SRP Engineering and Design History, Vol III, 200 F and H Areas

by

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SAVANNAH RIVER PLANT
ENGINEERING AND DESIGN HISTORY

VOLUME III OF VI

ENGINEERING DEPARTMENT

E. I. DU PONT DE NEMOURS & CO. (INC.)

PRIME CONTRACTOR

FOR

UNITED STATES ATOMIC ENERGY COMMISSION

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SAVANNAH RIVER PLANT
ENGINEERING AND DESIGN HISTORY

VOLUME III
#200-F&H AREAS

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E. I. DU PONT DE NEMOURS & CO. (INC.)
Wilmington, Delaware
Prime Contractor
For
UNITED STATES ATOMIC ENERGY COMMISSION

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SAVANNAH RIVER PLANT

PROJECT 8980

ENGINEERING AND DESIGN HISTORY

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- VOLUME II - #100 AREAS
- VOLUME III - #200 AREAS
- VOLUME IV - #300/700 AREAS AND GENERAL SERVICE
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SAVANNAH RIVER PLANT - PROJECT 8980

ENGINEERING AND DESIGN HISTORY

OF

#200-F&H AREAS

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SAVANNAH RIVER PLANT
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200F AREA

ENGINEERING AND DESIGN HISTORY

OF

#200-F&H AREAS

SAVANNAH RIVER PLANT

I - GENERAL SUMMARY OF AREA FACILITIES

The separation centers of the Savannah River Plant are located in the two areas designated #200-F and #200-H, each being two and one-half miles from the nearest #100 Area and approximately two miles from each other. An additional area designated #200-X, about two and one-half miles northeast of the #200-H Area, is reserved for future development. Original plans provided that "F" Area should be designed with full production facilities while "H" Area should contain only the basic production buildings with space provided for the installation of more complete facilities in the future.

This volume combines the record of events relating to the development of design for both the #200-F and H Areas. Chronologically, the definition of plant facilities was first established for the #200-F Area. The second area, #200-H, was projected initially to be a supplementary plutonium separations facility. This history explains the differences in character and capacity of the manufacturing facilities in both areas as production requirements and experience with separations processes advanced.

A prime factor in the layout of the two areas was the relationship of the Canyon (Separation) Building #221 to the Liquid Waste Disposal Building #241. Since both Buildings #221-F&H were designed originally to discharge radioactive liquid wastes by gravity to Building #241-F, it was necessary to locate the Separation Building at the highest elevation in both areas. This initial plan to use a single waste storage facility later was abandoned in favor of separate waste storage in each Area. The redesign of Building #241-F&H led to their location approximately 1,000 feet from each Building #221.

Once the locations of Buildings #221-F&H and #241-F&H were established, the other facilities of these areas were located from the standpoint of economy and their relationship to the over-all process.

For example, Buildings #221-F "A" Line, #211-F&H Tank Farm, #772-F Control Laboratory, #291-F&H Canyon Stack, #292-F&H

Fan House, #292-1 F&H Fan House and #294-F&H Sand Filters are adjacent or close to Buildings #221-F&H since these facilities supplement the operations of the Separation Buildings.

The Manufacturing Building #232-F and the Metallurgical Building #235-F were located on suitable ground east of the #221 Building. Building #217-F Product Storage was located in the least conspicuous corner of the #200-F Area to give as little indication as possible of any connection between it and other process buildings. The #200-F Area also has a Shops Building #717-F and a Laundry Building #723-F located south of the Separation Building. The "H" Area has only the standby Building #232-H and a liquid nitrogen storage facility, Building #210-H, northwest of Building #221-H, in addition to the buildings composing the main separations facilities.

With the exception of electrical power, which is supplied from a 115,000 volt primary transformer station, both #200-F and #200-H are self-sustaining. A steam generating plant and domestic, process, fire, and cooling water supply are located within the "power block" in each area.

Sidewalks, roads, and railroads furnish access to the buildings of both fence-enclosed #200 Areas. The railroad serves only Buildings #211-F&H, #221-F&H, #221-F "A" Line, and #717-F. However, spurs are provided in the "H" Area for the two latter facilities if they should be installed in the future.

SECTION II

SELECTION AND DESCRIPTION OF PROCESS

SELECTION OF PROCESS

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DESCRIPTION OF PROCESS

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II - SELECTION AND DESCRIPTION OF PROCESS

SELECTION OF PROCESS

The major processes of the #200 Area are the Purex process, the uranium trioxide recovery process ("A Line"), the button fabrication process ("B" Line), the component fabrication process ("C" Line), and the tritium separation process. These processes were installed at the Savannah River Plant only after they had been proven in prototype or by full-scale production at other AEC installations. In many cases, however, these facilities were modified for improved safety or greater efficiency.

Selection of the Purex process was based on development work at the Oak Ridge National Laboratory and at Knolls Atomic Power Laboratory where it was demonstrated to be an improvement over Hanford's Redox process because of its reduction in liquid wastes, and the use of a higher flash point solvent.

In the case of the "A" Line, basic design was derived from similar facilities at the Mallinckrodt Chemical Works. The "B" and "C" Lines were based on developments at Hanford and Los Alamos.

The tritium separation facilities were based on a process used at Hanford but modified by the utilization of additional information received from the Argonne National Laboratory, the Knolls Atomic Power Laboratory, Hanford and Los Alamos.

In the design of the various #200 Area facilities du Pont was assisted by the Blaw-Knox Company; Voorhees, Walker, Foley & Smith; Allstates Engineering Company; American Machine & Foundry Company; Lummus Company; the General Engineering Laboratory of the General Electric Company; and Gibbs & Hill.

Further information on the specific development of these facilities may be obtained by reference to the discussions of respective buildings.

DESCRIPTION OF PROCESS

The separation facilities were originally intended to produce metallic plutonium, uranium trioxide powder and tritium gas, and to fabricate plutonium shapes.

The principal operations in Building #221 are the chemical separation of uranium, plutonium, and fission products, the production of plutonium metal buttons and the recovery of decontaminated uranium as uranium trioxide. In addition to these major operations, auxiliary processes include waste concentration, solvent recovery, nitric acid recovery and rerun facilities. An outline of uranium processing is given on page 23.

The first step in the production of metallic plutonium and uranium trioxide requires the transportation of the irradiated uranium slugs from the reactors in the #100 Areas to Buildings #221-F&H. Here the aluminum jackets are dissolved from the uranium slugs and the metal is then dissolved to give a solution containing a mixture of uranyl and plutonium nitrates and fission products. After the dissolving step the raw metal solution is transferred to the head end treatment where some 90 per cent of the zirconium, niobium and iodine are eliminated, corresponding to a decontamination factor of about 10 across the head end step. This compares with a total D.F. for all fission products of about 10^8 accomplished in the entire Purex process.

After the head end treatment, the uranium is separated from plutonium, with the further removal of the fission products from the separated metals. Following this, the plutonium nitrate is concentrated by ion exchange and converted into metallic buttons while the uranyl nitrate is transferred from Buildings #221-F&H to Building #221-F "A" Line for concentration, further purification, and conversion to uranium trioxide. Subsequently, the plutonium buttons produced by the "B" Line in Building #221 are fabricated into metal shapes by metal shaping operations of the "C" Line in Building #235-F. In addition, plutonium skulls from "C" Line, as well as liquid and solid wastes from "B" Line, are processed through a skull dissolver and waste recovery system in "B" Line to minimize any loss of product.

The recovery of tritium takes place in Building #232-F. Building #232-H was originally planned as an additional facility but was not completed under this project. Irradiated aluminum-jacketed, lithium-aluminum slugs are transported in shielded casks by truck from the #100 Areas to the entry air lock of the Manufacturing Building. Here the slugs are picked up by monorail hoist and taken inside the air lock where they are placed on a remotely controlled transfer car and moved to the raw material handling enclosure for storage, drying, and mechanical decanning. After decanning, the slugs are loaded into a crucible and placed in an extraction furnace where the gaseous components are extracted under vacuum and high temperature. This gas then passes to other components of the integrated assembly where by-product gases and hydrogen are separated from the tritium.

Four other buildings in the #200 Areas are directly related to the process operations. These include Buildings #210-H, #211-F&H, #241-F&H, and #217-F. Building #210-H, a liquid nitrogen storage tank, was installed to supply liquid N₂ to both #200-F&H Areas. The two Tank Farms, Buildings #211-F&H, consist of chemical storage tanks, water handling systems, acid recovery units, general purpose evaporators, and, in "F" Area only, waste handling facilities. Building #241 provides underground storage tanks in each area to receive radioactive wastes, while Building #217-F provides security storage for plutonium and tritium awaiting shipment from the plant.

The uranium trioxide produced in Building #221 "A" Line is shipped from the plant in drums.

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SAVANNAH RIVER PLANT.....PROJECT 8980
OUTLINE OF URANIUM PROCESSING

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SECTION III

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III - BUILDING #221-F&H - CANYON BUILDING

DESCRIPTION AND DEVELOPMENT OF DESIGN

BUILDING #221-F - CANYON BUILDING

FUNCTION

Building #221-F houses the equipment and facilities of the remotely operated and maintained Purex process, the "B" Line, and the necessary offices, change rooms and services. That part of the process designated the "A" Line is located in a separate building but is considered a part of Building #221 process operation.

Uranium and plutonium are separated from the fission products and from each other by the Purex process which is housed in the solvent extraction facility.

"A" Line process entails the conversion of uranium nitrate by thermal decomposition into uranium trioxide.

"B" Line concentrates plutonium nitrate and reduces it to the metal.

Both the "A" and "B" Lines are treated in subsequent and separate sections of this discussion of Building #221-F.

PRINCIPAL COMPONENTS

Building #221-F is a four-story reinforced concrete structure approximately 122 ft. wide x 819 ft. long. Beginning at the south end of the building, there is one 85 ft. section and then sixteen 43 ft. sections and one 45 ft. 6-in. section. Processing equipment is located in canyons inside the east and west walls of the building and extending from sections five through eighteen, with the operating and service facilities in that portion of the building between the two canyons. Material and equipment for the Hot Canyon enter by means of a railroad tunnel and that for the Warm Canyon enters through a truck well. The "B" Line is installed on the third and fourth levels in the first four sections, while the "A" Line, as noted previously, is housed in a separate building.

The principal components of the Canyon Building may be classified under such categories as process, mechanical services, shops, decontamination, service transport, and personnel facilities as well as administrative areas.

Isometric views of several building sections are shown on pages 31, 33, 35 and 37.

Process Equipment

Hot Canyon

Process equipment, consisting principally of dissolvers, tanks, evaporators and mixer-settlers, is located in the Hot Canyon in building Sections 5 to 18. To provide for the flow of process fluids between equipment in the canyon, "rack" or header piping is located in an elevated area between the east or "hot" wall of the canyon proper and the east wall of the center portion of the building. Rack piping is connected to the imbedded piping which in turn is connected with the piping to the vessels in the canyon. Rack piping is also connected to imbedded piping leading to process lines outside the east wall of the building. The rack piping is arranged in flanged sections which can be remotely installed, connected, disconnected and removed by an overhead traveling crane. Sections of pipe which can also be remotely installed and removed are used to connect process equipment in the canyon to the rack piping and to other process and service facilities in the building by means of piping imbedded in the shield walls between the canyon and adjacent areas. Liquid materials may thus flow from feed tanks located in the central portion of the building through the "cold" wall nozzles to the process vessels. From these vessels material may be jetted through rack piping to other vessels in the Hot Canyon, through the "hot" wall to waste headers located below grade along the east wall outside the building, or through cross-overs through the center portion of the building to Warm Canyon vessels.

The "cold" wall also has nozzles which house electrical connections. By means of the overhead crane, jumper connections can be made to canyon equipment for electrically driven agitators, lubrication connections for motorized equipment and instruments connected to operating panel boards.

The sections of the Hot Canyon are dimensional duplicates, designed so that equipment can be interchanged remotely. Canyon vessels are accurately positioned by means of outriggers to which are attached trunnions which engage in positioning guides located on the canyon floor adjacent to the walls.

The canyon floor slopes toward the outer wall where sumps collect drainage from each section. Bottoms of the vessels resting on the floors are sloped to correspond to

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SECTION 9-9
BUILDING 221

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SECTION 14-14
BUILDING 221

the floor slope. To assist in accurately positioning a vessel, the bottoms are supported on a number of projections or feet, (approximately one each per square foot of area), the bottoms of which are ground to a plane corresponding to the true floor slope with the tank center line in a vertical position.

The crane cab is located in a concrete runway shielded from the rest of the Hot Canyon by a concrete labyrinth. The roof is a cantilevered concrete slab which leaves only a narrow opening on one wall through which the cab suspension projects from the crane. A vertical concrete curtain wall also hangs from the ceiling so that a relatively narrow opening exists between this wall and the top of the cantilevered slab.

Although the canyon vessels are located in Sections 5 to 18, the crane runway extends partially into Section 1 to give the crane access to the railroad well, crane maintenance shop, hot decontamination cell and swimming pool. Two rolling shielding doors separate the crane maintenance shop from the Hot Canyon.

The crane operator is able to observe the canyon equipment and maintenance operations only through an optical system which projects his vision around the shielding between the crane cab and the canyon.

Warm Canyon

The Warm Canyon is similar to the Hot Canyon except that the materials being processed are less radioactive and the crane cab is not located in a shielded runway. Moreover, the crane cab operator has a direct view of this canyon. A separate battery operated traveling maintenance platform is provided to facilitate entry-exit operations through the truck well and permit direct assistance to crane operations.

Since the Warm Canyon is on the opposite side of the building from the Hot Canyon, the directions are reversed. For example, the rack piping is located between the west or hot wall and the west building wall and the cold wall separates the east wall of the canyon and the center section of the building.

Feed Tank Gallery

Feed tanks are located in this area which occupies part of the third level in the central portion of the

building. These tanks are batch filled with normally non-radioactive process fluids which are then fed to the canyons through piping embedded in the cold walls. These lines contain liquid seals to avoid open lines between the canyons and the gallery tanks. Pumps are provided at the gallery tanks for fluids which must be fed to the canyon tanks at controlled rates.

Cold Feed Preparation

This area, on the first level in the central portion of the building, is where the process material is prepared prior to being pumped to the gallery feed tanks. Catch tanks for overflow from gallery feed tanks and for floor drainage from the second and third levels, are also located in this area.

Cold Piping Area

The cold piping area occupies the second level in the central portion of the building. Here are located the lines which lead through the "cold" walls of each canyon to the canyon vessels.

Gang Valve Areas

A gang valve corridor is provided for each canyon. It extends between Sections 5 and 18 under the canyon rack piping and between the canyon wall and the outer wall of the building. In it are located the gang valve assemblies used to supply steam to jets in the canyons. To decrease the possibility of suck-back of radioactive materials from the canyon equipment to direct access areas before, during, and after jet transfer, the gang valve assemblies automatically provide sequential connections to compressed air, steam and vent lines in correct order. Steam jet syphons are used for liquid transfer since they have no moving parts, are thoroughly reliable, and require less maintenance than pumps.

Normally the gang valves are controlled electrically from the operating control rooms, but in an emergency they can be operated manually at the gang valve installation.

A small room also is provided in the second section, second level, where other gang valves are located for jetting material from the railroad tunnel sump.

Sample Aisles

A sample aisle is provided for each canyon. In these aisles, samples of the processing material can be drawn from lines which circulate the material between canyon vessels and the aisles. These aisles also serve as exhaust ducts for center-of-building heating and ventilating system.

Process Waste Lines

There are four concrete encased 10-inch stainless steel process waste headers outside extending the entire length of and adjacent to, the east building wall. From these headers, 3-in. stainless steel lines continue beyond the building as a part of the outside underground process waste system.

Mechanical Services

Control Rooms

Four electric control rooms are located on the first level. Control room No. 1, in Section 1, contains a 600 kw. diesel generator set for emergency power, switchgear, two 750 kv.-a. load center type substations and 480 volt motor control center equipment. Control room No. 2, in Section 8, houses motor control center equipment only. Control room No. 3, in Section 12, has one 750 kv.-a. load center type substation, one 1500 kv.-a. load center type substation, and motor control center equipment. Control room No. 4, in Section 17, contains one 750 kv.-a. load center type substation and motor control center equipment. The motor control centers serve the process equipment, heating and ventilating equipment, and other motor driven equipment. Primary voltage for load center power is supplied via conduits and cable imbedded in the building foundation slab. These extend to the outside of the building and are tied, by a pole-mounted, fused disconnect switch, to overhead 13,800 volt electric lines on the west side of Building #221-F. Four of the load centers in Building #221-F consist of a primary switch unit, transformer unit, and a low voltage switchgear unit. The 13,800 volt cable terminates in the primary switch compartment at a 3-pole switch capable of interrupting the full load current of the 750 kv.-a., 13,800/480 volt transformer. This compartment has provisions for adding a future cooling fan. The low voltage compartment consists of a metering section for a watt-hour meter, voltmeter, ammeter, and three 600 amp., 25,000 amp. interrupting capacity drawout type air circuit breakers. One load center in Section 12 consists of a primary 3-pole switch capable of

interrupting the full load current of the transformer. The transformer on this unit is a 1500 kv.-a., 13,800/4160 volt delta-delta, 60 cycle, air cooled, indoor type. The low voltage section consists of a bus and meter compartment for a watt-hour meter, voltmeter, and ammeter. This unit controls the two 900 hp. compressor motors for the building air conditioning units. Also on the first level is a communication room where the switching frames for the private security telephone system and the amplifier racks for the safety alarm system are located.

Compressor Rooms

There are three compressor rooms housing compressors for plant and instrument air, air conditioning equipment and process air. Refrigeration equipment for air conditioning Building #772-F is housed in one of the compressor rooms in Building #221-F with the chilled water being circulated to Building #772-F.

The two large refrigerator compressors each require 900 hp. motors. A study was made to determine the voltage specified for the motors and consideration was given to the use of 480, 2300, 4160, and 13,800 volts. For economic reasons, a 4160 volt system was installed. Transformer manufacturers were checked to determine the minimum size to carry both motors, and a 1500 kv.-a. unit was selected. The starters specified were across-the-line type combination air contactor with fused-disconnect switch.

Heating and Ventilating Rooms

Five rooms are provided for the blowers, filters and heating coils required for building ventilation and heating. These are supplemented by exhaust blowers located in Building #292-F.

Air Ducts

Air ducts are designed so that flow is from the areas of least contamination to the areas of highest contamination. Canyon exhaust air passes through the Sand Filters, Building #294-F, before exhausting through a Stack, Building #291-F, to the atmosphere. Exhaust air from the central portion of the building is filtered in the Fan House, Building #292-F, and then exhausted to the atmosphere by way of the stack in Building #291-F.

Shop Facilities

Hot Canyon Shop

This shop is located at the south end of the Hot Canyon and is designed for maintenance of the largest piece of equipment that can be moved by the Hot Canyon crane. This shop has a stainless steel floor, removable shielding covers to permit access by maintenance personnel, and a separate ventilating system which discharges air to the Fan House, Building #292-F, which then passes to either the Sand Filters, Building #294-F, or directly to the Stack, Building #291-F.

"Swimming Pool"

A "swimming pool", of leak-proof design, with underwater illumination and movable personnel platforms is located at the south end of the Hot Canyon next to the Hot Canyon shop. It is used for underwater maintenance of highly radioactive equipment and is provided with two jib cranes with electric hoists and a traveling personnel bridge. A removable cover is provided to permit canyon crane service.

Warm Canyon Shop

This maintenance facility, a structural duplicate of the Hot Canyon shop, serves the Warm Canyon.

Crane Maintenance Shops

At the end of each canyon are well-shielded shops used for crane maintenance. Maintenance operations performed in these areas include lubrication, changing of tools, adjusting and changing brake shoes, adjustments and replacement of optical system components, and the checking and adjusting of the electrical system and its components.

Regulated Shop

The maintenance of small pieces of equipment is carried out in this second level shop. It is termed "regulated" because a control is kept on the number and frequency of personnel entry to this area.

Cold Shop

The cold shop, located on the first level in the central portion of the building, is used for the fabrication and maintenance of uncontaminated material and equipment.

Instrument Shops

Building #221-F has two instrument shops. The shop on the second level is used for the maintenance and storage of mildly contaminated instruments and parts as well as a storage area for instrument service carts when not in use. The second shop, on the fourth level, provides an area for testing, preventive maintenance, and general repair of Building #221 instrumentation.

Storage Rooms

Various rooms are provided in the building for the storage of chemicals and masks, operating and health instruments, and janitor's supplies. A storage area located adjacent to the railroad tunnel provides space for transient operating equipment. A leak-proof room also is provided for the underwater storage of buckets containing irradiated uranium slugs to be processed in this building.

Decontamination Facilities

Decontamination rooms, each capable of receiving two standard canyon tanks complete with connected piping, are located at the south end of the Hot and Warm Canyons. All equipment removed from the canyons for repair must be decontaminated before moving to the Hot and Warm Canyon shops. The rooms are equipped with removable covers, equipment positioning guides, wall connectors, and decontamination sprays so that both the inside and outside of canyon equipment can be washed down by circulating nitric acid, water or other decontaminating solutions.

The walls, floors, and sump pits of the decontamination rooms have corrosion resistant linings of stainless steel to protect the surfaces from reaction with chemicals used in the decontamination process. Each room has a drainage sump and steam jet to remove cell waste.

Tool and Mask Decontamination Rooms

These two rooms are adjacent to each other on the second level and serve as decontamination centers for tools and masks.

Personnel Decontamination Room

The personnel decontamination room is located adjacent to the counting room and change rooms on the first level so personnel can be checked when they leave or enter the areas. The room contains decontamination equipment, personnel monitoring instruments, and shelves for the storage of bottled decontamination fluids. The partition between the health instrument counting room and personnel decontamination room is removable, permitting conversion to one large room.

Service Transport Facilities

Railroad Tunnel

The railroad tunnel is the entrance through which materials and equipment enter the Hot Canyon. It extends beyond the south end of the building and is provided with heavy shielding doors at the entrance. The bottom of the tunnel, on which the railroad track is laid, extends through the first two building sections. Above the track, in Section 2, is the railroad well through which the Hot Canyon crane has access to the material on the railroad car placed in this section.

A direct current electric locomotive was provided for shifting cars into the railroad tunnel. Power supply is from a motor generator set located in a lean-to structure on the south side of Building #221. Angle iron members mounted on the east side of the track are used for electric trolleys and provide power and remote control via a trolley collector on the locomotive.

Truck Well

The truck well is located in Section 4 of the Warm Canyon, and a truck well tunnel extends outward from the well. Equipment can be moved into this section directly by truck or can be transferred by crane outside the tunnel from a special trailer to a transfer car traveling on rails which transports this equipment into the truck well. From here it then can be moved into the canyon by means of the canyon crane.

Elevators

Elevators, hoists, and dumb-waiters are provided for the movement of equipment and passengers between the various building levels. The head tower on the west side opposite Section 9 also has a personnel elevator.

A concrete unloading platform, with roof, stairs, and rails at the southwest corner of the Canyon Building permits the delivery by truck of various materials handled in the nearby freight elevator.

Personnel Facilities

Personnel Access

Facilities consist of three entrance towers and personnel tunnels at Sections 3, 9, and 15 of the Canyon Building. The personnel tunnels pass beneath these building sections and connect the head towers located on each side of the building to provide access by stairwells from the tunnels into the central portion of the building. A passenger elevator at Section 9 connects the personnel tunnel with all four levels. Corridors and stairwells are located in various parts of the building to give access to the four building levels. A platform is located on the north end of the building from which observation of the canyon areas is possible through special lead glass windows. A sample cart elevator, a combination freight elevator and maintenance hoistway, and a stairwell are located at the north end. Access to the crane maintenance areas, Hot and Warm Canyon cranes, and the canyon areas is strictly controlled.

Entrance to these and all other areas where radiation hazards or security restrictions exist is by means of locked doors, electrically released at the dispatcher's desk on the fourth level control room. Telephones on the safe side of each such door facilitate the obtaining of permission to enter. Indicating lights at the dispatcher's desk show door operation, and panic bolts on the restricted side of the door permit exit at any time.

Locker, Toilet and Change Areas

Separate facilities for men and women are located in the central portion of the first level. Additional toilets also are provided on the fourth level.

Lunch Rooms

A large lunch room accommodating 40 people, and a smaller lunch room, located on the first floor, are designed for use only by those employees who bring lunches, since food is served in the area cafeteria located in Building #704-F.

Administrative Areas

Located on the fourth level, these facilities consist of a vault and fourteen offices for the use of technical and operations supervision, clerical help, and operations control.

BUILDING FLOOR SPACE

	<u>Approx. Sq. Ft.</u>
Hot Canyon	45,737
Warm Canyon	38,445
Feed Tank Gallery	13,582
Cold Feed Preparation	3,712
Cold Piping	36,349
Gang Valve Areas	16,545
Sample Aisles	11,262
Control Rooms	7,419
Compressor Rooms	3,981
Heating and Ventilating Rooms	7,600
Air Ducts	26,690
Shops, Decontamination Facilities, and Store Rooms	19,966
Railroad Tunnel	4,075
Truck Well	1,401
Elevators	1,080
Personnel Access	31,476
Corridors and Entries	15,516
Tunnels (Personnel)	3,960
Observation Platform	720
Stairwells	8,783
Air Locks	2,063
Locker, Toilet, Shower and Monitor Rooms	7,158
Lunch Rooms	1,027
Administrative Areas	6,892
Spare Rooms	3,107
"B" Line	<u>10,552</u>
Total Building Floor Space	329,532

BUILDING DETAILS

Class - I

Size - The main portion of the building is four stories high, rectangularly shaped, composed of one 85 ft. section, and sixteen 43 ft. sections plus one 45 ft.-6 in. section. This portion is approximately 819 ft. long by 122 ft. wide x 66 ft. high. Grade is at approximately the second level.

On each side of the building there are head towers, each pair of which is connected by means of a transverse tunnel passing under the first building level. These tunnels provide access to the main building by stairwells. The towers also connect to the building by passageways opening into the gang valve corridors.

The railroad tunnel extends approximately 74 ft. beyond the south face of the building and is 22 ft. wide outside to outside and 35 ft. high. A shielding door at the entrance to the tunnel is approximately 49 ft. wide by 35 ft. high.

An enclosure at the north end of the building 40 ft. long and 65 ft. high and extending 8 ft. north of the main building contains a stairwell, elevator and hoist. Also at the north end and at approximately the third level is the observation platform. This is set on a cantilevered concrete slab approximately 95 ft. long which extends 13 ft. beyond the north building face and encloses the section housing the stairwell elevator and hoist at the third level. The observation platform superstructure is of steel framing with corrugated asbestos roofing and siding. The roof is of the lean-to type with an average height of 11 ft. Thick lead glass windows allow observation of the hot and warm canyon.

Total Building Area - 102,852 sq. ft.

Total Building Volume - 7,810,000 cu. ft.

CONSTRUCTION DETAILS

Foundations

Reinforced concrete slab.

Superstructure

Reinforced concrete walls and roof. Interior of Exterior Walls - Concrete throughout, either painted or unpainted. For details see W-147964.

Interior Partitions - Concrete or cement asbestos board, either painted or unpainted. Glass partitions are used for certain fourth level offices. Wainscots are either concrete or tempered Masonite except in the Hot and Warm Canyon Shops, which have stainless steel wainscots. All floors are of concrete except in lunch rooms which have asphalt tile covering. For a complete listing of floors, walls, wainscot, bases, and ceiling types, and paint schedules, see W-147964.

Roofing

Hot mopped asphalt.

Doors

Most of the doors are hollow metal, but a few are fabricated of laminated steel plate. These are located at vaults, the entrance to the railroad tunnel and crane maintenance areas. Many doors are equipped with electric locks. For complete details of door types, sizes, material, and locks see W-146749.

Heating and Ventilation

Extensive facilities are provided for building ventilation and heating by air. Pressure differentials are maintained between building areas by means of blower and exhaust fans, and by air locks between the areas. The building has been classified into four zones with Zone #4, the area of highest contamination, having the lowest air pressure so that air flow is always from areas of lower contamination to those of higher contamination.

Two main ventilating systems are installed to serve the Hot and Warm Canyons, Zone 4, and areas in the center of the building, Zones 1, 2, and 3.

In the canyons, air enters through filters at the south end, passes through the second level fan room in the center of the building, and then flows through the Hot and Warm Canyon air ducts. These ducts are located under the maintenance crane cab-ways and extend the full length of the canyons. Air enters the crane cab runways at various points from the air ducts and then passes into the canyons. Canyon air is withdrawn from each building section through openings near the floor level of the canyons. This air passes into exhaust ducts which extend the length of each canyon and continue south to Section 3 where they pass downward into one tunnel which leads to the sand filters in Building #294, the Fan House, Building #292, and the Stack, Building #291.

In the center of the building, air enters through shafts adjacent to the stair towers in Section 9, passes through a duct beneath the building and rises into the First Level Fan Room at Sections 10 to 13. From here some air is supplied to the first level with a portion recirculated and cooled. Cooled air is fed directly to the second level and some is supplied directly to the fourth level by distribution ducts at each level. Some first level, plus all second level air, passes upward and enters the third level. Fourth level air passes downward to the third level where it flows into the Hot and Warm Canyon sample aisles which serve as exhaust ducts. At the south end, these ducts pass downward through the building into one duct which leads to the Fan House, Building #292, and on to the Stack, Building #291.

Building air is heated for the most part by steam coils, but this is supplemented in certain offices and locker room areas by unit heaters.

Air Conditioning

The offices, lunch rooms, canyons and certain shops and locker room areas are cooled with conditioned air, the total installed refrigeration capacity being 1700 tons. Drawings W-146547 and W-146468 show by air flow diagrams the ventilation and air conditioning system for this building.

Building #772-F is air conditioned from refrigeration equipment located in Building #221-F. Water is chilled by the Building #221-F refrigeration system, pumped to Building #772-F where it is used in the ventilation system to condition the air, and then is recirculated to Building #221-F. A further description of the air conditioning system in Building #772-F is given on page 431.

Communications

A dial type private telephone system is provided within the building and from Building #221 to the "A" Line and Building #772-F for the exchange of security information which cannot be discussed on the Bell system. Dial relays are located in a communication equipment room on the first level of the center gallery.

A safety alarm system also is provided which consists of loudspeakers located throughout the building and controlled by the building dispatcher. This system is also connected to the area safety alarm system emanating and controlled from Building #701-1F.

Lighting

No permanent lighting facilities are provided in the ceiling of the Hot Canyon since accessibility for maintenance is not possible. Lighting for the Hot Canyon is by means of high intensity, incandescent, vapor-proof lighting fixtures, mounted on the bottom of the crane. The Warm Canyon is equipped with ceiling-mounted, combination mercury-vapor and incandescent fixtures. In general, the remaining lighting in the building is designed to fit local requirements. Fluorescent fixtures are used in offices, process control rooms, and areas requiring good illumination of the order of 30 foot-candles and above, while incandescent lighting fixtures are used in process areas where the level of required illumination does not justify the higher intensity type of lighting. Vapor-proof lighting fixtures are used in areas as required by moisture conditions or in areas defined as Class I, Division 2, according to the 1951 National Electric Code, Article 500. Ten to twenty-five per cent of the lighting fixtures, depending on the degree of occupancy and on safety requirements are connected to the emergency circuit which is supplied from the emergency diesel generator in case of an outage of normal power. Battery powered floodlights also are provided at strategic locations in stairs, corridors, control rooms and operating areas. These units are turned on automatically when normal lighting fails or during start-up of the diesel generator.

EQUIPMENT

Process Sections

Hot Canyon

- 2 Vertical dissolvers, stainless steel, 8' x 8', with opening closure and charger.
- 2 Dissolver Columns, 3'-8-1/2" x 15'-4".
- 2 Off-gas heater-reactors, stainless steel, 1300 and 330 gallon capacity for outer and inner vessel, respectively.
- 2 Off-gas filters.
- 2 Centrifuges, stainless steel, 40" x 24", with foundation blocks, grease measuring valves, and oil overflow tanks.
- 4 Mixer-settlers, stainless steel.
 - 1 1A Bank, 16 stage.
 - 1 1B Bank, 16 stage.

- 1 1C Bank, 12 stage.
- 1 Rerun Bank, 16 stage.

Each stage of the mixer-settlers is served by an agitator-pump driven from overhead by a variable speed motor.

4 Evaporators, stainless steel.

- 1 Head End Evaporator, 8' x 8', 8 coils.
- 1 Head End Evaporator Column, 4' x 12', three bubble cap trays.
- 1 High Activity Waste Evaporator, 8' x 8', 8 coils.
- 1 High Activity Waste Evaporator Column, 4' x 12', three bubble cap trays.
- 1 High Activity Condensate Evaporator, 8' x 8', 8 coils.
- 1 High Activity Condensate Evaporator Column, 4' x 12', three bubble cap trays.
- 1 Rerun Evaporator, 8' x 8', 6 coils.
- 1 Rerun Evaporator Column, 4' x 12', three bubble cap trays.

- 1 Rerun Decanter, stainless steel, 2' x 1'-6" x 6'.

24 Cell Tanks, stainless steel.

6' x 6'

- 1 Cake Slurry Hold Tank, 300 gal. operating fill.
- 1 1BP Run Tank, 592 gal. operating fill.
- 1 High Activity Vent System Condensate Tank, 500 gal. operating fill. (This tank is to be replaced after start-up by an 8' x 6' caustic circulating tank with two 150 g.p.m. submerged centrifugal pumps.)

These tanks have 22-inch diameter stirrers, 3 hp. motored reducers, slingers, anti-spark sleeves, oil overflow tanks, and trunnion supports.

- 1 Head end filter tank.

6' x 8'

- 1 LAW Run Tank, 989 gal. operating fill.

This tank has a 22-inch diameter stirrer, 3 hp. motoreducer, slinger, anti-spark sleeve, oil overflow tank, and trunnion supports.

8' x 8'

- 1 Dissolver Coating Solution Hold Tank, 1392 gal. operating fill.
- 2 Solution Adjustment Tanks, 1890 gal. operating fill.

These tanks have 29-inch diameter stirrers, 5 hp. motoreducers, slingers, anti-spark sleeves, oil overflow tanks, and trunnion supports.

8' x 11'

- 1 Head End Condensate Tank, 1745 gal. operating fill.
- 1 ICW Run Tank, 2807 gal. operating fill.
- 1 High Activity Waste Neutralizer 2550 gal. operating fill.
- 1 Water Run Tank, 1837 gal. operating fill.
- 1 High Activity Rerun Run Tank.
- 1 Organic Run Tank.
- 1 Aqueous Run Tank.
- 1 Condensate Run Tank.
- 1 P.H. Adjustment Tank.
- 1 Rerun Hold Tank.
- 1 Organic Hold Tank.

These tanks have 29-inch diameter stirrers, 5 hp. motoreducers, slingers, anti-spark sleeves, oil overflow tanks, and trunnion supports.

10' x 11'

- 1 Raw Metal Solution Hold Tank, 2780 gal. operating fill.
- 1 Centrifuge Feed Tank, 3960 gal. operating fill.
- 1 Centrifuge Run Tank, 2030 gal. operating fill.
- 1 ICU Run Tank, 4478 gal. operating fill.
- 1 Head End Tank, 3880 gal. operating fill.
- 1 High Activity Waste Hold Tank, 4030 gal. operating fill.

These tanks have 34-inch diameter stirrers, 10 hp. motoreducers except for the Head End Tank which has a 20 hp. unit, slingers, anti-spark sleeves, oil overflow tanks, and trunnion supports.

All stirrers on Hot Canyon cell tanks have grease measuring valves.

1 Crane, 50-ton, shielded cab.

- 1 50-ton Hoist.
- 1 10-ton Hoist.
- 2 Twin monorail hoists.

2 1000 lb. Hoists.

- 1 Vertical impact wrench.
- 1 Horizontal impact wrench.

2 2000 lb. Hoists.

- 1 Pipe grabber.
- 1 Standard hook.

2 Counter Balance Four Hook Yokes for use in Section 18.

- 1 1000 ft. Cable.
 - 1 Optical system.
 - 1 Farval lubrication system.
- Crane shielding doors.

Jets (Steam)

Constant Rate Jets

- *Type Z, 4-7 g.p.m.
- *Type Z5, 4-7 g.p.m.

(*Same internals and performance, externals different.)

- Type Z1-X-W, 1-1/2 to 3 g.p.m.
- Type QRS (Schutte-Koerting) 12-20 g.p.m.
- **Type Z6, 8-12 g.p.m.
- **Type QRS (Penberthy) 8-12 g.p.m.

(**Same internals and performance, externals different.)

Transfer Jets

Type C, 75 g.p.m.
 Type CB, 75 g.p.m. (high head).
 Type S1, 25 g.p.m.
 Type S2, 25 g.p.m. (high head).
 Type E, 10 g.p.m.

- 1 High Activity Vent Dehumidifier, Stainless Steel.
 (This dehumidifier is to be replaced after start-up with a 6'-6" x 16' caustic scrubber.)
- 1 High Activity Vent Fiberglas Filter with stainless steel casing.

Piping, stainless steel.

Imbedded
 Jumper
 Rack

Connectors, pipe and electrical.

Pipe connectors carry single two-inch and three-inch pipes or four smaller pipes of 1/8 to 1/2 inch in diameter. The electrical connector carries up to six separate cables with a corresponding number of contacts to provide power for motors and electrical contacts for instruments.

- 1 Set of concrete covers for cell tanks and pipe rack.

Warm Canyon

- 5 Evaporators, stainless steel.

- 2 1CU Evaporators, 8' x 8', 8 coils.
- 2 1CU Evaporator Columns, 4' x 12', three bubble cap trays.
- 2 Low Activity Waste Evaporators, 8' x 8', 8 coils.
- 2 Low Activity Waste Evaporator Columns, 4' x 12', three bubble cap trays.
- 1 Lab Waste Evaporator, 8' x 8', 6 coils.
- 1 Lab Waste Evaporator Column, 4' x 12', three bubble cap trays.

4 Mixer-settlers, stainless steel.

- 1 1D Bank, 16 stage.
- 1 1E Bank, 12 stage.
- 1 2A Bank, 16 stage.
- 1 2B Bank, 16 stage.

Each stage of the mixer settlers is served by an agitator-pump driven by a variable speed motor located on top side of the M-S unit.

30 Cell Tanks, stainless steel.

6' x 6'

- 1 2BP Run Tank, 230 gal. operating fill.
- 1 2BW Run Tank, 919 gal. operating fill.
- 1 2BP Hold Tank, 235 gal. operating fill.
- 1 Column Waste Tank No. 1, 272 gal. operating fill norm.
- 1 Column Waste Tank No. 2, 272 gal. operating fill norm.
- 1 Low Activity Vent Condensate Tank, 500 gal. operating fill.

These tanks have 22-inch diameter stirrers, 3 hp. motoreducers, slingers, anti-spark sleeves, oil overflow tanks, and trunnion supports.

6' x 8'

- 1 1DW Run Tank, 1047 gal. operating fill.
- 2 Oxidant Mixing Tanks, 899 gal. operating fill.

These tanks have 22-inch diameter stirrers, 3 hp. motoreducers, slingers, anti-spark sleeves, oil overflow tanks, and trunnion supports.

8' x 8'

- 1 1EW Run Tank, 2218 gal. operating fill.
- 1 2AW Run Tank, 1373 gal. operating fill.
- 1 Low Activity Waste Neutralizer, 1800 gal. operating fill.

These tanks have 29-inch diameter stirrers, 5 hp. motoreducers, slingers, anti-spark sleeves, oil overflow tanks, and trunnion supports.

8' x 11'

- 1 Spent Caustic and Water Hold Tank, 2950 gal. operating fill.
- 1 Lab Waste Neutralizer, 2950 gal. operating fill.
- 2 1CU Acid Adjustment Tanks.
- 1 Condensate Run Tank, 2950 gal. operating fill.
- 1 Low Activity Rerun Run Tank.

These tanks have 29-inch diameter stirrers, 5 hp. motoreducers, slingers, anti-spark sleeves, oil overflow tanks, and trunnion supports.

10' x 11'

- 1 1CU Hold Tank, 4478 gal. operating fill.
- 1 1CU Feed Tank, 4478 gal. operating fill.
- 1 1CU Condensate Tank, 4478 gal. operating fill.
- 1 LEU Run Tank, 3590 gal. operating fill.
- 1 LEU Hold Tank, 3666 gal. operating fill.
- 1 Low Activity Waste Hold Tank, 4630 gal. operating fill.
- 1 Evaporator Feed Tank, 4630 gal. operating fill.
- 1 Overhead Run Tank, 4630 gal. operating fill.
- 2 Spent Solvent Hold Tanks, 4630 gal. operating fill.
- 2 Solvent Wash Tanks, 2440 and 4100 gal. operating fill.

These tanks have 34-inch diameter stirrers, 10 hp. motoreducers, slingers, anti-spark sleeves, oil overflow tanks, and trunnion supports.

All stirrers on Warm Canyon cell tanks have grease measuring valves.

- 3 Solvent Recovery Decanters, stainless steel, 1'-6" x 1'-6" x 7'.
- 1 Crane, 15-ton.
 - 1 15-ton Main hoist.
 - 1 5-ton Auxiliary hoist.
 - 2 Twin monorail hoists.

2 1000 lb. Hoists.

- 1 Vertical impact wrench.
- 1 Horizontal impact wrench.

2 2000 lb. Hoists.

- 1 Pipe grabber.
- 1 Standard hook.

- 1 Electric Hoist, motor-driven trolley, 17-ton cap.
- 2 Standard Canyon Yokes for use in Section 18.
- 1 Maintenance Bridge, 3-ton, with ladders.
- 1 Totally enclosed structural steel cab with three-sided movable shatter-proof glass observation panels.

Crane shielding doors.

Jets (Steam)

Constant Rate Jets

- *Type Z, 4-7 g.p.m.
- *Type Z5, 4-7 g.p.m.

(*Same internals and performance, externals different.)

Type Z1-X-W, 1-1/2 to 3 g.p.m.
Type QRS (Schutte-Koerting) 12-20 g.p.m.

- **Type Z6, 8-12 g.p.m.
- **Type QRS (Penberthy) 8-12 g.p.m.

(**Same internals and performance, externals different.)

Transfer Jets

Type C, 75 g.p.m.
Type CB, 75 g.p.m. (high head).
Type S1, 25 g.p.m.
Type S2, 25 g.p.m. (high head).
Type E, 10 g.p.m.

- 1 Low Activity Vent Dehumidifier, stainless steel.
- 1 Low Activity Vent Fiberglas Filter with stainless steel casing.

Piping, stainless steel.

Imbedded
Jumper
Rack

Connectors, pipe and electrical.

Pipe connectors carry single two-inch and three-inch pipes or four smaller pipes of 1/8 to 1/2 inch in diameter.

The electrical connector carries up to six separate cables with a corresponding number of contacts to provide power for motors and electrical contacts, for instruments.

- 1 Set of concrete covers for the cell tanks and pipe rack.

Feed Tank Gallery

7 Carbon steel tanks

- 1 Caustic Feed Tank, 15 gal. operating fill, 2' x 3'.
 - 1 Scale, 21" x 29".
- 2 Dissolver Caustic Feed Tanks, 4' x 3', 129 gal. operating fill - 2 - Scales, 48" x 48".
 - 1 Feed Tank, 280 gal. operating fill, with agitator.
 - 1 50% Caustic Feed Tank, 4' x 6', 257 gal. operating fill.
 - 2 Caustic Feed Tanks, 6' x 6', 222 and 373 gal. operating fill.

57 Stainless steel tanks.

2' x 3'

- 1 Mn (NO₃)₂ Feed Tank, 19.2 gal. operating fill.
- 2 NaNO₂ Feed Tanks, 50 gal. operating fill.
 - 2 Scales, 21" x 29".
- 2 Cake Wash Feed Tanks, 30 gal. operating fill.

- 1 Cake Solvent Feed Tank, 60 gal. operating fill.
- 4 Ferrous Sulfamate Feed Tank, 11.36 gal. operating fill.
- 4 Scales, 21" x 29".
- 2 Oxidant Feed Tanks, 12 gal. operating fill.
- 2 Scales, 21" x 29".
- 1 Acid Feed Tank.
- 1 Scale, 21" x 29".
- 1 2' x 3' acid adjustment tank with remote operated valves.

3' x 6'

- 1 Gang Valve Drainage Catch Tank #1.
- 1 Gang Valve Drainage Catch Tank #2.

4' x 3'

- 2 Acid Measuring Tanks, 71 gal. operating fill.
- 1 Caustic Feed Tank, 81 gal. operating fill.

4' x 6'

- 2 Acid Adjustment Tanks, 363 gal. operating fill.
- 2 IAS Feed Tanks, 440 gal. operating fill.
- 2 HNO₃ Feed Tanks, 427 gal. operating fill.
- 2 Acid Feed Tanks, 283 gal. operating fill.
- 2 TBP Feed Tanks.
- 2 Water Feed Tanks, 373 and 222 gal. operating fill.

6' x 6'

- 1 Dissolver Drowning Tank, 1150 gal. operating fill.
- 2 Dissolver Acid Feed Tanks, 850-856 gal. operating fill.
- 1 KMnO₄ Feed Tank, 595 gal. operating fill.
- 2 IBS Feed Tanks, 589 gal. operating fill.
- 2 HNO₃ Feed Tanks, 568 gal. operating fill.
- 2 2AX Feed Tanks, 919 gal. operating fill.

- 2 2AS Feed Tanks, 460 gal. operating fill.
- 2 2BX Feed Tanks, 460 gal. operating fill.
- 1 Aqueous Feed Tank.
- 1 Solution Feed Tank.

1 Scale, 1-22 inch diameter stirrer, 3 hp. motoreducer, and anti-spark sleeve.

- 2 Decontaminating Feed Tanks (#1 and #2), 866 gal. operating fill, with 22-inch diameter stirrers, 3 hp. motoreducers, slingers, and anti-spark sleeves.

8' x 8'

- 2 1AX Feed Tanks, 2216 gal. operating fill.
- 2 1DX Feed Tanks, 2218 gal. operating fill.
- 2 1EX Feed Tanks, 1753 gal. operating fill.

8' x 11'

- 2 1CX Feed Tanks, 2190 gal. operating fill.

32 Pumps, stainless steel.

- 2 Horizontal Cake Wash Feed Pumps, 20 g.p.m., with 15 hp. motors.
- 2 Vertical 1AS Feed Pumps, 18 g.p.m., with 1 hp. motors.
- 2 Vertical 1AX Feed Pumps, 18 g.p.m., with 1 hp. motors.
- 2 Vertical 1BS Feed Pumps, 18 g.p.m., with 1 hp. motors.
- 2 Vertical 1CX Feed Pumps, 18 g.p.m., with 1 hp. motors.
- 2 Vertical 1DX Feed Pumps, 18 g.p.m., with 1 hp. motors.
- 2 Vertical 1EX Feed Pumps, 18 g.p.m., with 1 hp. motors.
- 4 Pumps, 1BX, 3 g.p.m., with 1/4 hp. motors.
- 2 Pumps, 1DS, 3 g.p.m., with 1/4 hp. motors.
- 2 Pumps, 1DS', 3 g.p.m., with 1/4 hp. motors.
- 2 Vertical 2AS Feed Pumps, 18 g.p.m., with 1 hp. motors.
- 2 Vertical 2AX Feed Pumps, 18 g.p.m., with 1 hp. motors.
- 2 Vertical 2BX Feed Pumps, 18 g.p.m., with 1 hp. motors.

- 2 Vertical Aqueous Feed Pumps, 18 g.p.m., with 1 hp. motors.
- 1 Vertical Hot Water Pump, 50 g.p.m., with 5 hp. motor.
- 1 Vertical Hot Acid Pump, 50 g.p.m., with 5 hp. motor.

Cold Feed Preparation

- 1 Fork Lift truck.
- 60 Wood pallets.
- 1 Wright safeway army type plain trolley hoist (for loading hoppers).
- 1 Trolley hoist and monorail track (for carrying hoppers to vessels).
- 5 Loading hoppers with Gemco valves and stands.
- 1 Citric acid hopper.
- 1 NaNO_3 hopper.
- 1 Iron powder hopper.
- 1 NaNO_2 hopper.
- 1 KMnO_4 hopper.

32 Tanks

Aluminum

- 1 H_2O_2 Head Tank, 4' x 3', 115 gal. operating fill.

Stainless Steel

12" x 12"

- 3 Vacuum Surge Tanks.

2' x 3'

- 1 Special Feed Preparation Tank on portable stand.
- 1 $\text{Mn}(\text{NO}_3)_2$ Head Tank, 19 gal. normal operating fill.
- 1 Citric Acid mixing tank, 100 gal. operating fill.

3'-6" x 10"

- 1 Drainage Skimmer Tank.

4' x 3'

- 1 Ferrous Sulfamate Adjustment Tank, 90 gal. operating fill.
- 1 30% NaNO_2 Mixing Tank, 208 gal. operating fill.
- 1 $\text{Mn}(\text{NO}_3)_2$ Mixing Tank, 19.2 gal. operating fill.

These tanks have commercial 430 r.p.m. agitators.

- 1 50% $\text{Fe}(\text{NH}_2\text{SO}_3)_2$ Head Tank, 54.5 gal. operating fill.

4'-6" x 6'

- 1 2BX Mixing Tank, 460 gal. operating fill.

6' x 6'

- 1 26% NaNO_3 Mixing Tank, 618 gal. operating fill.
- 1 Cake solvent mixing tank, 705 gal. operating fill.
- 1 KMnO_4 Mixing Tank, 595 gal. operating fill.

These tanks have 22-inch diameter stirrers, 3 hp. motoreducers, slingers, and anti-spark sleeves.

6' x 8'

- 1 50% HNO_3 Weigh Tank, 974 gal. operating fill.
- 1 Recycle Drainage Tank #1, 1200 gal. operating fill.
- 1 Recycle Drainage Tank #2, 1200 gal. operating fill.
- 1 Floor Drain Collection Tank, 1200 gal. operating fill.

The Recycle Drainage Tank #1 and #2 and the Floor Drain Collection Tank have 22-inch diameter stirrers, 3 hp. motoreducers, slingers, and anti-spark sleeves.

8' x 8'

- 1 0.63% HNO_3 Mixing Tank, 1180 gal. operating fill.

This tank has a 29-inch diameter stirrer, 5 hp. motoreducer, slinger, and anti-spark sleeves.

10' x 11'

- 1 3.7% HNO₃ Mixing Tank, 4309 gal. operating fill.
- 1 17% HNO₃ Mixing Tank, 3471 gal. operating fill.

These tanks have 34-inch diameter stirrers, 10 hp. motoreducers, slingers, and anti-spark sleeves.

10' x 13'

- 4 Solvent Hold Tanks, 6044 gal. operating fill.

These tanks have 34-inch diameter stirrers, 10 hp. motoreducers, slingers, and anti-spark sleeves.

- 2 Exterior slab-mounted Solvent Hold tanks with shielding wall. These tanks are identical to the Solvent Hold Tanks above.

Carbon Steel

- 1 NaOH Weigh Tank, 2' x 3', 31.8 gal. operating fill.
- 2 0.5% NaOH Mixing Tanks, 8' x 11', 2950 gal. operating fill.

The NaOH Mixing Tanks have 20-inch diameter stirrers, 5 hp. motoreducers, slingers, and anti-spark sleeves.

21 Pumps

Stainless Steel

- 1 Vertical 17% HNO₃ Pump, 50 g.p.m., with 5 hp. motor.
- 1 Vertical Ferrous Sulfamate Pump, 5 g.p.m., with 2 hp. motor.
- 1 Vertical 3.7% HNO₃ Pump, 50 g.p.m., with 5 hp. motor.
- 1 Vertical 0.63% HNO₃ Pump, 25 g.p.m., with 3 hp. motor.

- 1 Vertical Cake Solvent Pump, 25 g.p.m., with 3 hp. motor.
- 1 Vertical Solvent Transfer Pump, 100 g.p.m., with 5 hp. motor. (Located outside of Building #221-F)
- 1 Vertical 50% HNO_3 Pump, 50 g.p.m., with 2 hp. motor.
- 1 Vertical Special Feed Pump, 8 g.p.m., with 5 hp. motor.
- 1 Vertical Recycle Drainage Sump Pump, 50 g.p.m., with 2 hp. motor.
- 1 Vertical Drainage Transfer Pump, 50 g.p.m., with 5 hp. motor.
- 1 Vertical Recycle Drainage Sump Pump, 25 g.p.m., with 3 hp. motor.
- 1 Vertical Drainage Transfer Pump, 50 g.p.m., with 15 hp. motor.
- 1 Vertical Solvent Drainage Pump, 100 g.p.m., with 7-1/2 hp. motor.
- 1 Vertical 26% NaNO_3 Pump, 25 g.p.m., with 3 hp. motor.
- 1 Vertical 30% NaNO_2 Pump, 8 g.p.m., with 3 hp. motor.
- 1 Vertical $\text{Mn}(\text{NO}_3)_2$ Pump, 8 g.p.m., with 5 hp. motor.
- 1 Vertical KMnO_4 Pump, 25 g.p.m., with 3 hp. motor.
- 1 Vertical Floor Drain Transfer Pump, 50 g.p.m., with 7-1/2 hp. motor.
- 1 Vertical 2BX Transfer Pump, 50 g.p.m., with 3 hp. motor.

Cast Iron with Stainless Steel Impeller

- 1 Vertical 0.5% NaOH Pump, 50 g.p.m., with 7-1/2 hp. motor.
- 1 Horizontal 50% NaOH Pump, 10 g.p.m., with 5 hp. motor.
- 2 Pump Containers
 - 1 Solvent Transfer Pump Container (outside Building #221-F).
 - 1 0.5% NaOH Pump Container.
- 2 Carbon Dioxide Converters.
- 1 Solid Carbon Dioxide Storage Box.
- 3 Water Jet Exhauster Type Aspirators, stainless steel.

4 Scales.

- 1 Dial scale on dormant platform.
- 1 Dial scale on dormant platform, 1250 lb. capacity.
- 1 Dial scale on portable platform, 21" x 29".
- 1 Tank scale with cabinet-type indicating dial, 21,000 lb. capacity.

14 Pipe Line Filters.

5 to 100 g.p.m. capacity, carbon steel or stainless steel casings with Dynel or spun glass cartridges - (See Det. 127963-4).

3 M/W-2 Unit Air Filters, 40 c.f.m.

Sample Unit Assemblies.

Cold Piping Areas

Piping, stainless steel.

61 Pipe Line Filters.

0.03 to 50 g.p.m. capacity, carbon steel or stainless steel casings with Dynel or spun glass cartridges - (See Det. 127963-4) - Serve Feed Tank Gallery.

Gang Valve Areas

Gang Valve Assemblies, motor driven and manually operated.

Unit Heaters.

- 3 5-ton Self-contained air conditioning units in both Hot and Warm Canyon G.V. Corridors.

Sample Aisles

Air jet syphons.
 Sample unit assemblies.
 Sample carts.
 Needle valves.
 Steel doors.

Process Waste Lines (Headers Outside Building #221)

- 4 10" Stainless steel lines - 600' each.

Carbon steel pan under lines.

Mechanical Services

Control Rooms

- 1 Diesel generator, 600 kw.
- 1 Evaporative condenser.
- Storage battery units.
- Motor control centers.
- Transformers.
- Telephone equipment.
- Motor generator sets.
- Unit substations.

Compressor Rooms

- 2 Plant air compressors with auxiliary controls and 75 hp. motors.
- 3 Instrument air compressors with auxiliary controls and 100 hp. motors.
- 3 Process Air Compressors.
- 2 850-ton Water Chiller Condensing Units for Buildings #221-F and #772-F.
- 2 Air Dryers.

Canyon Supply Fan Room

- 4 Supply Blowers, 56,800 c.f.m. (2 spares).
- Water cooling coils.
- Steam heating coils.

Heating and Ventilating Equipment Rooms

- 2 Supply Blowers, 63,800 c.f.m. (1 spare).
- 1 Supply Fan, 28,760 c.f.m.
- 1 Horizontal Type Air Conditioning Unit (Second Floor).
- Refrigeration Expansion Tank, Carbon Steel, 5' x 11'-2".
- 7 Pumps

Cast Iron Casing with Bronze Impeller.

- 2 Double Suction Horizontal Cooling Water pumps, 2600 g.p.m. with 125 hp. motors.

- 1 Horizontal Centrifugal Chilled Water Booster Pump, 1200 g.p.m. with 30 hp. motor.
- 1 Double Suction Horizontal Chilled Water Circulation Pump, 360 g.p.m. with 7-1/2 hp. motor.
- 1 Double Suction Horizontal Chilled Water Circulation Pump, 260 g.p.m. with 7-1/2 hp. motor.

Bronze Fitted.

- 2 Horizontal Condensate Return Pumps, 225 g.p.m. with 10 hp. motors.

Air Ducts.

Steam Coils.
Exhaust Fans.

Shop Facilities

Hot Canyon Shop

- 1 Combination pipe vise.
- 1 Storage rack.
- 2 Work benches.

"Swimming Pool"

- 1 Steam jet syphon, Type "CB", 75 g.p.m. high head (for emptying).
- 5 Swimming pool lighting fixtures.
- 2 Jib cranes with hoists.
- 2 Appleton reelites.
- 1 Movable platform.

Warm Canyon Shop

- 1 Steam jet syphon, Type "SI", 25 g.p.m., (for sump).
- 1 Combination pipe vise.
- 2 Tool storage boards.
- 1 Storage rack.
- 2 Work benches.

