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SAFEGUARDS INSTRUMENTATION FOR THE NEW ROCKY FLATS PROCESSING FACILITY

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ABSTRACT

This paper describes the safeguards instrumentation planned for the plutonium Waste Processing and Recovery Facility under construction at Rocky Flats Plant. Descriptions are given of the new plutonium Recovery Facility, the material handling systems and the nondestructive assay equipment.

INTRODUCTION

Rocky Flats Plant is a producer of plutonium parts for nuclear weapons. The DOE is presently constructing a new plutonium recovery facility, Building 371, at Rocky Flats. The facility will be used to reprocess plutonium contaminated residues and impure plutonium oxide and metal in order to recover and purify as much plutonium as practical. The facility will also extract americium from the main plutonium stream and decontaminate enriched uranium and beryllium. This paper describes the safeguards instrumentation and computer reporting system planned for this facility.

Figures 1, 2, and 3 provide an overview of the facility and processing areas located on three working levels. The main processing operations are separated into numerous modules located on the ground floor (Fig. 3). Small packages of oxide, impure metal or contaminated residues are received, weighed and analyzed in the shipping and receiving module. This material is stored in the stacker-retriever (S/R) vault awaiting processing. Other small packages are received in the site return module where metals are weighed and processed. Residues generated in the site return module and most other modules in the building are also stored in the S/R vault. Product plutonium metal is produced and sampled for laboratory analysis in the metal reduction module and delivered to the shipping and receiving module via the stacker retriever vault. Contaminated residues packaged in 55 gallon drums, containing plutonium above the approved discard level, are transferred to Building 371 and placed in one of three drum storage areas. These residues are subsequently placed in glovebox processing lines via down draft enclosures and down draft tables.

As plutonium bearing liquids and solids are transferred from one accountability area to another the contained plutonium is recorded in the computer system. The stacker retriever vault acts as a repository for the analyzed solids from most all accountability areas.

SECURED STORAGE VAULT

Accountable dry materials awaiting processing will be stored in the central secured storage vault, Figure 4. The nitrogen atmosphere vault is enclosed by hardened walls except for openings required for vault operation and maintenance. These openings include eight installed and two future In and Out (I/O) stations where materials are transferred to and from glovebox work areas. Other glovebox type construction in the vault walls includes the inventory station, the preventive maintenance bay, the repair bay, access air locks, and the Stacker/Retriever electrical termination glovebox.

This concrete vault, with automated Stacker/Retriever system consists of a storage aisle approximately 300 feet long, 40 feet high, and 15 feet wide. It is located in the center of the hardened area, running east and west, with elevation between the subbasement floor level and the basement ceiling. The vault does not penetrate the ground floor. A total of 1428 storage bins or shelves are permanently mounted on the vault walls on either side of the storage aisle. Steel railroad type tracks run down the center of the aisle for the computer controlled Stacker/Retriever to move on as it travels from one station to another within the vault. At the east end of the vault these tracks end in a large transfer bay connecting the storage aisle with two maintenance areas; the repair bay and preventive maintenance bay. The Stacker/Retriever (S/R) moves material within the vault from one I/O station to storage or from storage to an I/O Station. The computer controlled S/R positions itself at the proper location in the vault through the use of a read head and code bars. The S/R moves at a speed of 400 ft/min horizantally and 60 ft/min vertically. The worst case transfer time to store or retrieve a pallet is 3 minutes. The S/R transfers aluminum pallets that are about four feet square and hold four permanently attached double-walled water-filled, lead shielded containers; one container at each corner of the pallet. Accountable dry material is double canned, placed in the water shielded, lead lined container on the metal pallet, and stored by the S/R. The pallets are numbered and the containers are lettered (A,B,C,D) for identification purposes. The "inner" can containing the accountable material is also identified for proper accounting. The "inner" can is made of smooth stainless steel with slip fit cover. This can has spring clips to hold the cover firmly in place and allows the can to be carried by the cover handle. The "inner" can is placed inside another stainless steel can that has a hinged lid and positive lock clasp. This second or "outer" can has a magnetic stainless steel handle to allow automatic weight verification in the inventory station. The "inner" can comes in two sizes (about 1 and 3.8 litre capacity) to accomodate specific material types. For example, metal buttons and oxide will be stored in the small, one litre cans. Scrap such as incinerator ash will be stored in the 3.8 litre capacity can.

Initially the vault will contain 1150 of these container type pallets that are stored on steel shelves in the central storage vault. There are also 100 maintenance or supply pallets that do not have the water-filled containers attached. Maintenance pallets have a four inch lip around the edge of the pallet to prevent dry reagents used in the various gloveboxes from falling into the vault during transfer. These pallets also transfer inoperative, contaminated equipment to and from the hot maintenance glovebox located on the sub-basement level.

When material is stored or retrieved from the storage vault a simple "store" or "deliver" request is required. A supervisory computer located in the computer center accepts the typed request, scans it for request validity and commands one of two satellite computers to direct the S/R in completing the request. The two satellite computers are interchangeable providing redundancy and decreasing maintenance down time. To safeguard the stored material, access to the supervisory computer is limited to a few authorized people. This access is gained through a programmed number assigned to each authorized user. This individualized access number can be changed as required to prevent unauthorized vault access through a compromised access number.

An inventory station automatically verifies inventory data. It is capable of determining pallet type, pallet orientation, can size, and can weight. The weight of accountable material determined by the chemical operator can be verified within $\pm$ 10 grams. All pallets being stored or returned to the vault pass through this inventory station. It consists of four load cells and electromagnets suspended from a cross arm and four metal proximity detectors to determine pallet orientation. This system provides an automatic check on possible operator error such as entering the wrong can size in the store request or placing a can in the wrong container or entering the wrong weight. When an error is discovered at the inventory station the entire pallet is placed in a hold status. The S/R transfers the pallet to a storage shelf and removes the pallet from general use. Under direction of the computer room supervisor, the pallet is later sent to a specific I/O station for error reconciliation.

This system provides for a complete running net weight vault inventory. A complete running estimated plutonium vault inventory is possible within about one hour of the time of request. A few cans of plutonium compounds, however, will undoubtedly be stored in the vault awaiting analytical lab results that can be supplied within a matter of hours.

CONTAMINATED SOLID AND LIQUID SCRAP AND WASTE HANDLING

Contaminated scrap in the form of impure metal, oxide, and various compounds will be delivered to the recovery facility in shipping containers such as bird cages or 55 gallon drums. The small packages containing materials such as impure plutonium oxide will be delivered to the shipping and receiving module. Contaminated items packaged in 55 gallon drums and above the approved discard level will be transferred to the building and stored in one of three areas for future processing.

