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MANUAL OF PROCEDURES FOR EFFECTING CONTROL OF SS MATERIALS AT STATION JWA

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IDAHO NUCLEAR CORPORATION
NATIONAL REACTOR TESTING STATION
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U. S. ATOMIC ENERGY COMMISSION

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MANUAL OF PROCEDURES FOR EFFECTING CONTROL OF SS MATERIALS AT STATION JWA

BY

F. H. Tingey
B. S. Lewis

IDAHO NUCLEAR CORPORATION

A JOINTLY OWNED SUBSIDIARY OF
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I. INTRODUCTION

This manual is written for the express purpose of outlining the basic principles and techniques necessary to establish and maintain adequate surveillance and control of all SS materials at the Idaho Chemical Processing Plant (ICPP). The intent of its authors is to present a logical, sequential approach to the management of SS materials by discussing the four basic data functions: (a) gathering, (b) observation, (c) summarization, and (d) reporting. The second function (data observation) demands close attention at the Chemical Processing Facility simply because all generated data must be carefully scrutinized and evaluated for its quantitative and qualitative properties. Consequently, an entire section of this manual will be devoted to defining limits of uncertainties in a complex system. These uncertainties are regarded as a vital and integral part of the materials-management problem because they represent the only means by which one can evaluate process irregularities, shipper-receiver differences, nuclear material losses, and plant imbalances.

The control effort applied at Station JWA is keyed to the intrinsic value of the material. Economically, it is good business practice to apply sound and, if necessary, detailed control for SS materials having a high monetary unit value. It also is sound practice to guard against the indiscriminate use of certain fissionable materials. Some typical examples would include health hazards, criticality hazards, and the hazards of the application of certain fissionable materials to military use. It is conceivable that the hazards impose a special importance on the control system over and above any economic consideration.

At the Idaho Chemical Processing Facility, the requirements and needs for successful plant operation are closely related to the requirements and needs for successful materials management. Efficient operational control forms the basis or foundation for a good control system for SS materials management while eliminating the poor economics of exerting duplicate effort to obtain the same end result. Consequently, the Nuclear Materials Management Group utilizes processing data generated by persons reporting to operations supervision and not to the Nuclear Materials Control supervisor. Therefore, only a small, well-trained staff is needed to record, evaluate, summarize, and report data quantities. It is important that a state of harmony and intercommunication exists between the two groups. This is accomplished by placing the Nuclear Materials Control Group into the proper administrative organizational structure to help effect the issuance and acceptance of procedural changes.

1. NUCLEAR MATERIAL CONTROL FUNCTIONS AND RESPONSIBILITIES

It is the duty of the Nuclear Materials Control accountant (station representative) to implement and enforce procedures applicable to the receipt handling and shipping of SS materials associated with ICPP. The procedures are implemented through Idaho Nuclear Corporation management channels by the issuance and enforcement of INP 8.15.

All material balance and inventory reports required by AEC Manual, Chapter 7400, are submitted directly to the Idaho Operations Office without Idaho Nuclear management approval. The correctness of these reports places a direct responsibility on the Chief of the Nuclear Materials Control

Group to Idaho Nuclear management. This responsibility is transmitted from Idaho Operations Office in the form of an annual survey report on the Nuclear Materials Control system in existence at station JWA. The internal control and record system is also subject to review by the Idaho Operations Office. Therefore, any deviation or alteration from AEC-approved procedures places a direct responsibility on the Nuclear Materials Control Group for corrective action. Such action in many cases may require Idaho Nuclear management attention.

Inventory management functions, including SS materials forecasting, utilization, and safeguard handling, are assigned to the Nuclear Materials Control Group. In all cases actions pertaining to these functions are approved by Idaho Nuclear management before transmittal to the Atomic Energy Commission.

The Nuclear Materials Control Office is also responsible to Idaho Nuclear management to perform audit inspection of the internal control systems and to safeguard handling practices. The auditor in charge of these surveys is required to report periodically to Idaho Nuclear management all results pertinent to the audit findings. Therefore, corrective action needed is brought to Idaho Nuclear management attention for the implementation, alteration, or enforcement of existing procedures.

II. STATION JWA NUCLEAR MATERIALS CONTROL TECHNOLOGY

1. SCOPE

The Idaho Chemical Processing Plant was designed to recover highly enriched uranium from spent fuel elements alloyed with other materials such as aluminum, zirconium, or stainless steel. The particular processing procedures for any given fuel are determined by the alloying constituents involved. Two basic types of processing are performed: either batch or continuous processing. The choice of either of these processing techniques is dependent upon the volume of fuel to be processed. Each process consists of dissolution of the elements followed by solvent extractions for recovery and purification of the uranium. The product of the recovery plant is an aqueous solution of uranyl nitrate, with a radioactivity level essentially that of virgin uranium.

The material control aspects included in this manual will cover the entire processing facility in addition to the fuel storage basin, waste storage facilities, auxiliary plants, and research- and chemical-analysis laboratories.

Nuclear Materials Control surveillance requires a perpetual and continual observation of all fuel-element movement and process flows. The observation must be compatible with a systemized inventory procedure to verify and acknowledge the plant inventory at specific intervals. The continual effort necessary to perform these functions is dependent upon the combined efforts of Nuclear Materials management, safeguards, operations, security, and technical personnel. The Nuclear Materials Control organizational structure now effective for station JWA is outlined in Figure 1. It should be noted that, as a section of the Operations Analysis branch, the Nuclear Materials Control Group has a direct line to the project manager. It is, therefore, possible to cross organizational lines to implement control procedures. It should be stated here, however, that the control group does not carry the direct responsibility for physical assignment and handling of SS material. This responsibility is assigned the operations and technical personnel who assume custody in the various facets of the operation. These people are directed by written procedure (INP 8.15) to issue the necessary paper information to the Nuclear Materials Control Group. It is therefore mandatory that the ICPP complex be divided in specific geographical boundaries (Material Balance Areas) for the purpose of defining custodial responsibility.

2. CONTROL OF MATERIAL FLOW AT STATION JWA

2.1 Material Balance Area Accounting

The control process from a records point of view is designed to reflect SS material movements and inventories for the recovery process and all associated auxiliary laboratories. To properly segregate the various process functions into geographical boundaries, a record system was designed to reflect inventory control by designating each geographical location as a material balance area. SS material transfers affecting more than one material balance area must be regarded as an official "Within-Area Transfer" movement and

Fig. 1 Organization chart.

must be represented by an internal transfer document provided for that purpose. Therefore, for the purpose of this manual, the words "Within-Area Transfer" will be defined as a movement of SS material from one material balance area to another, rather than a movement of SS material within a particular material balance area.

Each material balance area has been assigned a numerical prefix for the purpose of describing SS material movements numerically rather than descriptively. The material balance areas and their coded designations are listed below.

<u>Material Balance Area</u>	<u>Area Code</u>
SS Storage Basin and Process Dissolvers	110
Chemical Engineering Design	210
Process Recovery	310
Analytical Laboratories	510
Waste Storage Tank Farm	710
Product Storage Vault	810
Chemical Development Laboratories	910

The pictorial diagram depicting the various material balance areas and all required SS material movement transfer points is shown in Figure 2. Each coded

ENRICHED PROCESS STREAM SS MATERIAL ACCOUNTABILITY
FOR
CPM, STAINLESS STEEL AND ZIRCONIUM

STREAMS REPRESENTED BY ——— REQUIRE PREPARATION OF SS MATERIAL TRANSFER
STREAMS REPRESENTED BY - - - - - REQUIRE PREPARATION OF PRECODED SS SAMPLE TRANSFER FORM TO ACCOMPANY SAMPLE TO LABORATORY

Fig. 2 Flow diagram -- signifying SS material transfer stations.

transfer series (110-302, etc) is represented by an internal material transfer form of the same series code. The generation, calculation, grouping, and disposition of these transfer forms will be discussed in a later section of this manual under the section "Within-Area Transfer Forms and Journals".

The solid lines shown denote a bulk material transfer. Dotted lines denote the routine transfer of uranium sample solutions to the various laboratories.

2.11 Receiving (110 Area). The fuel storage basin is located inside a large corrugated steel building which accommodates both motor freight vehicles and freight trains. All spent fuel is transferred to the basin in shipping casks designed to shield against radiation hazards. The casks are lowered by crane into the basin (approximately 20 feet) where the fuel is removed. After removal, the fuel is counted, identified, and transferred to storage buckets until processing is scheduled. The storage buckets are attached to bucket yokes hanging from the storage basin ceiling fixtures. Each yoke can be transferred to any location within the storage basin by simply manipulating the yokes along the various ceiling tracks provided. When processing is scheduled, the fuel is removed from the buckets and transferred back into shielded casks for transfer to the processing building.

2.12 Process Recovery (310 Area). The process-recovery material-balance area includes only the chemical processing vessels used in the recovery process. Definite boundaries segregate laboratory functions, product storage, and waste disposal tanks. See Figure 2 for process recovery parameters.

2.13 Waste Storage (710 Area). The waste-storage material-balance area consists of large underground storage tanks located behind the main processing building. All processing waste solutions are collected and measured in the process recovery vessels before they are transferred to storage tanks. First-cycle extraction wastes are stored in cooled, stainless steel, underground storage tanks. All second- and third-cycle extraction wastes are blended and combined with other process and laboratory wastes and stored in uncooled, stainless steel, underground tanks.

2.14 Product Storage (810 Area). The product-storage material-balance area includes the product withdrawal and sampling room and the product storage vault. Uranium nitrate solutions are held here awaiting shipment to other AEC facilities.

2.15 Analytical Laboratories (510 Area). This material balance area includes all processing laboratories directly associated with the recovery process. These include control, spectrochemical, analytical, mass spectrometric, and radio chemical laboratories.

2.16 Research and Development (910 Area). This material balance area includes only those laboratories associated with research and development studies.

III. RECORDS SECTION

1. EXTERNAL SOURCE DATA

1.1 Out-of-Area Transfer Form AEC 101-284 (Figures 3 and 4)

Form AEC-101 is used to transfer SS material between two Nuclear Materials Management SS Stations. The form is designed to contain a complete description of the SS material including auxiliary information relating to weights, analytical methods, uncertainties, and signatures. It provides space for both the receiver's and shipper's data. The SS weighted values shown on the 101 form are posted to the "Out-of-Area Transfer Journal", a book of original entry. (This journal will be discussed fully in a later section.)

Detailed instructions concerning AEC-101 transfer forms are found in the Nuclear Materials Management Handbook for Control of SS Material issued by the Headquarters Division of Nuclear Materials Management (Appendix 7401). This manual covers all phases of the distribution, numbering, description, measurement methods, limits of uncertainty, adjustments, and corrections, etc, in the issuing and receiving of AEC-101 transfer forms.

In addition to instructions issued in the above-mentioned handbook in the issuance of 101's, only one material type per AEC-101 is permitted except in cases of absolute necessity. Experiments contained in a single unit with several material types inserted are often shown on a single AEC-101 transfer form. Enclosed in parentheses in the lower left hand corner of the last page of the 101, the month followed by the initials "MBR" is inserted to denote the reporting period to which the 101 was transferred to the station. All incoming 101's will contain the same statement in the lower right hand corner except those transfers involving fuel stored for processing. These transfer forms are held for processing measurements (receiver's data). Acceptance of the material based on SS weight measurements is performed at a much later date. Therefore, immediately upon receipt of the material, the station representative issues form AEC-284 accepting piece count, or container count individual element verification and distributes the same to all offices awaiting receipt of the AEC-101 transfer form involved.

1.11 Classification and Documentation of Form AEC-101. There are two types of classifications covering AEC-101 forms. These are "Secret" and "Confidential". The first classification (secret) is documented and the second (confidential) can be either documented or undocumented. The secret or confidential markings are placed at the top and bottom of the document, preferably in the center. The first page of each form AEC-101 must be stamped with a "Restricted Data" stamp regardless of which classification is used. In addition, all classified documents must contain the "Group I" stamp on the first page of the document. All copies, except JWA's file copy, are transmitted with documentation to Idaho Nuclear Corporation's document control section (via AEC courier) for distribution. An exception is made to the above rule when the product is shipped from JWA. In this case, the secret AEC form 101 is documented on a document receipt. The receipt number is assigned by the document control center. The receipt (Figure 5) is then completed as if the SS Nuclear Materials Management Section were the Document Control Section. Copies 1, 2,

16-75751-1 GPO

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and 3 of the document receipt are transmitted with AEC-101 copies 1, 2, 3, 5, and 6 to the receiver. Copy 4 of the document receipt is sent to the Document Control Section for file purposes. The AEC-101's and the three copies of the document receipt are placed in an envelope marked Secret and Restricted Data

FORM AEC-124 (11-57)			
UNITED STATES ATOMIC ENERGY COMMISSION			
SS MATERIAL TRANSFER RECEIPT			
SS MATERIAL ON TRANSFER	FROM (STATION SYMBOL)	TO (STATION SYMBOL)	NO. <div style="border: 1px solid black; width: 100px; height: 20px; margin-top: 5px;"></div>
SHIPPING DATE		DATE RECEIVED	
MATERIAL HAS BEEN VERIFIED AS FOLLOWS (CHECK ONE):			
PIECE COUNT ☐		CONTAINER COUNT ☐	
OTHER: _____		GROSS WEIGHT CHECK ☐	

SHIPPER'S WEIGHTS AND SS CONTENTS ARE ACCEPTED PENDING FINAL VERIFICATION MEASUREMENTS AND COMPLETION OF FORM AEC-101.			
BY _____		(ACCOUNTABILITY REPRESENTATIVE)	

Sender's Receipt No.	Document No.	Copy No.(s)	Copies	Series	Date of Doc.	Class
		of				
Date of this Receipt	Remarks: IDAHO NUCLEAR CORPORATION CLASSIFIED DOCUMENT RECEIPT AED FORM 32 - REVISED 2/55					
☐ R & D Report						
☐ Other						
TO:		FROM:				
I have personally received the material identified above, and assume full responsibility for its safe handling, storage, transmittal elsewhere, and/or return in accordance with existing security regulations.						
1	SENDER FORWARDS WITH DOCUMENT RECIPIENT SIGNS AND RETURNS TO DOCUMENT CONTROL					
		Signature _____ Date Document Received _____				

front and back. The envelope is then sealed, addressed, and placed in a plain, unmarked, unaddressed envelope. This package is given to the AEC courier accompanying the shipment. The courier (in return for the package) gives the SS Nuclear Materials Management Section a signed courier receipt (Figure 6).

1.12 Application of Receiver's Measurements. SS material received at Station JWA for process recovery is usually stored several months prior to processing. ICPP measurements are obtained from dissolved fuel batches numbered in sequential-run-code order. The volumetric and analytical data representing each fuel batch are entered on an internal transfer form (110-302) and transmitted to the Nuclear Materials Management Control Office for contained uranium calculations. This transfer form will be discussed in detail under the section "Within-Area Transfer Forms." The SS material recovered in each processing run frequently represents several reactor fuel cores received from various reactor operators. Therefore, the ICPP measurement data for each AEC-101 transfer series is entered in total on the last AEC-101 in each vendor series.

Under present methods of plant operations, the spent reactor fuels containing uranium alloyed with aluminum are processed by the continuous dissolution method eliminating dissolver batch processing. For economic reasons, it was found desirable not to perform a dissolver cleanout between fuel types such as MTR, ETR, PWR, LPTR, OWR, etc. Consequently, an ICPP measurement allocation problem exists for each fuel type before the total measured values can be applied to each AEC-101 transfer series. When a particular reactor fuel type is measured with prior and subsequent dissolution cleanout, ICPP measurement values are quoted with associated limits of uncertainty at the 95-percent confidence level. However, it is impossible to apply measurement uncertainties to dissolved fuel batches where batch dissolution overlap occurs between two different fuel types. The proration problem existing because of dissolution overlap can be solved only through fission stoichiometry. This procedure is based on two primary assumptions: First, the pre-irradiated total uranium content and isotopic enrichment distribution must be known. Second, the post-irradiated distribution must be known and must be representative of each fuel type. This distribution is obtained from weighted assay enrichments reported on the coarse-feed batch samples. If the above conditions exist, one can predict (on the basis of residual mass-distribution measurements) the residual U-235 content for each fuel type or segment. Such predicted values can then be used to determine a set of factors which, when normalized (ie, divided by the sum of all factors), provide prorating factors for the total measured residual U-235. This procedure assumes a constant value for α (capture to fission ratio) which is associated with the reactor involved.

The factors are determined by the relationship

$$f_n = f_n^1 - f_n^0 - 1 \qquad n = 1.2. \dots k$$

where

k = the number of participants, and the subscript designates the ordered sequence or cores processed in addition to a particular vendor's segment of material, $f_0 = 0$

$$f_n^1 = \frac{U_o (1 + \alpha - E_o)}{\frac{1 + \alpha}{E_1}} = U_o E_o \left[\left(\frac{1 + \alpha}{E_o} - 1 \right) \left(\frac{1 + \alpha}{E_1} - 1 \right) \right]$$

U_o = cumulated cold-uranium content of all cores up to and including the n^{th} processed

E_o = weighted-average cold-enrichment (U-235) fraction identified with all cores up to and including the n^{th} processed

E_1 = residual weighted-enrichment fraction determined from all processing batch measurements including those corresponding to the n^{th} processed

α = capture-to-fission cross-section spectrum average for U-235.

From extensive processing data this value has been estimated to be 0.185 ± 0.008 for a thermalized reactor. The actual prorating factors are

$$\frac{f_n}{k} = F_n$$

$$\sum_n F_n = 1$$

In cases where the two necessary conditions of proration by fission stoichiometry of U-235 are not met, proration is based on post-irradiated reactor values. In using this method the SS Nuclear Materials Management Section must make sure that the vendor is transferring the material to Station JWA at post- rather than pre-irradiated values. Also, one must be certain that the vendor has applied his burnup data correctly by allowing for the capture-to-fission buildup of the U-236 isotope. The only way to insure the above conditions are met is to obtain the pre-irradiated fuel values. One must also assume that all reactor operators are equally accurate in calculating burnup and fission loss. The proration is then made on the basis of the ratio of the individual vendor's post-irradiated values to the sum total of all vendors' post-irradiated values processed during the run. The ratio thus obtained for each respective reactor is applied to the total JWA measured values. The value thus obtained is then placed on the form AEC-101.

Details for filling out the receiver's section of form AEC-101 and its distribution are given in the Nuclear Materials Management Handbook for Control of SS Material (Appendix 7401).

