SEQUOYAH FUELS CORPORATION

REPORT No. 2

# TECHNICAL RECOMMENDATIONS IN THE DESIGN AND OPERATION OF A PLUTONIUM FUEL FABRICATION FACILITY TO FACILITATE DECONTAMINATION AND DECOMMISSIONING

This report is prepared and submitted as a Task 3 requirement in accordance with contract DE-AC06-83RL10382.

U. S. Department of Energy
Richland Operations Office
P. O. Box 550
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# I. EXECUTIVE SUMMARY

Sequoyah Fuels Corporation(formerly Kerr-McGee Nuclear Corporation) is in the process of decontaminating and decommissioning the Cimarron Plutonium Facility. This facility was designed to produce mixed oxide(Pu-U)$O_2$ fuel using the co-precipitation process.

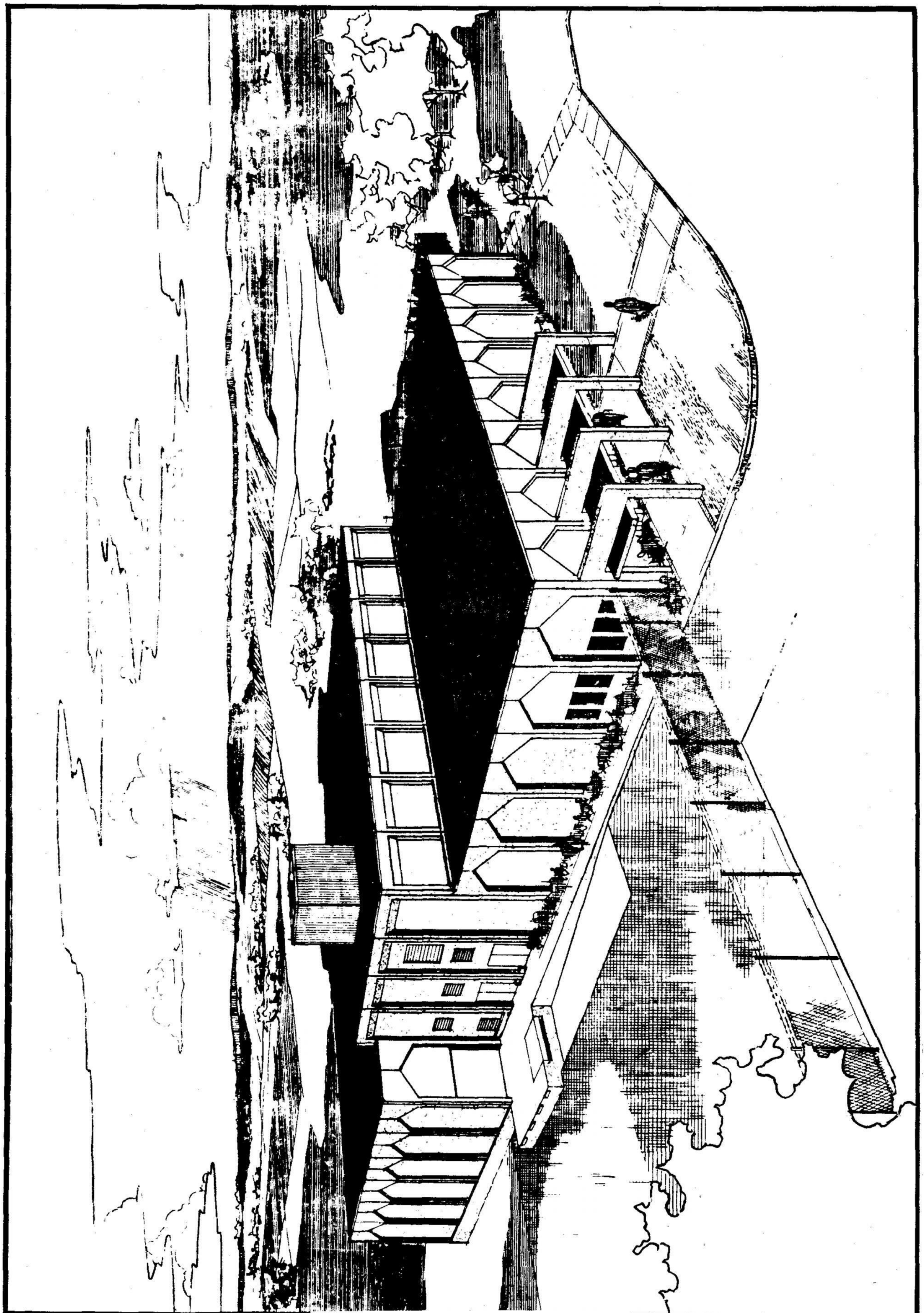
This report is intended to address three topics: (1) identify problem areas which were revealed during the first phase of the decontamination and decommissioning(D&D) effort which could have been minimized by use of different design criteria; (2) provide recommendations which would have minimized Pu hold-up or made non-destructive assay(NDA) for inventory more accurate and less difficult, and (3) identify the limitations of the current NDA equipment being used at the Cimarron Plutonium Facility.

The major problem areas uncovered to date and possible resolutions are identified.

## II. INTRODUCTION

The Sequoyah Fuels Corporation Cimarron Plutonium Facility was designed and constructed in 1969 near Crescent, Oklahoma and produced mixed-oxide fuel pins for the Zero Power Plutonium Reactor(ZPPR) and the Fast Flux Test Facility(FFTF) through 1975. The Plutonium Facility is shown in Figure #1. Various plutonium concentrations from 15-25% Pu were handled during the manufacturing phase. Due to economic and political considerations the Corporation decided to decommission the facility to permit unrestricted future use. This activity is now underway.

Although the effort to date is far from completed the preliminary data indicates that problems of D&D are affected by the design of the building and equipment as well as the selection of materials for construction and equipment. This report will discuss these findings and make recommendations for reducing high costs and physical effort associated with the labor intensive operations of the D&D phase.



Cimarron Plutonium Facility
Figure #1

## III. ORIGINAL DESIGN OF THE PLUTONIUM FACILITY

The Plutonium Facility was designed in 1969 to be a manufacturing facility for the safe production of fuel pins containing co-precipitated mixed-oxide $(Pu\text{-}U)O_2$ pellets.

### A. Design Criteria

The facility contains 26,000 square feet of floor space and was constructed of precast, prestressed concrete exterior walls and roof. All exterior and interior joints in the precast building were caulked to make an airtight structure. The interior walls, ceiling and floors have a smooth coated surface for easy cleaning. The process area includes a poured-in-place concrete storage vault.

The building ventilation system is divided into three subordinate systems. The first consists of building supply fans, the second consists of room air exhaust fans, and the third is made up of process equipment exhaust fans.

