

UNITED STATES
ATOMIC ENERGY COMMISSION
OAK RIDGE OPERATIONS OFFICE

report of the
**SURVEY OF NUCLEAR
MATERIALS
MANAGEMENT AND
CONTROL FUNCTIONS**

of

UNION CARBIDE CORPORATION
CARBON PRODUCTS DIVISION
NUCLEAR FUELS DEPARTMENT

OR-226 FBV FACILITY

for the period AUGUST 1, 1965 to JULY 31, 1966

The NUCLEAR MATERIALS
CONTROL BRANCH of the
PRODUCTION DIVISION

APR

SPECIAL NUCLEAR MATERIALS SAFEGUARDS SURVEY
UNION CARBIDE CORPORATION, LAWRENCEBURG, TENN.
FACILITY FBV -. SURVEY OR-226

I. INTRODUCTION

1.01 - A survey was made by the Nuclear Materials Control Branch, Production Division, ORO, of the accountability control exercised over special nuclear materials (SNM) by the Union Carbide Corporation, Nuclear Fuels Division (NFD), Lawrenceburg, Tennessee.

1.02 - The survey covered the period August 1, 1965 through July 31, 1966. The field work and audit was performed during the interval August 22, 1966 through August 24, 1966. The results of the chemical and isotopic analysis of the samples taken by the survey group were received on January 17, 1967.

1.03 - The Nuclear Fuels Division was, during the survey period, engaged in converting UO_2 to UC_2 , coating UC_2 , and fabricating it into shapes for reactor fuels or shipping uranium oxides and carbides to other facilities for further fabrication. In addition, uranium bearing graphite-carbon residues were being oxidized in air to yield a concentrated but impure U_3O_8 residue. This concentrated scrap material was being shipped off-site for purification and return to the AEC.

II. SCOPE OF SURVEY

2.01 - The survey covered all SNM held by the facility and the records associated with these materials. Specifically, the survey included reviews of: Facility inventory procedures; application of these procedures in the plant; measuring equipment and practices; analytical procedures; losses and loss mechanisms; discards; labeling, and identification of SNM items; procedures manual status, and the degree of internal control exercised over SN material. The audit of the records included analyses of SNM control ledgers, testing of supporting documents, and preparation of comparisons between the NFD book inventory, the NFD physical inventory and the survey group's independent listing of SN material items, both as to uranium and uranium-235 content.

2.02 - An independent listing was made by the survey group of the SN material items on physical inventory, and this listing was programmed through ADP equipment. The accuracy of the facility's statement of the SNM content of items on inventory was tested by checkweighing and sampling a number of items randomly selected from the inventory.

III. OPINION

3.01 - The survey group is of the opinion that the SN material inventory reported by Facility FBV as of July 31, 1966, does not present fairly their holdings as of that date because of:

- a. The low confidence that can be placed in the facility's statement of the uranium content (Reference 3.06).
- b. The low confidence that can be placed in the facility's statement of the uranium-235 content of SN materials (Reference 3.07).
- c. The excessive number of weighing errors found in the inventory samples selected by the survey group (Reference 3.08).

3.02 - This opinion is qualified to the extent that most of the errors involved the statement of the SN material content of scrap which was, at the time of the survey, being partially processed at Lawrenceburg, Tennessee, and finished at Facility FAX, Nuclear Fuel Services, Inc., Erwin, Tennessee, for eventual return to AEC.

3.03 - Of the 50 kilograms of U-235 listed on inventory, approximately 38 kilograms were contained in scrap items and were involved in the errors detected by the survey group. On the other hand, the survey group found that the NFD measurements of product materials were satisfactory as to isotopic content.

3.04 - Because of the above qualification and the fact that a relatively small inventory (50 kilograms of U-235) was involved, the survey group is of the opinion that there was no significant safeguards problem at NFD at the time of the survey. It is noted, however, that the potential existed for a real problem if a larger inventory was as imprecisely measured. The accomplishment of the recommendations given below in Section IV is, in the opinion of the survey group, the necessary minimum action required to maintain safeguards control over SN materials processed under the fully operating flow-sheet of the NFD facility.

3.05 - Statement of Certification - The certification statements made below were calculated from the data obtained by chemical and isotopic analysis of items randomly selected from the NFD inventory.

3.06 - Assuming that all defective items in the sample were detected by the survey group, it can be certified with 95% confidence that at least 23% of the items on hand at NFD meet the survey group's chemical composition acceptance criteria.