Contaminated items generated by Recovery Operations will be sorted by material type, packaged in 3.8 litre containers and transferred to in-line can counters or calorimeters for plutonium concentration analysis. Materials determined to be below the approved economic discard limit will be removed from the process line via down draft tables or barrel take-out ports and transferred to the drum counter for final plutonium measurement.

Some used in-line filters will be transferred to incineration via the filter pneumatic conveyors while others will be transferred in French cans. French cans are transfer containers with special gaskets. These containers are attached directly to the glovebox and can be easily removed from the box without contaminating the immediate area. Liquid and solid samples will be transferred to the analytical laboratory via sample pneumatic conveyors. Some in-process solids will be bulk pneumatically conveyed into process equipment while others will be transferred from one processing module to another through the storage vault via the Stacker/Retriever.

Low level waste solutions (less than 10^{-5} g Pu/l) will be held in tanks that have locks on all inlet and discharge valves. Waste Treatment personnel will lock out the tanks, take the analytical sample, and transfer the solutions to the Waste Treatment Facility. Solutions that are ready for discard to Waste Treatment will be circulated for a preset period of time, double sampled and double analyzed to reduce sampling error, and transferred to Waste Treatment. All other solutions will be purified through anion exchange, concentrated by evaporation to high level solutions, (30 - 50 g/l plutonium), and converted to the pure plutonium metal form for use in the foundry.

MATERIAL BALANCE AREAS

In accordance with ERDA manual Chapter 7401 the Material Balance Areas (MBA) have been based on the Modular Construction of the processing area and each module's interface with the central storage vault. The individual MBA's are shown in Figures 5, 6, and 7.

MBA	DESCRIPTION
A	Molten Salt/Electrorefining, Pyrochem Salt, Metal and Glass Leach
B	Site Return
C	Remaining Process Areas
D	Drum Storage

MBA-C is divided into a number of small units called Internal Control Balance Areas (ICBA). Identifying numbers for ICBA's correspond to the secured storage vault I/O station number servicing the ICBA in question. Therefore, the first ICBA number is assigned to the Shipping and Receiving Module, the second to the Incineration Module since its I/O station is number 2 and so on. ICBA numbers 5 and 6 are not used because I/O station 5 and 6 service MBA-A and -B, respectively. ICBA numbers 9 and 10 are reserved for future use since I/O stations 9 and 10 are not installed at this time. Floor space has been reserved for installation of these two I/O stations at a later date. The final ICBA areas, Ion Exchange and Americium Recovery are not serviced by the storage vault and therefore have no corresponding I/O station numbers. These two ICBA's receive the next highest numbers, 11 and 12, to complete the numbering of the eight ICBA's as shown in Table I.

Other items in Figure 7 labeled with designations beginning with D and P refer to holding tanks and pumps which are associated with MBA/ICBA's in modules other than the ones in which they are located. These exceptions arise because the tanks receive material only from the MBA with which they are physically connected by plumbing and because sampling and analysis occurs after the transfer of material.

MBA and ICBA process systems are debited or credited with plutonium as it is transferred from on place to another for process reasons. Generated material transfer data becomes a

TABLE I

MBA-C, ICBA IDENTIFICATION NUMBERS

Numbers	Description
1	Shipping and Receiving (Figure 7)
2	Incineration: High Specific Activity (HSA) Low Specific Activity (LSA), off-gas scrub systems. Caustic treatment (Figures 5, 6, 7).
3	Fluorination, Reduction, Button Break Out (Figure 7).
4	Precipitation, Filtrate Kill Evaporator, Calcination (Figure 7).
5 & 6	Do not exist because I/O Stations 5 & 6 service MBA-A (MS/ER) and MBA-B (Site Return).
7	Standards and Analytical Labs (Figure 7).
8	Dissolution, ash hydrofluorination, Filtration, Secondary Recovery, (Figures 5, 6).
9 & 10	Do not exist at this time. Numbers reserved for future expansion.
11	Anion Exchange, Feed Evaporator, Secondary Recovery Evaporator, Nitric Acid Recovery Distillation Column (Figure 7).
12	Americium Purification (Figure 7).

part of the nuclear materials control system (NMC) for Rocky Flats. These material transfers pertain to both liquid and solid plutonium forms.

TRANSFERS AND MEASUREMENTS

Plutonium containing solutions are generated by dissolution and leaching processes, ion exchange and precipitation systems, scrubbers, decontamination efforts, general cleanup, and inventory procedures. Plutonium concentrations vary from 10^{-5} g Pu/l to 50 - 60 grams Pu/litre of solution. Holding tanks provide staging areas for batching adjustments and in-process nuclear materials accountability.

Holding tanks are equipped with differential pressure cells for remote readout of the contained volume. Raschig ring filled holding tanks contain permanently fixed ultrasonic probes electronically attached to a calibration cart. In accord with a preset schedule developed by Chemical Operations and Chemical Standards personnel, ring filled tanks are calibrated with water using ultrasonic probes and sensitive metering pump equipment. The differential pressure cells are certified by adjusting their readings to match their specific calibration curve.

Raschig ring filled holding tanks are periodically calibrated and the calibration certified by standards laboratory personnel. Prior to sampling, the solutions in these certified tanks will be circulated for a preset period of time for the purpose of homogenizing the contents. Samples will be taken at the glovebox contained circulation/transfer pumps and the sample vials transferred to the analytical lab via pressurized pneumatic transfer system or French cans.

For process control purposes the actual volumes of the holding tanks will be recorded automatically by the Process Data Acquisition system (PDAS) computer. This system will display the tank volume on cathode ray tubes (CRT's) located in the control rooms and in the computer center.

The PDAS also will provide immediately a hard copy and magnetic tape record of the tank volume for future reference. The tank volume will be displayed on the control room sequence panel via the differential pressure cell level transmitter and amplifier. The sequence panels are a part of the control board that supplies process control through automatic and manual control instrumentation. All process line connections at holding tanks and equipment are hard piped, eliminating the possible operator error inherent with plastic tubing connections that are manually manipulated.

Also interfaced to the PDAS computer are ten process balances one drum scale and six load cells located throughout the facility. Data from these devices are available to the stacker/retriever computer upon request for material accountability purposes.

All liquids transferred by a pump will be sampled at the pump location for accountability and process control. Appropriate nuclear material control documentation is completed at the time of each transfer. Plutonium values will be determined for each of these systems in the process holding tanks and the plutonium values will be assigned to specific MBA's or ICBA's by Chemical Operations Production Control and Nuclear Materials Control personnel as experience dictates.

