FUNDAMENTAL NUCLEAR MATERIALS CONTROL PLAN

Submitted to

U. S. Nuclear Regulatory Commission
Division of Safeguards
Materials Control and Accounting
Washington, D. C 20545

By

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CHAPTER 1

1.0 ORGANIZATION

1.1.1 Corporate Organization

Figure A is a chart of the corporate organization structure which is related to special nuclear material control and accounting at the Union Carbide Sterling Forest Laboratory (SFL). Figure B is a chart of the SFL organization which is directly responsible for Special Nuclear Material (SNM) control and accounting.

1.1.1.1 Functional Descriptions

(a) The Manager, Health Physics (SNM Accountability Officer) is responsible for developing, revising, and administering the SFL FNMC Plan. He or his designee maintains the Master Log and all accounting records. He or his designee will schedule and coordinate the physical inventories and witness sampling for inventory.

(b) The Manager, Quality Assurance develops, revises, and administers the SNM measurement and calibration program under the FNMC Plan. When the Measurement Quality Assurance program is developed and approved the Quality Assurance Manager will administer it. His organization will perform analyses for inventory. He will maintain standards and measurement records for determining error statistics.

(c) The Manager, Radiochemical Production develops, revises, and administers in process handling procedures for SNM under the FNMC Plan. He or his designee will be responsible for shipping and receiving SNM, sampling and volume determinations for inventory. He or his designee will calculate LEMUF and determine MUF.

(d) The Manager, Nucleonics appoints and supervises individuals in performance of the above functions. In conjunction with the Nuclear Safeguards Committee, he approves procedures for implementing the FNMC Plan.

(e) The Nuclear Safeguards Committee, as previously described in UCC application for license renewal dated 4/28/69, reviews and approves all initial plans and procedures and changes thereto. It also performs audits of operations.

(f) The Sterling Forest Lab Operations Manager is responsible for operating the physical plant at the Sterling Forest site. In this capacity he monitors the operations of the Nuclear Safeguards Committee and is aware of all operations within the Nucleonics groups relating to the status of the physical plant or requring the attention or use of any of the site services groups.

(g) The Senior Research Scientist is responsible to the Manager Nucleonics and is assigned in a staff capacity as consultant to and/or auditor of operations when necessary or desirable.

(h) Special Nuclear Material Custodians are authorized individuals in each MBA who are responsible for maintaining accountability and security of SNM in their respective MBA's.

Detailed job descriptions of these positions are presented in Appendix "G".

1.1.1.2 Staffing

The control, measurement and accounting for SNM under the UCC SNM-639 License will be accomplished within the organization at the Sterling Forest Laboratory. This organization is accountable to the Corporate Group IV V.P. thru the General Manager, Clinical Diagnostics and thru the Director, New Business Development respectively.

1.1.1.3 Organization Charts

Figure "A" and "B" are charts of the corporate organization and SFL site organization respectively which are concerned with operations under the SNM-639 License.

1.1.1.4 Job Descriptions

The job descriptions relating to operations under SNM-639 are presented in Appendix "G".

1.1.2 Site Organization

Figure "B" is a chart of the SFL site organization which has the responsibility for SNM under SNM-639.

1.1.2.1 Internal Organization

Figure "B" is also a chart of the internal organization which identifies areas of SNM control program functions. Detailed job descriptions are presented in Appendix "G".

1.1.2.2 Separation of Functions

The organization of work involving SNM serves to separate functions so that the activities of one individual or organization serve as checks of others. Figure "C" shows the basic plant process flow of SNM. Figure "B" shows the organization of personnel to accomplish the work. The separation of functions exists between:

(a) Control Functions and Operating Functions.

Operating functions exist within the Radiochemicals Production group. This group is responsible for receiving SNM, fabricating targets, irradiating targets, containing SNM, separating fission products from irradiated SNM, and shipping irradiated and scrap SNM. The Quality Control Laboratory is responsible for assaying all SNM in process and at inventory. The Health Physics (H.P.) group administers the SNM accounting and control program. When material is received it is recorded in appropriate MBA logs by the custodian of the material and the Master Log by the H.P. group. Whenever material is transferred between MBA's, an SNM Transaction Form is filled out and signed by the custodians of both the issuing and receiving MBA's. This form, which is serial numbered, is sent to the H.P. group to record the transaction and adjust the master log. Some degree of control or check is afforded in that the flow of SNM in the plant process goes thru groups under separate administrative control, i.e.

[Feed] → [Plating→Encapsulation] → [α Contamination] →
Prod. — Production — H.P.

[Target Assay] → [Irradiation] → [Processing]
Q.C. — Operations — Production

(b) SNM Custody and Accounting.

The functions of custody and accounting are separated by the dual record keeping system of individual MBA logs and a master site log. In addition, inventories are performed by individuals in all groups not one of which is responsible for performing and reporting all components of an inventory measurement function in a single area.

(c) SNM Measurements and Accounting.

All assays of SNM are performed by the Q.C. group. The Q.C. group is only accountable for small quantities of SNM in NDA standards.

(d) Auditing and the Functions Being Audited.

Auditing is performed by the Nuclear Safeguards Committee thru a staff member outside the line organization of Production, Q.C. and H.P. The current auditor is the Senior Research Scientist shown in Figure "B".

1.1.2.3 Outside Support

It has not been necessary to procure outside support in the form of a technical services contractor or consultant to date. If such services are procured in the future they would most probably be procured and administered by the group manager having functional responsibility for the items or services rendered.

1.2 RESPONSIBILITIES AND AUTHORITIES

1.2.1 Overall Program Management

The Manager, Health Physics will be responsible for the overall planning, coordination and administration of the SNM control program. Figure "B" shows the functional responsibilities of this position which relates to the SNM control program. The qualifications of the individual to occupy this position shall include, a B.S. degree in a Nucleonics field, a working knowledge of Title 10, CFR and prior experience in SNM handling and control.

1.2.1.1 & 1.2.1.2 Independence of Action and Functional Relationships

Figure "B" and Section 1.1.1.1 show the functional and management relationship of this position to the other groups within the organization.

1.2.2 Accounting Management

The centralized SNM accounting system is the responsibility of the Manager, Health Physics. This is accomplished thru his designee to maintain the Master Log for SNM under SNM-639. The central SNM accountant shall, as a minimum, be in a technician grade level of Technical Specialist as defined by the SFL personnel job descriptions. The functional duties of this position relating to SNM-639 shall include:

(a) Maintain a current record of all SNM on site under authority of SNM-639 (Master Log).

(b) Witness receipts and shipments of SNM.

1.2.3 Special Nuclear Material Custodial Units

The organizational units which have custody of SNM are:

(a) Reactor Operations

(b) Radiochemical Production

(c) Quality Assurance

(d) Health Physics

1.2.3.1 SNM Custodians

SNM custodians have been designated as follows:

Reactor Operations

Title	Qualifications
Asst. Reactor Supervisor	Technical Specialist
Chief Reactor Operator	Technical Specialist

Radiochemical Production

Production Associate, Radiochemical Production	Technical Specialist
Shift Technician, Target Plating Lab	Technician

Quality Assurance

Shift Technician, Q.C. Lab	Technician

The duties of SNM custodians are as follows:

(a) Maintain custody of and be accountable for material within his MBA.

(b) Keep the MBA log up-to-date.

(c) Maintain proper security in his MBA.

The minimum qualifications for each job title are as described in the SFL personnel job descriptions.

1.2.4 Special Nuclear Material Control and Accounting Units

Figure "B" and Section 1.1.1.1 gives descriptions of the functions and authority of the organizational units concerned with handling material under SNM-639. See also Appendix "G".

1.2.5 Audits and Reviews

The Nuclear Safeguards Committee, thru a designated representative, will have the authority to perform audits of the special nuclear material control and accounting program and the measurement program.

1.2.6 Delegation of Authority

Delegation of authority and responsibility is made in writing when individuals are appointed to the above described positions related to special nuclear material controls. Such responsibility and authority is delegated by the next highest line function in the organization.

1.3 TRAINING PROGRAMS

The minimum annual training program will be as follows:

(a) Sixteen hours of instruction on the requirements of 10 CFR 70 and SNM License requirements will be given all management and supervisory personnel who have direct responsibility for control and accounting of SNM.

(b) Sixteen hours of instruction on 10 CFR 70, specific license requirements and operational procedures will be given to all personnel working directly with SNM.

(c) Effectiveness of training can be evaluated thru audits of operations by UCC and NRC personnel by noting adherence to established procedures and license requirements. Individuals will be retrained as indicated by such audits.

(d) Records of personnel training will be maintained by the Health Physics Manager.

(e) Each new employee assigned to work with SNM shall be given 2 weeks on-the-job training under the direction of a Senior Technician or a supervisor.

MANAGER, NUCLEONICS

This position is responsible for all activities (i.e. production, development, operations, Q.C., marketing) which are carried out in the Radiochemical and Radiodiagnostic production endeavors. This position is accountable to the Clinical Diagnostics General Manager and directs the activities of Radiochemical Production Manager, H.P. Manager, Q.A Manager, Senior Research Scientist and others not involved in operations with SNM.

Specific Duties

1. He, in conjunction with the Nuclear Safeguards Committee, reviews and approves procedures for reports of operations with SNM (except those reports required to be signed by corporate officers).

2. He appoints qualified individuals to positions reporting to him which involve operations with SNM.

Authority

The occupant of this position has line authority over all operations with SNM. He shall act in conjuction with the Nuclear Safeguards Committee in matters of SNM accounting, control and criticality safety.

Qualifications

The occupant of this position should be a senior staff member with several years experience in management of Nuclear Operations or other technical management experience.

MANAGER, RADIOCHEMICAL PRODUCTION

This position is responsible for Nuclear Operations and Radiochemical Process at SFL. This position is accountable to the Manager, Nucleonics and directs the activities of the Reactor Operations Supervisor and the Radiochemical Production Supervisor.

Specific Duties

1. He manages the Radiochemical Production group and the Reactor Operations group where all operations with SNM are performed.

2. He, in cooperation with the H.P. Manager, develops, revises and administers in process handling procedures for SNM.

3. He, or his designee, will be responsible for shipping and receiving.

4. He or his designee will, in cooperation with other managers, gather samples for physical inventory, calculate LEMUF and reconcile MUF with LEMUF. He or his designee will write a LEMUF report for each material balance period.

Authority

The occupant of this position has line authority over personnel performing operations with SNM. He may, in conjunction with the Nuclear Safeguards Committee, initiate investigations into the SNM Operations when he deems advisable or necessary.

Qualifications

The occupant of this position should have an educational background equivalent to a Bachelor's degree in science. He should have a working knowledge of Title 10 CFR and local license requirements. He should have had a few years work experience in managing nuclear operations.

MANAGER, HEALTH PHYSICS (H.P.)

This position is responsible for the general radiological health and safety at SFRL. This position is also designated as the Site Accountability Officer (SAO) and is responsible for developing, revising and administrating the Sterling Forest Laboratory (SFL) Fundamental Nuclear Materials Control Plan (FNMC). The position is accountable to Manager, Nucleonics and directs the activities of several H.P. staff members, professional and para-professional.

Specific Duties

1. He or his designee will maintain the SFL Master Log.

2. He, in cooperation with other managers involved will schedule and plan physical inventories and promulgate procedures for SNM Operations, control and accounting.

3. He or his designee will witness receipt and shipment of SNM.

4. He or his designee will witness drawing of samples for physical inventory measurements.

5. He or his designee will prepare an inventory report and other required SNM reports to NRC.

6. He will cooperate with other managers in determining LEMUF and reconciling MUF with LEMUF. He will direct any investigations into MUF's which must be conducted pursuant to regulations or because a MUF is determined to be significant.

Authority

The occupant of this position has the authority to cause operations with SNM to be interrupted if he deems advisable for safety or security reasons. He may, in conjunction with the Nuclear Safeguards Committeé initiate investigations into SNM Operations when he deems advisable or necessary.

Qualifications

The occupant of this position should have an educational background equivalent to a Bachelor's degree in science. He should have a working knowledge of Title 10 CFR. He should have had work experience in operations with SNM.

MANAGER, QUALITY ASSURANCE

This position is responsible for the overall Quality Assurance activities (i.e. Radiochemical, Radiodiagnostics and Chemical Reagents Q.C, establishing GMP, establishing production protocal, and drug regulatory affairs) carried out at the SFL. This position is accountable to the Manager, Nucleonics and directs the activities of the Q.C. groups for all chemical products which are made at SFL and the Drug Regulatory group.

Specific Duties

1. He manages the Radiochemical Q.C. laboratory where all assays are performed for SNM control and accounting.

2. He will establish procedures for measurements of SNM.

3. He will maintain a measurement standards program and record data for determining error statistics.

4. He will establish and administer a measurement quality assurance program.

Authority

The occupant of this position has line authority over personnel performing SNM measurements.

Qualifications

The occupant of this position should have an educational background equivalent to a Bachelor's degree in science and a few years experience in analytical techniques, preferably nuclear analytical methods.

SENIOR RESEARCH SCIENTIST

This is a staff position accountable to the Manager, Nucleonics. The occupant serves as a technical consultant to any member of the line organization.

Specific Duties

1. Serve as technical consultant to managers of H.P., Production or Q.A. in matters of SNM control or safety.

2. Serve as auditor for Nuclear Safeguards Committee for SNM safety and control.

Authority

Thru the Nuclear Safeguards Committee, interrupt operations with SNM or initiate investigations if it is considered necessary or advisable for safety or security reasons.

Qualifications

The occupant of this position should have an educational background equivalent to a Master's degree. He should have several year's work experience in operations with SNM. He should have a working knowledge of Title 10 CFR and site license requirements.

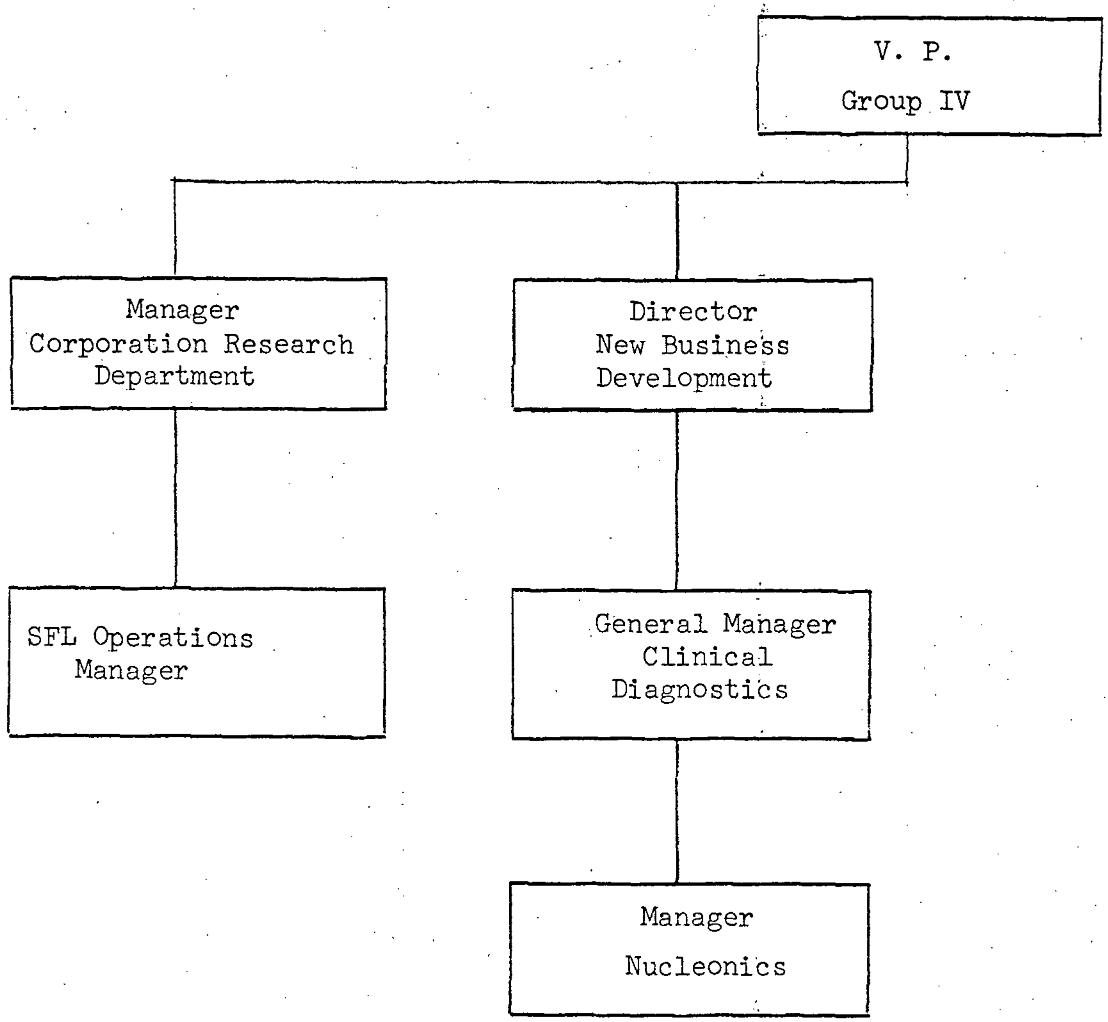
SNM CUSTODIANS

and

CENTRAL SNM ACCOUNTANT

See Section 1.2

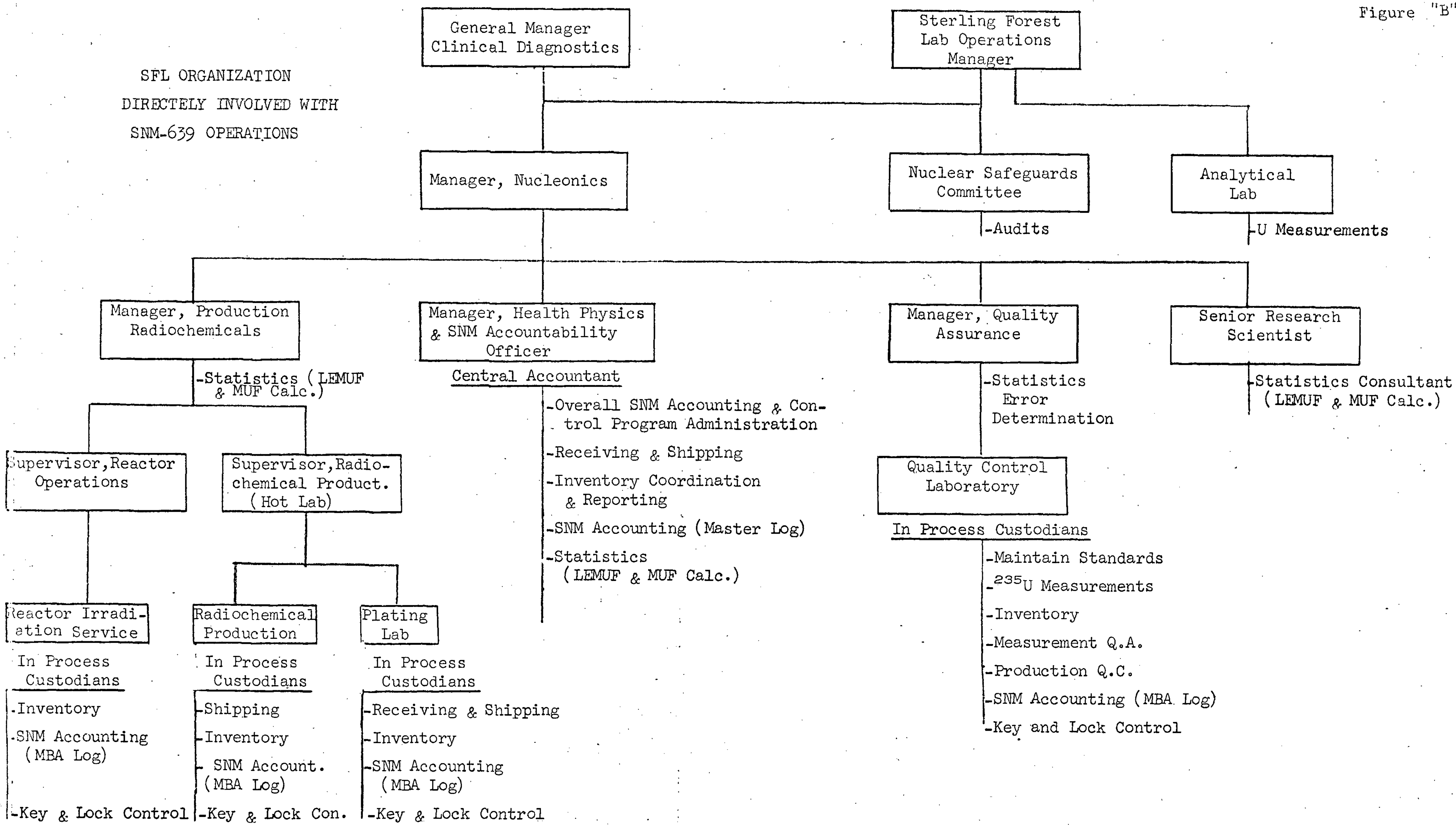
Figure "A"



CORPORATE ORGANIZATION OVER
SFL SITE LEVEL
RELATED TO SNM-639

Figure "B"

SFL ORGANIZATION
DIRECTELY INVOLVED WITH
SNM-639 OPERATIONS



CHAPTER 2

2.0 MATERIAL CONTROL AREAS

2.1.1 Plant Areas

The plant at the SFL site consists of the Reactor/Hot Laboratory buildings.

2.1.2 Internal Control Areas

Figure "C" is a chart of the control areas within the plant. The locations of these control areas are as follows: (Ref. Figure "D")

(a) The SNM feed area is located on the upper level of the Hot Laboratory.

(b) The Plating Encapsulation and Quality Control MBA is established by process parameter rather than physical boundaries. The MBA consists of 3 plating laboratories on the upper level of the Hot Laboratory, a welding lab on the first level of the Hot Lab, the H.P. Lab on the mezzanine of the reactor building, and a Quality Control Lab on the upper level of the Reactor Building.

(c) The Reactor Operations MBA is located in the middle office on the upper level of the Reactor Building and in the Reactor Pool.

(d) Radiochemical Operations MBA is located in the main Hot Cell bank in the Hot Laboratory.

2.1.2.1 & 2.1.2.2 Process and Physical Boundaries

Figures "C" and "D" show a process flow diagram and a physical layout of the plant respectively. MBA 1, the SNM feed area, is located on the upper level of the Hot Laboratory. All incoming SNM in either UO_2 or U_3O_8 form is converted to $UO_2(NO_3)_2$ solution and is stored in this area. This area consists of metal storage cabinets arranged in a critically safe array and secured to the Hot Laboratory structure. MBA 2, the plating, encapsulation, α contamination check and Q.C. area, is located in four areas within the Reactor - Hot Lab building complex. These locations are the three laboratories on the upper level of the Hot Lab where target plating and chemical analysis for U element determinations are performed, the welding lab on the main level of the Hot Lab where target encapsulation is performed, the H.P. lab on the mezzanine of the Reactor where α contamination checks are made on finished targets and finally the counting lab located on the Reactor Building upper level where targets are assayed. MBA 3, the Reactor Operations area, is located in the middle office on the upper level of the Reactor Building, and in the Reactor Pool. Targets, which are awaiting irradiation, are stored in a steel cabinet which is welded to the building structure. Targets being irradiated are located in the Reactor Pool. MBA 4, the Radiochemical Operations area, is located in the main hot cell bank. In this area, uranium in irradiated targets is dissolved and specific fission product isotopes are removed. The uranium waste from this process is stored for ~ 60 days and then prepared for disposal by solidifiying it in concrete. All the uranium waste is shipped to a licensed burial site.

2.1.2.3 Selection Criteria

The control areas were selected with the following parameters in consideration:

(a) The UO_2 Feed area is separated by location and administration. Access to this area is controlled by the Manager Radiochemical Production.

(b) The Plating Encapsulation and Quality Control MBA is separated by process requirements; the process being the fabrication of finished irradiation targets.

(c) The Reactor Irradiation MBA is separated by process, location and administration.

(d) The Radiochemical Operations MBA is separated by process, location and administration.

The separation of material control by the above MBA's provides for localization of lossess in the following manner:

(a) The UO_2 Feed area consists of locked steel cabinets. All incoming material is assayed for shipper-receiver difference and placed into this area for subsequent incremental additions to the plating process. Each batch received retains its identity until it is all fed into the plating process. Each batch is measured volume (1 liter) and is usually consumed within a 2 week period. Diversions can be detected easily.

(b) The Plating Encapsulation and Quality Control MBA has three mechanisms for material control.

1. Material brought into the plating labs is added to one of four plating solution batches. These batches are assayed before and after each plating process (usually within one week). Diversion of material can be promptly identified within this period of time.