1.2 AEC-388 Transfer Form (Figure 7)

When SS materials are transferred between licensees or SS Stations and licensees, the transfer is effected by the use of a lease-material transfer form AEC-388. The Nuclear Materials Management Handbook for the Control of SS Material (Appendix 7401, Subsection G2.0) will give all details necessary for the issuance and distribution of these forms. However, procedures for handling AEC-388 transfer forms representing commercial fuel shipped for processing are not adequately covered in the above manual. Therefore, a summary of the special handling procedures required in these cases will follow:

COURIER RECEIPT

N- 1851

I have received: No. of envelopes No. of packages No. of containers

Transmitted by
(Name and address of sender)

Addressed to
(Name and address of addressee)

Identified as follows:
.....
.....

(Name of person from whom received (if courier, include
Courier Card Number))

(Signature of recipient (if courier, include Courier Card Number))

GPO 16-58893-1

(Place of transfer)

(Date)

Fig. 6 Courier receipt.

Commercial fuel deliveries to the ICPP are covered by contract between the Atomic Energy Commission and the licensee. Idaho Nuclear Corporation acts merely as an agent of the Atomic Energy Commission. As each fuel shipment is received at Station JWA, the accompanying form AEC-388 (four copies) is signed and dated. This signature merely indicates acknowledgment of receipt of the shipment. Three signed copies are transmitted to the Idaho Operations Office. The fourth copy is retained by the station representative as a memo copy for filing. Uranium values for these shipments are not transferred to the AEC contract records but are posted to a memo account for future verification. After the complete fuel segment delivery has been made (as defined in the contract terms) the Idaho Operations Office notifies the station representative and the representative in turn prepares eight copies of form AEC-388 (see sample, Figure 8), entering the shipper's SS weight values for all shipments covered in the contract delivery specifications. This transfer form may show values representing several AEC-388's previously received but not accepted. The station representative in turn checks Block 9.C indicating the return of licensee material to the AEC for credit, see Sections 11 and 12, and likewise enters the date the last shipment was received in the contract schedule. At this time the words "data are provisional" are written across the face of form AEC-388 indicating that the shipper's values will be forwarded to the AEC contract-material records but will be subject to change pending completion of ICPP dissolution measurements. Six copies are mailed to the Idaho Operations Office for distribution. One copy is retained in the Idaho Nuclear Materials Management files. The remaining copy is mailed to Idaho Nuclear Corporation Finance Division.

When the ICPP input measurement data are available, another AEC-388 transfer form is generated correcting the provisional transfer form previously issued. This correction is issued to reflect the ICPP input-processing measurement values. In addition, the S/R difference is entered directly below the receiver's values. A statement defining the receiver's values as being a product of ICPP dissolution is written across the face of the form. Sections 9C, 11, and 12 are completed in the same manner as shown in the provisional acceptance. (See Figure 9 for sample of completed form.)

UNITED STATES ATOMIC ENERGY COMMISSION
SS MATERIAL TRANSFER FORM—LEASED MATERIAL

1. Transfer Series: A. _____ B. _____ C. _____ (From) (To) (Number)							
2. Shipped by (Shipper): Name _____ Address _____	3. Shipped to (Receiver): Name _____ Address _____						
4. Shipped for Account of: Lic. No. _____ Name _____ Address _____ Lease No. _____	5. Shipped to Account of: Lic. No. _____ Name _____ Address _____ Lease No. _____ Order No. _____						
6. (For AEC Use Only): Nuclear Material Draft (Form AEC-437) Number _____	7. SS Material (Check One): (A) Enriched Uranium () (B) Uranium-233 () (C) Plutonium () (D) Other _____ ()						
8. Material Description: 	9. This Transfer Involves: (A) Initiating lease responsibility () (B) Transfer of lease responsibility () (C) Return to AEC for credit () (D) No change in lease responsibility () (Transfer of material only)						
	10. Material Quantities: A. Weight Units _____						
B. Container No.	C. Piece Count	D. Gross Weight	E. Tare Weight	F. Net Weight	G. Element Weight	H. Weight % Isotope	I. Isotope Weight
Totals							
11. The Items and Quantities Listed Above Were Shipped: On _____, 19_____ _____ (Shipper's Signature)				12. The Items and Quantities Listed Above Were Received: On _____, 19_____ _____ (Receiver's Signature)			

16-76001-2

Fig. 7 AEC-388.

UNITED STATES ATOMIC ENERGY COMMISSION
SS MATERIAL TRANSFER FORM—LEASED MATERIAL

1. Transfer Series: A. IDAHO NUCLEAR CORP. B. JWA C. 1 (R-4) (From) (To) (Number)							
2. Shipped by (Shipper): Name IDAHO NUCLEAR CORPORATION Address P. O. Box 2067, Idaho Falls, Idaho	3. Shipped to (Receiver): Name IDAHO NUCLEAR CORPORATION Address P. O. Box 2067, Idaho Falls, Idaho						
4. Shipped for Account of: Lic. No. R-4 Name Battelle Memorial Institute Address 505 King Avenue, Columbus, 1, Ohio Lease No.	5. Shipped to Account of: Lic. No. Name USAEC, Idaho Operations Office Address P. O. Box 2108, Idaho Falls, Idaho (For AEC Use Only): Lease No. Order No.						
6. (For AEC Use Only): Nuclear Material Draft (Form AEC-437) Number	7. SS Material (Check One): (A) Enriched Uranium (X) (B) Uranium-233 () (C) Plutonium () (D) Other ()						
8. Material Description: 121 MTR Fuel Type Elements	9. This Transfer Involves: (A) Initiating lease responsibility () (B) Transfer of lease responsibility () (C) Return to AEC for credit (X) (D) No change in lease responsibility () (Transfer of material only)						
10. Material Quantities: A. Weight Units Grams							
B. Container No.	C. Piece Count	D. Gross Weight	E. Tare Weight	F. Net Weight	G. Element Weight	H. Weight % Isotope	I. Isotope Weight
(121) MTR Fuel Elements from	five (5) Shipments				17,428.03	89.063	15,521.91
Data Provisional							
July MBR							
Totals					17 428.03	89.063	15,521.91
11. The above items and quantities shipped On 6-21-63, 19... Ralph A. Duce (Shipper's Signature)				12. The above items and quantities received On 6-21-63, 19... Ralph A. Duce (Receiver's Signature)			

Fig. 8 AEC-388 -- provisional acceptance.

UNITED STATES ATOMIC ENERGY COMMISSION

SS MATERIAL TRANSFER FORM—LEASED MATERIAL

1. Transfer Series: A. IDAHO NUCLEAR CORP. B. JWA C. 1cc (R-4)							
(From)	(To)						
2. Shipped by (Shipper): Name IDAHO NUCLEAR CORPORATION Address P. O. Box 2067, Idaho Falls, Idaho	3. Shipped to (Receiver): Name IDAHO NUCLEAR CORPORATION Address P. O. Box 2067 Idaho Falls, Idaho						
4. Shipped for Account of: Lic. No. R-4 Name Battelle Memorial Institute Address 505 King Avenue, Columbus 1, Ohio Lease No.	5. Shipped to Account of: Lic. No. IDA Name USAEC, Idaho Operations Office Address P. O. Box 2108 Idaho Falls, Idaho Lease No. Order No.						
6. (For AEC Use Only): Nuclear Material Draft (Form AEC-437) Number	7. SS Material (Check One): (A) Enriched Uranium (X) (B) Uranium-233 () (C) Plutonium () (D) Other ()						
8. Material Description: 121 MTR type elements	9. This Transfer Involves: (A) Initiating lease responsibility () (B) Transfer of lease responsibility () (C) Return to AEC for credit (X) (D) No change in lease responsibility () (Transfer of material only)						
10. Material Quantities: A. Weight Units							
B. Container No.	C. Piece Count	D. Gross Weight	E. Tare Weight	F. Net Weight	G. Element Weight	H. Weight % Isotope	I. Isotope Weight
121 MTR Fuel elements received in five (5) shipments					17,522	88.625	15,529
					± 270		± 240
		S/R difference			(94)		(7)
(Adjustment for processing values on October 1963 MBS) Uranium data are determined from dissolved fuel batches by the isotopic dilution method of analyses, and U-235 concentration obtained from mass spectrometer. Material was processed in July 1963. This correction issued to change reactor values reported on Form PPCo-CPI-1 to CPP in-put data. Above values have been accepted by Battelle Memorial Institute, Refer to letter W. A. Erickson to R. W. Scott.							
Totals					17,522	88.625	15,529
11. The Items and Quantities Listed Above Were Shipped On 6-21, 1963 R. A. Duce/ (Shipper's Signature)				12. The Items and Quantities Listed Above Were Received On 6-23, 1963 R. A. Duce/ (Receiver's Signature)			

Fig. 9 AEC-388 -- final acceptance.

2. INTERNAL SOURCE DATA

2.1 Receiving Report and Intra-Bucket Transfer Record (AED-261)

2.11 Purpose. This form (AED-261) was designed to serve a two-fold purpose. Namely, to record fuel transfer data associated with all incoming irradiated fuel shipments and to record all fuel transfer data associated with the intra-bucket transfer of irradiated fuel elements located in the SS storage basin facility. The form is always prepared (in duplicate) by the storage basin operator and co-signed by his respective supervisor.

The basin inventory consists of systematically arranged, numerically assigned storage buckets hanging approximately 20 feet below water level, each accommodating prescribed loadings of fuel-core sections (slugs, assemblies, elements, etc). Inventory control processes, therefore, consist primarily of fuel buckets (by number) and individual fuel-element identification contained therein. The receiving and intra-bucket transfer record (AED-261) reflects these inventory transactions and is used by the operations division as a backup document for assigning and segregating fuel cores, compositions, types, etc, for future process batching. The original copy of AED-261 is forwarded to the Nuclear Materials Management Group for concurrence and verification with AEC-101 transfer data. The SS content of each fuel bucket is not recorded on the form proper but is transferred from AEC-101 transfer form to IBM subsidiary records showing SS values, receiving dates, AEC-101 transfer series numbers, bucket numbers, individual-element identifications, discharge dates, etc. These records are discussed in a separate section of this manual.

2.12 Description (Figure 10). Descriptively, form AED-261 is self-explanatory. The bucket numbers and gross, tare, and net weights are obtained from the Howe teleprint scale. The form is inserted into the printing slide machine until the appropriate line is observed. For instance, line numbers 1, 4, 7, 10, etc, will print gross bucket weights whereas line numbers 2, 5, 8, 11, etc, print tare weights (yoke with empty bucket). Element identification for each bucket is recorded in the spaces located directly to the right of the bucket weights. The lower portion of the form (Section I) is used for the basin storage operator's and supervisor's signatures to verify receipt of fuel. Section II is reserved for operator signature upon completion of an intra-bucket transfer of fuel elements. The box in the lower right hand corner is a posting memorandum signifying the posting of AED-261 to the IBM subsidiary ledger (IBM cards).

2.2 Materials Requisition (AED-256)

The Materials Requisition Sheet was designed to record batch transfer data for irradiated fuel elements and assemblies leaving the SS storage basin for process dissolution (Figure 11). The form has been divided into four major sections serving the following functions: Section I is completed by the Operations supervisor showing material type and bucket number requested. This information is obtainable from predetermined batching schedules generated several days prior to a processing run. Section II is completed by the storage basin operator at the time the bucket or buckets are transferred to the fuel casks for transmittal to the processing building. The operator then enters the charge number, signature, time, and date. Section III is reserved for completion by the process operator transferring the elements to the charging cave and dissolvers. This operator completes Section IV showing the content of the charge cask, the

- ☐ I Interplant Carrier Unloading Record
☐ II Inter Bucket Transfer Record

No. _____

Date _____

Material Type			From	To	Number	Cask Number		
Batch No.	Bucket No.	Weight (Kg.)	Individual Element Identification or Count					
<u>1</u>		G						
<u>2</u>		T						
<u>3</u>		N						
<u>4</u>		G						
<u>5</u>		T						
<u>6</u>		N						
<u>7</u>		G						
<u>8</u>		T						
<u>9</u>		N						
<u>10</u>		G						
<u>11</u>		T						
<u>12</u>		N						
<u>13</u>		G						
<u>14</u>		T						
<u>15</u>		N						
<u>16</u>		G						
<u>17</u>		T						
<u>18</u>		N						
<u>19</u>		G						
<u>20</u>		T						
<u>21</u>		N						
<u>22</u>		G						
<u>23</u>		T						
<u>24</u>		N						

I. This constitutes an accurate record of materials transferred to the CPI SS Storage Area. Operator _____ I. This certifies acceptance of responsibility for the above listed materials placed in the CPI SS Storage Area. Supervisor _____	II. The above listed material was transferred within the CPI SS Storage Area from bucket(s) "A" to bucket(s) "B". Operator _____	Posted to Container Stock Ledger: Clerk _____ Date _____ Audited by: Clerk _____ Date _____
---	---	--

Fig. 10 AED-261 -- SS storage unloading record.

I SS MATERIAL REQUISITION

No. 10301

Date _____

Material Classification	No. of Fuel Elements Requested _____	Storage Bucket Nos. _____
		Requested by _____

II CHARGER LOADING RECORD — Material Removed From SS Storage

Batch No.	Bucket No.	Weight (Kg.)	Individual Element Identification					
3	G							
4	T							
5	N							
6	G							
7	T							
8	N							
9	G							
10	T							
11	N							
Charger No. _____ Loaded by _____ Time _____ Date _____								

III INTRAPLANT TRANSFER — CHARGER TO DISSOLVER

Contents of Charger No. _____ Charged to Dissolver No. _____

Slug Count _____ Time _____ Date _____ Batch _____

Operator _____

IV SS DEPARTMENT ENTRIES (All space below reserved for the SS Department)

Batch Number	Canned Weights		MWD Factor	Net Irradiated Weights	
	SS Net	U-235		SS Net	U-235
Totals					

Audited by _____ Date _____ Calc. by _____ Date _____

Posted to: Cont. Stk _____ Date _____ T. J. _____ Date _____

Fig. 11 AED-256 -- SS material requisition.

elements charged, dissolver number or dissolver line, time, date, batch number, and signature. The original copy is transmitted to the Nuclear Materials Control Office.

2.3 Within-Area Transfer Forms

2.31 Purpose. The Within-Area Transfer forms mentioned in Section 2.1 of this manual are basically identical with the exception of the transfer code serial number located in the upper right hand corner. Each code series identifies the shipping and receiving measurement station of two respective material balance areas. A detailed description of the use of each transfer series is shown in Table I.

As shown in Table I, the Sample Transfer, Sample Request, and Material Transfer Forms are precoded with the appropriate SS code number to identify the various material control transfer stations. Nuclear Materials Management can observe all batch transfers throughout the process by reading the SS code series or operational-run code designations. No attempt has been made to serially number each transfer series. The control mechanics are based entirely on proper operational-run code sequence (serially numbered batches). For example, should an operator fail to complete the precoded transfer form for a particular batch transfer, a break in the numerical-run code batch sequence would be evident. The control accountant observing this violation would promptly notify the ICPP Operations supervisor that paper work has been omitted.

2.32 Description. The Within-Area Transfer Forms are used to record chemical processing data by batch sequence for the purpose of calculating and accumulating SS material inputs and outputs (by weight) for periodical summarization of process SS material imbalances. The input-measurement transfer forms (110-302) not only provide accumulated uranium charges to the processing plant but also contain valuable information of an analytical nature for evaluating reactor burnup data. A sample of this form, Report of Material Transfer and Sample Analysis, is shown in Figure 12. The upper half of the transfer form is completed by the chemical operator at the time each batch transfer takes place. All data relating to batch description and volumetric calculation are entered for the transfer form directly from process instrumentation. The lower portion of the form is reserved for analytical requests and determinations. The chemical operator checks the left hand margin indicating the various analytical measurements required. A small sample of the batch solution is withdrawn from the measurement tank and transferred to the analytical laboratory with the 110-302 transfer form. After the analytical requests have been completed, the laboratory log clerk transfers the data to the lower portion of the form directly adjacent to the check marks entered by the chemical operator. The original is transferred to the Materials Management Group. The duplicate is retained by the analytical laboratory. The box located in the upper half of the transfer form is reserved for uranium batch calculation performed by the Nuclear Materials Control accountant. The batch calculation formulas for all pertinent process vessels are included in the measurement section of this manual.

The Within-Area Transfer Forms representing process waste transfers are generated in duplicate, processed, distributed, and calculated in the same manner described for input measurements. These forms are labeled 330-710, 335-710, and 340-710 (Figure 13). Since the three waste transfer series are identical with the exception of the transfer code, only one example was included.

TABLE I
DESCRIPTION OF USE OF TRANSFER SERIES

<u>SS Code</u>	<u>Operational Run Code Number</u>	<u>Description of Material Flow</u>
110-302	1 Fu	Dissolver solution transferred to feed run tanks (unadjusted) for input measurement, C-102, C-152, D-102, D-152, G-105, G-155.
330-710	1 Arm	First cycle raffinate transferred from U-129, U-130, G-115, G-116 to deep tanks.
335-710	PEW	Waste streams collected in WG-101, WH-100 from process equipment waste and transferred to the deep tanks.
340-710	II Arm	Second- and third-cycle raffinate streams collected in Y-140 and transferred to deep tanks.
380-810	III PM	Product transferred from storage banks Z-101, Z-104, and Z-107 to product and product reference sample bottles (product storage area).
360-510	II and III BP	Second- and third-cycle flowing stream extraction complex transferred to laboratory for analysis. Also includes Z cell samples.
380-510	III PM	Product bottle samples transferred to the Analytical Laboratory for analysis.
810-510	III PM	Product samples transferred to the laboratory after the product has been officially transferred to the product storage area.
510-310	None	Salvage accumulated in the analytical laboratory and transferred to process for recovery.
Uncoded	N. A.	Used for the transfer of SS samples or transfers which do not affect a designated material balance area.