Plutonium bearing solid scrap is generated by all recovery processes. Solid scrap normally containing more than 50% plutonium include miscellaneous oxide, plutonium tetrafluoride from direct fluorination, and plutonium metal buttons from molten salt, electrorefining, and reductions. Solid scrap normally containing less than 50% plutonium includes, but is not limited to, miscellaneous metal and glass, graphite, combustibles, sand, slag and crucible, incinerator ash, and filtration heels. All items will be transferred on a measured value or statistically established factor. Factors will be replaced with measured values as soon as they are available. Each transfer must have accountability documentation as appropriate.

Solid scrap will be subjected to chemical processing until the plutonium concentration is reduced to a value less than the DOE approved economical discard value for a specific material type. This value is determined by can counting, drum counting, laboratory analysis, or a total alpha smear technique in the case large equipment. Discardable solid waste is removed from the processing lines via drum take-out ports and the I/O stations.

NON DESTRUCTIVE ASSAY EQUIPMENT

In-line nondestructive assay instrumentation is located at eight assay points within the facility. The equipment was designed for ease of maintenance so that all electronics instrumentation is placed external to the glovebox assay stations. In addition as much of the electronics package as possible is placed in the process control room associated with the module in which the counter is located. This reduces the possibility of instrumentation contamination and places the instrumentation in easy access to conduit leading to the S/R computer where the results of the measurements are converted to assay data and entered into the NMC accountability system.

CAN COUNTERS

Four residue can counters are scheduled to measure waste generated and placed in 3.8 litre containers. The counters are shown schematically in Figure 8. Assays of plutonium wastes low in americium are made by measuring the intensity of the 400-key gamma-ray region emitted by each sample. Each counter consists of two NAI detectors, 2 inch in diameter and 1 inch thick, located one above the other in a lead shield. Each detector has associated with it a shuttered barium transmission source. Operation of the system is similar to that of the Rocky Flats Helix Counter which has been in use for assaying waste residues at Rocky Flats since 1970. The two transmission source, two detector arrangement was chosen to eliminate the axial movement of the sample, yet retain to some extent the segmentation of the sample along the axis. In addition each counter will be equipped with ^{3}He neutron detectors. The neutron detectors will be retrofit to the glovebox appendage and operated in a coincidence mode.

Two of the can counters measure material which is to be reprocessed to recover plutonium. One measures the plutonium concentration of the output of the HSA incinerator (MBA C/ICBA-8) prior to dissolution, the second measures the plutonium concentration of sand, slag and crucibles generated at the plutonium metal reduction operation (MBA-C/ICBA-3) prior to dissolution. The other two are located at drum take-out ports. One is used to screen waste to determine whether the plutonium content is above or below discard limits for contaminated metal and glass (MBA-A). The last counter is located in the scrap handling glovebox associated with the HSA incinerator (MBA-C/ICBA-2). This counter determines the plutonium content of in-line process filters prior to incineration and non-combustibles prior to further processing. Since these instruments are identical in operation, each could be used as a backup for another in case of malfunction by transferring the sample from the MBA to the vault and then to the functioning instrument.

CALORIMETERS

Twenty Calorimeter wells are available for measurement of kilogram quantities of plutonium oxide. The calorimeters are located in the shipping and receiving module (MBA-C/ICBA-1). The wells are located in the floor of the gloveboxes such that they are immersed in the isothermal water baths located beneath the gloveboxes. Initially, the wells will be connected in four banks of five cells yielding a total of sixteen measurement cells and four reference cells. These cells are interfaced to two Hewlett-Packard 3052A data collection and control systems. Data is collected and periodically transferred to the S/R computer where equilibrium prediction will be calculated to improve calorimeter throughput.

SEGMENTED SCANNER ASSAY

A segmented gamma scanner will be installed in the molten salt and electrorefining area (MBA-A) to measure the contaminated chloride salt scrap which contains both plutonium and americium. The counter will measure plutonium up to 400 gm and americium up to 30 gm. The elevator and turntable will be located in a well extending through the bottom of the glovebox. The transmission source and detector are located external to this well and under the glovebox. The hardware has been interfaced to a Nuclear Data, Inc., ND-6620 spectrometer system. The fortran software for reducing the spectral data and performing the assay is under development. The final assay results will be transmitted to the stacker retriever computer for entry into the plant NMC system.

LIQUID ASSAY SYSTEM

A second gamma-ray spectrometer will be located in the building analytical laboratory (MBA-C/ICBA-7). This spectrometer will view liquid samples through a window in the glovebox bottom. It will perform plutonium analysis by direct counting or by absorption edge densitometry and also provide the capability to perform isotopic measurements. The sample chamber will also incorporate a refractometer for measuring the normality of the liquid sample. Both the gamma-ray spectrometer and the refractometer are interfaced to the ND-6620 for data processing. Upon completion of the analyses of the data associated with each instrument, the results will be transmitted to the stacker retriever computer.