3.07 - Assuming that all defective items in the sample were detected by the survey group, it can be certified with 95% confidence that at least 40% of the items on hand at NFD meet the survey group's isotopic composition acceptance criteria.

3.08 - Checkweighing of randomly selected items was performed by the survey group, and in the first 18 checkweighings made, the survey group found 8 reject items. Since this number of rejects exceeded the allowable number for an acceptable population, no further checkweighing was performed. Due to the small number of checkweighings made by the survey group, no certification statement was calculated.

IV. RECOMMENDATIONS

4.01 - Prior Recommendation - It is recommended that NFD prepare and distribute a procedures manual outlining the functions of measurement, inventory, recording, and reporting of SS materials.

4.02 - Action Taken - A procedures manual had not been issued as of survey time. See current Recommendation Number 1.

4.03 - Current Recommendations

1. It is recommended that NFD prepare and distribute a procedures manual which outlines the functions and procedures for measurement, inventory, recording, and reporting of SS materials.
2. It is recommended that NFD adjust the book inventory to agree with the physical inventory as of the month the physical is taken.
3. It is recommended that measured discards and other known losses be entered in NFD records for the month in which such discards occur, and reported to the AEC in the Material Balance Report for the period in which such discards occur.
4. It is recommended that NFD establish and maintain a subsidiary ledger which will identify all SNM accounting transactions by job symbol, contract number, and project authority.
5. It is recommended that NFD obtain or apply more accurate measurements to SN material that is physically inventoried.
6. It is recommended that NFD labeling, inventorying, and record keeping procedures be revised to accommodate items with other than nominal enrichments within jobs.
7. It is recommended that scrap processing be kept current with scrap generation and that measurement of any scrap shipped off site for recovery be more accurate. If there is more than one job (contract) from which scrap could be generated, scrap items should be identified by job number.

V. DISCUSSIONA. Facility Inventory Procedures

5.01 - Facility inventory procedures consist of going to each room or area, in turn, identifying items, recording available data on ruled pads, extending data to uranium and U-235 quantities, summing, and comparing with book data. In the past, no sticker, mark, or other indication that an item had been inventoried has been placed on the item as it was inventoried; consequently, checks to assure that each item was inventoried once and only once, was less likely to be effective. The survey team was advised that NFD plans to place some indication on the item as it is inventoried to indicate that it has been listed. Processing is partially halted, and controlled intra-area and inter-area material movements are allowed during inventory. Equipment hold-up allowances have not been incorporated into the inventory statement.

5.02 - Special nuclear material records are not adjusted to reflect physical inventory results. Physical inventories are taken each quarter.

B. Labeling and Identification

5.03 - Labeling of items in storage at NFD is generally acceptable. With few exceptions, each item had a uranium content entered on the label or marked on the bag in the case of scrap, principally graphite contaminated with uranium and smaller amounts of thorium. As of survey time, all scrap in bags was assigned to the AVR contract so job identification was not marked on bags. However, it is expected that scrap from future processing will be segregated and identified by job, and possibly by source or process within a job.

C. Verification of Inventory

5.04 - Verification of inventory quantities by the survey team consisted of (a) checkweighing of randomly selected items, (b) obtaining statistically representative samples of the facility inventory for chemical and isotopic analyses, and (c) independently listing each SNM item in the facility on the SS Materials Detailed Inventory Form, editing, keypunching, and computer processing the data, and comparing the AEC listing to NFD inventory results.

5.05 - Of 18 items having an assigned NFD weight, 8 were outside the survey group's acceptance limits which were three times the scale unit increment. Weighing discrepancies of the magnitude found by the survey group could, on a larger inventory, constitute a safeguards problem.

5.06 - Additional verification steps included completion of Measurements, Inventory Procedures, Loss and Discard, Internal Control, and Procedures Manual questionnaires. Standard certified test weights were applied to accountability and process scales. Discussions on procedures and policies were held with plant personnel.

D. Measurements

5.07 - A review was made of laboratory procedures, scales, and balance programs and various measurement points throughout the facility. The laboratory procedures were determined to be adequate for the plant. Chemical and isotopic determinations are routinely made for enriched uranium and these determinations are reported as percent uranium for solids and grams uranium per liter for liquids. Other SS materials and related materials are measured periodically, as required.