The output Report of Material Transfer and Sample Analysis, commonly called the Product Transfer Form, is used to record all data pertaining to the description and calculation of product solutions generated in the recovery process. The form (Figure 14) is identical to those previously mentioned in the sense that operational data are entered in the top portion of the form while the lower portion is reserved for analytical determinations. The transfer code 380-810 is used for signifying both product bulk transfer and product reference

IDAHO NUCLEAR CORPORATION

MATERIAL TRANSFER CODE

REPORT OF MATERIAL TRANSFER & SAMPLE ANALYSIS

FROM 330 TO 710

Sample Code _____ Lab Log No. _____
 Charge Account ☒ _____ ☐ _____ ☐ _____ Date _____ Time _____
 Est. Activity _____ mr hr Rec'd _____ Logged _____ Process Engineer _____
 Total Sample Vol. _____ ml. Sampled by _____ Shift Supervisor _____

Vessel No. _____	Vessel Temp. _____ °C	Material _____
I. Liquid Level _____	X _____ = _____ = _____ (D ¹)	Units (check): ☐ l ☐ g
Specific Grav. _____	X _____ = _____ = _____ (D ¹)	_____ G
II. Liquid Level _____	X _____ = _____ = _____ (D ²)	_____ T
Specific Grav. _____	X _____ = _____ = _____ (D ²)	_____ N
III. Amount Transferred	Vessel Calibration Equation: Vol. = _____ + _____ (Depth)	
Volume _____	NX _____ X _____ = _____	
IV. Remarks:	Calc. _____ Ckd. _____ Post: _____	
	THIS SPACE FOR SS	

Determinations Desired	Sample Results				Units
			Average		
U					mg/g
U					mg/ml
Sp. Gr.					FD
t°C 20°C	@ °C	@ °C	@ °C		WB P
Acid or					NA NB
Acid. Def.					
Mass 234					Wt. %
A 235					Wt. %
B 236					Wt. %
C 238					Wt. %
Red Norm					N
a					c/m/ml
β					c/m/ml
Beta Ratio					
γ (icn ch.)					Ra eq./ml
Pu					c/m/ml
Ru					c/m/ml
Nb					c/m/ml
Zr					c/m/ml
Ce					c/m/ml
Spectrochem (Results attached)					

Results Recorded by _____ Rpt. Ckd. _____ Date _____

Distribution:

White (Original) — Accountability

Pink — Analytical Laboratory

Fig. 13 Report of material transfer and sample analysis.

is forwarded to the Nuclear Materials Control Office. The duplicate is retained by the analytical lab. The triplicate copy remains with the originator.

A few SS material transfers occur where process vessels are not concerned. These transfers include within-area movement of SS material from laboratories to the plant for reprocessing. The uranium to be recovered is usually collected in polyethylene or glass carboys. The Within-Area Transfer Form covering transfers of this nature is shown in Figure 15. The original is forwarded to

From To

510

310

REPORT OF SS MATERIAL TRANSFER

Run Code No. _____ Log. No. _____ Date _____

Vessel No. _____ Vessel Temp. _____ °C Material _____

I. Liquid Level _____	X _____ = _____	Units (check): ☐ l ☐ g
Specific Grav. _____	X _____ = _____ (D ₁)	_____ G
II. Liquid Level _____	X _____ = _____	_____ T
Specific Grav. _____	X _____ = _____ (D ₂)	_____ N
III. Amount Transferred	Vessel Calibration Equation:	
Volume _____	Vol. = _____ + _____ (Depth)	
IV. Equity Transferred	N X _____ = _____ X _____ = _____	L. E. = _____
	Calc. _____ Aud. _____ Post. _____ TJ _____ BUC _____	
	THIS SPACE FOR SS DEPARTMENT USE	

V. Remarks:

Sampled By: _____ Sample Transfer Code _____

Shipping Sup: _____ Material Rec'd By: _____

Fig. 15 Report of SS material transfer.

2.4 Adjusting Journal Entry Form (Figure 17)

The Adjusting Journal Entry Form is used to record corrections to previously applied values. Bias corrections to internal transfer values are typical examples of the use of this form. The adjustment reflects changes in two or more material-balance area inventories. Each journal entry is given a reference number for posting which reflects the month the entry was made and the number of the entry in that month. For example, J.E. No. 7/6/64 would indicate the sixth entry made in July 1964. All journal entries are transferred directly to the Material-Balance Summary Ledger. This ledger is discussed in the manual section titled Journals and Ledgers.

2.5 Transfer Form ID-164

This transfer form is used by the SS material custodian for those transfers (laboratory and research and development quantities) which occur between and among the various laboratories. In general, its use is to record SS material movement transactions which cannot feasibly be handled by the precoded transfer-series forms. A copy of the form and its distribution is shown in Figure 18.

2.6 INC 249 -- SS Materials Expended in Research

All SS materials expended in research or lost accidentally are reported by the custodian on form INC-249. The expenditure may be routine in nature or anticipated at various time intervals. In either case it is the duty of the SS materials custodian to prepare INC-249 by completing Section I. The description of SS material being expended must be sufficient to aid the Nuclear Materials Control accountant in identifying such items with an inventory account. In addition, he must also justify the reasons for the expenditure.

Section II is completed by the SS materials representative of Station JWA. The Nuclear Materials representative then transfers the form to ID Nuclear Materials management for approval. The distribution of INC-249 is shown in Figure 19.

ADJUSTMENT JOURNAL POSTING SHEET

Year _____

Fig. 17 Adjusting journal entry form.

2.81 Preparation and Distribution. The SS materials custodian requesting disposal of the material originates four copies of form ID-110 and completes Section I. After completion, all copies are forwarded to AED Health and Safety for approval signature. The copies are then forwarded to the INC Nuclear Materials Control Group for verification, signature, and date. The Nuclear Materials Control supervisor in turn transmits all four copies to the IDO Nuclear Materials Management Branch for completion of Section II. When the authorization number, signature, and date are entered, the IDO Nuclear Materials Management Branch forwards the original and first carbon to the IDO Site Survey Branch. The second copy is forwarded to the INC Nuclear Materials Control Office. The third carbon is retained in the Nuclear Materials Management Branch office files.

SS MATERIALS EXPENDED IN RESEARCH

SECTION I (TO BE COMPLETED BY ORIGINATOR)

THIS IS TO CERTIFY THAT THE FOLLOWING SS MATERIALS WERE EXPENDED IN RESEARCH
DURING THE PERIOD _____ 19____ TO _____ 19____
(GIVE DETAILS AS TO IDENTITY, COMPOSITION, ENRICHMENT, QUANTITY, ETC.)

THE MATERIALS ITEMIZED ABOVE WERE EXPENDED IN RESEARCH UNDER THE FOLLOWING
CONDITIONS. (PLEASE SUMMARIZE THE CONDITIONS SURROUNDING THE EXPENDITURE OF
THIS MATERIAL)

DATE

SIGNATURE _____
USER OF SS MATERIAL

SECTION II (TO BE COMPLETED BY INC MATERIALS CONTROL)

STATION OR MATERIAL REPRESENTATIVE _____
SIGNATURE _____

AEC 101 REF, IF ANY

DATE

SECTION III (TO BE COMPLETED BY ID SS MATERIALS REPRESENTATIVE)

APPROVAL REPRESENTATIVE _____ DATE _____
SIGNATURE _____

AUTHORIZATION NUMBER _____

PREPARE IN TRIPLICATE
FORWARD ORIGINAL AND ONE CARBON COPY TO NMC OFFICE
ORIGINATOR RETAINS SECOND CARBON FOR HIS FILES

Fig. 19 INC-249 -- expended in research.

U. S. ATOMIC ENERGY COMMISSION
IDAHO OPERATIONS OFFICE

RADIOACTIVE MATERIAL SHIPMENT RECORD

ORIGINATOR	TO _____
	FROM _____
	VIA _____ COLLECT _____ PREPAID _____
	EXPERIMENT OR _____ CHARGE NO _____ CHARGE % _____
	PROJECT REF. _____
	SHIP ON (DATE) _____ RADIOISOTOPES _____
	LOAD AT _____ RADIATIONS: ALPHA _____ BETA _____ GAMMA _____
	CONTAINER: TYPE _____ NEUTRON _____ CURIES _____
	SIZE _____ WT. _____ CHEMICAL CPD. _____
	NO. _____ ICC SPEC. _____ PHYSICAL FORM: SOLID _____ LIQUID _____
PALLETTED FOR: ROAD _____ RAIL _____ AIR _____ GAS _____ CONFINED SOURCE _____	
SECURITY CLASSIFICATION _____ GRAMS: U-233 _____ U-235 _____ PU-239 _____	
DATE _____ ORIGINATOR _____	
LOADER	CONTAINER LOADED PER SHIPPER'S INSTRUCTIONS _____ DRAINED _____ CLEANED _____
	CLOSURES SECURED _____ CHECKED FOR LEAKAGE AND CONTAMINATION _____
	REMARKS, INSTRUCTIONS FOR HANDLING IN TRANSIT, ETC. _____
HEALTH AND SAFETY	DATE _____ LOADER _____
	ICC LABEL ON CONTAINER: (COLOR) _____ RADIATION UNITS OF PACKAGE _____
	EXTERNAL RADIATION: CONTAINER SURFACE _____ MR/HR; AT ONE METER _____ MR/HR
	SURFACE CONTAMINATION _____ d/m/ 100 cm ² BETA-GAMMA: _____ d/m/ 100 cm ² ALPHA _____
	DATE _____ HEALTH PHYSICS MONITOR _____
	REMARKS _____
	CONTAINER PALLETTING APPEARS ADEQUATE FOR SAFE LIFTING AND/OR WEIGHT DISTRIBUTION.
	CONTAINER TIE-DOWNS AND CARRIER EQUIPMENT APPEAR SUITABLE FOR SAFE TRANSPORT OF CARGO.
	DATE _____ SAFETY INSPECTOR _____
	OPER.
DATE _____ SUPERVISOR _____	
TRANSP.	RADIOACTIVE SHIPMENT CATEGORY _____ CONTAINER TYPE: A _____ B _____
	CONTAINER SEAL NO. _____ APPROVED FOR NUCLEAR SAFETY BY _____
	CONTAINER AND CONTENTS APPROVED FOR AEC BY _____
	DATE RELEASED _____ SHIPPER'S AGENT _____

Fig. 20 ID-109.

WASTE DISPOSAL REQUEST AND AUTHORIZATION

SECTION I - (TO BE COMPLETED BY ORIGINATING ORGANIZATION)		
ORIGINATING ORGANIZATION _____		
DESCRIPTION OF WASTE: (Complete applicable parts)		
Liquid _____	Solid _____	Volume _____ Weight _____
Radioactive: Yes _____ No _____ Curies _____		
Mr/hr at container surface _____ at one meter _____		
SS Material Type _____	Amount: Net _____	Isotope _____
Classification: Secret _____ Confidential _____ Category: I _____ II _____ III _____		
Composition: _____		
Capital Equipment No. _____		
Associated Hazards: _____		
CONTAINER: Type _____ Destroy _____ Save _____		
MODE OF TRANSPORTATION _____		
APPROVAL:		
Originator _____	_____	_____
SS Account. Rep. _____	_____	_____
HP Rep. _____	_____	_____
(Signature)	(Title)	(Date)
SECTION II - (TO BE COMPLETED BY IDO SS MATERIALS SECTION IF SS MATERIALS ARE INVOLVED IN DISPOSAL OPERATION)		
Authorization Number _____		
(Signature)	(Title)	(Date)
SECTION III - (TO BE COMPLETED BY IDO HEALTH AND SAFETY DIVISION)		
Method of Disposal: _____		
Prescribed Precautions: _____		
APPROVAL:		
Site Survey Branch _____	_____	_____
Analytical Branch _____	_____	_____
S&FP Branch _____	_____	_____
(Signature)		(Date)
SECTION IV - (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)		
Disposal was made by means of _____		
at _____	on _____	_____
(Location)		(Date)
(Signature)		(Date)

Fig. 21 Waste disposal request and authorization form -- ID-110.

3. RECORDS FLOW OUTLINE

At this point the discussions in Section III have been centered around the external and internal source data generated for the purpose of summarizing and reporting. It is, therefore, advantageous to include here a section outlining the actual use to which these data forms are applied. Figure 22 presents an overall picture of the flow of source data and record compilation. Also included is a brief description of the mechanism by which Material Balance Reports and inventory summaries are prepared.

3.1 Receipt and Assignment of SS Material

Receipt of SS material at Station JWA falls into two major categories: (a) irradiated fuel stored at the basin for future processing and (b) research and development quantities received by technical personnel for analytical and research study. In either case the receipt of these items is documented through the AEC-101 and AEC-388 transfer forms. The latter is more concerned with licensee and private contractor fuel, the former being associated with AEC-owned SS materials. Assignment of SS material to the custodian of the storage basin is effected through the use of form AED-261 (see paragraph 2.2 of this section). Research and development receipts are transferred to technical and chemical personnel via form ID-164. This form is prepared by the JWA materials representative and transmitted through the various custodians assigned to each laboratory or development group. AEC-101 information is transcribed to the form before it is mailed for signature. Other source documents include procurements and invoices not received on the 110 and 388 transfer forms.

3.2 Posting Source Data to Internal Subsidiary Records

Immediately subsequent to the assignment of SS material to the responsible custodian, the AEC-101 and AEC-388 transfer information is transcribed to raw data inventory sheets which are in turn key punched to formulate IBM inventory decks. These decks will be discussed in a later section of this manual. Simultaneously the same AEC-101 and AEC-388 information is transcribed (on a different format) to a raw data sheet for the purpose of summarizing AEC transfer information into logical sequence.

3.3 Posting External Source Data to the Transfer Journal

The raw data sheet last mentioned is key punched to formulate a transfer-journal card deck for the purpose of summarizing AEC transfer information into a logical sequence which can be properly transcribed to the ledger accounts. The same information is also used to formulate a Material Balance Summary Report. The Transfer Journal and Material Balance Reports will be discussed in another section of the manual.

3.4 Posting Transfer Journal to Material Balance Summary

SS material quantities are transcribed monthly to the material balance summary ledger. These quantities are categorized and posted in total by RIS symbol. The entries are recorded in the JWA plant balance column and the associated material-balance area columns. (See section on the "Material Balance Summary Ledger".)

3.5 IBM Subsidiary Inventory Decks

The IBM Subsidiary Inventory Decks which represent SS material assignment to the various material-balance area (MBA) custodians is completed by

Fig. 22 Station JWA records flow outline.

IBM program. The resulting print out lists individual SS material items located in each MBA. The uranium totals of each area are compiled independently of T. J. data but must agree with the computed ending inventories compiled by hand in the Material Balance Summary Ledger.

3.6 Inventory Reports

The Project and Composition of Ending Inventory Reports are compiled by computer utilizing the same card decks from which MBA Inventory Summaries are formulated. A detailed description of these reports is discussed in another section under "Reports".

3.7 Compilation of the Material Balance Reports

As previously mentioned, the MBR is compiled by computer program utilizing the AEC-101 and AEC-388 transfer data discussed in (3.3) above. A more detailed description of the report format and transfer information will be discussed under the "Reports" section of this manual.

4. JOURNALS AND LEDGERS

4.1 Out-of-Area Transfer Journal (Figure 23)

The Out-of-Area Transfer Journal is a book of original entry designed to summarize receipts and shipments of SS material incident to Station JWA. This is printed by computer program utilizing the T. J. card deck mentioned in Section 3. A sample is shown in Figure 23. The journal is subdivided and categorized first by SS material type. Under each material type we find a major subdivision of "Receipts" and "Shipments". Within each of these subdivisions the data is categorized by RIS symbol and RIS Operations Office affiliation. The RIS data is also categorized by monthly and year-to-date totals.

4.11 Posting the T. J. to the MBS Ledger. Monthly totals representing RIS receipts or shipments are transcribed to the Material Balance Summary Ledger under each respective SS material type (please refer to Figure 24). The data is first entered in the plant total column then in the material balance area column affected.

4.2 Within-Area Transfer Journals

The Within-Area Transfer Journals consist of monthly summarizations of Within-Area Transfer forms indicated in 2.3 of this manual. These forms are precoded 110-302, 330-710, 340-710, etc. Each transfer series is consolidated monthly and includes a recap sheet on the front showing the month, transfer series, and SS material weights.

4.21 Posting Within-Area Transfer to the MBS. Each transfer series is posted by monthly total to the MBS Ledger. The data are recorded only in the Material-Balance Area Columns (see Figure 24). Receipts to a particular MBA are recorded in black ink. Shipments are shown in red. All posting is entered in the section of the ledger entitled "Intra Transfers".

FACILITY TRANSFER SUMMARY				
IDAHO NUCLEAR CORPORATION (JWA)				
FISCAL YEAR 1967				
ENRICHED URANIUM (GRAMS)				
STATION TITLE	PERIOD TOTAL		YEAR-TO-DATE TOTAL	
	SS NET	ISOTOPE	SSNET	ISOTOPE
RECEIPTS				
CZA-JWA 1 07-05-66	5790	3021		
CZA-JWA 2 07-05-66	1655	864		
CZA-JWA 3 07-08-66	5503	2873		
CZA-JWA 4 07-07-66	1661	867		
CZA-JWA 5 07-11-66	1200	606		
CZA-JWA 6 07-12-66	1906	984		
CZA-JWA 7 07-13-66	1754	915		
CZA-JWA 8 07-15-66	1535	1215		
CZA-JWA 9 07-14-66	1176	592		
CZA-JWA 10 07-18-66	1251	635		
CZA-JWA 11 07-19-66	1706	890		
CZA-JWA 12 07-21-66	2355	1133		
CZA-JWA 13 07-21-66	5727	2989		
CZA-JWA 14 07-22-66	1621	821		
CZA-JWA 15 07-26-66	1335	679		
07 TOTAL STATION CZA	36175	19084	36175	19084
07 TOT=AEC, CHICAGO OPERATIONS OFFICE	36175	19084	36175	19084
JWB-JWA 1 07-19-66	13	12		
JWB-JWA 2 07-22-66	13056	11362		
JWB-JWA 3 07-28-66	670	575		
07 TOTAL STATION JWB	13739	11949	13739	11949
JZA-JWA 1 07-01-66	1718804	644065		
07 TOTAL STATION JZA	1718804	644065	1718804	644065
07 TOT=AEC, IDAHO OPERATIONS OFFICE	1732543	656014	1732543	656014

Fig. 23 Transfer journal summary.

4.3 Adjust Journal Entry Form

The adjusting journal entry form (Figure 17 in Section 2.4) is used to record inventory adjustments which cannot be directly applied to the Out-of-Area and Within-Area Transfer Journals. Entries of this nature would be included as (a) bias adjustments to previous reported quantities, (b) recording of NOL, MUF, accidental losses, and write-offs, and (c) recording of corrections to omission or deletions of previous reported data.

Each entry is numbered to indicate the month the entry is made (prefix) and the entry number for that month (suffix).

The data recorded on the journal entry form are transferred monthly to the Material Balance Summary Ledger. Normally, all entries of this nature will enter the MBS Ledger under the category "Losses" shown in the lower left hand section of the ledger.