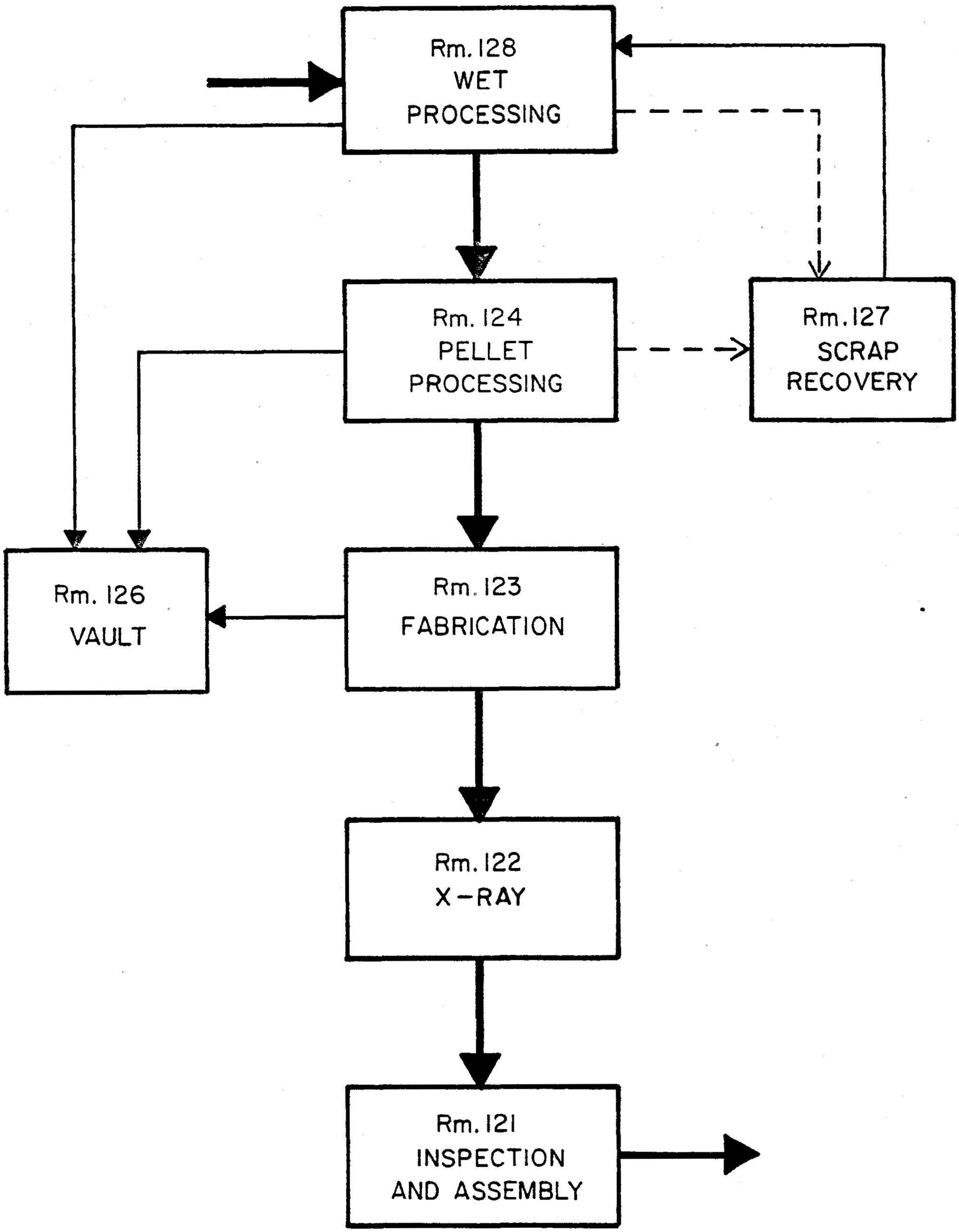
Gloveboxes for Pu processing were fabricated specifically for the operations to be performed and to insure total material containment. The gloveboxes were constructed of at least 3/16 inch stainless steel. Movement of material and tooling in and out of most of the gloveboxes was by bag-in and bag-out techniques.

B. Purpose of the Facility

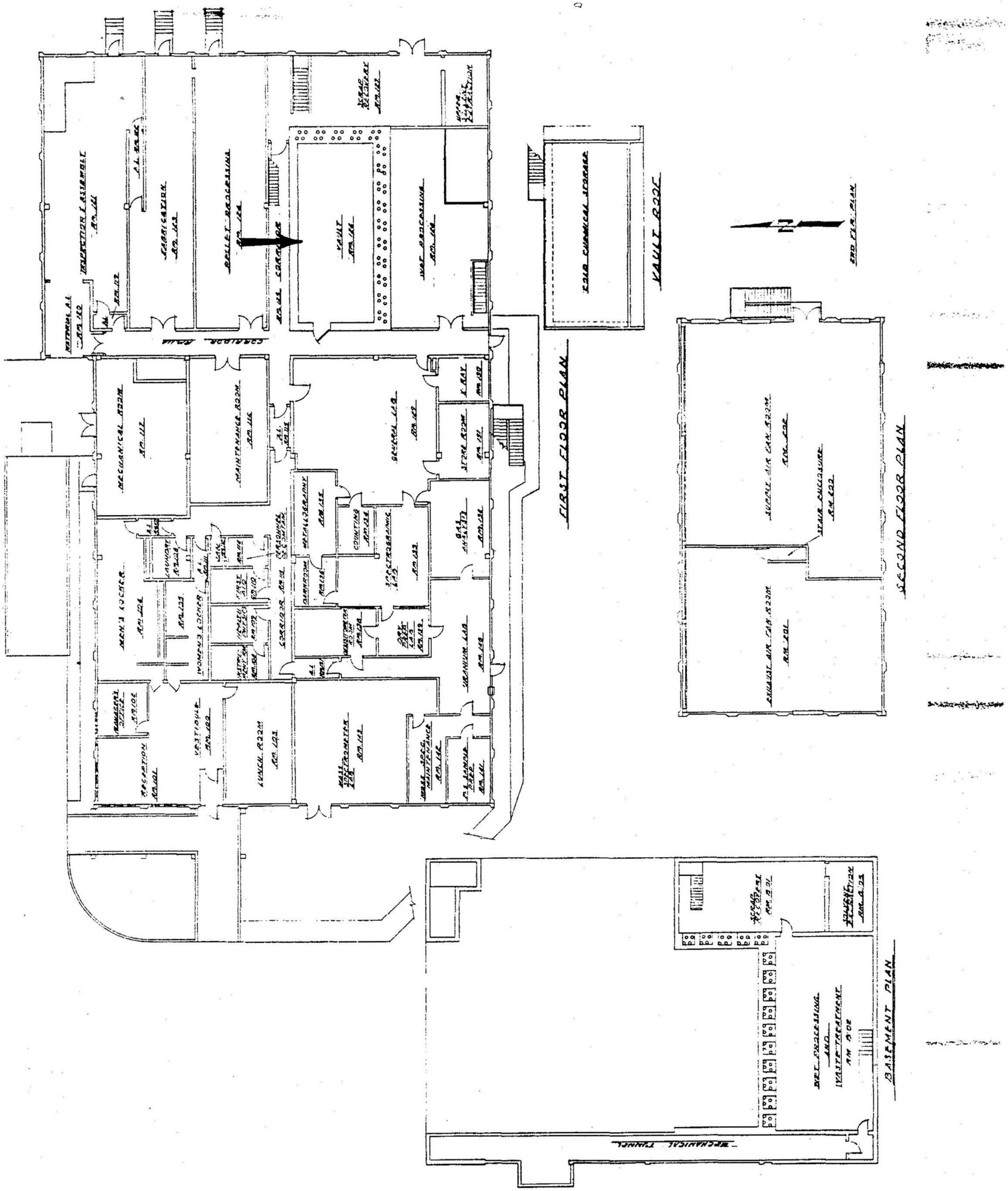
The Plutonium Facility was specifically designed to manufacture fast reactor fuel pellets and pins utilizing the co-precipitation process in order to produce homogeneous mixed-oxide pellets. This operation also contained facilities for the recovery of Pu from scrap materials which were suitable for recycle. Complete analytical laboratory facilities were included to support the manufacture of fast reactor fuel.