NEUTRON COINCIDENCE COUNTER

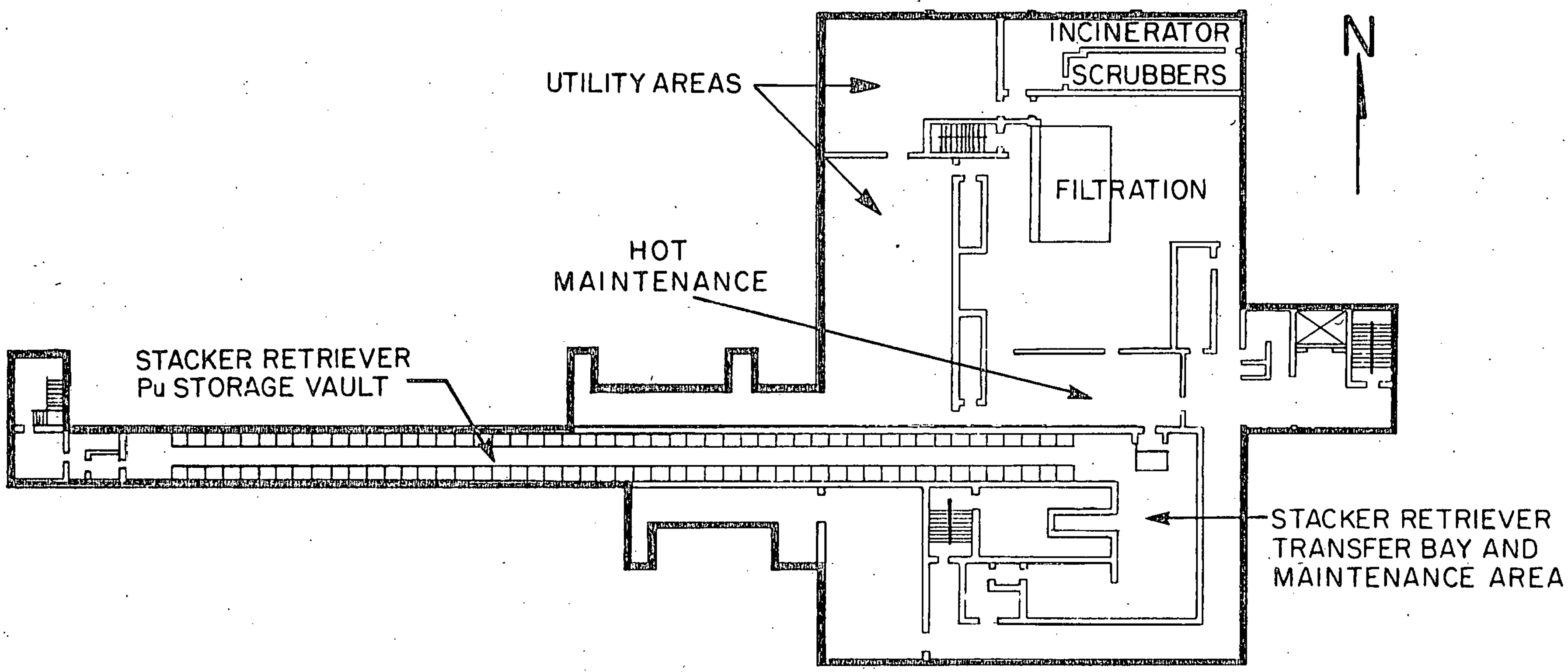
The calcined hydrogen peroxide precipitation product will be assayed in 1200 to 2000 gm quantities using neutron coincidence counting. The counter measures the output product of MBA-C/ICBA-4. The counter cavity is designed to hold the eight inch diameter by four inch tall stainless steel vessel used in the precipitation process. Output of the coincidence counter electronics will be transmitted to the stacker retriever computer. After counting, the oxide is bulk pneumatically transferred to the next processing step, florination.

SUMMARY

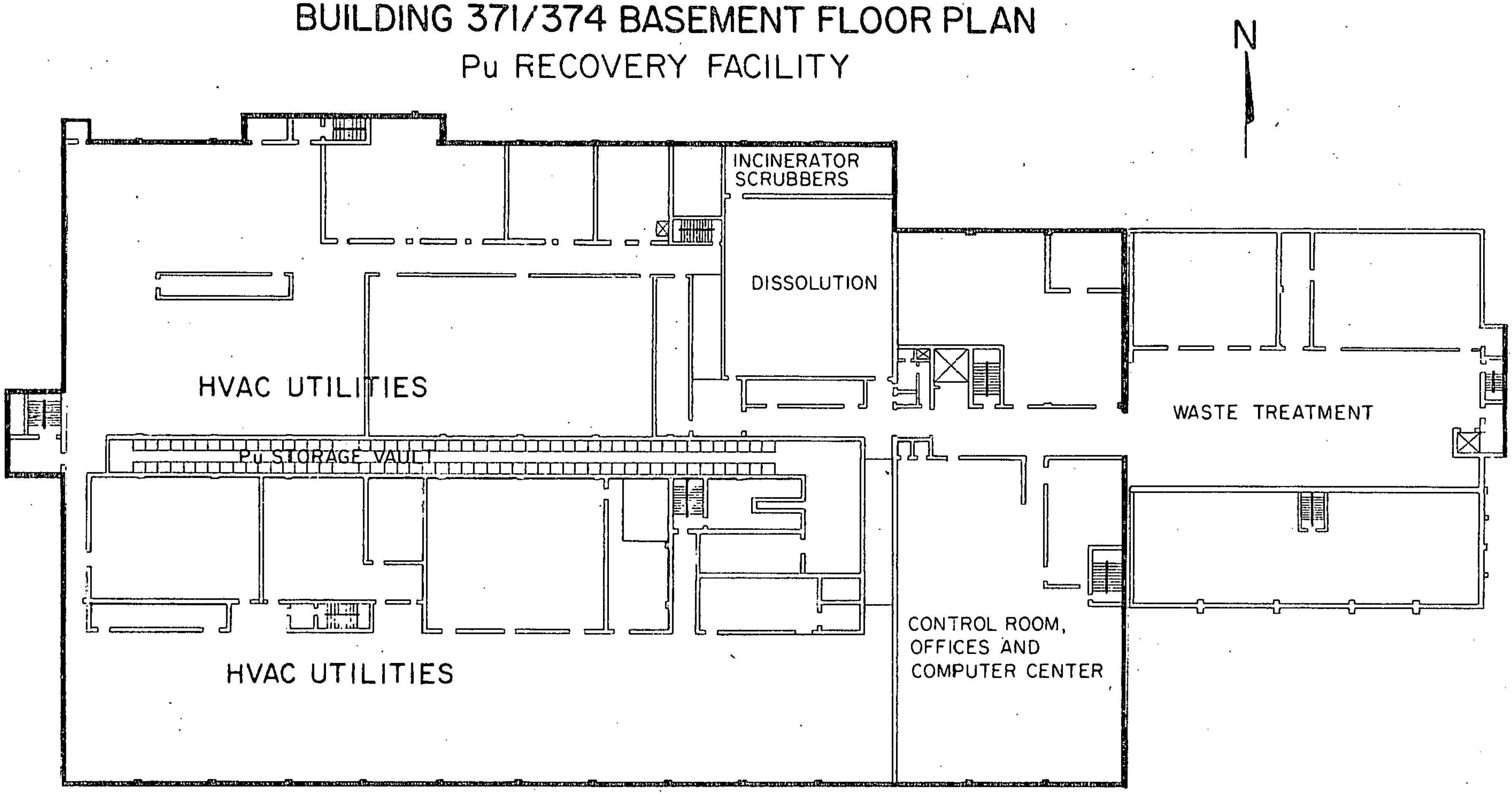
Information from the process data acquisition system computer, from manual input at data terminals, as well as information obtained from the NDA instrumentation comprise the material accountability system for the new process facility. Installation of all equipment is currently scheduled to be complete by March, 1980 with the facility beginning to process plutonium by August, 1981. The stacker retriever computer and storage vault system have been operational since 1976. All components for the NDA equipment are on hand and are currently undergoing laboratory assembly and calibration.