4.4 Material Balance Summary Ledger (Figure 24)

The Material Balance Summary Ledger is a book of final entry summarizing the monthly totals of all three journals listed in Sections 4.1, 4.2, and 4.3. The folio description in Figure 24 vertically describes the general information summarized for each MBA. Briefly these data are: beginning inventory, receipt, shipments, within-area transfers, losses, and ending inventory. The summation of the ledger is performed by hand. The resulting ending inventories for each MBA are crossfooted to agree with JWA total-plant column.

Fig. 24 Station JWA material balance summary ledger.

4.5 IBM Subsidiary Inventory Ledgers (Figure 25)

The IBM Subsidiary Ledgers represent the total inventory assigned to various SS material custodians. The inventory decks (see Section 3, "Records-flow Outline") are categorized by computer to show individual SS material assignment as well as MBA totals. The total for each MBA must be in agreement with the ending inventories shown in the Material Balance Summary Ledger.

OUT AREA AS OF 03-31-67									
CUSTODIAN	MATERIAL TYPE	DATE	LOT NUMBER	SS NET	ISOTOPE	DESCRIPTION	MT	PROJECT	LINE
HABCK	ENRICHED URANIUM	7- 1-64	120- 2	517.	482.	2 MARK 3-4 FUEL FOBS	38	228	150
		7- 1-64	120- 2	79.	70.	1 EBR CONE 3 PIN SBO,	38	228	150
		7- 3-61	125- 7	121.	113.	FOILS 16 PCS	38	228	150
TOTAL ENRICHED URANIUM				713.	662.				

Fig. 25 Custodian Inventory List

Fig. 25 Custodian Inventory List

Fig. 25 Custodian inventory list.

5. COMPUTER RAW DATA PREPARATION

Station JWA data processing techniques have been employed to produce a Transfer Journal, custodian inventory listings, and all reports currently requested by the Atomic Energy Commission. It is, therefore, necessary at this point to discuss the raw data preparation necessary to perform the processing functions listed above.

5.1 Raw Data Preparation for Transfer Journal and Material Balance Summary Report

The raw data transcription sheet shown in Figure 26 has been prepared as a standard format for recording AEC-101 and AEC-388 transactions involving shipments and receipts. The titles at the top of the transcription sheet direct the SS materials representative in recording the necessary data. Columns 1 through 44 contain Transfer Journal data which are analyzed by the computer program to categorize and print the Out-of-Area Transfer Journal and the Material Balance Summary Report. Columns 45 through 80 are reserved to record data identification of description not associated with output requirements but contain extraneous information sometimes needed by the SS materials representative. The footnotes at the bottom of Figure 26 direct the accountant concerning the recording procedures for showing negligible quantities.

5.2 Raw Data Preparation for Inventory Summaries

Figure 27 outlines the transcription format to record inventory data to produce the following: (a) custodian and MBA inventory listings, (b) Project Ending Inventory Report, and (c) Composition of Ending Inventory Report. The format has been labeled at the top of the transcription sheet to aid the accountant in transcribing the raw data. Information on this sheet includes individual item quantity and description rather than total quantities received on each shipment.

Fig. 26 Raw data format for transfer journal.

Fig. 27 Raw data format for JWA inventories.

IV. MEASUREMENT TECHNOLOGY

1. INVENTORIES

Physical inventories represent an intermittent appraisal of the value of the records. Adjustment of the book inventory values is necessary to reflect the efficiency of the control mechanisms. For instance, the accuracy of day-to-day measurement applications become apparent if a good physical inventory estimate can be made. The efficient management of an SS material inventory is somewhat dependent on the quantity, value, and importance of that material. Therefore, the frequency of a particular physical inventory is highly dependent on these qualifications.

1.1 Frequency

SS Storage	- semiannually -- physical monthly -- subsidiary check
Process	- semiannually -- physical monthly -- book inventory (by difference)
Chemical Engineering Development	- semiannually -- physical monthly -- subsidiary check
Analytical Laboratory	- semiannually -- physical monthly -- subsidiary check
Shipping Storage	- semiannually -- physical monthly -- subsidiary check
Chemical Development	- semiannually -- physical monthly -- subsidiary check

Note that with the exception of the process area all inventories are verified monthly by IBM subsidiary check. This procedure involves the comparison of total uranium values in the custodian's inventory lists with the total ending inventory computed in the Material Balance Summary Ledger.

The (by-difference) inventory taken monthly for the process area represents a calculated inventory based on input minus output shown in the Material Balance Summary Ledger.

Physical Inventories for each Material Balance area are taken semi-annually. The procedure for each area is outlined in the following paragraphs:

1.2 Inventory Procedures -- Physical

1.21 SS Storage Basin. In general, the SS storage basin inventory consists of irradiated fuel pieces stored in fuel buckets, racks, and grids. Verification of these items is performed by visually checking the piece count for each rack

position or bucket against the computed inventory listing. Bucket numbers containing fuel not shown on the computed list is entered by hand to the list and later verified against AEC-101 data. This procedure is necessary to pick up inventory items which have arrived but have not yet been transcribed to the computer list. Extraneous items located in boxes, drums, casks, etc, which may be stored on top of the walking grates, are also checked against the computer list.

The dissolvers and cave are to be considered a part of the SS storage area (110) even though physically located in the plant processing area proper. The individual fuels, or slugs, can be counted or individually identified within the cave. This count, or individual identification, can be verified from form AED-256.

The dissolvers used for processing aluminum spent-reactor fuels in the batch processing system are C-101, C-151, D-101, and D-151. When plate elements are processed, the dissolver heel buildup can be disregarded. However, when nonplate material is being processed, the dissolver heel buildup should be taken into consideration. The heel buildup inventory is obtained from the Operations records. The buildup values are calculated from aluminum balance equations, stoichiometry, and by-difference. The aluminum balance and stoichiometric calculations are based on aluminum and fraction U-235 analysis from dissolver samples. The by-difference buildup is based on the reactor operator's measured values in minus ICPP measured value out. The precision of this buildup estimate is therefore only as reliable as the combined measurement errors for both the reactor operator and the chemical processor.

Dissolvers used for stainless steel and zirconium-type reactor fuel are labeled E-151 and E-101, respectively. The method of calculating dissolver heel estimates is the same as outlined above.

Dissolvers G-101 and G-151 are used for processing aluminum-type spent reactor fuels under the continuous process method (CP). These vessels are designed for infinitely safe loading; therefore, dissolver heel estimates are more difficult to obtain. However, a Health Physics fuel height reading is available. By using the formula fuel height reading $\times 0.593 - 0.2$ kgs a fair estimate of dissolver holdup inventory is obtained. The uncertainty of this equation is ± 2.9 kgs.

The amount of U-235 is approximated from the shipper's weight fraction U-235. These data can be taken from the charging logs, materials requisitions, and AEC-101 transfer forms. In the event that the fuel height reading is not available (instrument failure), the average operating level must be used. This operating level must be associated with a particular fuel type. Slug height readings vary depending on the dissolution rates of the material involved.

1.22 Process (310 Area). Material in process is capable of direct scrutiny only in the feed metering tanks and in the finished product room. An estimate of fair accuracy can be made at the product pump sumps (P.A. pots); this point is usually taken for the purpose of computing material balance downstream from the extraction system. The feed metering tanks in the CPM system are G-105 and G-155, and in the batch system, C- and D-102 and C- and D-152. Downstream from this point, uranium solution is passing through a three-stage system of liquid (liquid extraction columns with interstage evaporators and transfer pumps). Concentration varies widely; neither sampling nor volume measurements are possible.

In view of the above conditions, inventory procedures become complex and arbitrary. Before the procedures now in use are explained, a brief technical description of the process must be made.

Aluminum fuels in batch-type processing are dissolved in nitric acid with a catalyst additive. A flow sheet of the batch process which includes the dissolution and first-cycle extraction is shown in Figure 28. Dissolution rate is controlled by the concentration of the catalyst (mercuric nitrate). The dissolver product is adjusted in acidity by the addition of ammonium hydroxide. The specific gravity is adjusted by evaporation. The dissolver feed is filtered to remove undissolved solids prior to sampling. It is at this point that the feed-input measurement is made. The solution then becomes feed for the first-cycle extraction.

The uranium is the feed extracted into a hexone organic phase in the 1A column. Here the fission products and the uranium feed (less than one percent) are removed as waste. The waste is collected in a measurement vessel for uranium holdup calculations. This material control point (330-710) signifies the removal of first-cycle waste streams to the waste material balance area (710).

The uranium feed (rich organic phase) is now scrubbed with aluminum nitrate in the aqueous phase in the upper part of the 1A column. The scrubbing technique removes any additional fission products. The organic phase containing the uranium feed is now fed to the 1B column where it is contacted with a dilute nitric stream. The feed now transfers from the organic to the aqueous phase. The organic liquid (which contains very minute quantities of uranium) is returned to process for further reuse. The uranium-rich aqueous stream is now fed to the first-cycle evaporator for boil-down. After the evaporator solution has been concentrated, the feed is transferred to the second-cycle extraction system. The second- and third-cycle extraction procedures are identical to those described in the 1A and 1B columns.

The continuous aluminum-dissolution process is similar to the batch process with one exception: The dissolver solution adjustment in this case is made by varying the dissolver-chemical feed stream. The first-cycle extraction is TBP in kerosene.

Uranium is extracted from the aqueous phase into the organic phase in the 1A column and the 1A aqueous phase is discarded as waste. The aqueous phase is sampled and analyzed for uranium. This material control point is designated as 330-710. The uranium-rich organic phase from the 1A column is scrubbed with aluminum nitrate solution in the 1B column. The 1B aqueous phase may contain appreciable quantities of uranium and, therefore, is recycled to the first-cycle feed evaporator. The 1B organic product is stripped in the 1C column with a dilute nitric acid. The uranium depleted organic from the 1C column is washed in mixer-settler contactors and returned to process. The rich aqueous phase from the 1C column is washed with kerosene in the 1D column to remove minor traces of TBP. The 1D column product is then transferred to the first-cycle evaporation and becomes the second-cycle feed. The second- and third-cycle extraction procedures are identical to those shown for the batch-type processing. A flow sheet showing the continuous dissolution process and the first-, second-, and third-cycle extraction systems are shown in Figures 29 and 30 respectively.

Fig. 28 Batch aluminum dissolution (MTR elements) and first cycle extraction.

Fig. 29 Continuous aluminum dissolution (MTR elements) and first cycle extraction.

Fig. 30 Second and third cycle extraction for continuous MTR element dissolution.

Zirconium alloy fuels are dissolved in concentrated hydrofluoric acid. A flow sheet of the zirconium fuel process with material-control sampling points is shown in Figure 31. The use of hydrofluoric acid in the dissolution process requires that the dissolution equipment be made of monel. Aluminum nitrate is added to the dissolver product to complex the fluorid ion allowing the subsequent process to be performed in stainless steel equipment. It is necessary to add additional hydrofluoric acid with the aluminum nitrate to prevent precipitation. Chromic acid is added to the dissolver product to oxidize all the uranium to the extractable hexavalent state. The dissolver product is sampled at this point and analysed for uranium. This is a material sample transfer point 110-302.

The 1A column is used to extract uranium from the aqueous phase to an organic phase of TBP in kerosene. The 1A aqueous raffinate is discarded as waste. The waste material is sampled and analyzed for uranium. This is material control point 330-710. The uranium-rich organic stream from the 1A column is scrubbed in the 1B column with aluminum nitrate for additional fission product removal. The uranium is stripped back into an aqueous phase in the 1C column, and the depleted organic is washed and returned to the process. The uranium-rich aqueous phase from the 1C column is washed with kerosene in the 1D column to remove traces of TBP. The first-cycle product is concentrated by evaporation and becomes the second-cycle feed.

Stainless steel fuel is dissolved in a mixture of sulfuric and nitric acid. A flow sheet of the process is shown in Figure 32. Carpenter-20 is used for all dissolution equipment for stainless steel fuels. The nitric acid used in the dissolution process provides sufficient passivating effect to permit the use of stainless steel equipment for the remainder of the processing. Nitric acid is added to the dissolver product to provide the required salting strength; the use of aluminum nitrate could cause precipitation problems. The adjusted dissolver product is processed in the same equipment, and under essentially the same conditions, as the product from zirconium fuel dissolution.

The process inventory calculation is dependent upon processing conditions at the time an inventory is required. If the plant extraction columns are in operation, the physical inventory estimates of column holdup must be made. In addition, all vessels equipped with liquid level instrumentation and samplers must be calculated. These calculations are simplified by the fact that vessel calibration data are available for converting level readings into volumes. Samples can be pulled and analyzed for uranium concentration and mass fraction U-235. The specific gravity of the solution (lab analysis) is used to convert the liquid level readings into true liquid depth. The vessels containing liquid level recorders and samplers are: C-102, C-152, D-102, D-152, G-105, G-155, G-108, E-102, C-106, C-107, C-156, D-106, E-104, E-108, G-115, G-116, U-129, U-130, and Y-140. It is evident from this listing that only those tanks associated with input and waste measurements are capable of direct inventory scrutiny. Vessels containing LL readings and density recorders by no samplers are N-cell, Z-cell J-cell, and intercycle product evaporators. Uranium holdup estimates in these tanks are calculated by assuming gravity and uranium concentration. The specific gravity is converted from instrument density recorder readings. Concentration is assumed to be commensurate with ideal process design specification.

Fig. 3. Zirconium Dissolution (PWR elements) and first cycle flowsheet.

Fig. 32 Stainless steel dissolution (OMRE elements) and first cycle extraction.

Process holdup vessels not capable of direct scrutiny are shown in Figures 33 and 34. These illustrations include vessel numbers, estimated vessel volume at regular processing rates, and estimated piping volumes.

The columns were estimated from engineering specifications at the time the vessels were fabricated. The volumes for the intercycle evaporators were left blank. These tanks have liquid recorders for estimating more accurate holdup.

Uranium holdup calculations for the remainder of the vessel are described in the following paragraphs.

The extraction column, uranium concentrations, and volumetric estimates are obtained from the processing specification shown in the technical flow charts mentioned earlier. For example, the ratio of the feed rate entering a column in the aqueous phase (l/hr) to the organic feed rate (l/hr) is applied to the total engineering volume estimate. This ratio gives the fraction volume in the aqueous and organic phases. See example below:

$\frac{AF \ 500 \text{ l/hr}}{U = 2 \text{ g/l}}$	<div style="border: 1px solid black; padding: 10px; display: inline-block; transform: rotate(-90deg); transform-origin: center;"> $V = 500 \text{ liters}$ </div>	$\frac{OF \ 100 \text{ l/hr}}{U = 10 \text{ g/l}}$	
<p>AF = Aqueous feed OF = Organic feed AR = Raffinate feed</p>			
$\frac{OF \ 100 \text{ l/hr}}{U = 0 \text{ g/l}}$		$\frac{AR = 500 \text{ l/hr}}{U = 0 \text{ g/l}}$	

$$\text{Total volume in aqueous phase} = (V) \frac{AF}{AF + OF} = 417 \text{ l}$$

$$\text{Total volume in organic phase} = (V) \frac{OF}{OF + AF} = 83 \text{ l}$$

Assuming a linear liquid to liquid extraction rate, we express the holdup as:

$$\text{Holdup} = 417 \times \frac{2}{2} + 83 \times \frac{10}{2} = \underline{\underline{832 \text{ grams uranium}}}$$

or:

$$\text{Holdup} = (\text{Volume in liters of vessel}) \frac{AF}{AF \ \& \ OF} \times 2 \text{ g/l} = 834 \text{ g}$$

$$\text{Holdup} = (\text{Volume in liters}) \frac{OF}{AF \ \& \ OF} \times 10 \text{ g/l} = 833 \text{ g}$$

It is understood here that a linear (uniform) liquid-to-liquid extraction rate does not exist. Therefore, an uncertainty of approximately ± 50 percent could be applied to these values. However, the total holdup quantity in these vessels represent only a small fraction of the total process inventory. In view of this situation, it is felt that assuming uniform liquid-to-liquid extraction rates is justified.

BATCH PROCESS HOLDUP

Fig. 33 Batch processing holdup vessel estimates.

CPM PROCESS HOLDUP

Fig. 34 CPM processing holdup vessel estimates.

1.23 Laboratories (210, 510, and 910 areas). Semiannually the Nuclear Materials Management Section will visually verify all items in the laboratories against the printed composition inventory listings.

1.24 Product Storage (180 Area). Semiannually the product bottle and reference sample numbers are verified against the NMM computer inventory listings. Uranium values assigned to their inventory were calculated on 380-810 transfer forms generated at the time the product was pulled from the product storage banks.

2. CALCULATION PROCEDURES

2.1 Internal Transfer Calculations

The procedures for calculating internal transfer data will be subdivided into three major categories: (a) feed input calculation, (b) waste transfer calculation, and (c) product transfer calculation. The calibration equations mentioned in these discussions were derived from calibration procedures included under a separate section of this manual.

2.11 Feed Input Calculations. The feed input calculations are performed on the original copy of the internal feed batch transfer forms 110-302. As previously mentioned, the top portion of the form contains operational data for calculating vessel volume. The lower portion of the form is reserved for analytical concentrations, impurities, and mass spectrometry data. The box on the upper portion of the form is used for consolidating all information for calculating SS material batch weights.

The liquid level readings of all input batch vessels (G-105, G-155, C-102, C-152, D-102, D-152, etc) are read from water or liquid monometers. The CPM feed batch vessels are equipped with meriam monometers containing monometer fluid with a specific gravity of approximately 2.95. The batch feed input vessels are equipped with water monometers with a fluid specific gravity of approximately 1.00.

The specific gravity of the batch solution is obtained from laboratory analysis for all input-batch weight calculations. The density recorder gravity quoted in the upper portion of the form is used only when it is impossible to obtain a laboratory value. This reading is more inaccurate and should be used only when necessary.

The vessel calibration equation converts all liquid level and specific gravity data into liter volumes. The volume is entered to the right of the calculation box.

Total uranium and U-235 isotopic weights are calculated from liter volumes, concentrations, and spectrometer mass fractions.