C. Facility Description

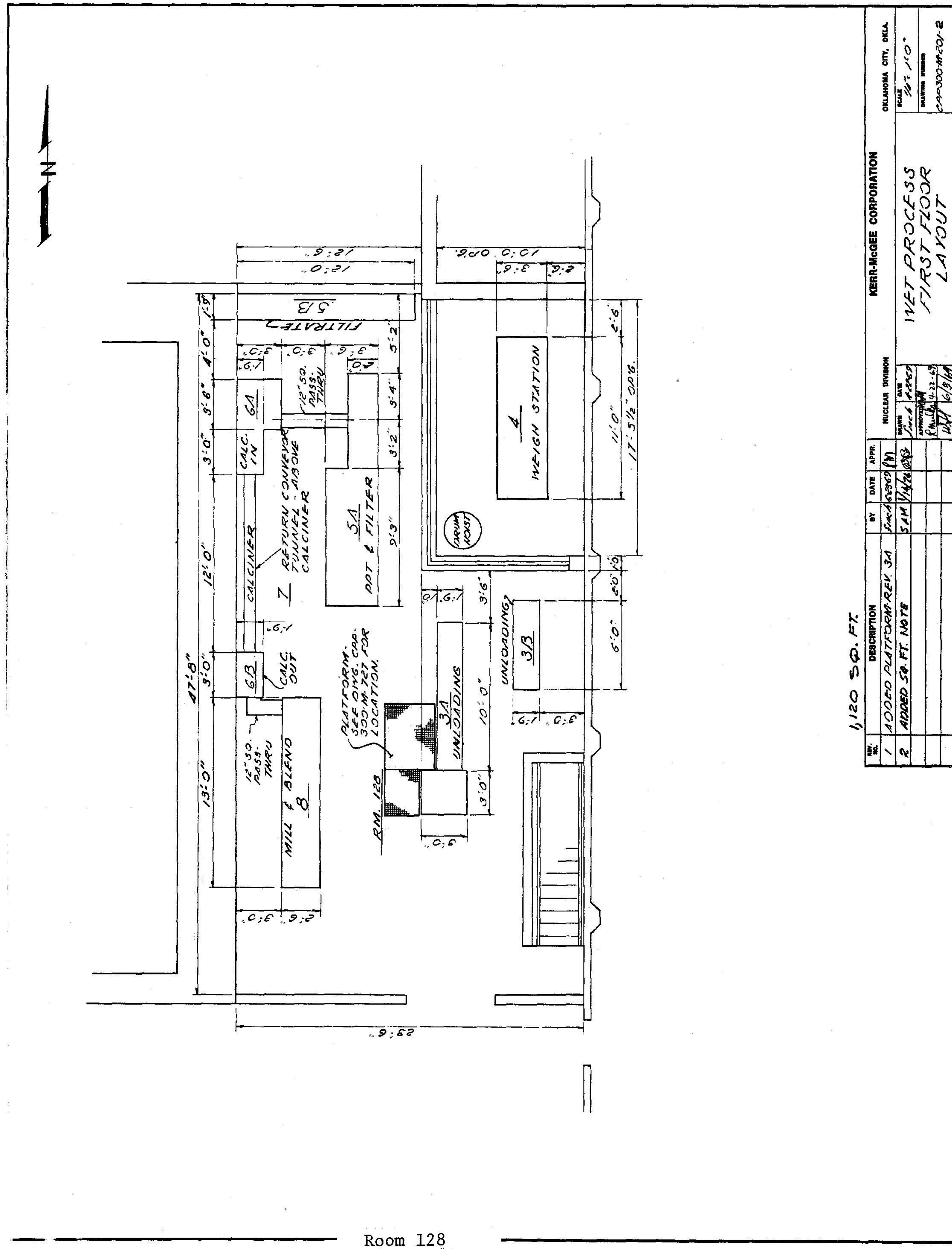
The material flow started in the wet process area at which time plutonium nitrate and uranyl nitrate were blended and co-precipitated as a homogeneous product. The flow of material is shown in Figure #2. As can be seen in the floor plan Figure #3, the vault separated wet processing from the dry processing areas. The utilities, analytical laboratories, production services, and maintenance areas were separated from the production areas by a central hall. The dry end of the process area consisted of powder and pellet processing, fabrication, inspection, and assembly. The second floor contains the air handling equipment. Figures #4 through #8 illustrate equipment layouts for each processing area.




Material Flow
Figure #2




Plant Floor Plan
Figure #3




Room 128
Figure #4

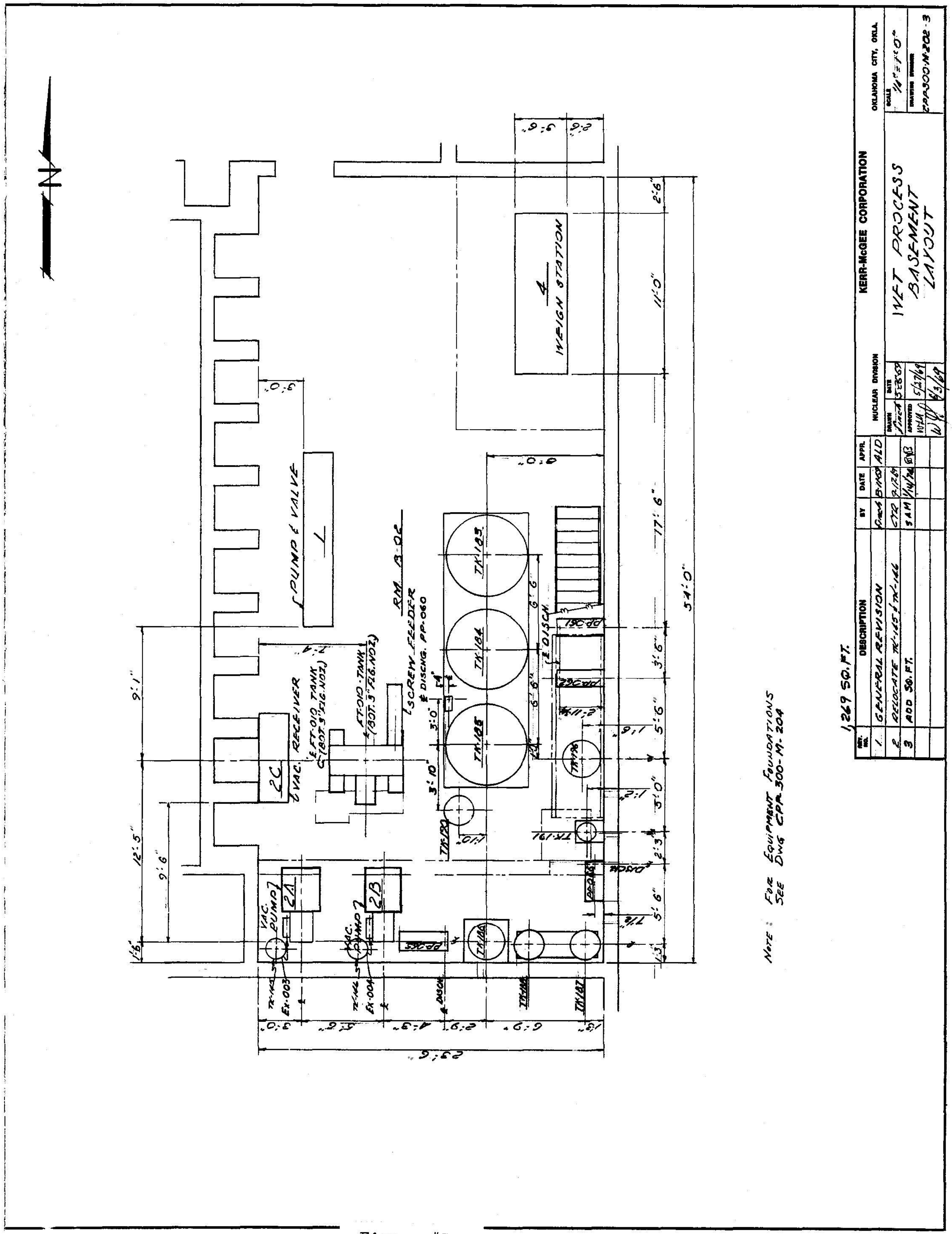

KERR-McGEE CORPORATION
NUCLEAR DIVISION
OKLAHOMA CITY, OKLA.
WET PROCESS BASEMENT LAYOUT
GENERAL REVISION
RELOCATE TK-125 & TK-126
ADD SQ. FT.
1,269 SQ. FT.
NOTE: FOR EQUIPMENT FOUNDATIONS SEE DWG CPR 300-M-204
WEIGH STATION
PUMP & VALVE
RM B-02
SCREW FEEDER
VAC. RECEIVER
VAC. PUMP
54'-0"
23'-6"