Regulated Shop

- 1 Pipe threading machine, 2".
- 1 50-ton Hydraulic press (hand).

- 1 Portable pipe bending machine, 3".
- 1 Pedestal drill press, 1/2".
- 1 Welding Machine.
- 2 Fume exhaust systems.
- 1 Exhaust fan.

Cold Shop

- 1 Filter loader.
- 2 Grease pumps.
- 2 Grease paks.
- 2 Oil pumps.
- 2 Alemite hose centers.
- 2 Alemite elbow adapters.
- 2 Machinist's vises.
- 1 Pipe vise.
- 4 Paper cutters on truck.
- 3 Work benches - heavy duty steel.
- 1 Korda desk.
- 1 Arc welding bench.
- 1 Gas welding bench.
- 1 Unit-locker compartment.
- 24 Steel shipping drums, 55 gal.
- Storage racks.

Instrument Shops

- 1 Pedestal drill press, 1/2".
- 1 Pedestal grinder, 8".
- 4 Instrument service carts.
- 4 Ceiling mounted hose reels.
- 4 Industrial roll benches.
- 5 Utility benches.
- 6 Wood top benches.
- 1 Steel top bench.
- 3 Shelf storage cabinets.
- 4 Multi-drawer cabinets.
- 1 Steel adjustable shelf.
- 3 Chairs.
- 1 Combination file - 4-drawer.
- 1 Korda desk.
- 1 Tool cabinet.
- 1 Sink - single drainboard, stainless steel.
- Miscellaneous tools for instrument repair.

Storage Rooms

- 2 Steam jet syphons, Type "CB", 75 g.p.m. high head (for sumps).

- 1 Support frame for bucket storage, stainless steel.
- 2 Supports for bucket storage floodlights, stainless steel.
- Storage racks.
- Battery charger.
- Unit heaters.

Decontamination Facilities

Hot and Warm Decontamination Rooms

- 2 Steam jets syphons, Type "CB", 75 g.p.m. high head (for sumps).

Tool and Mask Decontamination Rooms

- 3 Wall racks.
- 4 Storage racks.
- 3 Double drainboard sinks.

Personnel Decontamination Room

- 1 Shower stall with shower.
- 1 Medical type examination table.
- 1 Medical type examination chair.
- 1 Movable medical type table.
- 1 Decontamination kit.
- 1 Examination lamp.
- Personnel Checking Instruments.

Service Transport Facilities

Railroad Tunnel

- 3 Steam jet syphons, Type "SI", 25 g.p.m. (for sumps).
- 1 Remote control locomotive.

Truck Well

- 1 Transfer car.
- 9 Rails for transfer car.
- 1 Tractor.
- 2 Draw bars for tractor.
- 1 Truck well curtain.

Elevators

- 1 15,000 lb. Monorail system.
- 2 Passenger elevators.
- 1 Freight elevator.
- 1 Sample cart elevator.

Personnel Facilities

Personnel Access

Unit heaters.
 Exhaust fans.
 Portable breathing air blowing systems.
 Self-contained breathing air masks.

Locker, Toilet and Change Areas

Exhaust fans.
 Lockers,
 Benches.
 Monitoring instruments.

Lunch Rooms

Tables.
 Chairs.
 Lunch box racks.
 Refrigerators.
 Sinks.
 Stoves.

Administrative Areas

Conventional office furniture.
 1 Horizontal type air conditioning unit.

General Process Equipment

Piping, stainless steel.

Sample Units - Sample units consist of two types:
 Mechanical type for concentrated solutions of
 product; circulating jet type for cold solutions.

Vessel agitators - Generally all vessels larger than 1
 ft. in diameter have low speed mechanical agitators.

Vessels smaller than 1 ft. diameter are agitated by air sparging due to space limitations. An exception is the agitation of the 5 ft. diameter Resin Column Feed Tanks where agitation is performed by a submerged pump supplemented by air sparging.

3 Types of Transfer Jets.

Type Z1-X-W - 1, 2.3, and 3 g.p.m.

Type E - 10 g.p.m.

Type S2 - 25 g.p.m. (high head).

Valves (Approximate Quantities).

Gate Valves, stainless steel.

125-1/2" gate valves

35-1" gate valves

10-1-1/2" gate valves

10-3" gate valves

Globe Valves, stainless steel.

60-1/4" globe valves.

15-1/2" globe valves.

Globe Valves, monel.

10-1/4" globe valves.

Plug Valves, Duramet 20.

90-1/4" plug valves.

110-1/2" plug valves.

45-1" plug valves.

5-1-1/2" plug valves.

Plug Valves, monel.

25-1/4" plug valves.

Plug Valves - Non-lubricated, 3 way-3 port, stainless steel.

25-1" plug valves.

5-1-1/2" plug valves.

Plug Valves - Non-lubricated, 3 way-2 port, stainless steel.

5-1-1/2" plug valves.

5-3" plug valves.

Plug Valves - Non-lubricated, 4 way-4 port, stainless steel.

5-2" plug valves.

Needle Valves, stainless steel.

20-1/4" needle valves.

35-1/2" needle valves.

Supplementary Facilities

Office and Vault

Vault door.

Conventional office furniture.

Heating and Ventilating Rooms

6 Exhausters.

2 Third level exhausters, 13,615 s.c.f.m.

2 Mechanical cabinet exhausters, 750 c.f.m.

2 Fourth level exhausters, 4300 s.c.f.m.

Air Filters.

CWS filters, 8" x 8" x 3-1/8", 30 c.f.m.

CWS filters, 8" x 8" x 5-7/8", 50 c.f.m.

CWS filters, 24" x 24" x 5-7/8", 500 c.f.m.

CWS filters, 24" x 24" x 11-1/2", 1000 c.f.m.

Vent Header Filters.

Type A & C filters, 20 c.f.m., Fiberglas Filter housed in a 4'-3" x 14-1/4" O.D. stainless steel vessel.

Type B & D filters, 40 c.f.m., Fiberglas Filter housed in a 4'-3" x 19-3/4" O.D. stainless steel vessel.

1 Drying air blower, 20 c.f.m.

1 Chemical storage exhauster blower, 445 c.f.m.

2 Refrigeration units.

2 Air dryer units.

1 Air conditioning unit.

INSTRUMENTATION

A central instrument control office was adopted for Building #221-F because (1) it permits a more highly coordinated operation; and (2) it provides a safer design by the use of remote control panels and eliminates all process connections to these panels.

Signals are transmitted to the control gallery by transmitters at a number of locations.

1. Gang valve gallery where the transmitters for jet steam pressure, and the controllers with their control valves for rate jet systems, are located.
2. Pipe gallery where the transmitters for all remaining canyon vessel functions are located.
 - a. All canyon vessels having cooling or heating coils require temperature records and, in some cases, temperature controls.
 - b. Most canyon vessels require level records and, in a few cases, controls.
 - c. Most canyon vessels require a radiation record. The only exceptions to this are those located at a high elevation with respect to the canyon floor. Pick-up of radiation is accomplished through the use of ion chambers installed from the 2nd level, vertically downward, through a tube in the shield wall and located adjacent to the vessel being monitored.
 - d. In addition to those listed above, a small number of miscellaneous functions are recorded and controlled. For example, all mixer settlers receiving primary feeds require differential pressure record and control backed up by an electric probe for interface level record.
 - e. On-off and throttling type air-operated valves for water to vessel cooling coils and steam to vessel heating coils are located in this area.
3. Feed tank gallery - with only a few exceptions, levels in the feed tanks are transmitted to the control panels from transmitters located in the gallery. All valves for filling and feeding canyon vessels are located in this area and are air-operated from the panel boards. A small number of

controllers and control valves are located in the gallery for rate-feeding certain continuous equipment in the canyon. These critical feed streams have scale-mounted feed tanks which transmit to the control panels.

4. Miscellaneous - Cold feed preparation area tank level signals and various interdependent signals related to the vent systems and drain headers are transmitted to the central control panels.

The control gallery consists of a dispatcher's office located directly between control panels for the hot and warm canyon equipment. The centralized instrument control panel system, approximately 210 ft. long by 15 ft. wide, is located near the center of the fourth level control gallery. A breakdown of the panel system follows.

1. A centralized control panel, 98 ft. long by 15 ft. wide, is provided for warm canyon instrumentation. Instrumentation includes recorders and indicators receiving signals from transmitters located throughout the building; and automatic and manual control stations for remote indication and operation of control valves, alarms on various critical signals, loud speakers for pieces of canyon equipment requiring microphones, electrical switches for the operation of gang valves and electric motors, centrifuge wobble meters and controls.
2. A centralized control panel, 86 ft. long by 15 ft. wide, is provided for hot canyon instrumentation similar to the warm canyon.
3. The dispatcher's office, 25 ft. long by 15 ft. wide, contains health monitoring recorders, fire detection annunciator system, a console for communications and control of access to the various areas of the building from a health standpoint.

Ion chambers and electrometers are located at various strategic points throughout the building to insure adequate monitoring. These signals are recorded by a battery of multi-point recorders on panels in the office. Building #221-F instrumentation comprises 80 to 85 per cent of the #200-F Area instrumentation.

In addition to the instrumentation inside Building #221-F, an anemometer and wind direction transmitter are installed on the roof to provide wind data for emergency evacuation.

Electric power for operating the instruments in the Canyon and "B" Line is fed from a separate transformer. Light and power circuits are fed from the same load centers on a separate transformer. In case of failure of normal power supply, an automatic switchover is made to the emergency diesel generator. Studies were made to determine the best method of running the instrument tubing and wiring to the control panels with the result that the wiring enters a large pull box under the fourth floor in the rear of the instrument panels. Cables run from this box to the instrument panel directly above. Every effort was made to conserve space in the box for possible future process changes requiring relocation of instrumentation and controls.

DESCRIPTION OF PROCESS

The operations in Building #221-F comprise the chemical separation of uranium, plutonium, and fission products to produce plutonium metal buttons and a decontaminated uranyl nitrate solution.

The separation is accomplished in primary and auxiliary processing equipment located in the Hot and Warm Canyons which are separated by, and serviced and controlled from, a four-story center section containing the feed gallery, control rooms and administrative areas. The canyons form the main separation areas and provide facilities for processing material over two ranges of radioactivity. The more highly radioactive processing steps are housed in the Hot Canyon while those of lower intensity are contained in the Warm Canyon. Canyon mechanical operations and maintenance are performed remotely by two cranes. Telescopic vision is used on the Hot Canyon crane and direct vision on the Warm Canyon crane.

Primary Canyon Processes

The primary canyon processes consist of raw material solution preparation, head end treatment, and the Purex extraction cycles.

Irradiated uranium slugs, completely enclosed in aluminum jackets, are transported from the #100 Areas in specially designed buckets within lead-shielded casks on well-type flat cars which are transferred to the #200 Area by locomotive. These cars are moved into Building #221-F through the railroad tunnel by a remotely operated mine-type electric locomotive. Upon arrival in the Hot Canyon, the buckets of uranium slugs are transferred either to a storage area or directly to the raw metal solution preparation

equipment where they are emptied and the buckets returned to the cask cars for return to the #100 Areas.

Raw Metal Solution Preparation - Dissolving

The aluminum jacketed slugs are introduced into the charging hopper by the Hot Canyon crane, and dumped from there into the dissolver. Next, the addition of a sodium nitrate solution and a sodium hydroxide solution dissolves the aluminum jackets leaving bare uranium slugs. When this operation is completed, the chemical solution, carrying the dissolved aluminum jackets, is jetted to the dissolver coating solution hold tank and thence to the waste storage tanks in Building #241-F. Two subsequent rinses of the de-jacketed slugs remove residual caustic and jacket material. These rinsings are then jetted to the high activity waste hold tank.

Nitric acid from the acid hold tank is then added to the dissolver and the mixture of uranium metal and nitric acid is heated to the reaction temperature with steam in the dissolver vessel coils. Steam or cooling water in the coils of the dissolver control the reaction rates. This control of the reaction rate is effected by the pressure differential between the inlet and outlet of the column. The dissolving reaction produces off-gases which pass to the dissolver column and flow through a steam heated combination heater-reactor in which the reaction of the heated off-gases with silver nitrate coated Berl saddles removes the radioactive iodine. The off-gases from slug dissolution then pass through a steam jacketed fiberglass filter to remove particulate matter, through an off-gas cooler, and into the acid absorber in "A" Line. Absorber tailings are discharged through Building #291-F Stack. Coating removal off-gas passes through the same assembly but bypasses the absorber and is sent directly to Building #291-F Stack.

The final step in the dissolving operation is the cooling and jetting of the dissolved uranium to the raw metal solution hold tank. After dissolving and transfer of the first batch to the head end treatment, a second slug dissolving cycle is begun.

Head End Treatment

The function of the head end process is to eliminate the zirconium and niobium from the raw metal solution coming from the dissolver.

The head end system provides for the treatment of the raw metal solution with potassium permanganate, the separation of precipitate from the product stream, and the concentration and adjustment of the resultant liquor in preparation for processing by the 1A Bank mixer-settler.

Precipitation with KMnO_4

In the head end tank two dissolver batches are combined with the cake washes returned from the centrifuges during the previous head end cycle. The composition of raw metal solution is adjusted to 43% $\text{UO}_2(\text{NO}_3)_2$ and 0.85% HNO_3 by adding acid, caustic or water. The batch is heated to 185°F. and an excess of 5% KMnO_4 solution is added to it from a gallery feed tank. The permanganate oxidizes the fission products and is in turn reduced to MnO_2 . The oxides are occluded or adsorbed on the large surface area of the precipitating dioxide. The acid content of the batch is of a major importance, since at high concentration ruthenium decontamination decreases appreciably while at lower concentrations or in neutral solutions the precipitation of MnO_2 is inhibited. Off-gases from the head end tank pass through the vessel's enclosed head end filter where minute quantities of ruthenium are removed, and then pass to the process vent system and are exhausted through Building #292-1F. After agitation and cooling, the contents of the head end tank are jetted to the centrifuge feed tank from which the solution is fed at a constant rate to one of the centrifuges.

Centrifugation

The head end slurry is jetted to one of the vertical basket type centrifuges. Clear liquor from the centrifuge flows to the centrifuge run tank where it is cooled. When one-half the initial contents of the centrifuge feed tank has been processed through the centrifuge, the operation is stopped and the liquid accumulation in the centrifuge run tank is sampled to check solution clarity. After agitation, if the sample indicates that precipitate is present, the tank contents are returned to the head end tank for reprocessing. If the solution is clear, half of it is transferred to the head end evaporator for concentration. After evaporation, the product is cooled and jetted from the evaporator to one of the two solution adjustment tanks and the cycle is repeated.

At the conclusion of centrifuging, the cake in the centrifuge is washed with dilute nitric acid to recover soluble uranium and plutonium products. The wash solution pumped from the gallery feed tanks is added through spray

nozzles into the baskets of the centrifuge, the cake is slurried several times, and the excess water is removed by skimming. This wash water is returned to the head end tank for reprocessing.

At the end of cake washing, the centrifuge is run at low speed and the remaining cake is slurried again in dilute nitric acid. This mixture is transferred to the cake slurry hold tank where it is dissolved by gluconic acid from a gallery cake solvent feed tank. The solution is neutralized with caustic and then jetted to the waste storage tanks in Building #241-F.

Evaporation

Prior to first cycle extraction, the clarified metal solution from the head end treatment must be concentrated. Dilution in the head end process is the result of (1) cake washes returned from the preceding batch, (2) solutions added in the head end tank, and (3) steam from jet transfers.

Approximately one-half the contents of the centrifuge run tank is handled by the evaporator at one time. Eight hundred and ninety gallons are charged into the pot before starting the evaporation, then an additional 145 gallons are jetted in after a like amount has been boiled off. As the vapor is condensed it flows to the head end condensate tank where it is cooled and transferred to the high activity waste disposal system. The concentrate is cooled and transferred to one of the two solution adjustment tanks. The concentrate in this tank is sampled and adjusted by adding sodium nitrite and nitric acid from their respective gallery feed tanks. This cycle is repeated with each liquor batch received from the centrifuges.

After the plutonium valence is reduced to the proper value in the solution adjustment tank, the metal solution is ready for treatment by the Purex process. Since the subsequent extraction steps are a continuous operation, the feed tanks to the first bank must be scheduled to provide a constant flow at all times. Therefore, while one of the solution adjustment tanks is being filled, the second provides an adjusted feed to the 1A Bank.

Purex Process

The Purex process is an organic extraction method for the removal of fission products from the nitric acid solution of uranium and plutonium and for subsequent

separation of plutonium from uranium. To accomplish extraction and separation of the organic and aqueous phases, pump-type mixer-settlers are used.

These units are multi-stage liquid-liquid contactors with each stage consisting of a mixing section and settling section in which phase contacting and separating are carried out.

A flow diagram of the Purex process is shown on page 81.

Flows of radioactive aqueous feed streams 1AS, 1DF, and 2AF are controlled through an orifice at a rate determined by the liquid level in the removable feed connection. Active streams to banks 1B, 1C, 1E and 2B enter their respective mixer-settlers by gravity flow at rates determined in the banks from which they emanate.

First Cycle Extraction (Banks 1A, 1B, and 1C)

The purpose of the Purex first cycle extraction is to remove fission products from the plutonium and uranium, and to partition the plutonium from the uranium.

Bank 1A

Feed solution from one of the two solution adjustment tanks is jetted to one of the middle stages of Bank 1A by a constant rate jet. The extractant (tributyl phosphate in Ultrasene) from the 1AX gallery feed tank, enters the mixer-settler from one end and the scrub, (dilute nitric acid) from the 1AS gallery feed tank, enters from the other end and flow counter currently through Bank 1A. Due to proper valence adjustment and pH conditions, the plutonium and uranium in the feed stream are extracted from the aqueous phase into the organic phase. In addition, the nitric acid stream accomplishes the dual purpose of scrubbing the organic phase to remove traces of fission products and of maintaining the acid concentration of the aqueous phase at the optimum level for uranium and plutonium extraction.

The aqueous phase, containing the greater portion of the fission products, overflows a fixed weir at one end of the mixer-settler and passes to the 1AW run tank. The product bearing organic phase also overflows a fixed weir which is located at the opposite end of the bank. Aqueous wastes are sampled and their final disposition from the 1AW run tank is determined by the quality of extraction. If satisfactory, the aqueous phase is transferred to the high activity waste evaporation facilities for concentration.

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Occasional unsatisfactory batches (too high a percentage of recoverable product remaining in solution) are jettied to the rerun station.

Bank 1B

In this step, the organic phase from Bank 1A flows into Bank 1B and is contacted by a solution of nitric acid and ferrous sulfamate. This induces a valence change of the plutonium ion which brings about the selective extraction of the plutonium by the aqueous phase and leaves the uranium in the solvent phase.

The plutonium bearing aqueous stream passes to the 1BP run tank where it is held pending further treatment in the second plutonium cycle. The uranium bearing organic stream flows to Bank 1C.

Bank 1C

Organic solvent containing the uranium flows to Bank 1C where it is contacted with acidified process water which is pumped from the 1CX feed tanks. The acidified water removes the uranium from the organic solvent. The stripped solvent flows to the 1CW run tank where it is jettied to the spent solvent hold tank in the Warm Canyon to await treatment in the solvent recovery facilities. The aqueous uranium solution flows to the 1CU run tank where it is held for processing in the first cycle uranium concentration facilities.

First Cycle Uranium Concentration

First cycle uranium concentration, a Warm Canyon facility, consists of equipment for evaporating the dilute uranyl nitrate solution as received from Bank 1C to the concentration required for second cycle decontamination in Bank 1D and 1E.

The uranyl nitrate solution in the 1CU run tank is agitated and cooled before it is jettied to the 1CU hold tank in the Warm Canyon. The aqueous solution in the 1CU hold tank is analyzed for the presence of solvent and, if the sample indicates that no organic phase is present, it is transferred to the 1CU feed tank which serves both 1CU evaporators.

At the completion of sampling, if the aqueous solution is found to be satisfactory, the solution in the evaporator feed tank is jettied into one or both of the two 1CU evaporators.

As evaporation proceeds, the distillate from the evaporator column passes to the LCU condensate run tank where it is agitated, cooled, and sampled. If the condensate is of discard water quality, it is transferred to the LCU condensate transfer tank in Building #211-F. If the activity of the condensate is above this limit, it is jetted to the rerun station.

At the completion of evaporation, the bottoms are cooled and jetted to either of the two acid adjustment tanks where a sodium nitrite-nitric acid solution from the acid measuring gallery feed tanks is added. After agitation, heating, cooling and sampling, the contents of the acid adjustment tank are ready for second cycle uranium decontamination in Banks 1D and 1E.

Second Cycle Uranium Decontamination (Banks 1D and 1E)

The purpose of this Warm Canyon cycle is the further removal of fission products and plutonium from the aqueous uranium solution.

Bank 1D

This cycle begins when the aqueous solution of uranium is jetted from one of the LCU acid adjustment tanks to Bank 1D. The solution is contacted with streams of tributyl phosphate (TBP) solution, nitric acid, and a blend of ferrous sulfamate and nitric acid from the 1DX, HNO_3 , and ferrous sulfamate gallery feed tanks, respectively. As was the case in 1A Bank, TBP extracts uranium from the aqueous phase while the scrub stream removes portions of the remaining traces of fission products from the organic phase.

The aqueous stream leaving Bank 1D, containing fission products, flows to the 1DW run tank. From there, it is jetted to the waste hold tank of the low activity waste evaporation facilities. If rerun is necessary, (because of a high residual uranium concentration) the fission bearing aqueous phase may be jetted to the rerun station.

The decontaminated uranium solution from Bank 1D flows to Bank 1E.

Bank 1E

The organic phase from Bank 1D is contacted in Bank 1E with acidified water from the 1EX gallery feed tanks in order to extract uranium back into the aqueous phase.

Upon completion of extraction, the uranium-depleted organic stream flows to the LEU run tank where it is jetted to the spent solvent hold tank of the solvent recovery facilities. The aqueous uranium solution flows to the LEU run tank.

Second Cycle Uranium Concentration

The purpose of this cycle is to remove as much water as possible from the decontaminated uranium solution prior to feeding it to Building #221-F "A" Line. The LEU evaporator and associated tanks are located outside the canyon, at the south end of the "A" Line Building.

The uranyl nitrate solution from Bank 1E passes to the LEU run tank where it is agitated, cooled, and stored until jetted to the LEU hold tank. The solution is checked for the presence of organics. If the analysis is satisfactory, the uranyl nitrate solution is jetted to the evaporator feed transfer tank in Building #211-F. From there, the solution is pumped to the LEU storage tank to await concentration by one of the LEU evaporators. This evaporation cycle is discussed under the "A" Line process.

The next step of the Purex process in the Warm Canyon is second cycle plutonium decontamination in Banks 2A and 2B.

Second Cycle Plutonium Decontamination (Banks 2A and 2B)

The purpose of this cycle is the further removal of fission products from plutonium.

Bank 2A

The aqueous plutonium solution from the LBP run tank in the Hot Canyon is jetted to the Warm Canyon oxidant mixing tanks. Sodium nitrite and nitric acid are added and the solution is sampled and readjusted, if necessary. The content of one of the feed tanks is continually jetted by a constant rate jet to Bank 2A where it is contacted by TBP solution and nitric acid streams from the 2AS gallery feed tanks, respectively. The TBP extracts plutonium while the fission products and iron (reduced ferrous sulfamate) are removed from the solvent by the nitric acid scrub.

The fission product bearing aqueous phase flows to the 2AW run tank where a sample is analyzed. If the analysis indicates satisfactory plutonium extraction, the contents of the tank are jetted to the low activity waste evaporation

facilities. If unsatisfactory, the batch of aqueous solution is transferred to the rerun station.

The plutonium bearing organic phase overflows to Bank 2B.

Bank 2B

The solvent stream from Bank 2A, containing plutonium, flows into one end of the mixer-settler while the aqueous strip solution (hydroxylamine sulfate) is pumped into the other from the 2BX gallery feed tank.

In this bank the plutonium is stripped from the organic phase to the aqueous phase. The organic phase flows to the 2BW run tank where it is sampled. If analysis indicates negligible plutonium, the material in the tank is jetted to the solvent recovery facilities. If unsatisfactory, the batch is jetted to the rerun station.

The plutonium bearing aqueous solution overflows to the 2BP run tank where it is sampled to check the operations of Bank 2A and 2B.

After sampling, the contents of the 2BP run tank are jetted to the 2BP hold tank where the plutonium bearing aqueous solution is cooled, agitated, and resampled. If sample analysis indicates unsatisfactory decontamination, the batch is jetted to the rerun station for reprocessing. If satisfactory and the solution meets the criticality requirements, it is jetted from the 2BP hold tank to one of the two resin column feed tanks in the "B" Line which are located on the fourth level.

Although final plutonium concentration is performed in "B" Line, its supplementary facilities in the Warm Canyon include such vessels as the column waste tanks No. 1 and 2.

After a batch of 2BP solution has passed through a "B" Line resin column and the plutonium has been adsorbed, the spent solution is returned to one of the column waste tanks. When a waste batch has accumulated, it is agitated and sampled to determine the efficiency of plutonium extraction. If the solution contains plutonium, it is jetted back to the 2BP hold or rerun tanks for reprocessing. If no plutonium is present, the solution is jetted to the column waste transfer tank in Building #211-F where it is pumped to the general purpose evaporator tankage.

Periodically, a high activity solution from a regeneration of one of the resin columns is received along with a normal waste batch. Depending on results of the sample analysis, this solution may be sent from the column waste

tanks to the low activity waste evaporator for elimination from the process or to the rerun station for reprocessing.

Auxiliary Canyon Processes

The auxiliary canyon process in Building #221-F includes waste concentration, solvent recovery, laboratory waste concentration, and the rerun station.

Waste Concentration

This includes the high activity waste evaporation facilities in the Hot Canyon and the low activity waste evaporation facilities in the Warm Canyon both of which reduce the volume of the aqueous waste streams which must be stored in Building #241-F. The low activity waste evaporation process also provides for the recovery of nitric acid in the evaporator overhead.

High Activity Waste Evaporation

The high activity wastes concentrated by this facility include dissolver wastes, head end condensate, and the LAW stream from the LA Bank.

Waste streams are blended in the high activity waste hold tank. Aqueous waste solution is jetted from this tank to the high activity waste neutralizer where it is cooled and then neutralized by NaOH solution from the 50% caustic gallery feed tank. Neutralization prevents oxidation, and therefore volatilization, of any ruthenium carried over in the LAW stream. After agitation and cooling the neutralized waste is normally jetted to the high activity waste evaporator.

Once the evaporator is filled, its contents are heated to boiling temperatures and evaporation continues until the neutralizer tank is empty. After cooling, the concentrated waste is jetted to Building #241-F.

The overhead vapors from the waste evaporator pass through its condenser section and the condensate flows by gravity to the high activity condensate evaporator. In this evaporator the condensate is re-evaporated to decrease the total activity of the overhead.

The bottoms are normally accumulated, but after approximately twenty-one batches these bottoms are cooled and jetted back to the waste evaporator to start the next

cycle. This occasional back jetting prevents the build-up of radioactive materials in the bottoms of the condensate evaporator.

The overhead vapors from the condensate evaporator are condensed in the integral condenser and flow to the water run tank. During the collection period the tank contents are agitated, cooled and sampled. If analysis indicates a satisfactory low level of radioactivity, the batch is jetted to the water transfer tank from where it is pumped to the process water skimmer in the water handling system of Building #221-F. If, however, the analysis indicates excessive amounts of radioactive material, the condensate is jetted to the rerun station. If the high activity waste evaporator is inoperative, neutralized waste may be jetted directly to the waste storage area in Building #241 or to the rerun station.

Low Activity Waste Concentration

The low activity wastes concentrated in this facility come from the LDW run tank, 2AW run tank, column waste tanks, spent caustic and water hold tank of solvent recovery, the condensate tank of the low activity vent system, and the "B" Line solvent storage tank. In addition to concentration, the major portion of the nitric acid solution in the waste streams is recovered and transferred to the nitric acid recovery system at Building #211-F.

In this process the low activity process streams are jetted to the waste hold tank at four hour intervals. These transfers are so staggered as to drain the run tank every eight hours and the spent caustic and water hold tank every four hours. The contents of the condensate tank are jetted directly to the evaporator feed tanks.

The waste hold tanks contents are cooled and then jetted to the evaporator feed tank except for a heel which is kept for cooling future inlet batches.

In the evaporator feed tank the solution is cooled and jetted to one of two low activity waste evaporators in parallel where the aqueous waste is concentrated to a bottom concentration of salts and nitric acid.

Once every eleven days each evaporator is shut down and bottoms of the evaporator are cooled and jetted to the waste neutralizer. The solution in the waste neutralizer is treated by a 50% caustic solution, recooled, analyzed to check neutralization, and jetted to the concentrate waste tanks in the waste storage area of Building #241-F.

The overhead vapors from the evaporators contain approximately 7-1/2% nitric acid. These are condensed and flow to the overhead run tank. After cooling, the condensate in the overhead run tank is sampled for decontamination. If sufficiently decontaminated, the overhead condensate is jettied to the dilute HNO_3 transfer tank from where it is pumped to the dilute nitric acid feed tank of the nitric acid recovery system in Building #211-F.

In the event the evaporators are shut down, the waste stream is run through the by-pass from the waste hold tank to the waste neutralizer and then directly to waste storage after neutralization. If the entire waste system is inoperative, the contents of the waste hold tank can be jettied to the rerun station for processing prior to storage.

All vessels except the evaporators, caustic feed tank, and dilute HNO_3 transfer tank are equipped with agitators to permit uniform samples and to improve heat transfer during cooling. In the neutralizer the agitator also facilitates complete neutralization.

Solvent Recovery

This Warm Canyon portion of the process prepares spent solvent for re-use in the plutonium and uranium solvent extraction cycles by removing not only uranium, plutonium, and fission products but also such hydrolysis products of the tributyl phosphate solution as dibutyl and monobutyl phosphate.

Solvent enters the recovery system from four different sources in batch increments. These sources include the LCW, 2BW, and LEW run tanks, and the organic hold tank in Rerun Station No. 1. In normal operation only spent solvent from the three run tanks is processed. Spent solvent from the organic hold tank is processed at irregular intervals corresponding to operation of rerun station No. 1.

At eight hour intervals, the LCW and 2BW streams are jettied to the spent solvent hold tank No. 1 while the LEW stream is jettied to the spent solvent hold tank No. 2. A cool liquid heel from a previous washing cycle is retained in the spent solvent hold tanks to reduce the temperature of incoming solvent. After cooling, sampling, addition of solvent make-up, and adjustment of TBP concentration in the solvent, the contents of the spent solvent hold tanks are jettied to the solvent wash tanks where the solvent is washed four times with the following reagents in order: (1) water, (2) dilute caustic, (3) water, and (4) dilute nitric acid.

In wash No. 1, the spent solvent is contacted vigorously with water to remove residual uranium. The solvent batch and wash No. 1 are agitated and settled following which the wash water in each wash tank is jetted to separate decanters where the heavier aqueous phase is separated from the lighter organic phase. From each decanter, the aqueous phase flows to the spent caustic and water hold tank, while the organic solvent overflows and runs back to its respective solvent wash tank. A temperature sensing element at the decanter feed signals the completion of aqueous phase jetting and actuates the cut-off of steam to the jet pump.

In wash No. 2 a quantity of caustic is added to the solvent and agitated and settled. Wash No. 2 removes the fission product radioactivity from the solvent. Again, the aqueous layer is jetted to the decanters as in wash No. 1. The spent caustic flows by gravity to the hold tank, while the organic solvent returns to its wash tanks.

Wash No. 3 and wash No. 4, water and acidified water washes, respectively, are similar in operation to wash No. 1 and both remove traces of caustic remaining in the solvent.

After wash No. 4 is completed, the second cycle uranium solvent is jetted to the cold feed preparation area and the first cycle uranium and second cycle plutonium solvent to two hold tanks outside and adjacent to the cold feed preparation area on the west side of Building #221-F. The solutions in the spent caustic and water hold tank are jetted to the waste tank of the low activity waste evaporation facilities.

Laboratory Waste Evaporation

This Warm Canyon facility concentrates laboratory solutions which are too active for evaporation in the general purpose evaporators.

Laboratory waste solutions are jetted from the laboratory waste storage tanks in Building #211-F to the lab waste neutralizer in the Warm Canyon. As a charge is received in the neutralizer tank, it is agitated, cooled and sampled. When the correct amount of caustic, as indicated by analysis of the sample, has been added, the solution is jetted to the laboratory waste evaporator.

Wastes are concentrated until bottoms are composed of 35% dissolved solids or to the point where overhead activity starts to exceed discard water specifications (1×10^{-13} curies/cc.). Distillate in the condensate run tank is cooled, sampled, analyzed and normally discarded to the river. If,

on analysis, the condensate is found to contain sufficient activity to warrant reprocessing in the waste evaporator, it is returned to the waste neutralizer for re-evaporation.

Upon completion of the evaporation cycle, the bottoms are cooled and jetted to a waste header.

Rerun Station

This Hot Canyon facility consists of separation and evaporation equipment and auxiliaries.

Separation Process for Recovered and Reclaimed Solutions

This station treats rejected process batches, used decontamination solution, and any liquids collected in cell sumps of the Canyon Building.

Aqueous or organic streams, containing uranium, plutonium, and fission products, are collected initially in the high activity rerun tank in the Hot Canyon or in the low activity rerun tank in the Warm Canyon.

These two streams are combined in the high activity rerun tank where they are sampled and held for treatment. After analysis, they are contacted by a nitric acid solution to dissolve solids. If sampling indicates no solids remain, the solutions are jetted to the rerun decanter where the liquid organic phase is separated from the heavier aqueous phase. The latter phase flows to the aqueous run tank while the former phase flows to the organic run tank. If the organic phase contains uranium, plutonium, or fission products, as determined by analysis, it is jetted first to the organic hold tank and then to the rerun hold tank.

In the rerun hold tank, the organic phase is contacted by acidified water and agitated. In this process plutonium, uranium and fission products are transferred from the organic phase into an aqueous phase, which then is jetted to the rerun mixer-settler where it is contacted by fresh organic from the gallery aqueous feed tank. This results in the separation of the fission products remaining in the aqueous phase from uranium and plutonium which are extracted by the solvent.

When separation is complete, the aqueous phase in the rerun mixer-settler overflows to the aqueous run tank and the organic stream collects in the organic hold tank where it is jetted to the rerun hold tank.

In the latter tank, the organic stream is contacted by acidified water and agitated to transfer the recoverable products into the aqueous phase. The aqueous phase then is jetted to the rerun decanter where again the organic and aqueous streams are separated.

After cooling, the contents of the organic run tank are jetted to the organic hold tank where it is cooled and sampled. If the organic is not free of uranium and plutonium, batch extractions must be repeated. If free of these materials, the spent solvent is jetted to the spent solvent hold tank for treatment by the solvent recovery facilities.

In addition, the equipment has been so arranged that it is possible to batch extract product materials from the aqueous phase to the organic phase. Radioactive aqueous waste is received in either of the rerun tanks, cooled, sampled, and jetted to the rerun hold tank. If batch extraction is desired, a batch of tributyl phosphate solution flows from the gallery solution feed tank to the rerun hold tank where the mixture is agitated until the product materials are transferred into the organic phase. Then the mixture is jetted to the rerun decanter and processed as previously described.

If the solvent recovery facilities are unable to wash the decontaminated rerun solvent, the wash process can be performed at the rerun station.

Rerun Evaporator

This facility treats aqueous material coming from the decanter and the mixer-settler of the rerun separation process. The evaporator may also take over temporarily the functions of either high activity or low activity waste evaporation if one of these processes is inoperable.

The aqueous material may be treated in one of the three following ways: (1) if uranium or plutonium are present at a high enough concentration in the aqueous run tank, the liquid is transferred from this tank to the pH adjustment tank where the acidity is adjusted and the concentrate returned directly to the centrifuge run tank for reprocessing in the head end facilities; (2) if the solution contains recoverable quantities of uranium and plutonium in dilute form, it is concentrated in the rerun evaporator, the pH of the concentrate is adjusted in the pH adjustment tank, and the solution either reprocessed by the separation portion of the rerun station or rerun through the head end process; and (3) if the solution does not contain recoverable amounts

of uranium or plutonium, it is concentrated by the rerun evaporator, neutralized, and transferred to the waste storage tanks in Building #241-F.

The condensate from the rerun evaporator flows to the condensate run tank where it is agitated and sampled. If analysis indicates excessive amounts of uranium, plutonium or fission products, it is jetted back to the aqueous run tank for re-evaporation in the rerun evaporator. If satisfactory, it is jetted to the condensate transfer tank where it is held for processing in Building #211-F.

Supplemental Process Facilities

Building #221-F also houses supplemental process facilities which support and serve the canyon processes as well as the "B" Line. These include feed preparation areas, process samplers, ventilation, process vent, drainage, decontamination, maintenance and fire protection facilities in addition to such utilities as water, steam and air.

Cold Feed Preparation

The chemical solvents used in Building #221-F are prepared in separate areas on the first and third levels for canyon and "B" Line facilities, respectively.

The first level area is designated feed preparation No. 1 and No. 2. In No. 1 area, the solutions include varied concentrations of nitric acid, sodium nitrate, ferrous sulfamate and mixtures of nitric acid-hydroxylamine sulfate. In No. 2 area, the solutions include sodium hydroxide, citric acid, potassium permanganate, and mixtures of hydrogen peroxide-nitric acid. Tributyl phosphate solutions also are handled in area No. 2 inasmuch as they are transferred from this area through the feed tank gallery to the canyon processes and are received from solvent recovery for cooling and return to the system. Six solvent hold tanks serve Building #221-F. Two are installed on a slab within a shielding wall on the west side of the Canyon Building while four are inside the building in the cold feed preparation area. The two exterior tanks hold first cycle solvent while the other four contain solvent from the second cycle operation in the canyons.

Except for the preparation of ferrous sulfamate and hydrogen peroxide solutions, solid materials are brought into the area in drums or barrels. Hoppers located on scales are filled from these containers and then are transported by fork truck to the proper mixing tank. A monorail

hoist positions the hopper over the inlet funnel of the tank after which a solids handling valve in the funnel and a slide gate valve in the bottom of the hopper are opened to empty the hopper contents into the tank. Contaminated air and dust, remaining in the hopper after the contents have been emptied, are removed by suction.

After the solutions have been prepared, some with process water and/or chemical solvents as required, they are transferred to gallery feed tanks on the third level where eventually they are fed to their respective canyon processes.

The ferrous sulfamate solution, prepared under a carbon dioxide atmosphere to prevent oxidation to ferric sulfamate, and the hydrogen peroxide solution are received in drums or carboys, placed on a scale, and piped to their respective head tanks. From these tanks, both pass to mixing tanks where the former is mixed with water while the latter solution receives a concentrate of nitric acid in addition to a controlled amount of water. Carbon dioxide gas used in blanketing the ferrous sulfamate tanks is obtained from CO₂ cylinders.

The "B" Line feed preparation area on the third level of the building stores such dry chemicals as ammonium sulfate, ammonium sulfite, sulfamic acid, sodium nitrate, hydroxylamine sulfate and clay filter in addition to mixing these solutions as needed by the facilities.

Four mixing tanks, equipped with agitators and feed pumps, mix the larger quantity solutions blended in the feed preparation area. The smaller quantities are mixed by portable air-operated stirrers in 10 or 15 gallon plastic mixing vessels. Liquid or solid additions are made by graduate or beaker through the charging hatch. The solutions are fed to the proper "B" Line feed tank. Small amounts of solution are also transferred to the feed tanks by portable reagent containers.

In addition to the mixing facilities, the preparation area also houses a small laboratory still. The distilled water thus produced is pumped to a header which feeds it to the required "B" Line facilities.

This preparation station also houses such miscellaneous facilities as the hooded calcium and iodine weighing stations, and the gas storage room.

Calcium and Iodine Stations

These stations provide storage, weighing, and handling facilities for the calcium and iodine inserted in the mechanical "B" Line at the additions station. Calcium is handled in a nitrogen atmosphere to prevent oxidation while the iodine operations are performed under normal atmospheric conditions.

Gas Storage Room

A small room for storing and dispensing all gases required by "B" Line is located near the third level feed preparation room. Cylinders containing helium, oxygen, and nitrogen are connected to a header which carries the gas to "B" Line operations. Cylinders containing liquid anhydrous hydrofluoric acid are stored and handled in a separate room.

Process Samplers

Five types of samplers are used in Building #221-F to facilitate process control and provide operational safety. These include Hot and Warm Canyon, cold feed, air, and screw-type samplers.

Hot Samplers

These mechanisms are remotely operated inside sample boxes mounted on structural supports in the Hot Canyon sample aisle.

Initially, four sample bottles are assembled individually in lead filled containers, known as "door stops", at Building #772-F. These door stops are transported in a sample cart to Building #221-F where they are taken by elevator to the sample aisle on the third level and raised by monorail to the sample box. The operator turns a hand-wheel which moves the door stop to the center of the sample box, while removing its cover. As the door stop engages the cylinder sleeve, it is lifted by an air cylinder until the rubber closure is punctured by two hypodermic needles. Larger Q-Smith type tubes can also be employed but the sample bottle cap must be removed before the vertical movement of the door stop can be accomplished. The flow of process solutions is induced into the sample bottle by means of a steam or air jet which evacuates the sample bottle and discharges the fluids back into the canyon vessel being sampled. Facilities are also provided which catch drips from the

hypodermic needles and for washing out the sample box. After a sample has been drawn, the jet is shut off, vacuum in the sample bottle is released, and the door stop is lowered with the sample box. The above procedure is reversed to remove the door stop.

When four samples have been taken, they are removed from Building #221-F by sample cart to Building #772-F for analysis.

Warm Sampler

This is identical to the Hot Sampler except for less shielding and a lighter door stop. Also hand yokes are used instead of hoists to raise and lower the unit from the sample box. The "hot door stop" may be used in the Warm Sampler, but the "warm door stop" cannot be used in the Hot Sampler.

Cold Feed Samplers

These samplers are used by the gallery feed and "B" Line cold feed tanks. This step, a manually controlled operation, uses a sample flask in place of a door stop. The flask is clamped in its unshielded sample box in such a way that its neck is forced against a gasket to make an air-tight seal. After the sample enters the flask through Q-Smith tubes, a bakelite bottle cap is inserted in the mouth of the flask so it can be transported to Building #772-F for analysis.

In "B" Line, another type of feed sampler is used in conjunction with the cold feed sampler described in the above paragraph. This type, a bottle sampler, is mounted on cabinets kept under a slight negative pressure and is provided to service those vessels handling plutonium. Solutions pass from the process vessel through Q-Smith type tubes through the bottom of the sample bottles. When sampling is complete, the filled bottle is removed for analysis of its contents.

Air Samplers

Two types are used. These include a portable room sampler and Canyon and "B" Line air samplers. Both these samplers pull air through a filter medium which is removed for analysis.

Screw Type Samplers

This type of sampler is used in "B" Line to withdraw portions of the process solutions from the wet chemical cabinets. The complete unit, a cup-like carrier linked to a crank operated screw is enclosed in a long pipe with a series of holes for the circulation of the liquid in the vessels. After the filled carrier is manually cranked to the top of the assembly, a gate valve opens a line in which a pipette is inserted to draw the sample into vials.

Ventilation Systems

Canyons

The Hot and Warm Canyon ventilating system as discussed on page 49, supplies either heated or conditioned air at a rate of 51,000 c.f.m. to each canyon to assure safe operating temperatures for the Purex process at all seasons of the year. Canyon exhaust is discharged through sand filters to the stack by fans in Bldg. #292-F. Central portion exhaust is passed through CWS filters before discharge.

"B" Line

In "B" Line, the wet and dry chemical cabinets each employ separate ventilating systems which maintain negative water pressures of approximately 0.25 and 0.8 inches, respectively. A single filter air-flow type is used by the wet cabinets while a double filter type is provided for the hermetically sealed dry cabinets.

Wet Cabinets

This type of cabinet has separate air flows for normal operation and maintenance. Normally, air enters by seepage through cracks and openings in the cabinets and is exhausted through a filter. When maintenance requires the opening of a cabinet panel, additional exhaust air may be drawn from an adjacent corridor to prevent migration of particulate matter to the room.

Dry Cabinets

The ventilation system in these cabinets supplies dry air at a dew point of minus 10°F. to prevent corrosion and pitting of the equipment and to prohibit clouding of the glass panels in the cabinets. The air, received from Building #221-F conditioned air system, is dehumidified by two air dryers and is filtered as it enters and leaves these cabinets to remove any contaminated particulate matter.

All air drawn from "B" Line facilities is discharged directly to the stack.

Vent Header System

Air from vessels in the Hot and Warm Canyons is drawn through a dehumidifier and a fiberglass filter by the fans in Bldg. #292-1F and if radioactive level permits is discharged to the stack, Bldg. #291-F. If necessary the exhaust air can be directed through the ventilation air tunnel to the sand filters, Bldg. #294-F, before discharge to the stack.

Recycle Vent System

Air from some of the vessels in Bldg. #211, the #221-F "A" Line, and Bldg. #221-F is drawn through a heater and fiberglass filter by fans in Bldg. #292-F before discharge to the stack. Heaters are included in the recycle vent system to prevent a condensate deposit in the filter.

Drainage Facilities

The facilities which collect drainage and overflows of aqueous solutions are designated feed preparation and gallery drainage systems No. 1 and 2.

System No. 1

This facility receives nitric acid, sodium nitrate, and potassium permanganate solutions from the feed preparation, gallery, and "B" Line tanks. Drainage from the gallery tanks and "B" Line is collected in the recycle drainage tank where it is joined by solutions from the feed preparation area pumped from the recycle drainage sump. After agitation and sampling, this material is transferred to the hot laundry waste storage tank at Building #211-F for further processing in the general purpose evaporators.

System No. 2

This system handles drainage containing organic, caustic, and inorganic solutions from the gallery feed, "B" Line, and feed preparation tanks plus floor drainage collected in the various sumps of Building #221-F.

The aqueous solutions from the gallery feed and "B" Line tanks flow directly to the drainage skimmer while similar solutions from the feed preparation tanks flow to the recycle drainage sump from which they are subsequently pumped to the skimmer.

The skimmer, a continuous decanter, separates the organic phase of the solutions from the aqueous phase. The latter flows over a weir to the recycle drainage tank where it is agitated, sampled, and pumped to the low level waste storage tank at Building #211-F for concentration by the general purpose evaporators. The organic phase, however, passes over another weir at the opposite end of the skimmer, and is pumped to the skimmed solvent hold tank at Building #211-F.

Floor drainage is jetted to the floor drain collection tank where it is agitated before being pumped to the low level waste storage tank for concentration by the general purpose evaporators at Building #211-F.

Decontamination Facilities

Decontamination is accomplished in the canyons in one of two ways with nitric acid and water. A vessel either may be removed by crane to specially designed decontamination rooms or it may be decontaminated during operation. Under operating conditions, the solution inside the vessel is jetted to rerun station No. 1 and a rinse of service water is applied to the inside and outside of the vessel. After disposal of the rinse water to rerun station No. 1, the activity of the vessel is determined by means of ion chambers located in the walls of the canyons. If activity is still high, decontamination is repeated with different solutions.

In "B" Line, however, decontamination generally is accomplished as a step in the normal operation of the process.

Maintenance

The concept of remote maintenance is based on maintenance by replacement of units, similar in principle to plugging in a tube in a radio set. The "plug-in" feature is dependent upon standardizing pipe and equipment so that like pieces are completely interchangeable. To accomplish this it was necessary to adhere to very close dimensional tolerances in design and fabrication of pipe and equipment and in design and construction of the building itself. To

assure continuity of operation and to minimize costs it was necessary to design and build into the equipment an unusual degree of reliability and long life. During construction, the canyon floors were checked for various location and elevation accuracies and the imbedded piping in canyon walls was precisely positioned by the use of holding fixtures. The fabrication of all vessels, jumpers and rack piping for canyon installation was likewise held to close tolerances so that leak-proof connections could be made by remotely drawing flange faces against gaskets formed from materials selected only after exhaustive tests.

Maintenance in the canyons was also facilitated through mock-up of all equipment in Building #717-F before installation.

The canyons, identical in design, each house a single row of process vessels remotely maintained by separate cranes provided with main auxiliary, and twin monorail hoists with such accessories as impact wrenches, pipe grabber, and hook.

The lead shielded cab of the Hot Canyon crane is located in a runway behind a concrete wall. This requires the operator to view all operations through two periscopes. The Warm Canyon crane, however, has a totally enclosed cab with movable windows of clear shatterproof glass on three sides to give the operator maximum direct visibility at all times. A battery-operated traveling maintenance bridge is available for manual assistance to the operator during maintenance operations in the Warm Canyon.

In addition to the regular maintenance cranes, an electric hoist with motor-driven trolley is attached to an "I" beam under the roof to facilitate removal of the "C" type rack cover and the 8 ft. by 11 ft. cell tank in module "D" of Section 18 in the Warm Canyon. Controls for this hoist are located at the access platform on the north wall of the Warm Canyon. Facilities in the same section of the Hot Canyon are serviced by the regular crane, but are handled by two counter-balanced four-hook yokes.

The cell tanks in the canyons, except for the caustic circulating tank, are standardized in five different sizes. Each size group has a common nozzle layout arrangement and all nozzles accommodate the Hanford type connector.

To permit remote removal by crane, lifting trunnions are incorporated as a part of design on all canyon tanks.

The jumper piping used for all canyon vessels includes connectors which permit remote installation. The necessary

lifting bails and counterweights are installed on the canyon and rack piping to facilitate remote installation with the crane.

Connectors

The pipe and electrical connectors provide means for remotely installing "jumpers" joining canyon equipment with the process piping and electrical systems, using the electrically driven impact wrenches mounted on the maintenance crane.

In this operation, the impact wrench is lowered on the actuating screw of the connector and turns it to either tighten or loosen the connector as desired. The rotation of the screw in the connector actuates a nut carrying three jaws which engage the back surface of the connector flange and draw together the face of the flange and connector block which is a part of the connector assembly. The jaws pass through a jaw guide in the connector assembly and are shaped so that the jaw guide forces them against the flange when the jumper is installed. In removing a jumper the last few turns of the screw force the jaws against a kick plate located in back of the connector flange which will force the gasketed surfaces apart.

In addition to the above described connectors, an in-line type of pipe connector is provided on all sections of the pipe rack which carry process solutions to the mixer-settlers, evaporators and centrifuges. The in-line connector is similar to the other type except that the flow of fluids is straight through the body of the connector. An off-center geared drive (actuated by the impact wrench) is provided to remotely connect and disconnect horizontal sections of rack piping.

When equipment is removed by the crane from the canyons it first goes to the decontamination rooms, thence to its respective canyon shop for repair. Jumpers and other small equipment which can be submerged are placed underwater in a swimming pool for shielding purposes and then repaired with specially designed tools. If equipment is found to be unsuitable for further canyon use, it is decontaminated and sent to the burial ground.

Equipment entering the Canyon Building from Building #717-F storage area is delivered by railroad to the Hot Canyon and by truck to the Warm Canyon. Removal from the railroad tunnel and truck well and final installation is accomplished by crane.

In "B" Line, maintenance procedures vary with the type of exposure or hazard present. Of these, there are two general types; a dust containing plutonium, and a liquid containing plutonium. Equipment involved in the first type is housed in hermetically sealed cabinets called "dry" cabinets. All maintenance work is done through glove ports and the installation or removal of equipment and material in this line is done through bag ports using a plastic bag technique or the equivalent. Equipment involved in the second type of hazard is housed in cabinets with removable panels, called "wet chemical" cabinets. Maintenance work on this type of equipment is done by removing the panels and working inside the cabinets. In all cases, the maintenance workers are protected by special clothing.

For maintenance work on contaminated "B" Line equipment, a hood was installed in 1955 on the second level in the regulated shop. Filtered ventilation for the hood was provided together with equipment for cabinet operation under vacuum.

A similar equipment installation was made in the H Area.

Fire Protection

Fire protection facilities are required in the canyon areas as well as "B" Line to extinguish flash fires which may occur in these processes. The system of canyon fire protection is composed of "Fireye" units, a secondary thermocouple system, and Type B emulsifier water projectors, while the "B" Line is provided with several types of fire extinguishers.

Fireye Units

These detectors, lead sulfide cells sensitive to infrared radiation, are connected to an annunciator board in the dispatcher's office. When fire occurs, these detectors automatically turn on the water projectors of the building section affected and also the section on either side. The dispatcher or any operator in the gang valve aisles or the center of the building at second level also can turn on the projectors for other sections adjacent to the fire. The Fireye units are replaceable by remote maintenance.

Thermocouples

The secondary fire detecting system consists of thermocouples which measure the air temperature in the various

building sections. When readings go above a preset temperature limit, visual and audible alarms permit the dispatcher to flood the areas involved with water. Thermocouples are located in the canyon exhaust air slots, near expansion loops in the rack piping, and in each building section of the roof over the canyon vessels.

Water Projectors

Sixteen fire water projectors are provided for each canyon section and twelve projectors for the hot and warm pipe rack in each building section.

In addition to these fire protection facilities, an Ansul dry chemical system with fireeyes and an American District Telegraph detection system were provided over the solvent tanks on the first and third level feed areas.

For emergency use and ventilation control concrete covers are provided for the canyons, canyon rack piping, and the north end of the railroad tunnel. Concrete curtain walls may be installed between canyon sections to isolate an area if necessary.

Water

Three separate systems supply water to the canyon and "B" Line facilities. A separate water header supplies cooling water to canyon and "B" Line equipment where operation must remain uninterrupted by a power failure. Other cooling or domestic water is supplied from the normal water headers. The water for the fire protection system is obtained from a series of wells supplying domestic water to Building #221. In case of an emergency this water may be directed into the other two water systems.

In general, cooling water and steam condensate are returned to the cooling tower for re-use. However, many vessels in the canyons and "B" Line are considered highly probable sources of radioactive leaks. Therefore, possible contamination of the entire cooling water system is avoided by returning this water and condensate through a segregated water system. This is an independent system emptying into a detention basin complete with an activity sampler and diversion valves which divert the water either to the creek or, if radioactive, to a retention basin.

In "B" Line, cooling water and/or condensate from higher concentration processing equipment is passed through a closed cooling water system to prevent it from entering

the segregated water system where detection and economical recovery of the product would be difficult.

This system recirculates cooling water and/or condensate through a water hold-up tank, water coolers, and associated piping by a centrifugal pump. When recirculation and analysis are complete, the pump can discharge to the closed system for normal operation, through a "B" Line header to the segregated water system, via the column waste tanks in the Warm Canyon if low concentrations of product are detected. If recoverable plutonium is present, the water and/or condensate may be transferred to the "B" Line waste recovery system.

After the contaminating solution has been removed from this closed system, decontamination can be carried out using nitric acid followed by a water flush and a refilling with clean water.

Steam

Steam generated in Building #284-F is supplied to the canyon and "B" Line facilities for operation of the gang valves and jets, normal heating, and other process uses. The canyon processes receive steam at various pressures while "B" Line uses 150 p.s.i.g. to operate jets and other process equipment on the third and fourth levels and 15 p.s.i.g. exclusively for heating and process facilities on the third level.

All equipment condensate lines, except those where cooling water and/or condensate is used or where these utilities are supplied to equipment processing highly radioactive solutions, discharge through cooling water return headers to the cooling tower. The exceptions to this flow to either the segregated water system or the "B" Line closed cooling water system are described under "Water".

Air

Three independent systems are provided for compression and distribution of instrument, plant, and process air in Building #221-F. These consist of three 342 s.c.f.m., two 319 s.c.f.m., and two 70 s.c.f.m. compressors which supply oil-free air at 90, 110-125, and 150-165 p.s.i.g. for instrument operation, general plant and process use, and for jet air-blowing and pressuring coils of canyon vessels, respectively. The two 70 s.c.f.m. compressors are parallel with one 150 s.c.f.m. type compressor.

Compressors for instrument air and process air are supplemented by an automatic air dryer. The compressors in each system are connected to an emergency diesel electric generator so that air will be available in event of an interruption to the normal electric supply.

The air supply to "B" Line facilities is received from the plant and process air systems. The plant air system supplies air at 125 p.s.i.g. to operate the pneumatic system and the "air" in "B" Line samplers and at 15 p.s.i.g. for agitation in the process vessels. Process air is supplied at 160 p.s.i.g. to serve the jets and pressurize the coils in the waste solids dissolver and the precipitators, and catch tanks in the mechanical "B" Lines.

DEVELOPMENT OF DESIGN

Building

The basic design of Building #221-F was modeled after Hanford's original separation areas although there are major differences. These were brought about principally by the adoption of a solvent extraction process for the Savannah River Plant and by the incorporation in one building of the facilities in Buildings #221, #271, #224 and #231 at Hanford.

Evolution of Structural Design

Initially, the process was to be housed in four separate buildings with four degrees of shielding. These were to be the extraction, concentration, purification, and recovery facilities, respectively, and were to be grouped around a fifth building, the center of operations, which was to include offices, solution preparation, control room, change house, and other administrative functions. Later, this preliminary plan was developed into a second scheme of four buildings as wings radiating from the fifth.

Until the study was completed on process selection, Hanford's original Building #221 continued to be a guide in design since many of its features could be adapted to the several processes under consideration. Both the Redox and Purex processes are liquid-liquid type separations. The former, employed at Hanford, uses "pulse" columns while the Purex process uses mixer-settlers. Adoption of the Redox process would have required a high building to provide head room for equipment installation and changes and at the same time made undesirable the cellular type of construction then favored. As an improvement over Hanford conditions the cells

were to be larger to relieve congestion around the equipment, and the building itself was to be so designed that changes from one type of equipment to another could easily be made.