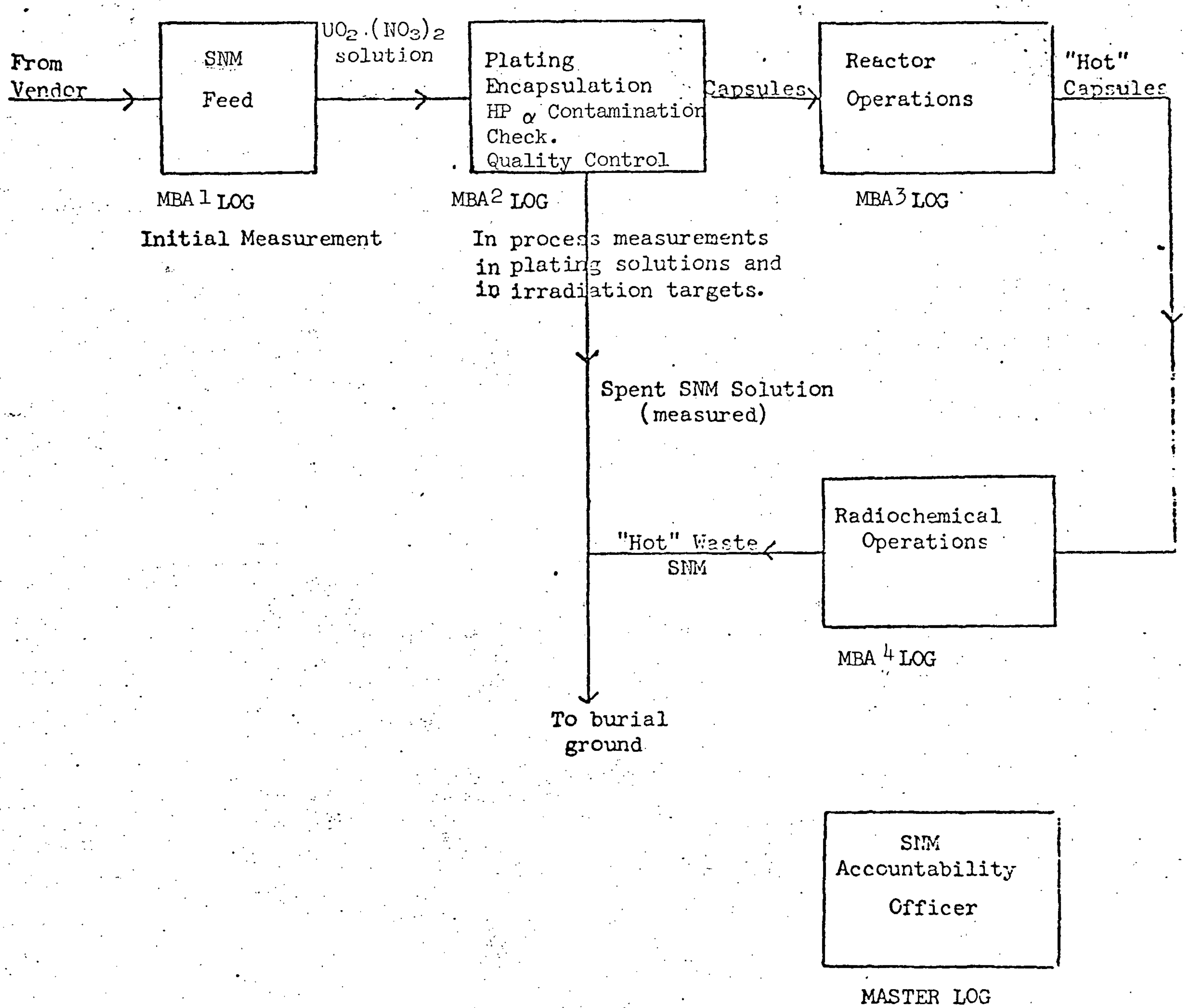
2. When material has been plated on targets, they are assayed and assigned a distinctive target serial number. Each sealed target retains its identity thru the next two material balance areas until it is combined with other targets (RW waste solutions) are assayed prior to shipment for burial in a licensed burial site. Diversion of targets can be detected if targets do not have serial number continuity as they are transferred from Plating to Reactor Operations.

3. Material in the plating waste solution is assayed ~ weekly. Any diversion would be detected as a result of a loss evident from the weekly assay.

(c) The Reactor Operations groupexercises material control thru positive item control on sealed targets. Any unexplained discontinuity in target serial numbers would be detected immediately.

(d) The Radiochemical Operations group exercises material control by positive item control on target serial numbers. In addition, the material which has been irradiated is highly radioactive and cannot be safely handled outside our Hot Cells. Diversion of such material would require a series of complex operations which could not be accomplished undetected. The U and ^{235}U content in all radioactive waste is measured prior to shipment.

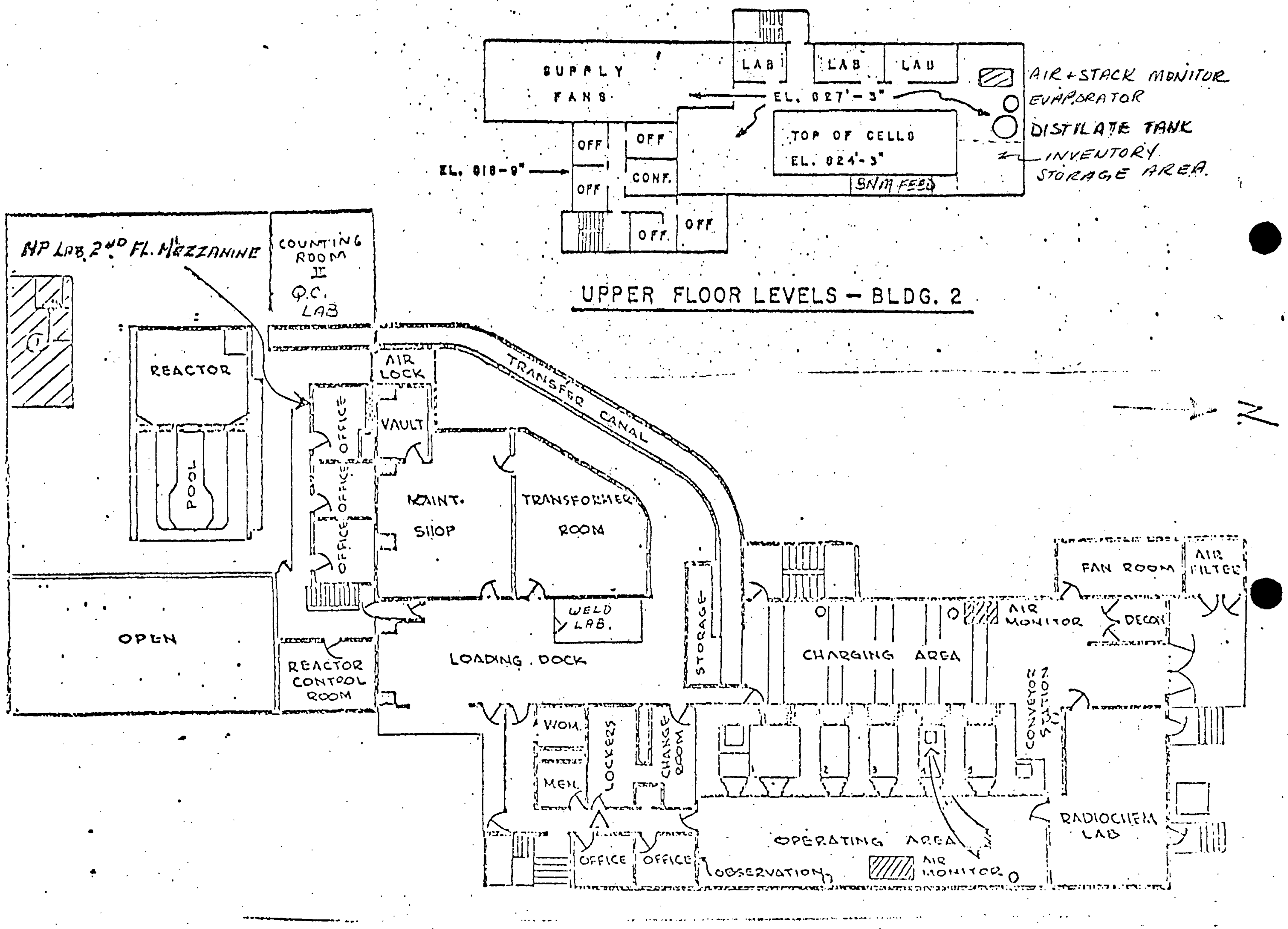
In addition to the above provisions to detect the diversions of SNM, reference is made to the UCC SFL Plant Security Plan in effect at our laboratory as described in our letter of 1/7/74 to the Commission.



PLANT PROCESS FLOW DIAGRAM

(Each block in flow chart represents a material balance area.)

Figure "D"


SUPPLY FANS
LAB
LAB
LAB
AIR + STACK MONITOR
EVAPORATOR
DISTILATE TANK
INVENTORY STORAGE AREA
EL. 027'-3"
TOP OF CELLS EL. 024'-3"
SNM FEED
OFF
OFF
CONF.
OFF
OFF.
OFF
EL. 018-9"
HP LAB 2ND FL. MEZZANINE
COUNTING ROOM II
Q.C. LAB
UPPER FLOOR LEVELS — BLDG. 2
REACTOR
POOL
AIR LOCK
TRANSFER CANAL
VAULT
OFFICE
OFFICE
OFFICE
MAINT. SHOP
TRANSFORMER ROOM
STORAGE
WELD LAB.
OPEN
REACTOR CONTROL ROOM
LOADING DOCK
FAN ROOM
AIR FILTER
AIR MONITOR
DECON
CHARGING AREA
CONVEYOR STATION
WOM.
MEN.
LOCKERS
CHANGE ROOM
RADIOCHEM LAB
OPERATING AREA
OFFICE
OFFICE
OBSERVATION
AIR MONITOR
N

CHAPTER 3

3.0 MEASUREMENTS

3.1 There are two basic types of analytical measurements made at SFL for SNM: the isotopic assay for ^{235}U (either radiometric or delayed neutron) and a chemical assay for total U. These assays are made at a number of points during a process cycle. The flow diagram in Figure "E" shows the process flow.

A. An initial qualitative measurement is made on the UO_2 powder as received from the vendor to determine that it is ^{235}U enriched. This is done on the oxide after a bulk weighing of the material to verify amount of oxide shipped and prior to dissolution of the oxide in 1:5 HNO_3. This measurement is done within 24 hours of receipt of material.

B. Initial quantitative measurements are made on the UO_2 Feed dissolved in 1:5 HNO_3. At this point, a volume measurement is made and samples are removed for isotopic analysis for ^{235}U content and destructive chemical analysis for total uranium.

C. A plating solution is made from this UO_2 Feed material. The volume of this plating solution is measured and samples are taken for isotopic analysis for ^{235}U and chemical analysis for total uranium.

D. After each plating operation there are two items to measure, the plated target capsules and the spent plating solution.

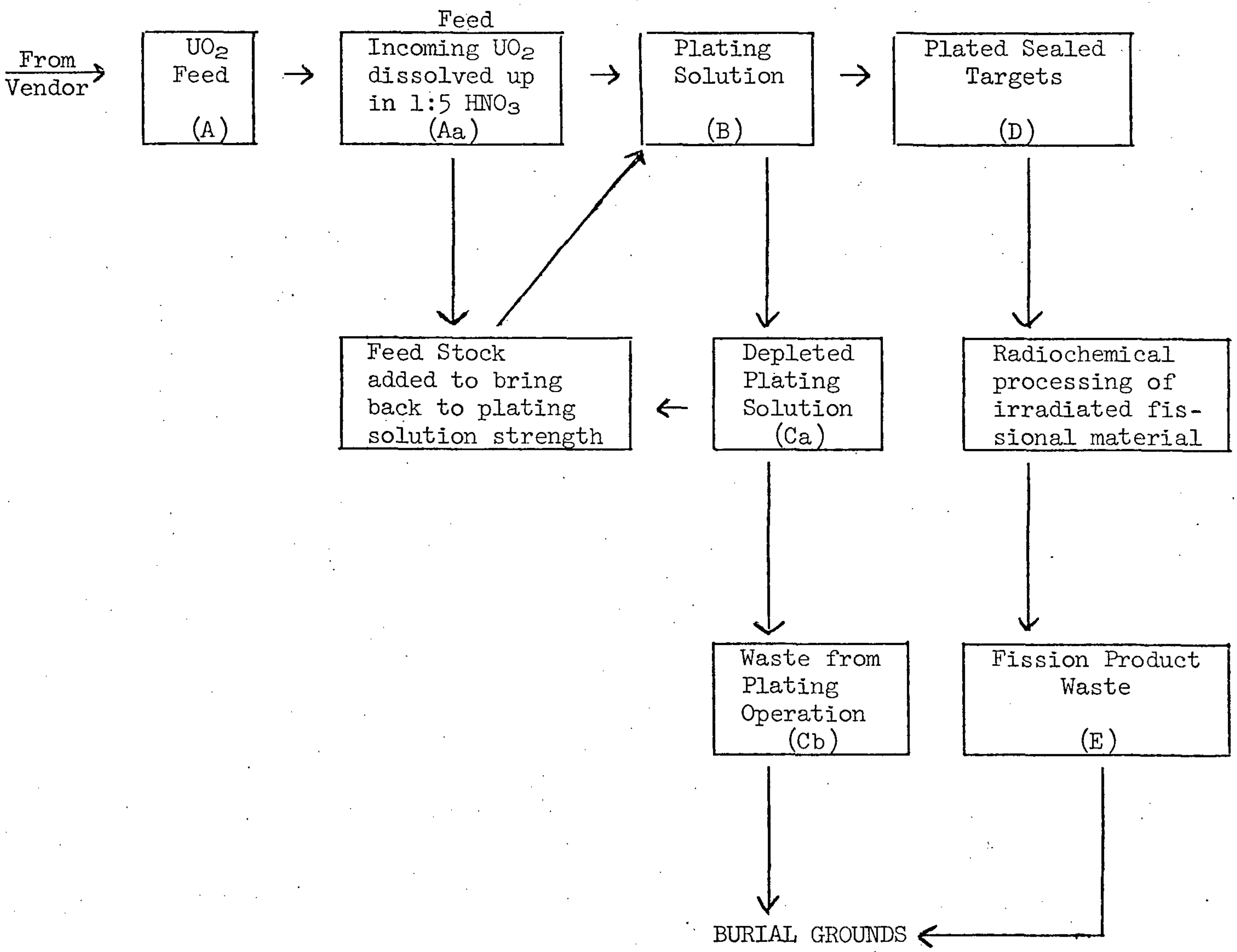
1. The spent plating solution, if it is to be used again, will have its volume measured and then be assayed for total uranium by chemical means. New feed material will be added to bring it up to plating solution strength, at which point it will be assayed as in Paragraph C. above.

2. The spent plating solution, if it is waste, will have its volume measured and then be sampled for both ^{235}U assay and total U assay as in Paragraph C. above.

E. The sealed target tubes will be assayed by non-destructive radiometric methods for total ^{235}U content. Knowing the enrichment factor from their plating solutions, a value for total U will be calculated for each target.

F. After the targets have been irradiated and the fission product separation is performed, the waste solution will be measured for volume and samples will be taken for isotopic analysis for ^{235}U and chemical assay for total U prior to the disposal of the fission waste solutions.

DIAGRAM OF SNM FLOW WITH DESIGNATED ASSAY POINTS



3.2 MASS MEASUREMENT

There is only one mass measurement (weighing of material) (Point A, Figure E) made and this is a preliminary check of the incoming UO_2 from the supplier. This weight is not used for a material balance but as a preliminary check as described in Section 7.1.1. The material is weighed on an analytical balance having a $\pm$ 0.1 mg accuracy.

3.3 VOLUME MEASUREMENT

With the exception of the target capsules and incoming UO_2 powder, all material will be in liquid form at each material assay point as shown in Figure "E".

3.3.1 At point (Aa) the UO_2 is dissolved in HNO_3 and then diluted to 1 liter in a 1 liter volumetric flask.

3.3.2 At point (B) the plating solution volumes are measured using vessels made of polyethylene or polypropylene which have been calibrated in one liter increments using standard 1 liter analytical graduated cylinders. Liquid levels (at one liter increments) are inscribed onto the vessel's side for measurement use. Typical volumes are 15 liters.

3.3.3 At points (Ca) and (Cb) the depleted plating solution volumes are measured using vessels made of polyethylene or polypropylene which have been calibrated in one liter increments using standard 1 liter analytical graduated cylinders. Liquid levels (at 1 liter increments) are inscribed onto the vessel's side for measurement use. Typical volumes are 15 liters.

3.3.4 At point (E) the fission product waste solution volume will be measured using a polyethylene vessel calibrated for 1 liter. The fission product waste from several runs will be combined and brought up to the calibrated volume (typically 1 liter).

3.4 SAMPLING SYSTEM

3.4.1 There is no sampling done at point (A). The whole bottle is assayed using nondestructive radiometric technique.

3.4.2 All sampling of the material for chemical analysis at points (Aa), (B), (Ca), (Cb), and (E) will be done using analytical T.D. pipets.

3.4.3 All sampling of the material for radiometric or delayed neutron nondestructive assays at points (Aa), (B), (Cb), and (E) will be done using Eppendorf T.D. pipets.

3.4.4 There is no sampling done at point (D). The whole target capsule is assayed nondestructively.

3.5 ANALYTICAL MEASUREMENTS

All chemical analytical measurements at points (Aa), (B), (Ca), (Cb), and (E) will be done using the procedure described in Section 5.11.1 a) and procedure "A".

3.6 NONDESTRUCTIVE RADIOMETRIC ASSAY MEASUREMENTS

3.6.1 All radiometric or delayed neutron assays at points (Aa), (B), and (Cb) will be done using the appropriate procedure as described in Section 5.11.1 c) or e). The primary assay technique will be the ASTM delayed neutron method[1] but as a back-up method to this we will use the radiometric method.

The isotopic assay at point (E) will be done using the delayed neutron procedure described in Section 5.11.1 b).

The radiometric assay at point (D) will be done using the procedure described in Section 5.11.1 d) and procedure "C".

3.7 SAMPLING AND MEASUREMENT UNCERTAINTIES

All sampling and measurement uncertainties are shown in terms of relative standard deviations in Appendix "D" (Chapter 5).

3.7.1 MASS MEASUREMENTS

This section is not applicable to the accounting system at SFL.

3.7.2 VOLUME MEASUREMENTS

a. UO_2 Feed Solution is measured in graduated flask of one liter capacity. Relative Systematic Standard Deviation (RSSD) 0.001 or ± 1 ml, Relative Random Standard Deviation (RRSD) 0.005 or ± 5 ml.

b. Plating Solution is measured in calibrated 16 liter vessels. RSSD 0.02 or ± 0.32 liters, RRSD 0.03 or ± 0.48 liters as described in 3.3.2.

c. Plating Waste is measured in calibrated 10-16 liter vessels. RSSD 0.001 or ± .016 liters, RRSD 0.006 or ± .096 liters as described in 3.3.3.

d. Radioactive Waste is measured in a calibrated 1 liter vessel RSSD 0.02 or ± .02 liters, RRSD 0.003 or ± .03 liters as described in 3.3.4.

3.7.3 ELEMENT SAMPLING

Element sampling will be done using graduated T.D. pipets, T.D. Eppendorf micro liter pipets all Relative Standard Deviations for each described system in Section 3.4.1 are found in Appendix "D" (Chapter 5).

(1) Materials Research and Standards, MTRSA, Vol. II, No. 4, p. 24 (1971).

a. UO_2 Feed Solution sampling will be done with Eppendorf pipets in the 100 μ liter range.

b. Plating Solution sampling will be done using 10 ml T.D. Analytical pipets.

c. Plating Waste sampling will be done using 10-30 ml T.D. Analytical pipets.

d. Radioactive Waste sampling will be done using 0.1-5.0 ml T.D. Analytical pipets.

e. Target Capsules can not be directly analyzed for elemental uranium.

3.7.4 ELEMENT ANALYSIS

Element analysis results are in terms of grams of material. All Relative Standard Deviations for each described system in Section 3.5 are found in Appendix "D" (Chapter 7). The sampling of material is done in such a way that the amount of U actually analyzed is ~ 50 mg.

3.7.5 ISOTOPE SAMPLING

Isotope sampling will be done using T.D. Eppendorf pipets for each system described in Section 3.4.2. The RSD's for each are in Appendix "D" (Chapter 5). The RSSD and RRSD are the same for all sample volumes (20 μ liter to 1000 μ liter). The uncertainty in sampling for the analysis in radioactive waste is larger because it is compounded by the necessity of a preliminary dilution done in a hot cell and a second dilution done in the laboratory.

3.7.6 ISOTOPE ANALYSIS

Isotope analysis results are in terms of grams and the RSD's for these are found in Appendix "D" (Chapter 7).

a. All materials in solution are analyzed in the same way except for the radioactive waste which requires double handling; hence a larger RSSD and RRSD.

b. The plated targets are analyzed as described in Section 5.11.1 d) and will vary from 5-13 grams of ^{235}U.

3.8 MEASUREMENTS PROCEDURE

An SNM Measurement Procedures Manual has been established and is being reviewed. The Manager, Radiochemical Operations, Manager, Health Physics, and Manager, Quality Assurance were responsible for the initial preparation and the periodic updating of this manual. The manual will be submitted to the Manager, Nucleonics and the Nuclear Safeguards Committee for approval.

CHAPTER 4

4.0 MEASUREMENT QUALITY CONTROL PROGRAM

This chapter will be submitted as required by NRC in the near future.

CHAPTER 5

5.0 PHYSICAL INVENTORY

Refer to the Physical Inventory Plan submitted in Union Carbide Corporation letter dated 10/17/74, and modified in Union Carbide Corporation letter dated 12/5/74.

CHAPTER 6

6.0 MATERIAL ACCOUNTING SYSTEM

6.1 System Description

The basic accounting program shall consist of a Master Log and subsidiary logs for each of the four material balance areas.

The Master Log is maintained so that the total quantity of enriched uranium possessed under License SNM-639 is recorded and maintained current.

The subsidiary logs for each material balance area are maintained so that the quantity of enriched uranium in each area is recorded and maintained current and that records are maintained of all transfers into or out of an area.

6.1.1 Account Structure

The account structure shall include the following ledgers:

Uranium Feed Log - Contains records on uranium feed material in ready storage.

Plating, Encapsulation, Quality Control Log - Contains records of enriched uranium being prepared for reactor irradiation.

Reactor Irradiation Log - Contains records of enriched uranium in the form of sealed targets either in the reactor or ready to be put in the reactor.

Radiochemical Processing Log - Contains records of irradiated enriched uranium being processed in the hot cells or being prepared for disposal.

Master Log - Contains records of the total quantity of uranium possessed under License SNM-639.

When material is received on site, it is assayed and the values entered in the Uranium Feed Log and the Master Log. When material is transferred internally between material balance areas, concurrent entries are made in the MBA Log of the area from and to which the material is transferred.

Internal transfer documents are used to document transfers between MBA's and ICA's (Figure "H"). The top portion of this form will be filled in by the person making the transfer. One copy shall be promptly sent to the accounting group and the original passed on to the receiver who will complete the lower half of the from and then promptly send the completed form to the accounting group. Each form shall be uniquely and serially numbered.

All receipts are opened within 24 hours and rapid turn over of material eliminates the need to maintain material under tamper-safing.

6.1.1.1 Accounting Forms

The following basic accounting forms will be used to provide data for the ledgers described in Section 6.1.1.