Figure #5

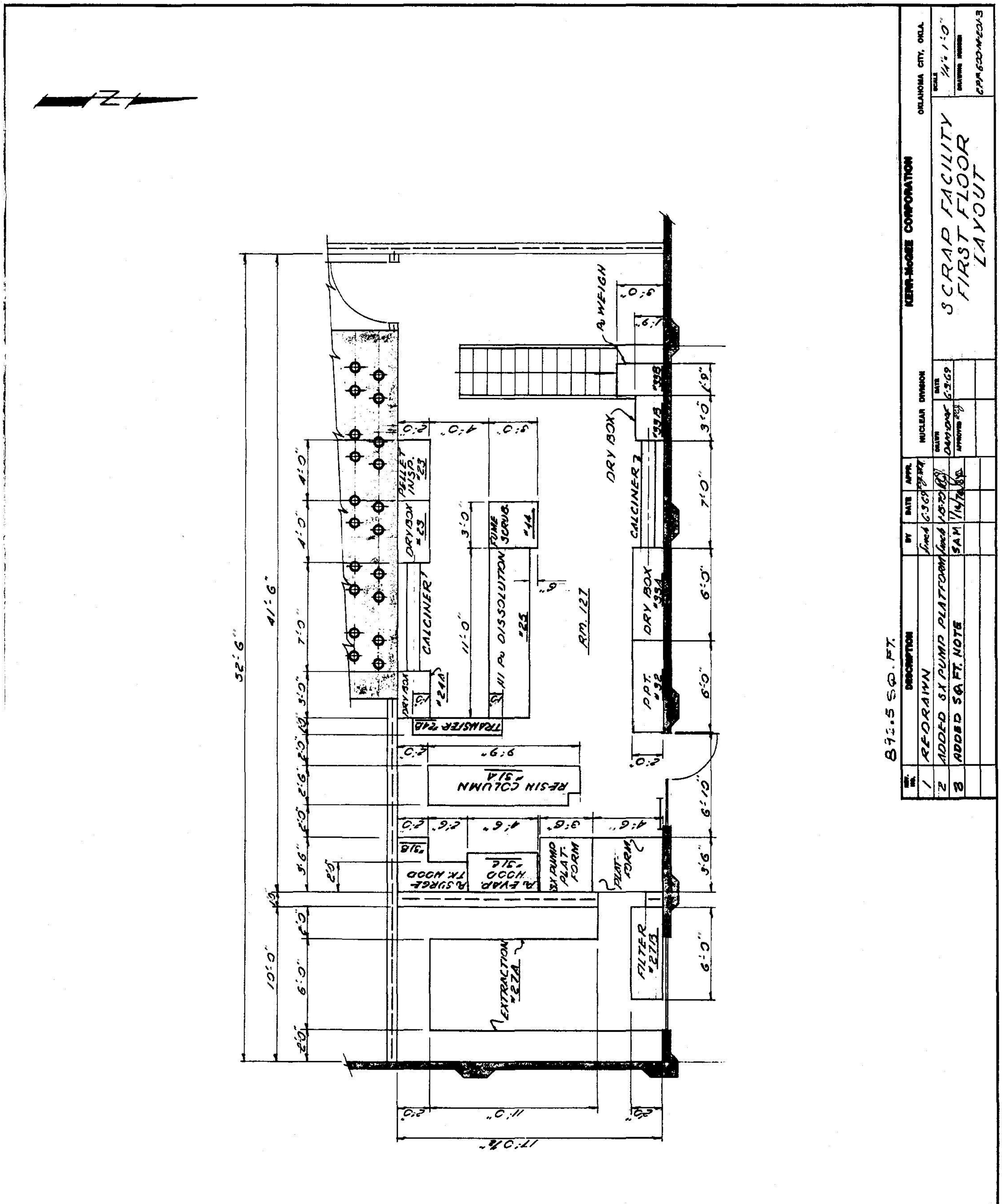

KERR-McGEE CORPORATION
NUCLEAR DIVISION
OKLAHOMA CITY, OKLA.
SCRAP FACILITY FIRST FLOOR LAYOUT
873.5 SQ. FT.
RM. 127
REDRAWN
ADDED SX PUMP PLATFORM
ADDED SQ. FT. NOTE