Symbols used in batch-transfer weight calculations are as follows:

V = Volume in liters

D = True depth (adjust liquid level) of liquid in vessel

LL = Monometer or instrument recorder reading of liquid height

DR = Density reading (specific gravity) obtained from density recorder

SG = Laboratory specific gravity or DR which has been converted to a true specific gravity reading

The calibration formulas for computing liter volumes on all input batch vessels are listed below:

$$C-102 \quad V = 16.01 (D) - 18.77$$

$$D = \frac{LL}{SG}$$

$$C-152 \quad V = 16.01 (D) - 14.41$$

$$D = \frac{LL}{SG}$$

$$D-102 \quad V = 16.03 (D) - 16.77$$

$$D = \frac{LL}{SG}$$

$$D-152 \quad V = 16.03 (D) - 15.91$$

$$D = \frac{LL}{SG}$$

$$G-105 - 155$$

$$\text{up to 20 inches} - V = \frac{82.66 (LL)}{SG} - 71.71$$

$$\text{over 20 inches} - V = \frac{85.40 (LL)}{SG} - 127.67$$

E-102 water monometer

$$V = 82.54 (D) - 82.20$$

$$D = \frac{LL}{SG}$$

The total uranium and U-235 weights are calculated by the following procedure:

$$\text{Total U} = V (\text{average concentration g/l})$$

$$\text{U-235} = \text{Total uranium} (\text{average mass fraction})$$

The averages quoted are arithmetic averages of the number of results reported for each sample.

2.12 Waste Transfer Calculations. The calculation of SS material weight batch transfers of waste solutions are performed on internal transfer forms 330-710, 335-710, and 340-710. The calculation procedures are identical to those shown for input vessels except that liquid level and specific gravity readings are obtained from instrumentation and not monometers or laboratory samplers. The calibration equations are listed below:

$$\begin{aligned} \text{U-129} \quad & \left\{ \begin{array}{l} V = 22.06 (D) - 39.17 \\ D = \frac{LL (0.7)}{SG} \end{array} \right. \\ & SG = 0.004985 (DR) + 0.9472 \end{aligned}$$

$$\begin{aligned} \text{U-130} \quad & \left\{ \begin{array}{l} V = 21.98 (D) - 30.95 \\ D = \frac{LL (0.7)}{SG} \end{array} \right. \\ & SG = 0.005056 (DR) + 0.9606 \end{aligned}$$

$$\begin{aligned} \text{U-140} \quad & \left\{ \begin{array}{l} V = 11.12 (D) - 4.08 \\ D = \frac{LL (0.7)}{SG} \end{array} \right. \\ & SG = .005066 (DR) + 0.9625 \end{aligned}$$

$$\begin{aligned} \text{G-115} \quad & \left\{ \begin{array}{l} V = 20.54 (D) + 16.70 \\ D = \frac{LL (1.5)}{SG} \end{array} \right. \\ & SG = (DR) .00501 + 1.0020 \end{aligned}$$

$$\begin{aligned} \text{G-116} \quad & \left\{ \begin{array}{l} V = 28.42 (D) + 20.50 \\ D = \frac{LL (1.5)}{SG} \end{array} \right. \\ & SG = (DR) .00476 + 0.9522 \end{aligned}$$

Total uranium is calculated as described for feed input batches. U-235 mass fraction is not run on dilute solutions. Therefore, the U-235 weights are

applied to total monthly waste transfers by using the weighted mass fraction of input for the same month.

Some waste solutions are collected in waste tanks WG and WG 100 tanks and measured prior to dumping. These transfer data are recorded on the internal transfer form code series 335-710. The liquid level readings are converted directly to liter volumes by using Table II.

2.13 Product and Product Sample Transfer Calculations. All final product transfer are reported to the Materials Management Group on the Product Transfer Form. This form has been consolidated to include two coded transfer series forms 380-810 and 380-510. The 380-810 transfer form reports product-bottle and reference-sample transfers from the Z-cell product storage tanks to the product storage vault. The 380-510 transfer form reports the transfer of uranium contained in samples transferred to the laboratory for analysis. The product-bottle gross, tare, and net weights are reported in the upper portion of the forms. These values are checked by the Nuclear Materials Management Group for arithmetic accuracy. Tare weight for each bottle is checked against an average expected tare weight established from earlier weighings on each bottle. The current tare weight must not disagree with the average expected weight by more than three grams. If there is a weight difference in excess of this value, the bottle must be reweighed or checked for heel solution or modification changes.

Concentration of product solution is reported in mg/g units. Therefore, the total uranium weights can be obtained from the product of the net solution weight and the reported concentration. The U-235 isotope weight is obtained in the same manner outlined for feed input batches.

For convenience, the product bottle numbers and expected weights are listed in Table III. This table should be referred to each time a product bottle is filled.

The uranium weight calculations for the laboratory sample (380-510) are identical to those shown for 380-810.

Uranium analysis and mass spectrometry results are not reported for each product bottle. The product solution is mixed in the Z-cell columns (storage banks) prior to bottle filling. This mixing creates a homogeneous solution for approximately ten bottles. The sampling and analytical control procedures for the product will be covered in a later section of this manual. However, the application on the analytical results to the Product Transfer Form will be included here.

Product bottles are withdrawn from the Z-cell storage banks in groups of ten. In each group, the uranium concentration and mass spectrometer results are reported only on bottles 1, 2, and 10, respectively. The total uranium and U-235 weights for the first bottle are calculated only from the data supplied for that bottle. The total uranium and U-235 weights for bottles 2 through 10 are calculated for each bottle by using the average concentration and mass fraction reported for bottles 2 and 10. Product reference and laboratory sample weights are obtained in the same manner.

TABLE II

LIQUID LEVEL READINGS AND LITER VOLUMES

Chart Reading (percent)	Volume in Liters	Chart Reading (percent)	Volume in Liters	Chart Reading (percent)	Volume in Liters
2.0	- 76	11.0	- 908	19.2	- 2070
		0.2	- 930	0.4	- 2090
3.0	- 151	0.4	- 970	0.6	- 2140
0.2	- 151	0.6	- 990	0.8	- 2175
0.4	- 170	0.8	- 1020		
0.6	- 189			20.0	- 2214
0.8	- 189	12.0	- 1041	0.2	- 2250
		0.2	- 1060	0.4	- 2290
4.0	- 227	0.4	- 1090	0.6	- 2330
0.2	- 227	0.6	- 1110	0.8	- 2363
0.4	- 246	0.8	- 1140		
0.6	- 265			21.0	- 2403
0.8	- 265	13.0	- 1173	0.2	- 2430
		0.2	- 1190	0.4	- 2470
5.0	- 303	0.4	- 1210	0.6	- 2500
0.2	- 322	0.6	- 1235	0.8	- 2535
0.4	- 341	0.8	- 1265		
0.6	- 360			22.0	- 2574
0.8	- 378	14.0	- 1287	0.2	- 2600
		0.2	- 1320	0.4	- 2636
6.0	- 378	0.4	- 1340	0.6	- 2675
0.2	- 398	0.6	- 1376	0.8	- 2713
0.4	- 416	0.8	- 1410		
0.6	- 416			23.0	- 2744
0.8	- 454	15.0	- 1438	0.2	- 2785
		0.2	- 1475	0.4	- 2830
7.0	- 473	0.4	- 1505	0.6	- 2870
0.2	- 492	0.6	- 1535	0.8	- 2910
0.4	- 492	0.8	- 1560		
0.6	- 530			24.0	- 2952
0.8	- 568	16.0	- 1590	0.2	- 2990
		0.2	- 1615	0.4	- 3025
8.0	- 568	0.4	- 1645	0.6	- 3065
0.2	- 606	0.6	- 1670	0.8	- 3100
0.4	- 643	0.8	- 1700		
0.6	- 643			25.0	- 3142
0.8	- 681	17.0	- 1741	0.2	- 3165
		0.2	- 1765	0.4	- 3195
9.0	- 681	0.4	- 1800	0.6	- 3225
0.2	- 719	0.6	- 1830	0.8	- 3255
0.4	- 719	0.8	- 1860		
0.6	- 757			26.0	- 3293
0.8	- 795	18.0	- 1893	0.2	- 3330
		0.2	- 1905	0.4	- 3370
10.0	- 795	0.4	- 1945	0.6	- 3410
0.2	- 833	0.6	- 1990	0.8	- 3460
0.4	- 833	0.8	- 2010		
0.6	- 852			27.0	- 3501
0.8	- 871	19.0	- 2044	0.2	- 3535

TABLE II (Contd.)

LIQUID LEVEL READINGS AND LITER VOLUMES

Chart Reading (percent)	Volume in Liters	Chart Reading (percent)	Volume in Liters	Chart Reading (percent)	Volume in Liters
27.4	- 3570	35.6	- 5231	41.1	- 6423
0.6	- 3610	0.8	- 5284	0.2	- 6446
0.8	- 3650			0.3	- 6469
		36.0	- 5337	0.4	- 6487
28.0	- 3690	0.2	- 5375	0.5	- 6510
0.2	- 3720	0.4	- 5412	0.6	- 6533
0.4	- 3755	0.6	- 5450	0.7	- 6552
0.6	- 3805	0.8	- 5488	0.8	- 6595
0.8	- 3840			0.9	- 6597
		37.0	- 5526		
29.0	- 3880	0.2	- 5578	42.0	- 6616
0.2	- 3915	0.4	- 5630	0.1	- 6639
0.4	- 3955	0.6	- 5681	0.2	- 6662
0.6	- 3995	0.8	- 5723	0.3	- 6681
0.8	- 4038			0.4	- 6703
		38.0	- 5753	0.5	- 6726
30.0	- 4069	0.1	- 5776	0.6	- 6749
0.2	- 4120	0.2	- 5799	0.7	- 6768
0.4	- 4160	0.3	- 5821	0.8	- 6790
0.6	- 4195	0.4	- 5840	0.9	- 6813
0.8	- 4228	0.5	- 5863		
		0.6	- 5886	43.0	- 6836
31.0	- 4258	0.7	- 5905	0.1	- 6855
0.2	- 4310	0.8	- 5927	0.2	- 6877
0.4	- 4353	0.9	- 5950	0.3	- 6896
0.6	- 4390			0.4	- 6919
0.8	- 4425	39.0	- 5973	0.5	- 6942
		0.1	- 5993	0.6	- 6964
32.0	- 4466	0.2	- 6014	0.7	- 6983
0.2	- 4500	0.3	- 6037	0.8	- 7006
0.4	- 4540	0.4	- 6057	0.9	- 7029
0.6	- 4570	0.5	- 6079		
0.8	- 4615	0.6	- 6101	44.0	- 7048
		0.7	- 6120	0.1	- 7070
33.0	- 4656	0.8	- 6143	0.2	- 7093
0.2	- 4700	0.9	- 6166	0.3	- 7116
0.4	- 4746			0.4	- 7135
0.6	- 4791	40.0	- 6185	0.5	- 7157
0.8	- 4836	0.1	- 6207	0.6	- 7180
		0.2	- 6230	0.7	- 7199
34.0	- 4883	0.3	- 6253	0.8	- 7222
0.2	- 4921	0.4	- 6272	0.9	- 7244
0.4	- 4959	0.5	- 6294		
0.6	- 4997	0.6	- 6317	45.0	- 7267
0.8	- 5035	0.7	- 6336	0.1	- 7286
		0.8	- 6359	0.2	- 7309
35.0	- 5072	0.9	- 6382	0.3	- 7332
0.2	- 5125			0.4	- 7350
0.4	- 5178	41.0	- 6404		

TABLE II (Contd.)

LIQUID LEVEL READINGS AND LITER VOLUMES

Chart Reading (percent)	Volume in Liters	Chart Reading (percent)	Volume in Liters	Chart Reading (percent)	Volume in Liters
45.5	- 7373	50.0	- 8335	54.5	- 9353
0.6	- 7396	0.1	- 8357	0.6	- 9375
0.7	- 7415	0.2	- 8380	0.7	- 9394
0.8	- 7438	0.3	- 8403	0.8	- 9417
0.9	- 7460	0.4	- 8422	0.9	- 9440
		0.5	- 8444		
46.0	- 7479	0.6	- 8467	55.0	- 9463
0.1	- 7502	0.7	- 8486	0.1	- 9481
0.2	- 7525	0.8	- 8509	0.2	- 9504
0.3	- 7547	0.9	- 8531	0.3	- 9527
0.4	- 7566			0.4	- 9546
0.5	- 7589	51.0	- 8554	0.5	- 9568
0.6	- 7612	0.1	- 8615	0.6	- 9591
0.7	- 7631	0.2	- 8637	0.7	- 9610
0.8	- 7653	0.3	- 8660	0.8	- 9633
0.9	- 7676	0.4	- 8679	0.9	- 9652
		0.5	- 8706		
47.0	- 7699	0.6	- 8728	56.0	- 9674
0.1	- 7718	0.7	- 8747	0.1	- 9697
0.2	- 7740	0.8	- 8770	0.2	- 9720
0.3	- 7763	0.9	- 8793	0.3	- 9743
0.4	- 7782			0.4	- 9762
0.5	- 7797	52.0	- 8811	0.5	- 9784
0.6	- 7820	0.1	- 8834	0.6	- 9803
0.7	- 7839	0.2	- 8857	0.7	- 9826
0.8	- 7861	0.3	- 8876	0.8	- 9849
0.9	- 7884	0.4	- 8899	0.9	- 9871
		0.5	- 8921		
48.0	- 7903	0.6	- 8944	57.0	- 9894
0.1	- 7926	0.7	- 8963	0.1	- 9913
0.2	- 7948	0.8	- 8986	0.2	- 9936
0.3	- 7971	0.9	- 9008	0.3	- 9958
0.4	- 7990			0.4	- 9977
0.5	- 8013	53.0	- 9031	0.5	- 10000
0.6	- 8036	0.1	- 9050	0.6	- 10022
0.7	- 8054	0.2	- 9073	0.7	- 10042
0.8	- 8077	0.3	- 9095	0.8	- 10064
0.9	- 8100	0.4	- 9114	0.9	- 10087
		0.5	- 9137		
49.0	- 8123	0.6	- 9160	58.0	- 10106
0.1	- 8142	0.7	- 9179	0.1	- 10129
0.2	- 8164	0.8	- 9201	0.2	- 10151
0.3	- 8187	0.9	- 9224	0.3	- 10174
0.4	- 8206			0.4	- 10193
0.5	- 8229	54.0	- 9243	0.5	- 10220
0.6	- 8251	0.1	- 9266	0.6	- 10238
0.7	- 8270	0.2	- 9288	0.7	- 10257
0.8	- 8293	0.3	- 9311	0.8	- 10280
0.9	- 8316	0.4	- 9330	0.9	- 10303

TABLE II (Contd.)

LIQUID LEVEL READINGS AND LITER VOLUMES

Chart Reading (percent)	Volume in Liters	Chart Reading (percent)	Volume in Liters	Chart Reading (percent)	Volume in Liters
59.0	- 10325	63.6	- 11336	68.1	- 12305
0.1	- 10344	0.7	- 11355	0.2	- 12328
0.2	- 10367	0.8	- 11378	0.3	- 12347
0.3	- 10390	0.9	- 11400	0.4	- 12369
0.4	- 10409			0.5	- 12392
0.5	- 10431	64.0	- 11419	0.6	- 12411
0.6	- 10454	0.1	- 11442	0.7	- 12434
0.7	- 10473	0.2	- 11465	0.8	- 12456
0.8	- 10496	0.3	- 11484	0.9	- 12475
0.9	- 10519	0.4	- 11506		
		0.5	- 11529	69.0	- 12498
60.0	- 10537	0.6	- 11548	0.1	- 12521
0.1	- 10560	0.7	- 11571	0.2	- 12543
0.2	- 10583	0.8	- 11593	0.3	- 12562
0.3	- 10606	0.9	- 11612	0.4	- 12585
0.4	- 10624			0.5	- 12608
0.5	- 10647	65.0	- 11635	0.6	- 12627
0.6	- 10670	0.1	- 11658	0.7	- 12649
0.7	- 10689	0.2	- 11681	0.8	- 12672
0.8	- 10712	0.3	- 11699	0.9	- 12695
0.9	- 10734	0.4	- 11722		
		0.5	- 11745	70.0	- 12714
61.0	- 10757	0.6	- 11764	0.1	- 12737
0.1	- 10799	0.7	- 11786	0.2	- 12759
0.2	- 10821	0.8	- 11809	0.3	- 12778
0.3	- 10840	0.9	- 11832	0.4	- 12801
0.4	- 10863			0.5	- 12824
0.5	- 10886	66.0	- 11851	0.6	- 12843
0.6	- 10905	0.1	- 11874	0.7	- 12865
0.7	- 10927	0.2	- 11896	0.8	- 12888
0.8	- 10950	0.3	- 11915	0.9	- 12911
0.9	- 10969	0.4	- 11938		
		0.5	- 11961	71.0	- 12930
62.0	- 10992	0.6	- 11980	0.1	- 12948
0.1	- 11014	0.7	- 12002	0.2	- 12967
0.2	- 11037	0.8	- 12025	0.3	- 12990
0.3	- 11052	0.9	- 12044	0.4	- 13009
0.4	- 11079			0.5	- 13028
0.5	- 11101	67.0	- 12067	0.6	- 13047
0.6	- 11120	0.1	- 12089	0.7	- 13066
0.7	- 11143	0.2	- 12112	0.8	- 13089
0.8	- 11166	0.3	- 12131	0.9	- 13107
0.9	- 11188	0.4	- 12154		
		0.5	- 12176	72.0	- 13126
63.0	- 11207	0.6	- 12195	0.1	- 13145
0.1	- 11230	0.7	- 12218	0.2	- 13164
0.2	- 11253	0.8	- 12241	0.3	- 13187
0.3	- 11272	0.9	- 12263	0.4	- 13206
0.4	- 11294			0.5	- 13225
0.5	- 11317	68.0	- 12282	0.6	- 13244

TABLE II (Contd.)