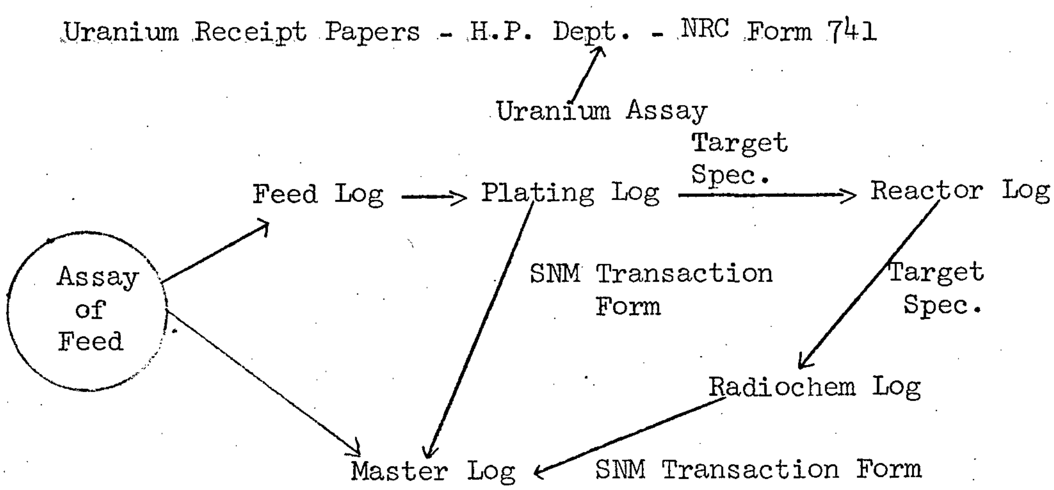
A. "Uranium Analysis Request" (see Figure "F")

B. "Target Specification and Q.A." (see Figure "G")

C. "SNM Transaction Form" (see Figure "H")

D. "Inventory Report" (see Figure "J")

6.1.1.2 Flow Chart



Report Form	Data Retention Points
Assay of Incoming Uranium	Feed Log + Master Log
SNM Transaction Form	Master Log
Target Specification	Radiochemical Log

RH 1/75

URANIUM ANALYSIS REQUEST

REPORT

CHARGE# 50-03

mR ____________

DATE ____________

Batch# ________ Type Solu. ________ Media ________ Source ________

No. Samples ________ Vol. Submitted ________ ml ^{235}U ________ Total U ________

liters

Total Volume in Batch ________ ml Approx. ^{235}U - Total U ________ mg/ml

Requestor ____________

RESULTS

^{235}URANIUM

^{235}U grams/ml (A) ____________

^{235}U grams/ml (B) ____________

^{235}U grams/ml (C) ____________

Avg. ^{235}U grams/ml ____________

Total Vol. in Batch X ____________

Total ^{235}U in Batch = ____________ gms

TOTAL URANIUM

Total U grams/ml (A) ____________

Total U grams/ml (B) ____________

Avg. Total U in Batch ____________

Total Vol. in Batch X ____________

Total U in Batch ____________ gms

ENRICHMENT FACTOR

Total ^{235}U ________ gms

________ x100 = ________ %

Total U ________ gms

Assayed by ____________

Notebook No. and Pg. ____________

Date ________ Time ________ hrs.

Assayed by ____________

Notebook No. and Pg. ____________

Date ________ Time ________ hrs.

F _ _ _ _ _ _ = Feed or Bulk = 350 mg/ml

Pl _ _ _ _ _ = Plating = 5 mg/ml

P.W. _ _ _ _ = Plating Waste=1-3 mg/ml

R.W. _ _ _ _ = F.P. Waste = 50-100 mg/ml

If this is a R. W. Sample - List

Tube Numbers: T ________, T ________

T ________, T ________, T ________, T ________

T ________, T ________, T ________, T ________

FIGURE "H"

No. S.N.M.-639 ______

S.N.M. TRANSACTION FORM

M.B.A. Area ______ Date ______

TRANSFERER

Transaction ______

______

ITEM	ELEMENT	ISOTOPE	ITEM	ELEMENT	ISOTOPE

TOTAL Element ☐ Isotope ☐

Signature ______

RECEIVER

M.B.A. Area ______ Date ______

Transferer's Values Accepted ☐

Not Accepted ☐

Remarks ______

______

______

Signature ______

Figure "G"

TARGET SPECIFICATION AND Q.A.

Hot Lab Standard HS-21

Capsule No. ________ Reactor No. ________ Power Generator Factor ____________

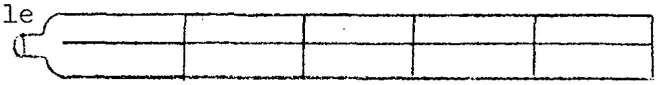
	Date	Initials
Radiometric Analysis		
Gross Count ______ c/5min Total ^{235}U ______ gm.		
Plating Batch No. ______ Enrichment Factor ______ %		
Total Uranium Content ____________ gm.		
^{235}U Profile counts / % 235 		
Metal Parts Inspection		
Vibration Test		
Sealing		
He Filled		
Primary Tested		
Decontamination		
Approved for Secondary Encapsulation		
Secondary Encapsulated ________ Normal ________ Inverted		
Secondary He Filled		
Secondary Leak Tested		
Reactor Restrictions:		
Load Position# ________ Date ________		
Moved to Position# ________ Date ________		
Removed ________ Date ________		
Processing		
Waste Disposal		

Figure "J"

INVENTORY REPORT

MBA ______________________ Period Ending ______________________

	Element Wt.	Isotope Wt.
Beginning Inventory		
Additions To Inventory		
Removals From Inventory		
Ending Inventory		

PHYSICAL INVENTORY

Identification	Element Wt.	Isotope Wt.

PHYSICAL TOTAL

LOG TOTAL

MUF

LEMUF

MUF Less Than LEMUF Log Adjusted Date ____________________ Initial _____

MUF Greater Than LEMUF SAO Notified Date ____________________ Initial _____

Report Form	Posting Point
Feed Log	In Feed Locker
Plating Log	2nd Floor Hot Lab
Reactor Log	Reactor Office
Radiochemical Log	1st Floor Hot Lab
Master Log	H.P. Office

6.1.2 Accounting Procedures

An accounting procedure manual will be established and maintained. The Manager of Radiochemical Operations, Manager of Health Physics, and the Manager of Quality Assurance are responsible for the initial preparation and the periodic updating of this manual. The manual will be submitted to the Manager, Nucleonics and the Nuclear Safeguards Committee for approval.

6.1.3 Source Data

Transaction Type	
1. External Receipts and Shipments	A. Chemical and Radiometric Analysis of Material
2. Internal Transfers	A. Chemical and Radiometric Analysis of Material
	B. Radiometric Analysis of Target
	C. Capsule Specification
3. Waste Removal	A. Chemical and Radiometric Analysis
4. Inventories	A. Chemical and Radiometric Analysis
	B. Identification of Target and Specification Sheet
	C. Identification of Irradiated Waste
5. Adjustments to Recorded Data	A. MBA Inventory Reports
	B. Calculations of LEMUF
	C. Statistical Analysis

6.1.4 Adjustments to Records

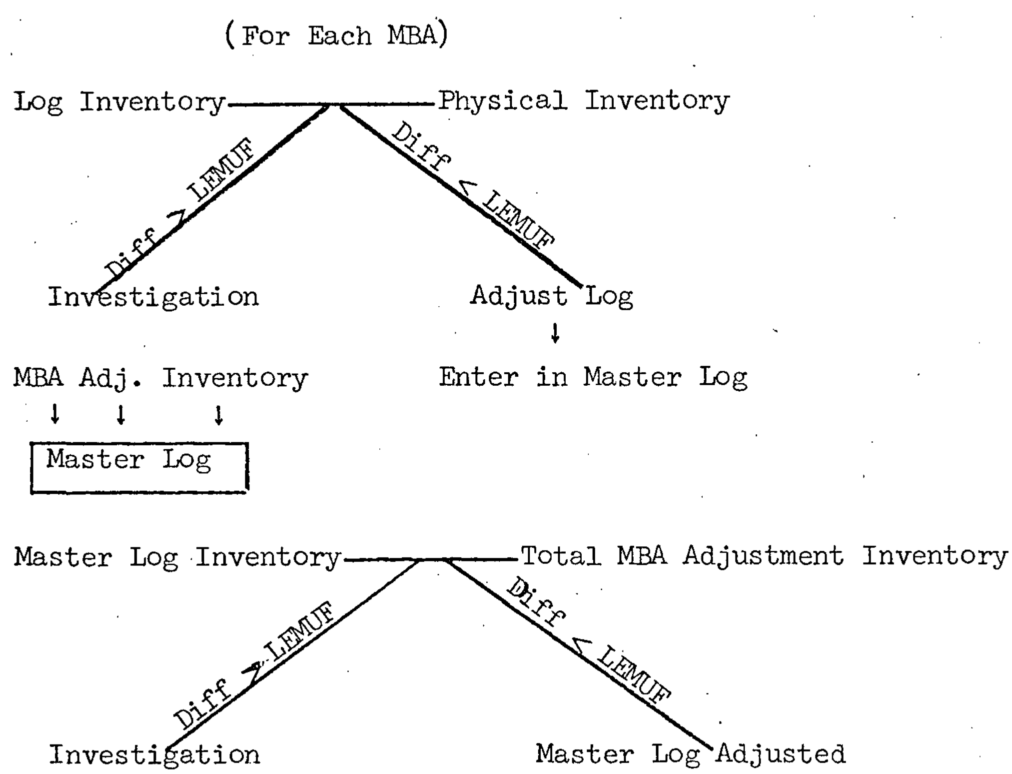
Adjustments to prior recorded values will be made in the appropriate log book or books. All adjustments will be initialled and dated by the Manager of Health Physics or his alternate. Inventory adjustments affecting prior inventory periods shall be made in a manner which will permit these adjustments to be distinguished from current period MUF.

6.1.4.1 Bias Adjustments

A statistical analysis will be performed on all required inventory adjustments. If this analysis indicates a recurring bias to a particular measurement, the measuring system will be re-evaluated for accuracy. All procedure modifications will be reviewed by the Manager of Health Physics and approved by the Nuclear Safeguards Committee.

6.1.5 Inventory Reconciliation

At the completion of each inventory the physical inventory quantities will be compared with each MBA Log inventory. Differences within the calculated LEMUF for that period will be noted in the log book and the log book corrected to reflect true inventory. Differences outside the calculated LEMUF will be investigated to determine the cause. After all MBA logs have been reconciled to the physical inventory results, the Master Log will be adjusted to reflect the true inventory.



Adjustments to MBA logs within LEMUF will be initialled and dated by the authorized individual in each area. Adjustments to the Master Log or to MBA logs which are outside the LEMUF will be initialled and dated by the Manager of Health Physics or his alternate.

6.1.6 Account Reconciliation

All logs will be reconciled with physical inventory quantities at the completion of each required inventory. The procedure and approvals for making adjustments are those contained in Section 6.1.5.

6.1.7 Electronic Data Processing

Initial operation of the Material Accounting System will not involve electronic data processing. Once the system is operating smoothly we will consider the use of electronic data processing.

6.2 RECORDS AND REPORTS

6.2.1 Accounting Reports

1. "Uranium Analysis Request" - used to request and report chemical and radiometric analysis of material. Data from this form will be used to record external receipts and shipments, internal transfers, waste removals, and physical inventories.

2. "Target Specification and Q. A." - used to relate capsule identification with uranium content. Data from this form will be used to record internal transfers and inventory of targets.

3. "SNM Transaction Form" - used to record transfer of uranium between MBA's and ICA's. Data from this form will be used to adjust MBA logs and the Master Log. Data from this form will also be used to prepare waste shipping documents.

4. "Inventory Report" - used to report physical inventory in each material balance area. Data from this report will be used to adjust the Master Log to agree with physical inventory.

6.2.1.1 Material Balance Reports

Material Balance Reports containing all the information required in 10CFR70.51 (e) (4), shall be completed within 30 calendar days after the start of each ending inventory required by 10CFR70.51 (e) (3).

6.2.1.2 Material Status Reports

Material Status Reports will be submitted in accordance with the requirements of 10CFR70.53.

6.2.2 Accounting Records

The following accounting documents will be retained as a part of the accounting record: Uranium Feed Log, Plating Encapsulation and Quality Control Log, Reactor Operations Log, Radiochemical Operations Log, Master Log, Uranium Analysis Request (incoming material and material for disposal), Target Specification and Q. A., Inventory Report, SNM Transaction Form. Records required by paragraphs (e) (4) (iii), (IV), and (V) of Section 70.51 will be retained for at least five years.

6.2.3 Short-Term Storage

The "Master Log", material balance areas "Inventory Report", the "Uranium Analysis Request" associated with incoming material and "Uranium Waste Disposal" documents will be kept locked up under the control of the Site Accountability Officer or his designee. Access to these records will also be under the control of the SAO or his designee. All other records will be controlled by the authorized individuals in each area.

6.2.4 Long-Term Storage

Long-term retention of the records required by paragraphs (e) (4) (iii), (IV), and (V) of Section 70.51 will be in a file cabinet under the control of the SAO.

6.2.4.1 Physical Form

Material records will be kept in original form.

6.2.4.2 File System

Records in the file system will be kept in chronological order.

6.2.4.3 Access

Access to inventory records and the Master Log will be controlled by the SAO. Access to the MBA Logs will be controlled by the authorized individuals in each area.

6.3 AUDITS

At least every 12 months the material control and accounting procedures and records will be reviewed and audited by the Nuclear Safeguards Committee. The individual (s) performing the audit will be independent of nuclear material control management, measurement, or utilization. The results of this review and audit, with recommendations, will be reported in writing to the Nucleonics Manager and will be kept available for inspection for a period of five years.

CHAPTER 7

7.1.1 RECEIVING PROCEDURE

When production requirements indicate that the acquisition of ^{235}U is necessary to maintain an efficient schedule, the inventory of SNM on hand is checked by the SAO in the Master SNM Log and the logbooks of the four MBA's involved, to determine the amount of ^{235}U which can be ordered without exceeding the quantity allowed by our license, SNM-639. In general, the amount of SNM ordered and its delivery date will be correlated by the SAO with the shipment of SNM off site as waste, so as to meet the requirements of our license.

Within 24 hours after arrival of an SNM shipment, the shipping documents are checked to ensure that we have been sent the proper order, containing the specified amount of ^{235}U. The outer package is checked, both the serial number of the DOT approved container and the seal number being compared to those on the shipper's documentation to verify that the proper container has been received and that it has not been tampered with during shipment. In the case that the shipment can not be verified or the seal is damaged, the shipper will immediately be notified and the shipment placed in a holding area. The exterior of the container is then surveyed by Health Physics personnel to make sure that it is not contaminated, the seal is broken, and the drum is opened. The interior of the drum is checked by H.P. to ensure that it is not contaminated and that there has been no spillage of SNM during shipment. When this has been done, and it has been determined that the material may be removed safely from the shipping drum, the primary SNM containers are taken out, counted, and the labelling on each individual package checked against the specifications described in the shipping papers. Once the lot number, inner container number and quantity have been verified, the SNM is transported to a laboratory used only for handling this material, and each package is immediately weighed, this value being checked against that provided by the shipper, verifying that the weights are the same. The primary container is then transferred to the quality control laboratory and a qualitative radiometric check is made for ^{235}U. If this check shows the material to be enriched uranium oxide and the shipping and receiving weights are in agreement, the receipt of the SNM is entered into the logbooks under the shipper's lot, batch, or item identification code, a UO_2 feed lot number is assigned to the material and entered in the log, so our lot number is immediately cross referenced to the shipper's identification code. The UO_2 is then dissolved in nitric acid, diluted to concentration of approximately 350 grams per liter, and transferred to volumetric flasks. At this point, a sample is taken and submitted to the analytical group for determination of both ^{235}U and total U as per (Procedures "A" and "D"). This stock solution is then quarantined pending completion of these analyses.

When the results of the U and ^{235}U assays are received, usually not more than 5 working days after receipt, the values are applied to the volume of stock solution, thus providing a check on the amount of U and ^{235}U present as previously determined by weighing, and on the values supplied by the shipper.

Once this has been done, the stock solution is released from quarantine and approved for use in production. These solutions are then stored in locked cabinets until the plating operation requires them, at which point a measured volume of the stock solution is logged out of the UO_2 Feed MBA Log, transferred to the plating lab, and logged into the PEQA (Plating, Encapsulation and Quality Assurance) MBA Log.

7.1.2 SHIPPER-RECEIVER COMPARISONS

If there is no disagreement between the results of our analyses and those of the shipper, the solutions are released to the UO_2 Feed MBA inventory as being available for use. If a significant difference should be found, the SAO will be notified, and the material will be held in quarantine until the discrepancies are resolved by contacting the shipper and investigating and evaluating all possible reasons for the conflict.

7.1.3 ACCEPTANCE CRITERIA

Due to the nature of the process in which SNM is used at this site, our tolerances with regard to such quantities as percent enrichment, trace impurity level, and chemical composition are sufficiently wide that we have considerable latitude in accepting material. Generally, once we are assured that standards of safety and the requirements of our license have been met, we will accept the shipment and then proceed to reconcile any discrepancies found in shipper-receiver comparisons directly with the shipper. Statistically, due to the small quantities of SNM received in any one shipment, shipper-receiver comparisons are performed on an individual shipment basis.

The combined systematic and random deviation on each measurement is applied to the result of the measurement as described in Appendix "D", giving a range of acceptable values for each measured variable. If the results of shipper-receiver comparisons fall within these ranges, no discrepancy will be considered to have arisen. However, if the results of the shipper-receiver comparisons fall outside of these ranges, the shipper will immediately be contacted and a determination made as to possible causes of the difference. These possibilities will then be investigated until the source of error is found, the quantities involved re-evaluated, and the discrepancy is reconciled. In all cases, the actual measured value as determined by our analysis will be used as the basis for logbook entries.

7.1.4 CONDITIONS FOR TRANSFER

Before any lot of SNM is released to operating components, the results of analysis for total U and ^{235}U must have been received, and any discrepancies found in the shipper-receiver comparisons evaluated and reconciled, so that an accurate basis for logbook entries has been established. Once this has been done, the material is cleared for release. Then, when the plating operation requires more UO_2 solution to maintain its production schedule, the PEQA MBA logbook will be checked to verify that this area will not acquire a greater quantity of SNM than allowed by our license. After this has been done, the custodian of the UO_2 Feed MBA will release the required amount of stock solution to the person responsible for the PEQA MBA, entering the transaction into the UO_2 Feed Log as a transfer out, while the PEQA MBA custodian enters the transaction into his log as a transfer of material into the MBA. Thus, all pertinent information regarding the transfer will be entered into both logbooks at the time of the transaction under the signatures of the responsible individuals.

7.1.5 RECORDS

Copies of form NRC-741 are kept on file to maintain a record of shipper's values for the amount of SNM shipped to our site, and to verify that proper procedures have been followed in shipping the material. In addition, our Master SNM Log contains entries listing the values determined by our analysis. Shipper-receiver comparisons may be made directly from these sources, and the evaluations of any discrepancies, as well as the results of any investigations into these discrepancies, are also recorded here.

Furthermore, all internal transfers of SNM between MBA's are recorded in the appropriate logbooks for each MBA, so that the movement of each lot of SNM may be followed from its arrival on site to its shipment off site as waste by consulting these logbooks. Copies of the SNM Master Log form and the form used for individual MBA logs are included as Appendix "A". All of these records will be kept on file for a minimum of 5 years, or longer if deemed advisable.

7.2 INTERNAL TRANSFERS

Transfer of SNM between MBA's on site is controlled through the use of logbooks and transaction reports which detail all the transactions involving the movement of SNM from one MBA or ICA to another. In each transation, the amount of material, its form, and the date are recorded in the logbook of the issuing MBA as a transfer out of that area and initialled by the person responsible for that MBA. The same information is transcribed into the logbook of the MBA accepting the material, and again initialled, this time by the person receiving the material. Transaction reports contain the signatures of both individuals. These entries are made promptly at the time of transfer, thus assuring timeliness and accuracy of the record system. SNM transferred between MBA's 1 and 2 will be measured at the receiving MBA. Transfers between MBA's 2 and 3 will be made in the issuing MBA. Transfers between MBA's 3 and 4 will be in sealed irradiation targets and data from prior measurements will be recorded.

7.3 STORAGE AND ITEM CONTROL

Due to the nature of our production process, Sections 7.31. Program Coverage, 7.3.3 Identification, and 7.3.3 Quantity Determination, may best be described on the basis of the individual MBA's involved, rather than as separate items.

1. SNM Feed MBA

   In this area, SNM will be present either in the form of UO_2 in powder as received from the shipper, or as a solution of UO_2 in HNO_3. No provision is made for storage of the UO_2 powder other than on a very short term basis, as this material is dissolved upon receipt, as soon as its documentation has been checked by the SAO or his designated representative, and it has been weighed to verify the shipper's value. The uranyl nitrate solution is stored in volumetric flasks, identified by the labelled with a plating solution batch no. which may be cross referenced in the UO_2 Feed MBA Logbook to the shipper's lot no. or serial no. The quantity of SNM in each flask is determined by individual assays on each batch, as described in Procedures "A" and "D", and this information is also recorded in the logbook. These flasks are stored in a locked cabinet the key to which is controlled by the custodian of the MBA.

2. Plating, Encapsulation and Quality Assurance MBA

SNM in this area will be in the form of uranyl nitrate solutions as received from the Feed MBA, plating solutions formulated from these Feed solutions, waste solutions resulting from the plating operation, and as a UO_2 coating plated onto irradiation targets. Since the plating solutions are made up directly from the uranyl nitrate Feed solutions in clearly labelled containers, the amount of SNM present will have been determined when the material is transferred into the MBA. However, since these solutions will lose their unique identity at this point, the uranium and ^{235}U concentration of these solutions will again be determined before the plating operation begins and at its conclusion, so that all material may be accounted for throughout the process. The provisions for the analysis of these solutions are described in Procedures "A" and "D". Once these solutions have been used to plate target, the resulting waste solutions will be collected in plastic bottles, segregated and labelled by batch, a sample aliquot taken, and the amount of SNM in each waste batch determined, also as described in Procedures "A" and "D". Since the irradiation targets onto which the uranium is plated consist of stainless steel tubes which are sealed by welding upon completion of the plating cycle, determination of the quantity of U deposited must be performed by a non-destructive, radiometric method, as described in Procedure "C". Upon completion of this assay, the finished target may be transferred to the Reactor Operations MBA, with appropriate entries being made in the logbooks for both areas. Each individual target will be uniquely identified by a target number engraved directly onto the tube, which will be traceable in the PEQA MBA Log to the plating solution used in its fabrication.

3. Reactor Operations MBA

Finished targets are transferred from the PEQA MBA to this area, where they are further encapsulated in a sealed aluminum tube to provide secondary containment during irradiation. Since, as mentioned above, the finished targets are in the form of sealed tubes, no provision is made for a separate determination of the amount of SNM present in this MBA. The individual target numbers are entered into the Reactor Operations MBA Log, along with the quantity of SNM present in each, then the targets are welded into their secondary containers, and the target number engraved directly onto this secondary container.

As required for production, these targets are then loaded into the reactor and irradiated for varying periods of time. Once they have received sufficient irradiation, they are transferred into the Radiochemical Operations MBA, with entries detailing the transfer entered into the appropriate logbooks.

4. Radiochemical Operations MBA

In this area, the UO_2 plating on the targets is dissolved in acid, the resulting solution drained from the target capsule, and the Fission Product ^{99}Mo extracted, leaving a waste solution containing that ^{235}U which has not undergone a fission reaction, as well as large amounts of MFP. Due to the extremely high level of radiation from these solutions, it is both difficult and dangerous to perform an assay on the solution until sufficient time has passed to allow at least some of the radioisotopes present to decay. For this reason, the quantity of SNM determined by the non-destructive radiometric assay on the sealed targets is used to calculate the amount on hand in the hot cells. After approximately a month the level of activity in the solution has diminished to a point where an assay can be performed, and this is then done, as described in Procedures "A" and "C", prior to solidification of the waste and its shipment off site to an approved disposal facility. Until such time as the assays are performed, each individual batch of waste is stored in a plastic coated glass bottle labelled with the appropriate production run no., which may be cross referenced in the radiochemical operations MBA logbook to the identification number of the particular targets used for that run. Once the assay on the waste solution has been performed, the material is transferred to an approved type 2R container, solidified, and this container placed in a properly labelled waste drum which is sealed with concrete before being shipped out for disposal.

7.3.4 RECORDS

The SNM Master Log and the individual MBA logbooks will be utilized to record the identity, location, and quantity of SNM on inventory. All of this information will be entered into the appropriate log at the time of each transaction. In addition, SNM will be stored only in specifically designated areas in each MBA so that its location may be verified promptly whenever necessary. Also, each particular lot, batch, or item will be clearly labelled so that its identity and the quantity of SNM involved may be easily determined. The SNM custodian in each area will perform daily item checks of decrete items in storage in his MBA. A weekly item check of these items will be performed by a designated individual who has no SNM custodial responsibilities. All item checks will be noted in each MBA Log.

In addition, a radiometric assay (Procedures "A" & "C") is performed on the waste solutions to ensure that the specified quantity is being shipped and that no material is unaccounted for. Also, the quantity shipped is checked by the SAO to ensure that no conflict occurs between dates of waste disposal and dates of incoming UO_2 shipments that would cause us to exceed our allowed inventory.

As mentioned above, no internal transfer is involved in the shipment of SNM off site as radioactive waste, therefore the records of these shipments are maintained in the Radiochemical Operation MBA logbook and the SNM Master Log.