Evaluation of the Redox and Purex processes indicated the latter to be better suited for Savannah River. Following the selection of the process, the requirements of remote maintenance became the most important element in building design. Cellular construction was discarded and one continuous canyon building was proposed. Further study of this design led to doubling back half of the single canyon and placing the two halves side by side with common facilities for each incorporated in one general area serving both. A number of layouts based on this plan, and some application of model work by Blaw-Knox, assisted in establishing an efficient design.

At one time Building #221-F was to be composed of both Class I and Class II construction. However, as the design became firm, it was determined that a Class I reinforced concrete structure would be most desirable because destruction of the building would mean (1) the loss of a large portion of the plant's operating capacity for an indefinite period, (2) the spread of radioactive fission products requiring isolation of the area, and (3) the loss of valuable quantities of in-process plutonium and uranium.

As a result of many studies, a two-canyon building consisting of eighteen 43-foot sections was adopted, but before design was completed the first section in each canyon was changed from 43 feet to 85 feet to provide additional space.

In the meantime, to permit construction to proceed before completion of building arrangements, the floor was poured in two parts, a main base slab and an upper concrete layer. The latter was not poured until design had been completed and equipment foundation plans were available.

Design Problems

Building #221-F basic design criteria called for remotely operated and maintained processing equipment to insure a proven, safe and efficient way to produce decontaminated plutonium solutions and decontaminated uranyl nitrate solutions. In order to meet this design requirement such basic criteria of safety, reliability, simplicity, interchangeability, standardization, and flexibility were adopted. These principles of design were applied to both building and equipment and particularly to the canyon equipment, piping, and other facilities required for materials handling and remote maintenance. In fact, emphasis was placed on

structural flexibility and the principle that the building should not be designed for any specific piece of equipment. An example of this is the flexibility afforded by the uniform wall sections and imbedded piping in the canyons. This design facilitates the rearrangement or relocation of equipment or operations in the future.

Future expansion beyond the north wall was provided by designing the building so that this wall may be removed with the minimum of structural changes. Provisions also have been made in the foundation mat for future expansion.

The main problems affecting the structural design included development of an adequate ventilation system, protective shielding requirements, establishment of an efficient layout, safe electrical facilities, and the inclusion in design of additional items required for operation.

Ventilation

It was established that a heating and ventilating system was necessary which would provide (1) a controlled ambient temperature in the canyons to reduce possibility of fires due to solvent used in the Purex process, (2) dust control at "B" Line to free it from the toxicity of plutonium, and (3) an air flow designed so that the occupied central portion of the building would be free from the danger of radioactive pollutants.

To meet these requirements, separate ventilating systems were provided for the two canyons and the center of the building. In addition, small separate systems were supplied where needed to meet individual requirements.

Once-through ventilation for the canyons was selected after consideration had been given to 100 per cent recirculation with or without inert gas. Complete recirculation of air was found undesirable, while the use of a recirculating system with inert gas was rejected because of its high installation and operating costs and potential hazard to personnel.

While the main design studies were in progress, it was determined also that two other factors required solution before satisfactory ventilating systems could be designed. These were heat emission from canyon equipment and the practicability of insulating high temperature surfaces. A study was made of the canyon heat loss in order to establish the required inlet air supply and assure safe canyon operation of the Purex process. Taking into account the

properties of the solvents under consideration, an optimum outgoing temperature at the exit end of the canyon exhaust ducts was established at 105°F. It was also judged permissible for this temperature to rise to 115°F. during two per cent of the July-August hours.

In 1954, twenty-eight butterfly type dampers were installed in the air vent slots between the canyons and ventilating tunnel to vary the amount of air exhausted from each building section to provide for distribution of the canyon air in proportion to the heat losses from the equipment in the various sections.

Due to these heat losses further attention was given to insulation and a study was made. However, because of the necessity of maintaining the canyons at a maximum temperature of 115°F. during the summer months and the high costs and low efficiency of the most feasible insulating method that would meet all requirements, it was found more economical to install refrigeration facilities external to the canyon to chill the canyon inlet air during the summer months.

Shielding

In Building #221-F, thick concrete walls and steel or lead plates are provided to protect personnel from the radioactivity hazards associated with the penetrating gamma and intense, but relatively non-penetrating, beta and alpha radiations.

Shielding design was based to some degree on Hanford experience but principally upon current studies which required that gamma ray dosage should not exceed, over an eight hour period, .008 roentgens in occupied and .08 roentgens in occasionally occupied areas.

Other examples of provisions made for special shielding include the cell covers, concrete encasement of waste headers, the gang valve corridor wall and the Hot Canyon sample aisle.

Initially, no cell or pipe rack covers were contemplated for it was believed that the curtain wall, the cantilever wall, the maintenance shielding doors of the Hot Canyon and the remotely operated railroad locomotive would be sufficient to protect operating personnel. Later the concrete shielding covers were adopted to provide ventilation control and to avoid spread of contamination from the canyon vessels. Those for the Hot Canyon shops, swimming pool and cells were standardized so that they could be transported in an oriented

position through the railroad tunnel, picked up by the crane, and set in place.

The four waste headers outside the east wall of the building were enclosed in a concrete encasement below ground level. Connections from the processing equipment in the building to the waste headers were enclosed in removable shields called "mummy cases".

The gang valve corridor wall common with the Hot Canyon wall is designed so that three inches of steel plate may be added for shielding purposes.

In the Hot Canyon sample aisle it was originally planned that structural concrete would be adequate to serve as shielding. However, a radiation level above tolerance occurred when the sample lines were sloped to the sample aisle. It was finally decided that utilization of four inches of lead would meet the shielding requirements.

Layout

Attention in the layout of Building #221-F centered also on the design of facilities which supplement the process in the Hot and Warm Canyons. These included the railroad tunnel, cold feed preparation area, sample aisles, gang valve corridor, tank gallery, and crane maintenance area.

In the railroad tunnel, accuracy is required in spotting the cask car to insure its accessibility to the Hot Canyon crane hooks. Since personnel cannot enter this area, a yardstick type pointer was developed which utilizes markers on the railroad tunnel to indicate the cask car's exact position.

The various tanks in the cold feed preparation area were so arranged that a portable platform could be used for vessel monitoring and maintenance and for general service in the area. A self-supporting, portable, stainless steel platform was designed for the installation or dismantling of a vessel. In 1954 two additional solvent hold tanks were placed on a slab within a shielding wall at the west side of Building #221-F. These tanks were designed to hold newly recovered first cycle solvent which might be too "hot" to handle within the cold feed preparation area.

The location of sample aisles presented a problem since the process required that the sample and control rooms be above the process equipment. At one point in design, a single sample aisle to serve both canyons was considered. However, this scheme was abandoned in favor of separate

canyon sample aisles because the single aisle would have required extensive horizontal piping runs buried in structural concrete. This was undesirable from the standpoint of construction and because it meant drawing samples through excessively long runs.

The location of the gang valves under the transfer pipe rack seemed advantageous in that it provided simplification in canyon jet piping. This simplification resulted from the fact that the steam supply and jet discharge are both on the same side of the canyon. Accordingly it was agreed that gang valves would be located on the side of the canyon opposite the control room.

Prior to locating the feed tank gallery on the third level of Building #221-F, it was thought that the tanks could be placed either below the canyon vessels or with the control room in an enclosed area on the roof of the main structure. The former scheme was undesirable due to flow-back hazards. The latter presented too many structural problems, required an unsatisfactorily shaped cold piping tunnel, and placed some cold headers and other pipe lines in the sampling aisles which are subject to controlled access.

Once the third level was established as the location of the feed tank gallery, the position of the tanks and scales in relationship to their scale dials in the fourth level control room was studied. It was decided that standardized transmitting scales should be used because it was not possible to arrange simple linkage between the scales and the scale dials in the control room.

Several designs were considered in an attempt to achieve a suitable crane maintenance area. Some of these plans included mounting a crane on an elevator at one end of the building so that it could be lowered to a crane maintenance area, the use of a rail traveling frame supporting two booms which would be controlled from the crane cab, and a turntable arrangement whereby a jib crane could be removed through a small opening for maintenance. After evaluation of several alternatives, identical crane areas with sliding steel doors were decided on and located on the fourth level of the building in line with the Hot and Warm Canyon cranes.

Later, towards the latter part of 1954, it became necessary to provide additional shielding around the ends of the doors on the Hot Canyon crane maintenance area to decrease radiation leakage. After a study of the problem, a carbon steel shielding baffle was attached to the east wall and installed to fit between the doors when they are in a closed position.

Electrical Facilities

Since concrete would be poured long before much of the detailed electrical design was made, the exact locations of much equipment in the center galleries could not be determined in time to imbed motor conduit runs in floors and walls. Furthermore, such installation of motor conduit runs would have made relocation and revamping of process equipment difficult. Lighting conduit and fixture installation were subject also to piping interferences. It was, therefore, decided to run exposed conduit for motor feeds. For the basic lighting system, conduit was concealed in concrete except in cases of interference where surface extensions were made. At Hanford each building section had its own instrument control panel and motor starters. This kept the amount of conduit and cable runs to a minimum. At Savannah River, however, instrument panels for all building sections were grouped together to facilitate operation. Because of space limitations, motor control was also grouped in control rooms. These factors greatly increased the amount of control and instrument wiring but improved control and permitted reduction in operating personnel.

Normal installation of conduit or metal duct would have been impossible because of prohibitive space requirements. Expanded metal trays were adopted. To minimize the likelihood of a fault in power feed or instrument wiring causing damage to other runs in the same tray, it was decided to use in these trays only multi-conductor cables, each with its own neoprene or plastic jacket.

Within the canyon areas a hazard not present in the original Hanford Plant was introduced by the use of flammable solvents. Ventilation, however, provided a positive down draft in the canyon which minimized the possibility of fire hazards extending beyond the canyon walls. Consultations between various du Pont groups, including Fire and Safety, led to the classification of the canyon area from the connectors downward as Class I, Division 2, locations as defined by the 1951 National Electric Code, Article 500. It was agreed that operation and maintenance of the canyon area would neither require nor allow separation of the two halves of the cell connector under load. All cell motors were specified as explosion-proof and were painted with special acid-resisting Amercoat, to reduce possibility of corrosion and subsequent shorting out.

A basic principle of design specified by du Pont was the complete interchangeability of wiring so that any electric cell connector could be used for any device or service. Of the electrical equipment used in the canyon, the largest load was a 40 hp. centrifuge motor requiring #4 wire with the type

of insulation specified. The fire detection equipment known by the trade name, Fireye, which was installed in the canyon, required shielded wire to prevent inductive or capacitive pick-up with other a.c. circuits in the same conduit. Three #4 and three #8 AWG shielded wires were used in the conduit from the center gallery second floor level through the canyon wall to all cell connectors. It was decided first that wire insulation used in the canyon areas would be a polyvinyl chloride type duplicating that at Hanford. After radiation exposure tests at Knolls Atomic Power Laboratory, however, polyethylene plastic insulation which was not as subject to embrittlement and cracking under prolonged exposure to radiation was selected.

In order to proceed with construction while detailed design was being made firm, a basic design for concrete and imbedded piping was made for all building sections. Equipment grounding cables were cast into the concrete with inserts on the surface at locations where connections were required. Electric conduits for all anticipated requirements were cast into the concrete. These extended from the outside of the building to the foundation slab and then to the first level of the center gallery. They also were installed from gang valve galleries to the first level of the center gallery and between levels in the center gallery. Slots were left between levels for installation of additional electric conduit, piping, and instrument tubing where detailed design had not yet been completed.

Auxiliary Power

Inasmuch as it was vital that some ventilation motors, lighting, and key process equipment be operated without interruption, an auxiliary source of power was deemed necessary. Battery installations were considered but discarded because of the large capacity required and also because most of the process equipment required a.c. power. Estimates were made of emergency power demands and data compiled on equipment in nearby buildings which could be supplied most economically from Building #221. From this information a total power capacity was determined. Gibbs and Hill then designed and procured all emergency diesel generator sets.

On the basis of the anticipated demand load, a 600 kw., .8 power factor, 60 cycle diesel-driven generator was purchased. From an electrical standpoint, a preferred location for the generator would have been near the center of Building #221. However, space limitations and the need for diesel cooling facilities in a Class I structure placed it in building Section 1. In the same vicinity was located the low voltage emergency switchgear consisting of two 1200

ampere circuit breakers, one connected to the emergency generator and the other to the normal power supply through a 750 kv.-a. load center, and electrically interlocked so that in case of a normal power failure, the diesel is started by battery power. When emergency power becomes available, the normal air circuit breaker connection is opened and the emergency air circuit breaker connection closed. Also included in the low voltage emergency switchgear equipment were secondary air circuit breakers for the vital equipment in the building.

Additional Items

Truck Well

Shortly after the outside walls of the Canyon Building had been poured, and major equipment sizes established, it was found that while the truck well opening into the Warm Canyon was large enough to permit entry of equipment and piping, the clearances were smaller than desirable and provided little allowance for installation of larger size equipment in the future. At first it was suggested that the well be moved to Section 18 but analysis indicated it to be more desirable to retain the well in Section 4 and increase its size.

A major heating and ventilating problem also arose in connection with the truck well opening. Due to the negative air pressure maintained in the Warm Canyon, it was discovered that the truck well door, if left open any length of time, would unbalance the air flow, causing possible contamination of clean areas. As a result, an extension tunnel with an air-tight rolling door was designed and a canvas curtain was installed to reduce air flow when the door is open. In addition, improved efficiency of this ventilation system can be obtained by the use of a special rail transfer car in the truck well. A mobile yard crane outside the well can lift equipment from a truck and set it on the rail car for transfer to the Warm Canyon crane by way of the truck well.

Observation Deck

The observation deck at the north end of the building, housing the observation windows in the hot and warm canyons, and the windows in the crane maintenance doors were added to provide direct observation of the canyons.

Bucket Storage Area

This was added to reduce the number of railroad cars required to deliver the slugs to the building.

"Swimming Pool" Work Platform

A personnel work platform was added across the "Swimming Pool" to make it easier to work on equipment in the pool.

Hot Canyon swimming pool tools and facilities for remote maintenance of contaminated equipment were added in 1955. These consist of an equipment holding fixture supported by three winches, a wrench assembly, gasket cutter, gasket inserting tool and a clamping tool to hold jumpers on the equipment holding fixture.

Similar facilities and tools were provided in the H Area.

Yoke and Jumper Storage Racks.

These were added to both the Hot and Warm Canyons to provide storage space for these components.

Unloading Platform

This facility was erected at the southwest corner of Building #221-F late in 1954 to facilitate the delivery of work clothing to the freight elevator. The addition of this concrete structure eliminated entry of material in a regulated zone.

Equipment

Evolution of Machine and Process Equipment Design

The design of major process equipment in Building #221-F is based either on proven facilities operated at Hanford or on experimental prototypes developed by U. S. Atomic Energy Commission installations at Los Alamos (LA), Oak Ridge National Laboratory (ORNL), Argonne National Laboratory (ANL), and the Knolls Atomic Power Laboratory (KAPL). Modification and improvement of design were accomplished through the cooperation of such du Pont groups as the Atomic Energy Division of the Explosive Department, and the Design Division, the Engineering Research Laboratory (ERL), and the Mechanical Development Laboratory (MDL) of the Engineering Department. Assistance in over-all design was given by du Pont's subcontractor, the Blaw-Knox Construction Company, of Pittsburgh, while special equipment design work was also done by the American Machine and Foundry Company and Gibbs and Hill, of New York, the Schutte-Koerting Company, of Cornwell Heights, Pa., the Penberthy Injector Company, of Detroit, and the Allstates Engineering Company, of Trenton, New Jersey.

Separation Process

Major items in the remotely controlled separations process consist of the dissolvers, centrifuges, evaporators, mixer-settlers, decanters, cell tanks, piping, instrumentation and jets. These are supplemented by cranes, samplers, gang valves, process vent systems, and gallery tanks.

Dissolvers

The two vertical stainless steel dissolvers in the Hot Canyon are modeled after the Hanford design and have the same material of construction, metal thicknesses, instrumentation and services. They differ only in that (1) they have a mechanical device for charging slugs through a small opening and (2) the off-gases from these units pass either through an iodine reactor and filter to Building #221-F "A" Line absorber or are directed through Building #292, Fan House, to Building #291, Stack.

Before a final design for the process could be adopted, decisions had to be made on the use of fumeless or Hanford Type dissolvers, and the use of a caustic scrubber or heater-reactors for off-gas removal. In addition, an acceptable design had to be developed for charging and closing the dissolvers.

Design effort at the start centered on developing a fumeless dissolver which would remove and separate the inert gases from the highly radioactive gases, mainly krypton and xenon, without releasing off-gases to the atmosphere. The Oak Ridge National Laboratory investigated this process and provided du Pont with the information required to design a fumeless dissolver. Additional information was obtained from a study of prototypes developed both at Oak Ridge and at the Argonne National Laboratory. The Oak Ridge National Laboratory model was followed largely because it operated without pumps or valves, in line with a principle adopted to preclude the possibility of any radioactive gas escaping during the dissolving process.

On August 31, 1951, Oak Ridge released a preliminary flow sheet for an off-gas process using the fumeless dissolver which provided for the storage of the removed krypton and xenon in metal cylinders. Due to the large volumes involved, an underground tank storage area was considered and designated Building #242-F. Later, on November 11, 1951, an estimate was prepared which placed the cost of gas processing for the "F" and "H" Areas at \$14,000,000. This cost was prohibitive and design of the off-gas recovery and storage facilities was discontinued by a directive of the AEC.

When design of the off-gas processing system was halted, attention turned to a new system providing for gas disposal to the atmosphere. On December 18, 1951, design was authorized to proceed with a system of piping gases from the iodine removal equipment to the "A" Line absorber. Provision also was to be made for by-passing the absorber and sending the off-gases to the stack, Building #291.

In connection with the plant's development program on flat fuel elements, brief attention was given early in 1953 to the installation of a horizontal dissolver. When it was evident that the adoption of the new fuel shape would be delayed, further developmental work on the horizontal unit was discontinued.

Charger

The charger which is used to load uranium slugs into the dissolver consists of a funnel type hopper, a transport bucket, and guides for locating the bucket in relation to the hopper. Designed and tested by AM&F, it was adopted on the basis of simplicity, ruggedness and ease of operation. The following were considered as alternative designs. Non-splashing of the radioactive fluids was an important consideration.

1. A hopper which would be pivoted in the dissolver and discharge its contents on an inclined chute so that the slugs would slide into the fluid.
2. A spiral chute which, after being loaded, could be lowered into the vessel.
3. A fully charged bucket to be lowered, with its contents, into the dissolver.
4. A vending machine type hopper.
5. A gooseneck hopper, one end of which would be charged and the other pivoted into the vessel.

Closure

The closure, which seals the vessel against gas and acid leakage, is a renewable, conical lid. After the dissolver is charged through the 12-inch opening, the closure is lowered in place by the crane.

The following methods and materials were considered for sealing the dissolver: "O" rings retained on a 12-inch cylinder with the lid held down by clamps; "O" rings retained by a torus with a weight supplying the pressure; flat gasket on flanged lid; solid Kel-F "O" rings with standard size grooves; solid Kel-F "O" rings with under size grooves; Kel-F coated silicone rubber "O" rings; Teflon flat gaskets on a tapered lid; and a conical lid with "O" ring retaining grooves.

The conical closure arrangement was selected because of its simplicity, ease and economy in replacement. The other designs were more complex, costlier and provided no better seal than the conical closure.

Heater-Reactors

The original design of the dissolver system called for the use of a caustic scrubber to remove the off-gases. In April, 1951, however, the equipment was changed to utilize a silver nitrate reactor which had been designed by and used at Hanford since October, 1950. The principal reason for the change was the finding that the silver nitrate reactor was better than 99% effective in the removal of radioactive iodine from the off-gases. It was determined also that the life of the silver nitrate reactor would be from 10 to 15 years and that replacement of the unit could be made whenever its reactivity was exhausted. The use of such a reactor also removed the need for the storage facilities required by the caustic scrubber. This alone made the selection of the reactor economical.

The problem of heating the silver nitrate reactor during processing of the off-gases produced several lines of investigation. Finally, it was determined that steam was preferable to electricity because it simplified temperature control and eliminated the need for replacing burned-out electrical heating elements.

The dissolver off-gas heaters and reactors in Building #221-F were designed originally as separate units for 150 p.s.i.g. steam pressure operation. However, in the latter part of 1952, these were combined in one unit with the heater designed as a jacket around the reactor. This change provided operation of the combined unit at 195 p.s.i. as well as facilitating maintenance due to its compactness.

Centrifuges

The two stainless steel basket-type centrifuges used in the head end treatment in the Hot Canyon are similar to

the Bird Machine Company's design used at Hanford. Extensive development and testing was done at Savannah's Building #678-G, Pilot Plant, to overcome the mechanical faults of the Hanford unit. The plows used in the Hanford unit to remove cake from the interior of the bowl were eliminated since the cake is cut from the bowl with sprays, and removed as a slurry. The bowl sprays are mounted at different elevations in the centrifuge bowl to facilitate the removal of the cake. A d.c. braking system was added to insure stopping the bowl without reversing the rotation. This reversing action had in the past damaged the skimmers. Later, a "Revatrol" control system, developed at Hanford, was installed to permit the operation of the centrifuge at predetermined speeds below motor synchronous speeds.

Evaporators

Evaporator design was obtained from performance data on boil-up and condensing rates, and decontamination factors resulting from tests on a Savannah prototype evaporator operated at ORNL. In addition, data from prototypes operated at Brookhaven National Laboratory and the Mound Laboratory, were correlated with ORNL's findings to assure adequate design.

In the beginning, a single effect plate column was favored for all evaporators but this was later discarded for double evaporation in the high and low activity ranges to achieve the desired decontamination. Insulation was considered for both the dissolvers and evaporators, but a cost study indicated the results did not justify the expense.

When the Savannah River pilot plant evaporator exploded early in 1953 a detailed study of its design was made, but it was found in general to be adequate. However, changes were made to minimize the possibility of over-concentrating the bottoms product and plugging the vents through misoperation.

As an additional precaution against mishaps in evaporator operation, the steam pressure was reduced from 125 p.s.i.g. to 25 p.s.i.g. on all except the high activity waste and head end evaporators. This was done to prevent the temperature from rising above 130°C. Provisions were also made to convert the steam pressure from 125 p.s.i.g. to 50 p.s.i.g. on the high activity waste and head end evaporators if found necessary. Temperature limitation was incorporated because it had been determined that evaporators if operated above 130°C. could, through misoperation, effect a violent exothermic reaction of the tributyl phosphate with nitric acid, uranyl nitrate, or mixtures of the two. This reduction in steam pressure necessitated an increase in heat transfer surface to maintain the required evaporation rates. Therefore, two additional

pancake coils were added to all the evaporators which had not been fabricated. Also, when the steam pressure was reduced, it was necessary to install two LCU evaporators, since one could not handle the load under the new conditions.

In order to provide adequate throughput at the resultant lower evaporation rates, double evaporation in the low activity waste system was eliminated and the system was modified so that the two evaporators operated in parallel. At one point in design, an alternate low activity waste evaporation system was considered in which all feed would be neutralized before evaporation in order to eliminate any potential explosion hazards. This was abandoned since this system would reduce the amount of nitric acid recovered and add substantially to the volume of waste to be stored in Bldg. #241.

Additional review also brought other changes in the low activity waste evaporator columns as well as elimination of the flash evaporator which had been provided for removal of butanol from waste streams prior to evaporation. These evaporator columns formerly were non-standard to the extent that they did not contain bubble cap trays but utilized Centrifix mist eliminators. Centrifixes had been selected originally to avoid the fractionating effect and consequent reduction in nitric acid content of the overhead product when trays are used. With the elimination of double evaporation, the column decontamination factor overshadowed nitric acid recovery in importance so that bubble cap trays were selected in preference to Centrifixes because of the greater decontamination factor available.

In the process of minimizing potential hazards it was decided to transfer the LEU evaporator to the #221-"A" Line Building and also to eliminate the first stage evaporator. The latter was feasible since ion exchange proved more advantageous for final concentration of the plutonium nitrate solution which was previously the function of the first stage evaporator.

In 1953, a laboratory waste evaporator was added in the Warm Canyon to concentrate laboratory waste solutions which are too active for evaporation in the general purpose evaporators of Building #211-F.

As an added precaution all evaporator coils were pressurized to prevent the flow of fission products into the cooling water system. The automatic operation of the steam valve is such that the time required to close the valve is sufficiently long to permit air to enter the coil and maintain the coil at 8 p.s.i.g. minimum pressure. Opening of the water valve also is delayed automatically until the steam in the coil is displaced with air.

Safe operation of the evaporators was accomplished mainly by the use of flow recording controllers, temperature recorders and water temperature alarms. In addition, in the interest of avoiding another explosion, high temperature alarms, automatic steam shut-offs and pressure controllers were installed to prevent the coil steam pressure in the rerun, low activity waste, IEU, ICU, and laboratory waste evaporators from exceeding 25 p.s.i.g.

Mixer-Settlers

The stainless steel mixer-settlers of the Purex process consist of three 16-stage and one 12-stage units in both the Hot and Warm Canyons of Building #221-F. These eight multi-stage countercurrent contactors are operated on a continuous basis with agitation being provided by an agitator-pump located at the end of each stage of the mixer-settlers.

The full-scale mixer-settlers designed for the Savannah River Plant resulted from the combined efforts of KAPL, Blaw-Knox, SRP's pilot plant, and the du Pont Design Division and Engineering Research Laboratory.

At the inception of the Savannah River project a study was made comparing columns and mixer-settlers as they apply to the Purex process. Conclusions of the study favored the mixer-settlers. From a design standpoint, mixer-settlers are more compact and easily removed and replaced.

The Purex process, a chemical process for recovering plutonium and uranium and for process stream purification, was chosen over other separation processes in use at Hanford because the solvent used has a relatively high flash point, and because the process reduced the amount of high activity wastes to be stored. Initially, a tributyl phosphate-kerosene solution was to be employed as the extractant. In 1953, a still higher flash point kerosene, called Ultrasene, was substituted.

In adapting the Purex process for the Savannah River Plant use, the principal problems in the M-S units were process cycle development, standardization of M-S units and their stages, perfection of remote maintenance, the effect of the Hot Canyon vent header system on M-S operation, and the design of such mixer-settler components as the impeller, feed control assembly and disengaging chamber.

Originally work at KAPL on three prototypes known as "Mini", "Midi" and "Maxi" showed that 20 mixer-settlers operating on three cycles would be needed for an efficient Purex process extraction system. However, it developed later that two extraction cycles would give adequate purification, reducing the number of mixer-settlers to eight.

Early tests made by KAPL gave some evidence that emulsification would not be a problem and that standardized M-S units with a reasonable number of stages would suffice. These tests were instrumental in developing the full-size prototype units in Building #678-G.

Before standardization was accomplished many functional and flow tests were made to assure efficient operation. On July 20, 1951, a theory was advanced that Banks 1A, 1B, and 1C could be designed as a single unit to conserve space in the Hot Canyon. However, while the idea was operationally sound, it presented too many complex maintenance problems to be satisfactory.

From the earliest development days the predicted number of bank stages fluctuated until tests conducted in Building #678-G formally proved that standardization of the M-S units and stages could provide the required capacity and purification for Savannah's extraction process. On August 10, 1951, it was decided that the mixer-settlers would be standardized, adopting Type "A" with 16 stages and Type "C" with 12 stages.

In March, 1954, du Pont requested Blaw-Knox to study means of lowering the temperature of the jetted feed to 1A and 1D banks. As a result, stainless steel jacketed, pipe-type, heat exchangers were installed not only on Banks 1A and 1D but also on Bank 2A. This was preferred over the operation of precooling the feed before jetting, raising the feed tanks or providing direct jumpers to the banks to reduce the head and thereby lower jet dilution.

Several problems in remote maintenance developed in the design of the mixer-settlers. The unusual shallowness and large area characteristic of the mixer-settler induces tipping during remote handling. This is intensified by the shift in center of gravity due to the motion of the liquid held up in the bank. The difficulty was overcome by placing the lifting trunnion far enough above the center of gravity of the bank to reduce the tilt to a minimum. The height of the trunnions also was determined by the elevation of the canyon covers above the 1A Bank. To increase this suspension point, and to insure safe lifting, a mechanically interlocked connection is provided between the hook on the lifting yoke and the trunnions.

Because the mixer-settlers in the Hot Canyon are tied into the Hot vent system, fluctuations in the vent header pressure could affect mixer-settler performance adversely. This was corrected by providing a pressure equalizing hole in the vent jumper to bring the mixer-settler pressure closer to atmospheric level and thereby reduce the effect of header fluctuations.

The selection of variable speed drives and the regulation required at any set speed was based on tests at Building #678-G. The first impellers delivered to the site were defective because of shroud plate and vane warpage. To correct this the width of the vanes was increased so that the plates could be riveted instead of welded to the vanes. Riveting, however, caused the plates to split, so welded tie rods were used to attach the plates to the vanes.

Speed variation for the mixer-settler motors is provided by means of a 20-60 cycle variable frequency electrical generator for each bank. Control and indication are provided at fourth level instrument panels. Original operation instrument requirements were modified after start-up to include the indication of stoppage of an agitator motor in its initial stage or the cessation of any other motor. Since spare connectors were not available in the canyons, a relay system was developed using existing connectors and motor wiring.

The design of a removable feed connection was also a direct result of Building #678-G operation. Jetting required a jet feed control to insure a constant, steady flow to the mixer-settlers in order to effect maximum separation. This unit also was designed as a separate, remotely removable assembly to eliminate removal of the entire mixer-settler for maintenance of the feed assembly. Automatic feed control is discussed in greater detail under "Instrumentation".

Major contributions to safety in operation of the mixer-settlers are: (1) the use of chemical solutions which purify as well as separate the highly radioactive metals as they pass through the first three banks in the shielded Hot Canyon to the more lightly shielded Warm Canyon; (2) a limitation of M-S and tank size to safe-batch quantities to prevent criticality; (3) the separate processing of uranium and plutonium; and (4) the installation of numerous features for remote maintenance.

Decanters

Four stainless steel rectangular box-shaped decanters are employed in the canyons. One decanter is installed in the Hot Canyon rerun station and the other three are installed in the Warm Canyon in the solvent recovery system.

The decanter is an original design developed through the joint efforts of KAPL, ORNL, du Pont and Blaw-Knox engineers. The two National Laboratories furnished the necessary process data, while the engineering forces of both companies designed the decanter subsequently tested at the SRP pilot plant.

As a result of this testing, the design was modified to assure adequate separation of the organic and aqueous phases processed by the rerun station and the solvent recovery system. Later, major changes in decanter design consisted of submerging the liquid inlets and installing temperature measuring and control instruments to provide for turning off the steam at the gang valve when the decanter temperature became excessive. Modification included changes to the internal baffling.

The usual safety features incorporated in other canyon vessels are included in the decanter design in addition to the use of filters, seal pots and liquid seal loops to assure safe and efficient operation.

Cell Tanks

These tanks are stainless steel vessels standardized in five sizes with each having agitators, coils for heating or cooling, standard nozzle patterns, oil overflow tanks and lifting trunnions. They are patterned largely after similar tanks in use at Hanford with the exception that they are equipped with coils instead of jackets.

Jets

Two types of steam jets, transfer and constant rate jets, are employed to transfer process liquids between the canyon vessels in Building #221-F. The transfer jets are used for intermittent bulk transfer of liquids, while the rate jets provide a feed stream at a constant rate to the mixer-settlers, evaporators, and centrifuges.

Design of these stainless steel jets was accomplished by (1) adaptation of basic Hanford design for the transfer jets, (2) development of rate jets by the Schutte-Koerting and Penberthy Injector Companies, and (3) operational pretesting by the du Pont Engineering Research Laboratory and the SRP pilot plant.

The initial Blaw-Knox specifications indicated the need for 25 different jet sizes. Following a review by du Pont and Blaw-Knox engineers, it was agreed to reduce this number to a minimum, therefore, five of the proposed 11 constant rate jets were eliminated by better grouping. The number of transfer jets was reduced from 14 to 5 types by the same methods.

At first, this jet design program met with limited success in producing satisfactory prototypes. Problems encountered in the initial test work showed a need for an expanded jet testing program under more representative conditions. The water tests by ERL finally were abandoned and the program was expanded by providing facilities for pilot plant testing. In addition, a "jet committee" of du Pont specialists was set up for weekly discussions to formulate designs from test results. Final results permitted the consolidation of transfer jets and rate jets into standard types.

Piping

Specifications for process piping in Building #221-F were written by Blaw-Knox and Gibbs & Hill under the supervision of du Pont.

The canyon equipment is served by embedded, rack and jumper piping fabricated from stainless steel. All lines entering or leaving the Hot or Warm Canyon are embedded in the concrete walls and enter the canyons in most cases in a standard pattern for each 10-foot module of the building. The walls between the canyons and the center of the building contain piping and service facilities for cooling water, introduction of chemicals to the canyon equipment, piping to the samplers and instruments, and lubrication and electrical connections. The embedded piping in the opposite wall of the canyon provides for feeding steam to jets, removal of condensate and cooling water from the canyon, transfer of process fluids to the rack piping and for the removal of water and waste to the outside of the building. Rack and jumper piping is designed for remote installation and removal by means of angle-type or in-line connectors. These jumper pipes are prefabricated in sections of various lengths and shapes, designed to effect the required connections between wall nozzles, vessels, and pipe rack connections. Cell jumpers not in use are stored on a rack in the canyon or may be stored in the decontamination cell. Pipe rack jumpers have support legs to permit their temporary storage on any convenient horizontal surface in the canyons.

Special precautions are taken in the treatment of lines which transfer concentrated plutonium solutions from the canyon to "B" Line. Where these lines pass through areas which may be occupied by operating personnel, they are contained in watertight ducts or are enclosed in jackets pressured by compressed air. Special provisions are also provided for indicating and collecting drainage from these ducts and jackets.

All streams entering the canyon vessels from the gallery feed tanks are filtered to remove solids. A block valve outside and a seal pot inside the shielded areas guard against the back flow of gas from the canyon through the feed lines. A blind is also provided in all lines used for decontamination solutions since these lines are not normally used. This precaution was taken to guard against operational errors in the event the decontamination solution valve is opened by mistake.

Considerable time was spent on the design of the canyon jumper bailing required for remote installation and removal of the canyon piping. To simplify and standardize, and thus effect cost savings, a study was made of the Hanford bailing design. As a result of this study and an investigation of the stresses imposed on jumper piping and bailing during installation or removal, standardized bailing designs, using round bars and U-bolt connections, were developed. These designs were proof-tested in Building #717-F and adopted for all canyon piping. Adaptations of the standardized designs to accommodate special features were taken care of in mock-up prior to installation in the canyons.

One of the important piping features is the connector. This is a special jaw-type device by which pipes and conduits can be remotely connected by tightening a stainless steel screw. In the remotely maintained areas, removable sections of piping have a connector fitted on each end for attachment to connector flanges on process vessels and to fixed piping built into the structure. The Hanford type connector and the SRP in-line connector are the two types utilized.

Connectors for pipe and electrical use are identical to those employed at Hanford except that they have a stainless steel actuating screw and jaws. The modifications of the Hanford connector were due to the inadequacy of the gasket and the rust and corrosion of the steel actuating screw. The use of stainless steel rather than carbon steel for the jaws and screw created two additional problems; namely, the elongation of the connector jaws and galling of the screw threads. The solution to these problems is outlined in the following paragraphs.

Tests by ERL were initiated in 1952 to find a combination of Teflon and asbestos or fiberglass which would give the chemical and physical properties required for a satisfactory gasket. Hanford experience had indicated that neither the Blue African asbestos nor Teflon provided a leak-free, thermally resilient, resealable, and re-useable gasket with the long life required for remote operation in the canyons. The first step in this project was a preliminary survey conducted by the Johns-Manville Company and ERL which eliminated many types of Teflon impregnated asbestos and fiberglass because they did not meet one or more of the requirements.

Selected materials were then tested for compressibility, cold flow, recovery from compression, sealing efficiency, and crush resistance. It was concluded that Teflon-filled fiberglass and Teflon-filled woven Blue African asbestos laminates were generally suitable for further investigation.

On the basis of these findings, ERL subjected gaskets of the selected materials to three series of tests in dummy flanges and Hanford connectors exposed to varying nitric acid solutions, steam pressures, and cold water. Also, an impact wrench from Hanford was used to study the effects of pressure applied by this device on the gasket materials.

Field tests conducted at SRP using canyon piping and equipment indicated that the gasket materials adopted for canyon service were not capable of withstanding actual operating conditions in some cases. These tests showed that the Teflon-filled Blue African asbestos gasket was best for the majority of canyon applications, and Blue African asbestos service sheet with Buna-S bonding was best for the more critical applications.

Review of the problem in January, 1954, indicated that while the previous tests showed Teflon-filled Blue African asbestos and Buna-S bonded Blue African asbestos gaskets to be applicable to process and service connections, respectively; there were enough unknown factors to justify further work to develop back-up materials in case these two failed to meet operating standards.

In order to expedite development of better gasket materials, a program was initiated to develop gaskets under laboratory conditions at the Johns-Manville Company and also test the candidates in a jumper mock-up unit installed behind Building #717-F to simulate such operating conditions as misalignment, impacting, and sticking.

Over a period of time, several types of materials were tested at Johns-Manville and in the mock-up facilities at the Savannah River Plant. Of those tested, a gasket known as JM-719, fabricated of Teflon impregnated white asbestos with two fine strands of stainless steel wire, and the newly developed Teflon stainless steel ring gasket showed the most potential. As a result of these tests, JM-719 type gaskets were installed in all 3-inch connectors in the canyon piping. However, since the strength of the JM-719 gasket was only slightly greater than the expected loading to which they would be subjected, it was decided to continue testing other gaskets. It was determined from this second test period that a variation of the stainless Teflon ring gasket would be capable of withstanding the maximum loading imposed by

the connector assembly. These gaskets, therefore, have been recommended for replacement of the JM-719 gasket if it should become necessary.

During testing of the prototype of the Hanford connector at Building #717-F it was found that the connector jaws had a tendency to elongate after extensive use. This shortcoming was overcome through the use of heat treated type 410 stainless steel forgings for the jaws on those connectors requiring frequent use.

To overcome the problem of pivot screw galling, molybdenum disulfide grease was applied on the screw.

The in-line connector, a new design developed by the du Pont Mechanical Development Laboratory, is similar to the Hanford type except that it provides for in-line flow and has an off-center geared drive instead of a direct drive by a pivoted screw.

MDL began its work in September, 1952, in response to a request for a connector that could be operated remotely and would provide for expansion and contraction of the pipes. The first connector designed by the group could be coupled by a standard impact wrench and included a stainless steel bellows to compensate for any differences in pipe length resulting from thermal changes. Stainless steel bellows had supplanted Teflon which, under simulated service testing, had become brittle. As work with the experimental model proceeded it became evident that the drive mechanism was too complicated and the unit itself was too heavy. Four prototypes of a simplified design were then built by the MDL shop, two with stainless steel expansion bellows and two without. Continued testing led to a discard of the bellows model because of the likelihood of high maintenance costs and the accumulation of radioactivity. Two models without bellows were sent to Building #717-F at Savannah River for further analysis of their operating characteristics and efficiencies. These tests led to the adoption of the in-line connector.

For a time it was thought that the in-line connector could replace the expansion loop in the vertical rack piping and thus eliminate liquid hold-up, solids settlement, and other difficulties associated with mixer-settler feeding. Mock-up tests at Building #717-F showed that in-line connectors were well suited to 2-inch rack piping lines where pipe expansion could be accommodated in the normal configuration of the piping. Investigations were then started on the use of horizontal expansion loops with 3-inch in-line connectors but this idea was abandoned because the many changes required would delay design and construction. As a result, the use of in-line connectors was confined to 2-inch rack piping. As a

final change in piping in the Hot Canyon, the integral loops of the original rack piping vertical expansion, supporting plates were redesigned to make them individually removable from the plates by means of the in-line connector.

Extreme precautions were taken in the design and fabrication of embedded piping because this was regarded as a critical factor in determining the life and utility of the Canyon Building. All welded stainless steel pipe used for embedded services and for hot lines was, with very minor exceptions, X-rayed before installation. Configuration of the embedded lines had to be revised during the course of fabrication in order to provide for the maximum amount of shielding and protection to personnel.

Instrumentation

The instrumentation serving the separation process in the canyons of Building #221-F was developed through the joint efforts of Blaw-Knox and the process and instrument specialists of the du Pont Engineering Department. Study and criticism of each flow sheet and every instrument application served to develop the coordinated instrument system to its present design.

The operation of Building #678-G, the #200 Area Pilot Plant, during the early stages of design was responsible for the successful resolution of all questionable applications. The opportunity was taken to mock up, test, and alter as necessary, all instrument systems in which difficulties might be anticipated. It was found that some of these would have caused start-up delays due to on-the-spot development programs.

The instrumentation problems related to the canyon facilities of Building #221-F included those connected with the Fireye detection system, temperature monitoring system, centrifuge, process radiation monitoring, dissolvers, and off gas system, mixer-settlers, evaporators, decanters, and the feed tank gallery. In addition it was also necessary to modify commercial differential converters to meet the standards required by the Savannah River Plant.

Fireye Detection System

This system was chosen because of its ability to detect small fires on the basis of modulated photo radiation rather than thermal radiation. This was considered necessary because of the "open" type design (canyon rather than cellular) employed. It was felt that a thermal type of pick-up would be sensitive to large fires only, due to thermal drafts in-

volved in a large open structure. Actual tests developed the feeling that a flame as small as two inches in diameter and as large as three feet in diameter would actuate a Fireye system. However, it was found that the sensitivity of a Fireye system drops off to such an extent that actuation above fifty feet is unlikely. This was considered an advantage in the segregation of deluge canyon sections.

Radiation tests indicated that a minimum of four months photoelectric cell life could be expected in the head end of the process, while a considerably longer life could be expected in sections having lower gamma radiations. These tests also indicated that plastic lenses over the Fireyes were unsatisfactory, but that lime glass, even though it became violet in color, would be satisfactory.

Two Fireye systems were installed in each canyon section and connected to operate in a coincident manner. This was done to prevent false alarms occurring from certain types of Fireye failure. In the middle of 1954, these originally-installed units were replaced by a new type Fireye detector because the extended wet condition of the canyons caused failure of the existing cells. The new type of Fireye installed is a moisture-proof cell in a glass envelope similar to an electric light bulb.

Temperature Monitoring System

Sometime after it was decided that a Fireye system would suit conditions in the canyon, a thermocouple actuated temperature monitor was added. This monitor covers a number of points in each canyon, including the pipe rack and air duct outlets. It was added as a back-up device for the Fireye system and its primary importance lies in the fact that it senses fires of a large magnitude which could cause failure of the other system. This monitor has since become important as a means of manually balancing the heating and ventilating system.

At a relatively late stage of design, certain thermocouples in each building section were connected to a selector switch which allows a selection of thermocouples for temperature monitoring or heating and ventilation controls. This provides a temperature control based on the heat load from any canyon section, a feature desirable due to varying temperatures and loads in the various canyon sections.

Process Radiation Monitoring

In the early stages of design it was decided that the canyon process vessels should be monitored for radioactivity. Since this was being done at Hanford by means of ion chambers pushed through tubes in the shield wall, it was decided to do the same at the Savannah River Plant. As design progressed, it became apparent that the open canyon as compared with the Hanford cell-type canyon created a problem because of radiation interferences from adjacent vessels. The cell-type canyon at Hanford segregated the vessels and provided the necessary radiation shield between vessels.

One of the possible solutions investigated at Savannah was scintillation counting. It was decided, however, that even though scintillation would be selective for different energy levels, the count rate would be above the limits of resolution of any known equipment.

Another avenue of investigation involved the use of ion chambers in local shield containers immediately adjacent to the vessels. Since this would require the use of remote connectors in the signal cables or the "draping" of signal cables over the crane cab shield parapet, the scheme was abandoned.

It was finally decided that ion chambers in the shield walls would be used. This involved two problems: first, collimation, in which an ion chamber "looks" at only a particular low activity vessel; and second, a reduction of signal intensity in the case of the high activity vessels.

Collimation Collimation for the low activity vessels was achieved by adding lead and steel shields, parallel to the canyon wall, to shield the ion chamber from adjacent vessels. The window for the ion chamber was covered with a proper thickness of lead to absorb the secondary, reduced energy radiation from the vessel being monitored, but produced by adjacent vessels.

Reduction of Signal Strength This was achieved for high activity vessels by pulling the ion chambers up in the tube far enough to provide sufficient shield. It was noted that this method also produced good collimation for a vessel being monitored. The exact position required for the chambers was determined by trial-and-error methods. A satisfactory position is always obtainable since the ion chambers can be manually changed from a position of highest radiation to a position behind the shield wall where no radiation exists.

Dissolvers and Off-Gas System

This off-gas system of the Hot Canyon is combined with the operations of the "A" Line and Stack Building #292-F. For this reason, it was necessary to develop a fail-safe system which would divert dissolver off-gas to the Building #292-F steam jet in case of an electrical failure involving the off-gas blowers in "A" Line, loss of vacuum at the dissolver, or loss of instrument air at either the "A" Line or Building #292. To avoid collapsing the dissolver, due to excessive vacuum, a special "Varec" gravity loaded relief was employed.

A problem arose in the operation of the Nash positive displacement blower on the "A" Line absorber since it must be operating before connection to the dissolver. Since an open suction is required for starting the blower, a special bleed valve was added to the blower suction line to the dissolver. This valve is interlocked so that it will open when the dissolver is shut off.

Centrifuge Centrifuge skimmer actuators in the hydraulic system on the Hanford units were panel-mounted and manually controlled, whereas the Savannah units, due to distance from the control room, had to be controlled remotely. The skimmer, a means of drawing off effluent from the centrifuge, consists of a hydraulically-actuated pipe which is positioned to "skim" the surface of the rotating liquid causing that liquid, due to its velocity and mass, to flow into an adjacent vessel through the skimmer pipe. Outside the canyon wall is mounted a pair of hydraulic cylinders similar to those at the skimmer pipe. A lever is attached which, when moved, causes the piston to actuate the skimmer pipe via the hydraulic system. This duplex piston-lever arrangement is panel-mounted at Hanford and the manual operation allows a certain "feel" which can be utilized for exact positioning of the skimmer pipe. The handle position is also calibrated so that the location of the skimmer relative to the centrifuge bowl is known.

It was decided to reproduce the "feel" and handle calibration for the Savannah River Plant through the use of pneumatic instrumentation. The proposed method involved the use of a 200-inch differential pressure transmitter connected across an oil system, and with an equalizing valve.

After further study of this system, it was discovered that the oil differentials greatly exceeded 200-inches of water. The original transmitter had too low a range, so a transmitter with a much greater range had to be used. It was further found that some experience was necessary to

interpret gauge readings because of pressures developed in the hydraulic system due to piston friction. The hydraulic systems were reworked to provide minimum friction which, in turn, made interpretation of the gauge readings less difficult.

The actual plant installation brought to light another problem, that of filling the system with oil and bleeding the air. The jumpers, centrifuge piping, and outside canyon wall hydraulic piping all had to be reworked to provide greater than normal slopes. In addition, alterations and vents were added at various points to allow air bleeding.

Mixer-Settlers

The instrumentation problems related to the mixer-settlers were concerned with the development of a method for the remote measurement and control of the aqueous and organic interface level and of an automatic feed control for the constant rate jets transferring solutions to these units. These problems were solved through the cooperative efforts of the Knolls Atomic Power Laboratory and the du Pont Design Division and Engineering Research Laboratory, in conjunction with experimental testing at the Savannah #200 Area Pilot Plant in Building #678-G.

Interface Aqueous-organic interface level had been controlled primarily in a manual fashion by pressurizing an aqueous outlet weir box and observing the interface through a sight glass. Unsuccessful attempts had been made to control the weir box pressure automatically from an "average" signal from two dip tubes in the mixer-settler. This failed because of high capacity and lag in the settler signal and low capacity and fast response in the weir box control section. A satisfactory, stable control loop was finally obtained by moving the high pressure (aqueous) dip tube to the weir box. This method, even though the interface level lag was still present, allowed the signal lag to be reduced to the same as that of the weir box control lag.

Since the dip tube, or differential pressure type of interface level control, is sensitive to specific gravity, i.e., subject to error with changes in specific gravity of either phase, an insensitive device had to be developed. This took the form of a multi-resistance probe in which more or less resistance is shorted out by the aqueous phase. Development started with a Republic Flow Meters Company "flow scale", but the final unit has only 10 stainless steel electrodes on one-inch steps with 400 ohms across each electrode. This unit operates on an a.c. bridge recorder to record interface level in the mixer-settler. The multi-probe device gave indication of failure in very weak solutions,

and required such a long development and test period, that Design and ERL were requested to back it up by development of pneumatic and electronic alternates.

The Engineering Research Laboratory developed an RF type of inductance probe which proved satisfactory but its use, would involve rewiring the canyon jumpers and is considered only as a last resort.

The Design Division developed an all-pneumatic, specific gravity compensated, interface level detecting device which operates very satisfactorily over a wide range of specific gravity changes. Since this is cumbersome, complicated, and employs six major interconnected pieces of pneumatic instrumentation as a sensing element, it will not be used unless the electrode device proves unsatisfactory. It is anticipated that even then only those electrode devices which will not operate due to low acid concentration will be replaced.

Automatic Feed Control Constant rate jet feeding had been performed only in a limited manner prior to Savannah River design. In common practice, steam pressure on the feed jets was manually controlled, based on performance data and tank outages. Due to the quantity and complexity of equipment, a fully automatic mixer-settler jet feed control became desirable. The final system is somewhat unorthodox in that flow is measured by inference using as a guide the level in a feed "hat" having a limiting orifice in the bottom and that the jet rate is controlled by throttling steam pressure rather than by recirculating a portion of the discharge into the feed. This design was adopted to prevent overheating of the feed material and also because it met the criterion of no instruments in the canyon.

The first scheme investigated was to throttle the steam pressure as a function of "hat" level. This was an extremely unstable control loop in that it involved a high capacity and low capacity function in the same system. The final satisfactory control equipment required a cascade system in which a steam pressure loop is reset by a liquid level control. It was found that controller adjustments were not critical and that control could be maintained to better than required accuracy depending on the proximity of the control point to the jet low cut-off point. A low set point limiting device was added later to insure controller operation sufficiently above the low jet cut-off point.

Investigation of this control system instituted a jet design program in which du Pont worked with the jet vendor to produce satisfactory uniform feed jets.

In connection with the jet development program, mock-ups brought to light a deficiency in the rack piping. The rack piping used for the mixer-settler feed was redesigned, utilizing the "in-line" connector to force the pipe line to run "full" under all conditions.

To provide additional information on jet performance, steam flow meters were added to the constant rate jets. Steam flow vs. pumping rate curves are used to indicate reductions in jetting efficiency, thus indicating when maintenance is required.

Evaporators

Evaporators originally employed liquid level, specific gravity and temperature differential pressure instruments to indicate boil-up rate, steam flow rate to the coils, and vent temperature. Explosion of the pilot plant evaporator in January, 1953, emphasized the need for additional safety devices. The following were added:

1. A steam pressure control to the evaporator coil;
2. An interlock between the condenser water and coil steam so that the steam cannot be turned on until after the condenser water valve has been opened;
3. High coil pressure alarm and shut-down;
4. High evaporator batch temperature alarm and shut-down;
5. High evaporator body pressure alarm and shut-down; and
6. High and low level alarm.

In the evaporator redesign program, it was realized that combination steam and water coils should be pressurized at all times to prevent radioactive solutions from entering a leaking coil and subsequently entering the cooling water system. Several changes were made.

1. An air pressure regulator was added which is supplied with air at a higher pressure than the steam and adjusted to maintain a pressure on the coils above the pressure of the liquid in the vessel even though steam or water is shut-off.

2. A pressure control valve was placed after the steam traps to maintain a higher pressure ahead of the traps than that maintained by the air regulator.
3. A low steam pressure control valve shut-down and alarm was installed. The purpose of this device is to close the primary steam control valve at a slow rate when a preset low point has been reached. It was felt that this would prevent collapse, due to rapid condensation of the steam in the coils, or pressure and momentary vacuum in the coils, a condition which would suck radioactive materials through any breaks or openings.

Decanters

For safety reasons the jetting of solvent from the decanter was limited to a specified maximum temperature. A specially designed, high response, low mass resistance thermometer element was designed and positioned by trial-and-error in the decanters. This thermal system is connected to a recorder and high temperature alarm located on the panel board in the fourth level control room of Building #221-F.

Feed Tank Gallery

The fifty per cent caustic feed tanks created a problem in liquid level measurement. It was decided that dip tubes would not be used because CO_2 in the instrument air caused a buildup of NaCO_3 on the bottom of the tubes. The alternate used was a Taylor Instrument Company 1 to 1 diaphragm-actuated transmitter, and non-linearity of output pressure at low levels caused significant calibration errors. This was resolved by calibration between points at 40% and 100% of scale rather than the normal 0% to 100%. Since the system becomes unreliable at less than 10-inches of static water pressure in the vessel a minimum operating head of this amount is retained.

Differential Converters

Approximately 1000 differential converters purchased for use in Building #221-F and other project facilities were found to be unsatisfactory. After the required changes were made by the vendor, further operational data and test results indicated that the transmitter was barely acceptable. In fact, to avoid the purchase of another type of unit, the following special calibration procedure was adopted to prevent excessive "zero shift".

1. Necessary adjustments were made for range and zero.
2. Adjustments were set, cover bolted and transmitter exercised by applying a 400% over-range to the primary element 18 to 20 times.
3. Calibration was rechecked and the results obtained were accepted.
4. The loop, i.e., transmitter and recorder as a unit, was calibrated from 0 to 100% of the scale between primary element of transmitter and recorder pen reading only.

The above procedure was adopted for the majority of the transmitters at the Savannah River Plant.

Supplementary Canyon Equipment

Cranes

The cranes of Hanford and the Savannah River Plant are basically similar. The Hanford 75-ton crane does not have the fine control or certain special features as auxiliary truck-wheels and cable cutters provided on the SRP Hot Canyon crane. The 50-ton crane in the Hot Canyon and the 15-ton crane in the Warm Canyon of Building #221-F at the Savannah River Plant are primarily different in physical design since the latter is not provided with optical devices and does not have any shielding around its cab. However, in addition to its maintenance crane, the Warm Canyon is also serviced by a separate electrically-operated maintenance bridge.

Since the Hot Canyon at SRP is inaccessible, all illumination is provided by special industrial type lamps installed on the underside of each bridge girder. Lamps are so mounted that they can be maintained when the crane has been moved to the maintenance area. All cable is festooned to prevent entanglement. A separate 45 kv.-a. lighting transformer is provided. The crane power is supplied through overhead conductor angles by way of under-riding shoe type collectors.

Optical System

This system includes two large periscopes mounted under the crane girders to permit the operator to view the crane hooks, impact wrenches, yokes, and cell equipment from the crane cab. The system also is designed for viewing the right and left sides of the Hot Canyon through three lenses of different magnification.

Initially, Hanford's two magnification type lenses were to be used. However this system was redesigned for three lenses in order to guarantee sufficient magnification to view all of Savannah's canyon facilities. Orientation of the crane cab console with both of the optical system eye pieces required a considerable amount of study to place all controls within reach of the crane operator and to orient them for blind operation.

Maintenance Bridge

This Warm Canyon equipment was added at Savannah to simplify maintenance where low activity levels allow intermittent occupancy. This electrically controlled, overhead traveling bridge provides a platform from which workers, with long handled tools, can perform maintenance work on canyon equipment.

Consideration was given to a standard type of a.c. power drive for this unit but an open trolley system was considered too hazardous to personnel. In addition, the trolley conductors would be so close to the canyon that arcing trolleys would constitute an explosive hazard. The use of cable reels was discarded because of canyon length. It was then decided that a d.c. battery-operated unit would be the most feasible.

Communication System

Communication to the Hot and Warm Canyon crane operators is by means of a carrier current system utilizing trolley power conductors. At Hanford, telephone communication and intercommunication systems were used with separate trolley conductors. Operation of these systems had been noisy and a separate trolley or cable was expensive and required much maintenance. Cable reels were considered as an alternative but were discarded because of prohibitive lengths. When attention turned to a carrier current type system, Blaw-Knox and du Pont engineers visited the Homestead plant of the United States Steel Company in Pittsburgh to witness a somewhat similar installation in operation under very adverse conditions. The demonstration proved the system to be adaptable to canyon crane operation. At Savannah, two high frequencies superimposed on the 60 cycle power feeders are used for communication between the Hot Canyon supervisor's office and the Hot Canyon crane operator. Two different frequencies are superimposed on the 60 cycle trolley for communication between the Warm Canyon supervisor's office and the Warm Canyon crane operator. Later, a request was made for communication facilities between the crane cab and any station on the private security telephone system.

The manufacturer of the carrier system supplied a switching station at the canyon supervisor's offices for this connection and, after considerable experimentation, details of the circuits and circuit constants were worked out.

Special Control Devices

The following special features were incorporated in design for maximum protection of the crane operator in the Hot Canyon and to prevent production delays. In an emergency, the bridge and trolley can be moved from the crane cab either manually or by a fractional horsepower motor taking its power either from the crane lighting panel or from an external source in the event of main power failure. A 1000-foot cable can be used also to tow the crane manually to the crane maintenance area. An auxiliary set of wheels on hydraulically operated mounts is furnished for the end trucks. These wheels are for emergency use when one or more crane bridge wheels become inoperative. Operation of each wheel is controlled from the crane cab.

