf Portable LINAC Assay System which verified the U₂₃₅ content, but detected a + 20% difference in hydrogen content among the standards. Additional work with this type of material will be performed at United Nuclear Corporation.

As of this date, the schedule for delivery of the two ISAS Units is as follows:

October 14, 1970:

- a. Ship ISAS Unit No. 1 to United Nuclear Corporation, Hematite, Missouri; by air.
- b. Ship both ²⁵²Cf sources, within a single shipping container, to United Nuclear Corporation, Hematite, Missouri; by air.

October 21, 1970:

- a. Ship ISAS Unit No. 2 to United Nuclear Corporation, Wood River Junction, Rhode Island; by truck.

October 26, 1970:

- a. Ship one ²⁵²Cf source from UNC, Missouri to UNC, Rhode Island; by truck.
- b. Assembly and testing of ISAS Unit No. 1 at UNC, Missouri.

October 27 and 28, 1970:

- a. Training of UNC personnel in the operation of ISAS Unit No. 1 at UNC, Missouri.

November 11, 1970:

- a. Assembly and testing of ISAS Unit No. 2 at UNC, Rhode Island.

November 12 and 13, 1970:

- a. Training of UNC personnel in the operation of ISAS Unit No. 2 at UNC, Rhode Island.

Preparation and/or synthesis of calibration standards, under Sub-Task U01-4, by United Nuclear Corporation, will be completed prior to delivery of the ISAS Units. Measurement of these standards will commence immediately after training of United Nuclear Corporation personnel.

U₃O₈ I GLASS VIALS OF 5 GAS. (²³⁵ EACH NET COUNTS PER SECOND VS. GAS. U²³⁵

U₃O₈ IN CLASS VIALS OF 5 GMS U²³⁵ EACH
 CURVE NORMALIZED TO ²⁵²Cf STANDARD

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