Appendix "A"
Revised 1/22/75

MATERIAL BALANCE AREA LOG

Location ________________

Date	Transaction	Quantity		Balance On Hand		Recorded By
		Element	Isotope	Element	Isotope	

7.3.5 TRANSACTION RECORDS

The SNM Master Log and the individual MBA logbooks will also be used to record the source and disposition of all items. As SNM is received into an MBA, the quantity and its source will be entered in the logbook, and initialled by the responsible individual. Similarly, as SNM is transferred out of an MBA, the quantity and its destination will be entered as another transaction and again be initialled by the responsible person.

7.4 TAMPER SAFING PROGRAM

Due to the nature of the production process, no unirradiated SNM is stored for any appreciable length of time in any MBA. Rather, it is put in process very shortly after receipt, and is kept in process until the Fission Product ^{99}Mo has been extracted. At this point, the material is extremely radioactive, and is confined within the hot cell system. The radiation level within these cells is so high that no means of entering them is feasible. In addition, the conveyor system that is the only access to the cells is locked whenever no personnel are present. Therefore, no tamper safing devices are considered necessary at present.

7.5 SCRAP CONTROLS

No material meeting the definition of scrap, as described in 10CFR Part 70.4u, is generated in this process, therefore provisions for scrap control are inapplicable.

7.6 SHIPPING

The only off site shipments of SNM made from this process are shipments of highly radioactive waste material to be disposed of at an approved burial site, therefore the control procedures involved are fairly simple.

7.6.1 INTERNAL TRANSFER

No internal transfers are required to prepare our SNM waste material for disposal, as this operation is conducted within the same MBA that generates the waste material.

7.6.2 OVERCHECKS

The quantity of SNM to be shipped is first determined by verifying the weights of the irradiation capsules used in those production runs from which waste is being disposed. These values are determined from the MBA logbook. This is done to ensure that the allowable quantities of SNM for this type of shipment are not exceeded.

Appendix "A"
Revised 1/22/75

SNM MASTER LOG

Date	Transaction Type	Feed MBA		Plating MBA		Reactor MBA		Radiochem. MBA		Total		Recorded By
		Element	Isotope	Element	Isotope	Element	Isotope	Element	Isotope	Element	Isotope	

Balance Adjustment Date ______________ Recorded By ______________

Master Log Inventory
Physical Inventory
Log-Physical Inventory
LEMUF

PHYSICAL INVENTORY ACCEPTED

Date ______________

Signature ______________

DETERMINATION OF URANIUM IN ELECTROLYTE SOLUTIONS

(JONES REDUCTOR METHOD)

SCOPE

This method is designed for the determination of total uranium in the electrolyte solutions used in the ^{235}U target production.

PRINCIPLE OF METHOD

An aliquot of the solution is fumed with H_2SO_4, the uranium is reduced in the Jones Reductor and titrated with $KMnO_4$.

SPECIAL APPARATUS AND REAGENTS

Nine-inch Jones Reductor - Place a perforated porcelain plate in the bottom of the reductor tube, followed by a small wad of glass wool. Fill to the neck with amalgamated zinc. Prepare the zinc as follows: shake 800 g of 20 to 30 mesh zinc with 400 ml of $HgCl_2$ (25 g per liter) in a liter flask for 2 minutes. Wash several times with H_2SO_4 (5 + 95) and then thoroughly with water. Keep the reductor filled with water when not in use.

0.1N POTASSIUM PERMANGANATE

Stock Solution - Dissolve 6.25 g of $KMnO_4$ in 50 ml of boiling water. While still hot, filter through glass wool into a 100 ml volumetric flask and dilute to volume.

0.05N $KMnO_4$ - Filter 27.0 ml of stock solution into a 1000 ml volumetric flask through burned off asbestos and dilute to volume.

Standardization - Weigh 0.3000 g of sodium oxalate (N.B.S.) into a 600 ml beaker. Add 250 ml of H_2SO_4 (5 + 95) which has been boiled and cooled to ambient temperature. Stir until dissolved and add 39 to 40 ml of $KMnO_4$ solution. Stir slowly and allow to stand until the pink color disappears. Heat to 55 to 60°C and complete titration at this temperature. The end point should remain for 30 seconds. Determine a "blank" using the same volume of H_2SO_4 (5 + 95) and subtract. Calculate the normality, adjust to 0.1N $KMnO_4$ with water, and restandardize.

(0.300 g of sodium oxalate (N.B.S.) is equivalent to 22.39 ml of 0.1N $KMnO_4$ or 44.78 ml of 0.05N $KMnO_4$.)

PROCEDURE

Take a 10 ml aliquot of the electrolyte solution and transfer it to a 400 ml beaker, add 12 ml of 1.1 H_2SO_4, cover with watch glass and heat till fumes of SO_3 evolve. Cool the beaker, wash down the sides and watch glass, cover with water and refume to strong SO_3 fumes.

Adjust the volume of the uranium solution to about 100 ml and warm on the hot plate. Add $KMnO_4$ solution (25 g/l) dropwise until a pink color persists. Cool to room temperature.

Prepare the Jones Reductor by passing 100 ml of H_2SO_4 (5 + 95), followed by 100 ml of water through it. Discard these solutions. Pass the uranium solution through the reductor into the flask receiver. Wash the reductor with 100 ml of cold H_2SO_4 (5 + 95). Blow clean air through the reduced solution for 5 minutes. Wash the air purge column with water, allow to run into receiver, and remove the receiver from the flask. Titrate the solution in the receiver with standardized $KMnO_4$.

Run a blank using all things except uranium, and correct the volume of titrant for this blank.

CALCULATIONS

$$\frac{(A - B) \times 0.119 \times N\ (KMnO_4) \times 1000}{W} = g/l\ U$$

CODE:

A = volume of titrant used

B = volume of titrant used for blank determination

N = normality of $KMnO_4$ solution (standardized by the analytical lab)

W = volume of aliquot taken by pipette

^{235}U ASSAY ON LIQUID SAMPLES
(QUALITY CONTROL LAB)

These liquid samples may be from stock plating solutions, plating waste, and fission waste, as well as liquid standards.

1. Obtain bulk tap of sample from processing group.

2. Count ^{137}Cs (NBS #82) check source on #2 NaI system at 10 cm for 1-5 minutes; read out results. Do this at the beginning and end of assay period; record results in log book.

3. Count ^{235}U flame sealed vial 1 on base for 5 minutes at the beginning, middle, and end of the assay period. Record results in log book.

4. From the bulk tap of the sample, take duplicate aliquots (10 λ to 3 ml depending on uranium concentration) and place in standard disposable plastic vials and adjust to a 3 ml volume. Label vials with their sample code and aliquot and count on base for 5 minutes. Note: the integrated photo peak area should be in the 10,000 c/5 minute area to obtain 1% counting statistics. If the count rate is significantly below this (< 5000 counts), take a larger aliquot if possible. (Note 1)

5. Log all results in the log book; take average value of c/5 m for calculation of gms of ^{235}U. If the difference between the two counts (splits) is greater than 5%, redo analysis using two more splits. If the difference can not be resolved, notify Q.A.

6. Compute the gms of ^{235}U per ml of solution using the formula below.

$$\frac{(c/5\ m)\ \text{Photo Peak Area} \times \text{dilution factor} \left(\frac{1\ ml}{\text{split size}}\right)}{3.0658 \times 10^{6}\ (\text{standard } c/5\ m/gm\ ^{235}U)} = \text{gms}\ ^{235}U$$

7. Plot the average value of the ^{235}U control standard plus its 1 σ spread on the control chart to assure the equipment is functioning correctly. If the average value falls outside the control value, hold the analysis and notify Q.A. Review data to ascertain reason for difference.

8. Report results out to the proper department.

9. Once a month, review results with Q.A.; be sure all control charts are kept up to date.

6/75

URANIUM-235 TARGET ASSAY PROCEDURE

(QC Lab)

1. Obtain target cylinder after Health Physics has certified the outside is clean.

2. Count ^{137}Cs NBS #82 check source in #2 NaI system 10 cm for 1-5 minutes; read out on tally, typewriter or other and record.

3. Count whole cylinder on top of geometry stand (32 cm) making sure it is centered. Count 0-2 MeV/400 ch for 5 minutes and read out first 100 channels on tally, typewriter or other.

4. Submit spectra to the NUMPLA computer program or compute by hand.

5. Calculate total gms of ^{235}U present using photopeak area of gamma at channel 75 (185 keV gamma of 7.1×10^8 year ^{235}U). Gamma ray is 54% relative intensity.

6. Count standard tube at 32 cm geometry 3 times during counting sequence; record data and plot on control chart.

Calculations:

$$\frac{\text{Photopeak area (c/5 m)}}{A} = \text{gms } ^{235}U$$

A - Counts-per-minute-per-gram of ^{235}U from several calibrated sources 11/74 was 17,391 c/5 m/gm.

- ^{137}Cs c/m on calibration date 11/74 was 163,113 c/5 m $\pm$ 0.5%.

- The standard tube #804 was 166,518 c/5 m on 11/74, its control limits are $\pm$ 5%.

Note: If either standard does not fall within its stated deviation, notify Quality Assurance.

^{235}U DETERMINATION BY DELAYED NEUTRON

1. Prepare sample dilutions
   (2 μg ^{235}U should give about 40-50,000 cts/min, depending on the flux).

2. Pipette aliquot into Pemt and seal.
   Samples should be run in triplicate.

3. Check stability of scaler by counting several background cts.
   Scaler setting should be:
   threshold = 3.0, F.G. = 1.0, CG = 1, Window = 10, Pre Amp X10.
   If background counts are excessively high (> 60 cts/min), check for a noisy preamp connection or scaler malfunction.

4. Run samples and standards; 6 sec. irradiation, 20 sec. delay, 1 min. count. Blank rabbits should be run for each sample and standard and used as a background subtract. A standard should be run after every 3 to 5 samples (whatever number is practical) to monitor any fluctuations in the system.

5. Calculate cts/min/g for standards:

$$\frac{\text{Cts-Blank}}{\text{Weight in grams}} = \text{cts/min/g}$$

   Calculate mg/ml for samples:

$$\text{Sample mg/ml} = \frac{\text{Cts-Blank x Dilution Factor x } 10^3}{\text{*Std cts/min/g}}$$

6. Record sample mg/ml.

*If no fluctuation of standard value is seen, an average std cts/min/g may be used.

NOTE: Feed stock is ~ 300 g/L of ^{235}U.
Plating solution is ~ 5 g/L of ^{235}U.
Plating waste is ~ 2 g/L of ^{235}U.
Other low plating waste is ~ 0.5 g/L of ^{235}U.
Fission waste is ~ 9 g/100 ml of ^{235}U.

CHAPTER 8

8.0 MANAGEMENT

8.1 Procedures

Special nuclear material control and accounting procedures and their revisions are prepared by the Health Physics Manager. Review and approval of such procedures and revisions are performed by the Nucleonics Manager, the Manager having direct responsibility for carrying out such procedure, and the Nuclear Safeguards Committee. Approval of procedures will be in writing.

8.2 COMPLIANCE

8.2.1 Management Review

At least every 12 months the material control and accounting procedures and records will be reviewed and audited by the Nuclear Safeguards Committee. The individual(s) performing the audit will be independent of nuclear material control management, measurement, or utilization. The results of this review and audit, with recommendations, will be reported in writing.

8.2.1.1 Report

Reports resulting from 8.2.1 will be forwarded to the Nucleonics Manager and the Nuclear Safeguards Committee.

8.2.1.2 Action

Corrective action on deficiencies noted in audits shall be initiated by those managers responsible within the limits specified by Nuclear Safeguards Committee. Corrective action will be reported in writing for review by the Nuclear Safeguards Committee. Serious deficiencies will be reported to Nuclear Safeguards Committee and investigated immediately.

8.2.3 Shipper-Receiver Differences

The Health Physics Manager will be notified of any difference between the UCC assay and shipper's assay. He will evaluate the statistical significance of the difference. Significant differences will be reported to the Nucleonics Manager, (Ref. Chapter 7) and the shipper. A significant difference is defined in Section 7.1.3, para. 2, however any difference exceeding 50 grams will be investigated promptly.

8.2.4 Material Balance Discrepancies

When MUF exceeds LEMUF, the Health Physics Manager will notify and report the discrepancy to the Nucleonics Manager, and ROI of NRC shall be notified within 24 hours. If MUF > 1.5 x LEMUF an immeidate re-inventory shall be conducted. If MUF > 2 x LEMUF, licensed activities under SNM-639 shall be discontinued and a clean out inventory shall be conducted.

8.2.5 Item Discrepancies

If a discrete container or item containing special nuclear material appears to be lost or missing, and an immediate investigation does not resolve the loss, the Health Physics Manager will be notified. He will promptly notify the Office of Inspection and Enforcement (Region I) and conduct an investigation. The results of the investigation will be reported to the Nucleonics Manager.

SITE INFORMATION

1. Location

The laboratory site is located in Sterling Forest, 3-1/4 miles north-northwest of Tuxedo Park, Orange County, New York. The plant is constructed along Long Meadow Road on the eastern slope of Hogback Mountain at an elevation of approximately 800 feet. (Figure "K")

Sterling Forest is an area of approximately 27 square miles which has been set aside by the owner for technological development. The laboratory site, itself, consists of 100 acres of land, owned by Union Carbide Corporation.

2. Topography and Geology

Topography and geology have been described in detail in the report "Topography and Geology of the Site", attached as Appendix 3 to Final Hazards Summary Report UCNC Research Reactor, submitted November 1960 to the AEC's Reactor Hazards Evaluation Group.

The terrain is rolling to rough and varies from lake and peat humus swamp to rocky outcrops. The site elevation varies from 700 to 1000 feet above sea level. Peaks or knolls adjoining the site extend upward to a height of 1200 feet. The area is largely covered with second growth oak and maple, and miscellaneous deciduous trees with undergrowth of laurel and rhododendron.

The area lies on Indian Kill Creek in the Ramapo River Watershed. Indian Kill flows the year round. There is a low flow in the dry season but the creek is never dry.

The region is underlaid with gneiss with frequent outcropping and little cover except in the marshy areas. Rock outcrops show numerous cracks through which surface water infiltrates to deeper strata. Iron mines were worked in the forest around Sterling Lake during revoluntionary times. With the development of more economically favorable deposits, however, work was abandoned many years ago, and the mines are not in use.

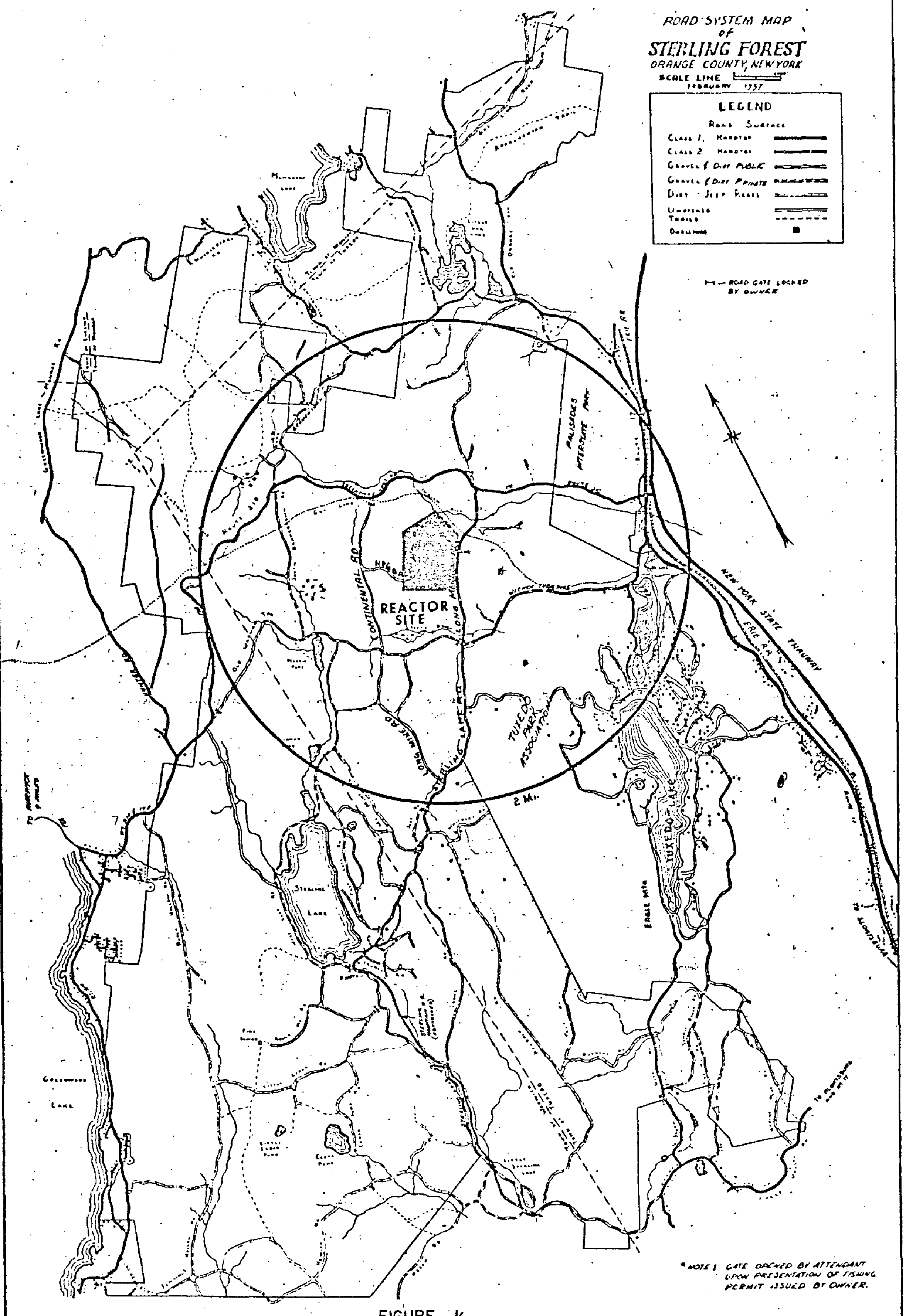


FIGURE K
2 MILE RADIUS MAP OF SITE

SNM OPERATIONS DESCRIPTION

Highly-enriched uranium oxide (UO_2), received from an SNM supplier, is dissolved to form a solution. The uranium is then plated out of solution in a layer on the inside of steel tubes. The amount of SNM plated in each tube is determined by radiometric assay. The tubes are welded closed. After quality control measurements, the sealed tubes are irradiated in a nuclear reactor. Irradiated tubes are transferred to shielded hot cells where they are opened, the uranium is dissolved, and the desired products are chemically separated. After a minimum 1 month decay the uranium solution, still highly radioactive, is packaged for shipment to a licensed burial ground.

The flow diagram (Figure "C") shows the sequence of operations, the waste streams, and the locations in the process where SNM logs are maintained [Material Balance Areas (MBA)].

HOT LAB DESCRIPTION

The Hot Laboratory is a concrete structure 139 feet long by 57 feet wide by 37 feet high. There are five hot cells, each having 4 foot thick walls of high density concrete (240 lbs/ft^3). The cells are separated from each other by 4 foot thick, high density concrete walls.

1. Hot Cells

The cells are general purpose units designed to accommodate a variety of operations including chemical experiments, radiochemical separations of isotopes, physical testing for evaluation of irradiated material, solid state investigations and metallurgical work. A general description of the cells is presented below.

Cell 1 is 16 feet wide by 10 feet long by 15 feet in height. This cell is equipped with a General Mills Remote Handling Arm (750 lb capacity), one pair of Heavy Duty Model 8 manipulators and one pair of Standard Duty Model 8 manipulators. Two Corning 4 foot thick glass shielding windows consist of Corning's Radiation Shield Standard Assembly 1480", which is their standard unit for 4 foot shielding walls. The windows are constructed from five sections 3.3 density lead glass each 9-1/2 inches thick.

A Kollmorgan periscope, currently in use in Cell 1, can be relocated to any of the other cells. With auxiliary attachments on the periscope it is possible to do in-cell microscopy and to take photographs of specimens in the cell.

Cells 2, 3 and 4 are 6 feet wide by 10 feet long by 12.5 feet in height while Cell 5 is 6 feet by 10 feet long by 25 feet in height. Cells 2, 3, 4 and 5 are each equipped with a Corning 4 foot thick glass shielding window and all cells are equipped with one pair of Model 8 Master Slave Manipulators.

Major access to all the cells is possible through the rear doors (7 feet wide by 6 feet high by 4 feet thick) which can be withdrawn utilizing electrical drives. The electrical connection and power supply to drive these doors are kept locked to prevent unauthorized entrance. An alarm sounds when any of these rear access doors are opened. The access doors for the cells are motor driven through a 1200:1 reduction worm gear and more on steel rails located in the floor of the charging area.

Access to all cells also is possible via top roof openings containing removable plugs. The roof and roof plugs of all cells are 3-1/4 foot thick magnetite concrete with a density of 240 lbs/ft^3.

The roof plug is made up of three 14 inch thick concrete slabs which must be removed individually with a 10 ton capacity overhead crane. A 6 inch diameter charging sleeve located in the center of the roof plug is fitted with an 8 inch long lead filled steel plug. Two 4 inch diameter charging sleeves also are provided through the roof. They have magnetite plugs 6 inches in diameter at the exterior surface and are stepped to 4 inches in diameter 18 inches from the interior surface. There are laboratories and a solution make-up room above the charging area but no occupied areas directly above the cells.

A canal containing water 12 feet deep connects Cell 1 with the reactor pool. Radioactive samples, specimens, isotopes, etc., are transferred through this canal and brought into Cell 1 via an automatic elevator mechanism.

2. Operating Area

The area on the front side of the cells is the operating zone and is maintained as a clean area. The viewing windows, manipulator controls, intercell conveyor controls, in-cell service controls (air, water, vacuum, gas) and periscope are located in this area. The operating control panels for the ventilation system and the Radioactive Waste Water Treatment System are located at the north end of this area.

Fifteen radiation monitrons serving the Hot Lab and cells are linked to a master panel which is located in the operating area. Both audio and visual alarms are activated at this master panel. Ten monitrons, located outside of the cell, are normally set to alarm at 5.0 mr/hr. Five in-cell monitrons are used to indicate the radiation level within the cells. These can be set to alarm at any level from 1 to 10,000 mr/hr.

In the front shielding wall of each cell there are twelve removable 2 inch diameter stepped pipe sleeves, one 8-1/2 inch diameter sleeve (to accommodate the periscope) and two 10 inch diameter sleeves (to accommodate the Model 8 manipulators). When the sleeves are not in use magnetite shielding plugs are placed in the sleeves. Special services not available within the cell (such as inert gas, high pressure air, natural gas) can be led into the cells through special plugs which can be inserted in place of the standard 2 inch diameter stepped pipe sleeves. Locking bars are used to prevent accidental removal of any of these plugs.

3. Charging Area

The charging area is located to the rear of the cells. Controls for the rear access doors to the cells are located here. Access to the decontamination room, exhaust fan room, waste treatment facility and conveyor loading station are from the charging area (see Figure "D").

The north loading dock is separated from the charging area by swinging doors. At the south end of the charging area swinging and sliding doors separate this area from the canal and the south loading dock.

In the rear shielding wall of each cell there are five 2 inch diameter stepped pipe sleeves. Each rear cell door also contains one 8 inch diameter stepped sleeve. These sleeves provide additional access ports from the charging area to the cells. They contain magnetite shielding plugs when not in use.

4. Radiochemical Laboratory

Low level radioactive specimens or samples will be handled in the Radiochemical Laboratory. Equipment available in the laboratory includes standard laboratory benches with stainless steel tops, glove boxes and hood.

Operations in this laboratory involving higher level radioactive gases will be conducted within special hoods. There are three hoods. These hoods, with interior surfaces of stainless steel, are 6 feet wide and designed for work with radioactive materials. All flow from these hoods pass through roughing filters, and absolute filters (these are standard units) prior to passage to an exhaust fan and monitoring system. The exhaust air flows to a 50 foot stack which also receives exhaust air from the Reactor area.

Supporting non-radioactive analytical work also is done in this laboratory. A plan view of the Radiochemical Laboratory is shown in Figure "C".

5. Second Floor Work Area

a. Laboratories

Three laboratories are located in this area. They will be used for work similar to that described for the Radiochemical Lab. All operations involving radioactive materials will be carried out in hoods, glove boxes or other suitable ventilation control devices.

b. Work Area

An area, 38 feet by 20 feet, on the north end of the second level is utilized for inventory storage. A unit for producing distilled water and a transmitter rack for instrumentation and a distillate hold tank from the liquid waste treatment system are located in this general area.

6. Maintenance Shop and Welding Lab

A machine shop, and welding lab are available in the Hot Lab. These shops contain a drill press, lathe, milling machine, band saw, electric and gas welding equipment, and a variety of hand tools.