Figure #6

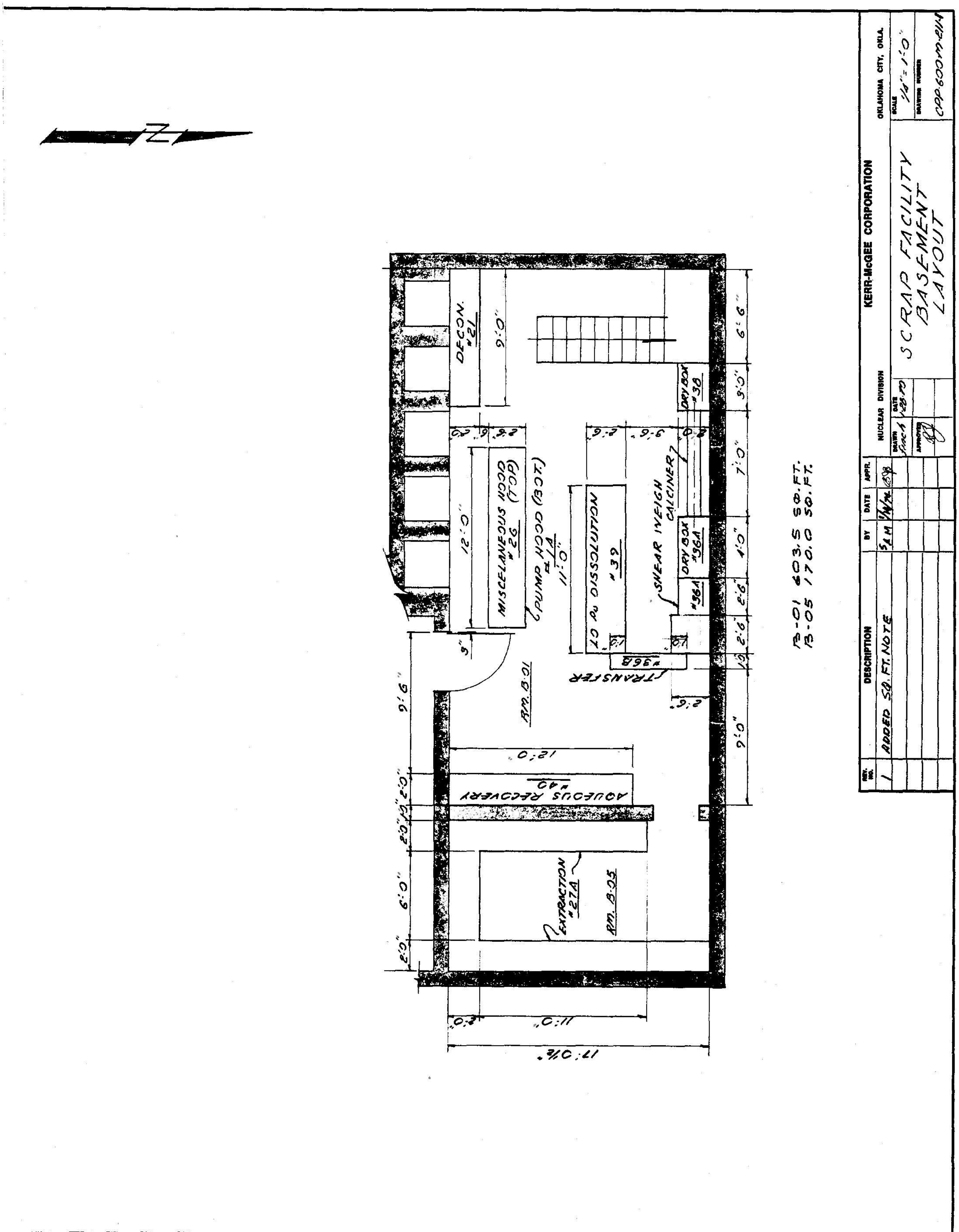

KERR-McGEE CORPORATION
NUCLEAR DIVISION
OKLAHOMA CITY, OKLA.
SCRAP FACILITY BASEMENT LAYOUT
1/4" = 1'-0"
ADDED SQ. FT. NOTE
B-01 603.5 SQ.FT.
B-05 170.0 SQ.FT.
DECON. #21
MISCELANEOUS HOOD #26 (TOP)
PUMP HOOD (BOT.) #1A
Pu DISSOLUTION #39
SHEAR WEIGH CALCINER
DRY BOX #36A
DRY BOX #38
#36B
TRANSFER
RM. B-01
AQUEOUS RECOVERY #40
EXTRACTION #27A
RM. B-05

Figure #7

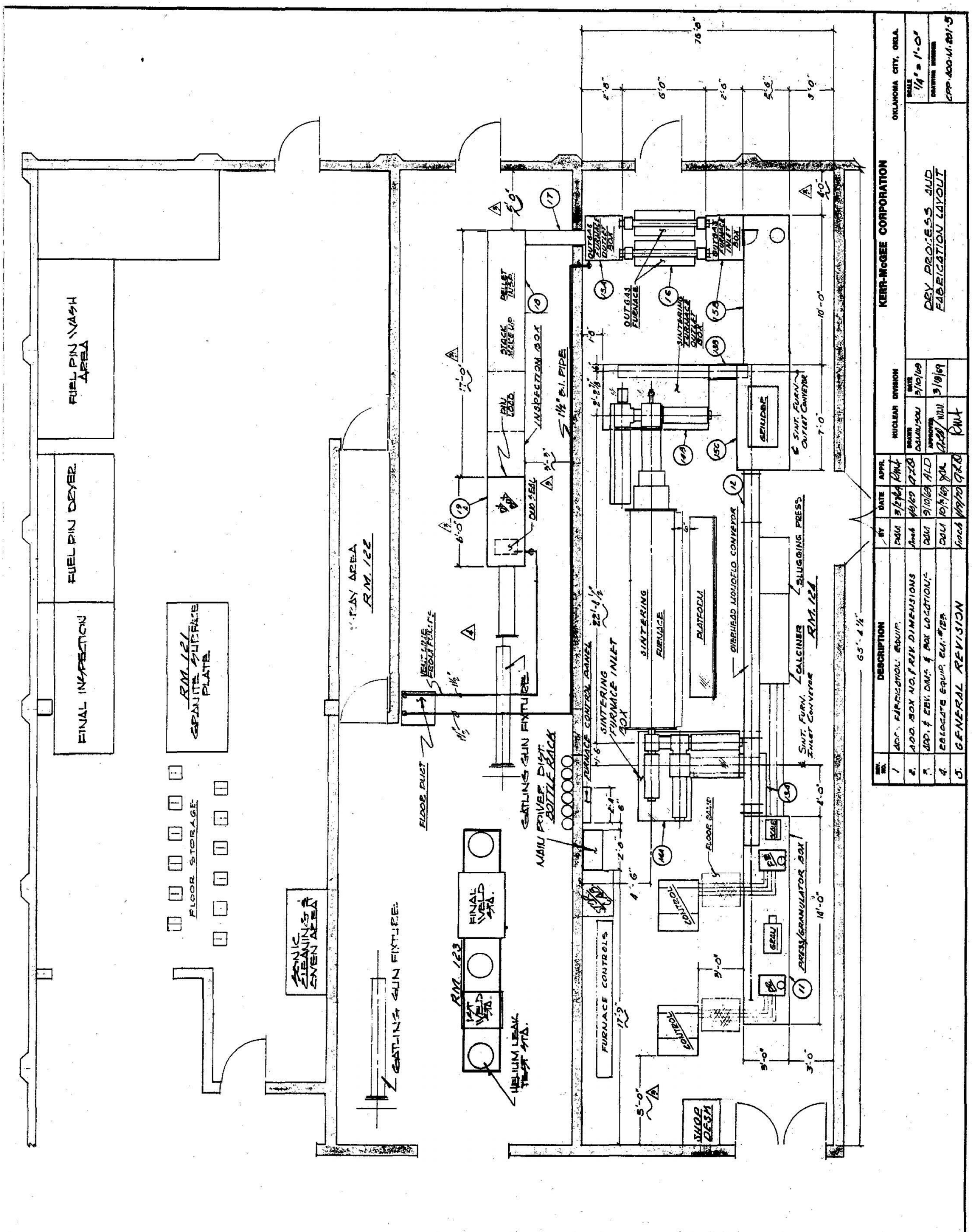

KERR-McGEE CORPORATION
NUCLEAR DIVISION
OKLAHOMA CITY, OKLA.
DRY PROCESS AND FABRICATION LAYOUT
FINAL INSPECTION
FUEL PIN DRYER
FUEL PIN WASH AREA
RM. 121
GRANITE SURFACE PLATE
FLOOR STORAGE
SONIC CLEANING & OVEN AREA
RM. 122
RM. 123
FINAL WELD STA.
HELIUM LEAK TEST STA.
GATLING GUN FIXTURE
FLOOR DUCT
INSPECTION BOX
PELLET INSP.
STACK MAKE UP
PIN LOAD
RM. 124
SINTERING FURNACE
PLATFORM
OVERHEAD MONOFLO CONVEYOR
SLUGGING PRESS
CALCINER
GRINDER
OUTGAS FURNACE
PRESS/GRANULATOR BOX
FURNACE CONTROLS
FURNACE CONTROL PANEL
CONTROL
SHOP DESK
GENERAL REVISION