5.08 - The SNM content of some items is determined theoretically and in some cases by factor assays, with the latter developed and verified at NFD from proven experience with materials associated with routine and specific in-process manufacturing steps.

5.09 - A large percentage of the residues on inventory at NFD had been gamma scanned for uranium-235 content since the scrap material for the most part was heterogeneous. These low level uranium residues consisted primarily of combustibles, ash, and contaminated graphite that is destined for ashing and recovery. The recovery work may or may not be done at NFD.

5.10 - Impure uranium oxides and other related SS materials are dissolved in nitric acid, filtered, peroxide precipitated, and recycled. The resulting filtrate is analyzed fluorometrically for uranium and discarded to the holding pond via the sewer if discard criteria are met.

5.11 - Scales and balances used for accountability purposes at NFD were checked with standard weights and determined to be in calibration.

5.12 - Sixty-eight samples were taken for inventory verification purposes and divided into two groups of twenty-two and forty-six, and forwarded to NBL and to the Y-12 Plant, respectively, for independent analysis.

E. Certification Statistics

5.13 - The survey group's sample was selected at random from the entire population of 476 items. No attempt was made to select the samples by material type in order to calculate certification statements on that basis.

5.14 - Using a "maximum allowable number of defectives" sampling plan and a pre-established certification level (95% confidence that at least 90% of the inventory items meet AEC acceptance criteria), the survey group was required to checkweigh and sample up to 125 items with six (6) allowable rejects for each gross weight, uranium, and U-235 category. This number of samples would amount to 26% of the items on inventory. Since this plan can be used on a sequential basis, it was decided to select 65 items (14% of the items on inventory) for checkweighing and sampling; the number of allowable rejects is reduced to two (2). If no more than two rejects were found, the pre-established certification level criteria would be met, and a comparable certification statement would be made.

5.15 - Finding - As was previously stated, eight (8) reject weight differences were noted after eighteen (18) items had been checkweighed. It was decided to curtail any further checkweighing at that time since the allowable number of rejects had been exceeded and the certification statement could not be made.

5.16 - The results of our sampling verification program are as follows:

	<u>Items Sampled</u>	<u>Rejects</u>
Uranium	67	45
U-235	61	30

Note: There was insufficient U-235 in six (6) samples for a % U-235 analysis, and one sample contained insufficient uranium and U-235 for analysis.

5.17 - A further breakdown of the survey group's sample results are as follows:

<u>Type Sample</u>	<u>Samples Uranium</u>	<u>Rejects Uranium</u>	<u>Samples U-235</u>	<u>Rejects U-235</u>
Whole Container Samples-Scrap	31	16	30	24
Samples from Containers-Scrap	18	16	13	5
Samples from Containers-Oxides	<u>18</u>	<u>13</u>	<u>18</u>	<u>1</u>
	67	45	61	30

5.18 - The "Whole Container Samples-Scrap" category contained low grade scrap items that had been gamma counted by the contractor. For our verification purposes, the contents of these containers were burned to an ash by the Y-12 Laboratory, and the ash sampled for uranium and U-235 analysis.

5.19 - The following reject limits were used in the above evaluation:

		Reject Limits	
		Uranium	U-235
Whole Container Samples-Scrap	$\pm 100\%$ of AEC Value))
Samples from Containers-Scrap	$\pm 40\%$ of AEC Value)) $> 20\%$ Assay $\pm 1\%$ Rel.
Samples from Containers-Oxides	$> 50\%$ U $\pm 1\%$ of AEC Value)) $> 10\%$ - 20% Assay $\pm 5\%$ Rel.
	$\leq 50\%$ U $\pm .75\%$ Uranium))

F. Losses and Material Unaccounted For (MUF)

5.20 - Losses and Loss Mechanisms - A review was made of losses and loss mechanisms at NFD. A loss mechanism flow sheet was completed during the survey. The review covers the forms of possible losses of SN material, e.g., stack losses, sewer losses, discards, write-offs, and unusual incidents. In addition, the processes and associated equipment where such losses occur, were examined by members of the survey team.

5.21 - The measurement of losses by NFD is for the most part adequate. Stack losses are periodically checked for accountability as well as for health and safety purposes. These periodic checks indicate that only minor quantities of enriched uranium are being discharged through the scrubber and stacks.