LIST OF FIGURES

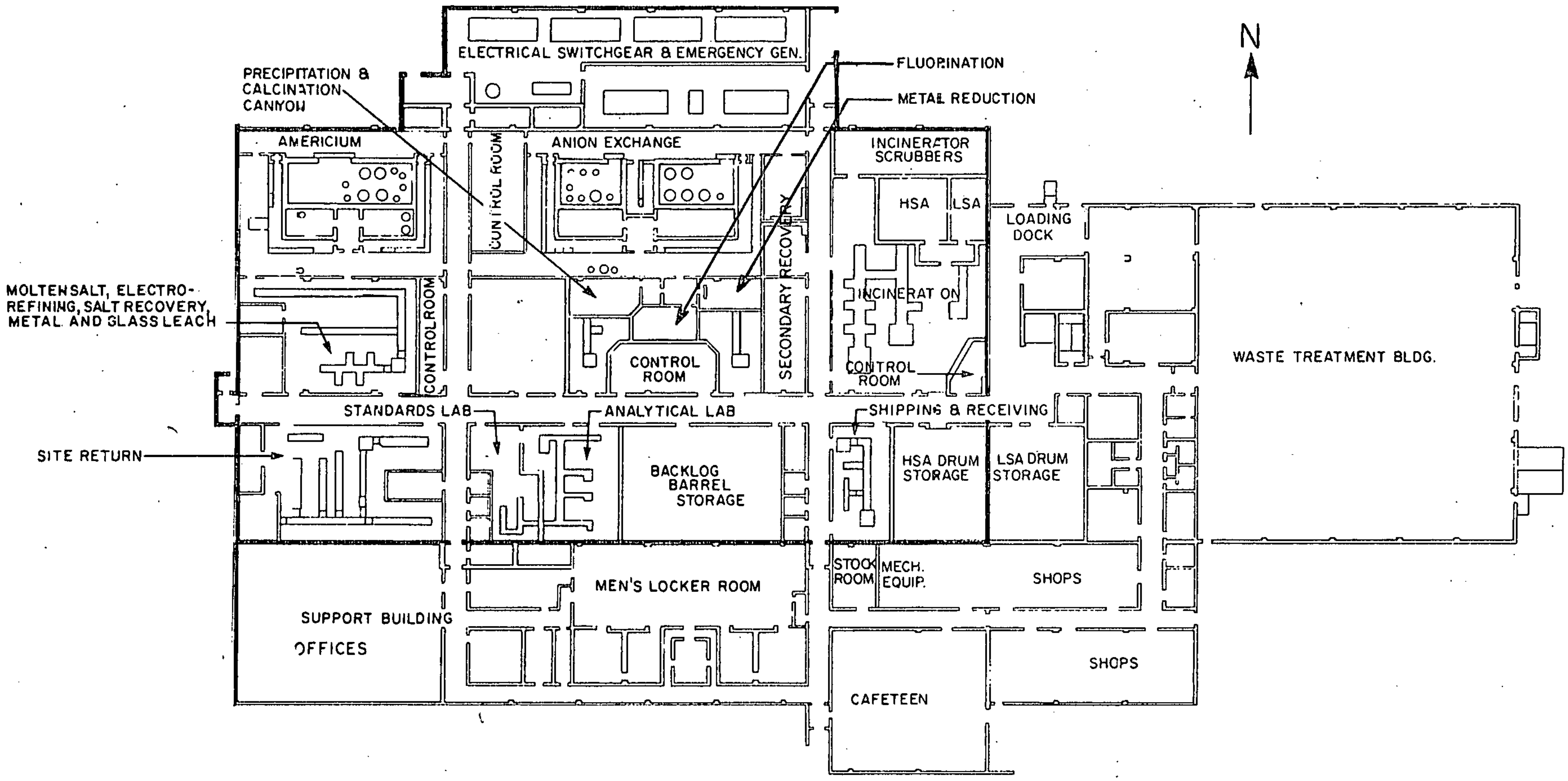
BUILDING 371/374 SUB-BASEMENT FLOOR PLAN Pu RECOVERY FACILITY

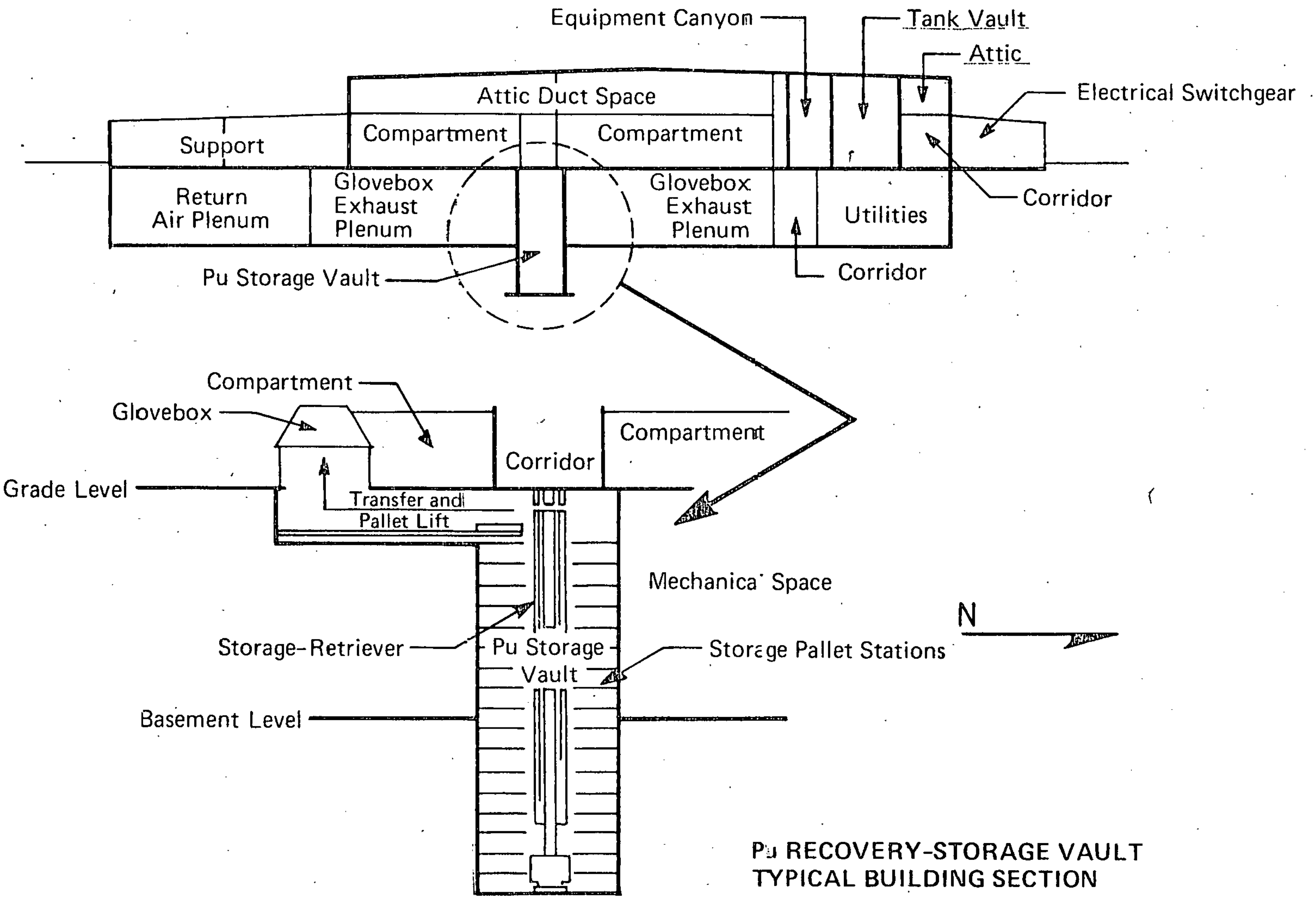


BUILDING 371/374 BASEMENT FLOOR PLAN