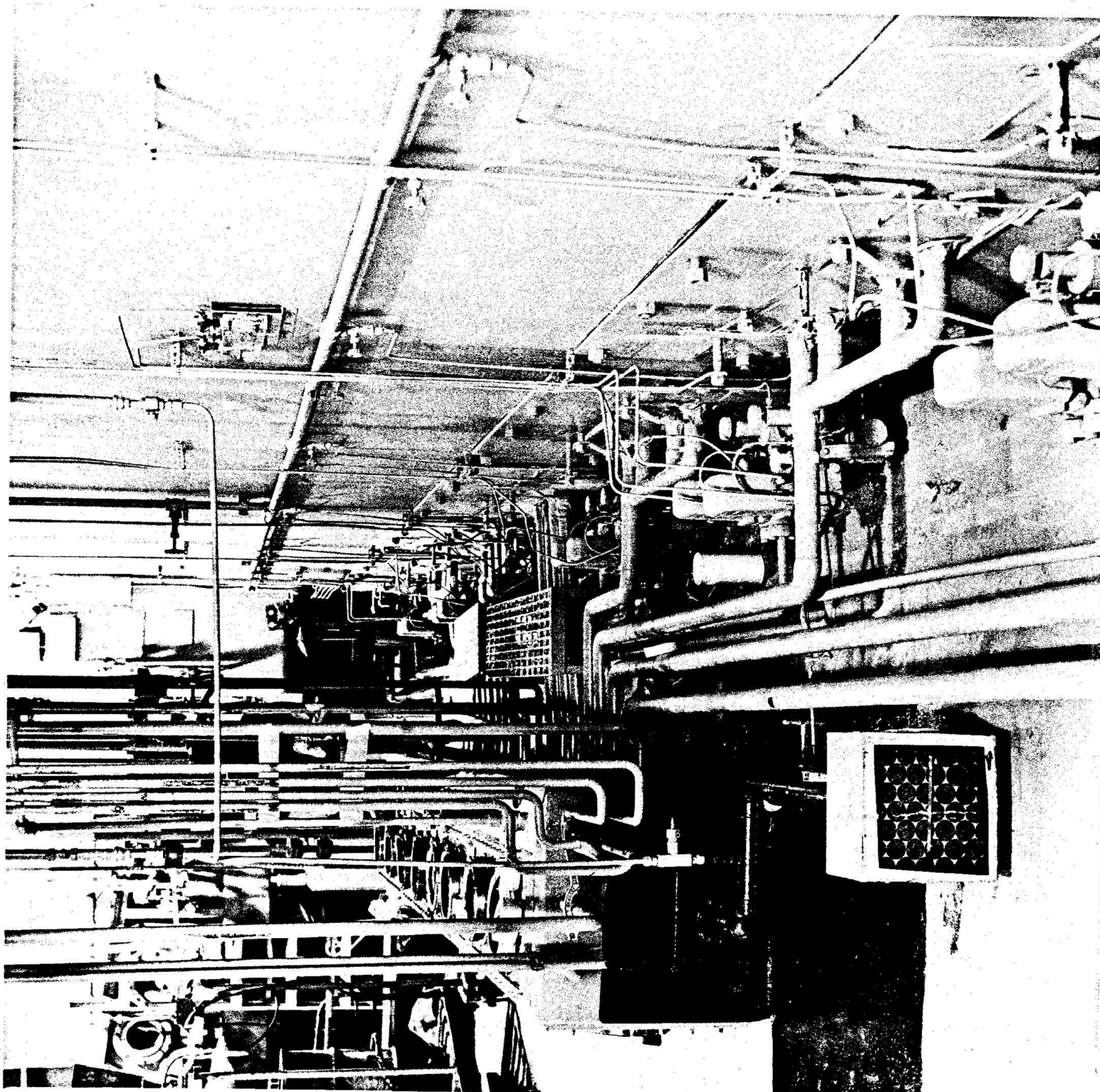
Figure #8

The piping system was fabricated from 304 stainless steel and was of all welded construction. Originally the system was designed for vacuum transfer but, as process changes were developed, modifications were made and pumps were added to pressurize the system. Figure #9 illustrates a welded piping system.

The glovebox system consisted of a myriad of sizes and shapes of gloveboxes designed to fit specific locations in the plant. The Solvent Extraction(SX) glovebox covered three walls of the SX area extending from the basement floor through the first floor to the ceiling. Three working levels were required to operate the equipment in this glovebox. In contrast, a small glovebox is used for solidification of waste liquid and is only large enough to cover a 55 gallon drum. This glovebox contains one window and one pair of glove ports. Figures #10 and #11 illustrate the various size gloveboxes designed for specific purposes.

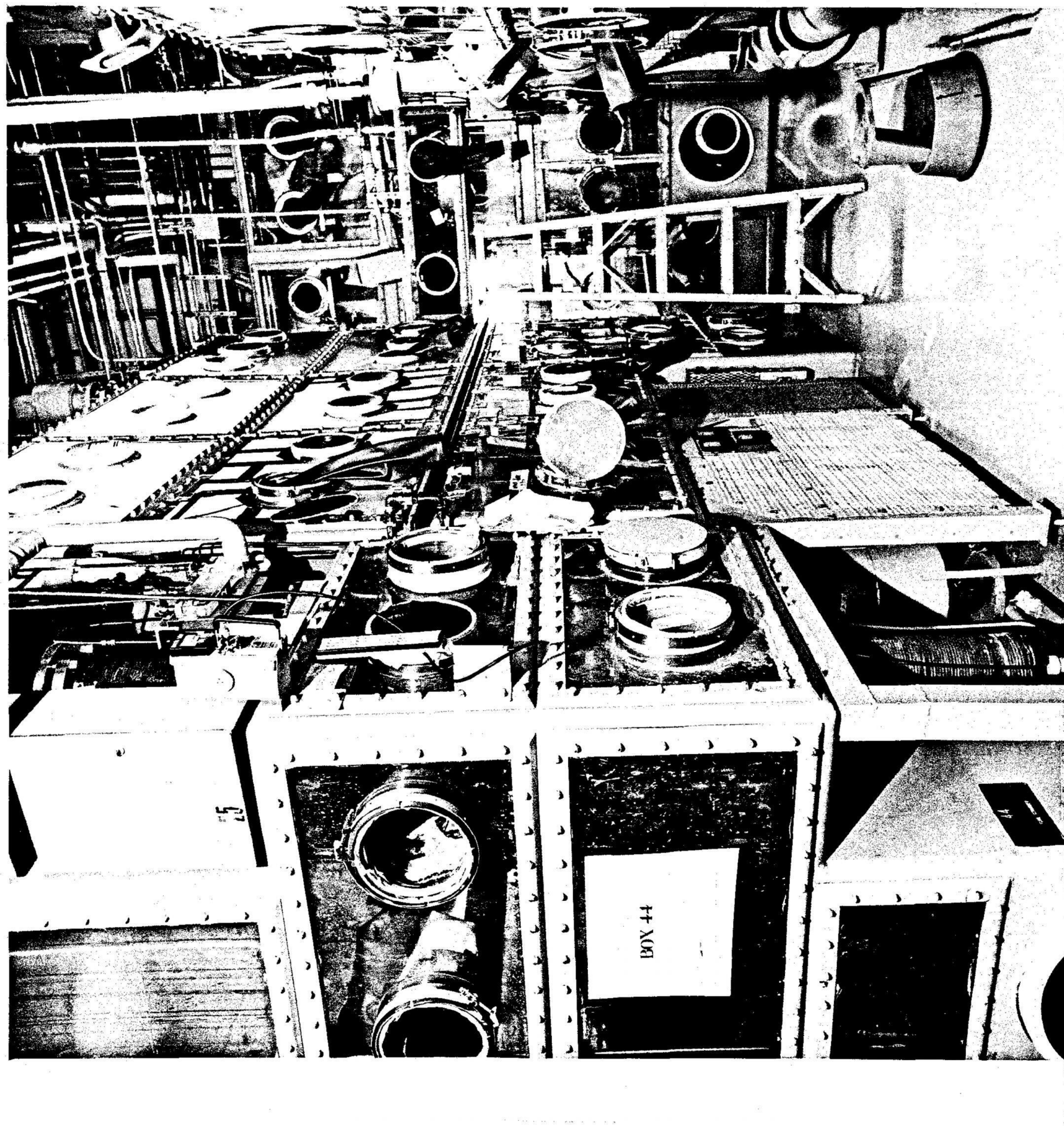
## IV. MAJOR PROBLEM AREAS

Although the D&D phase is still in progress there is sufficient evidence that the following problem areas could have been minimized if design criteria changes had been included in the equipment and facility design during the planning and construction phases.