LIQUID LEVEL READINGS AND LITER VOLUMES

Chart Reading (percent)	Volume in Liters	Chart Reading (percent)	Volume in Liters	Chart Reading (percent)	Volume in Liters
72.7	- 13263	77.3	- 14171	82.0	- 15042
0.8	- 13285	0.4	- 14190	0.1	- 15057
0.9	- 13304	0.5	- 14209	0.2	- 15076
		0.6	- 14228	0.3	- 15095
73.0	- 13323	0.7	- 14247	0.4	- 15110
0.1	- 13342	0.8	- 14269	0.5	- 15125
0.2	- 13361	0.9	- 14288	0.6	- 15155
0.3	- 13384			0.7	- 15170
0.4	- 13403	78.0	- 14307	0.8	- 15189
0.5	- 13422	0.1	- 14326	0.9	- 15208
0.6	- 13441	0.2	- 14345		
0.7	- 13459	0.3	- 14368	83.0	- 15223
0.8	- 13482	0.4	- 14383	0.1	- 15238
0.9	- 13501	0.5	- 14406	0.2	- 15257
		0.6	- 14425	0.3	- 15276
74.0	- 13520	0.7	- 14444	0.4	- 15291
0.1	- 13539	0.8	- 14466	0.5	- 15307
0.2	- 13558	0.9	- 14485	0.6	- 15325
0.3	- 13581			0.7	- 15344
0.4	- 13600	79.0	- 14504	0.8	- 15360
0.5	- 13618	0.1	- 14523	0.9	- 15375
0.6	- 13637	0.2	- 14542		
0.7	- 13656	0.3	- 14565	84.0	- 15394
0.8	- 13679	0.4	- 14584	0.1	- 15413
0.9	- 13698	0.5	- 14603	0.2	- 15428
		0.6	- 14621	0.3	- 15443
75.0	- 13717	0.7	- 14640	0.4	- 15462
0.1	- 13736	0.8	- 14664	0.5	- 15481
0.2	- 13755	0.9	- 14682	0.6	- 15496
0.3	- 13777			0.7	- 15511
0.4	- 13796	80.0	- 14701	0.8	- 15530
0.5	- 13815	0.1	- 14716	0.9	- 15549
0.6	- 13834	0.2	- 14735		
0.7	- 13853	0.3	- 14754	85.0	- 15564
0.8	- 13876	0.4	- 14769	0.1	- 15579
0.9	- 13895	0.5	- 14784	0.2	- 15598
		0.6	- 14803	0.3	- 15617
76.0	- 13914	0.7	- 14822	0.4	- 15632
0.1	- 13933	0.8	- 14837	0.5	- 15647
0.2	- 13952	0.9	- 14852	0.6	- 15666
0.3	- 13974			0.7	- 15685
0.4	- 13993	81.0	- 14871	0.8	- 15700
0.5	- 14012	0.1	- 14890	0.9	- 15715
0.6	- 14031	0.2	- 14905		
0.7	- 14050	0.3	- 14920	86.0	- 15734
0.8	- 14073	0.4	- 14939	0.1	- 15746
0.9	- 14092	0.5	- 14958	0.2	- 15761
		0.6	- 14973	0.3	- 15776
77.0	- 14110	0.7	- 14989	0.4	- 15795
0.1	- 14129	0.8	- 15008	0.5	- 15806
0.2	- 14148	0.9	- 15026	0.6	- 15825

TABLE II (Contd.)

LIQUID LEVEL READINGS AND LITER VOLUMES

Chart Reading (percent)	Volume in Liters	Chart Reading (percent)	Volume in Liters	Chart Reading (percent)	Volume in Liters
86.7	- 15844	91.0	- 16487	95.3	- 17072
0.8	- 15859	0.1	- 16503	0.4	- 17085
0.9	- 15874	0.2	- 16518	0.5	- 17099
		0.3	- 16533	0.6	- 17112
87.0	- 15897	0.4	- 16548	0.7	- 17125
0.1	- 15912	0.5	- 16563	0.8	- 17138
0.2	- 15927	0.6	- 16578	0.9	- 17152
0.3	- 15942	0.7	- 16593		
0.4	- 15961	0.8	- 16609	96.0	- 17165
0.5	- 15973	0.9	- 16624	0.1	- 17178
0.6	- 15988			0.2	- 17191
0.7	- 16003	92.0	- 16639	0.3	- 17204
0.8	- 16018	0.1	- 16654	0.4	- 17217
0.9	- 16033	0.2	- 16665	0.5	- 17231
		0.3	- 16680	0.6	- 17244
88.0	- 16048	0.4	- 16692	0.7	- 17257
0.1	- 16060	0.5	- 16707	0.8	- 17270
0.2	- 16075	0.6	- 16722	0.9	- 17284
0.3	- 16090	0.7	- 16737		
0.4	- 16105	0.8	- 16752	97.0	- 17297
0.5	- 16120	0.9	- 16767	0.2	- 17320
0.6	- 16135			0.4	- 17342
0.7	- 16151	93.0	- 16786	0.6	- 17365
0.8	- 16166	0.1	- 16799	0.8	- 17388
0.9	- 16181	0.2	- 16813		
		0.3	- 16826	98.0	- 17411
89.0	- 16192	0.4	- 16839	0.2	- 17433
0.1	- 16207	0.5	- 16853	0.4	- 17456
0.2	- 16223	0.6	- 16866	0.6	- 17478
0.3	- 16238	0.7	- 16879	0.8	- 17501
0.4	- 16253	0.8	- 16893		
0.5	- 16268	0.9	- 16906	99.0	- 17525
0.6	- 16283			0.2	- 17540
0.7	- 16298	94.0	- 16919	0.4	- 17555
0.8	- 16313	0.1	- 16930	0.6	- 17570
0.9	- 16328	0.2	- 16941	0.8	- 17585
		0.3	- 16953		
90.0	- 16344	0.4	- 16964	100.0	- 17600
0.1	- 16355	0.5	- 16976		
0.2	- 16370	0.6	- 16988		
0.3	- 16385	0.7	- 16999		
0.4	- 16400	0.8	- 17011		
0.5	- 16415	0.9	- 17022		
0.6	- 16431				
0.7	- 16446	95.0	- 17033		
0.8	- 16461	0.1	- 17046		
0.9	- 16476	0.2	- 17059		

TABLE III

PRODUCT BOTTLE NUMBERS AND EXPECTED WEIGHTS

<u>Bottle Number</u>	<u>Product Bottle Tare Weights (g)</u>	<u>Bottle Number</u>	<u>Product Bottle Tare Weights (g)</u>
201	14,567	232	14,416
202	14,376	233	14,373
203	15,262	234	14,345
204	15,061	235	14,338
205	14,317	236	14,366
206	14,354	237	14,395
207	15,354	238	14,198
208	14,209	239	14,429
209	15,270	240	14,273
210	14,417	241	15,457
211	14,406	242	15,139
212	14,266	243	14,463
213	15,595	244	15,007
214	14,469	245	14,611
215	14,812	246	14,344
216	14,744	247	14,315
217	14,257	248	14,631
218	14,451	249	14,464
219	14,333	250	14,474
220	14,443	251	15,644
221	14,421	252	14,512
222	15,649	253	14,506
223	15,616	254	14,473
224	14,275	255	15,550
225	14,433	256	14,449
226	14,457	257	14,574
227	15,688	258	14,441
228	15,381	259	15,497
229	14,419	260	14,648
230	14,409	261	14,533
231	14,442	262	14,419

TABLE III (Contd.)

PRODUCT BOTTLE NUMBERS AND EXPECTED WEIGHTS

<u>Bottle Number</u>	<u>Product Bottle Tare Weights (g)</u>	<u>Bottle Number</u>	<u>Product Bottle Tare Weights (g)</u>
263	15,434	294	14,420
264	14,374	295	14,476
265	14,553	296	14,385
266	14,474	297	14,501
267	14,389	298	14,494
268	14,456	299	14,325
269	15,738	300	14,481
270	15,463	301	14,548
271	14,490	302	14,388
272	14,348	303	14,590
273	14,675	304	14,666
274	15,333	305	14,323
275	14,380	306	14,345
276	14,393	307	14,446
277	15,444	308	14,414
278	15,976	309	14,470
279	14,741	310	14,356
280	14,436	311	14,339
281	14,469	312	14,432
282	14,498	313	14,364
283	14,535	314	14,406
284	14,373	315	14,486
285	14,647	316	14,424
286	14,536	317	14,384
287	14,356	318	14,357
288	14,176	319	14,402
289	14,458	320	
290	14,479	321	16,614
291	14,497	322	16,094
292	14,529	323	16,787
293	14,340	324	15,669

TABLE III (Contd.)

PRODUCT BOTTLE NUMBERS AND EXPECTED WEIGHTS

<u>Bottle Number</u>	<u>Product Bottle Tare Weights (g)</u>	<u>Bottle Number</u>	<u>Product Bottle Tare Weights (g)</u>
325	15,451	356	16,284
326	16,464	357	16,261
327	15,405	358	14,886
328	15,531	359	15,936
329	15,693	360	16,465
330	16,221	361	16,368
331	15,556	362	16,492
332	15,809	363	15,626
333	15,989	364	16,215
334	15,583	365	16,597
335	15,351	366	15,120
336	17,462	367	16,347
337	15,830	368	15,963
338	15,613	369	16,294
339	16,179	370	16,518
340	16,361	371	16,283
341	15,893	372	15,418
342	16,120	373	16,247
343	15,915	374	15,030
344	16,347	375	16,185
345	16,692	376	16,146
346	16,562	377	16,320
347	15,662	378	17,122
348	16,605	379	15,101
349	16,251	380	14,750
350	16,390	381	15,716
351	16,440	382	15,899
352	16,473	383	15,254
353	16,698	384	15,228
354	16,060	385	16,071
355	15,935	386	15,688

TABLE III. (Contd.)

PRODUCT BOTTLE NUMBERS AND EXPECTED WEIGHTS

<u>Bottle Number</u>	<u>Product Bottle Tare Weights (g)</u>	<u>Bottle Number</u>	<u>Product Bottle Tare Weights (g)</u>
387	15,488	398	17,284
388	15,909	399	16,164
389	14,985	400	15,582
390	16,161	401	16,540
391	16,421	402	16,674
392	16,141	403	16,818
393	15,265	404	15,761
394	16,124	405	16,041
395	16,383	439	16,167
396	16,226	449	15,474
397	16,433		

2.2 Other Vessel Calculations

This category includes those vessels which may contain uranium solutions at inventory time but excludes those vessels previously mentioned which involved only SS material transfer points. The calibration equations and specific gravity conversions are listed below. These data must be referred to when process inventory calculations are necessary.

$$\begin{array}{lcl}
 \text{B-100} & \left\{ \begin{array}{l} V = 5.43 + 2.55 (D) \\ D = \frac{LL (2)}{SG} \end{array} \right. & \\
 & & SG = 1.005 (DR) \\
 \text{B-110} & \left\{ \begin{array}{l} V = 4.7 + 2.252 (D) \\ D = \frac{LL}{SG} \end{array} \right. & \\
 & & SG = 0.01015 (DR) \\
 \text{C-106} & \left\{ \begin{array}{l} V = 16.07 (D) - 10.12 \\ D = \frac{LL}{SG} \end{array} \right. & \\
 \text{C-107} & \left\{ \begin{array}{l} V = 11.14 (D) - 7.77 \\ D = \frac{LL}{1.000} \end{array} \right. &
 \end{array}$$

$$\begin{array}{l} \text{C-156} \\ \left\{ \begin{array}{l} V = 16.04 (D) - 11.51 \\ D = \frac{LL}{SG} \end{array} \right. \end{array}$$

$$\begin{array}{l} \text{D-106} \\ \left\{ \begin{array}{l} V = 16.04 (D) - 13.43 \\ D = \frac{LL}{SG} \end{array} \right. \end{array}$$

$$\begin{array}{l} \text{E-103} \\ \left\{ \begin{array}{l} V = 37.74 (D) - 81.9 \\ D = \frac{LL}{SG} \\ SG = 0.961 + 0.00405 (DR) \end{array} \right. \end{array}$$

$$\begin{array}{l} \text{E-104} \\ \left\{ \begin{array}{l} V = 7.25 (D) - 7.90 \\ D = \frac{LL (0.4)}{SG} \\ SG = 0.987 + 0.00416 (DR) \end{array} \right. \end{array}$$

$$\begin{array}{l} \text{E-105} \\ \left\{ \begin{array}{l} V = 0.5916 (D) + 0.35 \\ D = \frac{LL}{1.53} \end{array} \right. \end{array}$$

$$\begin{array}{l} \text{E-108} \\ \left\{ \begin{array}{l} V = 41.87 (D) - 77.9 \\ D = \frac{LL}{SG} \\ SG = 0.961 + 0.961 + 0.00404 (DR) \end{array} \right. \end{array}$$

$$\begin{array}{l} \text{E-110} \\ \left\{ \begin{array}{l} V = 28.90 (D) - 84.71 \\ D = \frac{LL (1.3)}{SG} \\ SG = 0.93 + 0.0039 (DR) \end{array} \right. \end{array}$$

$$\begin{array}{l} \text{E-153} \\ \left\{ \begin{array}{l} V = 37.70 (D) - 77.9 \\ D = \frac{LL}{SG} \\ SG = 0.95 + 0.004 (DR) \end{array} \right. \end{array}$$

	$\left\{ \begin{array}{l} V = 28.75 (D) - 73.7 \\ D = \frac{LL (1.2)}{sg} \\ sg = DR (.00404) + 0.6061 \end{array} \right.$
H-110	$\left\{ \begin{array}{l} V = 0.553 (D) + 9.9 \\ D = \frac{LL (1.5)}{sg} \\ sg = (DR) 0.0501 + 1.0020 \end{array} \right.$
H-100-109	$\left\{ \begin{array}{l} V = 2.53 (D) + 5.33 \\ D = \frac{LL (3.5)}{sg} \\ sg = (D.R.) 0.0050 + 0.9548 \end{array} \right.$
	$\left\{ \begin{array}{l} V = 2.54 (D) + 4.86 \\ D = \frac{LL (3.5)}{sg} \\ sg = (DR) 0.0046 + 0.9562 \end{array} \right.$
N-120-129	$\left\{ \begin{array}{l} V = 2.52 (D) + 4.56 \\ D = \frac{LL (3.5)}{sg} \\ sg = (DR) 0.00501 + 0.9529 \end{array} \right.$
N-130-129	$\left\{ \begin{array}{l} V = 2.50 (D) + 5.28 \\ D = \frac{LL (3.5)}{sg} \\ sg = (DR) 0.00504 + 0.9577 \end{array} \right.$
N-140-149	$\left\{ \begin{array}{l} V = 2.54 (D) + 5.72 \\ D = \frac{LL (3.5)}{sg} \\ sg = (DR) 0.00500 + 0.9548 \end{array} \right.$

$$\begin{array}{l} \text{F-110} \left\{ \begin{array}{l} V = 0.1387 (D) + 0.67 \\ D = \frac{LL}{sg} \\ sg = 0.952 + 0.005 (DR) \end{array} \right. \end{array}$$

$$\begin{array}{l} \text{F-114} \left\{ \begin{array}{l} V = 11.12 (D) - 11.87 \\ D = \frac{LL (0.5)}{sg} \\ sg = 0.958 + 0.0030 (DR) \end{array} \right. \end{array}$$

$$\begin{array}{l} \text{F-115} \left\{ \begin{array}{l} V = 1.22 (D) - 1.14 \\ D = \frac{LL}{sg} \\ sg = 0.794 \end{array} \right. \end{array}$$

$$\begin{array}{l} \text{F-116} \left\{ \begin{array}{l} V = 0.76 (D) - 0.31 \\ D = \frac{LL}{sg} \\ sg = 0.794 \end{array} \right. \end{array}$$

$$\begin{array}{l} \text{F-119} \left\{ \begin{array}{l} V = 3.96 (D) - 2.85 \\ D = \frac{LL (0.3)}{cg} \\ sg = 0.936 + 0.00296 (DR) \end{array} \right. \end{array}$$

H-108 This is a two stage vessel so that the volume can only be accurately found when the H₂O has been jetted-off leaving the organic phase. All water has been jetted-off whenever a density recorder reading of 38.5 or less is recorded.

$$\begin{array}{l} \text{N-150-159} \end{array} \left\{ \begin{array}{l} V = 2.54 (D) + 3.49 \\ D = \frac{LL (3.5)}{sg} \\ sg = (DR) 0.00502 + 0.9543 \end{array} \right.$$

$$\begin{array}{l} \text{P-110} \end{array} \left\{ \begin{array}{l} V = 2.21 (D) \\ D = \frac{LL (0.2552)}{sg} \\ sg = (10 + DR) 0.0995 \end{array} \right.$$

$$\begin{array}{l} \text{Q-110} \end{array} \left\{ \begin{array}{l} V = 0.90 (D) \\ D = \frac{LL (0.2254)}{sg} \\ sg = (10 + DR) 0.1005 \end{array} \right.$$

$$\begin{array}{l} \text{S-110} \end{array} \left\{ \begin{array}{l} V = 1.01 (D) \\ D = \frac{LL (0.2314)}{sg} \\ sg = (10 + DR) 0.1005 \end{array} \right.$$

$$\begin{array}{l} \text{Z-101} \end{array} \quad V = 2.573 \left(\frac{LL}{sg} \right)$$

sg Reported by analytical laboratory from sample taken from tank.

$$\begin{array}{l} \text{Z-104} \end{array} \quad V = 2.585 \left(\frac{LL}{sg} \right)$$

sg Reported by analytical laboratory from sample taken from tank.

$$\begin{array}{l} \text{Z-107} \end{array} \quad V = 2.572 \left(\frac{LL}{sg} \right)$$

sg Furnished by analytical laboratory from sample taken from tank.

3. MEASUREMENTS AND STATISTICS

3.1 Measurement and Control

3.11 Sampling

(1) Feed Input. Routinely, three 5-ml samples are pulled from each feed batch. Two samples are selected on a random basis and analyzed for acidity and specific gravity. The third sample is held for possible future analyses. If the acidity and specific gravity determinations between the two samples analyzed are in agreement within prescribed tolerance limits, a single sample is randomly selected and analyzed for uranium concentration. This sample also is used for mass spectrometer determination. If there is a significant difference between the two samples (for specific gravity and/or acidity), a third sample is pulled and analyzed. Should two out of the three agree, one of the agreeing pair will be analyzed for mass assay and uranium concentrations. If all three disagree, the three will each be analyzed for uranium. This sampling and analytical procedure is used only for processing runs where historical statistical data are available to establish nomograph curves for acidity and specific gravity. These curves vary for each type fuel processed; therefore, some processing runs may include material types where no historical processing data or statistics are available to establish a nomograph curve. In such cases, the sampling procedures change. For instance, if there is an agreement between the first two samples (for specific gravity and acidity) both will be analyzed for uranium. Both results will be reported. If there is a disagreement between the first two samples, a third is analyzed. The two agreeing pairs will each be analyzed for uranium. If none agree, all three will be analyzed for uranium.

The criteria for reruns based on specific gravity and acidity are based on range limits. These limits are variable and cannot be quoted here to be used in all cases. Therefore, no attempt will be made to include this data in terms of actual quantities.

The Mass Laboratory will analyze all samples received. There are no rejection limits for triplicates; all three results will be reported. Range limits for duplicates are 0.13-mg total uranium per ml and 0.21 absolute percent of the U-235 isotope. If either of these limits is exceeded, the third sample bottle is analyzed. All results should be reported.

Until sufficient data are generated to establish a reliable relationship for uranium concentration as a function of acidity and specific gravity, duplicate mass spike analyses will be required.