Pu RECOVERY FACILITY



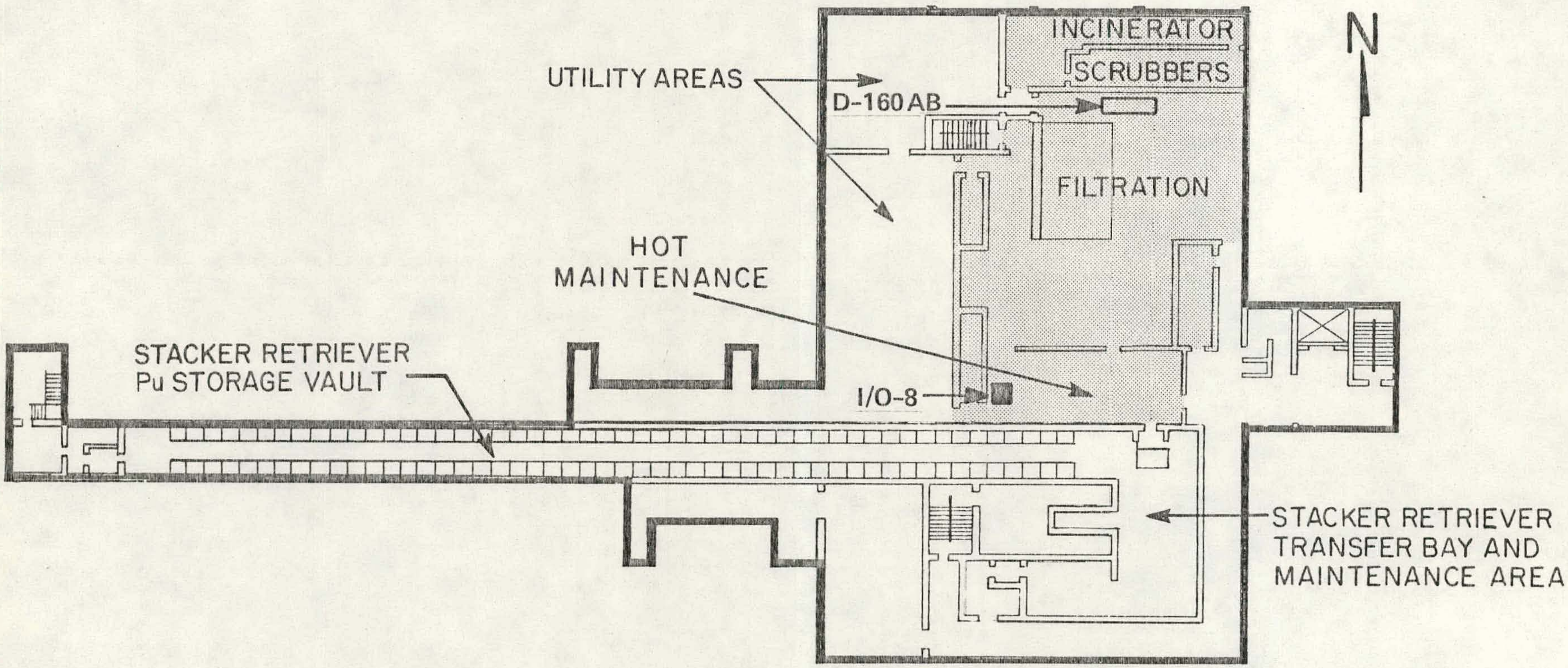
BUILDING 371/374
GROUND FLOOR PLAN
PU RECOVERY FACILITY





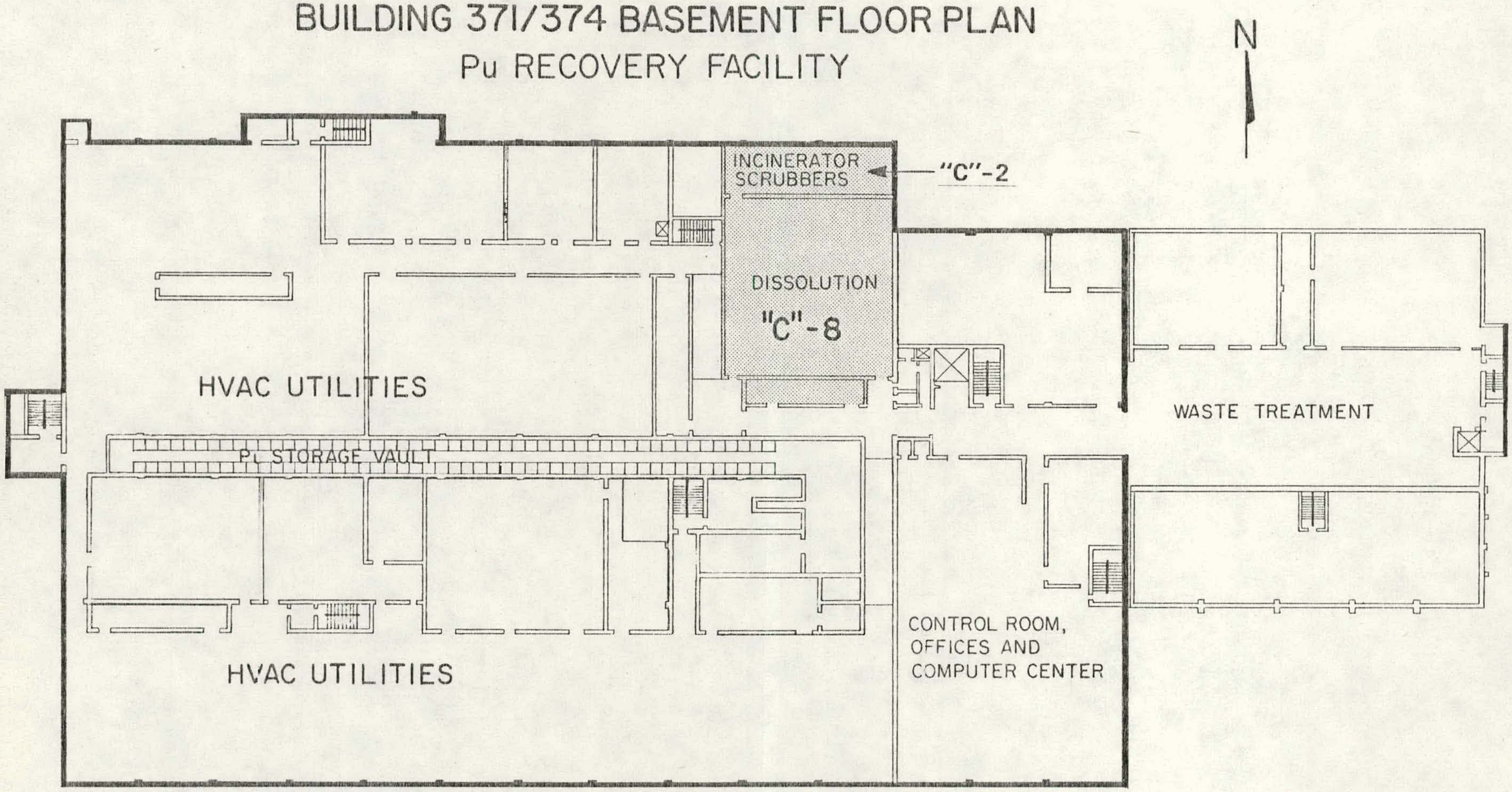
Pu RECOVERY-STORAGE VAULT
TYPICAL BUILDING SECTION