5.22 - Liquid process wastes are measured fluorometrically prior to discard to the holding pond. Each solution batch is thoroughly agitated and duplicate samples taken for analysis. The volume is determined and the solution batch released to the holding pond if the duplicate analyses agree and meet discard criteria.

5.23 - A log book is maintained on sewer and stack losses, but it was noted that these measured losses are not always reported to accountability. Until December 1965, a total estimated normal operating loss of 20 grams of uranium was reported each month. The 20-gram estimated loss per month was based on engineering calculations and was not reported after December 1965, since the jobs with which the estimate was associated were nearing completion and losses at the time were insignificant. The 20-gram uranium per month estimate appeared to be realistic but it was determined that a correction had not been made to the recorded quantities to reflect the actual measured value. NFD was requested to record and report such losses as they occur.

5.24 - Track-out of SS material at NFD is controlled through enforced showering, shoe covers, limited access and monitoring. Our review of these practices indicated satisfactory performance.

5.25 - Material Unaccounted For - An analysis of the book-physical inventory difference was made in an effort to determine the facility's over-all performance with respect to control of material, and to decide if a safeguards hazard could exist.

5.26 - After a records analysis of the ledgers and a comparison of the results of this book value with the physical inventory, we examined supporting documents and conferred with facility personnel in an effort to determine probable circumstances and causes which could contribute to the material unaccounted for experience at Facility FBV.

5.27 - The material unaccounted for by job is listed below:

<u>Job Designation</u>	<u>Customer</u>	<u>Uranium (Grams)</u>	<u>U-235 (Grams)</u>
WANL (Contract)	Westinghouse Electric Company	7,659	7,478
AVR (License)	Arbeitsgemeinschaft Versuch Reaktor	(10,589)*	(9,896)*
HTL (License)	Battelle Memorial Institute	2,907	464
LIC (License)	Union Carbide Corp., Carbon Prod. Division	<u>676</u>	<u>612</u>
	Net MUF	653	(1,342)*

*Gain.

5.28 - It is the opinion of the survey team that material cross-over has occurred between the WANL job (AEC contract) and the AVR job (leased material). The net MUF of 653 grams uranium and (1,342) grams U-235 does not appear to create a serious safeguards situation. We are of the opinion that processing contract material and leased material concurrently in such a way as to permit significant cross-over between the materials should be avoided in future operations.

G. Records and Reports

5.29 - The facility's record keeping is accomplished via a combination of external-internal general ledgers which combine the external transfers listed on AEC-101, Transfer Documents, and the assignment of the material to and from an internal area and/or process.

5.30 - The AEC-577, Material Balance Report, appears to adequately report the quantities recorded in the general ledger. However, it must be pointed out that these records reflect "book" inventories and that the physical inventories have been taken for the purpose of checking the book balances, but not as substitutions therefor.

5.31 - It is the opinion of the survey team that the record keeping system would be improved by the establishment of separate internal material balance areas; that every effort should be made to incorporate into the records in-process material, and equipment hold-up, and that credit be taken for known losses, e.g., filters, sewer losses, material vented to the atmosphere, etc. The present method of external accounting, frequently on a "by-difference" basis does not localize losses to the area and job in which the loss occurs.

H. Internal Control

5.32 - It is recognized that some effort has been expended by NFD to record initial internal assignments of SS materials. Subsequent movement has been recorded rather less precisely. We are suggesting in this report that inventory identification methods can be improved to assist in detecting unauthorized or unrecorded material transfers.

5.33 - As noted in Section G, Paragraph 5.31, it is sometimes difficult to localize losses to a plant area and job number. It is especially urged that steps be taken to eliminate cross-over of SN material between jobs, since this further complicates the problem of localizing losses.

I. Procedures Manual

5.34 - The contractor has not prepared and distributed an SS materials procedures manual, as recommended in prior Survey Number OR-211.

5.35 - It is the opinion of the survey team that incorporation of existing standard operating procedures into one volume would go far to accomplish the recommendation. Some additional writings, generally brief, concerning receipts, shipments, inventory procedures, loss mechanisms, records and reports would serve to complete in one volume an acceptable procedures manual for the control of special nuclear materials.

J. Analysis of Leased Material

5.36 - The current jobs with Arbeitsgemeinschaft Versuchs Reaktor, Julich, West Germany (AVR), the High Temperature Lattice Test Reactor, Battelle Memorial Institute, Richland, Washington (HTL), plus general license holdings for research and development, are performed under License Number SNM-724. All SN material is 93 percent isotopic ratio except the HTL which is 16 percent.