7. Personnel Facilities

Seven offices, a conference room, a change room, a locker room (30 lockers), and two rest rooms are in the Hot Lab.

8. Radioactive Waste Storage Building

The low level radioactive waste storage building which is identified in Figure "L" is located 600 ft. from the nearest property line, 300 ft. from the nearest building and 900 ft. from the nearest public road. (See Figure "L"). This building is used for the storage of drums containing radioactive wastes from the Hot Laboratory prior to shipment to a licensed burial ground.

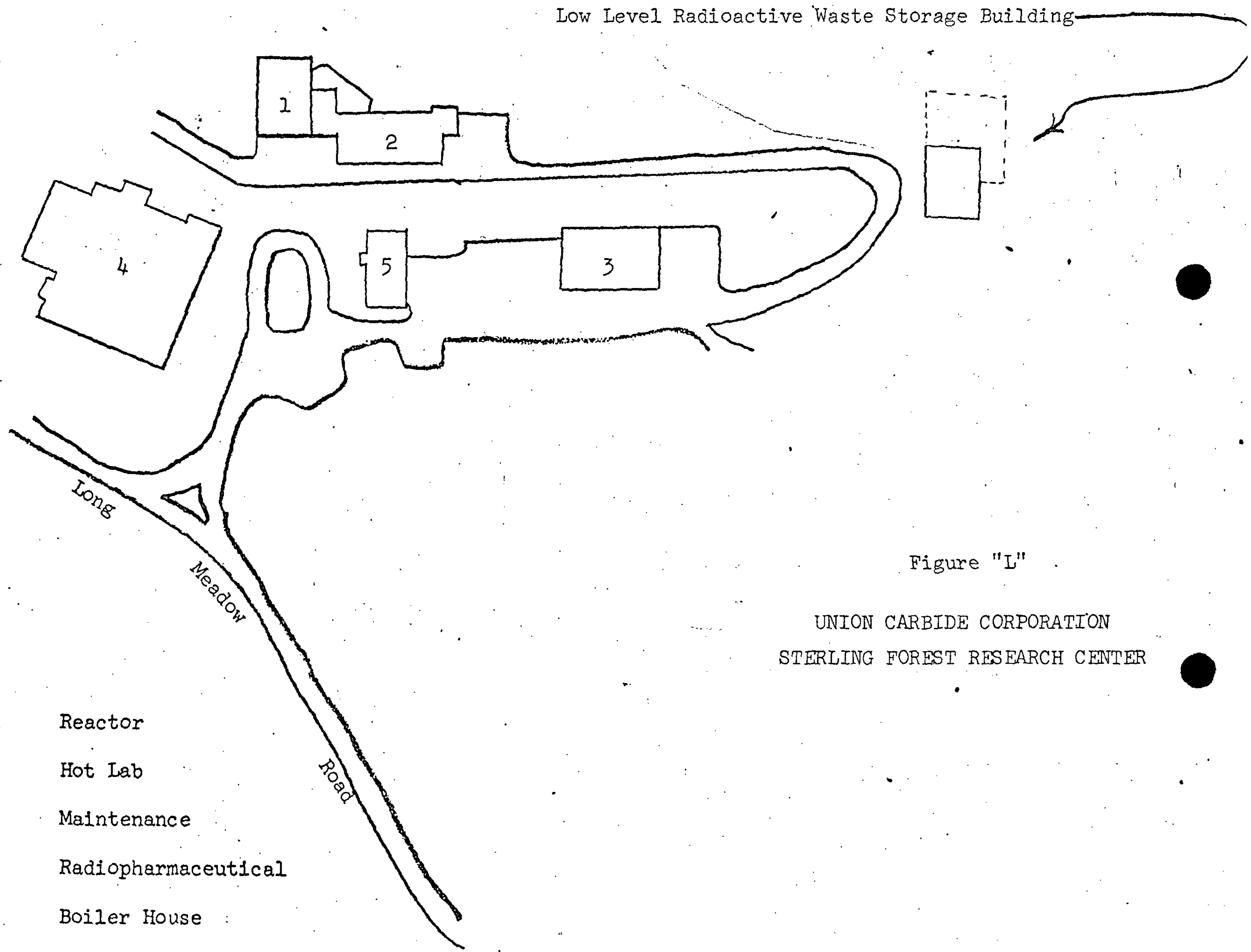


Figure "L"

UNION CARBIDE CORPORATION
STERLING FOREST RESEARCH CENTER

BUILDING 1	Reactor
BUILDING 2	Hot Lab
BUILDING 3	Maintenance
BUILDING 4	Radiopharmaceutical
BUILDING 5	Boiler House

REACTOR DESCRIPTION

The 5 megawatt pool-type research reactor is a light-water moderated, heterogeneous, solid fuel reactor in which water is used for cooling and shielding. The reactor core is immersed in either section of a two-section concrete pool filled with water.

Spanning the pool is a manually-operated bridge, from which is suspended an aluminum tower supporting the reactor core. Control of the reactor core is accomplished by the insertion or withdrawal of neutron-absorbing control rods suspended from control drives mounted on the reactor core bridge.

The reactor core is composed of MTR type fuel assemblies and the control rod fuel assemblies with built in control rod guides. The elements may be arranged in a variety of lattice patterns depending on experimental requirements on the grid plate. Special handling tools are used for the underwater insertion or removal of any of the above assemblies from the grid plate.

Heat, created by the nuclear reaction, is dissipated by a circulation cooling system. Externally located pumps, storage tanks, water-to-water heat exchangers, a cooling tower, a demineralizer plant, and a filter complete the water handling systems for the reactor.

The Reactor is housed in Building 1 (see Figure "L"). The Reactor is licensed pursuant to the Code of Federal Regulations Title 10 Part 50. The Reactor License number is R-81 (Docket 50-54).

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Union Carbide Corp. Tuxedo, NY	Jan. 24, 1975	Jan. 27, 1975	0161

LTR.	MEMO:	REPORT:	OTHER:
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Materials and Plant Protection Branch	1		

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NO ACTION NECESSARY ☐	COMMENT ☐	BY:

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ENCLOSURES:

Fundamental Nuclear Material Control

10 cys

REMARKS:

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Page 3 extras	1-27		
reg file cy			
PDR (memo & Ltr.)			
RO (2 ltrs. & 1 enclosure)			
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70-687

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RESEARCH CENTER

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January 24, 1975

U. S. Atomic Energy Commission

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Washington, D. C. 20545

Gentlemen:

The enclosed Fundamental Nuclear Materials Control

FUNDAMENTAL NUCLEAR MATERIALS CONTROL PLAN

Submitted to

U. S. Atomic Energy Commission
Directorate of Licensing
Materials and Plant Protection Branch
Washington, D.C. 20545

By

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CHAPTER 1

1.0 ORGANIZATION

1.1.1 Corporate Organization

Figure A, is a chart of the organization structure directly related to special nuclear material control and accounting at the Union Carbide Sterling Forest Laboratory (SFL).

1.1.1.1 Functional Descriptions

(a) The Manager, Health Physics (SNM Accountability Officer) is responsible for developing, revising, and administering the SFL FNMC Plan.

(b) The Manager, Quality Assurance develops, revises, and administers the SNM measurement and calibration program under the FNMC Plan.

(c) The Manager, Radiochemical Production develops, revises, and administers in process handling procedures for SNM under the FNMC Plan.

(d) The Manager, Nucleonics appoints and supervises individuals in performance of the above functions. In conjunction with the Nuclear Safeguards Committee, he approves procedures for implementing the FNMC Plan.

(e) The Nuclear Safeguards Committee, as previously described in UCC application for license renewal dated 4/28/69, reviews and approves all initial plans and procedures and changes thereto. It also performs audits of operations.

(f) The Sterling Forest Lab Operations Manager is responsible for operating the physical plant at the Sterling Forest site. In this capacity he monitors the operations of the Nuclear Safeguards Committee and is aware of all operations within the Nucleonics groups relating to the status of the physical plant or requiring the attention or use of any of the site services groups.

(g) The Senior Research Scientist is responsible to the Manager Nucleonics and is assigned in a staff capacity as consultant to and/or auditor of operations when necessary or desirable.

Figure "A"

SFL ORGANIZATION DIRECTELY INVOLVED WITH SNM-639 OPERATIONS

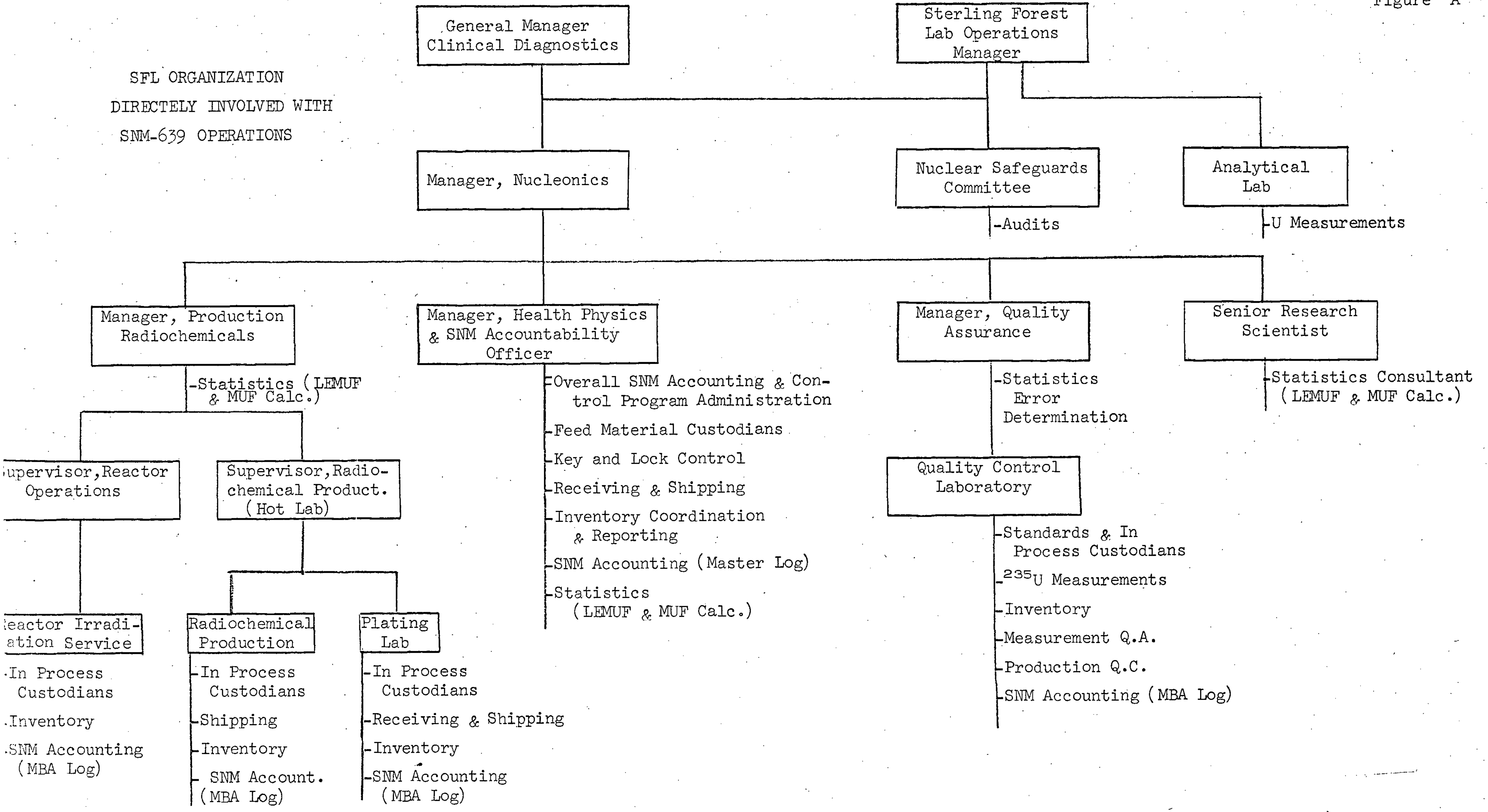
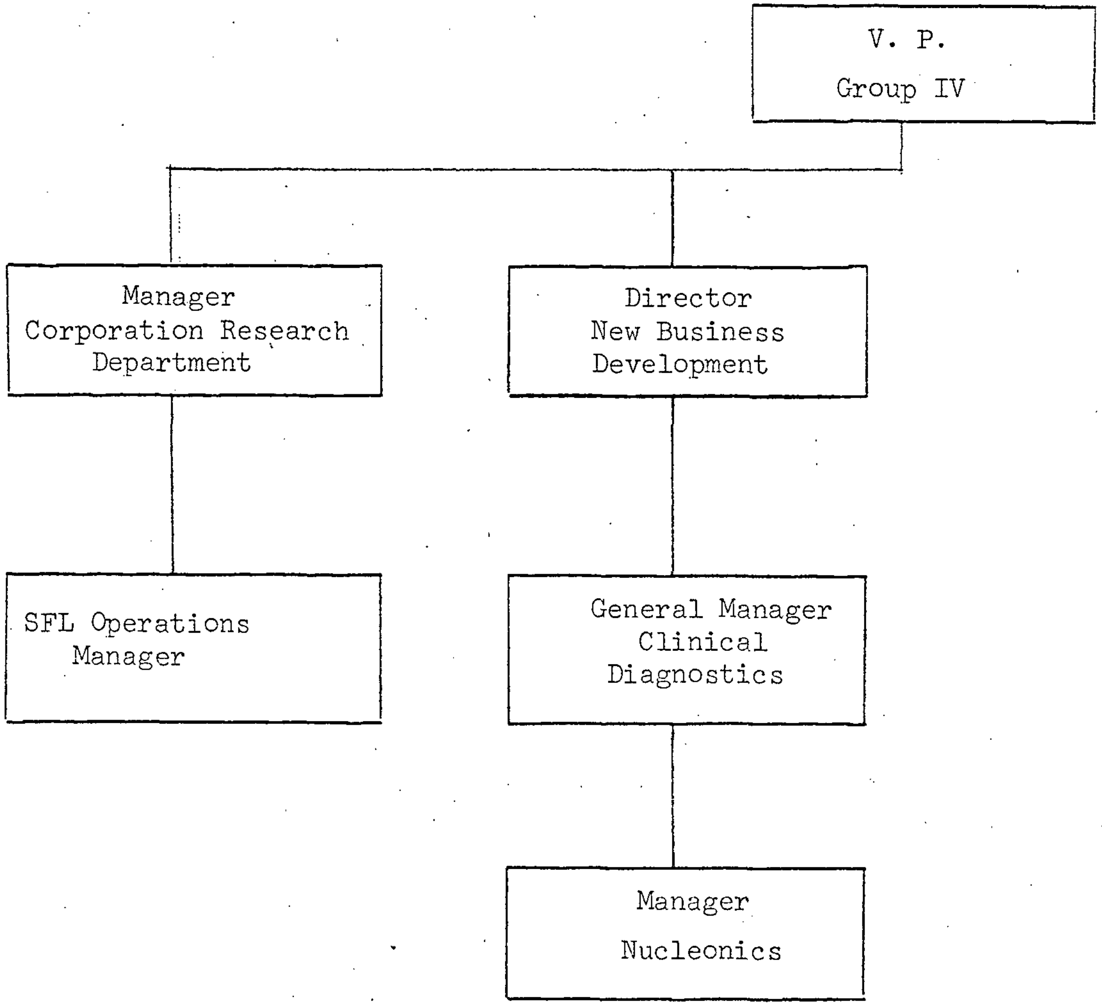


Figure "B"



CORPORATE ORGANIZATION OVER
SFL SITE LEVEL
RELATED TO SNM-639

1.1.1.2 Staffing

The management of SNM under the UCC SNM-639 License will be accomplished within the organization at the Sterling Forest Laboratory. This organization is accountable to the Corporate Group IV V.P. thru the General Manager, Clinical Diagnostics and thru the Director, New Business Development respectively.

1.1.1.3 Organization Charts

Figure "A" and "B" are charts of the corporate organization at SFL and from SFL to corporate headquarters respectively which are concerned with operations under the SNM-639 License.

1.1.1.4 Job Descriptions

The job descriptions relating to operations under SNM-639 are presented in Section 1.1.1.1.

1.1.2 Site Organization

Figure "A" is a chart of the SFL site organization related to SNM under SNM-639.

1.1.2.1 Internal Organization

Figure "A" is a chart of the internal organization identifying areas of SNM control program functions.

1.1.2.2 Separation of Functions

Figure "A" shows the functions performed within each group at the SFL site. Some functions in SNM control are common among the different groups but, because of the sequential nature of operations between groups, the operations of one group should serve as a check on the operations of neighboring groups. (See Figure "C" for material flow chart; refer to Chapter 5 Physical Inventory Plan dated 10/17/74 and amended 12/5/74; refer to Chapter 6 Material Accounting System; refer to Section 2.1.2.3 Selection Criteria (MBA Selection) for interaction among groups and MBA's.)

1.1.2.3 Outside Support

It has not been necessary to procure outside support in the form of a technical services contractor or consultant to date. If such services are procured in the future they would most probably be procured and administered by the group manager having functional responsibility for the items or services rendered.

1.2 RESPONSIBILITIES AND AUTHORITIES

1.2.1 Overall Program Management

The Manager, Health Physics will be reponsible for the overall planning, coordination and administration of the SNM control program. Figure "A" shows the functional responsibilities of this position which relates to the SNM control program. The qualifications of the individual to occupy this position shall include, a B.S. degree in a Nucleonics field, a working knowledge of Title 10, CFR and prior experience in SNM handling and control.

1.2.1.1 & 1.2.1.2 Independence of Action and Functional Relationships

Figure "A" and Section 1.1.1.1 show the functional and management relationship of this position to the other groups within the organization.

1.2.2 Accounting Management

The centralized SNM accounting system is the responsibility of the Manager, Health Physics. This is accomplished thru his designee to maintain the Master Log for SNM under SNM-639. The central SNM accountant shall, as a minimum, be in a technician grade level of Technical Specialist as defined by the SFL personnel job descriptions. The functional duties of this position relating to SNM-639 shall include:

(a) Maintain a current record of all SNM on site under authority of SNM-639 (Master Log).

(b) Witness receipts and shipments of SNM.

(c) Key and lock control for materials under SNM-639.

1.2.3 Special Nuclear Material Custodial Units

The organizational units which have custody of SNM are:

(a) Reactor Operations

(b) Radiochemical Production

(c) Quality Assurance

(d) Health Physics

1.2.3.1 SNM Custodians

SNM custodians have been designated as follows:

Reactor Operations

Title	Qualifications
Asst. Reactor Supervisor	Technical Specialist
Chief Reactor Operator	Technical Specialist

Radiochemical Production

Production Associate, Radiochemical Production	Technical Specialist
Shift Technician, Target Plating Lab	Technician

Quality Assurance

Shift Technician, Q.C. Lab	Technician

The duties of SNM custodians are as follows:

(a) Maintain custody of and be accountable for material within his MBA.

(b) Keep the MBA log up-to-date.

(c) Maintain proper security in his MBA.

The minimum qualifications for each job title are as described in the SFL personnel job descriptions.

1.2.4 Special Nuclear Material Control and Accounting Units

Figure "A" and Section 1.1.1.1 gives descriptions of the functions and authority of the organizational units concerned with handling material under SNM-639.

1.2.5 Audits and Reviews

The Nuclear Safeguards Committee, thru a designated representative, will have the authority to perform audits of the special nuclear material control and accounting program and the measurement program.

1.2.6 Delegation of Authority

Delegation of authority and responsibility is made in writing when individuals are appointed to the above described positions related to special nuclear material controls. Such responsibility and authority is delegated by the next highest line function in the organization.

1.3 TRAINING PROGRAMS

Upon initially assuming their duties in the SNM control program, all personnel are trained in those specific functions they will be accountable for. Retraining will be performed as determined to be necessary by annual audits of each function.

CHAPTER 2

2.0 MATERIAL CONTROL AREAS

2.1.1 Plant Areas

The plant at the SFL site consists of the Reactor/Hot Laboratory buildings.

2.1.2 Internal Control Areas

Figure "C" is a chart of the control areas within the plant. The locations of these control areas are as follows: (Ref. Figure "D")

(a) The UO_2 feed area is located on the upper level of the Hot Laboratory.

(b) The Plating Encapsulation and Quality Control MBA is established by process parameter rather than physical boundaries. The MBA consists of 3 plating laboratories on the upper level of the Hot Laboratory, a welding lab on the first level of the Hot Lab, and a Quality Control Lab on the upper level of the Reactor Building.

(c) The Reactor Operations MBA is located in the Reactor Building.

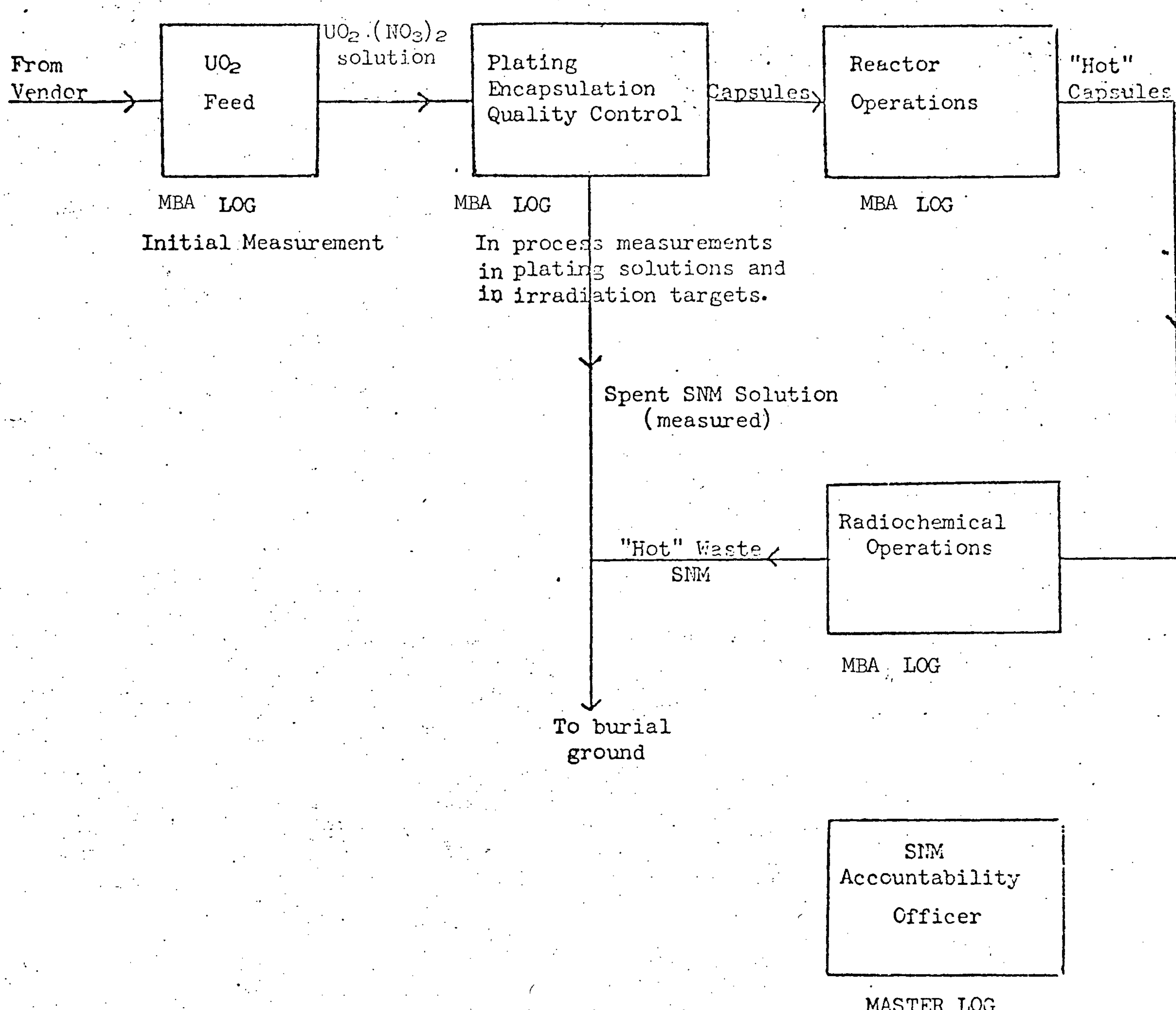
(d) Radiochemical Operations MBA is located in the Hot Cells in the Hot Laboratory.

2.1.2.1 Process Boundaries

Figure "C" is a chart of the process boundaries and shows the flow of material thru these areas.