(2) Waste Samples. Table IV summarizes the various limits for lean streams.

The following limits govern the analyses that are made:

- (1) One of the duplicate samples is analyzed.
- (2) If the result is less than the "Analysis Repeat Limit" it is reported, and no further analyses are required.
- (3) If the result exceeds the "Analysis Upper Limit", an immediate request is made for two additional samples, and the available duplicate also is analyzed. The additional two samples also are analyzed and all four results are reported.

- (4) If the result falls between the Analysis Repeat Limit and the Analysis Upper Limit, the duplicate is analyzed. If the mean difference is less than 35 percent, both results are reported.

TABLE IV

URANIUM LIMITS STATED IN GRAMS PER LITER

Code Sample	Limits for Transfer to	Emergency Limits	Process Limits	Repeat Analysis Limits
CFD	Service Waste	See (2) below	3.0×10^{-4}	1.0×10^{-3}
CFD	WL-102	See (1) below	1.5×10^{-3}	1.0×10^{-3}
PEW	WL-102	See (1) below	1.5×10^{-3}	1.0×10^{-3}
I ARM (CPM)	Permanent Storage	5.0×10^{-2}	6.0×10^{-3}	3.9×10^{-3}
II & III ARM	WL-101	3.3×10^{-2}	3.3×10^{-2}	2.2×10^{-2}
I ARM (Zirconium)	WM-103	8.0×10^{-3}	2.7×10^{-3}	2.0×10^{-3}
I ARM (Stainless Steel)	WM-106	8.0×10^{-3}	2.7×10^{-3}	2.0×10^{-3}
I BRM (Zirconium, Stainless Steel)	WM-100 via U-130	1.6×10^{-2}	1.6×10^{-2}	1.2×10^{-2}
ISW (Zirconium, Stainless Steel)	WM-100 via U-130	6.8×10^{-2}	6.8×10^{-2}	5.0×10^{-2}

If the mean difference is 35 percent or greater, two additional samples are requested. If the result of one is less than the Analysis Repeat Limit, all three results are released and the fourth sample need not be analyzed. If greater, the duplicate is analyzed, and, if the mean difference is less than 35 percent, all four results are reported. If the second duplicates do not agree within 35 percent, further duplicates are analyzed until agreement is obtained.

Data on the stainless steel waste stream is not available at this time. It is also possible that the zirconium system limits stated above will be subjected to revision.

- (1) Uranium concentrations up to and including 1.5×10^{-3} gms/l may be approved by the shift superintendent. Uranium concentration above 1.5×10^{-3} gms/l must be approved by the Operations superintendent.

The laboratory will automatically run the duplicate sample, if the first sample exceeds a uranium concentration of 3.0×10^{-4} gms/l and will not report a result until agreement is reached between samples. If necessary, the laboratory will request additional samples.

In emergencies PEW and CFD tanks may be pumped without waiting for an analysis if permission is obtained from the Operations superintendent.

- (2) Up to 25 grams of uranium per week may go to ground from CFD.

In all cases the approval of the Operations superintendent or the assistant Operations superintendent is required to dispose

of solutions which exceed the emergency limit for uranium concentrations.

(3) Final Product Sampling. Samples are submitted representing either a top or bottom sample (selected randomly) of each bottle (usually ten) filled in one sequence. Specific gravity is determined on each sample. Mass isotopic distribution, spectrochemical impurities, and gravimetric uranium are determined on the first, second, and last bottles.

(a) Specific Analytical Procedure for the First Bottle

- (1) If (a) the difference in concentration between the first and second bottle is less than 1.0 mg/g and if (b) the difference in U-235 percentages is less than 0.30 percentage points, then the analytical results as found for the first bottle are to be reported for that bottle.
- (2) If neither (a) and/or (b) above obtain, then the second sample from the first bottle is to be analyzed. If the second sample analyses agree with the first to within 0.8 mg/g for concentration and within 0.23 percentage points for U-235, then the two results are to be reported.
- (3) If (1) and (2) are not obtained, then an additional sample is to be drawn from the first product bottle after again rocking for 20 minutes and repeat analyses are to be made on this sample until two successive concentrations agree to within 0.8 mg/g and successive U-235 percentages to within 0.23 percentage points.

(b) Specific Procedure for Bottles Subsequent to the First Drawn

- (1) If (a) the range of specific gravity determinations for all bottles except the first drawn is less than 0.002, if (b) the difference between concentrations for the second and last is less than 0.8 mg/g, and if (c) the difference between U-235 percentages for the second and last bottles is less than 0.23 percentage points, then the analytical results of samples from the second and last bottle are to be reported and associated with all product bottles except the first drawn.
- (2) If the range of specific gravity determinations for all product bottle samples except the first drawn is less than 0.002 but (b) and/or (c) do not hold, then the second samples from the second and last product bottle are to be analyzed. If (b) and (c) hold for the repeat sample analyses, the analytical procedure terminates and the two repeat analyses are to be reported and associated with all product bottles except the first drawn.
- (3) If (a) does not hold and/or either of the pair of repeat analyses is out of limits, then the samples from each product bottle intermediate to the second and last are to be analyzed for mass assay, spectrochemistry, and concentrations.

- (4) With reference to Table V if (a') the range of the n-1 concentration determinations corresponding to all product bottles except the first is less than the corresponding tabled value, and if (b') the range of the n-1 U-235 percentages is less than its corresponding tabled value, then the analytical effort ceases and each analysis is identified with the corresponding product bottle.
- (5) If (a') and/or (b') are not obtained, all product bottles are to be resampled after being mechanically rocked for a minimum of 20 minutes and repeat analyses are to be made on each of the resamples from each product bottle until agreement between successive determinations per sample is within 0.8 mg/g for the concentration and 0.23 percentage points for U-235.

TABLE V
PRODUCT CONCENTRATION RANGE LIMITS

Total Number of Bottles Exclusive of First (n-1)	Concentration (mg/g)	U-235 Percentage Points
2	0.8	0.23
3	0.9	0.26
4	1.0	0.28
5	1.1	0.29
6	1.1	0.30
7	1.1	0.31
8	1.2	0.32
9	1.2	0.33

3.12 Calibration. The calibration of all pertinent ICPP vessels was accomplished by introducing into the vessels known increments of water as determined by weight tank measurements and relating these to the corresponding liquid levels as determined from a direct reading manometer. The choice of calibration curve depends upon the shape of the vessels. Usually the vessels approximate a right circular cylinder to sufficient degree that a linear equation is representative. However, if the tank has been welded at some height laterally around the vessel, distortion may require that a second-degree equation or possibly two straight lines be fitted to the resulting calibration data. The usual method for determining the parameters of the calibration equation is Least Squares. It is to be noted, however, that the Least Squares method of fit and resulting inference is based upon the assumption that the independent variable (in this case, volume as related to the weight of water introduced in the tank) is exactly determined and that the dependent variable (liquid level for a given volume) is normally distributed about an assumed "true" calibration curve. The incremental nature of subsequent volume determinations in a given calibration run introduces opportunity for a compounding of errors in volume measurements as the

run progresses unless extreme care is taken at each step in the calibration run.

ICPP vessels that have been modified to the extent that internal changes are necessary will be recalibrated to form a new regression curve and calibration equation. Some changes may be required to install new instrument devices, or to modify existing lines on instruments within the vessels.

3.2 Stoichiometric Relationships

The total feed to the plant in increments of clean dissolver to clean dissolver also can be verified by a stoichiometric U-235 balance equation (Equation (1), Paragraph 3.6) or by a U-236 balance equation (Equation (2), Paragraph 3.7). For each such increment of feed, these equations are applied and the result compared to the total uranium found by the accumulated batch quantities as determined by the isotopic dilution method of analysis and volume measurement.

3.3 Computation of Recognized Limits of Uncertainty in Material Balance Calculations

The uncertainty to be associated with a given entry in a material balance calculation depends upon:

- (a) The manner in which the fundamental process measurements combine to give the entry and
- (b) The random and systematic error in each fundamental measurement.

If I denotes a given material balance item and $X_1, X_2, \dots, X_k$ the fundamental process variable from which I is computed, by the function $f(X_1, X_2, \dots, X_k)$, ie,

$$I = f(X_1, X_2, \dots, X_k)$$

then the variance, $(V)I$, of I , from which the uncertainty in I can be estimated, is related to the variance of the systematic and random errors in the X_i 's by the expression

$$V(I) = \sum_{i=1}^k \left(\frac{\partial f}{\partial x_i} \right)^2 V(X_i) + 2 \sum_{i=1}^k \sum_{j>i}^k \left(\frac{\partial f}{\partial x_i} \right) \left(\frac{\partial f}{\partial x_j} \right) V(X_i, X_j)$$

where the partial derivatives are evaluated at the mean levels of the variables and $V(X_i, X_j)$ denotes the co-variance of the variables X_i and X_j .

The actual estimate for the components are obtained in the usual manner.

3.4 Stoichiometric Relationship Between U-235 and U-236 Percentages in Spent Reactor Fuel

If we define for a given quantity of fuel

U_0 = pre-irradiated uranium content

U_1 = post-irradiated uranium content

E_0 = pre-irradiation fraction U-235

E_1 = post-irradiation fraction U-235

Z_0 = pre-irradiation fraction U-236

Z_1 = post-irradiation fraction U-236

α = cross section "capture-to-fission" for U-235

then the following relationships obtain:

$$(1) U_1 = U_0 \frac{(\alpha + Z_0)}{\alpha + Z_1}$$

$$(2) U_1 = U_0 \frac{(1 + \alpha - E_0)}{1 + \alpha - E_1}$$

$$(3) E_1 = \frac{\alpha}{\alpha + Z_0} [E_0 + \frac{Z_0}{\alpha} (\alpha + 1)] + Z_1 \left[\frac{E_0}{\alpha + Z_0} + \frac{Z_0(\alpha + 1)}{(\alpha + Z_0)} \frac{\alpha + 1}{\alpha} \right]$$

Equation (1) results from

$$\text{Fissioned U-235} = \frac{\text{U-236 Production}}{\alpha} = \frac{U_1 Z_1 - U_0 Z_0}{\alpha}$$

and

$$U_1 = U_0 - \text{Fissioned U-235}.$$

Equation (2) follows from

$$E_1 U_1 = E_0 U_0 - \text{Burnup}$$

and

$$\text{Burnup} = (1 + \alpha) (U_0 - U_1).$$

Equation (3) is derived from

$$\text{U-236 Production} = U_1 Z_1 - U_0 Z_0$$

and also

$$\text{U-236 Production} = \frac{\alpha}{1 + \alpha} (U_0 E_0 - U_1 E_1)$$

along with (1); ie,

$$U_1 = \frac{U_0 (\alpha + Z_0)}{\alpha + Z_1}.$$

3.5 Aluminum Balance Equation

Define

C_i = Uranium content (shipper's figures) for the ith charge

V_i = Volume of the ith batch as determined from level reading, calibration curve, and batch specific gravity

A_i = Moles of aluminum in the ith charge as determined from fabrication data and subsequent weights when batching at ICPP.

It has been reported that the molarity of the aluminum (E_i) in the ith batch is reasonably approximated by

$$E_i = \frac{\rho_i - 1.00120 - 0.0012(\text{g Hg/l})_i - 0.3177(\underline{M} \text{ UNH})_i - 0.03096(\underline{M} \text{ HNO}_3)_i}{0.1553}$$

Thus, if we assume that the percent uranium dissolved is the same as the percent aluminum, grams of uranium per batch can be estimated by

$$\text{Grams of uranium for ith batch} = \frac{C_i E_i V_i}{A_i}$$

or

$$\text{Concentration of ith batch} = \frac{C_i E_i}{A_i}$$

3.6 Propagations of Limits of Recognized Uncertainty of ICPP Final Product Solutions.

The procedure for determining the limits of recognized uncertainty for product solution is outlined in section 3.3 by this manual. The errors in the product weights in this case are considered to be negligible.

4. EVALUATION OF S/R DIFFERENCES

4.1 Responsibility For

It is the duty of the station representative to appraise and evaluate all shipper/receiver differences incident to ICPP fuel processing and development studies. As a member of the Operations Analysis Branch he has at his disposal the necessary technical and mathematical assistance to properly evaluate numbers generated in the Operations and Analytical Chemistry Branches.

4.2 Procedure

The primary tool for evaluating S/R differences on dissolved fuel batches rests in one's ability to properly appraise all measurement data. The appraisal routine in all cases is centered around the quality of the data. This quality

is expressed as measurement error and generally regarded as "Limits of Recognized Uncertainty". By applying the procedures outlined in this section of the manual, the SS representative can propagate the error associated with any particular fuel processed.

The S/R difference value can only be properly evaluated by comparing it with the total known measurement error associated with the shipper's and the receiver's value. In some cases the reactor operator (shipper) does not evaluate his measurement data in terms of error propagation. Therefore, it sometimes becomes a matter of arbitration as to whether the shipper or the receiver is responsible for the entire measurement difference. In general, if the ICPP measurement error is greater than the measurement difference, the SS representative can regard the difference as insignificant. If the difference is greater than the ICPP measurement error, the quantity outside the uncertainty must be related to reactor-burnup calculation error. If this is not possible, arbitration will be necessary.

S/R differences which are less than the error reported by the fabricator or ICPP processor are considered to be insignificant. All insignificant differences between the reactor operator and ICPP will be adjusted to reflect the latter's total measurement value.

V. REPORTING

All inventory and Material Balance Reports mentioned in this section will be transmitted to the Idaho Operations Office Nuclear Materials Control officer before or on the ninth working day following the end of the stated report period.

1. SEMIANNUAL MATERIAL BALANCE AND INVENTORY REPORT

Semiannually (June 30 and December 31) the Idaho Nuclear Materials SS representative must prepare a summary of SS material transfer transactions concerning inventories, losses, writeoffs, MUF's, and AEC transfer data. This report (MBR) is compiled and printed by computer program through the use of the out-of-area Transfer Journal data cards. A printed sample of this report is shown in Figures 35 and 35A. Lines No. 1, 38, 60, 61, 62, and 63 are not part of the regular Transfer Journal data. Therefore, data cards must be punched showing SS material quantities applicable to each line number and inserted with the MBR program deck. The source data backup for entries of this nature is the Journal Entry adjustment form (see section on journals). The period and year-to-date totals are summarized in the monthly loss schedule reports mentioned later in this section.

Each line entry shown on the Material Balance report for Lines 2 through 27, 30 through 37, and 42 through 59 is further supported by an attached RIS -- Operational Office Summary Subschedule. A typical schedule for a single-line entry backup is shown in Figure 36. The period and year-to-date totals for each RIS within a particular Operations Office is summarized showing the uranium values incident to that Operations Office. The summary is separated by material type and further subdivided by "receipts" and "shipments".

2. COMPOSITION OF ENDING INVENTORY REPORTS

The Composition of Ending Inventory reports must be prepared quarterly (December 31, March 30, June 30, and September 30). The format of this report is outlined in Chapter 7400 of the AEC Manual. Semiannually (June 30 and December 31) the Composition reports will be modified to reflect the total projected and nonprojected quantities on Lines 102 and 103. The total projected and nonprojected quantities must be in agreement with Line 190 (total nonproduction reactors and R & D). A sample of these reports is shown in Figure 37. On March 30 and September 30 the COEI is reported with Line numbers 102, 103, and 104 omitted.

3. PROJECT INVENTORY REPORTS

Semiannually (June 30 and December 31) the Idaho Nuclear Materials Management representative is responsible for the issuance of a station inventory report showing project and/or nonproject quantities. This report is

U. S. A T O M I C E N E R G Y C O M M I S S I O N
M A T E R I A L B A L A N C E R E P O R T

DEPLETED URANIUM(KILOGRAMS)

IDAHO NUCLEAR CORPORATION (IWA)

JAN 1, 1966 THRU JUNE 30, 1966

FISCAL YEAR TO DATE

(TOTAL ELEMENT) (ISOTOPE)
5026 11

(TOTAL ELEMENT) (ISOTOPE)
120 *

1. BEGINNING INVENTORY

2. PROCUREMENT -RAW MATERIALS

3. -OTHER

4. PRODUCTION

5. DOD RETURNS -USE A

6. -USE B

7. -OTHER

8. FROM OTHER SS MATERIAL BALANCES

9. FIELD OFFICE -NEVADA

10. -ALBUQUERQUE

11. -BROCKHAVEN

12. -CHICAGO

13. -CLEVELAND SNPO

14. -DIVISION OF INTERNATIONAL AFFAIRS

15. -DIVISION OF NUCLEAR MATERIALS MGT

16. -DIVISION OF RAW MATERIALS

17. -GRAND JUNCTION

18. -IDAHO

19. -NEW YORK

20. -OAK RIDGE

21. -PITTSBURGH NAVAL REACTORS

22. -RICKLAND

23. -SAN FRANCISCO

24. -SAVANNAH RIVER

25. -SCHENECTADY NAVAL REACTORS

26.

28. TOTAL RECEIVED

29. TOTAL TO ACCOUNT FOR

4898 11

137 *

5037 11

5157 11

131

131

5157

Fig. 35 Material balance summary report.

30.	
31.	EXPENDED IN SPACE PROGRAMS
32.	SALES
33.	DOD -USE A
34.	-USE B
35.	-OTHER USES
36.	EXPENDED IN AEC TESTS
37.	ROUTINE TESTS(ALBUQUERQUE AND SANFRANCISCO)
38.	NUCLEAR LOSS
39.	DECAY
40.	SHIPPER-RECEIVER DIFFERENCE
41.	TO OTHER SS MATERIAL BALANCES
42.	FIELD OFFICE -NEVADA
43.	-ALBUQUERQUE
44.	-BROCKHAVEN
45.	-CHICAGO
46.	-CLEVELAND SNPO
47.	-DIVISION OF INTERNATIONAL AFFAIRS
48.	-DIVISION OF NUCLEAR MATERIALS MGT
49.	-DIVISION OF RAW MATERIALS
50.	-GRAND JUNCTION
51.	-IDAHO
53.	-NEW YORK
54.	-OAK RIDGE
55.	-PITTSBURGH NAVAL REACTORS
56.	-RICHLAND
57.	-SAN FRANCISCO
58.	-SAVANNAH RIVER
59.	-SCHENECTADY NAVAL REACTORS
60.	ACCIDENTAL LOSSES
61.	NORMAL OPERATIONAL LOSSES
62.	WRITE-OFFS
63.	MATERIALS UNACCOUNTED FOR
64.	TOTAL REMOVALS
65.	ENDING INVENTORY
66.	TOTAL ACCOUNTED FOR

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*	*
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5157	11
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5157	11
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*	*
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5157	11
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5157	11
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Fig. 35a Material balance summary report.