In addition, each hoisting unit is equipped with a mechanical load brake and an electrical speed control. A hydraulic brake for stopping the motor and holding the load is provided as well as two bridge brakes, one a hydraulic torque brake and the other a solenoid operated brake. Bridge footwalks are installed the full length of each girder in addition to a cross-over footwalk. Both the main and auxiliary hook cables and each cable of the monorail hoists can be severed by a cutting device in the event of a power failure. The bridge and trolley are lubricated from a manually-operated, centralized system.

Some of the special features characteristic of the Hot Canyon crane have been omitted on the Warm Canyon crane because the radiation hazard is less. These deletions include: (1) the auxiliary set of truck wheels, (2) the cable cutters, (3) the centrally controlled lubrication system, and (4) the bridge brakes, consisting only of the electrically controlled torque type.

The evaporator safety program undertaken in the early part of 1953 resulted in the decision to install a laboratory waste evaporator in Section 18 of the Warm Canyon. To provide for installation, maintenance and removal of these facilities it was necessary to install additional material handling equipment since the last module at the north end of each canyon could not be serviced by the maintenance cranes. In the Warm Canyon, an electrically operated monorail hoist and trolley were installed on a trolley beam suspended from the canyon roof. Additional yokes also were provided to assist in these operations. In the Hot Canyon, a special

four-hook yoke was furnished to lift the covers over the last two modules simultaneously.

Fireye Test Unit

At the Franklin Technical Institute, at Boston, devices were developed under the direction of the du Pont electrical design group to test the Fireye units in place. These consist of a pulsating light source, simulating a flame, mounted on the crane and directed towards the Fireye units. Under the control of the crane operator and with the observation of an assistant at the Fireye alarm panel in the dispatcher's office, each Fireye can be tested for satisfactory operability.

Impact Wrench

This facility is an adaptation of proven Hanford design. The only difference between the SRP and Hanford impact wrenches is the addition of an explosion-proof motor. Test work in Building #717-F determined average impacting periods for various connections in the Canyon Building. These tests also led to the installation of timers in crane cabs to stop the impact wrenches when the required impact times were reached.

Samplers

Four types of samplers serve the canyons or related facilities in Building #221-F. These include the Hot Canyon, Warm Canyon, cold feed and air samplers.

The remotely-operated sampling mechanisms in the Hot and Warm sample aisles of Building #221-F were modeled after a unit at the Argonne National Laboratory and improved through tests at ERL and Oak Ridge National Laboratory with design assistance from the Blaw-Knox Company.

In the early steps of design it was decided to follow the proven sampling units used by Hanford. However, after studies of more recent samplers at the various AEC national laboratories, it was decided to adapt the serum bottle-hypodermic needle principle to the Hanford sample cup. This combined design also was abandoned when it became apparent that the ANL sampler could not be adapted to the Hanford sample cup although it offered such potential advantages as more positive operation, less danger of contamination of equipment, greater operator safety, and increased flexibility.

The problems of sampler design included institution of a testing program to overcome the apparent deficiencies of ANL design, to prove the practicality of recommended changes, and to obtain operating data. Testing performed to develop an adequate sampler unit included a mock-up of piping by ERL which simulated the sampler's hydraulic system and prototype testing with actual solutions at ORNL. The latter led to improved carriage and needle wrench design which minimizes operational hazards.

In July, 1954, it was found advisable to install additional door stops for canyon service. Forty-one Hot and fifty Warm type door stops were ordered and a door stop is always kept in each sample box to catch any leakage from a previous sampling. Nine Warm Canyon door stops were modified to house a bottle capable of holding larger samples. Work with larger samples was of an experimental nature and it was first applied to sampling the spent solvent streams.

Later in the same year, sampling units receiving uranium solutions from several vessels in both the Hot and Warm Canyons were provided with additional connections and piping to allow operation by steam rather than air. Steam operation of these specific solution-bearing samplers prevented the crystallization of sampled material in the sampler piping.

The manually operated, flask-type, cold feed samplers attached to tanks in the gallery which feed the major components in both canyons were developed through the joint efforts of Blaw-Knox and du Pont. The portable room and canyon air samplers, however, were modeled after Hanford design and modified to meet the requirements of the Savannah River Plant.

The remotely operated sampling mechanisms serving or related to the canyon process were in general, except for the cold feed samplers, designed to obtain only controlled amounts of radioactive solution. Special sample carts were designed for safe transportation of the samples to Building #772-F for analysis.

Gang Valves

The gang valves at Savannah consist of an assembly of four Crane one-inch, brass bellows, sealed globe valves designed to provide in proper sequence the supply of steam and compressed air required to operate the transfer jets and steam spargers and for venting when they are not in use.

The design of these valves in the gang valve corridors of the Canyon Building was based on those in operation at Hanford. There the gang valves are operated manually. But

at Savannah River this is generally a remote, electric motor-driven operation. The position indicators on the SRP gang valves differ from Hanford in that signal lights are used for the three operating positions while Hanford uses a dial. Bellows sealed stems are utilized at Savannah in place of packed stem valves as at Hanford because seals reduce valve stem friction and steam leakage.

The major problems in design of Savannah's gang valves included selection of a valve disc which would result in less leakage than was experienced at Hanford, use of insulation, rearrangement of piping, and modifications to these facilities to obtain satisfactory operation.

Gang Valve Disc

Since operations at Hanford had shown that Crane discs had a tendency to leak, other materials were tested by KAPL and ERL, but this eventually led to modification of the Crane discs to provide a more leak-free design.

Insulation

Several modifications of conventional canvas covering were considered to achieve effective insulation of the gang valves and associated piping. These modifications included insulating multiple units in individual boxes and coating the present canvas covering with polyvinyl chloride. Both plans were abandoned as unsuitable to "F" Area gang valve operation.

Rearrangement of Piping

Design problems encountered in the gang valve corridor piping of Building #221-F were considerably amplified because development paralleled design. No Hanford design was applicable. It was necessary in the design of the gang valve piping for the Hot Canyon to provide for future insertion of steel plates behind the set-up for greater shielding if required. As the result of design experience in Building #221-F, an improved design was provided for Building #221-H.

Modifications

On the basis of prototype tests performed in Building #678-G Pilot Plant employing gang valves, a gang valve cam bar, and control valves it was found that the following modifications were necessary to obtain satisfactory operation.

1. The gang valve cam bar was redesigned to correct cam-stem clearance, and to increase the port opening to accomplish a reduction in pressure drop across the assembly.

2. Two hundred special gang valves with oversized ports were procured for use on start-up in locations where pressure drop might be too high.

3. On all jets handling solvents, reducing valves were provided to permit the required 85 p.s.i.g. operating pressure to be applied rapidly after the opening of the gang valves.

With these modifications it was felt that most of the jets would operate satisfactorily.

Safety in Design

Particular attention was given to reducing the possibility of contamination of gang valve piping and corridors from suck-back of radioactive fluids from the canyons. This is most likely to occur when the jets are started and shut down. Piping was carefully sloped to provide complete drainage and the pocketing of fluids in piping components was eliminated or kept to a minimum.

Emphasis was also placed on the use of proven Hanford design plus a great amount of operational testing performed by KAPL, ERL, and in SRP's Pilot Plant to assure adequate remotely controlled mechanisms to supply controlled amounts of air and steam to Building #221-F canyon facilities. For example, while testing has shown electrical control to be reliable, manual control of the components is also provided.

Process Vent Systems

Two types of vent systems exhaust air from the vessels in Building #221-F at a rate greater than that at which it is displaced when these facilities are being filled. These systems include the high and low activity vent systems serving the vessels in each canyon and the recycle vent system which exhausts air from the gallery feed tanks and closed sumps in the Canyon Building.

The major development work on these vent systems was done on the high and low activity vent systems because they handle the radioactive exhaust given off by the process in the canyons.

High Activity Vent Facilities

Initially, the vent systems in both the Hot and Warm Canyons were to be identical. However, in the middle of 1954, plans were made to revise the Hot Canyon vent system after start-up of Building #221-F. It was decided that the present dehumidifier and high activity vent system tank would be replaced with a caustic scrubber and a caustic circulating tank to remove ruthenium and iodine compounds from the Hot Canyon vent header. Moreover, to facilitate the operation of these new components, a feed tank was added to the feed tank gallery and changes were made to the piping, electrical facilities, and instrumentation in the ventilating tunnel, gang valve corridor, and cold section of the Canyon Building prior to start-up. Air from the vent system is carried through a vent header in a tunnel to the Sand Filters, Bldg. #294-F, freed of radioactive particulate matter, carried by a tunnel to the Fan House, Bldg. #292-F, and discharged through the Stack, Bldg. #291-F.

Headers

In the middle of 1952, the canyon vent system in each canyon was revised and was anchored in concrete to overcome expansion problems. Later, at the end of 1952, the process vent headers in the exhaust tunnels of both the Hot and Warm Canyons of Building #221-F were changed from 12 to 18 inches O.D. Further pressure drop calculations had indicated that the preliminary size of 12 inches for the header would be inadequate unless various sized orifices were installed in canyon vessel vent jumper piping. The use of such orifices was undesirable because it would have limited ability to interchange canyon vessels and piping, and required detailed records of the proper size orifices in the vent jumper at each location.

Filters

Initially two separate AEC #1 type filters operating in series were designed for each of the two process vent systems. This was later changed to parallel operation and the filter elements were changed to fiberglass because of the short life of the AEC or corrugated asbestos filters under the heavy loading imposed. These two separate fiberglass filters were later abandoned in favor of one high efficiency fiberglass unit comprising several layers of filter media enclosed in a stainless steel vessel to satisfy limited space requirements.

Safety in Design

Care was taken in design of the high and low activity vent systems to provide equipment which would decontaminate the exhaust from each canyon before releasing it to the atmosphere. For instance, a caustic scrubber was installed in the Hot Canyon to remove radioactive ruthenium and iodine, while the dehumidifier in the Warm Canyon prevents condensate from escaping with the exhaust. The recycle vent system has different components but their functions are similar since they are designed to remove contaminating particles from the exhaust before it is vented to the atmosphere.

Gallery Feed Tanks

The basic design of Savannah's stainless and carbon steel gallery feed tanks was acquired from Hanford. The principal problems of the feed tank gallery were concerned with providing equipment to control accurately the introduction of chemical feed to the canyon equipment. The installation of scale tanks as at Hanford was first favored, but it was later decided that gage glasses were adequate. Also, it was believed that horizontal centrifugal pumps would be adequate on those tanks requiring a controlled feed. After review of design, it was determined that vertical submerged pumps would be required to effect all transfers where a packing gland leak would create a hazard.

Development Problems

In 1954, one 4 ft. x 3 ft. and one 2 ft. x 3 ft. feed tank were added to serve the caustic scrubber and head end system in the Hot Canyon. Other modifications to the gallery included the rearrangement of the piping to accommodate the addition of these tanks for the caustic scrubber, and two solvent hold tanks outside Building #221-F. Moreover, space was provided for the insertion of either steel or lead shielding around the solution, aqueous, 1AX, 2AX, and 1BS feed tanks in case radioactivity reached a point where protection of the area became necessary.

Cold Feed Preparation Area

One of the more important changes in the cold feed preparation area was brought about by the need of 2BX mixing facilities to assure high quality product. These facilities were added to the cold feed preparation area when it was decided to reduce the volume of the 2BX stream in order to meet the product specifications. To accomplish this, it was

necessary to prevent plutonium losses by adjusting the plutonium valence by the addition of a hydroxylamine sulfate, nitric acid solution. To mix these two solutions, the mixing tank formerly used to prepare ferrous sulfamate was found to be adequate and lines were installed for the addition of the required solutions as well as an agitator, heating and cooling coils, sample unit, and standard instrumentation. A 25 g.p.m. submerged pump and line was provided to feed the 2BX solutions to its respective tank in the feed tank gallery.

DRAWINGS

W-146584	-	Architectural, Roof Plan & Details
W-146586	-	Architectural, Plan - First Level - 13 to 18
W-146941	-	Architectural, Plan - First Level - 1 to 6
W-146585	-	Architectural, Plan - First Level - 7 to 12
W-146747	-	Architectural, Plan - Second Level - 1 to 6
W-146937	-	" , Miscellaneous Details
W-146942	-	" , Plan - Third Level - 1 to 6
W-146587	-	" , Plan - Fourth Level - 1 to 12
W-146588	-	" , Plan - Fourth Level - 13 to 18
W-146749	-	" , Door Schedules & Frame Details
W-147964	-	" , Room Finish Schedule & Partition Sections
W-145934	-	Equip. Arrgt., Cross Sections, L, L, & M
W-147951	-	Equip. Arrgt., Cross Sections, P, R, & T
W-145933	-	" " " " " G, H, & J
W-145808	-	" " Plan, First Level, Change Room
W-145917	-	" " Plan, First Level, Sheet 2
W-145918	-	" " " " " 3
W-145920	-	" " Second Level, Sheet 2
W-145921	-	" " " " " 3
W-145923	-	" " Third Level, Sheet 2
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W-145926	-	" " Fourth Level, Sheet 2
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W-145928	-	Equip. Arrgt., Longitudinal Section through West Sample Aisle
W-145931	-	Equip. Arrgt., Longitudinal Section C & D Section 1-6
W-145932	-	" " Longitudinal Section E & F Section 1-6
W-146547	-	Heating & Ventilation, Air Flow Diagram, Central Portion
W-146468	-	Heating & Ventilation, Air Flow Diagram, Canyons
W-146188	-	Equip. Arrgt., Tunnel Entrance, Stair Towers
W-146487	-	" " , Plan, First Level, Sheet 1
W-146488	-	" " , Plan, Second Level, Sheet 1
W-146489	-	" " , Plan, Third Level, Sheet 1

W-146490 - Equip. Arrgt., Plan, Fourth Level, Sheet 1
W-148242 - Equip. Arrgt., Balcony Above Fourth Level,
Section 3 & 4

BUILDING #221-H - CANYON BUILDING

To avoid duplication of engineering effort and to benefit from experience gained during the construction of Building #221-F, the design of Building #221-H was initially a duplicate of the canyon building in the "F" Area. Nevertheless, over an extended period of time, the building was modified to incorporate design improvements, reduce construction costs further, and to incorporate changes suggested by pilot plant experience and early operation of the #200-F Area.

EVOLUTION OF DESIGN

Initially the differences between the two canyon buildings were minor. Each building was to have the same structural layout, except that the "B" Line facilities in the "H" Area were to include only one mechanical "B" Line and would have no skull dissolving facilities.

Area facilities supporting Building #221-H operations were, on the other hand, reduced to supply only minimum services when compared with the "F" Area. This plan deleted the control laboratories and laundry, and in turn, reduced the amount of liquid wastes to be segregated, condensed and stored. Consequently, only one general purpose evaporator was required in Bldg. #211-H and no waste handling facilities were installed. The reduction in waste quantities led initially to the elimination of four of the eight storage tanks in Bldg. #211-H. Later it was decided that, because of the reduced quantity of wastes, the laboratory waste evaporator in the Warm canyon could be eliminated.

Continued emphasis on cost reduction in Building #221-H and the #200-H Area led to further reductions in facilities. Triple evaporation was cancelled from the "B" Line in the belief that concentration by ion exchange would be eventually proven satisfactory by the time Building #221-H went into production. The "A" Line was reduced to minimum exterior facilities by the deletion of its proposed building enclosure and the UO_3 Process Line. This was justified on the basis that the Building #221-F "A" Line was capable of processing uranyl nitrate from both the F and H Area.

In 1953, evaporator design underwent a series of modifications in Building #221-F to provide a safer separations process in the canyons. These modifications were also included in Building #221-H, changing the location of the LEU evaporator from the Warm Canyon to the "A" Line.

Further modifications to Building #221-H occurred in 1954, principally because of plans to increase the designed throughput of irradiated uranium slugs from four to six batches a day. Other facilities in the #200-H Area were affected also by these throughput plans. The "A" Line was provided with a continuous type evaporator and supporting vessels, and four waste storage tanks of an improved design were added in 1955 to those originally installed in Building #241-H.

In summary, the specific differences between the two canyon buildings were, for the most part, the result of experience gained in construction of Building #221-F and the application of the latest operating and technical knowledge, with all changes designed to produce more reliable facilities capable of meeting higher production schedules.

SPECIFIC DIFFERENCES IN DESIGN

Toward the close of 1953, a design modification program for Building #221-H was initiated by the Engineering Department. Although the layout of the building was unaffected, the modification studies did achieve a higher degree of accuracy in canyon tolerances and economy in equipment, piping, electrical and instrument installations in the cold feed preparation and cold piping areas, the feed tank gallery, the gang valve aisles, and in the "B" Line facilities.

Canyon Tolerances

Meeting tolerances initially established in design for the canyon nozzles and jumpers within reasonable costs had caused enough difficulty in the #200-F Area to warrant re-study for the H Area. This tolerance study was undertaken late in 1953 to determine to what accuracy the canyon facilities could be constructed economically and the maximum misalignment that could be tolerated between gasket faces of canyon nozzles and pipe jumpers without leakage at operating pressures and temperatures. This study led eventually to lower construction costs through the use of optical tooling combined with well-designed fixtures and measurement controls which actually achieved closer tolerances than those specified for Building #221-F.

As the interchangeability requirements and construction tolerances became clarified, a program was instituted to develop improved connector gaskets which would insure satisfactory connections for canyon piping. This program was conducted simultaneously at the Johns-Manville Corporation research laboratory and in test facilities erected for this purpose at the Savannah River Plant. Work at both locations served to define the required properties of the gaskets and to develop gaskets which satisfied these requirements.

Cold Feed Preparation and Piping Areas and Feed Tank Gallery

During the construction of Building #221-F it was obvious that numerous minor design improvements could be made to facilitate more economical installation of equipment, piping, instrumentation and electrical work.

The cold feed preparation area on the first level of the H Area canyon building was the least affected by this program. However, other changes in this area did provide several differences in design as compared with the same area in Building #221-F. Bldg. #221-F contains six solvent hold tanks while the H Area has only four. Of the six tanks in the F Area, four are in the cold feed preparation area and two are outside of the canyon building. In the H Area, the four tanks are located in Bldg. #211-H. In place of the dry ice converter and heaters originally used in Building #221-F, both the F and H Areas are equipped with manifold systems which supply carbon dioxide gas to the cold feed preparation area from six cylinders on the loading dock outside of the Canyon Building.

The more important changes resulting from the modification program were made in the cold feed piping area and feed tank gallery on the second and third levels of Building #221-H, respectively. On both levels the process pipe supports were redesigned and individual rod type hangers were replaced with trapeze type hangers. Also, the pipe headers on the process vent system on the second level were elevated to eliminate numerous interferences throughout the building and in many cases piping details were revised to minimize congestion. On the third level, piping was redesigned to reduce fabrication costs and provide more accessibility around the lines and overhead valves. Where possible, bent pipe loops were replaced by standard long radius ells.

In line with these modifications, the electrical design also was revised to improve the original scheme at substantial savings in construction costs. The basic design duplicates that of Building #221-F in having 1044 two-inch underground conduits terminating at 58 pull boxes on the first level wall. However, all the conduit from the pull boxes to the cable

trough was eliminated and a single feeder tray installed for pairs of pull boxes. These trays were designed to be mounted along the wall, across the ceiling, and down into the cable troughs. Each tray is large enough to accommodate both existing and future conduits feeding the pull boxes. In addition, the tray design allowed the rearrangement of the cables and minimized any possible interference with piping and duct work in the building. Terminal blocks were installed, also, in the pull boxes at an accessible place on the first level to facilitate maintenance and checkout of the circuits.

The electrical layout was improved further by redesigning instrument trays and rerouting tubing runs to eliminate interferences with process piping, equipment and electric trays. Bypasses associated with control and block valves were relocated to facilitate manual control where applicable. Finally, ventilation and plumbing facilities were rearranged, consistent with the relocation of process, steam and service piping.

Gang Valve Aisles

Several changes in gang valve design were proposed as a result of the installation in Building #221-F. These improvements were studied, detailed, and tested in a full scale mock-up at Building #717-F before the new design was adopted for the H Area. A plug-in-type valve with a combined separator-strainer is used. Six of these valves are assembled in individual frames mounted away from the corridor wall. The new design allows mass shop fabrication, pre-assembly of the valves prior to installation in the corridor, and reduced installation time of the assemblies and their supplemental accessories.

Hot and Warm Canyons

To assure interchangeability of components, the canyons in the H Area are physically identical to those in the F Area. Some components vary, however, as the result of improvements brought about by continuing design studies and pilot plant testing, and by the advent of increased production schedules aimed at a greater throughput of materials.

Improvement in equipment design extended over a period from late 1953 to the close of 1954. The mixer-settler units were modified to obtain a more positive control of the Purex process by increasing the diameter of the aqueous outlet pipe on the Type "C" banks from 2 inches to 3 inches and by the installation of dip tubes on the 1A, 1C, 1D and 1E units. Standardization was also accomplished by the installation of

eight steam coils on all evaporators, and the Hot and Warm Canyon samplers were designed so that either type could be operated by means of steam or air. In addition to these modifications, a new sump drain collection system was provided in the Hot Canyon for prompt removal of sump liquids. By this system the sump accumulations can be jetted through a stainless steel header to a 10-foot by 11-foot collection tank for agitation and sampling before it is transferred to the rerun station.

To effect the increase from a four to a six batch process in 1954, a 10-foot by 11-foot LEU hold tank was added to the Warm Canyon and piping was installed to permit the use of the two LCU acid adjustment tanks with the two LCU evaporators. A third standard type evaporator and column were added to the low activity waste concentration facilities, and another decanter and a new 8-foot by 11-foot tank replaced the existing solvent hold tank which instead, was used as a wash tank in the solvent recovery system. These modifications led also to the installation and relocation of additional rack and jumper piping along with the use of new rate jets of various capacities. Minor changes in piping arrangements also were made in the cold feed preparation area and in the feed tank gallery to accommodate the modifications brought about by changes in the Warm Canyon.

In 1955, changes in piping connections to the rerun evaporator in the Hot Canyon were planned to permit the additional evaporation of the evaporator overheads in the event the radiation level of the condensate should become too high for normal processing in Building #211-H.

Also, to maintain operating flexibility with the cask cars available and to contribute to improved material handling, necessary with increased throughput in Building #221-H, additional bucket storage was obtained by erecting a wall across the Hot Canyon storage well about 36 feet south of the existing wall. The new storage area was lined with stainless steel; racks and guides were installed; and a domestic water source was added. The space thus used had been planned originally for the storage of railroad well blocks.

SOLVENT RECOVERY SYSTEM

Various experiments to improve the solvent recovery system had, by 1955, demonstrated that the desired low solvent activity level as well as a reduction in the amount of waste to be evaporated and subsequently stored could be achieved by the use of continuous solvent washers. It had been concluded that part of the difficulty encountered in maintaining a low solvent activity level in the batch system

might be due to poor phase separation resulting from mixed phases jetted through the decanters currently used. Plans were consequently made to replace the batch solvent recovery system in the Warm Canyon of Building #221-H and in Building #211-H with a continuous washing system, solution movement to be effected by motor-driven pumps with a rate jet retained as a spare for each pump. The new system was designed to provide segregated washing of the solvent used in the first product cycle, second metal cycle, and second product cycle.

Actual work on the installation of the new system in the H Area began late in 1955 and was authorized by a Field Design Memorandum. Similar work in the F Area was planned for 1956 to be authorized by means of a separate appropriation.

New Solvent Recovery Process

1CW Solvent Washing

Solvent from the 1C Bank flows by gravity to the 1CW run tank from which it is pumped continuously to the first of two continuous washers connected in series. As required, the aqueous layer accumulating on the bottom of the run tank is jetted to the spent aqueous hold tank.

In each of the 1CW continuous washers, the solvent comes in contact with a batch charge of 10 per cent Na_2CO_3 or NaOH wash solution. When depleted, the solution is jetted to the 1CW batch wash tank together with some solvent. This assures complete removal of the radioactive material which collects at the interface. Kerosene and TPB make-up is added to the first washer as required. Provision has also been made to add neutralizing acid and wash water if process changes in the future require this addition. Solvent is pumped continuously from the first washer to the second and then is pumped to the 1CW acid wash tank in Building #211-H.

In the 1CW acid washer the solvent is washed continuously in contact with a 3.7 per cent HNO_3 wash solution and overflows by gravity to the 1AX-1BS solvent hold tank. The acid remains in the washer for several days and then is drained to the decanting sump from which it is pumped to the process water skimmer or GP evaporator tanks.

From the solvent hold tank, the solvent is pumped continuously to the 1A and 1B banks in Building #221-H. Any aqueous layer collecting on the bottom of the tank is drained periodically to the decanting sump.

1EW Solvent Washing

Solvent from the 1E bank flows continuously by gravity into the 1EW wash tank where it is washed continuously in contact with a 10 per cent solution of Na_2CO_3 or NaOH . From there the treated solution is jetted to the 1EW-2BW batch wash tank with some solvent. Kerosene and TBP make-up is added to the washer as required and, if necessary, acid or water can be added.

From the continuous washer the solvent is pumped continuously to the 1EW acid wash tank in Building #211-H where it is washed with a batch charge of 3.7 per cent HNO_3 . At intervals, the depleted acid wash is drained to the decanting sump for disposal.

Solvent flows continuously by gravity from the acid washer to the 1DX solvent hold tank from which it is pumped continuously to the 1D bank in Building #221-H. Any accumulation of the aqueous phase on the bottom of the solvent hold tank is drained to the decanting sump.

2BW Solvent Washing

Solvent flows continuously by gravity from the 2B bank into the 2BW run tank and from there is pumped continuously to the 2BW wash tank. Any aqueous phase collecting on the bottom of the run tank is jetted to the LAW feed tank. In the continuous washer the solvent is in contact with a 10 per cent solution of Na_2CO_3 or NaOH . Spent solution is jetted to the 1EW-2BW batch wash tank with some solvent. Solvent is pumped continuously from the washer to the 2BW acid wash tank in Building #211-H.

When approximately 3000 gallons of depleted treated washes and solvent have accumulated in the batch wash tank, neutralizing 17 per cent HNO_3 is added and the solution is jetted to decanter No. 2 for phase separation. The solvent returns to the batch washer to be washed in turn with caustic and water, followed by successive decantations to remove the aqueous layer. The washed solvent is jetted to Building #211-H for subsequent acid washing.

Solvent is washed continuously in the 2BW acid wash tank in contact with a charge of 3.7 per cent HNO_3 . Periodically the depleted acid wash is drained to the decanting sump. Solvent continuously overflows from the acid washer to the 2AX solvent hold tank from which it is pumped continuously to the 2A bank.

The separated aqueous phases from decanters No. 1 and 2, together with any entrained aqueous decant from the 1CW run tank, are collected in the spent aqueous hold tank and periodically jetted to the 1AW feed tank.

Design Development

In designing the improved solvent recovery system every effort was made to use existing equipment, rack piping and vessel jumpers. Some vessel parts were interchanged, others were modified and in some cases vessel positions were exchanged. Considerable development work was necessary on the pumps which replaced the rate jets, and on the stand-by spare rate jets. Development work was required also in the application of draft tubes and agitators to the continuous wash tanks in the 1E and 2B banks and the Bldg. #211-H continuous wash tanks. In the case of the pumps, spares were provided for each vessel, but only the run tanks have installed spares. Necessarily, instrumentation had to be changed to give the desired flow and level conditions.

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W-147493	-	" Second " " 1 to 6.
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W-147523	-	"B" Line Elevations and Sections.
W-147391	-	Air Flow Diagrams for Canyons.
W-147392	-	Air Flow Diagrams for Central Portion.
W-147535	-	Equip. Arrgt., Cross Section, G, H & J, Sec. 1, 2, 3.
W-147536	-	Equip. Arrgt., Cross Section, K, L & M, Sec. 4, 5, 9.
W-147537	-	Equip. Arrgt., Typical Cross Section.
W-147539	-	Equip. Arrgt., Interior Stair Towers, Sheet 1.
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W-148860	-	Equip. Arrgt., Tunnel Entrance Stair Towers.
W-148871	-	Equip. Arrgt., Plan, First Level, Sheet 1.
W-148872	-	Equip. Arrgt., Plan, Second Level, Sheet 1.
W-148873	-	Equip. Arrgt., Plan, Third Level, Sheet 1.
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W-148875	-	Equip. Arrgt., Long. Sections A & B, Sec. 1 to 6.
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IV - BUILDING #221-F&H - "B" LINE

DESCRIPTION AND DEVELOPMENT OF DESIGN

BUILDING #221-F - "B" LINE

FUNCTION

The "B" Line facilities concentrate plutonium nitrate and reduce it to a metal.

Located on the third and fourth levels in Sections 1- to 4, the "B" Line operates as a separate process but utilizes the general services of Bldg. #221-F. Discussions of these services and their relationship to the "B" Line are included in the preceding general treatment of Bldg. #221-F.

PRINCIPAL COMPONENTS

The "B" Line process facilities consist of a final concentration room, final process rooms, a feed preparation room, a waste recovery room, and a feed-tank mezzanine. Supplementary facilities include a supervisor's office, vault, health physics storage room, and heating and ventilating room.

The feed material to the "B" Line, plutonium nitrate solution, is converted to metallic buttons of plutonium by concentration, precipitation, fluorination, and reduction. A waste recovery system is provided for the various wastes resulting both from the "B" Line operations and also from waste metal and slag obtained in Building #235-F processing.

Initially, triple evaporation was to be used for concentration but as design progressed it became clear that ion-exchange offered a better process, better control, and better decontamination. The decision to use ion-exchange came after the design of the F Area had progressed to the point where evaporation equipment had been ordered. Briefly, some thought was given to the installation of both systems but only ion-exchange equipment was installed. Procurement of the evaporation equipment had proceeded so far, however, that purchase was completed and the equipment was stored.

The "B" Line process facilities are housed in "dry" cabinets (D.C.) and "wet" cabinets (W.C.). The dry chemical cabinets include two mechanical equipment cabinets (46 ft. long by 24 in. to 40 in. wide by 31 in. to 49 in. high) and such other cabinets as the vessel receiving cabinet, waste receiving cabinet, skull dissolving cabinet, and

pressure chamber preparation cabinet, each of which is 68 in. long by 28 in. wide by 36 in. high. The wet chemical cabinets vary from approximately 5 ft. to 47 ft. long by 2 ft. to 5 ft. wide by 13 ft. high. These latter cabinets include the final concentration cabinet, alternate coupling feed tank cabinet, alternate coupling cabinet, precipitator catch tank cabinet, waste recovery cabinet, waste transfer cabinet and the scrubber feed cabinet.

The following are the major differences between the dry and wet cabinets.

Dry Cabinets

1. Solids processed.
2. Operation through glove ports, hand wheels, valves and rotary levers with maintenance accomplished by the "bag" technique.
3. Hermetically sealed cabinets with dry air ventilating system.
4. Cabinets held at a negative pressure of 0.8-inches of water pressure.
5. Stainless steel frames with Plexi-glass windows.
6. Mounted on structural support frames approximately 3 ft. from floor.

Wet Cabinets

1. Liquid solutions processed.
2. Remote operation by valves, burettes, and funnels located outside of the cabinets.
3. Single filter air flow type ventilation system.
4. Cabinets maintained at a negative pressure of approximately 0.25-ins. of water pressure.
5. Stainless steel and lead panels with safety glass windows.
6. Supported on six-inch channels grouted to the floor.

BUILDING FLOOR SPACE

Approx. Sq. Ft.

"B" Line Facilities

10,552

EQUIPMENT

Final Concentration Room (Third Level)

- 1 Alternate Coupling Cabinet (W.C.)
 - 6 Non agitated N-2 filters, - Each unit is a 7" x 12" stainless steel vessel with filter elements of micro-metallic, porous stainless steel.

- 4 Resin Columns with 3" lead shielding jackets, stainless steel, 7" x 19-1/8".
- 5 Tanks, stainless steel.
 - 2 Recycle Run Tanks, 7" x 48", 4.5 gal. operating fill.
 - 1 Product Run Tank, 7" x 24", 1.66 gal. operating fill.
 - 1 Recycle Hold Tank, 1-1/2' x 1-1/2', 13.7 gal. operating fill.

The above four tanks are mounted on lever system suspension hopper scales with exterior pedestal indicating dials - 115, 600, and 400 lb. gross weight capacity, respectively.

- 1 Spent Resin Elutriant Catch Tank, 3' x 3', 90 gal. operating fill.
- 1 Waste Transfer Cabinet (W.C.)
 - 1 Dip tube, piping, and transfer vessel connections.

Non-Cabinetized Equipment

5 Tanks.

Stainless steel

- 1 Spent Resin Elutriant Tank, 3' x 3', 90 gal. operating fill.
- 1 Product Elutriant Feed, 12" x 15", 2.55 gal. operating fill.
- 1 Bed Wash Feed Tank, 12" x 15", 3.49 gal. operating fill.
- 1 Water Hold-up Tank, 2'-6" x 3'.

Plastic

- 1 Uranium Elutriant Feed Tank, 2' x 2', 28.1 gal. operating fill.

All these vessels except the water hold tank are mounted on scales. The spent resin elutriant tank is on a stationary lever system platform scale with a pedestal dial while the other three have a similar portable type scale - 1800, 80, 80 and 500 lb. gross weight capacity, respectively.

- 5 Pumps, stainless steel.
 - 1 Proportioning Uranium Elutriant Feed Pump, 2 g.p.m., with 1/2 hp. motor.
 - 1 Proportioning Product Elutriant Feed Pump, 0-0.5 g.p.m., with 1/4 hp. motor.
 - 1 Proportioning Spent Resin Elutriant Pump, 0-0.1 g.p.m., with 1.4 hp. motor.
 - 2 Water Circulating Pumps, 2 g.p.m. with 1/2 hp. motor.
- 1 Monorail trolley with 1000 lb. hoist and adjustable lifting yoke.
- 1 Package refrigeration unit.
- 4 Pipe line filters with spun glass cartridges and stainless steel casings - .013 to 1 g.p.m.
- 2 Stainless steel heat exchangers
- Gang valve assemblies.
- 2 Portable air samplers.
- 1 Portable backwash dolly.
- 1 Portable filter backwash tank, stainless steel, 12" x 18".
- 1 Horizontal filter backwash pump, stainless steel, 1 g.p.m. with 1/8 hp. motor.
- 1 Movable platform.
- 1 Sampling platform.
- 1 Canning machine.
- 1 Lid embosser.
- 1 Work bench, steel, 28" wide by 4 Ft. long by 34" ht.

Final Process Rooms (Third Level)

- 2 Mechanical Equipment Lines. Each line contains a Boat Storage Cabinet, No. 1 Furnace Cabinet, No. 1 and 2 Precipitator Cabinets and Additions Cabinet

and a Mixer-Dumper Cabinet served by a No. 1 Conveyor. In addition, each Mechanical Line contains a No. 2 Conveyor which serves its No. 2 Furnace and Cutter Unit Cabinet, Cleaning and Exit-Entry Cabinets, and the End Dumper Cabinet. The last two assemblies include the glove port-operated Separation Cabinet, and the Sampling and Weighing Cabinets. These are dry chemical cabinets.

- 1 Boat Storage Cabinet Assembly
 - 1 4 Position manually operated symmetrical transfer fork for positioning filter boat for observation, drying and storage.
- 5 Filter Boats, hastelloy vessels with platinum lining, 7-1/4" x 7-1/2", and a sintered platinum filter disc 7" ϕ x 1/4" thick.
- 1 No. 1 Conveyor, stainless steel, reversible double-block chain, motor-driven unit with stop assembly, 21' long.
- 1 No. 1 Furnace Cabinet Assembly
 - 2 Electrically heated HF furnaces, hastelloy "C" housing and base plate with platinum top lining and copper cooling coils, 22" x 18".
 - 2 Hydraulic lifts.
- 1 No. 1 and No. 2 Precipitator Cabinet Assemblies
 - 2 Precipitators, pyrex vessels with an outer glass container mounted in stainless steel saddles with neoprene bumpers, 2.9l gal. operating fill.
- 1 Additions Cabinet Assembly (Mounted on top of main cabinet)
 - 1 Additions tunnel with hinged cover plate and internal catch screen.
 - 1 Container insertion port.
 - 1 Hydraulic lift.
 - 1 Container exit tube to separations.
- 1 Mixer-Dumper Cabinet Assembly

- 1 Mixer-Dumper with exterior mechanical and manual controls, stainless steel, 3' x 2' x 2' - Mixer-Dumper is supported by a trunnion mounted between two pedestals.
- 1 Vibrator assembly
- 1 No. 2 Conveyor, stainless steel single roller chain motor-driven, reversible unit with stop assembly, 15' long.
- 1 No. 2 Conveyor Furnace and Cutter Unit Cabinet Assemblies
 - 1 Reduction Furnace, induction type unit with hastelloy "C" top plate, copper induction coils and water cooled, 1' x 1-1/2'.
 - 1 Cutter Unit with five 11" hastelloy knife blades.
 - 2 Hydraulic lifts.
- 1 Cleaning Unit Storage and Entry-Exit Cabinet Assemblies
 - 1 Carbon steel "dummy" pressure chamber with motor driven rotary brush.
 - 1 Air lock for entry of 4" x 10" Carbon steel pressure chambers.
 - 1 Elevator for pressure chamber removal to waste recovery.
 - 2 Hydraulic lifts.
- 1 End Dumper Cabinet Assembly
 - 1 Manually operated End Dumper, stainless steel.
- 1 Separation Cabinet Assembly
 - 1 Vibrating arbor press.
 - 1 Wire dipping basket.
 - 3 Pickling baths, 3-3/4" I.D. x 4", 0.13 gal. operating fill.
 - 1 Solid waste receiving pan.
 - 1 Elevator tube for slag and crucible removal.
 - 1 Supply tube for containers from additions station.

1 Sampling and Weighing Cabinet Assembly

- 1 Electric drill.
- 1 Laboratory balance.
- 1 Torsion balance.

Supplementary Cabinets (For each Mechanical Equipment Line)

1 Furnace Off-Gas Disposal Cabinet (W.C.)

- 2 Limestone filled drums, carbon steel, 30 gal. capacity.
- 1 Carbon steel vacuum tank

1 Precipitator Catch Tank Cabinet (W.C.)

6 Tanks

Stainless Steel

- 2 Filter Head Tanks, 12" x 12", 4.44 gal. operating fill.
- 2 Precipitator Head Tanks, 12" x 12", 4.76 gal. operating fill.
- 2 Catch Tanks, 18" x 1'-9-3/4", 9.2 gal. operating fill.

2 Reflux condensers, stainless steel, 3" x 3'.

1 Vent Exhauster, Cabinet

- 1 "B" Line turbine type vent exhauster, 350 c.f.m.

Non-Cabinetized Equipment (For each Mechanical Equipment Line)

Gang valve assemblies

- 1 Package refrigeration unit.
- 1 Dry air blower.
- 2 No. 1 Furnace exhausters, 4.62 c.f.m. capacity at suction conditions.
- 1 Neutron recorder.

- 1 Ion chamber
- 1 Induction power supply, 20 kw.
- 1 Cooling water supply unit.
- 1 Instrument panel.
- 2 Reactrol panels.
- 1 Portable bag sealer.
- 1 Vacuum cleaner.
- 2 Portable platforms
- 2 Cabinets for gas mask storage.
- 2 Portable air samplers.

Feed Preparation Room - Third Level

Feed Preparation Area

Shelves and cabinets for storage of dry chemicals.

- 1 Large capacity platform balance - 200 lb.
- 1 Smaller capacity direct reading balance - 15 kg.
- 1 Laboratory work table.
- 1 Laboratory sink.
- 10 Bench mounted solution mixing vessels, plastic, (4 - 10 and 6 - 15 gal. vessels)
- 37 Portable reagent containers, plastic, (6 - 5-1/2 pint, 10 - 1, 12 - 2, 14 - 3-1/2, and 2 - 5 gal. containers).
- 16 Carrying pails, stainless steel, (9 for 3-1/2 and 5 gal. containers; 7 pails for 1 and 2 gal. containers).
- 2 Portable laboratory stirrers.
- 10 Air operated stirrers
- 1 Shelf mounted laboratory still.
- 1 Still condenser.

- 1 Tilting drum rack for 30% H_2O_2 30 gal. drum.
- 1 50% NaOH drum.
68% - HNO_3 drums, 55 gal.
- 1 Feed preparation dumb waiter.
- 7 Tanks, stainless steel.

2' x 2'

- 1 Spare solution mixing tank, 14.5 gal. operating fill.

2' x 3'

- 1 Distilled Water Tank.
- 1 HNO_3 Head Tank, 55 gal. operating fill.
- 1 Reductant Mixing Tank, 39.5 gal. operating fill.

3' x 3'

- 1 0.65% HNO_3 Mixing Tank, 78 gal. operating fill.
- 1 2.5% H_2SO_4 Mixing Tank, 136 gal. operating fill.

4' x 3'

- 1 68% HNO_3 Storage Tank, 205 gal. operating fill.

7 Pumps

Stainless Steel.

- 1 Horizontal 68% HNO_3 Feed Pump, 5 g.p.m., with 1-1/2 hp. motor.
- 1 Horizontal 0.65% HNO_3 Feed Pump, 5 g.p.m., with 3 hp. motor.
- 1 Horizontal Distilled Water Feed Pump, 5 g.p.m., with 1 hp. motor.

Duramet 20

- 1 Horizontal reductant feed pump, 5 g.p.m., with 3 hp. motor.
- 1 Horizontal 2.5% H_2SO_4 feed pump, 5 g.p.m., with 1-1/2 hp. motor.

Cast Iron

- 1 Horizontal Spare Feed Pump, 5 g.p.m., with 2 hp. motor.
- 1 Rotary Positive Displacement Hand Pump, 14 g.p.m.

1 Solid Calcium Weighing Hood.

- 1 Table - 2'-6" x 8'-x 3' -8" high.
- 1 Torsion balance, 500 gram capacity.

1 Solid Iodine Weighing Hood.

- 1 Table - 2'-6" x 8' x 3'-8" high.
- 1 Torsion balance, 500 gram capacity.

Alloy Preparation Area

- 1 Electrically operated refrigerator cabinet, 46" x 32" x 23".
- 1 Table for refrigerator cabinet, 48" x 32" x 23" high.
- 1 Electrically heated laboratory oven, 1' sq., 300° maximum working temperature.
- 1 Laboratory balance, 200 gram capacity.

Gas Storage Room

Cylinders for storage of nitrogen, oxygen, and helium.

HF Gas Storage Room

Cylinders for storage of liquid anhydrous hydrofluoric acid

Waste Recovery Room (Fourth Level)

- 1 Final Concentration Feed Cabinet (W.C.)
 - 2 3rd Stage Concentrate S/S Weight Tanks, 7" x 24", 1.66 gal. operating fill.
 - 1 3rd Stage S/S Head Tank, 7" x 24", 1.66 gal. operating fill.
- These tanks are mounted on lever system hopper scales with exterior pedestal indicating dials - 125 lb. dead load capacity.
- 2 N-2 Filters - Each is a 7" x 12" stainless steel vessel with a filter element plate of micrometallic porous stainless steel.
 - 2 Vessel Receiving Cabinets (D.C.)
 - 2 Elevators and drives.

Pressure Chamber Preparation Cabinet (D.C.)

- 1 Container insertion port
- 1 Electrically heated crucible oven, 150°F. maximum working temperature.
- 1 Table with pressure chamber storage and gasket storage shelves, 3' x 8'.
- 1 Pressure chamber preparation tool.
- 1 Vibrating table, 20" x 20".
- 1 Waste Receiving Cabinet - includes Waste Receiving, Transport, Skull Dissolving, Transport, and Waste Receiving Cabinets - (D.C.)
 - 1 Skull Dissolving Cabinet
 - 1 Skull Dissolver, stainless steel shell with platinum lining and a 500 watt electric heating mantle, cooling jacket and baffles - 0.40 gal. operating fill.
 - 2 Dissolver Condensers, stainless steel jacket with platinum tube, 1" x 12".
 - 1 Filter, stainless steel body with stainless steel micrometallic and glass cloth filter elements - 2".
 - 3 Tanks

Stainless Steel

 - 1 Filtrate Catch Tank No. 1, 7" x 15", 0.343 gal. operating fill.

Plastic

 - 1 Reagent Hold Tank, 7" x 6", 0.25 gal. operating fill.

Glass

 - 1 Condensate Run Tank, 4" x 12", 0.32 gal. operating fill.
 - 1 Waste Recovery Cabinet - includes Waste Solid Dissolving, Solvent Extraction, Ion Exchange, Waste Tank, and Vacuum System Cabinets - (W.C.)
 - 1 Waste Solid Dissolving Cabinet.

d.

- 1 Waste Solid Dissolver, stainless steel shell and outer cooling jacket, 2' x 3', 36 gal. operating fill.
- 1 Reflux Condenser, stainless steel, 6" x 24".
- 1 Iodine Scrubber Trap, stainless steel, 18" x 3'-6", 21 gal. operating fill.
- 1 Iodine Scrubber, stainless steel, 14" x 4'-8", 21 gal. operating fill.
- 2 Agitated N-1 Filters - Each unit is a 14" x 12" stainless steel vessel with a filter element plate of micrometallic, porous stainless steel.
- 4 Tanks, stainless steel.
 - 1 Evaporator Acid Tank, 2' x 2', 36 gal. operating fill, mounted on a lever system, suspension hopper scale with an exterior pedestal indicating dial- 800 lb. gross weight capacity.
 - 1 Filtrate Catch Tank No. 2, 7" x 24", 1.72 gal. operating fill.
 - 1 Supernate Hold Tank, 3' x 3', 110.4 gal. operating fill.
 - 1 Filtrate Catch Tank with shielding jacket, 3' x 4', 150 gal. operating fill.
- 1 Dumb Waiter.
- 1 Solvent Extraction Cabinet
 - 1 Countercurrent Extraction Scrubber, stainless steel, 40" x 20" x 7".
 - 1 Countercurrent Stripper, Stainless steel, 40" x 20" x 7".
 - 2 Tanks, stainless steel.
 - 1 Raffinate Hold Tank, 3' x 5', 177 gal. operating fill.
 - 1 Solvent Storage Tank, 2'-6" x 3', 64 gal. operating fill.
 - 1 Ion Exchange Cabinet

2 Resin Columns, 4" I.D. x 29-1/4".

2 Tanks, stainless steel.

1 Head Tank, 3' x 4', 150 gal. operating fill, mounted on a lever system suspension hopper scale with an exterior pedestal indicating dial- 2500 lb. gross weight capacity.

1 Effluent Hold Tank, 2' x 2'-6", 47.0 gal. operating fill.

1 Waste Tank Cabinet

4 Tanks, stainless steel.

1 Recycle Hold Tank, 7" x 3', 2.33 gal. operating fill.

1 Run Feed Tank, 2' x 2', 28.8 gal. operating fill.

1 Waste Run Tank, 4' x 4', 286 gal. operating fill.

1 Run Prep Tank, 7" x 2', 1.74 gal. operating fill, mounted on a lever system suspension hopper scale with an exterior short stand type indicating dial - 125 lb. gross weight capacity.

1 Vacuum System Cabinet

1 Separator, stainless steel, 2' x 3'.

2 Aspirators, stainless steel, 26-1/2" x 7-1/2".

3 Tanks, stainless steel.

1 Separator Hold Tank, 7" x 24".

2 Aspirator Water Tanks, 3' x 4', 100 gal. operating fill.

2 Vertical Water Aspirator Pumps, stainless steel, 150 g.p.m.

1 Alternate Coupling Feed Tank Cabinet (W.C.)

5 Tanks, stainless steel.

1 Elutriant Head Tank, 3' x 3', 90 gal. operating fill.

2 Resin Column Feed Tanks, 5' x 5', 285.4 gal. operating fill.

The above tanks are mounted on lever system hopper scales with exterior pedestal indicating dials - 1800 and 8250 lb. gross weight capacity, respectively.

- 2 Feed Head Tanks, 8" x 6', 11.8 gals. operating fill.
- 2 Vertical Cold Feed Pumps, stainless steel, 15 g.p.m. with 1-1/2 hp. motors.

Non-Cabinetized Equipment

Gang valve assemblies.

- 2 Portable air samplers.
- 1 Portable backwash dolly.
- 1 Portable filter backwash tank, stainless steel, 12" x 18".
- 1 Horizontal filter backwash pump, stainless steel, 1 g.p.m. with 1.8 hp. motor.
- 1 Portable bag sealer.
- 1 Movable platform.
- 1 Sampling platform.

Feed Tank Mezzanine (Fourth Level)

- 1 Waste Recovery Scrubber Feed Tank Cabinet (W.C.)
- 1 Solvent S/S Head Tank, 2' x 3', 52.8 gal. operating fill.
- 1 Resin Bed S/S Feed Head Tank, 2' x 2', 28.8 gal. operating fill.

These tanks are mounted on two lever system suspension scales with exterior stand type indicating dials adjacent to the cabinet enclosed scales - 600 lb. gross weight capacity.

Non-Cabinetized Equipment

- 1 Caustic Feed Tank, 2' x 3', 55.6 gal. operating fill, S/S.
- 1 68% HNO₃ Feed Tank, 2' x 3', 36 gal. operating fill, S/S

- 1 Solvent Wash Feed Tank, 2' x 2', 11 gal. operating fill, S/S.
- 1 Scrub Feed Tank, 2' x 2', 26 gal. operating fill, S/S.
- 1 Strip Feed Tank, 2' x 2', 26 gal. operating fill, S/S.
- 2 Reductant Feed Tanks, 2' x 2', 9.72 gal. operating fill, S/S.

The Scrub and Strip Feed Tanks are mounted on platform dial scales while the Reductant Feed Tanks are on portable platform scales with pedestal indicating dials - 1500 and 550 lb. gross weight capacity.

- 1 $\text{Al}(\text{NO}_3)_3$ Feed Tank, 12" x 18", 4.94 gal. operating fill, plastic.
- 1 Product Elutriant Feed Tank, 12" x 12", 2.33 gal. operating fill, plastic.
- 1 Uranium Elutriant Feed Tank, 2' x 2', 16.5 gal. operating fill, plastic.
- 1 Bed Wash Feed Tank, 12" x 12", 1.74 gal. operating fill, plastic.
- 1 Solution Adjustment Tank, 12" x 18", 2.8 gal. operating fill, plastic.
- 1 Proportioning Scrub Feed Pump, S/S, 0.5 g.p.m. with 1/4 hp. motor.
- 1 Proportioning Uranium Elutriant Feed Pump, S/S 0-.05 g.p.m. with 1/3 hp. motor.
- 1 Proportioning Product Elutriant Feed Pump, S/S 0-.25 g.p.m. with 1/3 hp. motor.
- 1 Proportioning Bed Wash Feed Pump, S/S, 0-.25 g.p.m. with 1/3 hp. motor.
- 9 Pipe Line Filters - with spun glass or dynel cartridges and stainless or carbon steel casings - .013 to 5 g.p.m.

INSTRUMENTATION

"B" Line instrumentation consists of that required for the process of final plutonium concentration and reduction to metal.

The tanks used in the chemical end are so small that, in general, the contents are weighed by means of scales. High level alarms in tanks are actuated by the use of electrode devices. Vessels which are not weighed, primarily the tanks containing water or condensate, have level indicators. Evaporators have temperature indicators and stream flow recorder controllers. Gauges mounted on the vessels measure the vacuum which is used to transfer liquids from vessel to vessel.

The vessels in the chemical end and metal reduction lines are enclosed in cabinets which are maintained at a slight negative pressure. This requires differential pressure control and indication.

Two of the furnaces inside the cabinets require temperature recorders and throttling resistance heating controls. Another furnace requires an RF heating control with a recorder. Pressure, flow and temperature records and controls are required on the various reaction and blanket gases entering the fluorination furnaces.

Hydraulic and electric controls in connection with the mechanical devices inside the cabinets are mounted on the cabinets and cabinet supports.

The various recording and indicating devices, distributed in three different locations, are mounted on eight control panels, 44 in. wide by 7 ft. -6 in. high.

DESCRIPTION OF PROCESS

The "B" Line facilities convert plutonium nitrate into metallic plutonium shapes referred to as buttons. The process equipment is housed in stainless steel cabinets in the south end of the third and fourth levels of Building #221-F.

The steps of this process include alternate "B" Line concentration, liquid processing, fluorination, and reduction to metal, in addition to recovery of plutonium from waste streams in the waste recovery equipment by dissolving, extraction, concentration, and skull treatment.

Alternate "B" Line Concentration

The concentration facilities on the third level consist of four ion exchange resin columns which are used to effect a

100 to 1 volume reduction and free the plutonium of active and ionic impurities in the nitrate.

Initially, plutonium nitrate is jetted from the 2BP hold tank in the Warm Canyon to one of two resin column feed tanks on the fourth level. After cooling, hydroxylamine sulfate is added to adjust the plutonium valence so that it can be adsorbed by the resin columns. After air sparging, cooling, and sampling, the plutonium nitrate is fed from the feed head tank through modified N-2 type filters at a controlled rate to one of four resin columns on the third level of Building #221-F.

After all the feed has passed through the resin column, the uranium elutriant, sulfuric acid from the U elutriant feed tank, is passed through the column to remove the uranium contamination adsorbed by the resin bed. Upon leaving the column, the eluate, as well as the nitric acid rinse from the uranium elutriant feed tank which follows, flows to the column waste tanks in the Warm Canyon. An aqueous solution of sulfamic and nitric acid is then pumped from the product elutriant feed tank through the resin column to desorb the plutonium. Approximately the first third of this plutonium-containing solution flows to a recycle run tank as displaced uranium eluate while the remaining solution or product eluate containing the bulk of the plutonium is transferred to the product run tank. After the product eluate is weighed, agitated by air sparging, and sampled, it is transferred by vacuum to the third stage concentrate weigh tank on the fourth level.

Finally, dilute sulfamic and nitric acid from the bed wash feed tank is pumped through the resin column to displace the small portion of plutonium eluate remaining in the resin bed and to condition it for receiving the next batch. This solution is collected in the recycle run tank where it combines with the first portion of the product eluate and is jetted to the recycle hold tank. After sampling, the contents of this tank are jetted to the resin column feed tank for reprocessing.

After an extended period of time, the resin bed may build-up in radioactivity or lose its efficiency. It is then necessary to regenerate or discard the resin. The adsorbed plutonium heel must be removed prior to the removal of the radioactive fission products. The plutonium is separated from the spent resin by backwashing the resin bed with controlled amounts of a sulfamic and nitric acid from the spent resin elutriant tank. The solution containing plutonium is collected in the eluate catch tank where it is held until re-fed to the resin column with an incoming batch of plutonium nitrate. Fission product elutriant,

when required, is added through the U elutriant feed tank. Effluent goes to the column waste tank in the Warm Canyon.

When this liquid has passed through the column, the column may either be continued in service or discarded. A discarded column is sealed in a plastic bag, removed to the burial ground, and replaced by a completely new unit.

When a new resin column is put into service, or whenever gas accumulates from disuse or other causes, it is washed with refrigerated wash from the uranium elutriant tank to absorb the gas from the resin bed. After passing through the resin columns, the cold wash flows to either column waste tank in the Warm Canyon.

A waste transfer cabinet is also installed in the final concentration room on the third level of Building #221-F along with the ion exchange facilities. This cabinet has been piped so that concentrated plutonium nitrate or liquid supernate wastes from Building #221-H may be processed either in the mechanical "B" Line or the waste recovery system, respectively. Both product and waste solutions are transported to Building #221-F by truck from Building #221-H in transfer vessels enclosed in stainless steel containers. Upon arrival at the final concentration room, a monorail lifts the transfer vessel from its container and places it in the waste transfer cabinet where it is connected to its proper line.

After concentration, the following steps of liquid processing, fluorination, and reduction to metal are each performed on the third level of Building #221-F in two mechanical equipment cabinets designated "B" Line #1 & #2.

Liquid Processing

This part of the Button Line process converts the concentrated plutonium nitrate to plutonium peroxide.

The concentrated solution is transferred from the third stage concentrate weigh tank through Nutsche-type N-2 filters to the third stage head tank and can then be fed by gravity from the fourth level to one of two precipitators in the Button Line.

Once the batch is in the precipitator, adjusting solutions are added and the batch is cooled to 59°F. Next, the precipitant, hydrogen peroxide, is added and formation of the precipitate is accomplished by mild agitation. The precipitator temperature is controlled by direct expansion refrigeration or steam, as required, through separate heat exchanger bayonets. After precipitation, the contents settle at a temperature of 41°F. to minimize solubility.

The supernatant solution then may be decanted by an adjustable dip tube to remove all but a small liquid heel in the precipitate. The level of the dip tube is set just above the precipitate so that the sucking action does not agitate and remove any precipitate. The dip tube extends through a flexible connection to the precipitator head tank. Vacuum applied to the head tank accomplishes transfer of the supernate from the precipitator. The supernate is transferred immediately from the head tank to the catch tank where decomposition of residual peroxide can be handled safely.

The plutonium peroxide precipitate is then washed. The washes flow from the feed tank and enter on a slinger disc to wash the walls of the precipitator. Next, the precipitate and wash are agitated at 41° to 45°F. To reach this temperature within the precipitator, the washes are pre-cooled to 41°F. in the feed tank by Freon refrigerated bayonet. The agitation is continued to minimize settling of the precipitate. The precipitator slurry then is drawn through another dip tube, extending to the cone-shaped bottom of the precipitator, to the filter boat where the peroxide cake is collected on a sintered platinum filter while the supernate passes through the filter and is carried to the filter head tank. After the cake is collected on the filter, additional washes feed into the precipitator to carry any precipitate on the walls to the filter, and pass through the filter into the filter head tank.