BUILDING
371/374 SUB-BASEMENT FLOOR PLAN
Pu RECOVERY FACILITY



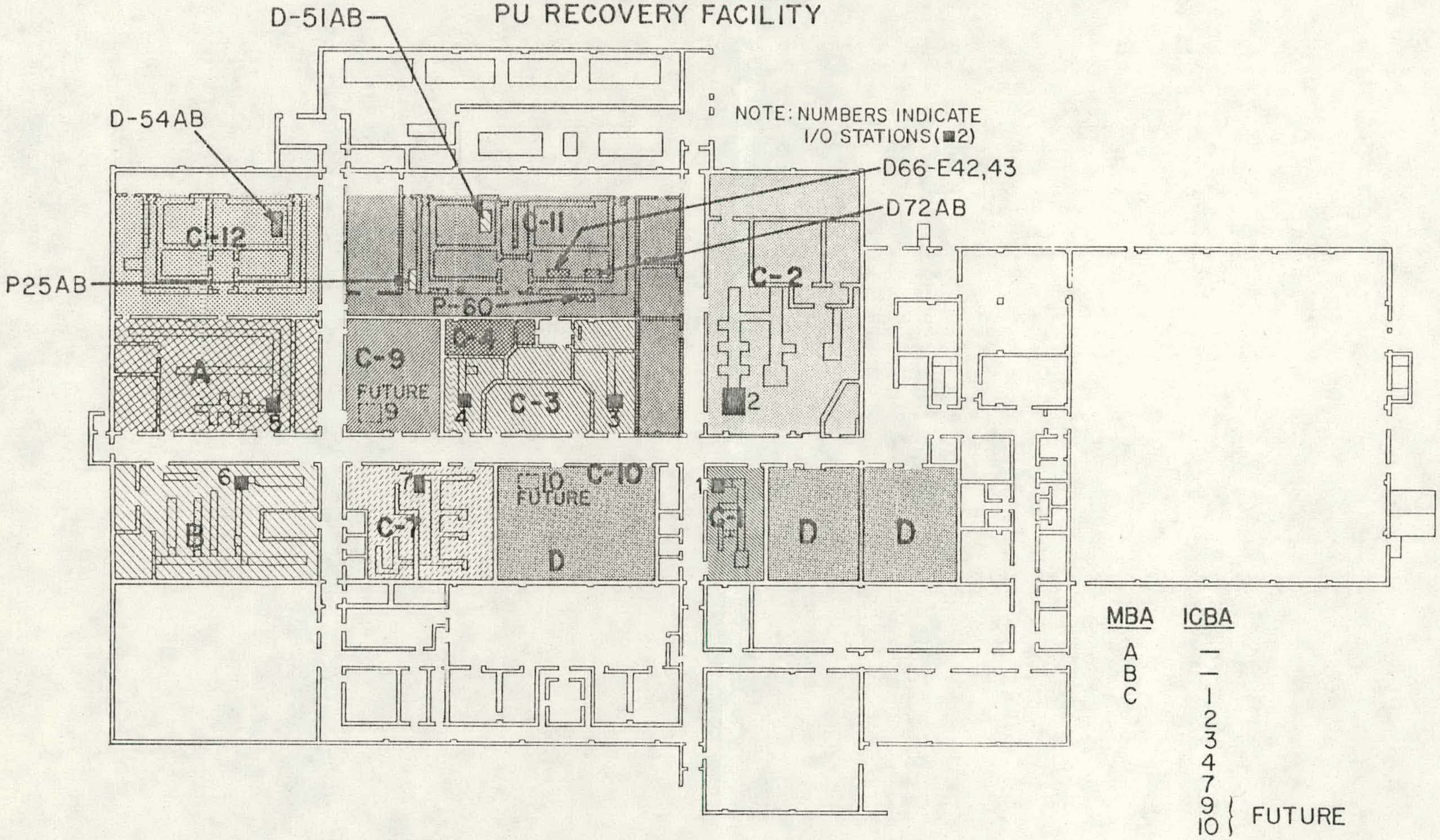
MATERIAL BALANCE AREAS
SUB-BASEMENT

BUILDING 371/374 BASEMENT FLOOR PLAN
Pu RECOVERY FACILITY

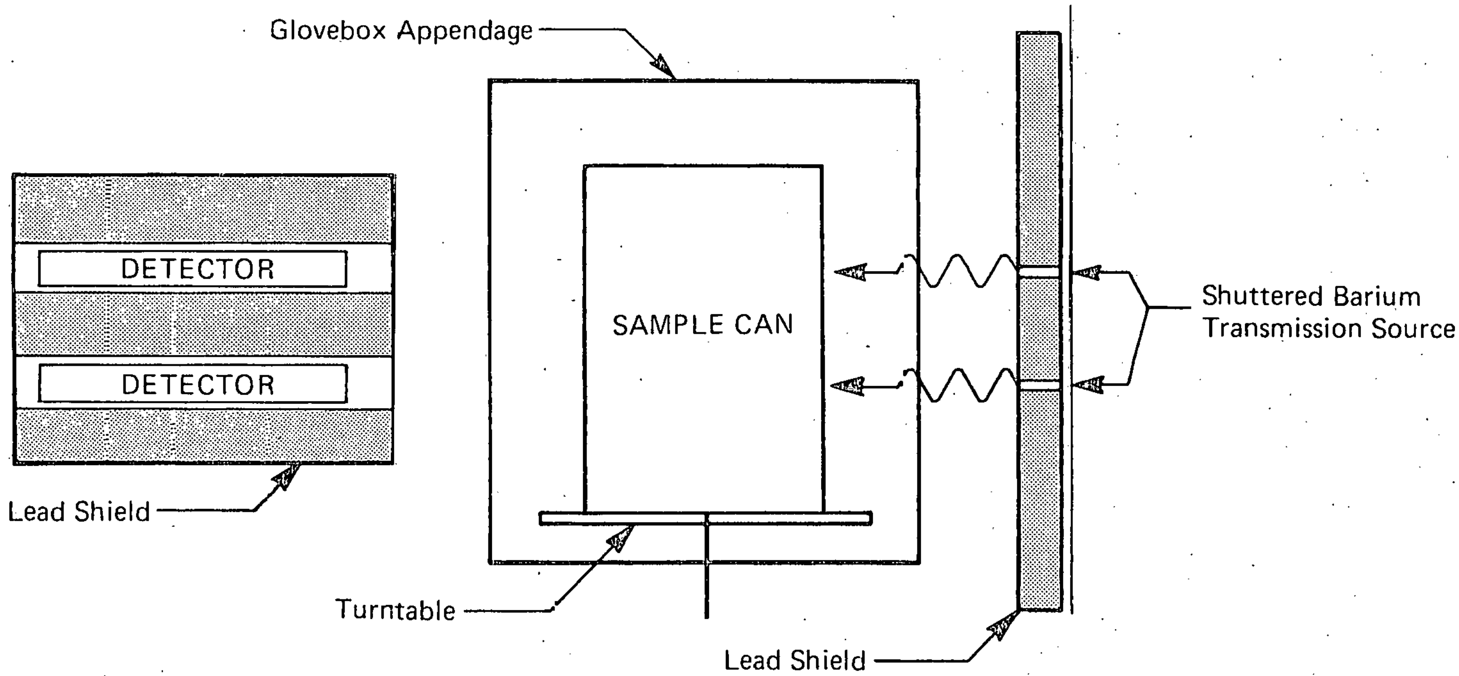