STATION FZA	131	*	131	*
STATION FZC			6	*
TOTAL USAEC, OAK RIDGE OPERATIONS OFFICE	131	*	137	*

Fig. 36 Material balance summary report subschedule.

IDAHO NUCLEAR CORPORATION STATION JWA				
COMPOSITION OF ENDING INVENTORY AS OF JULY 31, 1967				
ENRICHED URANIUM				
LINE NUMBER	MATERIAL STATUS	MATERIAL TYPE	-----GRAMS----- SSNET ISOTOPE	
102	PROJECT QUANTITIES		1260005	989967
103	NONPROJECT QUANTITIES		229389	213676
104	TOTAL		1489394	1203643
120	USABLE, STORED FOR DEFINITE USE	31	288	14
120	USABLE, STORED FOR DEFINITE USE	37	113	95
120	USABLE, STORED FOR DEFINITE USE	38	229389	213676
150	IN MISCELLANEOUS R AND D	23	390	6
150	IN MISCELLANEOUS R AND D	28	250	159
150	IN MISCELLANEOUS R AND D	31	871	41
150	IN MISCELLANEOUS R AND D	32	2567	137
150	IN MISCELLANEOUS R AND D	33	2502	337
150	IN MISCELLANEOUS R AND D	36	374	200
150	IN MISCELLANEOUS R AND D	37	6361	5692
150	IN MISCELLANEOUS R AND D	38	7397	6883
150	IN MISCELLANEOUS R AND D	39	206	199
180	IRRADIATED MATERIAL IN STORAGE	28	715	21
180	IRRADIATED MATERIAL IN STORAGE	31	621	25
180	IRRADIATED MATERIAL IN STORAGE	33	12383	2606
180	IRRADIATED MATERIAL IN STORAGE	34	800	242
180	IRRADIATED MATERIAL IN STORAGE	36	397031	246894
180	IRRADIATED MATERIAL IN STORAGE	37	613023	527351
180	IRRADIATED MATERIAL IN STORAGE	38	214113	199065
190	TOTAL NONPRODUCTION REACTORS AND R AND D		1489394	1203643
282	IN RECOVERY PROCESS - IRRADIATED	36	44535	23131
290	TOTAL IN PROCESSES		44535	23131
354	UNH SOLUTIONS	36	45981	22802
354	UNH SOLUTIONS	37	58405	41873
354	UNH SOLUTIONS	38	5	4
380	TOTAL INTERMEDIATE PRODUCTS		104391	64679
477	TOTAL ENRICHED URANIUM	21	1638320	1291453

Fig. 37 Composition of ending inventory.

segregated by material type, project code, and enrichment ranges so specified by the Atomic Energy Commission. A sample of the report is shown in Figure 38. The total projected and nonprojected quantities must be in agreement with total nonproduction reactors and R & D shown in the COEI report.

Idaho Nuclear Corporation cannot transfer SS material from one project number to another without prior approval from the Idaho Operations Office. The only exception to this rule would be the transfer of spent reactor fuel transferred to project J-25000-00-01 for ICPP processing.

Upon dissolution and measurement all projected material from project numbers J-25000-00-01, 02, 03, and 04 are automatically transferred to "production". See Lines 290 and 380 on the Composition of Ending Inventory Report (Figure 37).

IDAHO NUCLEAR CORPORATION(JWA)				
SUMMARY OF ALLOTMENT INVENTORIES AS OF JANUARY 31 1967				
ENRICHED URANIUM				
GRAMS				
PROJECT NUMBER	PROJECT TITLE	MT	SSNET	ISGTCPE
IC-48001-02-01	ETR FUEL ELEMENTS	38	180	167
IC-46001-01-01	SPERT	25	1906	57
IC-46001-01-01	SPERT	33	12	1
IC-44002-01-01	FUEL ELEMENT DEVELOPMENT	32	6	7
IC-44002-01-01	FUEL ELEMENT DEVELOPMENT	36	11	7
IC-44002-01-01	FUEL ELEMENT DEVELOPMENT	36	11	10
IC-46001-02-01	POWER BURST FACILITY	32	21	1
IC-46001-02-01	POWER BURST FACILITY	33	14	2
IC-44004-03-01	ANALYTICAL AND DEVELOPMENT	28	1023	15
IC-44004-03-01	ANALYTICAL AND DEVELOPMENT	26	200	156
IC-44004-03-01	ANALYTICAL AND DEVELOPMENT	31	921	43
IC-44004-03-01	ANALYTICAL AND DEVELOPMENT	32	2693	147
IC-44004-03-01	ANALYTICAL AND DEVELOPMENT	33	2505	333
IC-44004-03-01	ANALYTICAL AND DEVELOPMENT	35	5	2
IC-44004-03-01	ANALYTICAL AND DEVELOPMENT	36	617	304
IC-44004-03-01	ANALYTICAL AND DEVELOPMENT	37	6583	5817
IC-44004-03-01	ANALYTICAL AND DEVELOPMENT	38	7089	6598
IC-44004-03-01	ANALYTICAL AND DEVELOPMENT	39	230	223
IC-23020-10-04	LAB CERTIFICATION	31	288	14
IC-23020-10-04	LAB CERTIFICATION	37	113	95
IC-25000-00-01	AEC IRRADIATED MATERIAL	31	1022544	41107
IC-25000-00-01	AEC IRRADIATED MATERIAL	33	12383	2606
IC-25000-00-01	AEC IRRADIATED MATERIAL	34	800	242
IC-25000-00-01	AEC IRRADIATED MATERIAL	36	197615	116662
IC-25000-00-01	AEC IRRADIATED MATERIAL	37	318912	278007
IC-25000-00-01	AEC IRRADIATED MATERIAL	38	196610	182782
IC-25000-00-02	DOMESTIC LICENSEE IRRADIATED MATERIAL	37	51714	44427
IC-25000-00-03	FOREIGN NATION IRRADIATED MATERIAL	33	21581	4240
IC-25000-00-03	FOREIGN NATION IRRADIATED MATERIAL	36	3983	3139
IC-25000-00-03	FOREIGN NATION IRRADIATED MATERIAL	37	3353	2692
IC-25000-00-04	DEPARTMENT OF DEFENSE IRRADIATED MATERIAL	36	54338	40582
IC-25000-00-04	DEPARTMENT OF DEFENSE IRRADIATED MATERIAL	37	83051	67453
IC-25000-00-04	DEPARTMENT OF DEFENSE IRRADIATED MATERIAL	38	1404	1306
IC-44000-00-01	BASIC RESEARCH - BMI	33	13	2
IC-40201-10-05	PIQUA FUEL EXAMINATION	32	18	1
IC-40402-01-01	MARITIME SHIP RECTOR AND D	36	25	23
TOTAL PROJECTED QUANTITIES			1992772	799663

Fig. 38 Project inventory report.

4. LOSS SUMMARY JOURNAL

Monthly, the SS materials representative must prepare a loss summary outlining the loss entries incident to Lines 60, 61, 62, and 63 on the Material Balance Summary Report. This summary shows period totals and YTD totals for each line entry (see Figure 39). The Summary is prepared by extracting monthly loss transactions from the Material Balance Summary Ledger. The ledger values as indicated previously were documented by the journal entry adjustment record.

5. MATERIALS ACTIVITY SCHEDULE

Semiannually the Nuclear Materials Control Representative is required to submit a Materials Activity Schedule (Figure 40) to all addressees for which licensee material is being held. The report is prepared in triplicate and mailed to the respective licensee. Material transferred to Station JWA on AEC-388 transfer forms indicating a "return to AEC for credit" is regarded as Commission material, therefore, eliminating the need for the Material Activity Schedule. However, the report must be completed and mailed to all licensees who indicated in the original 388 transfer document that the material was being transferred to Station JWA indicating "no change in lease responsibility". Transfers of this nature include fuel transferred for recovery extending over a considerable

STATION _____			
SCHEDULE OF ACCIDENTAL LOSSES - NORMAL OPERATIONAL LOSSES, WRITE-OFFS, AND MATERIAL UNACCOUNTED FOR Material Type _____			
	Actual		Year-to-Date
	SS Net	ISOTOPE	
Accidental Losses	_____	_____	_____
Normal Operational Losses	_____	_____	_____
Write-Offs	_____	_____	_____
Material Unaccounted For *	_____	_____	_____
<u>Total Plant</u>	=====	=====	=====

Fig. 39 Schedule of JWA plant losses.

time period. In such case the licensee will issue several AEC-388 transfer forms each representing a particular shipment in the transfer series. These shipments (for the reporting period) are all listed on the activity schedule in Section 7. On receipt of the final shipment in the transfer series the NMC accountant will indicate same by showing the total accepted value in Section 10. This entry is made to indicate no licensee material is being held by Station JWA.

MATERIAL ACTIVITY SCHEDULE

For Government-Owned Special Nuclear Material Handled for the Account of Another License to Support
Item 16b. on Form AEC-578, Material Status Report
(Prepare a Separate Schedule for Each License)

1. REPORTING LICENSEE: (Physical possessor)

A. NAME _____
B. ADDRESS _____
C. LICENSE NO. _____

2. LICENSEE: (Responsible under a lease)

A. NAME _____
B. ADDRESS _____
C. LICENSE NO. _____

3. MATERIAL (A separate schedule by material type)	4. WEIGHT UNITS	5. TOTAL QUANTITY	
		A. ELEMENT	B. ISOTOPE
6. BEGINNING INVENTORY:			
7. RECEIPTS FROM: (Name, license and document number)			
8. TOTAL RECEIPTS			
9. MATERIAL TO BE ACCOUNTED FOR (Total lines 6 and 7)			
10. SHIPMENTS TO: (Name, license and document number)			
11. TOTAL SHIPMENTS			
12. PROCESSING LOSSES, DISCARDS, ETC.			
13. BURN-UP			
14. ENDING INVENTORY			
15. MATERIAL ACCOUNTED FOR (Total lines 11, 12, 13 and 14)			

16. PREPARED BY: _____
(Accountable Officer)

DATE: _____

ACCEPTED BY: _____
(Accountable Officer)

DATE: _____

Fig. 40 Materials activity schedule.

An additional Materials Activity Schedule is required for submission to the licensee upon completion of ICPP process measurement calculations. The shipper's values will be reflected in the receipt section (Section 7) of the schedule. The ICPP measure value will be shown in Section 10. In Section 12 the resulting S/R difference will be entered. The above corresponding "receipt" and "shipment" entries will result in a "0" ending inventory.

6. INVENTORY CUTOFF PROCEDURES

At the end of each reporting period (June 30 and December 31), all transfer source documents (AEC-101 and -388), which are associated with SS materials shipped by all other SS stations in the report period, must be entered into the Out-of-Area Transfer Journal. Therefore, no "material in transit" will exist between any two SS stations. If anticipated receipts are evident, it is the SS representative's duty to contact the shipper and obtain posting values for in-transit shipments and enter same into the transfer journal card deck. In these cases it will not be necessary to wait for AEC-101 transfer forms which could arrive after the period close out. During this waiting period the telephone call will be documented on paper and filed with the AEC 101 document.

Likewise, if the station representative for JWA issues an AEC-101 late in the reporting period, he should inform the receiver of the material that an in-transit exists which should be accounted for on his records in the current report period.

In view of the above condition it is usually necessary for the SS representative to maintain an open book of accounts until all source data concerning shipments and receipts for the period have been received. Theoretically, this procedure assumes no in-transit condition and, therefore, requires no journal entry for in-transit items.

7. MISCELLANEOUS PLANT INVENTORY ADJUSTMENTS

As indicated previously, the AEC-101 and -388 transfer forms represent a media through which the total plant inventory is decreased or increased. However, the total plant balance can be affected by normal operational losses, writeoffs, accidental losses, and material unaccounted for. A brief description of these adjustments is therefore included to outline the events which contribute to each category.

7.1 Normal Operational Losses

Normal operation losses include those that are routine in nature as well as those which are intermittently anticipated. For example, waste stream losses occurring in the process extraction columns are routine in nature and are transferred monthly to the "normal operation loss account". Research and Development studies which involve cutting, shipping, dissolving, sharing, etc., are not routine in nature but are anticipated and also need to be transferred to the normal operational loss account.

Unapproved normal operational losses (other than process extraction losses) are defined as losses which exceed \$200 per month. All normal operational losses which exceed \$200 per month must not be transferred to the loss account without special Idaho Operations Office approval. As mentioned earlier, this approval is obtained by the submission of form INC-249.

7.2 Writeoffs

SS material items contained in instrument counters or installed in monitoring devices are usually considered to be a capital item. They are therefore, transferred to the "writeoff account". Should shipment of an item to another SS station outside the jurisdiction of the Idaho Operations Office be necessary, the quantities involved will be transferred back to the records inventory. An AEC-101 transfer will then be made. However, prior approval for this action must be obtained from the Idaho Operations Office. This information is required by the local office for the purpose of obtaining permission from the receiver's operations office.

7.3 Accidental Loss

Accidental losses are regarded as those losses which were neither normal nor anticipated. Examples would include accidental spills, inadvertant burial, or losses occurring during a nuclear incident.

7.4 Material Unaccounted For

The MUF account is used to record plant inventory increases or decreases resulting from adjustments not included in the above. Examples of MUF include rounding errors, imbalances due to measurement uncertainty (this includes S/R differences and plant measurement imbalances), and all unexplained losses.

1. FORECAST REQUIREMENTS

By January 10 of each year the Nuclear Materials Control office is required to submit to the Idaho Operations Office a forecast of nuclear material withdrawals and returns which will cover the period July 1 of that year to June 30 of the following year. The forecast must be submitted by quarters and must be issued on form AEC-408 (Figure 27). The annual forecast must include all project numbers covering SS material on inventory or to be forecasted. In other words, if it is not anticipated that a withdrawal or return is required during the forecast period for a specific project, the inventory value of that project must be included in the forecast schedule. Inventories also must include all nuclear material outside projection channels which were withdrawn for the 04 allotment for use under contract AT(10-1)1230. Such project numbers are associated with the prefix "J".

By September 10 of each year the Nuclear Materials Control office is required to submit a revision to the third and fourth quarters included in the previous annual forecast. This revision will not include inventory values for project numbers but will include only the withdrawal and return estimates. Changes made to the third and fourth quarter forecast must be justified by using the explanation space located at the bottom of form AEC-408. In addition to this revision, an additional forecast is required which covers the first and second quarters of the succeeding fiscal year.

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2. SPECIAL NUCLEAR MATERIALS SUBJECT TO FORECASTING

Nuclear material forecasts for withdrawals and returns which are submitted to the Idaho Operations Office Nuclear Materials Management officer must include the following material type categories:

- (1) Enriched U-235 -- all percentages
- (2) U-233
- (3) Plutonium
- (4) Pu-238.

3. FORECAST QUANTITIES

The reporting units for all forecast schedules must be commensurate with the following values:

- (1) Enriched uranium -- nearest full kg U-235
- (2) U-233 -- nearest full 100 grams
- (3) Plutonium -- nearest full 100 grams
- (4) Pu-238 -- nearest full 1 gram unit.

4. COMPLETING FORM AEC-408:

Sections 1-5 Self explanatory.

Section 6 The wt% U-235 is to be recorded to the nearest full 1/10 percent. Plutonium forecasts should be reported with regard to Pu-240 content to the nearest 1 percent whole unit.

Section 7 This section is used to record the anticipated inventory for each project number on the first day of the forecasting period. This estimate will include present inventory values plus or minus withdrawal and returns prior to the inventory date.

Section 8 This section includes quarterly estimates of anticipated withdrawals. Project quantities should include fabrication and conversion excess requirements. Supply agreement quantities should include only finished product requirements.

Section 9 Total of Section 8.

- Section 10 Includes quarterly return estimates for each project number. This section must be divided into two categories signifying whether the material is to be returned to production channels in the form of cold scrap or irradiated fuel. Returns for fuel cores must include an allowance for U-235 burnup. This allowance is dependent on reactor cycle time expectancy and U-235 loading.
- Section 11 Total of Section 10.
- Section 12 Section 9 minus Section 11; this value can be negative.
- Section 13 See paragraph 1.3 of this section.
- Section 14 The remarks section is to be used to fully justify the withdrawal or return of each project listed.

VII. SEMIANNUAL REVIEW

1. AUDIT INSPECTION AND INVENTORY VERIFICATION

1.1 Semiannual Review

In accordance with INCP 8.15, each SS materials custodian will subject to semiannual review his SS materials holdings. This review will be conducted by members of the Nuclear Materials Control Group.

1.11 Custodian Inventory Verification. Semiannually, the Nuclear Materials Control Group will issue an IBM listing to each custodian showing the SS material items for which he is responsible. This list must be reviewed, verified, signed, and returned to the Nuclear Materials Control Office within seven working days after receipt. The custodian's signature (other than exceptions noted) will be a valid confirmation that he has knowledge of the existence of all items on the IBM listings. Prior misplacement of an internal transfer form (ID-164) will not relieve the custodian of the responsibility for a misplaced item if that item was indicated on an inventory list which has his signature. In other words, a signature on an IBM list is a valid confirmation of the existence and location of all items on that list and will be interpreted as a direct replacement of all ID-164 transfer forms related to the listings.

1.12 Inventory Sampling Requirements. After the above conditions have been met the SS materials inventory for each custodian will be verified by members of the Nuclear Materials Control Group. The sampling requirements are indicated in the paragraphs below:

- (1) A random sampling inventory verification will be conducted on all items containing less than 15 grams of SS content.
- (2) Where feasible, all items containing 15 or more grams of SS content will be verified by visual inspection. Unirradiated items are verified 100 percent by comparing same with subsidiary records. Storage basin inventories are verified by comparing piece count with subsidiary lists.
- (3) The process inventory will be taken by a member of the INC Nuclear Materials Control Office. A member of the Operations Branch will be required to escort the NMC accountant throughout the plant for the purpose of recording instrumental data on all tanks containing uranium solutions. These data are used in conjunction with analytical results or estimates to formulate an inventory calculation.

1.13 Custodian Records Review. The audit inspector will be required to review the record systems used by the various custodians. Each custodian must maintain a proper file of all ID-164 transfer forms to verify all inventory items assigned to him.

1.14 Review Findings. The Nuclear Materials Control supervisor will be responsible for semiannually summarizing all review findings and reporting same to Idaho Nuclear Corporation management. This report will be made available to all SS material custodian department heads.