The cake within the filter boat is transferred by conveyor No. 1 to the boat storage station where it is washed with alcohol and dried by pulling cabinet air through the boat at the drying stands. Upon completion of this step, the filter boat is moved along conveyor No. 1 to the fluorination step in furnace No. 1 and then to the additions station and the mixer dumper unit, respectively.

Upon departure of the filter boat, the contents of the precipitator and filter head tanks are emptied into the catch tank. Any hydrogen peroxide remaining in the fluids is "killed" by circulating steam through the catch tank coils which raises the solution temperature to 158°F. This causes the peroxide to decompose, thereby liberating oxygen which bubbles through the solution and flows out of the reflux condenser through a filter to the "B" Line vent system. After the bubbling ceases, a sample of the solution determines its plutonium content. When this is complete, the solution may be jetted either to the supernate hold tank, the centrifuge run tank, or to the recycle hold tank. Normally, however, the "killed" solution is spent to the supernate hold tank in the waste recovery system.

Fluorination

This step of the process fluorinates the plutonium

peroxide precipitate to form plutonium tetrafluoride.

Initially, the filter boat, holding the plutonium peroxide cake, is brought by conveyor #1 from the boat storage station to one of two No. 1 furnaces where it is lifted into the furnace by a hydraulic piston assembly. After the furnace bottom plate is secure, the material is further dried by passing heated air through it. Next a combination of heated, vaporized hydrogen fluoride and oxygen is passed through the filter boat as it is gradually heated to a temperature of 500°C. As fluorination progresses, the off-gas, unreacted hydrogen fluoride and reaction products, pass to the limestone scrubbers where they are neutralized and passed to the "B" Line ventilating exhaust header. When fluorination is complete, the furnace and filter boat are cooled and the latter lowered to conveyor No. 1 to be transported to the inspection station and then to the additions station.

Since precipitation and fluorination have purified the plutonium, the next step in this straight line operation is reduction to metal.

Reduction To Metal

The first step in reduction takes place at the additions station where the filter boat containing plutonium tetrafluoride is lifted from the conveyor by a hydraulic piston and brought against the base of the station. This assembly provides the means of feeding calcium, iodine, and metal turnings into the filter boat without danger of external contamination.

The materials are brought to the additions station from the "B" Line feed preparation area where they are packed in bags and placed in cardboard cartons. These cartons are set into an insertion port leading to the additions assembly. The entrance seal is accomplished by replaceable rubber diaphragms between the tube wall and cartons. One carton remains in the tube continuously, preserving the seal, and as a new carton is added on the clean side, a carton is pushed into the additions assembly. By means of glove ports and a plastic window, the operator opens the cartons, empties the calcium, iodine and metal into a funnel leading to the filter boat, and places the used cartons in another tube leading to the Separation station.

The filter boat is then conveyed to the mixer-dumper where its contents are mixed and transferred to a pressure chamber. The pressure chamber, a metal bomb suitable for metal reduction temperatures, is prepared in a separate assembling area for use in the mechanical "B" Line.

The pressure chamber which is re-used is fitted with an

oven dried magnesia crucible. The unit is then placed in the pressure chamber preparation tool where dry magnesium oxide sand is packed between the crucible and pressure chamber wall by a small vibrating table, which vibrates the entire assembly. The pressure chamber is then fitted with a gasket. In this step, an alloying agent may be also added to the process by affixing it to the crucible. Next, the pressure chamber is returned into its exit-entry station where it is carried by dumb-waiter to the pressure chamber preparation cabinet.

As each filter boat reaches the mixer-dumper, a pressure chamber arrives, and the two vessels are clamped together top to top, forming a tight mixing chamber. After the plutonium tetrafluoride, calcium, and iodine are mixed, the mixer-dumper dumps the contents into the pressure chamber. Then the two vessels are separated, with the filter boat returning to the precipitator station and the pressure chamber going by conveyor No. 2 to the reduction furnace.

At furnace No. 2, the open-top pressure chamber is raised by a hydraulic lift into the furnace and held tightly against its top with a gasket providing a tight seal between the chamber and furnace ceiling. Before heating progresses, the pressure chamber is evacuated and filled several times with helium to guard against oxidation of its contents at high furnace temperatures. After reaction initiation temperature is reached, the plutonium tetrafluoride is reduced to metallic plutonium. After cooling, the pressure chamber is transported via conveyor No. 2 to the cutting station.

The No. 2 furnace is prepared subsequently for another reduction by the use of a cleaning unit which is lowered to the dolly track from a storage chamber and lifted into the reduction furnace. In place of a gasket, this "dummy pressure chamber" has a rotating brush which cleans the furnace flange forming the chamber seal. After cleaning, this unit is returned to storage and the furnace is ready for the next pressure chamber to be processed.

The processed pressure chamber travels from the furnace to the cutting station where a pneumatic-powered cutter crushes the crucible and breaks it into pieces to allow easy removal of the contents. The chamber is then conveyed to the end dumper where it is emptied into a pan installed in the separation station. The dumper then returns the empty pressure chamber to the conveyor by which it is returned to the exit-entry station. From here, the used chambers are sent to the pressure chamber preparation cabinet by dumb-waiter for reuse in the system.

In turn, the plutonium button is picked from the pieces of slag and broken crucible on the grating in the separation

station. Any slag or bits of crucible adhering to the button are removed by an air-driven vibrator tool. The button is then pickled in a nitric acid bath, rinsed in distilled water, and is finally dried in an ethyl alcohol bath. The magnesium sand, crucible pieces and broken slag, however, are placed for removal in cartons conveyed by tube from the additions station. The filled cartons are sent to the waste solids dissolver in the waste recovery system by dumb-waiter.

The "button" baths are filled periodically with fresh solutions by funnels on top of the cabinet while the spent pickle solution and water rinse are transferred back to the precipitator head tank to be sent to the recovery system with the precipitator supernates. In addition, the spent ethanol is discarded to the burial ground.

After the plutonium button has been pickled, it is placed in the weighing and sampling station where, under an inert atmosphere of helium, it is weighed on a torsion balance and sample turnings removed by an electric drill press and accurately weighed. The buttons then are tagged, removed from the end of "B" Line, and sent to the storage vault.

Prior to shipment to Building #235-F from the "B" Line area, the buttons are removed from the storage vault and placed in cans prepared by the canning facilities in the final concentration room.

Waste Recovery

The waste recovery system of "B" Line is on the fourth level of Building #221-F. This system recovers plutonium from liquid waste streams and solid residue accumulated throughout the process in Buildings #221-F&H. The end product is concentrated plutonium nitrate which, after sufficient accumulation, is used as a feed batch to the mechanical equipment cabinet for conversion to the metallic button. In addition to waste recovery, skulls from Building #235-F are dissolved by skull treatment for reprocessing.

The primary sources of "B" Line waste from Buildings #221-F&H are broken crucibles, slag and rejected or non-standard button batches from the separation station of the mechanical "B" Line. These crushed solids are placed in cartons, elevated to the waste recovery system by another dumb-waiter, opened by hand through glove ports, and dumped into the waste solids dissolver through a loading nozzle. When eight batches of solid waste or when waste bearing 350 grams of plutonium have been accumulated, the dissolver cycle is begun. In addition, any product-bearing drainage from the separator hold tank may be added with this material.

Dissolving

This process begins when nitric acid is added to the waste solids in the dissolver for reaction of the calcium in the slag. A small quantity of aluminum nitrate is also added for adjustment of free fluoride concentration to reduce corrosiveness in the mixture. After agitation by nitrogen sparge, another batch of nitric acid is added and the solution is heated to evolve iodine. The vapors from the dissolver pass through a heated condenser and go to the iodine scrubber which contains a caustic solution through which the off gas is bubbled, removing the iodine. After a third batch of nitric acid is added to the dissolver, the air sparge is started, and the dissolver contents is held at 120°C. for further iodine evolution. Next, a second batch of aluminum nitrate is added to completely complex the fluoride and then the dissolver is refluxed by use of a cooled condenser. After a second refluxing period, the silica in the solution is completely dehydrated.

Then the final reagent, sodium nitrite, is added from a portable charging container to reduce any iodate ion formed throughout the operation to iodide. When the dissolver solution is cool, it is drawn by vacuum through one of two Nutsche type filters to remove precipitated silicon dioxide, and then passed to the filtrate catch tank.

After removal of the solution, the dissolver and filter are washed with nitric acid and then the filter is washed with water.

Both of these washes are combined with the dissolver solution in the filtrate catch tank and are diluted by the final source of waste, supernate solutions, from "B" Lines in Building #221-F&H.

Next the total solution in the filtrate catch tank is adjusted by adding aluminum nitrate and water through the solution adjustment tank. After sampling the solution for the presence of aluminum fluoride, ferrous sulfamate is added to the adjusted solution in the filtrate catch tank.

This final solution is drawn by vacuum to the head tank as its valence is sufficiently reduced to be processed either by the ion exchange or solvent extraction facilities. Normally, however, the next step in the waste recovery system is solvent extraction.

Solvent Extraction

This step separates the plutonium from the dissolver

solutions by liquid-liquid extraction in two mixer-settlers designated the countercurrent extraction scrubber and the countercurrent stripper.

The units of solvent extraction are similar in performance to those of the second cycle plutonium decontamination in the Warm Canyon.

The waste feed stream from the filtrate catch tank enters the countercurrent extraction scrubber while the solvent, tributyl phosphate, and the scrub, nitric acid, pass into the mixer settler from their respective feed tanks. The tributyl phosphate extracts the plutonium from an aqueous phase into an organic phase, while the nitric acid retains traces of uranium, fission products, and other contaminants, maintaining the acid concentration of the aqueous phase at the optimum level for plutonium extraction.

When extraction is complete, the aqueous solution as well as the plutonium bearing organic phase overflow weirs at opposite ends of the mixer-settler. The aqueous waste solution flows to the raffinate hold tank where it is sampled for plutonium content.

If plutonium is negligible, the solution is jetted for disposal to the waste run tank where sodium hydroxide from the caustic feed tank neutralizes the solutions. After cooling, the neutralized solution is jetted to the dissolver coating solution hold tank in the Hot Canyon.

If plutonium is present in the solutions held by the raffinate hold tank, they are jetted back to the filtrate catch tank for rerun.

The plutonium bearing organic solution flows to the counter-current stripper in which the plutonium is transferred to an aqueous solution by scrubbing the organic stream with a stream of dilute nitric acid.

Upon settling the phases in the counter-current stripper, the stripped solvent overflows to the solvent storage tank. If sampling shows no "clean-up" is necessary, the solvent is recirculated to the head tank and used for the next batch that enters the solvent extraction facilities.

If the stripped solvent is contaminated, it is transferred to the solvent recovery facilities in the Warm Canyon for further treatment.

The aqueous plutonium phase flows from the stripper to the run feed tank where it is prepared for final concentration by the ion exchange facilities.

Concentration

This step, the final portion of the "B" Line waste recovery system, removes and concentrates the plutonium metal from the waste solution processed by the dissolving and extraction facilities.

The ion exchange phase of waste recovery begins when the aqueous solution enters the run feed tank where it may be mixed with contaminated effluent or recycle solution from the effluent and recycle hold tanks, respectively.

After agitation, the total solution is sampled and adjusted by the addition of hydroxylamine sulfate to reduce the valence of the plutonium so that it may be adsorbed by the resin column. If re-analysis shows proper adjustment, the batch is transferred by vacuum from the run feed tank to the resin bed feed head tank on the mezzanine. From here the plutonium bearing aqueous solution is added to one of the two resin columns at a controlled rate, the spent solution going to the effluent hold tank.

When all of the solution has passed through the resin column, a uranium elutriant of sulfuric acid, a product elutriant of sulfamic and nitric acid, and a bed wash of sulfamic and nitric acid from their respective feed tanks are admitted separately to the column to remove uranium contamination, to redissolve the plutonium adsorbed on the resin bed, and to remove the remaining eluate in the bed.

Upon leaving the resin column, the uranium eluate passes to the effluent hold tank where it is agitated, sampled, and analyzed. The effluent, if sufficiently low in plutonium content, is jetted to column waste tank No.2 in the Warm Canyon, but if the plutonium content is too high, it is drained as rerun to the run feed tank. The bed wash collects in the recycle hold tank with the uranium eluate displaced by the first third of the product eluate stream. After the solution has been agitated, sampled, and analyzed, it drains to the run feed tank for reprocessing.

The second two-thirds of the product elutriant, containing the bulk of plutonium, flows to the run prep tank where it is weighed, agitated by air sparge, sampled and analyzed. After this, it is adjusted and transferred by vacuum to one of the two third-stage concentrate weigh tanks from where it is returned eventually to the mechanical "B" Line for conversion into metal buttons.

After treatment of a waste batch by the ion exchange facilities, maintenance of the resin bed is carried out as described under alternate "B" Line concentration.

Skull Treatment

This facility, located on the fourth level with the waste recovery system, dissolves batches of waste metal and slag, known as "skulls", produced by the "C" Line in Building #235-F.

These skulls are transported to "B" Line in cartons and emptied into the skull dissolver through a charging hatch.

Dissolving operations, accomplished under a helium atmosphere, begin when a low concentration of nitric and hydrofluoric acid is poured from a portable container into the reagent hold tank. After this solution is added to the dissolver, the contents are heated until refluxing starts. Following this a second and higher concentration of nitric and hydrofluoric acid is added and heating is continued. When the reflux condenser is stopped, the total take-off condenser is started. After four-fifths of the dissolver solution has been evaporated, the concentrated remainder is cooled, by circulating water through the dissolver jacket, and sucked by dip tube through a Nutsche type filter to filtrate catch tank No. 1.

Upon filtration of the solution, the dissolver and filter are washed with sulfuric acid. This wash solution also goes to filtrate catch tank No. 1 where both the skull and wash solutions are transferred by vacuum to filtrate catch tank No. 2. Here they are sampled and drawn to one of the two third-stage concentrate weigh tanks for eventual processing by the mechanical "B" Line.

Condensate from the skull dissolver flows by gravity to the condensate run tank where it is sampled. If it contains plutonium, it is returned to the skull dissolver for re-evaporation, but if it is free of plutonium, it is transferred by vacuum to the filtrate catch tank in the main waste recovery system.

The vacuum system which transfers process solutions between the "B" Line facilities is also housed in a separate cabinet within the waste recovery cabinet on the fourth level of Building #221-F. This service is provided by an aspirator-separator system which contains two aspirators, two water tanks, a separator hold tank, and an aspirator water cooler. Each aspirator is actuated by water pumped from one of the two water tanks through it and back into the aspirator water tank. This operation pulls a vacuum on the separator to which are manifolded all the process vessels included in the vacuum system. By opening a vacuum line leading to any process vessel, a vacuum is pulled on that particular tank, which indirectly transfers the process solution.

DEVELOPMENT OF DESIGN

Equipment

The "B" Line (Button Line) in Building #221-F, is composed of ion exchange, mechanical metal production line, and waste recovery facilities. These facilities are supplemented by the following auxiliaries: vacuum system, cold feed preparation, filtering system, heating and ventilation, and instrumentation.

Major "B" Line Components

Ion Exchange

Equipment for the concentration of plutonium nitrate by use of stainless steel resin columns was originally installed at Savannah as an alternate system to triple evaporation coupling. However, the ion exchange method proved more applicable than triple evaporation to SRP's needs so, late in 1952, it was adopted as the primary concentration system.

By 1953, evaporation coupling had been deleted as an operating system as a result of studies made of the Savannah River pilot plant evaporator explosion in Building #678-G. It was discovered that conditions which initiated this explosion could possibly be duplicated in the first, second, and third stage evaporators of the triple evaporation coupling system. Moreover, ion exchange had been developed to a point where greater reliance could be placed on it as a superior method to produce pure product.

At the time of removal, the triple evaporation facilities were to be installed in a "wet" chemical cabinet on the third level of Building #221-F only. Because procurement was well advanced and cancellation charges would be excessive, all triple evaporation equipment was shipped to the Savannah River site for possible future use.

Upon adoption of the ion exchange principle many design problems arose in the scale up and development of plant scale resin columns and modifications to the Hanford filter to assure efficient ion exchange facilities.

Evaporators

The first, second and third stage evaporators, later deleted, were so designed by Blaw-Knox as to prevent the possibility of plutonium nitrate crystals forming on the heating element. Fansteel Metallurgical Corporation had rendered consultant assistance on the third stage evaporator in the use of tantalum which would prevent the build-up of impurities in the concentrate due to corrosion from boiling nitric acid solution.

Resin Columns

The basic research and development for these columns had been carried on at Oak Ridge National Laboratories for an extended period prior to the Savannah River Project. Confirmation of design resulted from tests initiated by the Atomic Energy Division of du Pont aided by the du Pont Engineering Research Laboratory. Final detailing was handled by the Allstates Engineering Company.

All of the test columns were fabricated from glass, the largest being six-inches in diameter. During the experimental period, one of these glass columns ruptured due to the expansion of resin, but the production unit was fabricated from stainless steel and is protected by the inclusion of an "ever-open" vent system.

A shielding analysis by du Pont and a re-survey of this problem by Blaw-Knox showed that approximately three-inches of lead shielding would be needed on the columns to prevent the spread of gamma ray activity from the plutonium nitrate solutions jetted from the Warm Canyon and to give protection from activity build-up on the resin bed.

Filters

Filters adaptable to the "B" Line were first reviewed in connection with the triple evaporation coupling process. Initially, conventional type "in-line" filters were under consideration, but these gave way to a modification of the N-2 Nutsche type filter used by Hanford. This design had been proven under conditions paralleling those present at Savannah River; namely, the remote handling of extremely toxic materials and contaminated filters. Using the basic design of the Hanford type filter, Blaw-Knox developed a seven-inch diameter Nutsche type filter. When design later was transferred to the Allstates Engineering Company it was decided to standardize on a seven-inch diameter. A filter study was made by Blaw-Knox comparing Filtros and Micrometallic filter elements. The Micrometallic element was selected because, for equal pressure drops and thicknesses, the micrometallic element had smaller pore openings and its elements could be made thinner and larger than the Filtros elements. At that time, also, a two-inch diameter Nutsche filter was designed for the skull dissolving equipment in "B" Line's waste recovery system.

Mechanical "B" Line

The first facilities for converting plutonium nitrate were designed by Los Alamos. The initial facility was replaced with a highly mechanical "Button" Line by the end of

1951. Although du Pont had access to the design of this line, it could not profit from any actual operating experience, since the Savannah River design was essentially complete before start-up of the Los Alamos facility.

Prior to the selection of a design, a review of the Los Alamos initial facility and Hanford's "Remote Mechanical Line" was made. Only those operating features of these lines were adopted that permitted a minimum of operator and maintenance exposure and requires little maintenance.

The final design of Savannah's "B" Line was based on technical information from Los Alamos which was developed by the Mechanical Development Laboratory and detailed by Blaw-Knox and Allstates Engineering. The complete mechanical "B" Line equipment and cabinet assemblies were fabricated by the du Pont Wilmington Shops where the line was also assembled and mechanically "de-bugged". These centralized fabricating facilities were chosen primarily to provide maximum security, to take advantage of MDL's experience in development of highly mechanized equipment, and to guarantee adequate liaison between designers and fabricators.

In general, the physical arrangement of the mechanical "B" Line is a departure from the layout at Los Alamos. At LA, the plutonium nitrate is fed to a precipitator and HF furnace toward the center where a single reduction furnace takes care of the supply from both ends. At Savannah River, two precipitators and HF furnaces are located side by side so that duplication of equipment is reduced to the minimum necessary for maintaining the desired capacity. Moreover, the Los Alamos "B" Line is a highly mechanized operation while the SRP line makes more extensive use of glove ports to simplify operation. In addition, the filter boat and pressure chamber at Savannah are lifted into position by hydraulic cylinders at various stations, whereas Los Alamos used a pneumatic cylinder.

MDL improved the Los Alamos design and included original ideas to assure higher operational efficiency of the major components. In addition, specialists from the du Pont Engineering Research Laboratory were consulted when necessary for the evaluation of new principles and operating techniques.

Development work, in general, encompassed such "B" Line facilities as precipitators, filter boat and No. 1 conveyor, boat storage station, No. 1 furnace, additions station and mixer-dumper, pressure chamber and No. 2 conveyor, reduction furnace, dummy bomb, cutting unit, end dumper, separations station, and the sampling and weighing facilities. Experience at AEC's Rocky Flats installation in Denver, Colorado, also demonstrated that the filter cake drying time could be

reduced significantly if alcohol was used for washing the filter cake. Facilities for this operation were added to the mechanical lines at the Savannah River Plant.

Precipitators

These two pyrex vessels are generally the same as those designed for Los Alamos, although minor changes have been made to facilitate maintenance and to utilize operating experience. They differ widely from the Hanford precipitators. The Savannah River design has two freon coolant bayonets. At SRP steam is supplied through a heating bayonet.

Following approval of the original precipitator at SRP, the Atomic Energy Division of du Pont requested that the volume of the equipment be increased by at least 50 per cent. This was done by enlarging the inner and outer pyrex vessels and re-locating some of the auxiliary equipment within the cabinet.

Filter Boat and No. 1 Conveyor

The hastelloy flask-like filter boat and reversible, double block chain, motor-driven conveyor designed for Savannah River differ in several respects from those at Los Alamos. At Savannah River the filter boat was redesigned to eliminate the boat dolly and the use of stop pins instead of microswitches simplified the design of the No. 1 conveyor.

Additional field experience indicated the need for a further change in boat design. Originally, the base was welded to the main part of the boat. It was found at Los Alamos that repeated heating and cooling tended to loosen the platinum filter, allowing some material to by-pass the filter. Therefore, the welded base was replaced with a ring and jack screw arrangement which permitted periodic tightening of the seal between the boat and the filter.

No. 1 Furnace

Due to the corrosive nature of hydrogen fluoride gas at high temperatures the withdrawal of the gas from the electrically heated No. 1 furnace was a major problem in the development of this equipment. Various proposals were discussed at considerable length by Los Alamos and du Pont consultants. It was finally decided that the off-gas should be carried away from the furnace by passing it through the filter cake and out the bottom outlet of the filter boat. This was accomplished by connecting a flexible hose to an opening made in the pedestal of the furnace bottom which carries the filter boat into the furnace.

Design of a fork-like transfer assembly to move the filter boat from the lift cylinder into the furnace eliminated

a boat storage problem and prevented tie-up of the No. 1 conveyor or delay in movement of other boats to the various stations of "B" Line.

Additions Station

The labyrinth port at the additions station was the result of the combined thinking of Los Alamos and du Pont engineers. The concept of a displacement procedure with replaceable inserts as developed for the Savannah River "B" Line was novel to atomic energy work. Tests of the insertion port with cartons by ORNL reaffirmed its reliability.

Mixer-Dumper

This facility, based on completely mechanical equipment at Los Alamos, was redesigned into a more compact unit by MDL with assistance from ERL which supplied the mixing specifications. Savannah River's mixer-dumper combines several functions of Los Alamos' equipment into a single unit. For example, the Los Alamos auxiliary funnel was replaced with a funnel-shaped top on the filter boat which facilitated transfer of the product to the pressure chamber; LA's loading hopper and its sub-assemblies were replaced with manual operations through glove ports; and their mixing vessel, with its associated valving and separated dumper, was eliminated by the combination of the mixing-dumping operation into one unit.

Pressure Chamber and No. 2 Conveyor

The use of the preassembled, disposable, carbon steel pressure chamber is one of the major differences between the Los Alamos and Savannah River "B" Lines. At Los Alamos, the pressure chamber is a non-expendable component and must be cleaned and reassembled within the enclosed cabinet. By the adoption of the disposable bomb at Savannah River, the cleaning operations were eliminated completely and the assembly process is done outside the line with uncontaminated materials. Later, Design revised the procedure to permit the re-use of the pressure chambers by the addition of facilities for re-assembly of the pressure chambers within an existing cabinet. This change was made based on the difficulty encountered in pickling of the pressure chambers for plutonium recovery prior to disposal.

It was only after much experimentation that a method was devised for holding the components in the bomb while it is inverted in the mixer-dumper. It was found that annealing would cause aluminum wool to pack tightly between the crucible and bomb without a binder, so that sealing method was adopted.

Experience gained at Savannah River necessitated the use of a dummy pressure chamber blanked at the top, during the

mixing operation, to prevent spillage of sand from the production chamber. The production pressure chamber is used during the dumping or transfer operation.

The introduction of the alloying agent was another problem. As the alloy had to be placed at the bottom of the charge, it was necessary to insert it through the material or put it in the pressure chamber before charging. Various schematic arrangements for doing this were drawn up, but in each case there were contamination problems and an uncertainty as to whether or not the piece was actually on the bottom of the pressure chamber. Finally a method of wetting the crucible was suggested and, after successful tests at Los Alamos, was accepted for the final design.

Development work also was required to obtain the aluminum oval shaped gasket finally employed for the lip of the pressure chamber.

Reduction Furnace

The No. 2 furnace at Savannah River is of the same design as that at Los Alamos, but a few changes were made in some of the associated equipment.

The safety device for holding the pressure chamber against the top of the furnace was simplified, and additional precautions were taken to prevent contaminated air from leaking out of the valve which controls the vacuum helium line. This is achieved by enclosing the valve in a hood and operating it through a syntron seal.

Dummy Bomb

This device, a wire brush and an electric motor contained in a modified pressure chamber, cleans the upper lid of the reduction furnace of encrusted matter. It is the same type of unit as that being used at Los Alamos with minor improvements.

Cutting Unit

This unit, a hydraulic cylinder with hastelloy "C" knife attachment, is similar to that used at Los Alamos. After some study, an improved shape for the five cutter blades was achieved.

End Dumper

This stainless steel mechanism was completely redesigned, with the objective of confining dusts, eliminating the auxiliary cover and its associated equipment and, at the same time,

insuring that dumping could not be carried out unless the dumping chamber was sealed from the rest of the cabinet. The new design keeps the bomb upright until it gets into the dumping chamber and provides for interlocks which prevent dumping until the cover is locked in place.

Separation Station

Manual operation through glove ports is one of the major pieces of design simplification in the Savannah River "B" Line.

The glove port method designed for Savannah River eliminates mechanical equipment and also the operational difficulties which have arisen at Los Alamos in connection with breaking the plutonium button away from the crucible.

Sampling and Weighing Facilities

This station, the last cabinet in the mechanical "B" Line, contains equipment for drilling a small test piece from the plutonium button, and weighing both the button and sample for accountability purposes. This facility was not included in the main cabinet at Los Alamos. For better accountability, it was decided to carry out this glove port operation before transferring the material to "C" Line in Building #235-F.

Waste Recovery

The initial flow sheet of the Savannah "B" Line waste recovery system was devised by AED with the assistance of ORNL. It included such recovery steps as crushing the solid wastes, dissolving, hydroxide precipitation, solvent extraction, and ion exchange. After a study of this flow sheet by Blaw-Knox, it was agreed that the crushing of the solid wastes would be taken care of adequately by the cutter unit and the arbor power hammer in the mechanical "B" Line. Hydroxide precipitation and centrifuge separation were eliminated as unnecessary. At the end of 1951, the issuance of a second revised flow sheet, along with numerous conferences between du Pont and Blaw-Knox personnel on waste recovery, led to a decision that the recovery system should include such major components as a waste solids dissolver, counter current scrubber and stripper, reflux condenser, iodine scrubber and trap, ion exchange facilities, and a skull dissolver.

Waste Solids Dissolver

Basic design of the stainless steel dissolver was developed in conferences with engineers from the Design Division of du Pont and Blaw-Knox. Initially, it was proposed

to include in design a Hanford type agitator and antiwhirl baffles. Later, however, the agitator proved unnecessary and was eliminated. Early in March, 1952, the waste solid dissolver was changed to accommodate slag and waste solution from eight plutonium buttons. This basis of eight batches superseded the previous basis of six batches for the entire "B" Line waste recovery system.

Counter Current Scrubber and Stripper

These units are small stainless steel mixer-settlers comparable in design to the units in the canyons. Designed by KAPL, they required no major revisions although the drive design was discussed in detail to determine a choice between a mechanical belt drive or individual speed control motors. The former was chosen since it was more economical, easier to maintain, and less cumbersome.

Reflux Condenser

This stainless steel unit was initially an original Blaw-Knox design to allow the condenser to be fitted into the limited space available.

Iodine Scrubber and Trap

The scrubber was designed by Blaw-Knox from a proven Los Alamos unit. The trap was added in response to a request from AED on May 15, 1952, for a plenum chamber between the reflux condensers and iodine scrubber to prevent suckback of caustic from the iodine scrubber to the dissolver.

Ion Exchange Facilities

Except for the difference in size, the stainless steel resin columns of the waste recovery system are identical to the ORNL designed columns used for the main ion exchange coupling.

Skull Dissolver

This funnel-shaped vessel was added to the "B" Line waste recovery system in December, 1951. A platinum lined dissolver was considered justifiable because of its small size and the relatively high plutonium production. The plutonium in the skulls is sufficiently free of impurities to allow the direct formation of a peroxide precipitate from the clarified dissolver solution and it was, therefore, considered poor economy to introduce corrosion products from a dissolver at this point. Blaw-Knox developed the initial design of the dissolver with modifications in design made later by du Pont.

Instrumentation

Instrumentation in "B" Line was a part of the initial studies undertaken to perfect the instrumentation serving the canyon facilities in Building #221-F.

The major problems of "B" Line instrumentation involved cabinet ventilation. The philosophy established was that all cabinets are potential health hazards and that dry cabinets are the most dangerous. On this basis it was decided to use heavy cast iron type pressure transmitters to measure dry cabinet pressure and draft gauges to measure wet cabinet pressures.

The reduction furnace where plutonium tetrafluoride is converted to plutonium presented a problem in that no satisfactory means had been developed for determining when the spontaneous reaction occurs. This reaction is accompanied by a pressure surge and a reduction in neutron flux in the immediate furnace area. The Savannah River Plant design provides a standard P-2 neutron chamber connected to an electrometer and recorder to indicate reduction of neutron flux. To indicate the pressure surge, a special pressure transmitter with indicating gauge is provided. This is a Taylor instrument company "Transaire" model with a special low volume sensing element connected to a capillary tube which is, in turn, connected to the furnace.

Supplementary Facilities

The major components of the Button Line are supplemented by protective cabinets, a vacuum system, solution transfer facilities, vessels, piping, and sampling mechanisms.

Cabinets

All "B" Line equipment is installed in ventilated stainless steel cabinets which are designed to keep each component under a slight negative pressure to prevent traces of radioactive particulate matter from escaping to the room. These enclosures, designated wet and dry chemical cabinets, were modeled after Hanford and Los Alamos design, respectively.

Vacuum System

This vacuum-aspirator type transfer system was designed to pull 15-inches of mercury vacuum. Subsequent requirements, however, altered this and further study proved a need for the present 26-inches of mercury vacuum.

Solution Transfer Facilities

These facilities were added to allow the transfer of concentrated feed or waste solutions from Building #221-H to Building #221-F for processing in "B" Line. The solutions are transported in stainless steel vessels, housed in an outer container, for safety in handling and to prevent the loss of costly and hazardous solutions. The inner container is handled in and out of the cabinet using an overhead chain hoist and trolley. A movable dip tube was selected over a stationary dip tube since it permits easier operator control and promotes safety in handling.

Vessels

General specifications for fabrication of all "B" Line process vessels were prepared by Blaw-Knox. Most of the vessels were fabricated from stainless steel. Due to the highly corrosive properties of other materials handled, platinum and hastelloy were used for some vessels. The standard No. 4 finish was specified for the outside surface of all vessels within the cabinets. Welds were ground but not polished. Local areas were freed of burrs and sharp edges which would possibly inflict wounds which could result in plutonium poisoning. The majority of the vessels handling concentrated plutonium solutions were limited to seven-inches in diameter to maintain non-critical configuration. These vessels were designed for operation under both atmospheric and full vacuum conditions. Moreover, all weigh tanks in the "B" Line process cabinets are mounted on scale platforms or on suspension rods which transmit the actual weights back to the scale dials. All transfer of solutions between vessels is by means of vacuum, jets, or gravity. In addition, electric motor-driven agitators are used on large vessels, while on the smaller vessels where an agitator and sampler cannot be mounted, agitation by air sparging is used.

Piping

A minimum of screw connections is used in lines handling process material and all other piping within cabinets to guarantee tightness and reduce hold-up. Individual vessels can be taken from the cabinets with a minimum amount of piping removal. Flanged connections at vessels and flanged valves inside the cabinet reduce maintenance; all vent-vacuum three-way valves have the same relative position at vent, vacuum, or shut-off, and the same direction of rotation to minimize error.

Precautions were taken in the design of the ion-exchange column piping to eliminate any possibility of drawing air into the resin column. All funnels are located so that they may be filled from the operating side. The feed pipes are equipped with a valve extension handle, so located that the operator filling the funnel may simultaneously operate the valve.

Sampling Mechanisms

The samplers serving the "B" Line facilities in Building #221-F include cold feed, screw type, and "B" Line air samplers.

Cold Feed Samplers

Two types of cold feed samplers are employed for "B" Line operation. Differences in design were produced by the presence of some fission products in the solution samples.

The first type, similar to the Blaw-Knox designed flask-type sampler used elsewhere in the Canyon Building, handles cold solutions and is slightly different in design due to the fact that flanged feet have been welded on two sides to facilitate the mounting of the sampler on the vessels.

The other type was modified for the handling of plutonium solutions. The bottle is smaller and is threaded instead of clamped to the gasket to effect an air-tight seal; the needle valve is replaced by an air valve to obtain increased flow control of the solutions; and, all pipe connections enter through the bottom of these samplers instead of through the sides.

Screw Type Samplers

These vertical samplers, as described in the process section of this history, are used to remove samples of process solutions from vessels contained in the wet cabinets of the Button Line and are similar to Hanford samplers.

"B" Line Air Samplers

This air sampler is designed to pull air through a filter which can be removed for analysis and consists of connected suction and exhaust lines which discharge air to the cabinet air duct thus forming a closed system. In addition, pipe outlets are provided on the cabinets for sampling "B" Line air.

General Safety Problems

Corrosion

The various chemical compounds used in the process such as hydrogen fluoride, nitric acid, and sulfuric acid solutions are highly corrosive requiring much of the equipment to be fabricated of stainless steel, monel, and platinum to protect product purity.

In addition to providing resistance to corrosion, the use of stainless steel assisted in contamination control. Since this metal is non-porous, contamination can be readily detected on the surfaces of installed equipment and removed by washing.

Criticality

Since plutonium is a fissionable material, it was necessary in the design of the "B" Line to prevent the accumulation of a mass of plutonium in such a geometric array that it could become critical by setting up a chain reaction. This problem of criticality was one of the principal problems encountered in the design of equipment carrying plutonium liquids. Its control was governed by the geometric size of the vessels, the amount of solution handled and its concentration. A close accounting of the solutions was provided by scale mounting all vessels. Concentration is checked by a specially designed sampler with which the operator extracts, manually, a small amount of the solution for analysis. The operating procedure is arranged to prevent the dumping of one batch of solution on top of another.

Shielding

In early plans the "B" Line cabinets were to be designed to accommodate shielding if this should prove necessary. The same was true of other equipment handling product solutions beyond the concentration step in the process.

A later Blaw-Knox study indicated the need for increased shielding. As a result, local shielding was provided around vessels, nozzles, and piping. In addition, lead replaced some cabinet panelling, barriers were installed to limit the approach of operators, floor areas were painted to identify radioactive areas during operation, and visual aids were also installed.

Toxicity

The presence of air borne solids amplified the problem of plutonium toxicity in the dry chemical cabinets. An isolated ventilation system to confine the plutonium was necessary and attention to detail in design was required to protect the operator during glove port operation and removal of equipment and air filters from the cabinet.

Filtering of all exhaust air was a problem common to both the wet and dry chemical cabinets. Due to the side location of intakes and the decision that air should be filtered as soon as possible, many filters had to be located in congested areas.

Moreover, there was a problem of providing sufficient air sweep through the wet chemical cabinet when a panel was removed. This was remedied by controlling the exhaust in adjacent rooms and corridors and increasing the flow of this air into the affected room when a panel is removed.

Mechanisms

For ease in operation, the controls, instruments, feed controls and filter aids had to be readily accessible. All controls, such as valve handles, switches, and levers were located outside and within reach of the operator at the various stations. Instruments were located so that all readings could be easily observed by the operator. Portable and removable platforms were designed to further facilitate accessibility to equipment. The limited space allocated for the "B" Line equipment caused serious arrangement and piping design problems, as well as space shortage for the storage of chemical solutions supplying the precipitation process.

"B" Line feed preparation methods were improved by substitution of plastic vessels with individual air-operated stirrers for the originally procured glass mixing vessels. Installation of a stirrer for each vessel eliminated the need for moving a portable unit between vessels; and air operation of the stirrers provided more efficient control of mixing because it permitted a variable speed range.

BUILDING #221-H - "B" LINE

Prior to modifications in 1954, the "B" Line facilities in the H Area differed from those in Building #221-F in that one mechanical "B" Line and no skull dissolving facilities were provided on the third and fourth levels. The 1954 modification program was at first undertaken to minimize interferences and obtain better accessibility around the cabinets and piping of the "B" Line. Later that year, modifications were extended to reduce congestion, provide easier maintenance and develop a simpler operation. As a result of this concerted drive for improvement, the waste recovery system was deleted and waste and product transfer facilities were added to permit the transfer of "B" Line solutions to Building #221-F for processing.

In addition, the scales beneath the weigh tanks were eliminated in favor of liquid level and specific gravity instruments, the booster fans were eliminated by the installation of high head fans in Building #292-H, and a dry type vacuum system was installed instead of the wet type used in Building #221-F. Changes of a minor nature were made also to supporting process and non-process equipment to provide sufficient space for the "B" Line facilities in Building #221-H.

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V - BUILDING #221-F&H - "A" LINE

DESCRIPTION AND DEVELOPMENT OF DESIGN

BUILDING #221-F "A" LINE

FUNCTION

The primary purpose of Building #221-F "A" Line is to produce uranium oxide (UO_3) powder from a uranyl nitrate hexahydrate solution.

The building's secondary function is to recover nitric acid from "A" Line reactor off-gas and from Building #221-F dissolver off-gas.

PRINCIPAL COMPONENTS

Basement

The basement consists of a service room, located under the reactor room, where six gas furnaces are provided to heat the six reactor pots.

First Floor

The first floor contains reactors, a surge tank to hold all feed from the evaporators to the reactors, acid handling equipment, drum loading and storage, electric switch rooms and a check station near the north door. In addition, the basement and first floor exhaust fans are located on this level.

In the reactor room there are six reactor pots where denitration by the application of heat to concentrated uranyl nitrate hexahydrate solution results in a conversion to uranium oxide powder.

Tanks, pumps, and a dissolver are located in the acid tank room where off-standard UO_3 may be dissolved and re-processed when necessary. A decontamination area, equipped with both a decontamination sink and a rinse sink, is separated from the process area in this room by a concrete curb.

The drum storage room has space for 96 full drums stacked upright two-high, and space for 70 empty drums stacked four-high on their sides. A fork truck and battery charger are provided in this room.

A roller conveyor connects the drum storage room with the

drum loading room which contains facilities for filling drums with uranium oxide powder. Vacuum hoods, a loading unit, a stationary dial scale for rough weighing, and a stationary print-weigh scale for fine weighing are included in the loading facilities.

Second Floor

The second floor contains two offices, a control room, a future mechanical equipment room, process rooms for acid recovery and product blending, and a toilet and janitor's closet.

The product blending room houses a blender, two dust collectors and filters. Evaporator controls and weigh, feed, run, and transfer tanks are provided in the other process room. Liquid uranyl nitrate is first concentrated in the evaporators located outside the building before being denitrated in the reactors.

The three hydrate evaporators are housed behind protective concrete barriers, one being located on the roof at the second floor elevation. Also at this elevation is the fresh air supply fan, condensate run tank and pump.

Third Floor

The third floor houses two separators and a vacuum dust room containing a pulverizer, blowers, filters, and hoppers.

Fourth Floor

The fourth floor is a penthouse which provides for the stairwell and also contains a general solids room with dust collection facilities.

Absorber Area

The absorber facilities are located outside and adjacent to the "A" Line building where the absorber is mounted on a concrete foundation and surrounded by a steel framework of about the same height as the roof of the penthouse on the "A" Line building. Steel steps and walkways are located so that direct access is possible to the absorber tower from grade level and from the first, second, and third floors of the "A" Line building.

Auxiliary equipment in the absorber area includes transfer pumps, off-gas and reactor exhausters, air compressor, off-gas coolers, and exhauster coolers.

Acid recovery is accomplished in the absorber by means of water absorption of denitration reactor off-gas and Building #221-F dissolver off-gas.

Outside Process Facilities

In addition to the absorber area, process facilities outside the building include three hydrate evaporators, silica gel equipment and a dissolver acid storage tank. The two LEU evaporators and their supporting equipment are also outside the building, but are mounted in a concrete basin with sump facilities and contained in an open steel structure. Access to the tanks serving the LEU evaporators is made possible by either ladders or catwalks. Exterior service facilities include a propane storage tank, a car spot and a catch basin.

BUILDING FLOOR SPACE

	<u>Approx. Sq. Ft.</u>
Offices (2)	470
Toilet and Janitor's Closet (2)	100
Future Mechanical Equipment Room	170
Electric Switch Room	270
Control Room	290
Drum Storage Room	825
Process Rooms (8)	8,325
Basement	2,220
Corridors and Stairwells	1,340
Heat and Vent. Equip. - Third Floor Roof	<u>290</u>
TOTAL	14,300

BUILDING DETAILS

Class - II.

Size

This is a three story building with penthouse and basement. Attached at the southwest corner is a single story and basement structure. Concrete blast barricade areas are located at the west side of the building and above the roof of the single story structure. Over-all dimensions of the building are 87 ft. by 49 ft. by 66 ft. ht. to the top of the penthouse. The basement area under the three story structure is approximately 46 ft. by 26 ft. by 9 ft. deep. The single story building is 46 ft. by 26 ft. by 24 ft. ht. from the basement floor to the roof.

Area - 5,363 sq. ft.

Volume - 186,015 cu. ft.

CONSTRUCTION DETAILS

Foundations

Reinforced concrete with spread footings. Basement walls are reinforced concrete.

Superstructure

Reinforced concrete columns with concrete slab floors and roof and reinforced concrete beams.

Exterior walls - Flat cement asbestos board above concrete curb 4 ft. high on first floor, and 2 ft. high on other floors. Exterior walls on south bay of denitrator room are enclosed with operable louvers.

Interior Partitions - Flat asbestos board above concrete curb, 4 in. high.

Ceiling - Under side of concrete floor slabs.

Doors - Hollow metal except for rolling steel door on outside drum storage room.

Windows - None

Roofing - Built-up

Floors - Concrete

Floor Covering - None

The hydrate evaporators are installed within reinforced concrete barriers. Two evaporator barricades are integral with the west wall of the building and the third evaporator barricade is situated on the roof of the single story denitration room addition.

Heating - Forced air through heaters and ductwork. Area power house supplies steam.

Air Exhaust - Through ducts to gravity roof ventilators and exhaust fans.

Air Conditioning - None, but provision made for possible future installation.

Lighting - Incandescent and fluorescent.

EQUIPMENT

The "A" Line equipment is contained in such process steps as the second cycle uranium concentration, silica gel treatment, hydrate evaporation and denitration system, oxide unloading, pulverizing, blending, and storage system, oxide fines recovery system, off-standard UO_3 recycle system, and the fume absorption system.

Second Cycle Uranium Concentration ("A" Line facilities only)

- 1 LEU evaporator, 8' x 8'
- 1 LEU separator column, 4'2" x 11'6"
- 1 LEU continuous type evaporator with combined boiler and separator vessel
- 1 LEU storage tank, 12' x 40' high, 30,000 gal. operating fill
- 1 LEU double pipe type cooler
- 1 LEU condenser
- 1 Steam condensate flash tank
- 1 LEU condensate run tank, 8' x 11', 3220 gal. operating fill
- 1 LEU condensate tank, 10' x 11', 6000 gal. operating fill
- 1 Feed storage tank, 8' x 30', 11,200 gal. operating fill
- 8 Pumps
- 2 LEU feed pumps, 40 g.p.m.
- 1 LEU pump, 75 g.p.m.
- 2 LEU product pumps 3.2 g.p.m.
- 2 LEU condensate pumps, 75 g.p.m.
- 1 Feed storage pump, 50 g.p.m.

Silica Gel Treatment

- 1 Silica Gel Feed Tank, 8'8" x 9', 4050 gallons operating fill, with a 5 g.p.m. submerged pump and agitator.

- 1 Nitric Acid Prep Tank, 4'6" x 9', 1070 gallons operating fill, with a 5 g.p.m. submerged pump.
- 2 Silica Gel columns, 2' O.D. x 15'.
- 1 Oxalic Acid Prep Tank, 6'6" x 9', 2234 gallons operating fill, with a 5 g.p.m. submerged pump and agitator.
- 1 Level Pot, 18" x 18", 7 gallons operating fill.
- 2 Silica Gel Product Hold Tanks, 8'8" x 9', 4050 gallons operating fill, with a 50 g.p.m. submerged pump and agitator.
- 1 Oxalic Waste Tank, 6'6" x 3', 2230 gallons operating fill, with a 50 g.p.m. submerged pump and agitator.
- 1 Oxalic Waste Tank (hot), 6'6" x 5', 1070 gallons operating fill, with a 50 g.p.m. submerged pump and agitator.
- 1 Sump Tank, 5' x 5' x 4'6", with 20 g.p.m. submerged pump.

Hydrate Evaporation and Denitration System

- 1 Hydrate Weigh Tank With Scale, 6' x 8', 870 gallons operating fill.
- 3 Hydrate Evaporators, 6' x 6', 870 gallons operating fill
- 3 Hydrate Evaporator Columns, 2' x 15', 8-tray, including condenser.
- 3 Condensate Run Tanks, 6' x 6', 725 gallons operating fill, two with 25 g.p.m. submerged pumps and agitators and one with centrifugal pump, but no agitator.
- 1 Final Metal Concentrate Transfer Tank, 6' x 8', 1160 gallons operating fill, with a 50 g.p.m. submerged pump and agitator.
- 1 Surge Tank, 6' x 20', 4330 gallons capacity, with heating coils.
- 6 Denitration Reactors, 6' x 1'7", 244 gallons operating fill, each complete with agitator, 20 hp. motor, gear reducer, Selas type gas burner, combustion air blower, and cooling air blowers which cool off the reactors.

- 1 Denitrator Measuring Tank, 2' x 3', 31 gallons operating fill.
- 1 Propane Storage Tank, 9' x 36'.
- 2 Basement Sump Pumps, 15 g.p.m.

Oxide Unloading, Pulverizing, Blending and Storage System

- 1 Pneumatic Unloading System, 60 hp.
- 1 Centrifugal Cyclone Separator, capacity: 30 lbs. of abrasive solid and 575 s.c.f.m. of air with low concentrated acid fumes.
- 1 Bag Type Dust Collector.
- 1 Oxide Storage Bin, 3' x 4', 6350 lb. capacity with inspection hatch, electric vibrator, and two screw conveyors.
- 2 Mikro-pulverizers, 1585 lbs./hr. capacity each.
- 1 Loading Storage Bin, 4'3" x 4'3", 14,000 lbs. fill capacity, with electric vibrator and two bottom outlet screw conveyors.
- 2 1000-lb. Scales.
- 1 Pant leg chute with vibrator
- 2 Bulk valves
- 2 Pulverizing drop chutes
- 1 Loading chute
- 1 Screw conveyor, 6-foot.
- 1 Drum loading hood
- 1 Oxide Roller Conveyor for removal of loaded steel drums.
- 1 Fork Truck

Oxide Fines Recovery System

- 2 General Bag Type Dust Collectors with hooded unloading facilities.

- 2 CWS Type No. 1 Air Filters (two housings each containing 8 such filters).
- 2 General Dust Collector Vacuum Units.
- 1 Lift Truck.
- 1 Industrial type vacuum cleaner unit.
- 1 Bag type vacuum cleaner dust collector with hooded unloading facilities.

Off-standard UO₃ Recycle System

- 1 Monorail
- 1 Off-standard Material Storage Bin with bottom outlet screw feeder, 3000 lb. capacity.
- 1 Oxide Dissolver, 6' x 6', 814 gallons operating fill.
- 1 Dissolver Transfer Pump, 25 g.p.m.
- 1 Micro Filter with stainless steel body and spun glass cartridge, 25 g.p.m.
- 1 Decontamination Enclosure with decontamination and rinse sinks.

Fume Absorption System

- 2 Separators, 2'6" x 5', 112 gallons operating fill.
- 4 Vertical Off-gas Coolers.
- 1 Off-gas Cooler Lag Tank, 3' x 4', 124 gallons operating fill.
- 1 Absorption Column, 6' x 57'2", 44 bubble cap trays.
- 2 Nitric Acid Hold Tanks, 6' x 8', 1310 gallons operating fill, with agitator.
- 1 Dissolver Acid Storage Tank, 9' x 36', 9170 gallons operating fill.
- 1 Discard Water Pump, 2-5 g.p.m., 8" x 2".
- 2 Acid Feed Pumps, 0.16-0.83 g.p.m.
- 2 Absorber Transfer Pumps, 2 g.p.m.

- 2 Hold Tank Transfer Pumps, 50 g.p.m.
- 1 Dissolver Acid Storage Transfer Pump, 50 g.p.m.
- 3 Reactor Exhausters, 400 c.f.m.
- 3 Dissolver Exhausters, 200 s.c.f.m.
- 1 Air Compressor, 1000 s.c.f.m.

Miscellaneous Facilities

- 1 8200 gallon Tank Car for material transfer (Account 602-G. Car is for both Bldg. #221-F & H "A" Line).
- 2 Car Spots.
- 1 Portable Self-Priming Stainless Steel Pump, 208 volt drive, with stainless steel flexible hose.
- 2 Outside Sump Pumps, 25 g.p.m.

All the above equipment is of stainless steel except the propane storage tank, the scales, the car spot, the fork truck, and the auxiliaries of the denitration reactors. Other items not of stainless steel include roller conveyor, lift truck, monorail, and air compressor.

Instrumentation

Seven 44" wide x 7'6" high control panels are required for all of the instruments needed in the general #221-F "A" Line Building.

The evaporator instrumentation includes a steam flow recorder and a temperature recorder on condenser water. The denitrator instrumentation consists of time cycle controller controlling B.t.u. input to the burners, temperature record and control, and vacuum record and control with necessary safety interlocks and level probes with indication and alarm.

Nitric acid recovery requires level and specific gravity records on feed and run tanks. The absorber column requires gas-air ratio controls and pressure record and control.

The dry oxide crushing, handling and packaging facilities require bin level alarms and controls, differential pressure measuring records and controls on bag filters and photo-electric type alarms to indicate bag breakage.

The off-standard recycle system requires temperature liquid level and specific gravity records.

DESCRIPTION OF PROCESS

Uranium, which has been isolated in Buildings #221-F & H by the first cycle extraction in the Hot Canyon and purified by the second cycle decontamination of the Warm Canyon, is transferred as dilute uranyl nitrate (UN) solution to the "A" Line for concentration, further purification and conversion to uranium trioxide (UO_3).

The first step in the "A" Line process is the concentration of the uranyl nitrate by the LEU evaporator from 9% to 40%. Next the concentrated UN is further decontaminated when passed through a silica gel column. The third step is concentration of the uranyl nitrate from 40% to 80% by the hydrate evaporators, and the final step is the conversion of the hexahydrate to UO_3 by heating in the agitated denitration reactors. Water vapor and nitrogen oxides given off by the reaction are cooled, the water condensed, and the remaining vapor passed through an absorption tower where nitric acid is formed and recovered.

After denitration is complete, the pot contains powdered UO_3 which is cooled to permit handling. Pots are emptied by a pneumatic system consisting of a hand-guided "gulper", a cyclone separator, dust collector, and exhaustor. The UO_3 discharged from the separator and collector passes through a pulverizer and a blender, then is loaded into resin-lined steel drums for shipment.

In addition to the above process facilities, "A" Line is also provided with an oxide fines recovery system and an off-standard UO_3 recycle system. The former is a vent system for the process equipment handling UO_3 powder which minimizes the escape of toxic or radioactive dust into the work area and atmosphere while the latter includes storage facilities and an oxide dissolver which recovers uranium from off-standard batches and scrap materials for reprocessing through the system.

DEVELOPMENT OF DESIGN

Building

The "A" Line Building is a three story Class II structure with penthouse, basement, and outdoor facilities. In 1955, it was extended at its south end to include an additional single story and basement structure to meet increased production schedules. The uranium trioxide production facilities housed in this building are similar to those in operation at the Mallinckrodt Chemical Works in St. Louis, Missouri.

The initial subcontractor assisting du Pont in design of the "A" Line Building was the Blaw-Knox Construction Company

of Pittsburgh, Pennsylvania. Later, in mid-April of 1952, the design responsibility for this building was transferred to the Lummus Company of New York City, to alleviate the design load on Blaw-Knox.

"A" Line facilities at Hanford had been placed in an existing building. It was established that the "A" Line process equipment at the Savannah River Plant would not require location in a shielded area of limited access. Based on economic studies it was decided to design a separate structure which would house such key equipment as denitration reactors, hydrate evaporators, pulverizing system and dust collection equipment, and provide space outside for an absorption column.

During the period of Blaw-Knox's design responsibility, three types of building arrangements were considered. The first two studies made were based on the utilization of three denitration reactors and two hydrate evaporators in each of the "F" and "H" Areas. The first set of drawings included a three-story building with a fourth level penthouse and a basement floor, while the second set of arrangements showed the same type of structure without a basement. At a later date, a third approach involved a larger three-story structure completely above grade which could house six denitration reactors and three hydrate evaporators in order to provide a single processing facility for both "F" and "H" Areas. In the latter stages of Blaw-Knox's responsibility, a combination of the second and third schemes was considered. However, after Lummus was assigned the design responsibility, the firming of design on reactor and furnace requirements resulted in a three-story structure with basement and penthouse. Later changes in scope increased the facilities located outside of the "A" Line Building.

The design concept of a three-story building with a basement and fourth level penthouse was adopted by Lummus and du Pont because it was shown that a first level would be suitable for the denitration reactors, second and third levels for the two hydrate evaporators and columns which drain to the reactors, while the penthouse provided the height necessary to allow gravity flow of the UO_2 powder from the cyclone through the pulverizer and blender to drum loading and storage. A basement was included to provide accessibility and space for the denitration gas heaters, air ducts, and blowers.

Once the layout of this facility had been established, it was decided that a Class II rather than a Class III structure would be best for the "A" Line Building because this type met the requirements for a potentially dusty operation involving toxic hazards and afforded a measurable degree of blast pro-

tection for the facility. Moreover, the interior surfaces of the building are designed to be smooth and free of cracks with a minimum of ledges, shelves, and dust collecting crevices.

The fundamental heating and ventilating concept was changed from one involving several individual units with short ducts to one involving a single large unit supplying all parts of the building through long ducts. This arrangement, which circulates clean filtered air through the building, was adopted to permit the future economical installation of chilling coils if it should be decided that part or all of the "A" Line Building required air conditioning.

As design progressed towards completion, modifications to and changes in design of its process components increased the amount of equipment to be located outside the "A" Line Building.

First of all, cancellation of the UO_3 production facilities of "H" Area led to the addition of a car spot and a 10,000-gallon tank for the storage of uranyl nitrate being transferred from #200-H "A" Line Area by tank car for processing in Building #221-F "A" Line.

Next, the installation of Selas type gas burners instead of electric furnaces under the denitration reactors required the addition of a car spot and propane gas storage tank outside the building.

In another case, the operation of the acid absorber under pressure rather than vacuum required the addition of off-gas coolers, exhausters, and an air compressor. Installation of these facilities made it necessary to relocate the absorption column.

In 1953, possible damage by explosion similar to that caused by an evaporator accident in Building #678-G, was minimized by relocating the LEU evaporator, from the Warm Canyon of Building #221-F, and the "A" Line's hydrate evaporators to the area outside "A" Line Building.

In addition, in 1954, the process and utility lines of Building #221-F "A" Line were provided with connections which facilitated the installation of a continuous type LEU evaporator to handle the increased throughput of uranyl nitrate solutions from Building #221-F. The new continuous evaporator was installed on the south side of the building adjacent to the original batch evaporator. Also installed with it were such attendant facilities as a LEU storage tank, condenser, product cooler, and condensate tank with additional pumps, piping, and instrumentation. The LEU storage tank is piped to feed either evaporator, but both units will not be

operated at the same time.

Finally, the increased need for fission product removal from uranyl nitrate required the addition of silica gel facilities between the LEU evaporator and the south end of Building #221-F "A" Line.

Over and above the increase in the number of exterior facilities, the original three story "A" Line Building was designed to allow for future expansion by the addition of bays at the south end of the building. Early in 1955, the need for expansion was justified since the separations process in the canyons of Building #221-H had been modified to increase its throughput from four to six batches of raw material a day. Inasmuch as Building #221-F "A" Line processed uranyl nitrate from both "F" and "H" Areas, it became necessary to add three denitrators, one hydrate evaporator and a separator plus auxiliary equipment to the existing facilities already installed in the "A" Line Building. As a result, a 46' x 25'6" x 24' single story structure with basement was added at the south end of the original "A" Line Building to accommodate this additional equipment.