2.1.2.2 Physical Boundaries

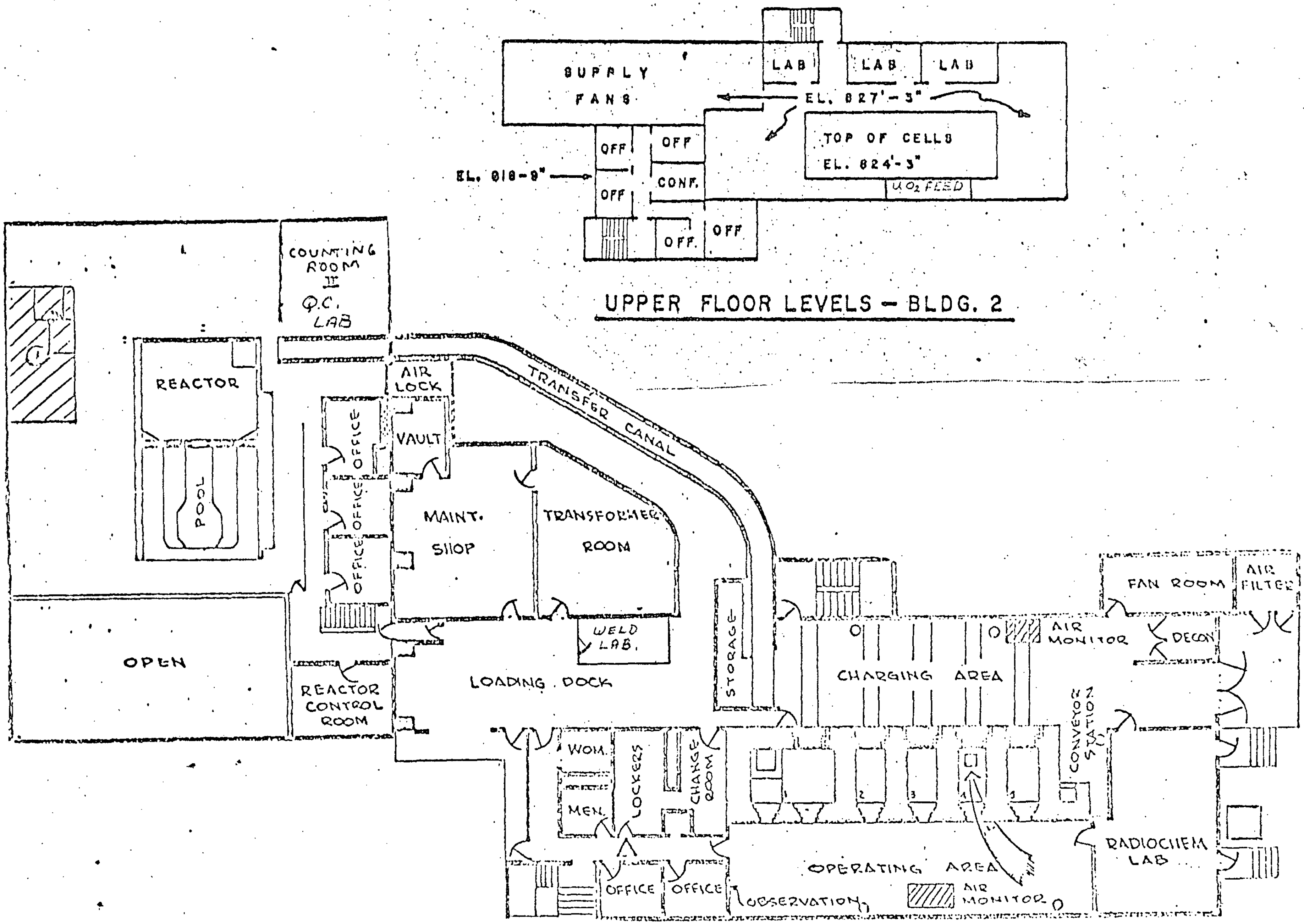
Figure "D" shows a plan of the Reactor and Hot Laboratory buildings. The Reactor Building walls and roof are constructed of reinforced concrete of a minimum thickness of 12" in walls and 8" in the roof. The Hot Laboratory is constructed of reinforced concrete and concrete block of a minimum thickness of 12". All partitions which form interior rooms are constructed of concrete block. The physical location of each MBA is as described in Section 2.1.2.



PLANT PROCESS FLOW DIAGRAM

(Each block in flow chart represents a material balance area.)

Figure "D"


SUPPLY FANS
LAB
LAB
LAB
EL. 827'-3"
TOP OF CELLS
EL. 824'-3"
UO_2 FEED
OFF
OFF
OFF
CONF.
OFF.
OFF
EL. 818-9"
UPPER FLOOR LEVELS - BLDG. 2
COUNTING ROOM II
Q.C. LAB
REACTOR
POOL
AIR LOCK
VAULT
OFFICE
OFFICE
OFFICE
TRANSFER CANAL
MAINT. SHOP
TRANSFORMER ROOM
WELD LAB.
STORAGE
OPEN
REACTOR CONTROL ROOM
LOADING DOCK
FAN ROOM
AIR FILTER
AIR MONITOR
DECON
CHARGING AREA
CONVEYOR STATION
WOM.
MEN.
LOCKERS
CHANGE ROOM
OPERATING AREA
RADIOCHEM LAB
OFFICE
OFFICE
OBSERVATION
AIR MONITOR

2.1.2.3 Selection Criteria

The control areas were selected with the following parameters in consideration:

(a) The UO_2 Feed area is separated by location and administration. Access to this area is controlled by the Manager, Health Physics.

(b) The Plating Encapsulation and Quality Control MBA is separated by process requirements; the process being the fabrication of finished irradiation targets.

(c) The Reactor Irradiation MBA is separated by process, location and administration.

(d) The Radiochemical Operations MBA is separated by process, location and administration.

The separation of material control by the above MBA's provides for localization of losses in the following manner:

(a) The UO_2 Feed area consists of locked steel cabinets. All incoming material is assayed for shipper-receiver difference and placed into this area for subsequent incremental additions to the plating process. Each batch received retains its identity until it is all fed into the plating process. Each batch is a measured volume (1 liter) and is usually consumed within a 2 week period. Diversions can be detected easily.

(b) The Plating Encapsulation and Quality Control MBA has three mechanisms for material control.

1. Material brought into the plating labs is added to 1 of four plating solution batches. These batches are assayed before and after each plating process (usually within one week). Diversion of material can be noted within this period of time.

2. When material has been plated on targets, they are assayed and assigned a distinctive target serial number. Each sealed target retains its identity thru the next two material balance areas until it is combined with other targets (RW waste solutions) and assayed prior to shipment for burial in a licensed burial site. Diversion of targets can be detected if targets do not have serial number continuity as they are transferred from Plating to Reactor Operations.

3. Material in the plating waste solution is assayed weekly. This material does not amount to more than ~ 4 gm/mo. Any diversion would be detected as a result of a loss evident from the weekly assay.

(c) The Reactor Operations group exercises material control thru positive item control on sealed targets. Any unexplained discontinuity in target serial numbers would be detected immediately.

(d) The Radiochemical Operations group exercises material control by positive item control on target serial numbers. In addition, the material which has been irradiated is highly radioactive and cannot be safely handled outside our Hot Cells. Diversion of such material would require a series of complex operations which could not be accomplished undetected.

In addition to the above provisions to detect the diversions of SNM, reference is made to the UCC SFL Plant Security Plan in effect at our laboratory as described in our letter of 1/7/74 to the Commission.

CHAPTER 3

3.0 MEASUREMENTS

3.1 There are two basic types of analytical measurements made at SFL for SNM. The radiometric assay for ^{235}U and a chemical assay for total U. These assays are made at a number of points during a process cycle. The flow diagram in Figure "E" shows the process flow.

A. Initial measurements are made on the UO_2 Feed dissolved in 1:5 HNO_3. At this point, a volume measurement is made and samples are removed for non-destructive radiometric analysis for ^{235}U content and destructive chemical analysis for total uranium.

B. A plating solution is made from this UO_2 Feed material. The volume of this plating solution is measured and samples are taken for radiometric analysis for ^{235}U and chemical analysis for total uranium.

C. After each plating operation there are two items to measure, the plated target capsules and the spent plating solution.

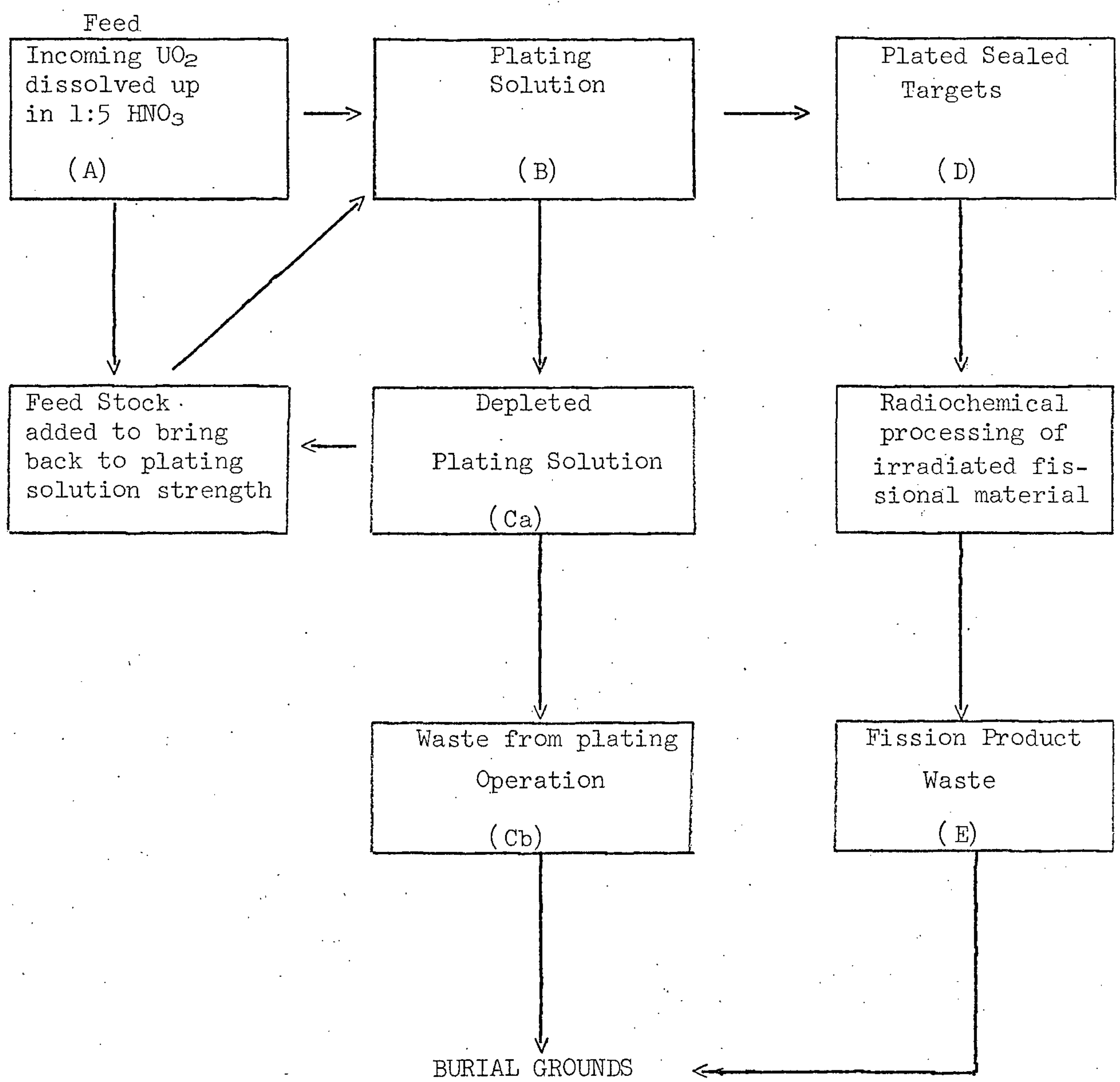
   1. The spent plating solution, if it is to be used again, will have its volume measured and then be assayed for total uranium by chemical means. New feed material will be added to bring it up to plating solution strength at which point it will be assayed as in Paragraph B. above.

   2. The spent plating solution, if it is waste, will have its volume measured and then be sampled for both ^{235}U assay and total U assay as in Paragraph B. above.

D. The sealed target tubes will be assayed by non-destructive radiometric methods for total ^{235}U content. Knowing the enrichment factor from their plating solutions a value for total U will be calculated for each target.

E. After the targets have been irradiated and the fission product separation is performed, the waste solution will be measured for volume and samples will be taken for radiometric analysis for ^{235}U and chemical assay for total U prior to the disposal of the fission waste solutions.

DIAGRAM OF SNM FLOW WITH DESIGNATED ASSAY POINTS



3.6.1 The radiometric assay at point E will be done using the procedure described in Section 5.11.1 b.

The radiometric assay at point D will be done using the procedure described in Section 5.11.1 d.

3.7 SAMPLING AND MEASUREMENT UNCERTAINTIES

All sampling and measurement uncertainties are shown in terms of relative standard deviations in Appendix "D" (Chapter 5).

3.7.1 MASS MEASUREMENTS

This section is not applicable to the accounting system at SFL.

3.7.2 VOLUME MEASUREMENTS

a. UO_2 Feed Solution is measured in graduated flask of one liter capacity. Relative Systematic Standard Deviation (RSSD) 0.001 or ± 1 ml, Relative Random Standard Deviation (RRSD) 0.005 or ± 5 ml.

b. Plating Solution is measured in precalibrated 16 liter vessels. RSSD 0.02 or ± 0.32 liters, RRSD 0.03 or ± 0.48 liters.

c. Plating Waste is measured in precalibrated 10-16 liter vessels. RSSD 0.001 or ± .016 liters, RRSD 0.006 or ± .096 liters.

d. Radioactive Waste is measured in a precalibrated 1 liter vessel RSSD 0.02 or ± .02 liters, RRSD 0.003 or ± .03 liters.

3.7.3 ELEMENT SAMPLING

Element sampling will be done using graduated T.D. pipets, T.D. Eppendorf micro liter pipets all Relative Standard Deviations for each described system in Section 3.4.1 are found in Appendix "D" (Chapter 5).

a. UO_2 Feed Solution sampling will be done with Eppendorf pipets in the 100 μ liter range.

b. Plating Solution sampling will be done using 10 ml T.D. Analytical pipets.

c. Plating Waste sampling will be done using 10-30 ml T.D. Analytical pipets.

d. Radioactive Waste sampling will be done using 5-10 ml T.D. Analytical pipets.

e. Target Capsules can not be directly analyzed for elemental uranium.

3.7.4 ELEMENT ANALYSIS

Element analysis results are in terms of grams of material. All Relative Standard Deviations for each described system in Section 3.5 are found in Appendix "D" (Chapter 5). The sampling of material is done in such a way that the amount of U actually analyzed is $\sim$ 50 mg.

3.7.5 ISOTOPE SAMPLING

Isotope sampling will be done using T.D. Eppendorf pipets for each system described in Section 3.4.2. The RSD's for each are in Appendix "D" (Chapter 5). The RSSD and RRSD are the same for all sample volumes (20 μ liter to 1000 μ liter). The uncertainty in sampling for the analysis in radioactive waste is larger because it is compounded by the necessity of a pre-analytical radiochemical separation.

3.7.6 ISOTOPE ANALYSIS

Isotope analysis results are in terms of grams and the RSD's for these are found in Appendix "D" (Chapter 5).

a. All materials in solution are analyzed in the same way except for the radioactive waste which requires double handling; hence a larger RSSD and RRSD.

b. The plated targets are analyzed as described in Section 5.11.1 d and will vary from 5-13 grams of ^{235}U.

3.8 MEASUREMENTS PROCEDURE

An SNM Measurement Procedures Manual will be established and maintained. The Manager, Radiochemical Operations, Manager, Health Physics, and Manager, Quality Assurance are responsible for the initial preparation and the periodic updating of this manual. The manual will be submitted to the Manager, Nucleonics and the Nuclear Safeguards Committee for approval.

CHAPTER 5

5.0 PHYSICAL INVENTORY

Refer to the Physical Inventory Plan submitted in Union Carbide Corporation letter dated 10/17/74, and modified in Union Carbide Corporation letter dated 12/5/74.

CHAPTER 6

6.0 MATERIAL ACCOUNTING SYSTEM

6.1 System Description

The basic accounting program shall consist of a Master Log and subsidiary logs for each of the four material balance areas.

The Master Log is maintained so that the total quantity of enriched uranium possessed under License SNM-639 is recorded and maintained current.

The subsidiary logs for each material balance area are maintained so that the quantity of enriched uranium in each area is recorded and maintained current and that records are maintained of all transfers into or out of an area.

6.1.1 Account Structure

The account structure shall include the following ledgers:

Uranium Feed Log - Contains records on uranium feed material in ready storage.

Plating, Encapsulation, Quality Control Log - Contains records of enriched uranium being prepared for reactor irradiation.

Reactor Irradiation Log - Contains records of enriched uranium in the form of sealed targets either in the reactor or ready to be put in the reactor.

Radiochemical Processing Log - Contains records of irradiated enriched uranium being processed in the hot cells or being prepared for disposal.

Master Log - Contains records of the total quantity of uranium possessed under License SNM-639.

When material is received on site, it is assayed and the values entered in the Uranium Feed Log and the Master Log. When material is transferred internally between material balance areas, concurrent entries are made in the MBA Log of the area from and to which the material is transferred.

All receipts are opened within 24 hours and the rapid turn over of material eliminates the need to maintain material under tamper-safing.

6.1.1.1 Accounting Forms

The following basic accounting forms will be used to provide data for the ledgers described in Section 6.1.1.

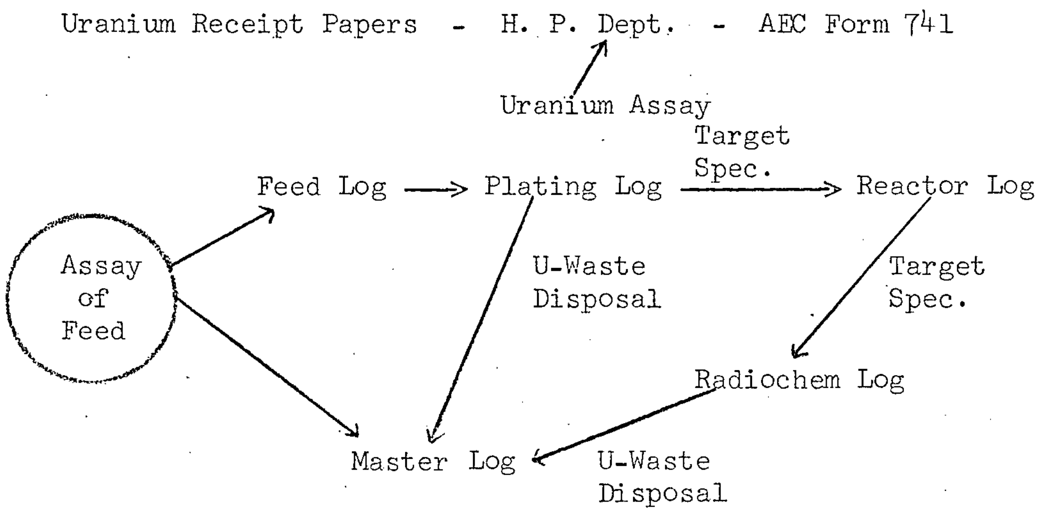
A. "Uranium Analysis Request" (see Figure "F")

B. "Target Specification and Q. A." (see Figure "G")

C. "Uranium Waste Disposal" (see Figure "H")

D. "Inventory Report" (see Figure "J")

6.1.1.2 Flow Chart



Report Form	Data Retention Points
Assay of Incoming Uranium	Feed Log + Master Log
Uranium Waste Disposal	Master Log
Target Specification	Radiochemical Log

Report Form	Posting Point
Feed Log	In Feed Locker
Plating Log	2nd Floor Hot Lab
Reactor Log	Reactor Office
Radiochemical Log	1st Floor Hot Lab
Master Log	H. P. Office

Figure "F"

RH 1/75

URANIUM ANALYSIS REQUEST

REPORT

CHARGE# 50-03

mR ____

DATE ____

Batch# ____ Type Solu. ____ Media ____ Source ____

No. Samples ____ Vol. Submitted ____ ml ^{235}U ____ Total U ____

Total Volume in Batch ____ liters ml Approx. ^{235}U - Total U ____ mg/ml

Requestor ____

RESULTS

^{235}URANIUM	TOTAL URANIUM
^{235}U grams/ml (A) ____	Total U grams/ml (A) ____
^{235}U grams/ml (B) ____	Total U grams/ml (B) ____
^{235}U grams/ml (C) ____	Avg. Total U in Batch ____
Avg. ^{235}U grams/ml ____	Total Vol. in Batch X ____
Total Vol. in Batch X ____	Total U in Batch ____ gms
Total ^{235}U in Batch = ____ gms	

ENRICHMENT FACTOR

$$\frac{\text{Total } ^{235}U \text{ \_\_\_\_ gms}}{\text{Total U \_\_\_\_ gms}} \times 100 = \text{\_\_\_\_ \%}$$

Assayed by ____	Assayed by ____
Notebook No. and Pg. ____	Notebook No. and Pg. ____
Date ____ Time ____ hrs.	Date ____ Time ____ hrs.

F _ _ _ _ _ _ = Feed or Bulk = 350 mg/ml

Pl _ _ _ _ _ = Plating = 5 mg/ml

P.W. _ _ _ _ = Plating Waste=1-3 mg/ml

R.W. _ _ _ _ = F.P. Waste = 50-100 mg/ml

If this is a R. W. Sample - List

Tube Numbers: T ____, T ____

T ____, T ____, T ____, T ____

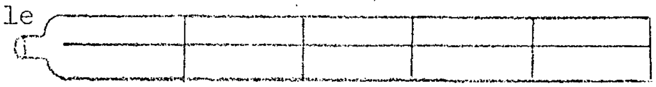
T ____, T ____, T ____, T ____

Figure "G"

TARGET SPECIFICATION AND Q.A.

Hot Lab Standard	HS-21

Capsule No. ________ Reactor No. ________ Power Generator Factor ________________

	Date	Initials
Radiometric Analysis		
Gross Count ______ c/5min Total ^{235}U ______ gm.		
Plating Batch No. ______ Enrichment Factor ________ %		
Total Uranium Content ____________ gm.		
^{235}U Profile counts / % 235 		
Metal Parts Inspection		
Vibration Test		
Sealing		
He Filled		
Primary Tested		
Decontamination		
Approved for Secondary Encapsulation		
Secondary Encapsulated ________ Normal ________ Inverted		
Secondary He Filled		
Secondary Leak Tested		
Reactor Restrictions:		
Load Position# ____________ Date ____________		
Moved to Position# ________ Date ____________		
Removed ____________ Date ____________		
Processing		
Waste Disposal		

URANIUM WASTE DISPOSAL

MBA AREA ______________________

Item	Element	Isotope	Initial/Date	Disposition

INVENTORY REPORT

MBA ______________________ Period Ending ______________________

	Element Wt.	Isotope Wt.
Beginning Inventory		
Additions To Inventory		
Removals From Inventory		
Ending Inventory		

PHYSICAL INVENTORY

Identification	Element Wt.	Isotope Wt.

PHYSICAL TOTAL

LOG TOTAL

MUF

LEMUF

MUF Less Than LEMUF Log Adjusted Date ______________________ Initial______

MUF Greater Than LEMUF SAO Notified Date ______________________ Initial______

6.1.2 Accounting Procedures

An accounting procedure manual will be established and maintained. The Manager of Radiochemical Operations, Manager of Health Physics, and the Manager of Quality Assurance are responsible for the initial preparation and the periodic updating of this manual. The manual will be submitted to the Manager, Nucleonics and the Nuclear Safeguards Committee for approval.

6.1.3 Source Data

Transaction Type	
1. External Receipts and Shipments	Chemical and Radiometric Analysis of Material
2. Internal Transfers	A. Chemical and Radiometric Analysis of Material
	B. Radiometric Analysis of Target
	C. Capsule Specification
3. Waste Removal	A. Chemical and Radiometric Analysis
4. Inventories	A. Chemical and Radiometric Analysis
	B. Identification of Target and Specification Sheet
	C. Identification of Irradiated Waste
5. Adjustments to Recorded Data	A. MBA Inventory Reports
	B. Calculations of LEMUF
	C. Statistical Analysis

6.1.4 Adjustments to Records

Adjustments to prior recorded values will be made in the appropriate log book or books. All adjustments will be initialled and dated by the Manager of Health Physics or his alternate.