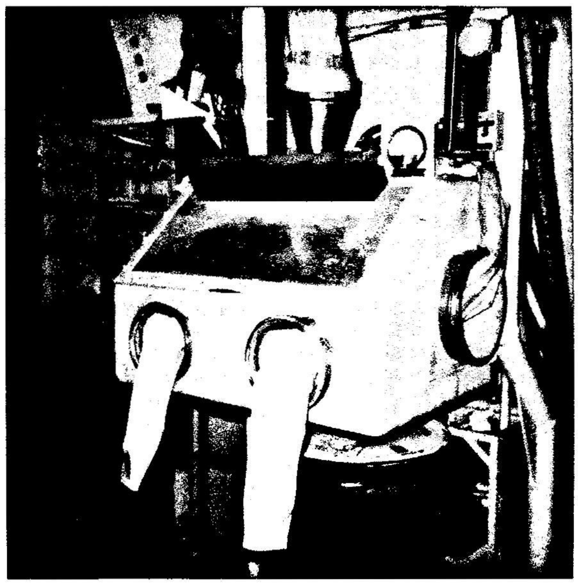
7 B-O-2 Wall Tank Piping - Looking South (Box 1 to Box 4)

Figure #9




1-127 South Aisle - Looking East (Scrap Area)

Figure #10



Cementing glovebox for 55 gallon drums.

Figure #11

A. Plant Layout

The orginal plant design criteria specified the smallest facility possible to minimize clean-up requirements between enrichments. Future production increases were to be met by a building design which would permit expansion of the floor plan. This design philosophy is now recognized as a major restriction which made it difficult in the D&D process to isolate or shield specific gloveboxes when making nondestructive assays(NDA) for radioactivity. In addition, because of the cramped quarters, it has been difficult to clean the gloveboxes and around some piping which, to save space, had been installed too close to walls and equipment.

The piping systems were originally designed for vacuum transfer. The piping systems added included pumps, valves and fittings which prevented complete draining and contributed to solution hold-up. This resulted in excessive "shine" (radiation) which if reduced would improve the NDA measurement of the piping systems.

B. Glovebox Design and Fabrication

The original design criteria included custom designed gloveboxes to fit and utilize all available space. This resulted in problems when sectioning and cutting-up for decommissioning because D&D equipment could not be standardized.

Because of space limitations, the glovebox piping was installed in as small a space as possible which increased the difficulty in obtaining inventory and accountability measurements. Isolation of a particular pipe near a glovebox for NDA was extremely difficult.

The surface finish on the gloveboxes caused a decontamination problem. The original design specified a flat matte finish which was developed by a fine sandblasting operation. This method produced a uniform and economical surface, but is time consuming to decontaminate.

The gasketed penetrations in wet gloveboxes became a source of contamination because they became saturated with process solutions and developed leaks during production. During the D&D operations the gasketed joints were difficult to disassemble due to corrosion.

## C. Contamination Control

Contamination control demonstrated during the manufacturing operations was good, but during the D&D phase the following areas were identified for potential improvement which would further reduce D&D problems.

The movement of Pu materials between most gloveboxes required that the material be bagged-in and bagged-out. Some gloveboxes were equipped with

connecting tunnels with revolving doors for material transfer. Those gloveboxes that were not equipped with tunnels used the bag-in and bag-out method for transferring. This resulted in a greater risk of contamination and also generated considerably more waste materials for disposal.

The Crescent, Oklahoma area is situated in the prevailing path of high winds and tornados. Building a structure to withstand the maximum probable windstorm was not a practical solution. The alternative was to build a tornado proof vault and establish an early warning system that would provide time to move all radioactive materials from the process equipment to the vault. This alternative proved to be costly in time and generated extra waste materials during periods of threating weather, primarily during the spring months of the year.

Some of the filter housings in the ventilation system were installed so that filter changes were not convenient which could increase the possibility of contamination spread.

The ventilation system design did not permit room isolation to minimize contamination spread in areas where basement and ground floor rooms were connected.

D. Handling of Waste

During production operations a system for counting waste materials was developed and used for separating nonrecoverable waste from economically recoverable scrap. This operation was performed in the vault which had a relatively high background. During the current D&D effort a system to determine L.S.A. levels of activity is required. To assure that these requirements for lower levels of activity are met, a new system has been developed and relocated in a low background area.

E. Decontamination of the Facility

The walls, ceiling and floors were made of concrete and were coated with paint for easy cleaning. The surface was found to be difficult to decontaminate to required low levels of activity.

V. NDA EQUIPMENT - DESIGN AND LIMITATIONS

The equipment used for NDA of TRU waste at the Cimarron Plutonium Facility consists of a sodium iodide detector coupled to a Ludlum Model 2500 Scaler Rate Meter which measures passive gamma. The system is calibrated using secondary standards, traceable to the National Bureau of Standards, and were made from the same FFTF

material that was processed during production operations and is present in the gloveboxes. The equipment being decommissioned is cut-up and packaged for NDA and disposal. To optimize NDA accuracy the size of each package is limited to 14" in its greatest dimension and the maximum contents per package is limited to 10 grams of Pu. These package restrictions were established as the most accurate calibrated range of the NDA equipment, which is 0.02 to 10 grams Pu, and the detectors optimum viewing window which will contain a 14" x 14" square. This equipment is maintained at a 95% confidence level. Based upon the above criteria the limit of error for individual rooms which have been completely decontaminated has proven to be $\pm$ 20%. The limit of error for the totally decommissioned facility after packaging is estimated to be $\pm$ 10%.

## VI. RECOMMENDATIONS

During the initial D&D phase at the Cimarron Plutonium Facility some problem areas were identified. The following recommendations should facilitate decontamination of future similar facilities.

### A. Plant Design and Layout

The design criteria for the building structure should include a low profile to minimize damage due to inclement weather.

The design should include strippable surfaces on all building walls, floors and ceiling for ease of decontamination and decommissioning.

Plant design criteria should also include sufficient space around and inside gloveboxes for ease of access in decontamination and to permit isolation or shielding of specific gloveboxes and piping to obtain accurate NDA. Arrangement of work stations should consider radiation interaction between gloveboxes.

The use of vacuum transfer of liquids is recommended. When pumping capacity must be installed the piping should be designed with good drainage without dead ends and liquid traps. Small diameter tubing should be used so that bending rather than fittings can be used to change tube direction which should reduce solution hold-up and minimize NDA problems.

B. Glovebox Design and Fabrication

Where possible, design criteria should include standardization of gloveboxes to simplify the design of cut-up gloveboxes and equipment for D&D. An added advantage would be the ease of rearrangement of gloveboxes during process changes or modifications.

Inside and outside surfaces of gloveboxes should have a high gloss finish for ease of decontamination. All inside corners should have generous radii and gloveboxes used for handling solutions should have a bottom sloping toward a clean-out point. Gloveboxes should be located away from walls to allow access to all sides for cleaning and decontamination. Piping penetrations should be of welded construction to eliminate gasket leaks.

The use of transfer tunnels between gloveboxes would minimize the potential for spread of contamination. Use of revolving doors would reduce the fire hazard. This design allows the movement of production product between gloveboxes without generating bag-in and bag-out waste, and reduces the potential for contamination spread.

C. Ventilation System

The ventilation system should be designed to permit room isolation to minimize the spread of contamination. In multiple floor level and stairwell areas the design should include doors to prevent contamination spread between upper and lower floors.

HEPA filter housings and their location should be designed to minimize the spread of contamination during the changing of the filters.