Equipment

The development of "A" Line represents coordinated planning by du Pont, Blaw-Knox, and the Lummus Company combined with UO_3 processing information from the Mallinckrodt Chemical Works of St. Louis, Missouri, (MCW), the Harshaw Chemical Company of Cleveland, Ohio, (HCC) and Hanford.

Operational inspection of Mallinckrodt facilities on March 12, 1951, established MCW design as a basis of Savannah's "A" Line because that firm's process had been successful for years and was the only facility having an extensive background of experience. Hanford and Harshaw facilities were used for their assistance in solving specific design problems.

Inspection trips to MCW resulted in the decision that changes in the Mallinckrodt design should be made to provide operator protection from UO_3 dusts, nitrogen oxide fumes, and boil-overs of the denitration reactors.

Other problems relating to the development of the Savannah "A" Line included relocation of the LEU and hydrate evaporators, improvement of the denitration reactors, dust and fume control system, oxide dissolver, acid absorber, selection of an adequate design for the separator, pulverizer, and blender, and the addition of silica gel facilities to achieve product purity.

Hydrate Evaporators

The three hydrate evaporators are stainless steel vessels with columns. Originally, only two were installed, these being designed by Blaw-Knox as replacements for the boil-down tanks used at Mallinckrodt Chemical Works. When the "A" Line was first conceived for the Savannah River Plant, it was believed that the LEU evaporator, then located in the Warm Canyon of Building #221-F, would concentrate the uranyl nitrate sufficiently before it went to "A" Line. However, further dehydration of uranyl nitrate hexahydrate (UNH) required the installation of the two original hydrate evaporators in "A" Line. In the early part of 1953, as the result of an evaporator accident in Building #678-G, the LEU evaporator was removed from Building #221-F to the "A" Line Area and the hydrate evaporators were moved outside the west wall of the "A" Line Building, supported in separate steel structures and placed behind concrete barricades as a safety precaution. In 1955, a third hydrate evaporator, similar to the existing equipment, was installed and barricaded on the roof of the single story denitration room added to the original "A" Line Building to meet increased production requirements.

Denitration Reactors

These six pot-like vessels are the key equipment in the processing of UNH to UO_3 . Originally, only three of these reactors were to be installed. However, three more with auxiliary equipment were installed in 1955 to meet increased production requirements. These new denitrators are housed in a single story denitration room added to the south end of the original "A" Line Building. Experience gained in the design of the original three denitrators served to facilitate the design of newly added equipment. The major problems solved in the initial stages of design included the size of units, MCW vs. batch process of denitration, and the use of gas burners vs. electric radiant heating.

MCW vs. Harshaw Denitrator

The first visit to MCW showed certain shortcomings of their smaller type denitrator. The larger Harshaw unit was adopted because it had greater productive capacity per "kettle-hour" and provided less frequent exposure of personnel to radioactive dust because of fewer pot unloadings per day. Agitator design was established at HCC in June, 1951. Design engineers concluded that the minimum diameter of the agitator shaft would be 4.5 inches, agitator speed would be variable around 20 r.p.m., and the gear and pinion for the shaft would have hardened teeth to reduce maintenance.

Continuous vs. Batch Process

Initially a continuous process of denitration was favored over the MCW batch process. However, early in 1951, it was decided that SRP's denitrators would be operated on a batch process because there was insufficient time to await the outcome of Hanford's, Millinckrodt's or Harshaw's development program on the continuous process. It was originally decided to install three denitrators in "F" Area with one being used for experimental work aimed at developing a continuous denitration process. Later developments required all three units for production.

Initially space was provided for three denitrators and a complete building in "H" Area. However, a re-estimate of design needs in June, 1952, eliminated "A" Line facilities in that area, except for nitric acid recovery equipment, because "F" Area had sufficient capacity to process the UNH manufactured in both Buildings #221-F and #221-H. Nevertheless, the "A" Line Building in the #200-F Area was designed so that three additional denitrators could be installed by erecting structural bays to the south end of the building. This addition was completed in 1955.

Gas Burners vs. Electric Radiant Heating

MCW engineers had not been satisfied with the performance of the gas burners used to heat their denitrators. At first it was believed that electric radiant heating should be used at Savannah because it would provide thermal uniformity, improved controllability, and longer life and also would minimize boil-overs of the denitrators. After careful study of the problem by du Pont and Lummus Co., it was decided on May 21, 1952, that gas heating using liquified petroleum gas (propane) as fuel would be best because (1) sufficient heat could be supplied using gas to meet the specified time cycle and make the initial production requirements with three denitrators (the largest practical electrical furnace, 300 kw., could not have supplied heat to meet the specified time cycle and a fourth denitrator would have been necessary), (2) initial cost of equipment would be less for gas heating, (3) annual operating costs favor gas heating, and (4) gas heating with the Selas type burner is more reliable and less costly to maintain. In fact, replacement of electrical heating elements would require removal of the denitrator whereas gas burners can be maintained without dismantling.

Dust and Fume Control

The basic design improvements upon the MCW system were the dust and fume control facilities.

Savannah's dust collector is modeled after the MCW design with some Hanford features. This system is capable of handling 10 c.f.m. of air per square foot of filter bag and is divided into parallel parts and instrumented to provide continuous filtration irrespective of filter bag breakage, mechanical breakdown, or bag plugging. An industrial vacuum cleaning system was chosen on the basis of tests by Mallinckrodt which demonstrated the superiority of U. S. Hoffman equipment.

The "A" Line fume control system is composed of sectional stainless steel ducts designed to allow easy removal, repair, and replacement.

Oxide Dissolver

The off-standard UO_3 dissolver was designed by Blaw-Knox from basic data received from MCW. The major design problem was the selection of a safe method of feeding the off-standard UO_3 to the dissolver. Initially, it was planned that UO_3 in drums would be lifted into a dissolver hood and fed manually through an oxide charge hopper. After considering the use of a water slurry or UO_3 powder feed, it was decided that drums of UO_3 powder should be emptied into a storage bin and the off-standard product fed at a controlled rate by a screw feeder into the dissolver vessel containing boiling nitric acid. This allowed good control of the reaction and avoided sudden release of the off-gases.

Acid Absorber

Review of MCW's nitric acid recovery system by du Pont engineers led to the conclusion that Mallinckrodt's equipment was not adequate to meet Savannah's requirements. Initially, the absorber at SRP was to be designed to recover nitrogen oxides from the denitration process. After du Pont had established basic criteria and data on off-gas composition, Eastern Laboratory was requested to submit a recommended tower for this service. The Eastern Laboratory reported on May 27, 1951, that absorption of gases from the denitration reactors would require a column 8.5 ft. in diameter by 30 ft. high containing 22 plates, or two towers 7 ft. in diameter by 30 ft. high operating in parallel. When it was decided to recover fumes from both the denitrators in "A" Line and from the slug dissolvers in the Hot Canyon of Building #221-F, a single tower 6 ft. in diameter with 44 bubble cap plates was selected. In its final design stages, the tower consisted of two standard 6 ft. diameter 22 plate columns stacked to form one column. In addition to Eastern Laboratory data, the design of "A" Line's absorber was also based upon the du Pont-designed nitric acid recovery column at Kankakee Ordnance

Works because this latter effectively absorbed nitrogen oxides, required a minimum of maintenance, and reduced hazards by requiring fewer pumps.

The decision to absorb nitrogen oxides from the dissolver off-gases as well as denitration off-gases led to changes in design which divorced the two gases in all equipment upstream of the absorber. In July of 1952, two separate lines were installed to bring dissolver off-gas from Building #221-F to the "A" Line absorber for separate processing. Replacement of the ejector in the original design with four Nash Hytor exhausters, four heat exchangers, and an air compressor permitted operation of the "A" Line absorber under pressure rather than vacuum as initially planned.

In August, 1954, discharge pressure controllers with associated piping were provided on the reactor and dissolver exhausters to prevent surging and provide adequate sealing liquid flow.

Separators, Pulverizer, and Blender

These were selected to accomplish efficient processing of the UO_3 powder at the Savannah River Plant. Review of Hanford's facilities led Savannah's designers to use Hanford's cyclone separator which initially was based on Mallinckrodt's equipment.

A Hance Cone mill pulverizer was originally used at Mallinckrodt but proved to be unsatisfactory because it was obsolete and replacement of parts was difficult. However, MCW tested a Mikro pulverizer which became the basis for "A" Line design and procurement.

A Sturtevant dry-batch mixer was installed in Savannah's "A" Line after tests by Mallinckrodt proved the equipment to be satisfactory.

Late in 1955 enlarged oxide finishing facilities were provided by the installation of a parallel system including a pulverizer, conveyor, a larger bin, and connecting chutes. At the same time, the blender was removed since operating experience had demonstrated that this step in the process was unnecessary.

Silica Gel Facilities

Installation of these facilities outside of the "A" Line Building was required in the early part of 1953 when studies by ORNL and KAPL demonstrated that solvent extraction alone was inadequate for removing fission products from the uranyl nitrate product in Building #221-F.

Part of this process required radiation shielding (silica gel columns and oxalic waste tanks and piping). Another problem involved the disposal of the oxalic and water washes which are passed through the silica gel bed to remove the fission products. Initially, there was to have been a single waste to be disposed of. However, laboratory data from Oak Ridge showed that 90 per cent of the fission product activity on the silica gel bed was removed on the first three washes of hot oxalic acid regenerant. This knowledge led to the neutralization of the first three washes and its transfer to the underground storage tanks of Building #241-F and the routing of the second group of oxalic and discard water washes to the G.P. evaporators of Building #211-F.

Many vertical submerged pumps are used in "A" Line. A portable self-priming stainless steel pump with flexible hose has been provided as a back-up against pump failure. In "A" Line or Building #211-F this pump required the installation of a 220-volt electrical distribution system with outlets throughout the "A" Line facilities and Building #211-F.

Less important problems were encountered and solved in development of the water system, samplers, and instrumentation of "A" Line which supplement the major components of this facility.

Water Systems

These systems were designed to provide cooling water for the process equipment, discard water for the process feed streams, and domestic water to be used for drinking, sanitary facilities, sinks, service stations, and safety showers.

A major concern was the selection of water used to make-up process streams. Initial planning favored use of process water from the water handling facilities of Building #211-F as process make-up liquid. Later, however, the radioactive content of the process water led to the use of discard water from the same facilities at Building #211-F for process feed make-up in "A" Line.

Samplers

The samplers of "A" Line, in general, are mechanical units which permit safe withdrawal of corrosive solutions having low radioactive level. The sampler used in the processing of UO_3 powder is simply a means of removing samples of UO_3 powder for analysis.

These mechanical type samplers include cold feed samplers like those used in Building #211-F and others used to sample the radioactive silica gel wastes. The latter type is identical

to the cold type sampler except it has handling devices which permit the installation or removal of the sample bottle from a safe distance.

UO₃ sampling takes place after blending. Originally it was thought that a continuous sampler, similar to that at Hanford would have to be used to assure uniformity of product. However, after some study, this was found unnecessary, and sampling is accomplished by the manual removal of small amounts of UO₃ powder either from the finished product storage bin or directly from the loaded drums.

Instrumentation

The instrumentation problems of this facility were concerned mainly with the denitration reactors.

This reactor vessel has a thermocouple which measures the batch temperature. Shutdown is automatic at a high predetermined temperature or if the vessel begins to sag. Standard Selas controls were modified for greater safety. A time-cam temperature control was installed to maintain an automatic, specific temperature cycle during the various steps of denitration. A portable alpha counter monitors the drums of UO₃ prior to final storage.

General Safety Problems

The major safety problems of "A" Line included the development of a ventilating system, the installation of specially designed equipment to assure safe and continuous operation, and the provision of adequate shielding around those facilities containing radioactive material.

Electric System

Electric power is supplied from an outdoor unit-type substation at 480 volts, 3 phase, through an underground feeder. Another underground feeder is provided from the emergency Diesel generator located in Building #292-F which supplies power to vital equipment, lighting, and instrumentation in case of an outage of normal power. The basement area of the "A" Line Building was classified as Class 1, Division 2, of the National Electric Code, and electrical equipment was designed accordingly. A room was provided on the ground level for motor control center equipment. Starter racks with oil immersed starters were used for the outdoor equipment.

Ventilation System

The "A" Line Building ventilation system was designed to provide for a possible noxious fume release in the reactor

room and to serve a facility which contains both contaminated and non-contaminated areas.

To meet these considerations the air-flow was designed to travel from non-contaminated to contaminated areas, and from non-dusty to dusty areas. All this is in addition to keeping the process equipment under a slight vacuum by a separate system provided as part of the process.

Those sections of the building handling process liquid and those handling process dust are ventilated through separate gravity roof ventilators. The reactor room is kept under negative pressure by an exhaustor.

Sufficient air was circulated to prevent the temperature in the building from rising more than 10°F. above the outdoor dry bulb temperature. In addition, duct arrangements permitted the addition of cooling coils to cool the offices and control room.

To deal with noxious fume release in the reactor room, air inlet and outlet ducts were located to sweep air away from operators and across the reactors to the back of the reactor room.

Changes to the original ventilating design were made in 1955. First, the offices and control room on the second floor were air conditioned. After that, three new reactors and burners were added in an extension at the south end of the existing building. The addition of these new facilities required one supply unit and two exhaust fans similar to the existing design. However, no east and west or south walls were provided in the new reactor room so that outside air is afforded free movement. The wall openings are louvered.

Safety Equipment

Safe operation of "A" Line is insured by temperature sensitive cut-off devices, interlock of instruments for shutdown or switch-over when a dust bag is torn, and emergency power facilities serving the dust system and air supply of the building.

As an added precaution, special instrumentation was installed on the LEU evaporators and propane systems to provide adequate explosion protection. This was not practicable in the case of the hydrate evaporators which were moved outside of the building and barricaded instead.

In addition, Robb Couplings at the tank car unloading facilities provide a drip-proof method of making hose and nozzle connections, while special consideration of flange

location, flange shields, and special gaskets, etc. at the propane storage tank minimized the effect of external fire and reduced the possibility of direct flame impingement on the vessel.

Shielding

In general, shielding was found unnecessary because the radiation of the UNH solution is of such low order that walls of vessels, pipe lines, and other equipment provide sufficient protection. The silica gel facility is the only exception. Four vessels in this facility require one foot thick concrete radiation shielding.

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BUILDING #221-H - "A" LINE

This "A" Line contains only minimum facilities compared with the Building #221-F "A" Line. There is no building and no UO_3 process line in the "H" Area, but the exterior facilities differ only slightly from those in the "F" Area. For example, the "H" Area has two 10 foot by 11 foot tanks to handle condensate from the LEU evaporator, one material storage tank, one car spot, and one fume absorption system with only two vertical off-gas coolers. Space was provided however, for the expansion of the "H" Area to maximum facilities if it should be necessary to enlarge it to that of Building #221-F "A" Line.

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VI ADDITIONAL PROCESS FACILITIES - #200 F & H AREAS

DESCRIPTION AND DEVELOPMENT OF DESIGN

BUILDING #210-H - LIQUID NITROGEN STORAGE

FUNCTION

This building provides the facilities necessary for the storage and handling of liquid nitrogen for both the "F" and "H" Areas.

PRINCIPAL COMPONENTS

The facility is installed in a fenced area of approximately 2000 square feet. Tank cars are brought in on the adjacent track and unloaded by a transfer pump into the storage tank. Containers with a 200 liter capacity, which are used for nitrogen distribution to #200-F and H Area, are brought in by truck and filled by gravity from the storage tank. Controls are located in a small shed at the end of the tank and a steel platform is provided for truck loading and for access to the control shed.

The storage tank is a horizontal, vacuum jacketed vessel, approximately 11 feet 6 inches in diameter by 34 feet in length mounted on concrete foundations.

Lighting in the control shed is incandescent and flood lights illuminate the fenced area and track.

EQUIPMENT

The tank, transfer and vacuum pumps, control shed and platform are the property of the Linde Air Products Company and are leased by du Pont on a rental basis.

DEVELOPMENT OF DESIGN

The storage facilities represent a standard Linde installation. Du Pont furnished the foundation, security fencing and floodlighting facilities and added an "L" shaped platform extension to that installed by Linde. The erection of this additional structure required the relocation of the Linde stairway and also the extension of take-off lines so that liquid nitrogen could be trucked in 200 liter Hofman containers to the #200-F and H Areas. In addition, a railroad spur was provided so that liquid nitrogen could be shipped to the plant by Linde tank car instead of by more costly local shipments in smaller lots via truck.

DRAWINGS

W-142179 Arrangement

BPF - 120792 Linde Air Products Drawings

BUILDING #211-F - TANK FARM

FUNCTION

The Tank Farm contains vessels and facilities to receive, store, transfer and treat liquid chemicals required for the process operation in Building #221-F. It also includes facilities for decontaminating and handling low activity process water for Building #221-F and waste from Buildings #772-F and #723-F.

PRINCIPAL COMPONENTS

Transfer Tanks

Eight stainless steel tanks receive solutions jetted from Building #221-F and, in turn, transfer these solutions to various other facilities in the Tank Farm or, in one instance, directly to the #221-F "A" Line.

Chemical Storage Tanks

These eleven tanks store the cold feed chemicals required for the Canyon Building and Tank Farm. An auxiliary storage platform and unloading facilities are provided in the event tributyl phosphate is shipped in 50-gallon drums. In addition, drum filling equipment was installed to handle the cold feed chemicals required for plant use.

Water Handling Facilities

These facilities receive, store, and distribute "process" water or dispose of "discard" water. In addition, the organic (solvent) material, which is normally pumped back to Building #221-F for the solvent recovery process, is separated from the feed streams.

Acid Recovery Facilities

This unit concentrates the dilute acid from the process for re-use.

Check Station

This is a small building through which personnel enter the fenced area of the Tank Farm facilities. In addition to personnel monitoring equipment, this station contains a small supply of safety clothing, shoe coverings and laundry bags for soiled clothing.

Control House

This one-story structure provides headquarters, minimum service facilities, and shelter for the control instruments used in conjunction with the operation of the general purpose evaporators, water handling, acid recovery, and waste handling facilities.

Recycle Materials Sump

This sump, of concrete construction lined with stainless steel, collects the drainage and overflow for all of the Tank Farm vessels which hold contaminated or recycled liquids.

General Purpose Evaporators

These evaporators concentrate the low activity wastes, which are then sent to the Building #241-F waste storage tanks. The overhead vapors from these evaporators are relatively uncontaminated and are condensed, monitored, and discarded.

General Purpose Evaporator Tankage

The evaporator tankage stores the liquid wastes until they are sent to the general purpose evaporators for concentration and disposal.

Waste Handling Facilities

The waste from Buildings #235-F and #772-F, and from the laboratory buildings in the #700 Area, is collected here for classification and hold-up prior to transfer to the proper disposal systems. Cold wastes, designated "trade wastes", are transferred to the river by way of the general purpose evaporator tankage, while low level activity wastes are sent to the general purpose evaporators for concentration. High level activity wastes, however, are pumped to the Laboratory Waste Evaporator in the Warm Canyon of Building #221-F.

Overhead Pipe Rack

This rack supports the overhead piping through which liquid chemicals are moved within the Tank Farm and adjacent areas.

Sample House

This small building houses the facilities which intermittently sample the process off-gas emanating from the dissolvers in the Hot Canyon of Building #221-F.

BUILDING FLOOR SPACE	<u>Approx. Sq.Ft.</u>
<u>Control House</u>	715
Control Room	390
Offices	231
Closet and Toilet Rooms	69
Store Room	25
<u>Check Station</u>	67
<u>Truck Unloading Station</u>	1473
Truck Stalls	1168
Gang Valve Room	305
<u>Off-Gas Sample Building</u>	120

BUILDING DETAILS

Control House

Class - III.

Size - Single-story, rectangular shape, 30 ft. by 28 ft. Peaked roof with mean height of 14 ft. 6-in. above floor slab over 18 ft. by 28 ft. main section, and shed roof of 9 ft. average height over 12 ft. by 28 ft. extension.

Area - 840 sq. ft.

Volume - 10,332 cu. ft.

Check Station

Class - III.

Size - Single-story, rectangular shape, 8 ft. by 10 ft. Height is 10 ft. to top of peaked roof and 8 ft. straight side to eaves.

Area - 80 sq. ft.

Volume - 880 cu. ft.

Truck Unloading Station

Class - III.

Size - Single-story, rectangular shape, approximately 40 ft. by 42 ft. by 26 ft. mean height of pitched roof. An underground pipe gallery, beneath this building, is approximately 9 ft. by 40 ft. by 8 ft. deep.

Area - 1975 sq. ft.

Volume - 44,300 cu. ft.

Off-Gas Sampling Building

Class - III.

Size - Single-story rectangular shape, approximately 11 ft. by 13 ft. by 11 ft. mean height of peaked roof.

Area - 140 sq. ft.

Volume - 1500 cu. ft.

CONSTRUCTION DETAILS

Control House

Of prefabricated steel framing, this building has foundations of reinforced concrete with spread footings and a concrete floor slab. The roof and all exterior walls are sheathed with corrugated asbestos. The interior partitions are faced with 1/2-in. cement asbestos board except that between the control room and supervisors' offices, originally an exterior wall, is faced on one side with corrugated asbestos. The suspended ceilings are 1/4-in. cement asbestos board. Windows have commercial projected metal sash and doors are standard industrial steel. Ventilation is provided by an exhaust fan in the toilet room and a forced draft ventilator mounted on the roof. Heating is supplied by two steam unit heaters in the control room and a fin-type wall radiator in the toilet room and supervisors' offices. The Control House is also air conditioned by a package type unit with separate air cooled condensers and 5 hp. compressor. Fluorescent lighting is used in the control room and supervisors' offices and incandescent lighting in the toilet and storage rooms.

Check Station

This is a wood frame structure attached to the Control House. Roofing and siding are of corrugated asbestos, and the floor is a concrete slab. There are no windows but the three wood doors have wire glass panels.

Truck Unloading Station

This building has a structural steel frame on reinforced concrete foundations with spread footings. Corrugated asbestos is used for roofing and siding. Three sides of the building are completely enclosed but on the fourth side the two truck stalls are open to a height of 15 feet. The floor throughout is of concrete, with that in the truck stalls being covered with stainless steel sloped to drain to stainless steel-lined sumps. The suspended ceiling is of 1/4-in. cement asbestos board and partition walls have 1/4-in. Masonite to a height of 8 feet and 1/4-in. cement asbestos board above this. Commercial projected metal sash and standard industrial steel doors are used. Walls and ceilings of the truck stalls are painted with Amercoat. Incandescent lighting is used throughout this building.

Off-Gas Sample Building

This building is of prefabricated steel framing with corrugated asbestos siding and roofing. The floor is a 6-in. thick concrete slab with Class I finish. There are two windows of commercial projected sash and one steel door.

EQUIPMENT

Transfer Tanks

8 Tanks, stainless steel.

6' x 6' - 1000-gal. operating fill.

- 1 Condensate transfer tank
- 1 Column waste transfer tank

8' x 11' - 1837-gal. operating fill.

- 1 Water transfer tank
- 1 Condensate transfer tank
- 1 1EU Evaporator feed transfer tank, 3430 gal. operating fill

10' x 11' - 4630-gal. operating fill

- 1 1CU Condensate transfer tank
- 1 Waste transfer tank
- 1 Dilute nitric acid transfer tank

- 7 Vertical pumps, stainless steel, 75 g.p.m., (one for each transfer tank).
- 2 LEU Transfer pumps, stainless steel, 8-10 g.p.m.
- 4 Sump pumps, stainless steel, 50 g.p.m.

Chemical Storage Tanks

- 11 Horizontal tanks - 17,700-gal. operating fill.

Stainless Steel

- 5 Nitric acid storage tanks, 9' x 36'.

Carbon Steel

- 3 50% Caustic storage tanks, 9' x 36'.
- 1 Tributyl phosphate storage tank, 9' x 36'.
- 2 Kerosene storage tanks, 9' x 36'.

- 11 Horizontal Pumps.

Stainless Steel

- 1 Nitric acid unloading pump, 100 g.p.m.
- 1 Nitric acid circulating pump, 100 g.p.m.
- 2 Nitric acid transfer pumps, 50 g.p.m.
- 2 Milton Roy proportioning pumps, 1.135 to 2.27 g.p.h.

Cast Iron

- 1 50% Caustic unloading pump, 100 g.p.m.
- 1 50% Caustic transfer pump, 25 g.p.m.
- 1 Tributyl phosphate unloading pump, 100 g.p.m.
- 1 Tributyl phosphate transfer pump, 25 g.p.m.
- 1 Kerosene unloading pump, 100 g.p.m.

- 2 Car Spots

A drum loading station for loading and weighing drums of chemicals from the tanks.

A barrel storage area, having a capacity of 210 full barrels and 100 empty barrels. This platform is equipped with a carbon steel unloading tank (4' x 2') and a cast iron pump (15 g.p.m.) for transferring the liquid chemicals from barrels to the horizontal storage tank.

Water Handling Facilities

2 Skimmers, stainless steel, 8' x 30'.

- 1 Discard water skimmer
- 1 Process water skimmer

7 Tanks, stainless steel.

16" x 2'

- 1 Platform-mounted caustic feed tank, 20-gal. operating fill.

8' x 30'

- 1 Skimmed solvent hold tank, 11,700 gal. operating fill.

9' x 36'

- 2 Process water tanks, 17,700-gal. operating fill.
- 2 Discard water tanks, 17,700-gal. operating fill.
- 1 0.06% HNO₃ Acid tank.

1 Mixing chamber with 1/4 hp. "lightning" mixer.

1 Conductivity cell

3 Heat exchangers, stainless steel.

- 1 Process water cooler.
- 1 Discard water cooler.
- 1 Condensate cooler.

6 Vertical pumps, stainless steel.

- 1 Discard water pump, 100 g.p.m.
- 1 Condensate pump, 100 g.p.m.
- 1 Skimmed solvent pump, 50 g.p.m.
- 2 Process water pumps, 300 g.p.m.
- 1 Final discard water pump, 300 g.p.m.

1 Sump pump, stainless steel, 50 g.p.m.

- 1 Portable self-priming stainless steel pump, electrically driven, with three lengths of stainless steel flexible hose.

Acid Recovery Facilities

7 Tanks, stainless steel.

3' x 6'

Flash Tank, 150-gal. operating fill.

6' x 8'

2 Recovered HNO_3 run tanks, 600-gal. operating fill.

9' x 36'

1 Dilute HNO_3 feed tank, 9464-gal. operating fill.

1 Recovered HNO_3 storage tank, 9464-gal. operating fill.

10' x 11'

2 Water hold tanks, 2560-gal. operating fill.

1 Tubular preheater

1 Nitric acid recovery column, stainless steel, 6'-6" x 27'.

1 Overhead condenser, stainless steel, 4' x 12'.

1 Reboiler, stainless steel, 3' x 17'.

1 Knockdown condenser, stainless steel, 18" x 10'.

1 Ejector, stainless steel, 12" x 18".

1 Product cooler.

Settling chamber and tankage recycle vent system.

12 Pumps, stainless steel.

1 Condensate pump, 30 g.p.m. with 3 hp., 1800 r.p.m. motor.

2 Column feed pumps, 25 g.p.m.

2 Product pumps, 10 g.p.m.

2 Recovered nitric acid transfer pumps, 50 g.p.m.

2 Water transfer pumps, 100 g.p.m.

2 Nitric acid transfer pumps, 100 g.p.m.

1 Sump pump, 50 g.p.m.

Check Station

Storage rack
Clothes hampers.

Control House

Desk and filing cabinets for Control Room.
 Instrument panel with controls and instruments.
 Office furniture for Supervisors' offices.
 Storage shelving

Recycle Material Sump

20,000 gal. operating fill. Stainless steel liner.
 1 Drainage pump, stainless steel, 50 g.p.m.

General Purpose Evaporators

12 Tanks, stainless steel.

3' x 3'-10"

2 Collection tanks.

3' x 10'

1 Flash tank, 150-gal. operating fill.

6' x 6'

1 Caustic mix tank, 600-gal. operating fill.

1 Dilute caustic feed tank, 600-gal. operating fill.

1 Concentrate hold tank, 800-gal. operating fill.

10' x 11'

2 Evaporator feed tanks, 3200-gal. operating fill.

4 Hold tanks, 3332-gal. operating fill.

2 Evaporators, stainless steel, 6' x 18'.

2 Evaporator condensers, stainless steel, 2'-6" x 12'.

2 Weir boxes, stainless steel.

2 Steam jet condensers, stainless steel.

2 Evaporator heaters, stainless steel, 12" x 12'.

4 Evaporator pumps, 750 g.p.m.

4 Overhead water pumps, 50 g.p.m.

1 Condensate pump, 35 g.p.m. with 3 hp., 1800 g.p.m. motor.

1 Drain sump pump, 50 g.p.m.

General Purpose Evaporator Tankage

9 Tanks

3' x 4' - Carbon steel.

- 1 50% Caustic feed tank, 200-gal, operating fill.

8' x 30' - Stainless steel.

- 2 Low level laboratory waste storage tanks, 11,700-gal. operating fill.
- 2 Laboratory trade waste storage tanks, 11,700-gal. operating fill.

9' x 36'

- 2 Low level laundry waste storage tanks, 17,700-gal. operating fill.
- 2 Laundry trade waste storage tanks, 17,700-gal. operating fill.
- 8 Vertical pumps, stainless steel, 50 g.p.m. (one for each tank).
- 1 Sump pump, stainless steel, 50 g.p.m.

Waste Handling Facilities

- 5 Tanks, stainless steel.

9' x 36'

- 2 Horizontal high level activity waste, 17,700-gal. operating fill.

10' x 11'

- 1 Vertical laboratory trade waste receiving tank, 5000-gal. operating fill.
- 1 Vertical active laboratory waste receiving tank, 5000-gal. operating fill.
- 1 Vertical active truck waste receiving tank, 5000-gal. operating fill.

All tankage facilities are enclosed in a concrete pit divided into cells with concrete covers. The waste handling pit has a ventilation system composed of two air heaters, eight roughing filters, eight CWS Type filters, four dampers, and two exhausters.

- 21 Gang valve assemblies, manually operated.

- 1 Steel truck-unloading platform with stairway.

Overhead Pipe Rack

Steel framework to support overhead piping.
Stainless and carbon steel pipe.

Sample House

- 1 Off-gas sampler enclosed in electrically-heated cabinet.
- 1 Caustic scrubber, stainless steel, 6" x 2'-8".
- 1 Off-gas sampler ejector, stainless steel.
- 1 Filter case enclosing a CWS Type 6 filter paper.
- 2 Transparent traps, 8" x 10".
- 2 Needle valves.
- 1 Exhaust fan.

Electrical

Electrical feeders to Building #211 for normal power and lighting were run from load centers in Building #221 since loads were relatively small and transformer capacity was available in Building #221. Power for instrumentation is supplied also by a feeder from Building #221 so connected that, in case of an outage of normal power, there is automatic switch-over to an emergency diesel generator. Oil immersed outdoor starters on racks were used to avoid the cost of housing normal indoor-type starters.

An expanded metal trough is run on top of the pipe rack structure to carry control and instrument cable runs for Building #211 and cables between Buildings #292 and #221 "A" Line to Building #221. Lighting fixtures are incandescent weather-proof type, and floodlights supplied from series road lighting circuits are provided for a portion of the area. Tank agitator motors with explosion-proof housings were purchased since it was originally thought that they should be interchangeable with Building #221 canyon equipment. The concept of such interchangeability was later abandoned, and totally enclosed motors specified. Welding receptacles and 3-phase 208 volt receptacles were provided throughout the area, the latter for portable pumps.

Instrumentation

The nitric acid, kerosene, TBP, and 50% caustic soda storage tanks are equipped with level transmitters with pneumatic transmission to panel-mounted indicators.

The nitric acid recovery facility evaporator control system consists of feed-flow control, preheat temperature control, vacuum control on the steam jet system, differential pressure record (across plates), reflux flow control and temperature control. The nitric acid feed and run tanks and the condensate hold tanks are equipped with specific gravity and level recorders. Other instrumentation on the various vessels includes temperature indicators, recorders, controllers and level alarms.

Instrumentation for the recycle drainage system includes level indicators and automatic pump controls.

The water handling system instrumentation consists of level indicators on the discard water tanks and level indicators with alarms on the solvent and process water tanks. In addition, instrumentation has been provided on the 0.06% HNO_3 acid tank to indicate the acid concentration of the condensate between the limits of .03 and .09%.

The instrumentation for the general purpose evaporator and its tankage includes feed-level control, steam flow control reset by specific gravity, pH control of feed, vacuum control on the jet and safety interlocks on the evaporator. Various temperature and level controls, specific gravity and level recorders and alarms are included for other vessels.

The waste handling facilities instrumentation includes temperature indicators, level recorders with alarms, and radiation recorders. The ion chambers for radiation monitoring are mounted in the shielding wall.

The instrumentation is installed on four standard 44-inch wide by 7-foot 6-inch high panel boards in the control house. Four enclosed outside panels are used for the tank gauges.

EQUIPMENT, DESCRIPTION AND USE

Chemical Storage Facilities

The eleven horizontal tanks contain a 60-day supply of nitric acid, caustic soda, tributyl phosphate, and Ultrasene for process use in the Building #221. Blending is performed in two of the nitric acid storage tanks to achieve the desired concentration of nitric acid. Solution transfer from drum or tank car, and between storage tanks or out of Building #211-F is accomplished by pumps of various capacities. This area is also equipped to load and unload drums and tank cars.

Process Facilities

These facilities include the tanks which receive waste

solutions from Building #221-F for transfer to treatment tanks in the area, as well as the equipment required for such processing steps as water handling, nitric acid recovery, general purpose evaporation, and waste handling.

Transfer Tanks

Eight "bounce" tanks, situated between Buildings #221-F and #211-F, include a column waste, water, 1CU condensate, waste, dilute nitric acid, 1EU feed and two condensate transfer tanks.

Column Waste Transfer Tank

The solutions in this tank are received from the column waste tanks in the Warm Canyon of Building #221-F and are transferred to the general purpose evaporator tanks where they are held until concentrated by the G.P. evaporators.

Water Transfer Tank

This vessel receives low activity condensate from the high activity condensate evaporator in the Hot Canyon of Building #221-F for transfer to the process water skimmer in the water handling facilities of the Tank Farm.

1CU Condensate Transfer Tank

This tank receives low activity condensate from the 1 CU evaporators in the Warm Canyon of Building #221-F for transfer to the process water skimmer of the water handling system.

Waste Transfer Tank

This facility holds discharge from the jets of the "swimming pool", railroad tunnel, hot work room, and slug storage in Building #221-F. The tank contents are pumped periodically to the low level laundry waste storage tanks of the general purpose evaporation facilities in Building #211-F.

Dilute Nitric Acid Transfer Tank

This tank receives condensate from the low activity waste evaporator in the Warm Canyon of Building #221-F for transfer to the acid recovery facilities of the Tank Farm.

1EU Feed Transfer Tank

This receives uranyl nitrate solution from Building #221-F. From here it is pumped to the 1EU storage tank outside of Building #221-F "A" Line where it is held until concentrated by the 1EU evaporators.

Condensate Transfer Tanks

These two tanks are identical in classification but one receives condensate from the Hot Canyon rerun evaporator from which it is pumped to the nitric acid recovery facilities while the other stores condensate from the Laboratory waste evaporator in the Warm Canyon of Building #221-F until it is transferred to the general purpose evaporator tanks for concentration by the G.P. evaporators.

Water Handling Facilities

This equipment is designed to receive, store and distribute or dispose of, discard and process water. The facilities are divided between those vessels which handle process or discard water, and include two decanters, six tanks, and a scale mounted caustic feed tank.

Process water is collected in the process water skimmer (decanter) where the organic material in the feed solution is separated from the water.

After separation, the water enters either of two tanks which are connected by a valved line so that both tanks can operate as a single or separate reservoir. Normally, skimmed process water feeds that tank which does not hold discard water make-up.

If high radioactivity is present in one of these tanks, the other may be readily isolated to receive process water for make-up purposes.

Evaporator overhead solutions from the first cycle uranium concentration in Building #221-F, and from the second cycle uranium concentration in the #221-F "A" Line Building, as well as overheads from the hydrate evaporator, are collected in the discard water skimmer.

The skimmed discard water flows to the first discard water tank which is connected to the second by an equalizing line to form one large storage vessel. The pumps in the first two discard water tanks run continuously to make discard water available at all times as make-up to the process water system and to refill the entire system in case the process water must be discarded because of high radioactivity.

Both process and discard water supplied to process users are pumped through heat exchangers to insure that the water temperature does not exceed 100°F. as returned to the process.

Moreover, organics from the two skimmer tanks are collected in a skimmed solvent hold tank and then pumped to the third

level feed tank gallery. From here the flow is by gravity to the kerosene and tributyl phosphate feed tanks of the solvent recovery facilities in Building #221-F.

The 0.06% HNO_3 acid tank receives condensate from the flash tanks of the nitric acid recovery and general purpose evaporation facilities. Upon arrival at the water handling facilities, the condensate may be acidified to a concentration of .06% HNO_3 by the addition of 50% HNO_3 from the chemical storage facilities. If, however, the condensate is not required for .06% HNO_3 feed, it may overflow to the segregated water system or be directed to either the process or discard water tanks for re-use as process water for discard to the river.

A concrete catch basin is provided under all tanks of this system to catch any leakage, spillage, rain water, or overflow or discard water.

Nitric Acid Recovery Facilities

These facilities separate condensate from the low activity waste evaporator, the rerun station, and the "A" Line hydrate evaporator into concentrated acid and water. The acid is sent to storage while the aqueous overhead solution is transferred to the water handling system. Eventually, both acid and water are re-used in Building #221-F.

The acid recovery equipment consists of a horizontal tank equipped with dual vertical pumps which feed through a tubular preheater to a bubble-cap column. The bottoms are circulated through a tubular reboiler for proper concentration, discharged to a horizontal cooler, and from there into either of two nitric acid run tanks.

If a check of the specific gravity shows the acid to be insufficiently concentrated, a higher concentration acid can be added from the nitric acid mixing tanks or it can be returned by means of the recovered nitric acid transfer pumps to the dilute acid feed tank for re-running. Process water lines, with automatic shut-off, are connected to the recovered nitric acid run tanks to adjust the acid concentration to desired levels before transfer to the various users. After agitation, adjusted acid from the nitric acid run tank is pumped to the recovered nitric acid storage tank.

Vapor from the recovery column is condensed by the overhead condenser and the non-condensibles pass to a knockdown condenser, where they are removed by an ejector to the vent system. The condensate flows by gravity through an overhead cooler and is collected in either of two vertical water hold tanks from which it is transferred intermittently to the process water skimmer of the water handling facilities. If, however, this

water is excessively acidic, it can be returned to the nitric acid feed tank for reprocessing.

All of the equipment comprising the nitric acid recovery facilities is mounted within an open structural steel framework with access to the elevated equipment being provided by stairways, ladders, and catwalks. A concrete catch basin under the equipment receives any leakage, spillage, or rain water.

General Purpose Evaporation

The evaporation facilities at Building #211-F consist of eight storage tanks each with concrete catch basin, one caustic feed tank and two evaporators. The storage tanks hold low activity waste received from Buildings #221, #772, and #723-F. There it is either monitored, neutralized and discarded or is concentrated in one of the two general purpose evaporators and discharged to Building #241-F waste storage facilities.

The waste solutions from the storage tanks are transferred to either one of two evaporator feed tanks and in turn passed through a baffle box, an external heater, and into the G.P. evaporators. Upon completion of the evaporation cycle, the concentrate is discharged to the waste storage tanks in Building #241-F. The overhead vapors after condensation pass through a weir box into one of two hold tanks where they are agitated, sampled, and, if sufficiently free of radioactivity, discarded.

Waste Handling Facilities

These facilities consist of six underground concrete cells, with removable covers, housing the tanks which store high activity, low activity, and trade wastes. The wastes from the Metallurgical Building #235-F and Waste Concentration Building #776-A are transferred by tank truck to the unloading station which has both a shielded and non-shielded truck stall with facilities for transferring to the proper storage tanks. The waste from the Control Laboratory #772-F also, is piped through an underground tunnel to these waste handling facilities.

The concrete cell vault enclosing the waste handling vessels has a sloped floor and sump to collect leaks. Moreover, each of the tanks, except the trade waste receiving tank, is provided with sprays and a line from the decontamination pump located outside the pit. If a vessel is sufficiently radioactive to prevent access by maintenance personnel, the vessel is emptied and decontaminated by spray washing with nitric acid.

High Activity Wastes

These wastes are pumped to either one of two high activity tanks or to the active truck waste receiving tank. From here they are piped through an underground pipe tunnel to the Warm Canyon of Building #221-F where they are treated with caustic in the laboratory waste neutralizer prior to concentration by the laboratory waste evaporator.

Low Activity Wastes

These are pumped separately to the active waste receiving tank from where they are transferred to one of two low level laboratory waste storage tanks serving the general purpose evaporators in Building #211-F.

Trade Wastes

These are pumped from the truck unloading station to the laboratory trade waste receiving tank, thence to the laboratory trade waste storage tanks and finally concentrated by the general purpose evaporators.

Active Laboratory Wastes

Active wastes from Building #772-F are piped to the active laboratory waste receiving tank of the waste handling facilities. If the activity level is high, the wastes are then transferred to the high activity storage tanks. If low, the active wastes are removed to the low level laboratory waste storage tanks which hold solutions awaiting concentration in the general purpose evaporators.

Service Facilities

Tank Farm components such as the overhead pipe rack, recycle materials sump, check station, control house, and sample house may be considered as service facilities inasmuch as they are auxiliaries to the processes in Buildings #211 and #221-F.

Overhead Pipe Rack

The 16-foot wide by 25-foot high overhead pipe rack carries process pipe lines and utilities to Building #211-F and adjoining facilities. Three water mains are buried below grade between the columns. A vent collection header, serving all Building #211-F tanks, is a part of this facility.

Recycle Materials Sump

The recycle materials sump is a 20,000-gallon underground,

metal-lined pit with a vapor-tight stainless steel cover. This sump, adjacent to the Control House, receives overflows and flushing water drainage from the concrete aprons beneath the water handling system, acid recovery facilities, and the general purpose evaporators. The sump is equipped with a vertical submerged pump which discharges the liquids to the low level laundry waste storage tanks for treatment prior to concentration by the general purpose evaporators.

Check Station

This facility contains personnel monitoring equipment and small supplies of safety clothing, shoe coverings, and laundry bags.

Control House

This structure houses an instrumentation control panel which monitors the nitric acid recovery column, water handling system, general purpose evaporators, active waste release system of Buildings #723, and #772-F, and the waste handling facilities. In addition to the above panel, the control house includes space for control room office equipment, a lavatory, two supervisors' offices and a storage room.

Sample House

The sample house contains the facilities which monitor the off-gas from the slug dissolver in the Hot Canyon of Building #221-F.

In the sampling station the off-gas from the Canyon Building is split into two streams. One flows through a filter case where any particulate matter is removed by CWS type filter paper. This filter paper is examined periodically to check the effectiveness of the glass wool off-gas filters. The other stream passes through a packed column (caustic scrubber) partially filled with 7N sodium hydroxide solution. After the gas has bubbled through the sodium hydroxide, the solution is drained from the column and analyzed to determine the iodine content. Presence of excessive amounts of iodine indicates improper performance of the iodine reactor in Building #221-F.

The sample house also is provided with a steam heater capable of keeping the temperature inside the enclosure between 130-150 deg. F. to prevent condensation inside the gas piping.

DEVELOPMENT OF DESIGN

Design of Building #211-F was developed jointly by Blaw-Knox and du Pont, with technical assistance on specific facilities from the Oak Ridge National Laboratory and Knolls Atomic Power Laboratory. It followed to some degree the design of the Building 211-T Tank Farm at Hanford, however, it includes a greater number of services. The Hanford Tank Farm is comparable only to the chemical storage facilities at Savannah River Plant. The Savannah River Plant facilities include a water handling system, an acid recovery unit, general purpose evaporators, and a waste handling facility.

An 18 ft. by 28 ft. single story building was originally thought adequate for the Tank Farm control room and operator headquarters. No other office space was provided in the initial design. However, it was later found advantageous to provide offices for the senior and shift supervisors at this site. Accordingly, the 28 ft. east side of the structure was extended 12 ft. resulting in over-all dimensions of 28 ft. by 30 ft. The additional space thus obtained provided two offices and a small storage room. The building air conditioning system was altered to include the two additional offices.

By mid-1955 it became evident that the radiation emanating from material being processed in the GP Evaporator cone bottom, the evaporator "bottoms" tank, and the adjacent recycle materials sump could affect operations in the control house. To protect personnel and to insure the reliability of health physics instruments used in the building, concrete shield walls were erected. A 12-inch thick concrete wall, 12 feet high, was added north of the control house. A 9-inch thick wall, 7 feet high, was placed south and east of the control house and adjacent to the sump pump. Finally, a 16-inch thick reinforced concrete slab was placed over the entire recycle materials sump including the portion under the monitoring room.

Shielding similar to that added to the control house in the F Area was also added in the H Area with the exception that the wall on the north side is 15 inches thick.

Design Problems

Accessibility

The development of Building #211-F followed the principal that the Tank Farm must be accessible to the Canyon Building and its equipment designed to assure continuous operation. Initially, it was proposed that a single tank farm serve both the #200-F and H Areas. In early 1951, this design was abandoned in favor of a tank farm for each area. The present location of Building #211-F, adjacent to and east of Building #221-F, as well as its over-all layout of walkways, roadways, and railroads, facilitates the flow and control of materials

necessary to achieve continuity of operations.

Continuity of Operations

The necessity for continuity of operation was an important factor in the design of many of the Tank Farm components.

Water Handling System

This system was designed by du Pont and Blaw-Knox, aided by process data from the Oak Ridge National Laboratory.

These facilities were first designed only to dispose of water diluting the process stream as the result of the condensation of steam due to the use of transfer jets. Later process developments dictated the handling of both process and discard water, either to be disposed of or recycled to the process. An evaporation step was also included in the original design.

Initially, it was planned that condensate from the nitric acid recovery and general purpose evaporation facilities would be stored in the water handling facilities until re-used in the process or discarded. In 1954, when it was determined that acid adjustment in Building #221-F was insufficient, equipment was added to accomplish periodic acidification of the condensate prior to storage in order to assure a larger supply of .06% nitric acid to the Canyon Building. This equipment included two Milton Roy pumps to transfer 50% nitric acid from the chemical storage facilities to the water handling system, a mixing chamber, and a conductivity cell.

Nitric Acid Recovery Unit

The acid recovery system was modeled after that at ORNL and similar facilities installed at the du Pont Sabine River Works. Initially the SRP facilities were designed to operate under atmospheric pressure. However, if this had been followed and due to the high temperatures resulting from such an operation, it would have been necessary to adopt tantalum reboiler tubes and Duriron bubble caps to combat excessive corrosion. This brought about the adoption of the Sabine rectifying column, the only change being an increase in size to permit the concentration of acid recovered from the high activity waste evaporator. Vacuum operation permitted the column and the reboiler to be fabricated from stainless steel due to lower operation temperatures. Corrosion evaluation at ORNL substantiated this design.

General Purpose Evaporators

These evaporators were modeled after similar facilities

at KAPL, and were designed on the basis of studies which showed the approximate amount of liquid waste these units would be required to process. Initial design called for two evaporators, but later surveys indicated that three units might be needed to handle the maximum flow from the Canyon Building. Therefore, spare facilities were provided for a possible third and fourth evaporator.

Waste Handling Facilities

These were designed after a survey established the volume of waste from Building #235-F and the #700 Area.

The only major change in design occurred in the latter part of 1953, when an exhaust system was added to the waste handling pit to provide ventilation.

Storage and Transfer Tanks

These tanks were designed from du Pont engineering standards. The chemical storage tanks were sized to accommodate a 60-day supply of process chemicals. The evaporator storage tanks were designed in two sizes to permit greater operational flexibility. Finally the transfer tanks were designed to hold the maximum amount of solution that can be pumped from a canyon vessel. In this case solutions are pumped because the use of jets would seriously limit the flexibility within the canyons of Building #221-F. Early tank design included the use of steam coils to prevent winter freezing of stored solutions, but later it was decided that this was unlikely to occur in these tanks and coils were omitted.

Pumps

A portable self-priming, stainless steel pump with a flexible stainless steel hose was provided as a back-up against possible failure of vertical submerged pumps installed in various tanks. This required the installation of a 220-volt electrical distribution system with outlets throughout the Bldg. #211-F area.

Piping

Approximately 90 per cent of all the overhead piping in Building #211-F is fabricated from stainless steel. Lines containing caustic and uranyl nitrate are steam traced and insulated to prevent freezing.

General Safety Problems

The primary safety problems encountered in the design of the Tank Farm included the handling of radioactive wastes and

the storage of flammable, mildly toxic and corrosive materials.

Radioactive Wastes

The presence of high activity wastes in the waste handling area required the provision of adequate shielding. Tanks were placed in sealed concrete vaults or cells to shield the equipment and place it at a low elevation to permit gravity flow of liquids from Building #772-F to the tanks. In operation, each cell is kept under negative pressure to prevent any leakage of contaminated vapors to the outside area.

Another major problem was the manual coupling and uncoupling of a shielded tank truck at the unloading station. The presence of radiation dictated the design of portable tools including a special uncoupling tool that permits the operator to remain at a minimum distance of two feet from the connection joints.

Precautions were taken to prevent errors in unloading the wastes. These included the use of separate stalls for shielded and unshielded tank trucks, the orientation of nozzles on the tank trucks so the high activity tank truck could not be connected to a low activity fill or suction line, and the placement of the high activity stall at a higher elevation than the low activity platform.

Provision of a monitoring instrument and alarm was made in the general purpose evaporators to guard against the accumulation of too high a level of activity.

Flammable and Toxic Materials

Although certain materials handled in Building #211-F are flammable and mildly toxic, the open nature of the construction generally precludes any likelihood of vapor accumulation in dangerous volumes. Toxic vapors from shielded and unshielded trucks are vented to the vent header located on the pipe rack. The off-gas sampler is enclosed and kept at a negative pressure to prevent the escape of vapors to the sampler room.

Corrosion

The largest factor contributing to corrosion is the handling of various concentrations of nitric acid. This accounts for the wide use of type 304 ELC stainless steel materials of construction and of type 309 Cb where elevated temperatures are encountered.

Personnel

The health check station was designed as a safety station to monitor personnel entering and leaving Building #211-F facilities.

In general, design of the Tank Farm facilities was developed to confine contamination and provide adequate and safe working conditions.

DRAWINGS

W-149096	General Plan of Facilities
W-148399	Recovery Facilities Equipment Arrgt.
W-148400	Recovery Facilities Equipment Arrgt.
W-145703	Chemical Storage Facilities
W-145912	Gen. Purp. Evap. Facilities
W-146049	Transfer Tank Arrgt.
W-146322	Evap. Tankage Facilities.
W-146662	Control House Layout, Equip. Arrgt.
W-145977	Chemical Storage Facilities
W-145955	Plan of Underground Struct.
W-148244	Water Handling Facilities.
W-149151	Waste Handling Facilities.
W-149152	Waste Handling Facilities.
W-149528	Check Station, Equip. Arrgt.
W-158742	Off-Gas Sample House

BUILDING #211-H - TANK FARM

This tank farm differs from Building #211-F in that its facilities were reduced to meet the minimized scope of production planned for the #200-H Area. There are no waste handling facilities and only one general purpose evaporator with two 8-foot by 30-foot storage tanks. In addition, it has only one condensate transfer tank, the need for a second tank being eliminated by the deletion of the laboratory waste evaporator in Building #221-H. This reduced the total number of transfer tanks to seven. The concrete foundation for an eighth tank was erected in the event an additional unit is required at a later date.

As an added difference, four solvent hold tanks are installed in the "H" Area; two to provide storage for "hot" first cycle solvent and two for "warm" cycle solvent from Building #221-H. All tanks are mounted on concrete slabs, but only the two "hot" solvent tanks are enclosed by a concrete shield wall. Late in 1954, additional pump connections were provided on these tanks to permit future installation of a purification system and the transfer of its discard water to the existing water handling facilities at Building #211-H.

Modifications were made also to attain a greater utilization of condensate. For example, equipment used in the 0.06 per cent nitric acid make-up step of the water handling facilities was

altered by replacing a.c. motors on all proportioning pumps with d.c. units and by adding a speed controller to vary the acid feed to correspond to the variable flow of condensate.

As a result of a design study, general improvement of all components brought better accessibility to valves, more direct routing of lines, simplification of conduit runs, and better instrument locations.

DRAWINGS

W-149150	Equip. Arrgt., General Plan of Facilities
W-148246	Equip. Arrgt., General Purpose Evap. Facilities
W-148412	Equip. Arrgt., General Purpose Evap. Facilities, Sections
W-158006	Equip. Arrgt., Chemical Storage Facilities
W-158007	Equip. Arrgt., Transfer Tank Arrgt.
W-158009	Equip. Arrgt., Control House Plans & Elev.
W-158075	Equip. Arrgt., Recovery Facilities, Plan
W-158076	Equip. Arrgt., Recovery Facilities, Elev.
W-142171	Equip. Arrgt., Segregated Solvent Area
W-158077	Equip. Arrgt., Water Handling System
W-158089	Equip. Arrgt., Sampling House
W-158088	Equip. Arrgt., Check Station

BUILDING #217-F - STORAGE MAGAZINE

FUNCTION

Building #217-F serves both the #200-F and #200-H Areas as the storage magazine for plutonium and tritium, in final packaged form, ready for shipment from the plant.

PRINCIPAL COMPONENTS

Vaults

Two vaults are provided for this storage of product. Vault "A" is used for the storage of plutonium and Vault "B" for the storage of tritium.

Vestibules

Vestibules "A" and "B" serve as entrance ways to the respective vaults and house the heating, ventilating, and monitoring equipment.

BUILDING FLOOR SPACE

Approx. Sq. Ft.

Vaults

Vault "A"
Vault "B"

610
430
180

	<u>Approx. Sq.Ft.</u>
<u>Vestibules</u>	252
Vestibule "A"	154
Vestibule "B"	98

BUILDING DETAILSClass - I

Size - Single story, rectangular shape, approximately 32 ft. square with a height of 11 ft. from floor to top of flat roof slab.

Area - 1024 sq. ft.

Volume - 13,410 cu. ft.

CONSTRUCTION DETAILSFoundations

The concrete slab is covered with two-ply membrane waterproofing, 1 in. cement plaster, and approximately 19 in. of reinforced concrete.

Superstructure

The exterior walls are of reinforced concrete with a concrete roof slab. Concrete hoods extend beyond the building face just below roof level to provide blast resistant ventilation openings. All interior walls are of concrete and ceilings are the exposed concrete roof slabs. Both vaults meet the specifications established by the National Surety and Underwriters Codes for Class IV bank vaults. Concrete vision barriers, in line with both sides and also on the center line of the building, extend outward 20 ft. from the building and upward to the height of the building on the entrance side. The exterior of the entire building is painted with one coat of a transparent, colorless, silicone type damproofing.

Roofing

Insulated, built-up roof.

Floors

Concrete, no floor covering.

Doors

Vaults have steel vault doors with "manipulation-proof" locks. Vestibule doors are steel with combination locks and multiple deadlock steel bolts which engage the door frame at top, bottom and hinge side.

Heating and Ventilation

All heating is by means of electric grid heaters provided to prevent condensation by maintaining the proper wall temperature. Two electric heaters are installed in each vault and also in Vestibule "A", with only one heater in Vestibule "B". In addition, each vault has a separate ventilating unit consisting of inlet and outlet ducts with a filter, electric heater, and fan located in the inlet duct. These are once through systems and are designed to handle heat gain resulting from heat emission of plutonium.

A complete monitoring system, consisting of Cuno Filter, air pump, ionization chamber, amplifier and recorder, is used to test automatically the air in Vault "B" for radio-activity.

Lighting

All building lighting is vapor-proof incandescent. Two portable battery lighting units are provided to light the exterior double-fenced enclosure surrounding this building in the event of power failure in this area. Emergency power supply is provided through an underground cable by a diesel generator located in Building #235-F.

EQUIPMENT

Plutonium containers, 20" x 20" x 20".

Tritium containers, 11-3/4" O.D. x 19-15/16" over-all height of stainless steel, and having an aluminum protective cover.

Steel grating platforms.

- 7 Electric panel heaters.
- 2 Electric duct heaters.
- 2 Electric circulating fans.
- 2 Portable battery lighting units.
- 2 Vault doors.

Door alarm system.

INSTRUMENTATION

The storage magazine is equipped with radiation monitoring instruments consisting of Cuno Filter, air pump, ionization chamber, amplifier, and recorder.

DEVELOPMENT OF DESIGN

In developing the design for a storage building of this nature it was necessary to consider the several aspects of product security and personnel safety.

The first basic design data stipulated the division of the plan into two vaults, with a separate vestibule for each vault and a room to house mechanical equipment for heating and ventilating. Class I construction was specified also, not only to safeguard the stored product from the possibility of bomb blast but, in conjunction with the required vault doors, to protect it from unauthorized access. This basic layout remained in effect until February of 1952, when the mechanical equipment room was eliminated. Instead, installation of the necessary equipment in each vestibule was specified. The Kanne chamber (ionization chamber) for sampling and monitoring Vault "B" air was to be placed in the vestibule to Vault "B" and all other equipment was to be placed in the larger vestibule to Vault "A".