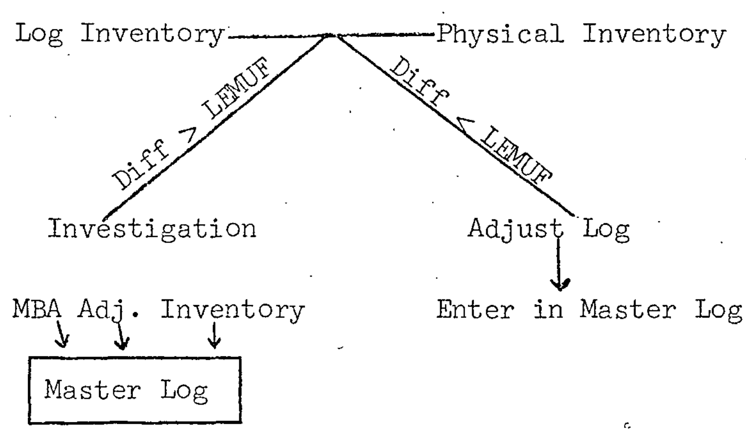
6.1.4.1 Bias Adjustments

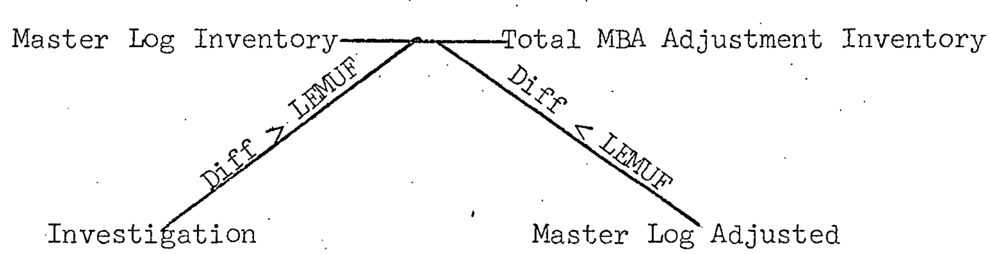
A statistical analysis will be performed on all required inventory adjustments. If this analysis indicates a recurring bias to a particular measurement, the measuring system will be re-evaluated for accuracy. All procedure modifications will be reviewed by the Manager of Health Physics and approved by the Nuclear Safeguards Committee.

6.1.5 Inventory Reconciliation

At the completion of each inventory the physical inventory quantities will be compared with each MBA Log inventory. Differences within the calculated LEMUF for that period will be noted in the log book and the log book corrected to reflect true inventory. Differences outside the calculated LEMUF will be investigated to determine the cause. After all MBA Logs have been reconciled to the physical inventory results, the Master Log will be adjusted to reflect the true inventory.

(For Each MBA)





Adjustments to MBA logs within LEMUF will be initialled and dated by the authorized individual in each area. Adjustments to the Master Log or to MBA logs which are outside the LEMUF will be initialled and dated by the Manager of Health Physics or his alternate.

6.1.6 Account Reconciliation

All logs will be reconciled with physical inventory quantities at the completion of each required inventory. The procedure and approvals for making adjustments are those contained in Section 6.1.5.

6.1.7 Electronic Data Processing

Initial operation of the Material Accounting System will not involve electronic data processing. Once the system is operating smoothly we will consider the use of electronic data processing.

6.2 RECORDS AND REPORTS

6.2.1 Accounting Reports

1. "Uranium Analysis Request" - used to request and report chemical and radiometric analysis of material. Data from this form will be used to record external receipts and shipments, internal transfers, waste removals, and physical inventories.

2. "Target Specification and Q. A." - used to relate capsule identification with uranium content. Data from this form will be used to record internal transfers and inventory of targets.

3. "Uranium Waste Disposal" - used to record disposal of uranium. Data from this form will be used to prepare waste shipping documents and to adjust MBA logs and Master Log for waste shipments.

4. "Inventory Report" - used to report physical inventory in each material balance area. Data from this report will be used to adjust the Master Log to agree with physical inventory.

6.2.1.1 Material Balance Reports

Material Balance Reports containing all the information required in 10CFR70.51 (e) (4), shall be completed within 30 calendar days after the start of each ending inventory required by 10CFR70.51 (e) (3).

6.2.1.2 Material Status Reports

Material Status Reports will be submitted in accordance with the requirements of 10CFR70.53.

6.2.2 Accounting Records

The following accounting documents will be retained as a part of the accounting record: Uranium Feed Log, Plating Encapsulation and Quality Control Log, Reactor Operations Log, Radiochemical Operations Log, Master Log, Uranium Analysis Request (incoming material and material for disposal), Target Specification and Q. A., Inventory Report, Uranium Waste Disposal.

6.2.3 Short-Term Storage

The "Master Log", material balance areas "Inventory Report", the "Uranium Analysis Request" associated with incoming material and "Uranium Waste Disposal" documents will be kept locked up under the control of the Site Accountability Officer or his designee. Access to these records will also be under the control of the SAO or his designee. All other records will be controlled by the authorized individuals in each area.

6.2.4 Long-Term Storage

Long-term retention of the records required by paragraphs (e) (4) (iii), (IV), and (V) of Section 70.51 will be in a file cabinet under the control of the SAO.

6.2.4.1 Physical Form

Material records will be kept in original form.

6.2.4.2 File System

Records in the file system will be kept in chronological order.

6.2.4.3 Access

Access to inventory records and the Master Log will be controlled by the SAO. Access to the MBA Logs will be controlled by the authorized individuals in each area.

6.3 AUDITS

At least every 12 months the material control and accounting procedures and records will be reviewed and audited by the Nuclear Safeguards Committee. The individual (s) performing the audit will be independent of nuclear material control management, measurement, or utilization. The results of this review and audit, with recommendations, will be reported in writing to the Nucleonics Manager and will be kept available for inspection for a period of five years.

CHAPTER 7

7.1.1 RECEIVING PROCEDURE

When production requirements indicate that the acquisition of ^{235}U is necessary to maintain an efficient schedule, the inventory of SNM on hand is checked by the SAO in the Master SNM Log and the logbooks of the four MBA's involved, to determine the amount of ^{235}U which can be ordered without exceeding the quantity allowed by our license, SNM-639. In general, the amount of SNM ordered and its delivery date will be correlated by the SAO with the shipment of SNM off site as waste, so as to meet the requirements of our license.

Upon arrival of an SNM shipment, its documentation is immediately checked to ensure that we have been sent the proper order containing the specified amount of ^{235}U. The Health Physics group then surveys the secondary packaging externally and internally to prevent the possible spreading of any radioactive contamination which may be present and to make sure that none of the SNM has escaped from its primary container. The primary container is then transported to vented hood used only for handling SNM and opened. The UO_2 is removed from its shipping container, each individual lot, batch, or item is immediately weighed and the resulting values compared to those provided by the shipper. If these two weights are in reasonable agreement, the receipt of the UO_2 is then entered into the SNM Master Log and the UO_2 Feed MBA Log, and the material prepared for use.

After entering the receipt of the SNM into the logbooks under the shipper's lot, batch, or item identification code, a UO_2 feed lot number is assigned to the material and entered in the log, so our lot number is immediately cross referenced to the shipper's identification code. The UO_2 is then dissolved in nitric acid, diluted to a concentration of approximately 350 grams per liter, and transferred to volumetric flasks. At this point, a sample is taken and submitted to the analytical group for determination of both ^{235}U and total U as per Appendices "B" and "C". This stock solution is then quarantined pending completion of these analyses.

When the results of the U and ^{235}U assays are received, the values are applied to the volume of stock solution, thus providing a check on the amount of U and ^{235}U present as previously determined by weighing, and on the values supplied by the shipper.

Once this has been done, the stock solution is released from quarantine and approved for use in production. These solutions are then stored in locked cabinets until the plating operation requires them, at which point a measured volume of the stock solution is logged out of the UO_2 Feed MBA Log, transferred to the plating lab, and logged into the PEQA (Plating, Encapsulation and Quality Assurance) MBA Log.

7.1.2 SHIPPER-RECEIVER COMPARISONS

Upon arrival of the material at our site, the shipping documents are checked against our original order to ensure that the correct quantity and enrichment, as specified by our order, have been provided. The outer package is checked, both the serial number of the DOT approved container and the seal number being compared to those on the shipper's documentation to verify that the proper container has been shipped and that it has not been tampered with during shipment. In the case that the shipment can not be verified or the seal is damaged, the shipper will immediately be notified and the shipment placed in a holding area. The exterior of the container is then surveyed by Health Physics personnel to make sure that it is not contaminated, the seal is broken, and the drum is opened. The interior of the drum is checked by H.P. to ensure that it is not contaminated, the seal is broken, and the drum is opened. The interior of the drum is checked by H.P. to ensure that it is not contaminated and that there has been no spillage of SNM during shipment. When this has been done, and it has been determined that the material may be removed safely from the shipping drum, the primary SNM containers are taken out, counted, and the labelling on each individual package checked against the specifications described in the shipping papers. Once the lot number, inner container number and quantity have been verified, the SNM is transported to a laboratory used only for handling this material, and each package is immediately weighed, this value being checked against that provided by the shipper, verifying that the specified amount of material has been shipped and received.

After the total amount of material received has been determined by weighing, it is dissolved in nitric acid, diluted to a concentration of approximately 350 grams per liter, and the quantity of solution measured in a volumetric flask. This solution is assigned a UO_2 Feed lot number, this designation being recorded in the SNM Master Log and the UO_2 Feed MBA Logbook, and cross-referenced to the shipper's lot number.

A measured aliquot of the UO_2 Feed solution is then drawn from the flask and submitted for assays of total U and ^{235}U content as described in Appendices "B" and "C", the remainder of the material being quarantined pending completion of these analyses. When the results of the analysis are received, they are checked against the values provided by the shipper to ensure that the amount of SNM and the percent enrichment of ^{235}U are as specified. If there is no disagreement between the results of our analyses and those of the shipper, the solutions are released to the UO_2 Feed MBA inventory as being available for use. If a significant difference should be found, the SAO will be notified, and the material will be held in quarantine until the discrepancies are resolved by contacting the shipper and investigating and evaluating all possible reasons for the conflict.

7.1.3 ACCEPTANCE CRITERIA

The documentation accompanying each shipment is checked immediately on arrival of the material at our site. It is compared to our original order, and must indicate that the specifications described in the order have been met, that the material was properly packaged, and that all necessary procedures and precautions have been followed during shipment. The package itself is also inspected to ensure that it has been handled properly, that it has not been tampered with in transit, and that no SNM has escaped containment.

Each individual package, container, or item is checked by qualified Health Physics personnel to quarantee that there is no danger either of spreading contamination or of unnecessarily exposing personnel to radiation. Once this has been done, the quantity of SNM received is directly verified by weighing to ensure that the inventory allowed by our license (SNM-639) is not exceeded. An analysis for both total U and ^{235}U is then performed to certify that the quantity and percent enrichment of the material are as specified.

Due to the nature of the process in which SNM is used at this site, our tolerances with regard to such quantities as percent enrichment, trace impurity level, and chemical composition are sufficiently wide that we have considerable latitude in accepting material. Generally, once we are assured that standards of safety and the requirements of our license have been met, we will accept the shipment and then proceed to reconcile any discrepancies found in shipper-receiver comparisons directly with the shipper. Statistically, due to the small quantities of SNM received in any one shipment, shipper-receiver comparisons are performed on an individual shipment basis.

The combined systematic and random deviation on each measurement is applied to the result of the measurement as described in Appendix "D", giving a range of acceptable values for each measured variable. If the results of shipper-receiver comparisons fall within these ranges, no discrepancy will be considered to have arisen. However, if the results of the shipper-receiver comparisons fall outside of these ranges, the shipper will immediately be contacted and a determination made as to possible causes of the difference. These possibilities will then be investigated until the source of error is found, the quantities involved re-evaluated, and the discrepancy is reconciled. In all cases, the actual measured value as determined by our analysis will be used as the basis for logbook entries.

7.1.4 CONDITIONS FOR TRANSFER

Before any lot of SNM is released to operating components, the results of analysis for total U and ^{235}U must have been received, and any discrepancies found in the shipper-receiver comparisons evaluated and reconciled, so that an accurate basis for logbook entries has been established. Once this has been done, the material is cleared for release. Then, when the plating operation requires more UO_2 solution to maintain its production schedule, the PEQA MBA logbook will be checked to verify that this area will not acquire a greater quantity of SNM than allowed by our license. After this has been done, the custodian of the UO_2 Feed MBA will release the required amount of stock solution to the person responsible for the PEQA MBA, entering the transaction into the UO_2 Feed Log as a transfer out, while the PEQA MBA custodian enters the transaction into his log as a transfer of material into the MBA. Thus, all pertinent information regarding the transfer will be entered into both logbooks at the time of the transaction under the signatures of the responsible individuals.

7.1.5 RECORDS

Copies of form AEC-741 are kept on file to maintain a record of shipper's values for the amount of SNM shipped to our site, and to verify that proper procedures have been followed in shipping the material. In addition, our Master SNM Log contains entries listing the values determined by our analysis. Shipper-receiver comparisons may be made directly from these sources, and the evaluations of any discrepancies, as well as the results of any investigations into these discrepancies, are also recorded here.

Furthermore, all internal transfers of SNM between MBA's are recorded in the appropriate logbooks for each MBA, so that the movement of each lot of SNM may be followed from its arrival on site to its shipment off site as waste by consulting these logbooks. Copies of the SNM Master Log form and the form used for individual MBA logs are included as Appendix "A". All of these records will be kept on file for a minimum of 5 years, or longer if deemed advisable.

7.2 INTERNAL TRANSFERS

Transfer of SNM between MBA's on site is controlled through the use of logbooks which detail all the transactions involving the movement of SNM from one MBA or ICA to another. In each transaction, the amount of material, its form, and the date are recorded in the logbook of the issuing MBA as a transfer out of that area and initialled by the person responsible for that MBA. The same information is transcribed into the logbook of the MBA accepting the material, and again initialled, this time by the person receiving the material. These entries are made promptly at the time of transfer, thus assuring timeliness and accuracy of the record system.

7.3 STORAGE AND ITEM CONTROL

Due to the nature of our production process, Sections 7.3.1 Program Coverage, 7.3.3 Identification, and 7.3.3 Quantity Determination, may best be described on the basis of the individual MBA's involved, rather than as separate items.

1. UO_2 Feed MBA

In this area, SNM will be present either in the form of UO_2 in powder as received from the shipper, or as a solution of UO_2 in HNO_3. No provision is made for storage of the UO_2 powder other than on a very short term basis, as this material is dissolved upon receipt, as soon as its documentation has been checked by the SAO or his designated representative, and it has been weighed to verify the shipper's value. The uranyl nitrate solution is stored in volumetric flasks, identified by and labelled with a plating solution batch no. which may be cross referenced in the UO_2 Feed MBA Logbook to the shipper's lot no. or serial no. The quantity of SNM in each flask is determined by individual assays on each batch, as described in Appendices "F" and "H", and this information is also recorded in the logbook. These flasks are stored in a locked cabinet, the key to which is controlled by the custodian of the MBA.

2. Plating, Encapsulation and Quality Assurance MBA

SNM in this area will be in the form of uranyl nitrate solutions as received from the Feed MBA, plating solutions formulated from these Feed solutions, waste solutions resulting from the plating operation, and as a UO_2 coating plated onto irradiation targets. Since the plating solutions are made up directly from the uranyl nitrate Feed solutions in clearly labelled containers, the amount of SNM present will have been determined when the material is transferred into the MBA. However, since these solutions will lose their unique identity at this point, the uranium and ^{235}U concentration of these solutions will again be determined before the plating operation begins and at its conclusion, so that all material may be accounted for throughout the process. The provisions for the analysis of these solutions are described in Appendices "B" and "C". Once these solutions have been used to plate target, the resulting waste solutions will be collected in plastic bottles, segregated and labelled by batch, a sample aliquot taken, and the amount of SNM in each waste batch determined, also as described in Appendices "B" and "C". Since the irradiation targets onto which the uranium is plated consist of stainless steel tubes which are sealed by welding upon completion of the plating cycle, determination of the quantity of U deposited must be performed by a non-destructive, radiometric method, as described in Appendix "E". Upon completion of this assay, the finished target may be transferred to the Reactor Operations MBA, with appropriate entries being made in the logbooks for both areas. Each individual target will be uniquely identified by a target number engraved directly onto the tube, which will be traceable in the PEQA MBA Log to the plating solution used in its fabrication.

3. Reactor Operations MBA

Finished targets are transferred from the PEQA MBA to this area, where they are further encapsulated in a sealed aluminum tube to provide secondary containment during irradiation. Since as mentioned above, the finished targets are in the form of sealed tubes, no provision is made for a separate determination of the amount of SNM present in this MBA. The individual target numbers are entered into the Reactor Operations MBA Log, along with the quantity of SNM present in each, then the targets are welded into their secondary containers, and the target number engraved directly onto this secondary container.

As required for production, these targets are then loaded into the reactor and irradiated for varying periods of time. Once they have received sufficient irradiation, they are transferred into the Radiochemical Operations MBA, with entries detailing the transfer entered into the appropriate logbooks.

4. Radiochemical Operations MBA

In this area, the UO_2 plating on the targets is dissolved in acid, the resulting solution drained from the target capsule, and the Fission Product ^{99}Mo extracted, leaving a waste solution containing that ^{235}U which has not undergone a fission reaction, as well as large amounts of MFP. Due to the extremely high level of radiation from these solutions, it is both difficult and dangerous to perform an assay on the solution until sufficient time has passed to allow at least some of the radioisotopes present to decay. For this reason, the quantity of SNM determined by the non-destructive radiometric assay on the sealed targets is used to calculate the amount on hand in the hot cells. After approximately a month the level of activity in the solution has diminished to a point where an assay can be performed, and this is then done, as described in Appendices "C" and "F", prior to solidification of the waste and its shipment off site to an approved disposal facility. Until such time as the assays are performed, each individual batch of waste is stored in a plastic coated glass bottle labelled with the appropriate production run no., which may be cross referenced in the radiochemical operations MBA logbook to the identification number of the particular targets used for that run. Once the assay on the waste solution has been performed, the material is transferred to an approved type 2R container, solidified, and this container placed in a properly labelled waste drum which is sealed with concrete before being shipped out for disposal.

7.3.4 RECORDS

The SNM Master Log and the individual MBA logbooks will be utilized to record the identity, location, and quantity of SNM on inventory. All of this information will be entered into the appropriate log at the time of each transaction. In addition, SNM will be stored only in specifically designated areas in each MBA so that its location may be verified promptly whenever necessary. Also, each particular lot, batch, or item will be clearly labelled so that its identity and the quantity of SNM involved may be easily determined.

In addition, a radiometric assay (Appendices "C" & "F") is performed on the waste solutions to ensure that the specified quantity is being shipped and that no material is unaccounted for. Also, the quantity shipped is checked by the SAO to ensure that no conflict occurs between dates of waste disposal and dates of incoming UO_2 shipments that would cause us to exceed our allowed inventory.

As mentioned above, no internal transfer is involved in the shipment of SNM off site as radioactive waste, therefore the records of these shipments are maintained in the Radiochemical Operation MBA logbook and the SNM Master Log.

MATERIAL BALANCE AREA LOG

Location ______________

Date	Transaction	Quantity		Balance On Hand		Recorded By
		Element	Isotope	Element	Isotope	

SNM MASTER LOG

Date	Transaction Type	Feed MBA		Plating MBA		Reactor MBA		Radiochem. MBA		Total		Recorded
		Element	Isotope	Element	Isotope	Element	Isotope	Element	Isotope	Element	Isotope	By

Balance Adjustment Date ______________ Recorded By ______________

Master Log Inventory
Physical Inventory
Log-Physical Inventory
LEMUF

PHYSICAL INVENTORY ACCEPTED

Date ______________

Signature ______________

DETERMINATION OF URANIUM IN ELECTROLYTE SOLUTIONS

SCOPE

This method is designed for the determination of total uranium in the electrolyte solutions used in the ^{235}U target production.

PRINCIPLE OF METHOD

An aliquot of the solution is fumed with H_2SO_4, the uranium is reduced in the Jones Reductor and titrated with $KMnO_4$.

SPECIAL APPARATUS AND REAGENTS

Nine-inch Jones Reductor - Place a perforated porcelain plate in the bottom of the reductor tube, followed by a small wad of glass wool. Fill to the neck with amalgamated zinc. Prepare the zinc as follows: shake 800 g. of 20 to 30 mesh zinc with 400 ml of $HgCl_2$ (25 g. per liter) in a liter flask for 2 minutes. Wash several times with H_2SO_4 (5 + 95) and then thoroughly with water. Keep the reductor filled with water when not in use.

0.1N POTASSIUM PERMANGANATE

Stock Solution - Dissolve 6.25 g. of $KMnO_4$ in 50 ml of boiling water. While still hot, filter through glass wool into a 100 ml volumetric flask and dilute to volume.

0.05N $KMnO_4$ - Filter 27.0 ml of stock solution into a 1000 ml volumetric flask through burned off asbestos and dilute to volume.

Standardization - Weigh 0.3000 g. of sodium oxalate (N.B.S.) into a 600 ml beaker. Add 250 ml of H_2SO_4 (5 + 95) which has been boiled and cooled to 27°C. Stir until dissolved and add 39 to 40 ml of $KMnO_4$ solution. Stir slowly and allow to stand until the pink color disappears. Heat to 55 to 60°C and complete titration at this temperature. The end point should remain for 30 seconds. Determine a "blank" using the same volume of H_2SO_4 (5 + 95) and subtract. Calculate the normality, adjust to 0.1N $KMnO_4$ with water, and restandardize.

(0.300 g. of sodium oxalate (N.B.S.) is equivalent to 22.39 ml of 0.1N $KMnO_4$ or 44.78 ml of 0.05N $KMnO_4$.)

PROCEDURE

Take a 10 ml aliquot of the electrolyte solution and transfer it to a 400 ml beaker, add 12 ml of 1.1 H_2SO_4, cover with watch glass and heat till fumes of SO_3 evolve. Cool the beaker, wash down the sides and watch glass, cover with water and refume to strong SO_3 fumes.

Adjust the volume of the uranium solution to about 100 ml and warm on the hot plate. Add $KMnO_4$ solution (25 g/l) dropwise until a pink color persists. Cool to room temperature.

Prepare the Jones Reductor by passing 100 ml of H_2SO_4 (5 + 95), followed by 100 ml of water through it. Discard these solutions. Pass the uranium solution through the reductor into the flask receiver. Wash the reductor with 100 ml of cold H_2SO_4 (5 + 95). Blow clean air through the reduced solution for 5 minutes. Wash the air purge column with water, allow to run into receiver, and remove the receiver from the flask. Titrate the solution in the receiver with standardized $KMnO_4$.

Run a blank using all things except uranium, and correct the volume of titrant for this blank.

CALCULATIONS

$$\frac{(A - B) \times 0.119 \times N\ (KMnO_4) \times 1000}{W} = \text{g/l U}$$

CODE:

A = volume of titrant used

B = volume of titrant used for blank determination

N = normality of $KMnO_4$ solution (standardized by the analytical lab)

W = volume of aliquot taken by pipette

^{235}U ASSAY ON LIQUID SAMPLES
(QUALITY CONTROL LAB)

These liquid samples may be from stock plating solutions, plating waste, and fission waste, as well as liquid standards.

1. Obtain bulk tap of sample from processing group.
2. Count ^{137}Cs (NBS #82) check source on #2 NaI system at 10 cm for 1-5 minutes; read out results. Do this at the beginning and end of assay period; record results in log book.
3. Count ^{235}U flame sealed vial 1 on base for 5 minutes at the beginning, middle, and end of the assay period. Record results in log book.
4. From the bulk tap of the sample, take duplicate aliquots (10 λ to 3 ml depending on uranium concentration) and place in standard disposable plastic vials and adjust to a 3 ml volume. Label vials with their sample code and aliquot and count on base for 5 minutes. Note: the integrated photo peak area should be in the 10,000 c/5 minute area to obtain 1% counting statistics. If the count rate is significantly below this (< 5000 counts), take a larger aliquot if possible. (Note 1)
5. Log all results in the log book; take average value of c/5 m for calculation of gms of ^{235}U. If the difference between the two counts (splits) is greater than 5%, redo analysis using two more splits. If the difference can not be resolved, notify Q.A.
6. Compute the gms of ^{235}U per ml of solution using the formula below.

$$\frac{(c/5\text{ m})\text{ Photo Peak Area x dilution factor }\left(\frac{1\text{ ml}}{\text{split size}}\right)}{3.0658 \times 10^{6}\text{ (standard c/5 m/gm }^{235}\text{U)}} = \text{gms }^{235}\text{U}$$

7. Plot the average value of the ^{235}U control standard plus its 1 σ spread on the control chart to assure the equipment is functioning correctly. If the average value falls outside the control value, hold the analysis and notify Q.A. Review data to ascertain reason for difference.