D. <u>Handling of Waste</u>

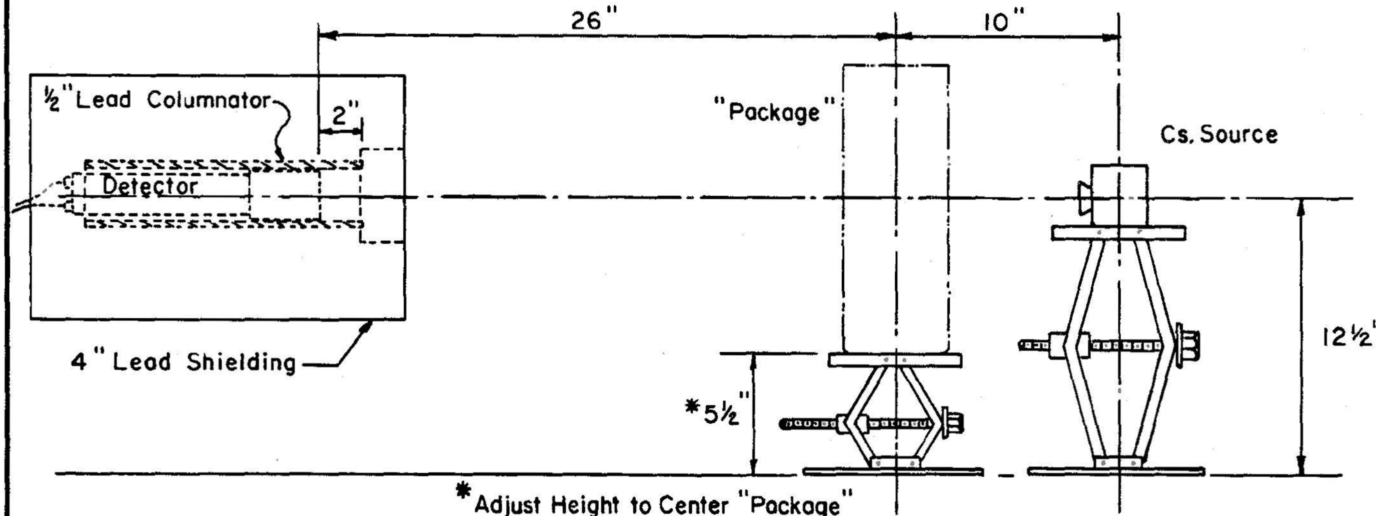
The design of the plant should include an isolated area where the background levels can be maintained at a very low level for NDA of waste.

To satisfy the requirements during the ongoing D&D of this facility, an area in the analytical laboratory where gamma background levels are low has been equipped for NDA of TRU waste. Figure #12 illustrates the dimensional set-up for the NDA of a typical TRU waste package. The various machine settings are established by counting a progressive set of standards which have known values traceable to the National Bureau of Standards.

A pit, previously used for welding FFTF pins, in Room 123 has been equipped for the NDA of LSA waste. Figure #13 illustrates the set-up for counting LSA waste in 55 gallon drums.

The use of this equipment in these areas improve the accuracy of NDA measurements. Complete NDA procedures is a topic of interest in D.O.E. Report No. 4 which will be completed at a later date.

# N.D.A.-1
## PACKAGE SET-UP




**Cs. THRESHOLD** ________ **Pu. THRESHOLD** ________

**WINDOW** ________ **WINDOW** ________

**HIGH VOLTAGE** ________

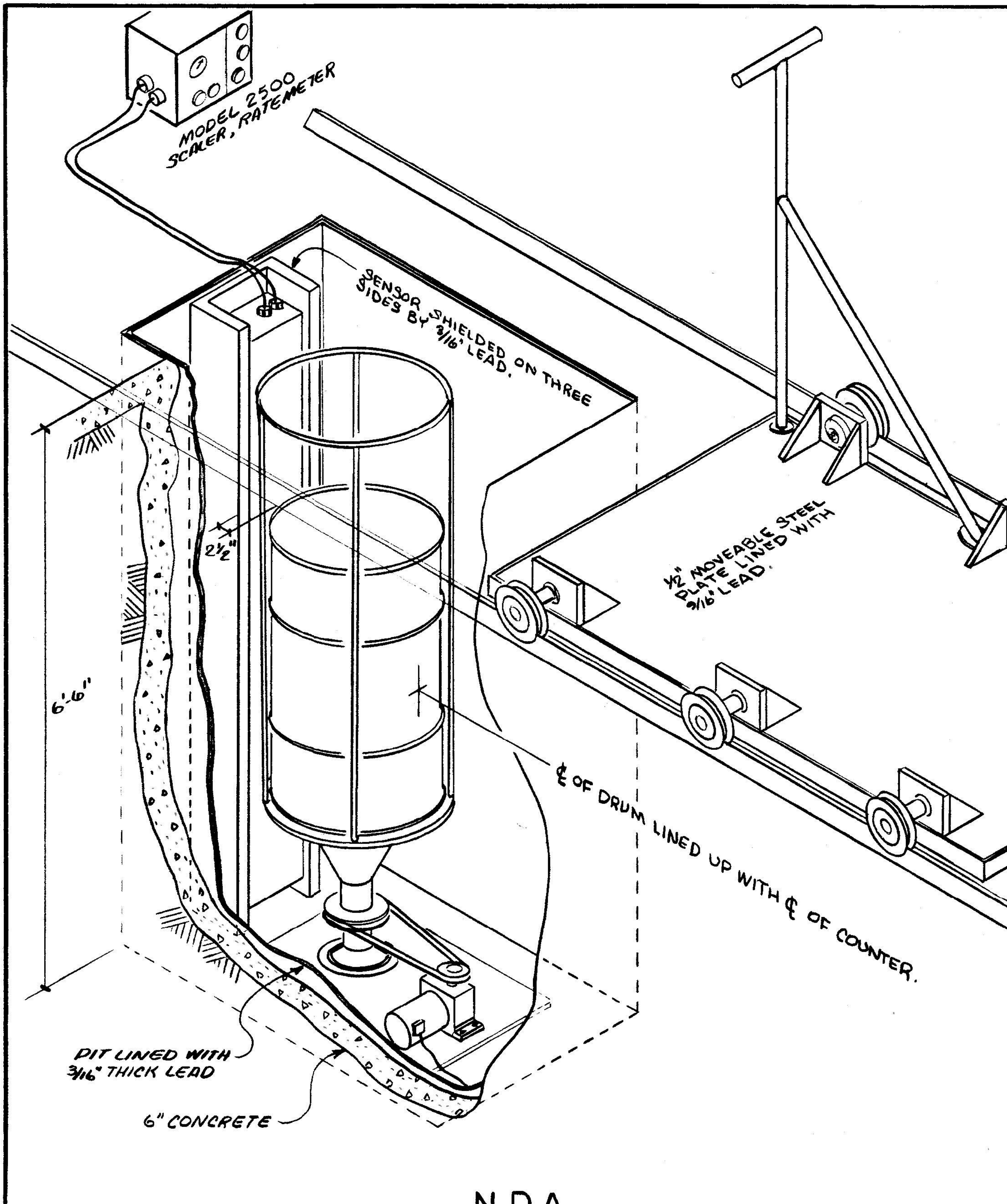
**CALIBRATION FACTOR** ________

**MINIMUM DETECTABLE LEVEL** ________

ASSIGN _____ TO ALL PACKAGES LESS THAN OR EQUAL TO _____ G. Pu.

MAXIMUM VALUE THAT CAN BE COUNTED ________ G. Pu.

Figure #12




N.D.A.

ROTARY DRUM COUNTER

SCALE ≈ 3/4" = 1'-0"

Figure #13