The original scheme for heating the vaults was based upon circulating hot air through ducts from hot-water unit heaters located in the equipment room. Air was to be exhausted from the vaults and carried back to these heaters through airtight ducts, the air from each vault being recirculated independently. A common hot water circulating system was to be utilized by the unit heaters from an electric hot water heater also located in the equipment room.

Later it was decided that Vault "B" should have neither a unit heater nor ductwork, but that a heating pipe connected to the water heater and circulating pump should be installed on the wall separating the two vaults. At this same time it was specified that the unit heater for Vault "A" should be so arranged that, if a leak developed in the water line, no moisture would pass through the air duct to the vault.

However, in June of 1952, the system of forced air, heated by hot water, was discarded entirely in favor of heating both vaults by electric panel heaters.

Original sketch plans called for the installation in Vault "A" of raised concrete pads or platforms on which to store product. However this placed a definite limitation on the location of the stored product, so the concrete pads were eliminated and steel grating platforms were designed to be movable to

any location within the vault.

During the early development of design, considerable thought also was given to the need for emergency electric power in this area in case of accident or interruption in supply from the plant power system. Emergency security lighting was therefore provided, and a decision was made that interruptions to electrically driven heating and ventilating equipment could be tolerated.

The over-all problem of security protection of the stored product required special consideration. It was considered advisable to surround the building with a double line of chain-link fencing topped with barbed wire and to equip both these fences and the access gates with a reliable signal alarm system. The Guard House, Building #701-5F, located at the entrance to the Bldg. #217 enclosure, served as the principal control center, but this was supplemented by a two-way radio, direct telephone connection, and the normal plant telephone system. A signal panel in this guard-house registers the fence alarm system as well as the alarm system installed on the doors to each vault.

DRAWINGS

W-157355	Structural - Foundation Plans and Details.
W-157356	Structural - Roof Plan and Wall Details.
W-157357	Architectural - Plans, Elevations & Details.
W-157358	Heating, Ventilating & Electrical.

BUILDING #232-F - MANUFACTURING BUILDING

FUNCTION

Building #232-F houses the equipment and facilities designed to extract tritium. The operation includes the decanning of irradiated aluminum-jacketed, aluminum-lithium slugs, and extraction of tritium gas, the purification of the tritium, and its packaging in containers.

PRINCIPAL COMPONENTS

Process Section

This section consists of a regulated electrical control room, a process room, process control room, monitoring room, two furnace rooms, decanning room, and a material handling room, as well as a furnace and storage room, corridor, and air-lock.

Service Section

The service section consists of a non-regulated electrical control room, a mechanical equipment room, area and shift supervisor's offices, clerical office and file room, non-regulated and regulated change rooms, toilet and shower rooms, janitor's closets, heater room, store room, Health Physics office and counting room, mechanical shop, electrical and instrument shop, a corridor and two outgassing and calibration rooms.

BUILDING FLOOR SPACE

Approx. Sq. Ft.

Process Section

Electrical Control Room (regulated)	280
Process Control Room	760
Monitoring Room	350
Furnace Rooms (2)	80
Furnace and Storage Room	420
Decanning Room	160
Material Handling Room	640
Process Room (including Basement)	900
Air-Lock	290
Corridor	<u>1770</u>
Total	5650

Service Section

Electrical Control Room (non-regulated)	580
Mechanical Equipment Room	3350
Offices (4)	700
Shops (3)	1410
Counting Room	310
Store Room	340
Locker, Toilet and Change Rooms	2300
Janitor's Closets (2)	110

	<u>Approx. Sq. Ft.</u>
Outgassing and Calibration Rooms	1100
Corridors	<u>590</u>
Total	10,790
Building Total	16,440

BUILDING DETAILS

Class - III

Size - This is a single story building with a process section and a service section.

The process section is approximately 42 ft. wide by 130 ft. long and has an air lock extension 11 ft. wide by 35 ft. long. The ceiling height of this section is approximately 28 ft. at the process room, 18 ft. over the air lock, 16 ft. over the decanning room, and 13 ft. over the remainder.

One area of the service section consists of a non-regulated electrical control room and a mechanical equipment room which, together, occupy an area 36 ft. wide by 107 ft. long. The other area, housing the remaining service facilities of the Manufacturing Building, measures about 70 ft. by 98 ft.

There is also a basement and sub-basement under the process room which house a portion of the process equipment and the inertia block supporting the thermal diffusion column.

Area - Approximately 17,400 sq. ft.

Volume - Approximately 252,500 cu. ft.

CONSTRUCTION DETAILS

Foundations - Reinforced concrete with spread footings.

Superstructure - Structural steel frame with concrete roof slab.

Exterior Walls - Flat asbestos board.

Interior of Exterior Walls - Flat cement asbestos board on steel studs.

Interior Partitions - Flat cement asbestos board on steel studs except for shower and toilet rooms and material handling and decanning rooms which are of concrete. The

process room has steel partitions.

Ceiling - Suspended flat asbestos board except over materials handling and decanning rooms.

Doors - Hollow metal swinging doors; roll-up metal doors; one sliding metal door.

Roofing - Concrete roof slab covered with insulation and built-up roofing. Over the materials handling and decanning rooms the concrete roof slab is 1 ft. and 2 ft. thick, respectively.

Insulation - Roof and exterior walls.

Floors - Concrete.

Heating - Forced air through heaters and duct work.

Air Conditioning - Building air conditioned with the exception of the mechanical equipment room and the non-regulated electrical control room.

Air Exhaust - By fans through ducts to the Stack Building #295-F. A few non-regulated change room areas and offices exhaust directly to the atmosphere.

Electrical - Power is supplied to Building #232-F through an underground 13.8-kv. cable to a 500 kv.-a. transformer located on a pad outside the building. This high voltage is reduced to 480 volts by the above dry-type transformer feeding to a motor control center (for normal power) in the non-regulated electrical room. This motor control center feeds an emergency motor control center which also is tied to a 100 kw. diesel generator set for use in case of main power failure. Power at 480-volt 3-phase is fed from the non-regulated electrical room to the regulated electrical room control center. Power for all building facilities such as lighting, ventilating and refrigeration is fed from the non-regulated electrical room, while all process equipment is fed from the regulated electrical room.

Dry-type transformers reduce the voltage to 120-208 volts 3-phase for lighting service. In general, lighting for the material handling area, mechanical equipment room, corridors, toilets, and utility rooms is incandescent. In the process area, control rooms, laboratory rooms and offices it is fluorescent. A 100 kw. emergency diesel generator is provided to start automatically and carry essential ventilating, process, and instrument loads in case of normal power failure.

A master intercommunication system operates from a control location in the process control room to various points in the process area.

EQUIPMENT

A monorail and 6-ton hoist for the transfer of slug casks from delivery truck to transfer car inside the entrance air-lock of Manufacturing Building.

Material handling rail car system.

Slug unloading and decanning equipment.

Slug drying hood.

Furnace for degassing crucibles.

Two extraction furnaces for the removal of product and by-product gases from heated slugs.

Two diffusers for primary separation between hydrogen, hydrogen isotopes, and heavier material.

A palladium and sand sorber for removal of small quantities of isotopes from inert gases.

A decomposer, containing uranium turnings, for removing water and other decomposable material from the sorber effluent.

Small storage and volume measuring tanks, approximately 10 gallons capacity, serving the integrated process assembly.

Mercury diffusion pumps in series with Sprengel pumps to transfer gases through the process assembly.

A liquid nitrogen system for cooling cold traps and sorber.

A thermal diffusion column for the separation of tritium from other hydrogen isotopes.

A mass spectrometer to monitor vapor effluents in the recovery system and check analyses.

Experimental glass and mechanical equipment, including instrumentation, equivalent to that of the process assembly, is provided in the outgassing and calibration laboratory to accomplish process control and improvement.

Ionization chamber type monitoring equipment for continuous sampling of air in the process section of the building.

Final product container (12-liter container fabricated of stainless steel).

Exterior methane gas storage facilities which supply

applications in the Health Physics Laboratory.

Air conditioning system.

A 100-kw emergency diesel generator.

A "Second-Metal Line", similar to the original processing facility installed at Hanford, is stored in the building and may be used as emergency spare equipment.

Instrumentation

The greater part of the process instrumentation used in this building is of special design due to the nature of the process gas. The entire process is remotely controlled from a graphic panel in the process control room.

Pressure measurement

Six mercury manometers of inconel metal are used for measuring absolute pressures. Measurements from these indicators are transmitted electrically to the control room for accounting purposes. Remote readings are made possible by a set of electrical coils on the legs of the manometers which are interconnected to form a Wheatstone bridge circuit and tied into a five-channel bridge in the control room. An unbalanced voltage from the bridge is converted into d.c. current and used as an indicator of mercury level in the manometers. By loading the legs of the manometers with argon or vacuum the absolute null balance pressure can be read on a precision balance.

Thermocouple vacuum gauges, with a range of 0-1000 microns, are used when the system is being evacuated. Flanged stainless steel envelopes are used for the primary sensing element and separate millivoltmeters are mounted on the graphic panel. The gauges are calibrated for argon but other gases may be used with suitable calibration charts.

The thermocouple vacuum gauge is of the heat conductivity type. Energy is supplied to a platinum iridium ribbon and is maintained constant. The temperature of the hot surface decreases with an increase in pressure and is detected with a nichrome ribbon thermocouple and a millivoltmeter. This gauge is not used for accurate measurements. Readability and factors such as oxidation of the filament limit its accuracy to $\pm 10\%$ of full scale. A constant 1-volt d.c. power supply for the heaters is fed from a common source for all thermocouple gauges, with the current adjusted by individual variable resistors in a common cabinet. A millivolt vacuum recorder is used for the extraction furnaces where the thermocouple vacuum gauge is the element.

Extremely low absolute pressures in the range of 0.01 to 500 microns are measured by a cold cathode type Phillips gauge. These are installed at the inlets of the extraction furnaces and the thermal diffusion column to ionize the gas, measure the ion current, and transmit it to the graphic panel. Although the Phillips gauge, as designed by the Consolidated Vacuum Corporation, is rugged and practically burn-out proof, the element must be removed periodically and cleaned.

To measure absolute pressures in the millimeter range a redesigned Foxboro D/P cell is used. This cell, flanged and welded to decrease the possibility of leaks, measures the difference in pressure between the process and zero absolute pressure. This information is transmitted to a 6-point pneumatic receiver recorder and indicating gauge on the graphic panel. All commercially available gauges were studied and found unsatisfactory for this application.

Static pressure and alarms are provided for all hood air exhaust ducts. Panalarms are on the graphic panel.

Temperature Measurement

Special nickel resistance thermometer bulbs, with an accuracy of ± 0.1 deg. C. over a range of 15-45 deg. C., are used for all accounting vessels.

Dial thermometers and temperature and flow switches are used on the cooling water exit lines. High temperature and no flow alarms are energized on the graphic panel.

Initially Magnetrol flow switches and Rotasight type alarms were installed for cooling water alarms on the diffusion pumps. However these were not satisfactory and were replaced by a stand pipe with a fixed flow orifice. The level in the stand pipe is measured by a Warrick type level probe and energized by an alarm if the level drops so as to indicate a loss in cooling water.

Temperature switches on diffusion pump boilers are interlocked with the power supply.

Temperature Control

Two thermocouples fabricated of chromel-alumel metal are located on the wall of the crucible at representative points and are connected to a recording potentiometer through a double-pole double-throw thermocouple switch. One thermocouple is used for control through a potentiometer recorder, pneumatic controller, rheostat and Reactrol system. Overload protection and high temperature alarms are provided. Manual control stations have been provided on the graphic

panel. The Reactrol unit which regulates the current to the furnace calrods can also be manually adjusted. Two thermocouples are located on the bottom of the crucible and connected to an electro-pulse recorder through a double-pole double-throw thermocouple switch. This is an on-off type temperature control. Loss of cooling water or high exit water temperatures energize a panalarm system. Similar Reactrol systems are used on the diffuser. Column temperature is controlled indirectly by regulating the heat input to the wire. Due to the temperature gradients caused by the variations in gas thermal conductivity, a variable resistor is used on the current input to the lower half of the column. This current is measured across a shunt and recorded. A pneumatic control system regulates a rheostat which in turn controls the Reactrol unit. Exit cooling water temperatures are indicated on the panel by means of a temperature transmitter.

Activity Monitoring

Furnace enclosure is monitored for beta-gamma rays by a Beckman amplifier and ionization chamber. The Beckman amplifier is located on a panel adjacent to the furnace.

Special stainless steel Kanne chambers and air sampling systems are provided for all hoods, stacks, offices and control rooms. Locally mounted 7-decade Brown recorders with high alarm Panalarms are in the control room. This eliminates the need of manually switching ranges.

Portable sniffers.

Metal enclosed glass ionization chambers sensitive to .001 per cent of product are used to detect product in the by-product gases before discharge to the stack. A multi-point switch and Beckman amplifier are used for measurement and indication.

Analysis

Spectrometer

A consolidated Nier isotope ratio spectrometer was rewired at Knolls Atomic Power Laboratory to provide for continuous magnetic scanning. Results are recorded on a four decade logarithmic recorder. Calibrated leaks are provided on each major piece of equipment with a continuous flow through a manifold and back to the system. A calibrated leak consists of a coil of capillary tubing with one end open to the process. The tubing is pinched in a V-block to restrict the flow. All restrictions must be made after installation for balancing the system. By manipulating valves any leak can be analyzed. A time cycle control on the column leaks gives indication of per cent of product on a five minute cycle.

Thermal conductivity cells at the column provide a continuous indication of feed, product and raffinate quality. This is an instantaneous reading. The mass spectrometer reading incorporates a 15 minute lag. Amplifiers and regulated voltage supplies are housed in a relay cabinet located in the control room.

Control Valves

Practically all the leading valve manufacturers were contacted for designs on high vacuum valves, but these were found unsatisfactory for application at the Savannah River Plant. Therefore a valve design was worked out with Hammel-Dahl which met the requirements and leak rates of not more than .001 micron cubic feet per hour, neglecting diffusion of gases through the plug material of the valve. This valve is a bellows, packless type with Teflon seal rings, a one piece forged body, and a piston operator.

Pressure and Flow Control

The feed surge tank pressure is controlled at 840 mm. Hg. abs. through by-passing the feed pump. A Hammel-Dahl spline plug valve controls the column feed from a manometer bridge assembly, Transducer and pneumatic controller. When the pump pressure decreases to a point where the range of the valve is exceeded, a second feed tank is opened. The raffinate and product are controlled by fixed capillaries.

PROCESS DESCRIPTION

The process in Building #232-F is designed to extract tritium from 3-1/2% lithium-aluminum slugs received from the #100 Areas and to separate it from other extracted gases and hydrogen, obtaining a 99% pure product.

The separation of tritium is achieved through a series of remotely controlled major operations and auxiliary services.

Major Operations

The primary operations consist of raw material handling, crucible preparation, slug drying, slug decanning, product extraction, primary separation, product stripping, isotope separation, and product container preparation. All process operations except the cubicle-enclosed decanning phase are contained in various sized stainless steel hoods with Homalite-type plastic windows which permit visual inspection of the facilities.

Raw Materials Handling

Lithium-aluminum slugs are transported from the #100 Areas to Building #232-F by motor truck in lead shielded stainless steel casks. Upon arrival at the building platform, the slug cask is moved on a monorail hoist into the air lock and placed on a transfer car.

After external monitoring with gamma detecting instruments, the transporting assembly (an electrically operated main car supporting a transfer car) travels on tracks out of the air lock through a passageway into the concrete-enclosed materials handling area. Here the top transfer car, operated by a self-contained detachable "mule", travels laterally and carries the slug cask into the storage area.

Electric power at 220 volts a.c. is fed to the main and mule cars through a flexible cable. One end of this cable is anchored to a receptacle in the floor at the midpoint of the material handling area between the main car tracks, while the other end is attached to a spring driven cable reel on the main car. A second cable reel on the main car is attached to the mule car which allows the latter to travel sideways from the main car in either direction on spur tracks.

A system of interlocking latches and limit switches secures the main car at specific spur track locations to allow the mule car to move off. Five control cabinets, located outside the material handling area at leaded windows, allow visual control of these cars.

Motors in both the main and mule cars are designed to deliver a maximum stalled torque of 27 pound-inches, and can be stalled at least 50% of their operating cycle without overheating.

Crucible Preparation

Empty furnace crucibles are degassed in a degassing furnace, stored in a crucible cask in an argon atmosphere to avoid moisture pick up, and transported when needed through the materials handling enclosure into the decanning cubicle.

Slug Drying

The loaded slug cask is moved from the storage area to the drying station where connections through its lid supply heated air to the interior to remove moisture from the slugs. Air is exhausted from the cask through a series of Fiberglas roughing filters and Atomic Energy Commission type filters to the Building #295-F stack.

After drying, the slugs as well as the degassed crucible and scrap container, all enclosed in their respective casks,

are moved separately on transfer cars to the decanning enclosure.

Decanning Facilities

When the three casks enter the enclosure, decanning operations are performed remotely by means of transfer car pin-locking devices, three cask lid-lifting hoists, two cask positioning mechanisms, a crucible lid closure actuator, and two master slave manipulators. All operations are remotely controlled from a panel outside the decanning enclosure. The slave manipulators are operated manually from outside the enclosure. Visual observation and inspection is possible through windows made of lead shielding glass.

The stainless steel decanning machine strips the aluminum can and raincoat from the lithium-aluminum core. The slug, placed in the feed hopper by one of the two manually-operated manipulators, drops into the feed slot and is forced by a ram past two sets of cutters which slit the raincoat and can longitudinally, remove the ends of the can, and slice the longitudinal pieces in half. On leaving the cutters, a vibrator unit removes any adhering aluminum cuttings and the core is discharged into a small bin. The decanned slugs are removed from the bin by a manually-operated master slave manipulator and loaded into a positioned crucible, the cover of which is attached and detached by a closure actuator.

Dust particles within the cutter hood are removed by a vacuum system, while aluminum cuttings fall through a sliding door in the decanning table, down a stainless steel chute, and into a disposable scrap container resting in its cask.

When decanning operations are complete, the empty slug cask mounted on its transfer car and the loaded crucible within its cask are lowered by their respective hydraulic lifts to a normal position. The mule moves the transfer cars into a position permitting the cask lids to be lowered into the casks. Then the slug and scrap container casks are taken into the storage area. The crucible cask is transported to the argon station where it is evacuated of air and charged with argon. Following this it is placed in the storage area until required to load the extraction furnaces. Scrap casks are taken to the burial ground for disposal of the contents.

Product Extraction

The objective of this step of the process is to extract product and by-product gases from the slugs with a minimum loss of tritium.

Product extraction takes place in two vertical, water-jacketed, electrically heated furnaces. Electric power is fed to these extraction furnaces from a 220-volt single-phase source through Reactrol equipment and booster transformers to approximately 300 volts on the calrod units in the furnaces. These calrod units within the furnaces have open ends connected by leaded leads to a disconnecting device in the bottom of the furnace. This feature allows the furnace to be removed from the furnace chamber by remote means.

In the original design of the furnace it was found that flash-over on the calrod leads would occur in the presence of argon gas when power to the calrod units was over 150 volts. Therefore the design was changed to obtain approximately 135 volts on the calrod units.

Control for the furnace loading mechanism and mule car is provided from control stations located behind leaded windows outside the furnace room.

The extraction process begins after one of the furnaces is outgassed and a charged crucible cask is moved into its furnace hood. From a control panel, an operator actuates a 1-ton hoist which removes the cask lid, then a mechanical boom is actuated to raise the crucible to the top of the furnace for loading.

After insertion of the crucible, the furnace cover is replaced, the furnace is evacuated and checked for leaks, and the charge is brought to 575°C. where it is held until about 90% of the gas content in the slugs has been evolved. Evolution of the remaining gases is accomplished by heating rapidly through the melting point (610°-630°C.) and holding at 700° to 800° until the vacuum is broken by admitting argon at one atmosphere to accelerate cooling and minimize furnace contamination with atmospheric gases.

After the furnace has cooled, its cover is raised by the mechanical boom and the crucible is removed from the furnace and lowered into its cask. After the cover is replaced, the cask is monitored externally for contamination and moved to the loading dock where it is transported to the burial ground.

The slug cask, scrap cask, and crucible cask are re-used in the process if monitoring shows them to be free of radioactivity; if not free of radioactivity the exteriors are cleaned and they are re-used.

The extracted gases leave the furnace and pass through a process assembly operated by a graphic type control panel which pictorially allows the operators to follow the important steps of the gas process.

Primary Separation

This phase of the over-all process prepares a suitable feed for the thermal diffusion column by separating hydrogen and tritium from helium and other contaminants.

Separation of the evolved furnace gases is effected by a subassembly of the process line which includes an extraction pumping system, two palladium diffusers in parallel, a measuring volume pumping system, and a measuring volume tank.

Extraction Pump System

This system consists of a liquid nitrogen cooled cold trap enclosed in a 10-inch stainless steel pipe, a mercury diffusion pump with cooling water tubing around it, and a 10-tube Sprengel-type pump.

Extracted gas passes through the cold trap where condensibles are removed and then is picked up by the mercury diffusion pump which boosts the gas to the Sprengel pump which forces it into the open chambers of the evacuated palladium diffusers. Separation of the isotopes is accomplished when the extracted gas is evacuated through palladium membranes which strip 95% of the tritium and hydrogen from the by-product gases. The remaining isotopes are removed from the by-product gas and concentrated for reprocessing in subsequent operations.

Palladium Diffusers

Primary separation in the diffusers occurs simultaneously with extraction. These units consist of a chamber housing four palladium membranes maintained at 400° to 600°C. by a Reactrol type heat controller. The walls of each diffuser are cooled by water coils wrapped around the outside of the chamber. One diffuser remains inactive but is kept heated at 150° C. in case the palladium tubes of the unit in use lose their permeability and require regeneration or replacement. In addition, the process is monitored by continuous on-line sampling of the separated and unseparated gases and by rapid mass spectrometer analysis as required.

Measuring Pumping System and Measuring Volume Tank

This system consists of a mercury diffusion pump which boosts the hydrogen-tritium isotopes from the palladium diffuser to a Sprengel pump which in turn transfers the gas to the stainless steel 3-1/2-gallon measuring volume tank.

Product Stripping

By-product gases from the primary separating unit are pumped to the 7-gallon by-product measuring tank where the composition of the gas is determined by mass spectrometer analysis. The gas then passes through a sorber which reduces the amount of tritium in the by-product gas to 0.1% so that it may be discharged safely to the exhaust stack, Building #295-F.

Sorber

Before the sorber is placed in the process assembly, its palladium bed is flushed with dry hydrogen and outgassed to remove adsorbed oxygen and water. The palladium bed, a mixture of palladium black and silica sand, is maintained at minus 100-103°C. by a pressure-controlled freon-liquid nitrogen heat exchange system.

In the product stripping operation, final separation of the isotopes from the by-product gas occurs when the gas is passed over the bed at minus 100°C. After one or two charges are processed, the palladium mixture is then heated to 105°C. to permit release of the isotopes to the decomposer. During the process, the efficiency of the stripping operation may be monitored as desired by continuous mass spectrometer analysis of the effluent gas as it leaves the sorber.

At the completion of the sorption operation, the by-product gas flows to a second by-product measuring tank and is analyzed. If the tritium content is sufficiently low, the gas is discharged to the stack.

Desorption

The secondary phase of product stripping includes the desorption operation. This takes place in an electrically heated double-walled decomposer which reduces oxides and water in the isotopes. The gas is pumped over a uranium chip bed at 500°C. and then returned to the palladium diffuser for final purification, where it is processed the same as a furnace charge.

Isotope Separation

The separation of tritium from hydrogen is carried out in a thermal diffusion column. This stainless steel unit consists of a vertical water-jacketed cylinder concentric with an electrically heated wire.

The molybdenum heating element in the thermal diffusion column is fed from a 48-50 volt d.c. source obtained from a 3-phase a.c. - d.c. rectifier. Control of the power source is provided by Reactrol equipment on the a.c. side of the rectifier. The heating element in the diffusion column is

supported from its ends. In order to reduce vibration in this element it was decided that direct current with less than 4 per cent ripple would be the power source for this application.

Upon start-up of a column or after a column has been open to contamination, it is cleaned by degassing and hydrogen flushing at 100°C.

The initial step of isotopic separation takes place when the tritium and hydrogen passes from the measuring volume tanks to one of two 7-gallon stainless steel storage feed tanks. From these tanks it is fed at a controlled rate to a spline valve which, in turn, feeds the column through a capillary. When the isotopes pass into the column, the lighter hydrogen molecules are concentrated in the rising stream near the hot wire and the heavier tritium molecules in the descending stream next to the cold wall. At the top of the column, the hydrogen is drawn off continuously, pumped into one of two stainless steel raffinate storage tanks, and released to the stack if the tritium concentration does not exceed health physics tolerances. The bottom of the column discharges tritium at a minimum purity of 99% to one of two stainless steel product storage tanks. Process data are obtained by semi-continuous mass spectrometer analysis and thermal conductivity control at feed and draw-off points.

After analysis, the tritium is transferred by the product unloading pump to a product container previously prepared in another area.

Product Container Preparation

The object of this operation is to ascertain that the stainless steel product container is leak-tight within specification, and to remove moisture and adsorbed gases to prevent contamination or dilution of the contents. Gases are removed by heating this container to 105 deg. C. and evacuating to 0.1 micron.

Each container is tested for body and valve seat leakage and then outgassed.

Container and Valve Body Leakage

This is determined by evacuating the container to one micron in a helium hood and measuring the leak rate with a helium leak detector.

Valve Seat Leakage

This test is accomplished by filling the container with helium and closing the valves so that the leakage instrument

may detect any gas escape around the valves. After this testing procedure the product is collected in the container in the basement of the process area. The container is housed in a hood during its use as a collector.

Auxiliary Operations

Functioning of the tritium separation equipment is supplemented by such auxiliary operations as temporary storage, recycle of product, evacuation of system, vacuum breaking, mass spectrometer analysis, and the cooling water system.

Temporary Storage

This operation provides facilities for the withdrawal of gas from the primary separation equipment of the isotope column feed tanks if safe operation of the system is threatened by mechanical breakdown or contamination induced by gas leakage.

Recycle Operations

Off-quality gas results from maloperation of the thermal column, from contamination by leakage, or from tritium breakthrough during stripping. This gas is returned to the appropriate stage of separation for reprocessing by using existing process pumping systems.

Evacuation

The objective of this operation is to reduce the pressure in any major component or subassembly of the system from one atmosphere of argon to a pressure of 0.1 micron.

Evacuation of the tritium separation facilities is accomplished by the high vacuum system. All high vacuum connections are manifolded into a high vacuum header which connects with the high vacuum diffusion pump discharging to the high vacuum ballast tank. The H.V. system discharges from the ballast tank to the stack. No gas containing an appreciable tritium concentration is exhausted by this system.

Vacuum Breaking

All process equipment and flange connections must be pressured to one atmosphere before these components may be removed for maintenance or other purposes. The vacuum is broken by argon to prevent the contamination of process equipment by air.

Argon was selected for use in breaking vacuum in the primary separation and product stripping subassemblies because of its density, ease of detection in case of valve seat or palladium membrane leakage, and because its presence in these assemblies

does not lead to ambiguity in the measurement of the He⁴ in the by-product. It was also selected for initial use in the isotope separation subassembly and its auxiliaries because of the ease with which it is detected.

Mass Spectrometer Analysis

This operation maintains process control at critical points in the separation process and provides a means of determining the quality of the final product with a minimum loss of tritium due to sampling. The operation is accomplished by continuously sampling process gas at sixteen designated points in the system, analyzing the gas from one sample point with a modified Consolidated-Nier isotope ratio mass spectrometer, and pumping the gas sampled to a stainless steel accumulator from which it is returned to the system through the primary separation subassembly.

The spectrometer and its scanning equipment are located in the process control room. The spectrometer is enclosed in a ventilated hood which provides access to the back of the instrument and sufficient working space for maintenance.

In addition, grab-sampling connections are provided at both the product loading and temporary storage flanges. Tritium is removed from these samples by absorption techniques on laboratory equipment.

Cooling Water System

Cooling water is applied to jackets and coils of the extraction furnaces, diffuser, thermal diffusion column, and diffusion pumps in the tritium separation line. By serving as a coolant, it also reduces the rate of diffusion of tritium through stainless steel. Process cooling water is discharged to Four Mile Creek through the process sewer.

DEVELOPMENT OF DESIGN

Building

Design of Building #232-F was directed initially by du Pont with the Blaw-Knox Construction Company of Pittsburgh, Pa., serving as subcontractor. However, in April, 1952, Voorhees, Walker, Foley & Smith of New York relieved Blaw-Knox of their architectural responsibilities in order to alleviate the latter firm's work load and expedite over-all design. Nevertheless, extensive development time was required to achieve a firm design because of the relative newness of the process, its required equipment, and necessary auxiliary facilities.

Numerous layout studies were made by Blaw-Knox from February, 1951, until the termination of their design responsibility in mid-1952.

Initial design favored a Class I and Class II structure, with Hanford's "Metal Line" being housed in the Class I and its auxiliary facilities in the Class II portion of the building.

Another proposed scheme included a combination of Building #232-F with Building #235-F. It was planned that one "Metal Line" and two "C" Lines should be located in a Class I structure while common service facilities would be housed in a Class II portion of the building. This also was abandoned because it was not feasible to house two processes with such different hazards in a single building.

The next series of preliminary arrangements produced a two story Class I structure to house only Building #232-F facilities. These sketches were made to consider "L" and "T" shaped buildings in addition to finding the most efficient and economical arrangement for the process and service areas.

Upon completion of the above sketches, emphasis on minimum facilities in Building #232-F led to the preparation of an estimate covering the cost of a two story concrete Class I structure vs. a single story Class III building of friable material. This estimate showed a saving of better than a million dollars if the minimum facilities were installed in a Class III structure. A new scope of work was issued outlining to Blaw-Knox the minimum facilities to be housed in a Class III structure.

Several plans of a single story Class III building were offered by Blaw-Knox before Voorhees, Walker, Foley & Smith were asked to design the Manufacturing Building. The alternative schemes recommended by Blaw-Knox included various sized Class III buildings with process and service areas plus outside facilities. One sketch provided a building with a lean-to for heating and ventilating equipment while the other had such exterior facilities as power and lighting transformers, heating and ventilating blowers and exhausters, and two water disposal tanks.

Shortly before VWF&S assumed this assignment, it was definitely decided that an integrated process assembly with isotopic purification facilities should be built. Although the decision to build a Class III structure remained firm, installation of the revised process assembly and its required auxiliaries increased the amount of building space required. This increase in the size of the facility necessitated the ordering of new structural steel to replace that which had been specified for Blaw-Knox designs. However, the work of Voorhees,

Walker, Foley & Smith consisted mainly, of developing the most functional layout of process and service facilities to attain the greatest amount of efficiency and space economy. For example, in final design, ventilation and air conditioning equipment was located on the roof instead of in a full basement; a subbasement was provided to house the thermal diffusion column within a single story building; ductwork was located on the roof instead of inside the building; electrical controls for the process area were installed convenient to the process control room; emergency generator facilities were given added protection by location inside instead of outside the building; and ample space was provided within Building #232-F for the remotely controlled transfer car assembly and decanning facilities.

Equipment

Design of the over-all tritium process line represented a general integration by du Pont of separate operations at Hanford, Los Alamos, Argonne National Laboratory, and Knolls Atomic Power Laboratory.

Du Pont was assisted in the development of these facilities by the Blaw-Knox Company; Voorhees, Walker, Foley & Smith, New York; Allstates Engineering Company, Trenton, N.J.; American Machine and Foundry Company, New York; and the General Engineering Laboratory of the General Electric Company, Schenectady, N.Y.

Blaw-Knox Company

This firm was responsible for design, arrangement and procurement of all equipment not being developed by GEL and AM&F. However, in April, 1952, this work was reassigned between VWF&S and the Allstates Engineering Company to alleviate the heavy work load on Blaw-Knox.

Voorhees, Walker, Foley & Smith

VWF&S was assigned the responsibility for building design, auxiliary equipment arrangement, and for purchasing of all equipment used in Building #232-F.

Allstates Engineering Company

Allstates responsibility (process equipment only) included the preparation of equipment designs and specifications except those items assigned to GEL and AM&F, preparation of drawings detailing the location of process and material handling equipment, the drafting of flow, piping, and instrument diagrams and the preparation of drawing schedules and material and equipment lists.

General Engineering Laboratory

Initially GEL was requested to fabricate a duplicate of the second Hanford "Metal Line". Later, this order was terminated and instead, consultant service was provided for two years on the development of an integrated process assembly.

American Machine and Foundry Company

AM&F was assigned the task of developing an experimental slug decanning machine, building a prototype, and designing the handling equipment serving the decanner.

Design Problems

The tritium separation process was still in a stage of evolution when design work was initiated at the Savannah River Plant. The comparative newness of the process dictated that the SRP facilities be cautiously developed and based upon proven and pre-tested equipment. This emphasis on reliability created many problems which had to be solved through extensive development work.

Successful manufacture of tritium gas required the development of raw material handling equipment, slug decanning facilities and a workable tritium processing line combined with an efficient high vacuum valve and pumping system. Instrumentation, also, was a primary part of design development in achieving a dependable tritium production facility.

Raw Material Handling Equipment

Several alternative methods of remote handling were considered to determine the most practicable and reliable facility for the transfer of raw materials, scrap, and casks within the Manufacturing Building. From among the alternatives considered, the car transfer system was selected because it provided the greatest reliability in remotely controlling the precise spotting of the casks while complying with rigid safety requirements. This raw material handling facility proved to be the one most compatible with the design of the decanning machine and furnaces built by AM&F and GEL, respectively.

This system was prototyped at Reliable Welding and Machine Shops of North Bergen, N.J., under the supervision of du Pont, and subsequently field tested at the Savannah River Plant. Minor changes suggested by these tests were then incorporated and this facility performed satisfactorily during the final run-in at the site.

Slug Decanning Facilities

The basic design of the slug decanning facilities was furnished by the Argonne National Laboratory and improved in prototype by the American Machine and Foundry Company.

From this prototype AM&F designed the decanning machine and such auxiliaries as the scrap chute positioner, the crucible closure and actuator, the scrap container and cask, and the general arrangement of the decanning facility. AM&F was also responsible for developing, fabricating and testing the manipulator mounting, three lid hoisting mechanisms, the decanner dust shield, the vacuum system, the slug, and the scrap and crucible lid lifters. This firm also assisted either in the design of, or the procurement and testing of such other facilities as the decanning enclosure, loading and unloading manipulators, slug casks and bucket, hydraulic system and crucible cask.

Pull Type Decanning Machine

The initial design of this machine was based on the theory that the slugs would be loose fitting within the cans. The principle employed was to cut the can circumferentially at the center in much the same manner as tubing is cut and pull the halves apart leaving the slug behind. Approximately four months were spent on the design of an automatic machine which would perform these functions. Concurrently, development work on target materials had determined that the nature of the fit between the can and the slug had to be changed from a loose fit to the equivalent of a "press" fit. It was evident that the pull type machine would not handle this condition and various methods were proposed to loosen the can before entering the machine. Work proceeded in this manner until du Pont and the American Machine and Foundry Company decided to abandon this design and to develop a ram type decanning machine which conformed to the new conditions.

Ram Type Decanning Machine

This type decanner was developed from experimental tests which proved that the cans, when slit along their length, would free themselves from the slug. From this principle and from extended tests with various types of cutters the design of an automatic machine was completed.

Shortly after basic design had been well started, a change in can length and diameter was introduced plus the addition of another operation so that the alloy surface of the slugs could be "scored". It was decided also to remove simultaneously both the can and the "raincoat" sheath from the slug in one operation. These conceptual changes resulted in the redesign of the decanner although the "scoring" operation was later dropped from the design. When fabrication was completed,

the decanner was tested and found to operate with some measure of success. However, to provide easier disposal for the scrap cans and raincoats, it was necessary to redesign the slitter head to include an additional cutter which would reduce the size of the scrap. This change was made and the machine, employing the new slitter head, was tested and found to cut successfully. After several meetings between du Pont and the American Machine and Foundry Company, it was determined that shielding changes, due to increased radiation hazards, would necessitate some major redesign on the decanner. It was decided that the new design should be defined in a set of new specifications so that the machine could be rebuilt and re-tested. After complete redesign, fabrication and testing, the ram type decanner was sent to the Savannah River Plant.

Scrap Chute Positioner

It was originally intended to raise the scrap cask and scrap container by means of a hydraulic lift similar to the method used for the slug cask. The weight of the scrap cask, however, made it undesirable to place such a necessarily large lift under the decanning machine. Also the height of the lift involved was so small that the use of such a large unit was impractical. After layout work had started on the hydraulic lift, it was decided to consider an alternate design. The final development employed the principle of lowering a heavy platen over the cask instead of raising the cask. This design produced a simpler installation and made the scrap chute positioner a component part of the decanning machine, eliminating the installation problems of a hydraulic hoist.

Crucible Closure and Actuator

AM&F responsibility for the crucible included the design of a closure method which would hold the cover to the crucible body. Consequently the crucible closure actuator necessarily was designed to suit the type of closure. The development of both items, therefore, was covered simultaneously.

In the development of a closure, such designs as weldment, snap ring, and cam lock were considered.

Welding

It was originally intended to remotely weld the crucible cover to the crucible body. This method was discarded after preliminary investigation and design layouts, since it would have involved a complete welding set-up inside the enclosure.

Snap Ring

Complete design and jury rig fabrication was carried out

on a method of closing the seal and cover to the body by a large snap ring. This was tested and found to be mechanically satisfactory. However, due to heating the cask, it was decided that the risk of distortion of the snap rings would be too great to permit the closure to be opened by a manipulator.

Cam Locks

The ultimate design chosen consisted of three cam locks around the circumference of the crucible. These cam locks can be turned into position where they hold the cover to the crucible body. This is accomplished with a crucible closure actuator designed specifically for this purpose. The advantages of this system over the previous two is that the cam locks can be produced more economically and the actuator is a simple manual device with minimum possibility of failure.

Scrap Cask and Container

The scrap container was designed and fabricated to meet the unique requirements of the decanning machine, since, upon investigation, it was not possible to obtain a suitable commercial container.

The relative merits of a square vs. a round cask were considered, the round cask being decided upon because of easier and more economical fabrication.

General Arrangement of the Decanning Assembly

The American Machine and Foundry Company's responsibility regarding this item was the proper arrangement of all decanning equipment within the decanning enclosure and subsequently within Building #232-F. It was necessary to work in close conjunction with others who had the responsibility for cask transportation systems, building design and other factors. The key to the location and positioning of all equipment was the cask transportation system.

Tritium Processing Line

The initial design pattern of the SRP tritium processing line was established on January 11, 1951 when the du Pont Atomic Energy Division (AED) issued a scope of work recommending Hanford's "Metal ("M") Line" as a model. Complete acceptance of the Hanford Line was delayed until Hanford's drawings and flow diagram could be studied. After review, it was decided that some redesign of the piping, hoods, and ventilation equipment would reduce contamination and also the ventilation requirements, and increase the reliability and safety of the equipment.

Upon approval of the basic "Metal Line" design, it was decided that the Savannah River Plant would receive the second Hanford "M" Line then being fabricated at the General Engineering Laboratory of the General Electric Co. This line was not to include isotopic purification facilities. However, GEL was expected to fabricate two extraction furnaces, two furnace liners, a degassing furnace and leak testing facilities similar to the Hanford design but revised dimensionally to accommodate Savannah slugs and to conform mechanically to the Building #232-F layout. On July 12, 1951, du Pont was advised that the Hanford second line would not be available for SRP and, therefore, an SRP order was placed with GEL for a similar facility.

Inasmuch as the "M" Line was relatively new, the Knolls Atomic Power Laboratory was authorized to develop an improved extraction furnace, to investigate alternate methods of tritium separation and isotopic purification, and to relate its program to any pertinent research developed by Los Alamos or Argonne National Laboratory.

The original concept of using the "Metal Line" was changed on August 7, 1951 when AEC authorized du Pont to install facilities for the isotopic purification of tritium. Du Pont engineers decided that it was impractical to combine the "M" Line with the isotopic purification facilities because this design duplicated equipment and demanded excessive building space. This decision established a trend towards the integration of the extraction and purification equipment into a single processing facility.

Du Pont cancelled the "M" Line fabrication and requested GEL to study, develop, and fabricate an integrated process assembly as outlined by an AED preliminary flow diagram. While the General Engineering Laboratory agreed that such a design was feasible, it felt that its work load was too heavy to undertake the design of the new process assembly. Consequently, after further consideration, GEL agreed to furnish consultant advice based on previous experience.

When design responsibility was established, AED directed the Engineering Department to suspend further design on October 13, 1951 in order that KAPL might study technical data to establish the basis for an integrated separation process.

Two important events occurred in December, 1951. First, design was resumed when AEC approved a scope of work outlining minimum facilities for the production of tritium, and second, du Pont received the GEL proposed flow diagram of the process assembly.

Minimum Facilities

The issuance of this scope de-emphasized the production schedule and re-emphasized cost reduction. This economy drive led to a review of components under fabrication at GEL where it was reaffirmed that it would not be economical to integrate the second Hanford "M" Line with the Savannah facilities. Therefore, it was decided that the "Metal Line" should be packed, shipped and stored at Savannah.

Flow Diagram

After review, the du Pont Engineering Research Laboratory recommended a simplified design to overcome the complexity of the General Engineering Laboratory proposal. ERL requested authority to institute a development program aimed at replacing the GEL vacuum tanks with gasometers and re-designing the palladium bed similar to those in operation at the Oak Ridge Diffusion Plant. This design was recommended in order to reduce the number of pieces of equipment under high vacuum, to reduce the hold-up of gases and provide a feed system which would eliminate the need for evacuation after every charge.

On February 12, 1952 the du Pont Atomic Energy Division rejected the proposed ERL development program because in the intervening period de-emphasis of the need for Building #232-F facilities diminished the urgency of improving or supplanting equipment which then appeared satisfactory with respect to operability and safety.

The process assembly installed at the Savannah River Plant was based on that proposed in the GEL flow diagram. It consisted of both batch and continuously operated process steps. The batch operated components include two product extraction furnaces, cold traps, two palladium diffusers, and a sorber and desorber. Continuous operation occurs in the thermal diffusion column which separates the hydrogen isotopes.

Product Extraction Furnaces

These units were designed, fabricated, and tested by the General Engineering Laboratory with assistance from the Knolls Atomic Power Laboratory and the du Pont Engineering Research Laboratory. Initially it was planned to use two Hanford furnaces with liners and a degassing furnace until GEL could build a prototype for KAPL to "prove out" design so that an improved furnace could be fabricated. Upon adoption of the integrated process assembly, the Hanford design was abandoned and GEL was given complete authorization to design, fabricate, and test a pilot model. Selection of GEL for furnace fabrication was based on the ERL recommendation that a unit developed by GEL would incorporate know-how of the General Electric Company, du Pont, and indirectly of the National Research Corporation inasmuch as this company had designed a number of

similar furnaces for the General Electric Company.

Originally the process assembly was to include a degassing and extraction furnace. Later, when minimum facilities were adopted, it was found to be economical to use the extraction furnace to perform both operations. However, by February 1953, an increase in production schedules required the installation of two extraction furnaces and one degassing furnace. The latter unit is similar in design to the extraction furnace except that its heating elements have a reduced capacity.

The new furnace design incorporated such improvements as a reduction in gas diffusion, a shorter time cycle and top loading. Operation was improved further by the development of an efficient method for loading the crucible.

Gas Diffusion

Water cooling was incorporated in the furnace design upon recommendation of ERL to prevent loss of production from gas diffusion. This feature resulted from an Engineering Research Laboratory study of KAPL data which revealed that excessive diffusion of hydrogen and tritium occurred in the extraction furnace.

Time Cycle

Extraction at the Savannah River Plant requires eight to twelve hours compared to ten to twenty-four hours at Hanford. One extraction furnace was required to meet original production requirements, being used for extraction three days per week and for degassing two days per week. Increased production requirements made it necessary to provide a second extraction furnace and a separate furnace for degassing to operate on a 24-hour day, seven-day week basis.

Top Loading

Initially the SRP extraction furnace included bottom loading facilities. However, this design was changed to top loading because it simplified operations and reduced costs by eliminating electrical leads and replacing hydraulic hoisting facilities with a mechanical boom.

Crucible

The loading crucible used at Savannah was intended, initially, to be that applicable to Hanford's "Metal Line". However, as furnace design progressed, and with the advent of the integrated process assembly, it became apparent that development of a different type of crucible was necessary. The crucible finally adopted for the Savannah River Plant, developed

by the General Engineering Laboratory through experimentation and tests, was designed to hold a greater number of larger slugs, is provided with increased shielding, and facilitates loading and charging to the product extraction furnace.

As design progressed, slugs of greater activity were developed. This necessitated redesign of the crucible cask, to provide greater shielding protection. The consequent increased size and weight of the cask, made it necessary to modify the remote handling and loading facilities.

Specifications, issued October 27, 1952, established that the units should be vertical, water-jacketed furnaces, electrically heated by a cylindrical coil and bottom heater. Top loading was incorporated in the design along with a removable furnace bottom to facilitate maintenance.

Cold Traps

The high vacuum required for process operation in Building #232-F necessitated the insertion of cold traps between the vessels being evacuated and the mercury diffusion pumps. Originally, the Hanford type cold trap was to be used in the Manufacturing Building, but later an improved type was designed through the joint efforts of du Pont and the Consolidate Vacuum Corporation, which minimized the tendency toward freezing during operation.

The cooling medium used in the cold traps and the sorber is liquid nitrogen. The use of this coolant in the integrated process assembly required the installation of a liquid nitrogen system consisting of an exterior platform-mounted 200-liter stainless steel storage tank, a similar type supply tank in the process room, two 10-liter stainless steel Dewar flasks for hand filling operations of instrument cold traps and cold trap in the degassing room, vacuum jacketed transfer tubing, and manually operated discharge devices.

Initially, normal materials were considered for insulating the transfer tubing. However, due to space limitations within the hoods of the process assembly, it was found they could not be used because of the thickness required. Therefore, vacuum jacketed transfer tubing was selected because of its compactness and high insulating qualities.

Palladium Diffusers

Diffusion through palladium tubes was chosen because it was the only method proven by operating use. The design basis of the diffusers was Hanford's unit developed by the General Engineering Laboratory. The gaseous mixture is introduced to the outside of heated, dead-ended tubes. The hot palladium

being "transparent" only to hydrogen and hydrogen isotopes, product is drawn through the tube wall into the bore and to secondary refining operations while impurities are removed batchwise to stripping operations.

Sorber and Desorber

The sorber and desorber were originally developed by GEL as an adjunct to Hanford's second "Metal Line". These units were considered after demonstration on a laboratory scale and adopted when their efficiency was proven at Hanford.

Sorber

As a result of operation at Hanford, the sorber was modified to improve nitrogen control, increase outside insulation, and provide adequate mounting for the units.

Decomposer

In this facility Hanford had used both a uranium and a magnesium type bed; but because there was longer operating experience with the uranium bed, it was adopted for the Savannah River Plant.

Thermal Diffusion Column

Initially, thermal diffusion, gaseous diffusion, and distillation were considered as alternative means of accomplishing isotopic separation. However, thermal diffusion was adopted because the other two processes either required excessive equipment or lacked demonstration.

The thermal diffusion column was specified by the General Engineering Laboratory from technology developed at Los Alamos and data supplied by the Knolls Atomic Power Laboratory. The Los Alamos design was adopted inasmuch as it was the only thermal diffusion column which had proven successful for the separation of hydrogen isotopes.

Early thinking favored replacing the Los Alamos continuous design with a batch operated unit. The batch unit idea was discarded when further investigation revealed that it would reduce capacity and entail a significant loss in product.

The product purity required at the Savannah River Plant was established by the U. S. Atomic Energy Commission. Inasmuch as these requirements were more stringent than those attainable by the column at Los Alamos, it was necessary to make mechanical alterations in its design. The mercury well was eliminated as well as the hot wire adjustment springs, an electrical shunt was used for zone control of temperatures,

spacers were used for wire alignment, and a mounting was developed to minimize vibration of the column.

Mercury Well

This change eliminated the necessity of mercury hold-up required by the L. A. design.

Adjustment Springs

At first, the hot wire tension springs were relocated from the bottom to the top of the column to eliminate possible interference with product flow. Later, it was necessary to completely eliminate the springs and use a weight to achieve the desired results. Spacers were added for wire alignment.

Electrical Shunt

This connection is located at the center of the column to provide for variable temperature control of the bottom half of the column below the operating temperature of the upper half. It also allows operation of the entire column at a uniform temperature. Since temperature measurement is dependent on resistivity of the molybdenum hot wire it was necessary to obtain laboratory measurements of resistivity at operating temperatures. This work was performed by Franklin Technical Institute, in Boston, Mass.

Mounting

A special concrete spring-inlaid mounting minimizes vibration of the column reducing turbulence within the unit to assure efficient operation.

The design data for the thermal diffusion column were subsequently reviewed by the Engineering Research Laboratory. The original design calculations were checked and theoretical analyses applied to obtain the effect of vibration, wire eccentricity, and "ripple" in the current supplied to the wire to assist in improving the mechanical design of the column. The majority of improvements suggested were directed toward increasing the column efficiency for the "H" Area diffusion column.

While design of the process assembly was being completed, a development program was instituted to provide these facilities with adequate high vacuum valves and pumps.

High Vacuum Valves

One of the most troublesome problems encountered by the designers of the integrated assembly was the development of

a reliable high vacuum valve which would completely shut off process flow to a major component to prevent product contamination.

Initially, du Pont intended to follow the valve design used by Hanford. However, reports from Hanford and Los Alamos indicated that mechanically sealed valves were a poor risk in handling radioactive gas because their neoprene seal failed due to heat developed by the solenoid, requiring frequent replacement to prevent leakage. The Du Pont Mechanical Development Laboratory reviewed the problem and recommended development of an improved seal or a mercury "Y" seal valve.

After review of MDL findings, design engineers recommended that development of a mercury "Y" valve be approved because its simple and reliable in-line parts would simplify maintenance problems. The Atomic Energy Division rejected this proposal from an operating standpoint because the mercury "Y" valve required long connections which necessitated undesirable hold up of product and greatly extended pumping down time for the reduction of pressure to desired levels. The AED decision resulted in the adoption of the other alternative of mechanical valves with an improved seal.

Development of a self-draining mechanical valve, with a metal bellows at the stem and a Teflon seal, was undertaken separately by Hammel-Dahl Company and Consolidated Vacuum Corp. Hammel-Dahl was chosen for its experience in manufacturing valves with Teflon seals and CVC was selected because of its previous work for other AEC installations.

Hammel-Dahl developed a stainless steel mechanical valve by rearranging standard components in a special body. This design was adopted for use in the process assembly after it had passed a cold test at H-D. However development work continued at the Consolidated Vacuum Corporation in the event that any weakness in design became evident by hot tests of the Hammel-Dahl type valve at the Knolls Atomic Power Laboratory.

Upon adoption of the Hammel-Dahl valve, the du Pont Engineering Research Laboratory proposed a theoretical probability analysis which was executed by Design to obtain an estimate of shut-down time due to vacuum valve failures. This analysis confirmed previous conclusions that the rigid specifications for the valves be continued and that an extensive test program was necessary before valves could be placed in operation at the Savannah River Plant.

Process assembly design includes 105 high vacuum valves, two spline plug control valves and two Foxboro flow restrictors in addition to manually operated Hoke vacuum valves which control the flow of argon, helium, and hydrogen to the major components. All high vacuum valves are controlled remotely through a main control panel. The control valves may also be manually operated.

High Vacuum Pumps

The major problem of pump design was the selection of a reliable unit which guaranteed leak-proof transportation of gas through the integrated assembly. Du Pont had the choice of two pumps, either the Toepler, in operation at Hanford, or the General Engineering Laboratory untested Sprengel. GEL believed the Sprengel to be an improved design over the Hanford unit because it eliminated the tendency of the Toepler pump to allow entrainment of gas in its actuating mercury.

The two pumps differed in that the GEL design used a mercury diffusion pump in series with a single stage Sprengel pump, while Hanford used a double stage Toepler pump. Although du Pont favored the proven design, it was decided to observe the GEL tests and have the Mechanical Development Laboratory further survey the entire field of vacuum pumps.

On December 27, 1951, du Pont engineers attended tests of the two types of pumps at the Knolls Atomic Power Laboratory. The Sprengel was found to be a simple, potentially reliable, and flexible unit compared with the single and double stage glass Toepler pumps which were extremely sensitive to pressure changes and required considerable maintenance. After the tests, recommendations were made to improve the reliability of the Sprengel pumps. However, it was found that du Pont would have to modify the pump because the General Engineering Laboratory schedule did not permit further extensive design changes.

Tests at KAPL were further endorsed when the MDL report of January 2, 1952 eliminated as candidates other commercial displacement pumps because of their lack of durability, and rejected the Toepler pump because of its complex design, its instability under varied pressures, and its tendency toward gas entrainment in the actuating mercury.

On January 11, 1952, the du Pont Atomic Energy Division approved a development program aimed at improving the Sprengel pump. The Mechanical Development Laboratory was authorized to initiate a study to prevent gas entrainment by developing a model weir to size the drops of mercury fed to the pump and increase its volumetric efficiency by designing a drop tube with a long tapered inlet.

Initially, it was intended that both Sprengels and Toeplers should be purchased so that the latter could be used if the Sprengel design was not successful. However, on January 31, 1952, AED determined that it was uneconomical to back up the Sprengel pump with another system inasmuch as no quick change-over was possible because of the Toepler's operating difficulties and non-interchangeability. Moreover, it was believed

that the Sprengel pump had been proven in principle by actual test and further minor difficulties could be corrected with relatively simple changes or additions.

Mercury Diffusion Pumps

These pumps were selected in preference to vapor steam jets because they had been proven by tests at the Knolls Atomic Power Laboratory. The mercury diffusion pumps represent a modification of the Consolidated Vacuum Corporation pump used at Los Alamos. At first, pumps manufactured by the National Research Corporation were considered until it was established that L. A. Pumps were more reliable than other standard pumps.

Facilities designed to supplement the major components of the integrated process assembly included a product loading system and gas analysis facilities.

Product Loading

This step is performed inside a separate hood provided with special ventilation to definitely prevent leakage of product into the outside room atmosphere.

Gas Analysis Facilities

The sample testing facility in Building #232-F was developed at Los Alamos, proven in operation at Hanford, and adapted for the Savannah River Plant by the Knolls Atomic Power Laboratory. A Nier isotope ratio mass spectrometer was purchased by du Pont from the Consolidated Engineering Corporation and sent to KAPL where it was modified to L.A. specifications, tested, and sent to the Savannah River Plant.

One other problem in the design of the gas analysis facility was that of obtaining a leak-proof value for this system. At first, it was believed that Skinner solenoid valves would meet the desired specification. However, after testing, they were found to leak. In addition, attempts to weld this valve failed because it was fabricated of magnetic stainless steel which has poor welding characteristics. Finally a Hoke packless type diaphragm valve with Teflon seat was developed that proved to be leak-proof.

Process Assembly Fabrication

There were two major requirements to be met in the design of the process assembly, namely: high vacuum and immaculate internal cleanliness of the equipment and piping.

In order to achieve these fundamental requirements, training programs were initiated at the Consolidated Vacuum Corpo-

ration at Rochester, N.Y., and at the Savannah River Plant. These programs covered the fabrication and construction techniques necessary to insure proper control of welding, joint preparation, cleaning, and final inspection of the assembly.

The equipment contained in the process hoods was fabricated by Consolidated Vacuum Corporation, the valves and manifolds were made at Hammel-Dahl in Providence, R. I., and the hoods were built by Blickman, Inc., at Newark, N.J. These components then were sent to the Consolidated Vacuum Corporation where they were assembled in a special air-lock type building.

Studies were made by both the Design and the Engineering Service Divisions of du Pont to determine the best method for packaging this assembled equipment and handling it in order not to incur leaks or contamination during shipment to the Savannah River Plant. After consideration of transportation by rail, barge, and air, it was decided that the assembly should be shipped via railroad because its safe arrival could be more easily controlled.

The first step to solve this material-in-transit protection problem began with a series of negotiations, meetings, and development studies between the Consolidated Vacuum Corporation the New York Central Railroad, and du Pont to establish procedures for a test mock-up run between Rochester and Buffalo, N.Y. As a result of this preliminary run, it was agreed that the vendor should structurally brace the components within the hoods, seal the hooded compartments in plastic bags, and compress the hoods between cork pads in special wood-steel shipping crates. Moreover, the New York Central arranged a special train of well cars provided with rubber shock mounts, while du Pont provided such instrumentation as an oscilloscope, accelerometers, and mechanical ride recorders.

Safe transportation of this special pre-assembled equipment was possible because of extensive planning and testing prior to its trip to the plant. The use of detailed packaging specifications, rubber shock mounts for load support, and special railway equipment provided maximum cushioning. In transit, this was supplemented with special instrumentation and continuous supervision by du Pont personnel to obtain proper speed control of the train. By the application of these practical techniques, the maximum material-in-transit protection was provided for this shipment.

Upon arrival at the Savannah River Plant, an air lock also was provided for accepting this shipment and from which the packaged facilities were uncrated and installed in the

process area of the building. During this period of final installation, vacuum tests of the gasket joints led to the modification of the original type gasket which facilitated meeting the specified vacuum requirements of the assembly. In addition, after its erection, this facility was "dummy-run" to insure the internal tightness of its integrated components.