MATERIAL BALANCE AREAS-BASEMENT

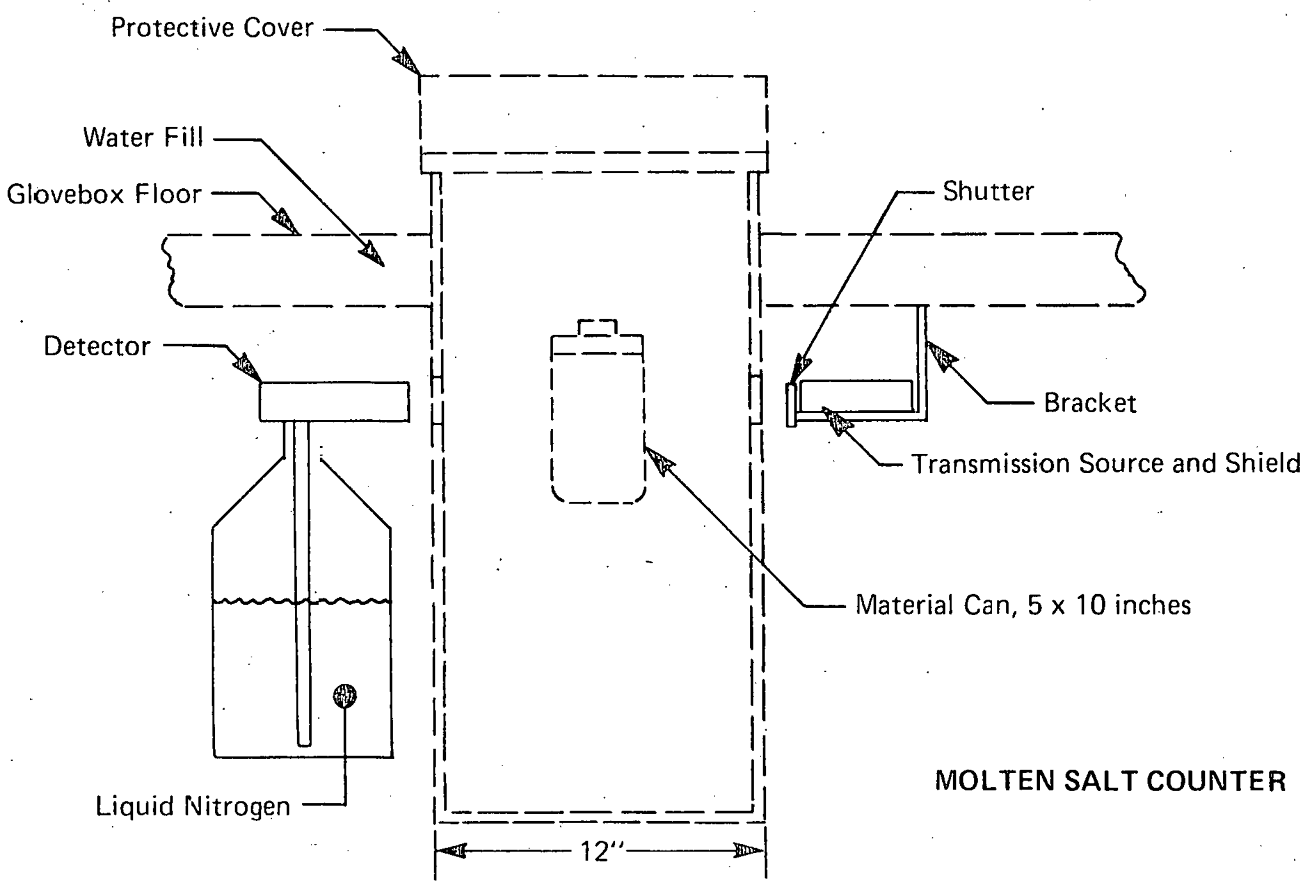
BUILDING 371/374
GROUND FLOOR PLAN
PU RECOVERY FACILITY



MATERIAL BALANCE AREAS—GROUND FLOOR



SCHEMATIC OF RESIDUE CAN COUNTER



MOLTEN SALT COUNTER