8. Report results out to the proper department.

9. Once a month, review results with Q.A.; be sure all control charts are kept up to date.

Note 1 - For the fission waste sample - this will be from an extraction for uranium in n-octyl amine. To dilute to 3 ml if necessary, you must use petroleum ether and not 1:5 HNO_3 as in the inorganic aqueous samples.

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MEASUREMENT ERROR STANDARD DEVIATIONS

Location and Type of Material	Relative Systematic Standard Dev.	Relative Random Standard Dev.
Volume Determination Element & Isotope	$\sigma_{\delta i}$	$\sigma_{\delta i}$
1. UO_2 feed (Uranyl Nitrate Solution)	.001	.005
2. Plating solution (Uranyl Nitrate)	.02	.03
3. Plating waste batch (Uranyl Nitrate)	.001	.006
4. Radioactive waste batch (Uranyl Sulfate) shipped	.02	.03
5. Radioactive waste solution in cell (targets)	0*	0*
6. Targets (UO_2)	0	0
Element Sampling	$\sigma_{\Delta i}$	σ_{ni}
1. UO_2 feed solution	.02	.01
2. Plating solution	.006	.01
3. Plating waste solution	.006	.01
4. Radioactive waste solution shipped	.006	.07
5. RW solution in cell (targets)	0*	0*
6. Targets	0	0
Element Analysis	$\sigma_{\theta k}$	$\sigma_{\omega k}$
1. UO_2 feed solution	.004	.01
2. Plating solution	.004	.01
3. Plating waste solution	.004	.01
4. Radioactive waste solution shipped	.004	.07
5. RW solution in cell (targets)	.067	.04
6. Targets	.067	.04
Isotope Sampling	$\sigma_{\lambda l}$	$\sigma_{\mu l}$
1. UO_2 feed solution	.02	.01
2. Plating solution	.02	.01
3. Plating waste solution	.02	.01
4. Radioactive waste solution shipped	.02	.07
5. Radioactive waste solution in cell (targets)	0*	0*
6. Targets	0	0

*Previous measurements from plating solutions and targets.

URANIUM-235 TARGET ASSAY PROCEDURE

(QC Lab)

1. Obtain target cylinder after Health Physics has certified the outside is clean.

2. Count ^{137}Cs NBS #82 check source in #2 NaI system 10 cm for 1-5 minutes; read out on tally, typewriter or other and record.

3. Count whole cylinder on top of geometry stand (32 cm) making sure it is centered. Count 0-1 MeV/400 ch for 5 minutes and read out first 100 channels on tally, typewriter or other.

4. Submit spectra to the NUMPLA computer program or compute by hand.

5. Calculate total gms of ^{235}U present using photopeak area of gamma at channel 75 (185 keV gamma of 7.1x10^{8} year ^{235}U). Gamma ray is 54% relative intensity.

6. Count standard tube at 32 cm geometry 3 times during counting sequence; record data and plot on control chart.

Calculations:

$$\frac{\text{Photopeak area (c/5 m)}}{\text{A x B x C}} = \text{gms } ^{235}\text{U}$$

A - ^{137}Cs c/m on calibration date 11/74 was 163,113 c/5 m ± 0.5%.

B - Counts-per-minute-per-gram of ^{235}U from several calibrated sources 11/74 was 17,391 c/5 m/gm.

C - The standard tube #804 was 166,518 c/5 m on 11/74, its control limits are ± 5%.

Note: If either standard does not fall within its stated deviation, notify Quality Assurance.

11/74 revised

RADIOCHEMICAL SEPARATION FOR URANIUM

Reagents:

1) 5% Tri-n-octylamine V/V in Petroleum ether with 2%-Octyl alcohol added.
2) M-cresol purple indicator, ~ 0.04 gm dissolved in 100 ml of demineralized water.
3) Blast burner or hot plate, centrifuge cones, separatory funnels.

Separation:

1) Obtain sample from Hot Lab, be sure total volume and batch number are on paper work.
2) Do analyses in duplicate, take a sample split and place in a 250 ml Vycor beaker.
3) Add 1 ml con. HNO_3, 1 ml HCl, and 1 ml HBr, and fume down to white fumes of H_2SO_4 (H_2SO_4 is waste solution).
4) If charring shows, add 1 ml of con. HNO_3 and repeat until no charring occurs.
5) When cool, add 100 ml of water and several drops of m-cresol indicator. If at proper pH, indicator will turn red.
6) Wash solution into a 250 ml separatory funnel having 10 ml of 5% TOA. Rinse beaker with ~100 ml of H_2O and put into separatory funnel.
7) Using wrist shakers, shake funnel for ~1 minute, allow to stand and draw off aqueous layer and discard. Add 25-30 ml of 0.1 N-H_2SO_4 and shake ~ 15 seconds to wash out organic layer. Allow to stand and draw off aqueous layer and discard.
8) Draw off organic layer into a calibrated centrifuge cone and spin for 2-3 minutes. Measure volume of organic layer.
9) For nondestructive counting draw off 3 ml of solution and count for ^{235}U, adjusting for fraction of total volume.
10) For chemical analysis of Total Uranium, draw off 10 ml of organic (or more) and do chemical analysis for total uranium.

NOTE: The extraction of Uranium VI at pH of 1.0-1.4 is quantitative but each transfer must also be quantitative.

CHAPTER 8

8.0 MANAGEMENT

8.1 Procedures

Special nuclear material control and accounting procedures and their revisions are prepared by the Health Physics Manager. Review and approval of such procedures and revisions are performed by the Nucleonics Manager and the Nuclear Safeguards Committee.

8.2 COMPLIANCE

8.2.1 Management Review

At least every 12 months the material control and accounting procedures and records will be reviewed and audited by the Nuclear Safeguards Committee. The individual(s) performing the audit will be independent of nuclear material control management, measurement, or utilization. The results of this review and audit, with recommendations, will be reported in writing.

8.2.1.1 Report

Reports resulting from 8.2.1 will be forwarded to the Nucleonics Manager and the Site Operations Manager.

8.2.1.2 Action

Action on recommendations will be reviewed by the Nuclear Safeguards Committee, with appropriate deadlines for receipt of revised procedures.

8.2.3 Shipper- Receiver Differences

The Health Physics Manager will be notified of any difference between the UCC assay and shipper's assay. He will evaluate the statistical significance of the difference. Significant differences will be reported to the Nucleonics Manager, (Ref. Chapter 7) and the shipper.

8.2.4 Material Balance Discrepancies

When MUF exceeds LEMUF, the Health Physics Manager will notify and report the discrepancy to the Nucleonics Manager, and ROI of NRC shall be notified within 24 hours. If MUF > 1.5 x LEMUF an immediate re-inventory shall be conducted. If MUF > 2 x LEMUF, licensed activities under SNM-639 shall be discontinued and a clean out inventory shall be conducted.

8.2.5 Item Discrepancies

If a discrete container or item containing special nuclear material appears to be lost or missing, and an immediate investigation does not resolve the loss, the Health Physics Manager will be notified. He will promptly notify Directorate of Regulatory Operations (Region I) and conduct an investigation. The results of the investigation will be reported to the Nucleonics Manager.

SITE INFORMATION

1. Location

The laboratory site is located in Sterling Forest, 3-1/4 miles north-northwest of Tuxedo Park, Orange County, New York. The plant is constructed along Long Meadow Road on the eastern slope of Hogback Mountain at an elevation of approximately 800 feet. (Figure "K")

Sterling Forest is an area of approximately 27 square miles which has been set aside by the owner for technological development. The laboratory site, itself, consists of 100 acres of land, owned by Union Carbide Corporation.

2. Topography and Geology

Topography and geology have been described in detail in the report "Topography and Geology of the Site", attached as Appendix 3 to Final Hazards Summary Report UCNC Research Reactor, submitted November 1960 to the AEC's Reactor Hazards Evaluation Group.

The terrain is rolling to rough and varies from lake and peat humus swamp to rocky outcrops. The site elevation varies from 700 to 1000 feet above sea level. Peaks or knolls adjoining the site extend upward to a height of 1200 feet. The area is largely covered with second growth oak and maple, and miscellaneous deciduous trees with undergrowth of laurel and rhododendron.

The area lies on Indian Kill Creek in the Ramapo River Watershed. Indian Kill flows the year round. There is a low flow in the dry season but the creek is never dry.

The region is underlaid with gneiss with frequent outcropping and little cover except in the marshy areas. Rock outcrops show numerous cracks through which surface water infiltrates to deeper strata. Iron mines were worked in the forest around Sterling Lake during revolutionary times. With the development of more economically favorable deposits, however, work was abandoned many years ago, and the mines are not in use.

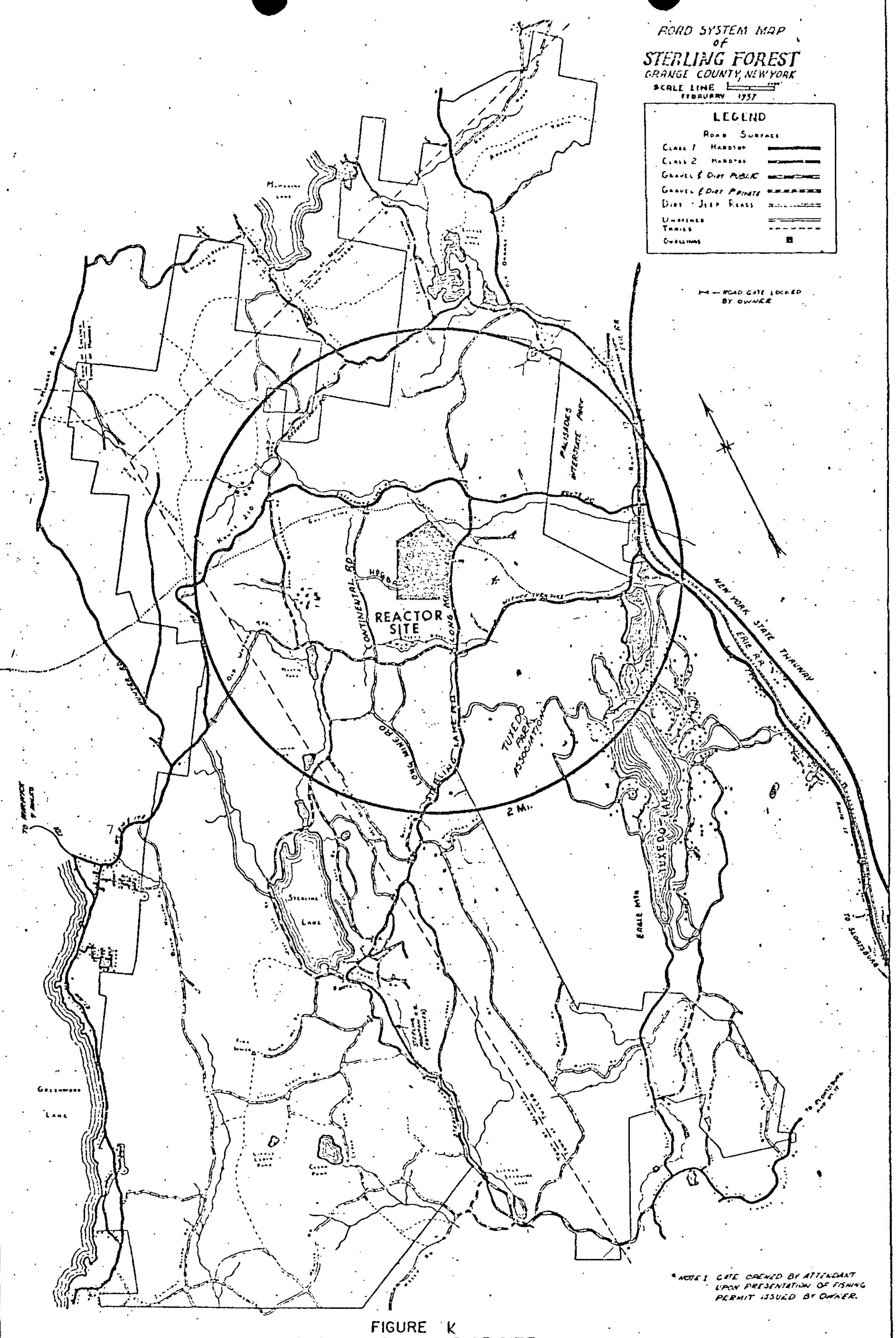

FIGURE K
2 MILE RADIUS MAP OF SITE

SNM OPERATIONS DESCRIPTION

Highly-enriched uranium oxide (UO_2), received from an SNM supplier, is dissolved to form a solution. The uranium is then plated out of solution in a layer on the inside of steel tubes. The amount of SNM plated in each tube is determined by radiometric assay. The tubes are welded closed. After quality control measurements, the sealed tubes are irradiated in a nuclear reactor. Irradiated tubes are transferred to shielded hot cells where they are opened, the uranium is dissolved, and the desired products are chemically separated. After a minimum 1 month decay the uranium solution, still highly radioactive, is packaged for shipment to a licensed burial ground.

The flow diagram (Figure "C") shows the sequence of operations, the waste streams, and the locations in the process where SNM logs are maintained [Material Balance Areas (MBA)].

HOT LAB DESCRIPTION

The Hot Laboratory is a concrete structure 139 feet long by 57 feet wide by 37 feet high. There are five hot cells, each having 4 foot thick walls of high density concrete (240 lbs/ft^3). The cells are separated from each other by 4 foot thick, high density concrete walls.

1. Hot Cells

The cells are general purpose units designed to accommodate a variety of operations including chemical experiments, radiochemical separations of isotopes, physical testing for evaluation of irradiated material, solid state investigations and metallurgical work. A general description of the cells is presented below.

Cell 1 is 16 feet wide by 10 feet long by 15 feet in height. This cell is equipped with a General Mills Remote Handling Arm (750 lb capacity), one pair of Heavy Duty Model 8 manipulators and one pair of Standard Duty Model 8 manipulators. Two Corning 4 foot thick glass shielding windows consist of Corning's Radiation Shield Standard Assembly 1480", which is their standard unit for 4 foot shielding walls. The windows are constructed from five sections 3.3 density lead glass each 9-1/2 inches thick.

A Kollmorgan periscope, currently in use in Cell 1, can be relocated to any of the other cells. With auxiliary attachments on the periscope it is possible to do in-cell microscopy and to take photographs of specimens in the cell.

Cells 2, 3 and 4 are 6 feet wide by 10 feet long by 12.5 feet in height while Cell 5 is 6 feet by 10 feet long by 25 feet in height. Cells 2, 3, 4 and 5 are each equipped with a Corning 4 foot thick glass shielding window and all cells are equipped with one pair of Model 8 Master Slave Manipulators.

Major access to all the cells is possible through the rear doors (7 feet wide by 6 feet high by 4 feet thick) which can be withdrawn utilizing electrical drives. The electrical connection and power supply to drive these doors are kept locked to prevent unauthorized entrance. An alarm sounds when any of these rear access doors are opened. The access doors for the cells are motor driven through a 1200:1 reduction worm gear and more on steel rails located in the floor of the charging area. Figure 5 is a picture of one of the rear access doors in the open position.

Access to all cells also is possible via top roof openings containing removable plugs. The roof and roof plugs of all cells are 3-1/4 foot thick magnetite concrete with a density of 240 lbs/ft^3.

The roof plug is made up of three 14 inch thick concrete slabs which must be removed individually with a 10 ton capacity overhead crane. A 6 inch diameter charging sleeve located in the center of the roof plug is fitted with an 8 inch long lead filled steel plug. Two 4 inch diameter charging sleeves also are provided through the roof. They have magnetite plugs 6 inches in diameter at the exterior surface and are stepped to 4 inches in diameter 18 inches from the interior surface. There are laboratories and a solution make-up room above the charging area but no occupied areas directly above the cells.

A canal containing water 12 feet deep connects Cell 1 with the reactor pool. Radioactive samples, specimens, isotopes, etc., are transferred through this canal and brought into Cell 1 via an automatic elevator mechanism.

2. Operating Area

The area on the front side of the cells is the operating zone and is maintained as a clean area. The viewing windows, manipulator controls, intercell conveyor controls, in-cell service controls (air, water, vacuum, gas) and periscope are located in this area. The operating control panels for the ventilation system and the Radioactive Waste Water Treatment System are located at the north end of this area.

Fifteen radiation monitrons serving the Hot Lab and cells are linked to a master panel which is located in the operating area. Both audio and visual alarms are activated at this master panel. Ten monitrons, located outside of the cell, are normally set to alarm at 5.0 mr/hr. Five in-cell monitrons are used to indicate the radiation level within the cells. These can be set to alarm at any level from 1 to 10,000 mr/hr.

In the front shielding wall of each cell there are twelve removable 2 inch diameter stepped pipe sleeves, one 8-1/2 inch diameter sleeve (to accommodate the periscope) and two 10 inch diameter sleeves (to accommodate the Model 8 manipulators). When the sleeves are not in use magnetite shielding plugs are placed in the sleeves. Special services not available within the cell (such as inert gas, high pressure air, natural gas) can be led into the cells through special plugs which can be inserted in place of the standard 2 inch diameter stepped pipe sleeves. Locking bars are used to prevent accidental removal of any of these plugs.

3. Charging Area

The charging area is located to the rear of the cells. Controls for the rear access doors to the cells are located here. Access to the decontamination room, exhaust fan room, waste treatment facility and conveyor loading station are from the charging area (see Figure "D").

The north loading dock is separated from the charging area by swinging doors. At the south end of the charging area swinging and sliding doors separate this area from the canal and the south loading dock.

In the rear shielding wall of each cell there are five 2 inch diameter stepped pipe sleeves. Each rear cell door also contains one 8 inch diameter stepped sleeve. These sleeves provide additional access ports from the charging area to the cells. They contain magnetite shielding plugs when not in use.

4. Radiochemical Laboratory

Low level radioactive specimens or samples will be handled in the Radiochemical Laboratory. Equipment available in the laboratory includes standard laboratory benches with stainless steel tops, glove boxes and hood.

Operations in this laboratory involving higher level radioactive gases will be conducted within special hoods. There are three hoods. These hoods, with interior surfaces of stainless steel, are 6 feet wide and designed for work with radioactive materials. All flow from these hoods pass through roughing filters, and absolute filters (these are standard units) prior to passage to an exhaust fan and monitoring system. The exhaust air flows to a 50 foot stack which also receives exhaust fan and monitoring system. The exhaust air flows to a 50 foot stack which also receives exhaust air from the Reactor area.

Supporting non-radioactive analytical work also is done in this laboratory. A plan view of the Radiochemical Laboratory is shown in Figure "C".

5. Second Floor Work Area

a. Laboratories

Three laboratories are located in this area. They will be used for work similar to that described for the Radiochemical Lab. All operations involving radioactive materials will be carried out in hoods, glove boxes or other suitable ventilation control devices.

b. Work Area

An area, 38 feet by 20 feet, on the north end of the second level is utilized inventory storage. A unit for producing distilled water and a transmitter rack for instrumentation and a distillate hold tank from the liquid waste treatment system are located in this general area.

6. Maintenance Shop and Welding Lab

A machine shop, and welding lab are available in the Hot Lab. These shops contain a drill press, lathe, milling machine, band saw, electric and gas welding equipment, and a variety of hand tools.

7. Personnel Facilities

Six offices, a conference room, a change room (17 feet by 9 feet), a locker room (30 lockers), and rest rooms are in the Hot Lab.

8. Radioactive Waste Storage Building

It is located 600 ft. from the nearest property line, 300 ft. from the nearest building and 900 ft. from the nearest public road. (See Figure "L"). The building is used to store drums containing radioactive wastes generated by the Hot Laboratory prior to shipment to a licensed burial ground.

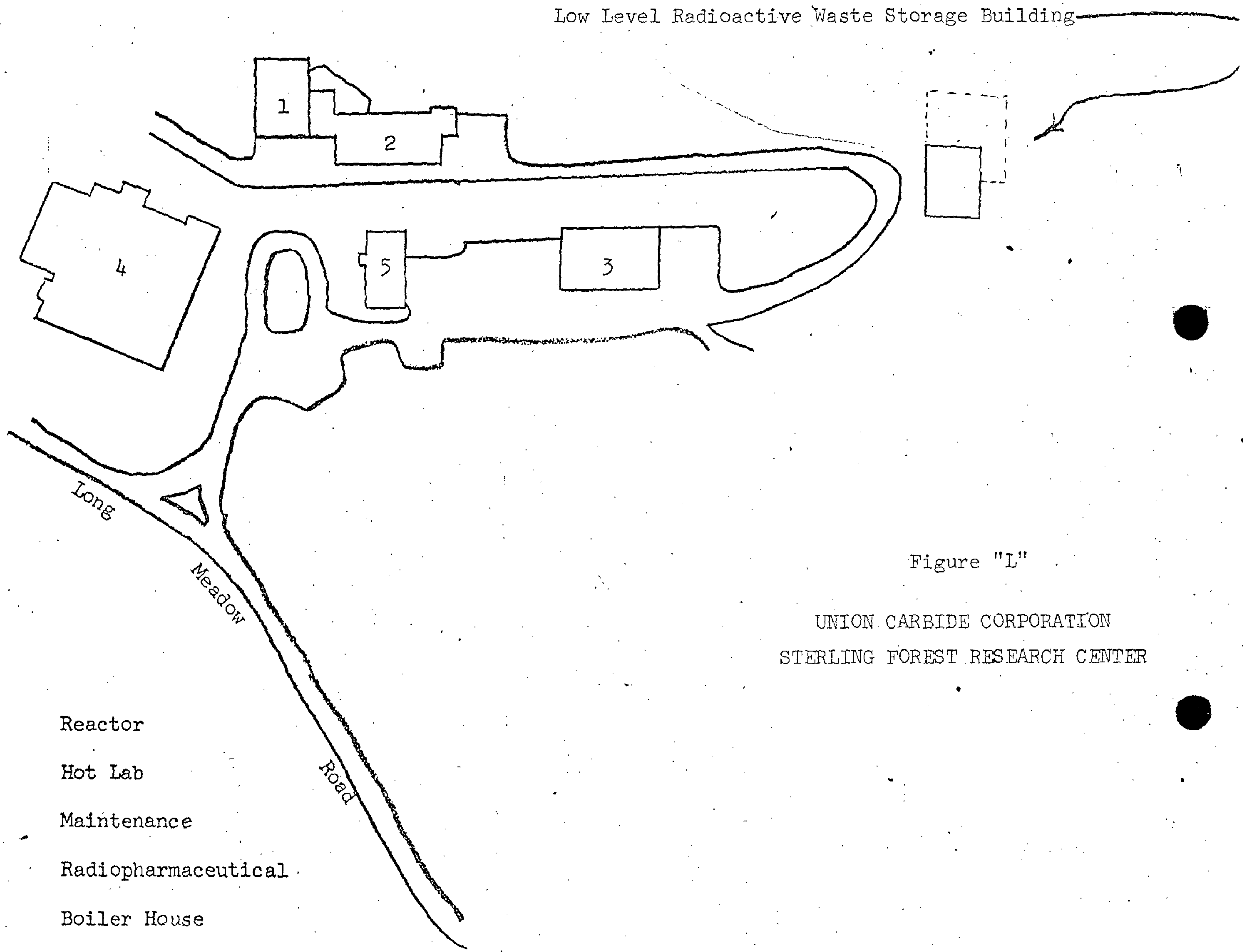

Figure "L"

UNION CARBIDE CORPORATION
STERLING FOREST RESEARCH CENTER

BUILDING 1 Reactor

BUILDING 2 Hot Lab

BUILDING 3 Maintenance

BUILDING 4 Radiopharmaceutical

BUILDING 5 Boiler House

REACTOR DESCRIPTION

The 5 megawatt pool-type research reactor is a light-water moderated, heterogeneous, solid fuel reactor in which water is used for cooling and shielding. The reactor core is immersed in either section of a two-section concrete pool filled with water.

Spanning the pool is a manually-operated bridge, from which is suspended an aluminum tower supporting the reactor core. Control of the reactor core is accomplished by the insertion or withdrawal of neutron-absorbing control rods suspended from control drives mounted on the reactor core bridge.

The reactor core is composed of MTR type fuel assemblies and the control rod fuel assemblies with built in control rod guides. The elements may be arranged in a variety of lattice patterns depending on experimental requirements on the grid plate. Special handling tools are used for the underwater insertion or removal of any of the above assemblies from the grid plate.

Heat, created by the nuclear reaction, is dissipated by a circulation cooling system. Externally located pumps, storage tanks, water-to-water heat exchangers, a cooling tower, a demineralizer plant, and a filter complete the water handling systems for the reactor.

The Reactor is housed in Building 1 (see Figure "L"). The Reactor is licensed pursuant to the Code of Federal Regulations Title 10 Part 50. The Reactor License number is R-81 (Docket 50-54).