5.37 - The overall performance under License SNM-724, as itemized in the attached material balance summary, Exhibit I-A, discloses the following results:

	Uranium (Grams)	U-235 (Grams)
Beginning Inventory	-0-	-0-
Material Receipts	139,527	62,166
Material Removals	20,966	19,532
Book Inventory	118,561	42,634
Physical Inventory	<u>125,567</u>	<u>51,454</u>
Difference (Gain)	(7,006)	(8,820)

5.38 - Inasmuch as the difference on the WANL Job (under AEC contract) which is analyzed on the attached Exhibit I, is a deficiency of 7,659 grams uranium and 7,478 grams U-235, it seems apparent that a cross-over of SN material occurred between Jobs AVR (leased material Section 53) and WANL (Non-Section 53 material). According to our observation, the Lessee is already taking steps to negotiate an agreement between the parties concerned, in accordance with Article 5, Paragraph h, of the Standard AEC Special Nuclear Material Lease Agreement.

5.39 - In the opinion of the survey group, NFD should take steps to improve the material handling procedures with a view to achieving positive identification of all batches and/or in process materials so as to minimize cross-over.

Attachments:

1. Exhibit I
2. Exhibit I-A

Date: March 29, 1967

E. D. Marshall
E. D. Marshall, Chief
Nuclear Materials Control Branch

Approved:

Charles A. Keller
Charles A. Keller, Director
Production Division

Distribution:

- D.E. George, DNMM, HQ(3)
- E.D. Marshall(2)

EXHIBIT I

UNION CARBIDE CORPORATION, CARBON PRODUCTS DIVISION
NUCLEAR FUELS DEPARTMENT, LAWRENCEBURG, TENNESSEE

Special Nuclear Materials Balance Statement

July 31, 1966

FBV

OR-226

<u>Job Symbol</u>	<u>Contract No.</u>	<u>Project Number</u>	<u>Customer</u>	<u>Beginning Inventory</u>	<u>Material Receipts</u>	<u>Material^{1/2} Removals</u>	<u>Book Inventory</u>	<u>Physical Inventory</u>	<u>Difference</u>	<u>Percent Differ.</u>
WAN ^{1/1}	59-NY-46186	CL-42002-01-1	Westinghouse Elec. Corp.,	0	691202	683008	8194	535	7659	1.11
			Astronuclear Lab.	0	643680	635702	7978	500	7478	1.16

Note 1: In the quantity columns, the uranium is followed by U-235, in grams.

Note 2: A SN Material write-off of 391 grams uranium and 364 grams U-235 has been excluded from Material Removals. Consequently the book inventory, as reported here, exceeds the contractor's ledger by these quantities.

FBV

EXHIBIT I-A

OR-226

UNION CARBIDE CORPORATION, CARBON PRODUCTS DIVISION
NUCLEAR FUELS DEPARTMENT, LAWRENCEBURG, TENNESSEE

Special Nuclear Materials Balance Statement
July 31, 1966

<u>Job Symbol</u>	<u>License Number</u>	<u>Contract Number</u>	<u>Customer</u>	<u>Beginning Inventory</u>	<u>Material Receipts</u>	<u>Material Removals</u>	<u>Book Inventory</u>	<u>Physical Inventory</u>	<u>Difference</u>	<u>Percent Differ.</u>
AVR	SNM-724	NO. 7046111	Arbeitsgemeinschaft Versuchs Reaktor, Julich, W. Germany	0	50638	20966	29672 ^{/1}	40261	(10589)	(20.91)
HTL	SNM-724	JO-53280	Battelle Memorial Inst. Richland, Washington	0	47174	19532	27642 ^{/1}	37538	(9896)	(20.98)
LIC	SNM-724	NONE	Union Carbide Corporation Carbon Products Division Nuclear Fuels Department, Lawrenceburg, Tennessee	0	87845	0	87845	84938	2907	3.31
				0	14038	0	14038	13574	464	3.31
				0	1044	0	1044	368	676	64.75
				0	954	0	954	342	612	64.15

N. B. In the quantity columns, the uranium quantity is followed by the U-235, in grams.

^{/1} Our book inventory excludes a net quantity of 51 grams uranium and 45 grams U-235, a combination of "Losses" and "Measurement Imprecision" which appear as credits on the Lessee's ledger.