Instrumentation

The major problem related to instrumentation in Building #232-F was concerned with modification to the Kanne Chambers to assure adequate air monitoring and with liquid level measurement of the mercury in the diffusion pumps plus such other items of the process assembly as product ion chambers, and Bourdon type restrictor valves and D/P cells.

Kanne Chambers

Modification to this facility included redesigning a special Hanford type chamber in stainless steel to achieve a higher sensitivity. In addition, Beckman and the du Pont Engineering Research Laboratory designed a new Model V-5 amplifier with a six decade logarithmic scale. This allowed the reading of an entire range on one chart without manually changing ranges.

Moreover, to remove particles as small as one micron in the sample air line, a number of filter media were investigated and tested. Cotton pack, horse hair, and other similar materials would not meet the specifications, but a stainless steel sintered disc was found acceptable and was adopted.

Liquid Level Measurement

Various means of measuring the liquid level of mercury in the boiler of the diffusion pumps were studied. Some of these included vacuum alarm, probe assembly, and temperature in the boiler. After further investigation, a temperature switch on the bottom of the boiler was used to give the desired measurement without requiring a process connection.

Precision Temperature Measuring Elements

To achieve accurate temperature measurement at certain points in the process assembly it was necessary to use special calibrated nickel bulbs. However, platinum elements subsequently were installed in Building #232-H when it was discovered that reproducibility was better on platinum than on nickel.

Glass Product Ion Chambers

A glass to metal seal on the chamber created a problem in manufacturing. A dozen glass bottles were made and enclosed in a stainless steel housing without success. Various grades of glass were combined to effect a proper glass to metal seal.

Restrictor Valves and Cells

The cells of this facility leaked when initially tested. They were reworked to an acceptable quality by welding the diaphragm and process connections.

General Safety Problems

The main objective, on the whole, was the development of a relatively new radioactive process into an efficient manufacturing facility which would meet du Pont safety standards.

Safe operation in the Manufacturing Building was achieved by adherence to proven design, control of gamma activity and beta radiation, and development of an adequate ventilation system.

Proven Design

The basic design of process components in Building #232-F had been proven by prototype at other AEC Laboratories or in production at Hanford. Nevertheless, du Pont developed safer operation by simplifying design by full scale testing of such equipment as the decanning machine, product furnace and the high vacuum valves and pumps. In addition to these tests, it was planned that all components would be given final "hot" testing at the plant before being used in full-scale production.

Control of Gamma Activity and Beta Radiation

Two types of radiation had to be controlled in Building #232-F to assure operator safety and facilitate efficient operation of the tritium extraction process. Throughout the material and handling operations, gamma radiation is emitted by the raw metal. At the same time, tritium is, by its nature, a beta emitter. Employee exposure to gamma radiation is prevented by the use of protective shielding, gamma detection instruments, remote operations, and adequate scrap and dust control in the materials handling areas. Beta radiation originating in tritium requires little or no shielding for personnel protection but does compel the use of techniques that eliminate personnel exposure to tritium-bearing liquids, solids, or gasses.

The raw material transfer assembly and decanning facilities are housed in separate, lead and concrete shielded enclosures. Movement of all raw material, scrap, and crucibles is performed

remotely in lead shielded, closed stainless steel casks. Observation of slug transfer to and from, and handling within, the decanning cubicle is possible through shielded lead-glass windows. This shielding arrangement provides that personnel continuously exposed to radiation will receive no more than 1 mr per hour or 100 mr per week of gamma activity.

Gamma Detecting Instruments

These portable instruments are used to externally monitor incoming slug casks and outgoing scrap, crucible, and empty slug casks. If incoming casks show radiation beyond the safe level they are returned to the #100 Area, and if outgoing casks become contaminated they are retained in the materials handling enclosure for decontamination.

Scrap and Dust Control

Safety was the primary factor which guided design of the scrap and dust control facilities, because the decanning step produces such high levels of gamma activity. This fact required that both operations be designed for remote operation to secure maximum efficiency.

Initially, conveyor belts were considered as a means of carrying aluminum scrap cuttings away from the operating components of the decanning machine. However, danger of scrap build-up led to the adoption of a chute fed container designed to hold scrap from 128 slugs. After the scrap cask lid is secured, the assembly is transported from the feed chute by a transfer car to the air lock where a monorail hoist places the loaded scrap cask on a truck. The assembly is moved to the burial ground where the scrap container is discarded and the cask is returned to operations.

The dust control equipment eliminates the danger of radioactive dusts and particles being inhaled by employees while remotely controlling the decanning operations. Spread of dusts to the atmosphere is prevented by a stainless steel shield over the cutting blades combined with a vacuum system to collect the particles. The vacuum system includes connectors for a flexible hose and vacuum nozzles which further facilitate dust removal. The hose removes radioactive dusts from the shields, inside wall surfaces and machine parts while the nozzles pick up fine particles at the entry-exit points of the cutting assembly and vibrator.

Beta Radiation

Beta radiation control was vitally important because of the danger of internal absorption of tritium. Tritium enters the body absorbed on solid dust particles or as tritium gas.

The former occurs during the inhalation of contaminated dust suspensions in the air while the latter is considerably more dangerous because tritium may be absorbed in the body by surface contact with the skin and by breathing.

Control of beta radiation is achieved by complete enclosure of the process assembly in stainless steel hoods, reduction of tritium diffusion through process components, prevention of accidental release of tritium to the stack, health physics monitoring, and solid waste disposal.

Non-Explosive Design

The equipment, instrumentation, and controls of the process assembly are designed to prevent the formation of explosive mixtures of tritium and oxygen.

Process Hoods

The stainless steel hoods enclosing the process assembly are based on Hanford's experience on containing radioactive materials. Stainless steel was chosen because it could be given a smooth finish and was impervious to corrosion, which made it easy to maintain and to keep clean. The process hoods were provided with a polished surface without crevices and sharp corners to prevent contamination pick-up and to permit proper decontamination. Moreover, the windows in the hood are of Homalite rather than Lucite because the former material is scratch resistant.

These hood enclosures were designed as compactly as possible to prevent the escape of radioactive tritium and yet permit easy and safe access to all components. The furnace hood is provided with doors to accommodate material handling operations, controlled entry of personnel, and removal of the furnace. This furnace hood, as well as the other hoods, are also designed with glove ports or removable panels to facilitate remote handling and hazard free maintenance. The process equipment mounted in these hoods is maintained at negative pressure with respect to the room, and ventilation is such as to minimize eddy currents and back diffusion.

Tritium Diffusion

Tritium diffusion through metals was reduced to safe proportions by combining water cooling of the extraction furnace and thermal diffusion column with enclosure of all process components in stainless steel hoods.

Tritium Stacking

A safeguard against accidental tritium stacking is provided through the use of a double lock and key arrangement which prevents indiscriminate opening of the process exhaust valves. In addition, all the vacuum exhaust lines in the process assembly are vented to the stack and monitored with Kanne chambers.

Health Physics Monitoring

The greatest contamination hazard is internal beta radiation. Urinalysis is a more reliable means of detecting body contamination because soft beta radiation is difficult to monitor with health physics instruments.

Air in the process area and control room is monitored for tritium by Kanne chambers and periodic sampling is used to detect any tritiated water in the atmosphere.

Solid Waste Disposal

Solid wastes other than aluminum scrap and spent furnace crucibles must be discarded safely in order to prevent contamination of the process area and personnel. Such materials as valve stems, furnace gaskets, and paper are enclosed in plastic bags, collected in a hooded fibre drum, and taken periodically to the burial ground by truck. The filters serving the process area are placed in dust tight bags and sent to the burial ground with other solid wastes. Contaminated oil and mercury are removed from the system by applying vacuum to a disposal container and drawing off the liquid from the equipment. The filled container is then sent to the burial ground for disposal.

Ventilation System

The ventilation system in the process area is designed to control dusts in the decanning area and to reduce process assembly vapors to safe working limits.

Safe design was achieved by meeting the Separation Area air conditioning standards and providing ventilation facilities which maintain pressure differentials and controlled flow of air from areas of minimum hazard to areas of maximum hazard.

In addition, radioactive particles in the exhaust air are removed by Fiberglas and Atomic Energy Commission type filters before the air is discharged to Building #295-F Stack for release to the atmosphere.

DRAWINGS

W-156324	Architectural, Equipt. Arrgt., Process Wing.
W-156325	Architectural, Equipt. Arrgt., Service Wing.
W-156366	Architectural, Hood Details - Sheet #1.
W-156430	Architectural, Miscellaneous Furniture Details - Sheet #1.
W-156433	Architectural, Miscellaneous Interior Details - Sheet #2.
W-147548	Architectural, Service Arrgt. Plan.
W-157549	Architectural, Service Arrgt. Sections.
W-157575	Architectural, Door and Finish Schedule.
W-157605	Architectural, Equipt. Arrgt., Plan Lab. Wing.
W-157601	Architectural, Process Wing Plan - Sheet #1.

BUILDING #232-H - MANUFACTURING BUILDING

A number of important differences exist between Buildings #232-F and H.

By original design Building #232-H was to have housed two process lines in a structure offering more than twice the usable floor space contained in Building #232-F. Construction was begun on that basis but while the building was being erected production requirements were decreased and the need for one process line was eliminated. By that time it was not economical to alter the structure to accommodate this change and it was completed as originally planned. Still later, a further decrease in production schedules resulted in the cancellation of the second production line. The process equipment for the first line was stored and the building, complete with services was placed on a standby basis. Toward the end of 1954, slight modifications were made to adapt part of the building temporarily for use as a testing laboratory by the Works Technical Department. When arranging furniture and services and changing partitions for this temporary occupancy, care was taken to be certain that the building could be reconverted readily to a production facility.

By the end of 1955 a new directive was received from the AEC to submit a new appropriation request for the rehabilitation of Building #232-H to include two process lines and the relocation of the Works Technical facilities in a new building. This work was carried out under a separate project appropriation.

In planning the design of the building, Class I construction and a location in the #200-F Area were seriously considered. However this was abandoned and a building with both Class I and Class III construction was erected northwest of Building #221-H to permit waste drainage to Four Mile Creek.

Building #232-H, like the corresponding facility in the F Area, has both a process and a service section. In the F Area the single story structure is of Class III construction. In the H Area the process section is Class I and contains a full basement, a main floor and some second floor space. The single-story Class III service section houses the facilities not essential to maintaining production and the basement contains auxiliary equipment. The building design provides a much more pronounced separation of the contaminated and clean areas of the process and service sections. In the process area, operations were changed to provide remote automatic handling of gamma-active materials. Service areas were expanded to include complete facilities.

The problem of cross contamination was minimized in the layout of the material handling area by providing air locks to regulate the movement of material to the storage facilities on the south or to the concrete enclosed process components on the north of the car transfer system. Two main air locks serve an entry-exit points for the three types of casks used in Building #232-H. Machine parts and scrap casks from decanning are handled through the south air lock, while crucible casks destined for the extraction furnaces pass through the north air lock. In addition, the decanning and extraction areas, sources of gamma and beta radiation respectively, were divided by a third air lock which allows movement of the main transfer car between these areas without danger of cross contamination.

The ventilation system is similar to that in Building #232-F except that the supply and exhaust ducts were removed from the roof and installed in the basement of the building.

Initially this building's ventilation system was to provide for varying the dew point in the process section between 50 and 60 degrees F. Later studies proved the requirements were the same for both the F and H Areas and this feature, not provided in the F Area, was abandoned.

For improved operation, additional facilities were included to service the two process lines originally to be installed. In the process section, containing the separation and purification equipment, air locks, emergency exits at all three levels, and dumb-waiters were added. The process section also includes a vault for the storage of product containers, a process storage room for crucibles and other supplies frequently used in the process area, and a mask decontamination room.

Additional facilities in the service section include a plant assistance laboratory for experimental operations, and a mock-up area for tests with full-scale plant equipment.

EVOLUTION OF LINE DESIGN

Expansion of the tritium manufacturing facilities at the Savannah River Plant was undertaken as the result of increased production schedules established by the U.S. Atomic Energy Commission in the early part of 1953. The prospect of an early start-up for the new facility led to the conclusion that two processing lines should be installed similar to the one in Building #232-F, with only minimum modifications to increase efficiency and improve control of contamination. However, a review of the facilities in Building #232-F indicated extensive modifications of a time consuming nature were needed to improve the Sprengel pumps, extraction furnace, and thermal diffusion column to the ultimate in design for Building #232-H. It was finally agreed that plans should be made to use "F" design in the "H" area with a concurrent program instituted to improve these three components before start-up of Building #232-H.

As the result of an upward revision of production requirements by the AEC in the early part of 1954, the capacity of the process assemblies being fabricated was increased. Also considered for the future, but later abandoned, was the addition of two more process assemblies to those originally planned for the "H" Area Manufacturing Building.

In March 1954, a downward estimate of the production requirements initiated the de-emphasis on tritium production by the relaxation of the start-up date of Building #232-H. Although work continued on the design of increased capacity for the process assemblies, in May and then in July 1954, one line was ordered to be stored for future installation and the second line was cancelled except for components well advanced in fabrication.

Process Line Modifications

The stored manufacturing line is, for the most part, similar but improved over the process line in Building #232-F.

The major points of improvement in the H Area line include the car transfer system, decanning facilities, and the process assemblies.

Car Transfer System

Modifications to the original F Area design of the car transfer system were necessary to provide a system capable of serving two process lines in the most efficient manner. The major differences between these systems in Building #232-F&H include:

F Area

1. Car transfer system consists of an assembly which includes a main and mule car and numerous transfer cars.
2. Assembly powered by cable and reel.
3. One speed motor on main and mule car.
4. Remote-visual control on five separate panel boards.
5. Positioning of cars by jogging, required observation through lead glass.
6. Limit switch on floor is actuated by cam on main car to prevent collision.
7. Monorail used to transport casks between truck and car transfer system in exit-entry air lock. This method requires positioning of truck to handle casks. Monorail in line with main track "ties-up" the car transfer system during truck loading and unloading operations.

H Area

1. Car transfer system consists of an assembly which includes two main and mule cars and numerous transfer cars.
2. Main car powered by trolley collector system; mule car powered by cable and reel.
3. Two speed motor on main car; one speed motor on mule car.
4. Assembly controlled via centralized console board with observance of movement by indicators.
5. Console dial controls permit "blind" automatic positioning which eliminates the need for "jogging".
6. Limit switch on main car actuated by movement of main car bumper to prevent collision.
7. Bridge cranes provided in north and south air locks to transport casks between truck and car transfer system eliminates repositioning of truck. Bridge cranes operating perpendicular to the main track allows positioning of casks

H Area

on transfer cars while the main car is freed from loading and unloading operations for other uses in the materials handling area.

The possible future reactivation of Building #232-H includes plans to modify the limit switch arrangement of the car transfer system along with the main and spur trough cover plates to facilitate cleaning and to minimize contamination in the troughs.

Two decanning areas are provided in Building #232-H, with each area designed to house a decanning machine and its auxiliary handling equipment. However, at the time the facilities were cancelled, it was planned to install only one complete assembly. The second decanning area was to house only auxiliary devices until another decanning machine was required.

The decanner for H Area, now in storage at the Savannah River Plant, is a modification of the AM&F machine installed in Building #232-F. Redesign was accomplished by the du Pont Development Engineering Division at the plant site.

The decanner in Building #232-F can handle only the irradiated lithium-aluminum pins that are 0.808-in. in diameter by 10.14-in. long. The decanner in the H Area can process this pin size and the .930-in. by 5.565-in. and 1.364-in. by 4.00-in. pins. The H Area decanner also has improved scrap removal facilities and more efficient auxiliary equipment.

Pin Decanning

The three pin sizes are processed by the use of interchangeable cutters; one for the 3-1/2% pins, one for enriched or LM pins and one for the Hanford 10% pins.

Scrap Removal Facilities

The scrap removal facilities were improved by redesigning the scrap chute as well as the scrap chute positioning mechanism and enclosure seal to eliminate any danger of scrap build-up during operation.

Improvements to the auxiliary equipment were all made to insure adequate supplemental facilities for the decanning machine. Such modifications included redesign of the crucible closure actuator to prevent accidental dropping of the crucible

lid and the addition of interlocks to delay the movement of the crucible hoist until the actuator is out of the way and to prohibit operation of the decanner until the vacuum is applied to the stationary positions. The depth of the crucible dust shield door and the diameter of the vacuum system piping were reduced to minimize interference with the operation of the crucible closure actuator and bring the piping into agreement with du Pont Standards. In addition, mirrors were installed so that all casks used in decanning can be observed.

Process Assemblies

The two process assemblies, originally to be installed in concrete-walled rooms of Building #232-H, differ from the assembly in Building #232-F in that each was designed to provide increased output of product by means of an improved extraction furnace with additional pumping capacity, to use an additional sorber in parallel with the existing one to replace the "F" type diffuser, and to employ a simplified welded type of thermal diffusion column. In addition, the protective hoods enclosing the components are of an improved design, and the liquid nitrogen facilities have been improved to provide more efficient operation.

Extraction Furnace

Improvements to the extraction furnace resulted from extensive study of the F Area design developed by the General Engineering Laboratory of the General Electric Company at Schenectady, New York. The two H Area furnaces which are part of the process assemblies but separately enclosed, were redesigned to reduce their weight; the heater assembly was modified so that the leads from the furnace heaters were brought out through the top flange; the cooling water circulation system was changed to provide a larger cooling surface; and a stronger auxiliary hoist with accurate controls was provided to remove the furnace. A Sprengel pump was added to the extraction pumping system of each furnace to increase the flow of extracted gas to the primary separation facilities of the process assemblies.

Sorbers vs. Diffusers

Separation of the hydrogen isotopes from helium and other heavy gases was achieved by replacement of the F type diffuser in each process assembly with a new sorber manifolded to other sorption, desorption, and by-product lines. Deletion of the diffuser simplified the H type assemblies because it eliminated the need for the measuring pump and volume system used in Building #232-F.

Other alterations in the separation step of Building #232-H included relocation of the temporary storage facilities in the primary separation hood and replacement of the product stripping hood of Building #232-F design with a by-product hood in each assembly to house the product and by-product pumping system; the flow control system of the sorbers and desorbers, and flanged nozzles for installation of a future sorber bed. These modifications from the F Area design provided better location and more compact arrangement of the H Area facilities.

Thermal Diffusion Columns

The thermal diffusion columns of Building #232-F&H accomplish the separation of tritium from hydrogen. While basic design is similar, the mechanical design of the H type column was simplified to achieve more efficient separation at an increased rate.

The major difference between the columns is the increased separation rates obtained by substituting a 36-foot long column for the 24-foot unit used in Building #232-F. Moreover, the concrete structural support in the H Area is designed to mount two columns in each process assembly. This second column is to be used as a spare and can be put on stream if the operating unit fails.

The H type column has been improved in several ways over the "CO" vessel in Building #232-F. For example, the number of flange connections and "O" rings used in the F Area column has been reduced and a "strongback" integral with the unit has been provided to facilitate its installation or removal and to minimize vibration during operation. The expansion and contraction on the heater wire of the F type column is compensated by a counterweight arrangement at the top of the column while on the H type column a counterweight is immersed in mercury at the bottom of the unit. The electrical shunt was eliminated in the Bldg. 232-H unit to simplify electrical design. In general the design changes in the H Area were aimed at simplifying column construction, reducing the number of joints in the column, and providing a "cleaner" column interior.

An additional improvement was the replacement of the F type capillary tubes with spline plug throttle valves which allowed an increase in product and raffinate flow from the H Area column.

In January, 1954, it was decided that a prototype of the H type column should be installed at the Savannah River Plant so that a "CO" vessel program could be instituted to improve mechanical design and increase capacity. After Building #678-G had been selected over Building #776-A for its installation, the facilities of Building #232-H were placed on a stand-by basis. Although it was originally intended that

this program be undertaken to improve the thermal diffusion column in Building #232-H, it was continued so that any applicable mechanical improvements could be incorporated into the design of Building #232-F.

Process Hoods

The process hoods are in general similar to those employed in Building #232-F, however, the H type hood is of a heavier design due to the strengthening of its structural members. Also, it has corner post duct work which provides improved circulation over the central type duct that ventilates the hoods in Building #232-F.

Modification of these hoods was necessary to eliminate the shortcomings of those installed in Building #232-F. Because the F type hoods fitted one against the other, installation was sometimes difficult as a result of the discrepancies in fabrication that are normal in this type of work. The need for accurate alignment made adjustment necessary in the field. This was avoided in Building #232-H by spreading the hoods and establishing an allowance for normal tolerances. Along with this improvement, the H type hoods were designed to be more rigid structurally, and this eliminated the need for additional structural bracing employed on the F type hood during shipment to the plant site. Moreover, the process hoods in Building #232-H were enlarged to assure more simplified installation and improved access for maintenance than in Building #232-F.

Liquid Nitrogen Facilities

Liquid nitrogen is used as a coolant in Buildings #232-F&H. In the H Area, the F system was redesigned to meet the new physical layout of the Manufacturing Building, to eliminate permanent storage of liquid nitrogen in the process section as in Building #232-F, and to minimize the need for long runs of piping.

Liquid nitrogen supplied to Building #210-H arrives by tank car from Linde Air Products Company. As needed in Building #232-H, nitrogen is trucked in 200 liter containers to the Manufacturing Building. Upon arrival at the building, the container is placed in the non-regulated portion of the basement where it is connected to vacuum jacketed tubing through which the liquid nitrogen is transferred to an identical container in the regulated portion of the basement. From here, this second container is sent to the process section where it is connected to another run of vacuum jacketed tubing through which the nitrogen is supplied to users in the process assembly. The Dewar hand flasks are loaded from the 200 liter

container in the process section as required for degassing and laboratory operations.

Safety in Design

The operational hazards in Building #232-H are similar to those in Building #232-F. However, safety in design of the H Area facility was emphasized because of the magnification of the problems resulting from the original intention to house two process lines.

Over and above the problems common to producing tritium in both F and H Area Manufacturing Buildings, the installation of two process lines created the problem of cross contamination of gamma and beta radiation between the decanning and extraction areas, respectively, and the limiting of its spread between the two process rooms of Building #232-H.

Cross contamination is minimized by the use of air locks to control the movement of material into and out of the material handling area as well as between the decanning and extraction areas. Contamination control is also provided by segregation of the two radiation centers. Casks entering or leaving these areas may be monitored and, if necessary, internally and externally decontaminated.

Spread of contamination within the process rooms of Building #232-H is minimized by the protective hoods surrounding the equipment. The ventilating system incorporated in the hood design provides an adequate sweep of air into the hoods which discharges to Building #295-H Stack. Each process assembly is enclosed in a room with an exit-entry air lock, and the rooms are separated by a permanent barrier. This barrier was erected to prevent the spread of contamination between the rooms and also to provide blast protection.

Such safety devices as Kanne chambers, air samplers, protective clothing, shoes, and masks provided for Building #232-F are also employed in Building #232-H.

DRAWINGS

W-159557	Key Plan and Roof Plan
W-159558	Service Floor Plan
W-159559	Main Floor Plan, Sheet 4
W-159560	Main Floor Plan, Sheet 1
W-159561	Main Floor Plan, Sheet 2

W-159562	Main Floor Plan, Sheet 3
W-159565	Building Elevations, Sheet 1
W-159566	Building Elevations, Sheet 2
W-159575	Equip. Arrgt., Sheet 1
W-159576	Equip. Arrgt., Sheet 2
W-159591	Service Arrgt., Plan Sheet 1
W-159592	Service Arrgt., Plan Sheet 2
W-154460	General Arrgt., T Pin Decanning
W-161532	Process Equip. Arrgt., Elevations
W-161356	Process Equip. Arrgt., Main Floor and Basement Plan
W-144704	Process & Service Piping Diagram, Sheet 1
W-144705	Process & Service Piping Diagram, Sheet 2
FS-1212	Flow Diagram and Material Balance

BUILDING #233-H - MANUFACTURING BUILDING NO. 2

FUNCTION

This building, as conceived in 1953, was planned to contain facilities for the compounding of tritium (Bldg. #232 product) and deuterium (Bldg. #421-1D product) with lithium, and the forming of this compound into components for shipment off the site to another AEC facility. Since the product deteriorates during storage, facilities also were required for the recovery of tritium from deteriorated material.

DESCRIPTION OF PROCESS

Tritium, deuterium and lithium were to be combined in a reactor under controlled conditions of heat, pressure and controlled atmosphere over the materials. The resulting compound, a granular material, was to be reduced in particle size, hydraulically pressed into the desired shapes, machined as required, and packaged for storage or shipment off the site.

Deteriorated materials were to have their gaseous products removed by heating under controlled conditions, the gases

separated in thermal diffusion columns or electrolytic cells, and the recovered tritium and deuterium re-used in the process.

DESIGN PROGRESS

Numerous alternative building layouts were presented to the Atomic Energy Division of the du Pont Company for its review. Various layouts for the process areas also were studied. Design was well advanced in the study of the internal arrangements of the hoods (the cabinet enclosures) for the fabricating line. Details of a chemical pump, various dies, machining equipment, jigs and gauges, and a compound grinder were prepared.

Design was halted in April 1954 at the request of the Atomic Energy Division upon advice of the AEC. All active studies were terminated and all pertinent data was collected and placed in the Project 8980 files.

BUILDING #235-F - METALLURGICAL BUILDING

FUNCTION

This building houses the Component Fabrication Line ("C" Line) and auxiliary facilities for handling and processing plutonium.

PRINCIPAL COMPONENTS

First Floor Process Area

Part of the first floor process area contains a service corridor, a material corridor, and two process rooms in one of which is installed the "C" Line and related equipment. Space for a future "C" Line is provided in the other process room. The remainder of this area is divided into two decontamination and inspection rooms, a regulated shop, an instrument shop, a radiography room, an autoradiography room, a dark room, a product inspection room, a physical testing office, a film reading room, an inspection office, a shift supervisor's office, a vault, and a bag sealer room.

The "C" Line consists of a stainless steel cabinet 28 in. wide by 106 ft. long, enclosing operating equipment which is visible but remotely controlled through glove ports or by mechanical devices and conveyors. The area within this cabinet is highly contaminated.

First Floor Service Area

The service area contains personnel corridors, locker and change rooms for men, women, and janitors, a counting room, personnel decontamination and health instrument rooms, mechanical equipment rooms and a store room.

There are both Zone #1 and Zone #2-3 areas in the men's, women's and janitors' locker rooms, with monitoring instruments and air locks provided so that radioactive contamination can be controlled. Air locks are provided also at most of the building entrances.

Second Floor

The second floor contains three supervisor's offices, an accountability office and vault, stenographic and clerical offices, personnel and janitors' lunch rooms, an emergency generator room, an electrical control room, die and maintenance shops, four areas for heating and ventilating equipment and space for handling inert gas.

Outside Areas

A concrete mat partially covered by a canopy is located near the material entrance for the storage of propane gas used in the die shop furnaces. Another concrete mat, also partially covered by a canopy, adjoins the building outside the process rooms, and is used for the storage of the inert gases, helium and nitrogen. A concrete-encased waste retention tank also is located outside the building. A concrete exhaust duct below grade leads from the east side of the building to the Metallurgical Building Stack, #293-F.

Building #235-F is adjacent to Building #232-F, with an exclusion fence surrounding both buildings. In addition, the Metallurgical Building is provided with an alarm system which detects unauthorized entry when its facilities are not operating.

BUILDING FLOOR SPACE

First Floor Process Area

Approx. Sq. Ft.

Offices (2)	348
Shops (2)	1875
Vault	540
Process Rooms (2)	7310
Testing and Inspection Rooms (8)	1800
Corridors, Air Locks and Stairways	1554
Janitor's Closet	14
Ventilation Ducts	26
Total	<hr/> 13,467

First Floor Service AreaApprox. Sq. Ft.

Locker and Change Rooms (21)	4028
Compressor and Transformer Rooms (2)	891
Store Room	805
Personnel Decontamination, Health-Instrument and Counting Rooms (3)	913
Corridors, Air Lock and Stairways	2962
Janitor's Closets (3)	145
Ventilation Duct	4
Total	9748

Second Floor

Offices (7)	1237
Vault	130
Shops (3)	3236
Electr. Control and Emerg. Gen. Rooms (2)	1134
Heating and Ventilating Equip. Rooms (6)	14,367
Corridors, Air Locks and Stairways	1530
Filter Unloading Room	423
Filter Rooms (3)	348
Janitor's Closet	107
Lunch Rooms (2)	577
Hot Water Heater Room	126
Total	23,215

Outside Areas

Inert Gas Storage Area	480
Propane Gas Storage Area	120

BUILDING DETAILS

Class - I

Size - Two story, rectangular shape, approximately 109 ft. wide by 222 ft. long by 28 ft. high from the top of the first floor to the top of flat roof slab. Two areas of the second floor slab over the process room presses are raised approximately 6 ft. in order to provide head room for the presses. Each of these 19-ft. wide raised portions measures about 32 ft. in length.

Area - 48,300 sq. ft.

Volume - 676,000 cu. ft.

CONSTRUCTION DETAILS

Foundations - Reinforced concrete with spread footings.

Superstructure - Reinforced concrete walls and flat roof.

Exterior walls - Concrete.

Interior of exterior walls - Concrete, either painted or unpainted. (See W-146619, Room Finish Schedule).

Interior partitions - Concrete, either painted or unpainted, or cement asbestos board on metal studs. (See W-146619 for details)

Wainscot - Concrete 4 ft. high with cove base, concrete 7 ft. high with cover base, 1/4-in. Masonite 4 ft. high. (See W-146619 for details.)

Ceiling - Concrete painted or unpainted, or acoustic ceiling. No suspended ceilings. (See W-146619 for details)

Doors - Hollow metal except for vault doors which are of bank vault design.

Roofing - Built-up roofing, gravel surface.

Floors - Concrete.

Floor covering - Asphalt tile in lunch rooms only.

Paint - Amercoat in process areas, standard paint in lunch rooms, certain offices, and parts of locker room areas.

Heating, Ventilation and Air Conditioning

The ventilation system is designed to insure air flow always from the least contaminated to the most highly contaminated area. Separate ventilation units, exhaust fans, and seven air conditioning units, as well as the controls required for temperature and pressure differential, are provided, with steam coils in a duct system supplying the necessary heat.

In addition, the "C" Line can be supplied with helium or nitrogen at all stations where the metal is worked by pressing, cutting, blasting, or heating. Recycle inert atmosphere (air diluted with nitrogen) is supplied at all other stations except X-gas units, monitoring, polishing and air locks. Recycle inert gas is not provided at these stations to avoid the possibility of contamination spread on the outside of the finished product. However, if experience indicates that contamination does not build-up in the recycle inert, removal of a

blank header will allow the distribution of recycle inert to these points in the "C" Line. The entire recycle system is maintained under a slightly negative pressure and filters are provided at each station in the system. Exhaust from the system is discharged to the atmosphere through the #293-F Metallurgical Building Stack.

Electrical

Power is supplied to Building #235-F through an underground 13.8 kv. cable. This high voltage is reduced to 480 volts by a 750 k.w.-a. dry-type transformer load center located on the first floor. Dry-type transformers further reduce the voltage to 120-208 volts 3-phase for lighting service. In general, lighting for the shop area, utility areas, corridors and toilets, is incandescent. Lighting for offices and "C" Line area is fluorescent. A 100 kv. emergency diesel generator is provided to start automatically and carry the essential ventilating and instrument load in case of normal power failure. This unit also supplies power to Building #217-F and provisions are made for a future tie of Building #235-F emergency bus with that in Building #232-F. Loud speakers for the area safety alarm are located throughout the building. The electrical design for all of Building #235-F except "C" Line power was prepared under the direction of du Pont and Blaw-Knox personnel by the Peter F. Loftus Company of Pittsburgh, Pennsylvania.

EQUIPMENT

Process Room

- 1 Air lock entry and weighing station.
- 3 Furnace stations consisting of 1 ft. x 2 ft. vacuum furnaces.
- 1 Sawing station with power driven hack saw.
- 2 Density and weighing stations.
- 2 Turning stations with toolroom type bench lathes.
- 1 Pressing station housing two 200-ton presses, a mono-rail and hoist, two induction furnaces, two quench tanks, four die loading cans, and a conveyor track.
- 1 Stripper unit.
- 1 Grit blasting station with filter cabinet.
- 1 Remote work holder and special entry door.

- 6 Coating stations with work holders and vacuum units with inlets and outlets, conveyors, etc.
- 1 Coating station with high vacuum unit.
- 1 Polishing, gaging and monitoring station with buffing wheel, inspection gages, and monitoring equipment.
- 1 Gaging station.

Shops, Regulated and Instrument

- 1 Drill press.
- 1 Arc welding machine.
- 1 Grinder.
- 1 Helium leak detector.
- Instrument shop tools.
- 1 Set of electronic test equipment.
- 1 Hood, stainless steel.
- 1 Sink, stainless steel.
- Work benches and tool lockers.

Decontamination and Inspection Rooms

- 1 Metal storage cabinet.
- 2 Decontamination hoods, stainless steel.
- 1 Metal table.

Radiography Room

- 1 Hydraulic lift.
- 1 Radiation shield.

Autoradiography Room

- 1 A.R. table
- 1 X-ray film cabinet
- 1 Work bench

Product Inspection Room

Work bench and conventional office furniture.

Physical Testing Office and Film Reading Room

1 Densitometer.

1 High intensity illuminator.

Conventional office furniture.

Inspection Office

Conventional office furniture.

Shift Supervisor's Office

Conventional office furniture.

Vault

1 Vault door.

1 Vault gate.

Storage racks.

Conventional metal office furniture.

Bag Sealer Room

1 Bag sealer machine

1 Hose storage cabinet

Locker and Change Rooms

Monitors, "Poppy" type.

Conventional locker room equipment.

Counting Room

4 Scaler tables.

4 Scalers.

Health Instrument Office

Conventional office furniture.

Personnel Decontamination Room

Conventional first aid room furniture.

Compressor Room

- 1 Reciprocating chilled water air conditioning unit.
- 2 Chilled water circulating pumps, 510 g.p.m.
- 1 Instrument air dryer.
- 2 Instrument air compressors.
- 1 Shop desk.

Transformer Room

Transformer unit.

Store Room

Conventional shelves and racks.

Supervisor's, Accountability, Stenographic and Clerical Offices

- 1 Vault door.

Conventional office furniture.

Personnel and Janitors Lunch Room

- 2 Hot plates.
- 2 Refrigerators.
- 2 Drinking fountains.

Tables, chairs, and shelving.

Emergency Generator Room

- 1 Diesel generator, 100 kw.

Electrical Control Room

Motor Controls.

Maintenance Shop

- 1 Do-all saw

- 1 Drill press.
- 3 Work benches.
- 1 Hot water heater.
- 1 Cabinet.
- 1 Tool Rack.

Die Shop

- 1 Wall safe.
- 1 Hydraulic surface grinder.
- 1 12" x 48" Universal grinder.
- 1 Hardness tester.
- 1 Pedestal grinder - 10".
- 1 Drill press 1" capacity.
- 1 5-ton arbor press.
- 2 Portable precision grinders.
- 1 Dry-ice ice box.
- 1 Hardening furnace.
- 1 Tempering furnace.
- 1 Atmosphere generator.
- 1 Oil quench tank.
- 6 Work benches.
- 1 Flash freeze unit.
- 4 Storage cabinets.
- 1 Heating furnace for die alloy.
- 1 Portable crane.
- 1 Monorail system.

Note: A gear head lathe, toolmaker's lathe, tool grinder, milling machine, surface plate and stand, drilling machine,

and rotary tilt table were removed subsequently by Operations and installed in Building #773-A.

Heating and Ventilating Equipment

- 6 Air conditioning units.
- 10 Exhaust blowers, capacities range from 80 to 18,280 c.f.m.
- 2 Recirculating blowers for inert gas, 595 c.f.m.
- 2 Exhaust blowers for inert gas, 95 c.f.m.
- 3 Horizontal type vent unit heaters, 12,040 c.f.m.
- 7 Preheat coils.
- 1 Inert gas dryer.
- 1 Monitoring system vacuum pump, 200 s.c.f.m.
- 2 Activated carbon filters.
- 36 After filters.
- 36 Roughing filters.
- 74 Prefilters.
- 1 Trolley and hoist, 5-ton.
- 1 Platform truck for filters.

Waste Disposal System

- 1 Waste retention tank, 500-gal. steel with concrete encasement.
- 1 Sump jet.

Instrumentation

Pressure indicators and controls comprise the instrumentation for the equipment cabinet vent systems. Other instruments include precise differential pressure recorders and controls for pressure between cabinet sections housing the various pieces of equipment. An ultra-violet gas analyzer and a vacuum recorder are required for operating the plating equipment. Temperatures and pressures are measured, recorded and controlled in the furnaces and pressing units.

Portable health physics equipment is used to control the spread of contamination in various areas of the building. There is also equipment for personal monitoring of employees working in the "C" Line Area.

A total of nine control panels, each approximately 4 ft. wide by 8 ft. high, are required to mount the various pressure and temperature recording and indicating devices. These are mainly for control of the casting and plating furnaces in "C" Line.

DESCRIPTION OF PROCESS

The Component Fabrication Line ("C" Line) of Building #235-F consists of 27 stainless steel cabinets or hoods enclosing a series of metal shaping operations.

The cabinets are composed of flanged sections bolted together, with neoprene gaskets, to form a single unit 106 feet long. In general, most of the cabinets have been standardized. Each has safety glass windows, sliding doors for the transfer of process material, glove ports, and switches on the front side to control operations. Utility connections and bag ports are located in the rear of the cabinets for removal of miscellaneous material. Separation barriers or sills are installed to compartmentalize the operation, retain spills, and prevent dropped material from rolling out of reach of hand or glove ports. In addition, all cabinets are kept at a negative pressure and contain such ventilation facilities as top inlet and bottom outlet ducts sealed by AEC Type 1 particulate filters.

The majority of operations within the cabinets are performed in an inert atmosphere of either nitrogen (Inert Gas #1) or helium (Inert Gas #2). Inert gas is used to prevent the oxidation of plutonium because of its pyrophoric nature. Helium is used at all stations where the metal is heated, pressed, cut, or blasted, while nitrogen is supplied to all other stations except Hoods #11, 26, and 27.

The arrangement of equipment in "C" Line allows maximum flexibility of operations and efficient fabrication of weapon components. In most cases, the process steps follow the numerical sequence of their hooded stations.

Entry Station (Hood #1)

This cabinet encloses the entry air lock through which such materials as plutonium buttons from "B" Line, pieces for refabrication, crucibles for casting, magnesium oxide sand for blasting, miscellaneous equipment, and replacement

parts are introduced into the enclosed facilities of "C" Line.

The air lock is designed with double doors and a blower to prevent the escape of expensive inert gas and contaminants to the atmosphere and the entry station. One door opens to the room, the other door to the adjoining cabinet or weighing station, the two doors being interlocked so that one cannot be opened unless the other is closed. When the outer door is opened, the air entering from the outside prevents the inside atmosphere from escaping. The pressure of the entering air opens a valve to the stack which continues to sweep air into the hood while the door is open. When the door is closed the pressure decreases until the valve closes. As the inner door is released by the interlock mechanism, a blower is actuated to suck air from the weighing hood through filters into the entry hood. When the inner door is opened, the materials pass to Hood #2 and as the inner door closes the blower stops.

Weighing Station (Hood #2)

At this station the plutonium buttons are removed from their plastic bags using the glove ports. They are weighed for accountability on a Seederer and Kohlbusch precision balance, placed in a cardboard box, and transferred through the door to the Casting Station.

Casting Station (Hoods #3, 4, and 5)

In this operation, the plutonium buttons are cast into ingots by one of three casting furnaces. Two of these furnaces are in Hood #3, with one standby furnace in Hood #5. Hood #4 contains a 110 v. electric oven which dries and stores the crucibles.

Operation begins with the operator transferring the plutonium buttons from the weighing station to the work area in Hood #4 and removing a set of magnesium oxide crucibles from the oven. The buttons are placed in the pouring crucible which in turn is placed on top of the casting crucible. Finally these two nested crucibles are placed in a tantalum basket and the entire assembly is lowered into one of the furnaces, covered and sealed, evacuated to a pressure of 0.1 micron of mercury, and heated by electric resistance coils to the casting temperatures.

Vacuum casting consists of melting several plutonium buttons so that they coalesce and flow through a small hole of the funnel-like pouring crucible into the casting crucible. Impurities remain in the pouring crucible and are reworked as "skulls" to obtain plutonium value. After casting, the melt is kept at 900-1000° C. to distill out the impurities. The

power then is decreased and the casting allowed to cool to 400-450° C., where it is held for annealing.

Two pumps and a water cooling system are employed by each casting furnace, the roughing and vacuum pumps bringing the pressure down to a point where the metal can be freed of volatile impurities while the water circulatory system protects the hood and Teflon seal gasket and cools the furnace walls.

After casting and annealing, the plutonium is allowed to cool slowly and solidify. As it solidifies it expands, cracking the bottom casting crucible which is then brought out of the furnace to the work area and broken from the ingot. Next, the skull is knocked out of the pouring crucible which is returned to the storage oven, the skulls and broken crucible fragments being placed in containers and removed from "C" Line through bag ports. The skulls are transferred to the "B" Line dissolving facilities in Building #221-F and the ingot is passed to the parting station.

Parting Station (Hood #6)

At this point in the process, the operator, working through glove ports, positions the ingot in a vise so that it may be cut in several pieces by a vertically mounted Lipe-Rollway power hack saw. The operation is designed so that the saw motor cannot be started unless the operator withdraws his hands from the gloves and depresses an actuator button with each hand.

The chips from the sawing operation are collected in a tray at the bottom of the hood, removed through bag ports and sent to the additions station of "B" Line in Bldg. #221. Worn tools, saw blades, and articles to be replaced are also removed through these same ports.

This station is separated from the other hoods by barriers, with sliding doors, which help to control migration of dust and recoverable particles of plutonium.

Double Weighing Station (Hood #7)

In this hood, the plutonium pieces from the parting and turning station are weighed for specification and accountability purposes and tested to determine the density of the metal.

The scale in Hood #7 is identical with that at the first weighing station except that another tray has been added. For density measurement the piece is placed on the second

tray and a vessel of bromobenzene is raised until the piece is completely submerged. Calculations made from the weight in air and the weight in liquid permit determination of metal density. The vessel of bromobenzene is mounted under the scale and is lifted manually through a mechanical linkage. The temperature of the bromobenzene is checked frequently by a dial-type immersion thermometer.

Turning Station (Hoods #8 and 9)

These hoods enclose two commercial metal turning lathes which face the piece from the parting operation, to remove any foreign material, and machine them to the approximate required weight. Weight control is maintained by a torsion balance scale which weighs the metal turnings. The Los Alamos type cutter on Lathe #2 is used to reduce the size of chips to be returned to "B" Line to avoid the possibility of balling in a subsequent mixing operation.

These lathes are placed side by side in Hoods #8 and 9, while their drive is located beneath the hood in a separate, but gasketed, enclosure which prevents any contaminant leakage on the assembly. Each lathe has a different drive reduction and each has a high and low motor speed.

Inasmuch as this operation is exposed to a high degree of radioactivity, it also has a barrier design similar to that in Hood #6.

Pressing Station (Hoods #10, 11, 13, 14, 15, 15-1/2, 16)

The equipment in these cabinets performs the pressing operation to produce metallic shapes.

The pressing station consists of a main cabinet about 19 feet long which is composed of three special hoods and several auxiliary cabinets.

The main cabinet (Hoods #10, 13, and 16) contains the equipment for lubricating the plutonium piece and assembling it into the dies and cans; the Loftus induction furnace and two quench tanks for the heating and subsequent cooling operations; and the overhead monorail hoist for moving the dies and cans within this hood. Behind, and at right angles to the main cabinet are two hoods for the entry (Hood #11) and storage (Hood #14) of dies and cans. In front of the main cabinet are two presses, one of which is connected to the cabinet by a hood (#15) while the other is completely separated and used to calibrate the dies and cans for size, shape and thermal properties. Hood #15-1/2 is the press within the line. There is no Hood #12.

Because of the complex shape and large size of the pressing station hoods, the ventilation system consists of a number of inlets with a single exhaust outlet to permit adjustment of air distribution throughout the pressing station cabinets.

Die Shop

The various types of dies used in the pressing station are fabricated in the die shop on the second level of Building #235-F. In addition to the ordinary die fabrication equipment, two electrically controlled Lindberg type furnaces are provided to heat-treat and harden the dies to withstand the pressure applied by the Clearing type metal shaping press in "C" Line.

Cleaning and Stripping Station (Hood #17)

After pressing, the component is moved to Hood #17 where flash or other protrusions are trimmed and the parting line of the dies is removed with emery paper. The piece is then transported in alcohol to prevent oxidation and to reduce the migration of particulate matter. In addition, nitric acid is kept in a double vessel set in the floor of Hood #17 in order that rejected parts may be dipped after stripping the nickel coating to remove trace quantities of nickel adhering to the piece prior to rework in the sandblasting and coating operations.

After cleaning or stripping, the component is passed through an extra hinged door at the rear of the cleaning station into a small tunnel which leads to the blasting station behind Hood #17.

Blasting Station (Hood #18)

The remotely-operated assembly in Hood #18 includes a work table which rotates and oscillates in order that the grit blasting equipment can remove impurities from all exterior surfaces of the plutonium component. This table rests on a oscillating yoke mounted on a rotating platform. The worm geared yoke is operated by a handwheel while the platform is powered by a cone-type friction drive. Rotation speeds are variable and are controlled by a flexible shaft actuated by the operator.

The grit blasting sub-assembly consists of a neoprene-lined hopper, a flexible neoprene hose, and a ceramic-hardened carbon steel blast gun. After the piece is placed on the table, it is blasted with magnesium oxide sucked from the hopper and propelled against the piece by a jet of helium.

As the table oscillates and rotates, this operation is repeated until the entire component is cleansed of impurities.

Filtering Station (Hood #19)

The filtering station, located behind Hood #18 and to the rear of "C" Line, contains "mole skin" bag filters which remove contaminated dust particles from the helium-air atmosphere exhausted from the blasting hood.

After filtering, the helium, along with some air, is picked up by a blower between the two hoods and recirculated at 150 c.f.m. to the blasting station. The remaining air passes through AEC Type 1 particulate filters and is exhausted to the atmosphere through the Building #293-F Stack.

Double Weighing Station (Hood #20)

After being blasted, the plutonium piece passes through Hood #17 into another weighing station. There it is carefully weighed, checked for density and dimensions, and scrubbed in alcohol. If it meets all requirements, it is placed on a carrier and manually set into a double-lidded alcohol trough between Hoods #20 and 21 to await retransfer on another carrier to the vessel of alcohol resting on the automatic conveyor in Hood #21.

Transfer Station (Hood #21)

The plutonium shape is picked up by its carrier and placed in a vessel of alcohol which is moved by an electrically operated conveyor to the proper coating hoods.

Coating Station (Hoods #22, 23, 24, 25)

At this station, seven nickel carbonyl (X-gas) units apply a protective coating of nickel to the piece so that it may be removed from the "C" Line, stored, and transported without the problem of contamination. The application is performed at a pressure of 250 microns and a temperature of 105°C.

The hoods enclosing the coating units differ from other "C" Line hoods in that they have glove ports at the front and back, an interior longitudinal barrier between the conveyor and coating areas with doors which cannot be opened unless the conveyor lid is closed, and a light barrier between the two coating units within each hood.

When the piece arrives at one of the coating units, the operator manually removes it from the conveyor and places it on the tripod holder which protrudes from the bottom of the cabinet.

The initial step within the hood begins when an induction coil type bell jar is lowered over the tripod holder. This bell jar is evacuated to 50 microns and checked for leaks after which it is further reduced in oxygen content by purges with helium. The surface of the plutonium piece is heated to 105°C. and X-gas is admitted where it is decomposed on the surface. This is repeated 10 to 16 times as the piece is rotated by the tripod holder. Repetitive cycles are used to build up the required thickness.

After about five mils of nickel have been deposited, the bell jar is raised and the piece transferred manually to another conveyor which runs along the front of the hoods, taking the piece to the Inspection Station in Hood #26.

Inspection Station (Hood #26)

This station provides space for such operations as preliminary coating inspection and final dimensional and density checks, and also serves as an open-fronted transfer area between the enclosed coating and buffing operations of "C" Line.

If, upon inspection in Hood #26, any gross breaks are found in the coating, the piece is returned to Hood #17, stripped, and reworked through grit blasting and again coated. Otherwise, if it meets specifications, the piece is moved to the Buffing Station in Hood #27.

Buffing Station (Hood #27)

At this last station of the "C" Line, the nickel-coating is polished to give the piece a fine finish. The equipment within the hood consists of two motor-driven buffing wheels, the first a coarse unit of linen with aluminum oxide and the second a fine wheel of felt with jewelers rouge.

These buffing facilities are enclosed in a standard hood to permit dust control as well as to provide maximum protection in case the coating should break during polishing. In addition, the motor is completely enclosed to permit easy cleaning in the event of contamination of the mechanism.

After polishing, the piece is removed from the line and taken to another location where it undergoes final inspection. Product testing is carried out in several steps. First, the uniformity of the nickel coating is tested by autoradiography and then followed by radiography which detects voids in the metal. After the piece is checked for small breaks in the coating by an electrolytic test, efforts are made to achieve satisfactory assembly of two halves. Pieces are selectively checked with each other until two are found which provide

acceptable tolerances between the mating surfaces. This selective assembly continues on as a single assembly and an integrated direct count is made followed by a total neutron count.

Packaging of the component is done in the inspection rooms, the plutonium being placed in "bird-cage" shipping containers and kept in a finished product vault in Building #235-F until finally stored in Building #217-F.

The by-products of "C" Line, including skulls, crucible fragments, contaminated grit, and other residue are returned to the "B" Line waste recovery system in Building #221-F. The machine turnings are added to the reduction stage of the mechanical "B" Line, also housed in the Canyon Building.

All by-products except plutonium nitrate and concentrated nitric acid are transported in plastic bags enclosed in cardboard boxes. The plutonium nitrate is removed from Building #235-F in stainless steel containers sealed by plastic bags, and the concentrated nitric acid is transported from the Metallurgical Building in polyethylene bottles to the "B" Line waste recovery system in Building #221-F.

DEVELOPMENT OF DESIGN

Building

Building #235-F was not modeled after any previous AEC installation. As designed by du Pont with the sub-contractual assistance of Blaw-Knox and the Peter F. Loftus Co., it provides the space needed to house the "C" Line and its auxiliaries.

Evolution of Design

Initial planning considered the installation of two "C" Lines housed in a Class I structure with supplementary facilities located in adjoining Class II structures. Also studied was a single combination Class I and II building housing the facilities of both Buildings #235-F and #232-F in addition to "L" and "T" shaped buildings, some designed with a basement and first floor and others with first and second floors. In April, 1951, it was decided that a two story Class I structure should be erected for the following reasons: (1) it was not possible to attach a Class II structure to a Class I building and still maintain the desired arrangement; (2) certain auxiliary facilities on the second floor would be more economical to construct than a large single story structure; (3) loss of this facility would eliminate the only plutonium fabrication building at the Savannah River Plant and would seriously affect the flow of completely fabricated plutonium pieces from SRP;

(4) valuable quantities of in-process and in-storage plutonium are contained in this building; and (5) severe damage to this building would result in the dispersal of contaminants throughout the #200 Area.

Although it was planned initially to install two "C" Lines in Building #235-F, a review of other existing facilities by AEC led to the conclusion that two lines were not immediately necessary. This did not alter the design of Building #235-F because space was provided for the eventual installation of a second line if it should be required.

Design Problems

After the over-all design had been established, several related problems had to be solved. The primary problems included: (1) heating, ventilation, and air conditioning design; and (2) selection of servicable locations for the transformer, electric control, emergency generator rooms, and the waste retention tank.

Heating, Ventilation, and Air Conditioning

Initial planning on these facilities centered around a ventilating system to serve both Buildings #235-F, and #232-F. However, after a study by du Pont specialists, it was decided that combining the hazards of plutonium and the material in Building #232-F would complicate design and result in an uneconomical installation. The design adopted provides for the flow of warm or cool air through separate facilities for each zone in a down draft manner in order to control heavy dusts. Air from Zones II and III are filtered and exhausted through Building #293-F stack. All intake and exhaust shafts are covered by concrete canopies to guard against shock waves in the event of a nearby blast.

Selection of Locations for Auxiliary Facilities

Initially, it was considered feasible to locate the transformer, electric control, and emergency generator rooms outside of the Metallurgical Building. However, upon review of the problem, it was found that use of exterior facilities would change the rectangular shape of the structure. This change in building shape was deemed unsatisfactory both from the point-of view of blast resistance and economy. Later, this was modified when the inert gas and propane storage facilities were placed outside Building #235-F for safety reasons.

Originally, it was anticipated that the waste retention tank would be installed inside the building below the floor level of the decontamination room in order to simplify oper-

ation and inspection requirements. This would house any pumping equipment inside the building without excessively long suction lines. Accessibility, however, required that this tank be installed outside the building. All wastes are collected in a common sump and transferred to this tank by means of a jet.

In addition, minor difficulties arose in providing facilities for the removal of the liquid wastes from the waste retention tank. A loading platform was designed to permit coupling and uncoupling an unshielded truck to transport the liquid wastes to the waste handling facilities at Building #211-F.

In summation, building design flexibility was emphasized so that the prime purpose of each facility layout would be that of serving the "C" Line in the most efficient and economical way. For example, the inner walls between the personnel decontamination room, health instrument counting and work room, and health instrument office are removable to provide either a large area or to utilize the original design of separate rooms.

Equipment

The component fabrication line at the Savannah River Plant was developed on the basis of process data provided by Los Alamos and mechanical design proven at Hanford.

Lack of written data on plutonium fabrication required field trips to Hanford and Los Alamos to select a pattern for the SRP "C" Line. After inspection of Hanford's rubber glove line, and remote mechanical line and the Los Alamos "C" Line facility, it was decided to adopt a rubber glove line patterned after Hanford and Los Alamos. By virtue of the reduced mechanical complexity of the glove line over the remote mechanical line, it was expected that personnel exposure would be minimized through the elimination of the hazards of mechanical maintenance within the line itself by permitting the exterior to be more freely decontaminated. It was decided also to adhere to the Los Alamos basic chemical and metallurgical processes except where major advantages and improved reliability could be proven otherwise; and to develop further flexibility in this facility to allow for nominal changes in the size and shape of the final pieces and to assure floor space for additional equipment and hoods.

The transformation of the rubber glove line into an improved facility was accomplished with the assistance of Hanford and Los Alamos personnel and by the cooperative efforts of the du Pont Mechanical Development Laboratory, Atomic Energy Division, Design Division, Engineering Research Laboratory, Engineering

Service Division, and Wilmington Shops. In addition, development and design work by du Pont was expedited through the assistance of the Blaw-Knox Company. This subcontractor procured all commercial equipment, designed utility lines up to the cabinets, and issued the initial work order to MDL for two "C" Lines. The scope subsequently was reduced to one line in November, 1951, when it was decided that a single facility had sufficient capacity to meet the production schedule. In addition to the efforts of Blaw-Knox, the Allstates Engineering Company of Trenton, New Jersey, assisted in the development of "C" Line equipment, by working on such specific items as the hydraulic lift and radiation shield.

The security aspect of the work made it desirable to have the Wilmington Shops fabricate the "C" Line because it was familiar with security requirements and was close to du Pont Engineering facilities.

Design Problems

The major problem in design of the SRP "C" Line was the modification of the rubber glove line into a facility which would overcome any existing operating deficiencies, simplify equipment wherever possible, and yet provide sufficient mechanical means to insure maximum protection for personnel and adequate control of the process operations.

The major development efforts were expended on the inert gas system and process hoods together with the entry, casting, parting, pressing, blasting, filtering, transfer, and coating stations. Emphasis was also placed on instrumentation for this facility.

Inert Gas System

The first step in the design of the inert gas facilities was the selection of the type of gas needed to prevent oxidation of the plutonium. Initially, it was believed that the "C" Line would best be served by the use of helium. However, both nitrogen and helium were adopted after a cost estimate proved that a considerable saving could be achieved by using nitrogen for general blanketing and helium for small critical consumption units. The inert gas system, modeled after the Hanford facilities, maintained the required negative pressure within the hoods, supplied sufficient air velocity at open ports, was readily adaptable to the SRP use of helium and nitrogen, and included a recirculating and cooling system.

Process Hoods

The cabinets enclosing the "C" Line process equipment are a modification of the hoods in use at Hanford. Although the

SRP cabinet retained the general shape of the Hanford enclosure, MDL studied the problem further and standardized most cabinets in accordance with the latest information available on hood design. In addition to standardization, the hoods were designed to facilitate assembly, reduce vibration and provide air tightness, increased visibility, ease of cleaning (both inside and outside), and maximum convenience and safety for working through glove ports.

Assembly and Vibration

The method of fastening the cabinet sections together was simplified by flaring the edges to provide a flanged surface for bolting. Interior fastenings were made by projecting welded studs instead of using reinforced flanges with drilled, tapped holes and bolts. This method speeded up assembly by eliminating the difficult job of tapping stainless steel and also overcame the distortion problems arising from welding reinforcing strips. National threads were specified for all studs to reduce the possibility of loosening the frame by vibration, while Acorn nuts were specified to cover the exposed threads.

Air Tightness

In order to have air tight end fittings on each cabinet, a technique was developed by the Mechanical Development Laboratory to permit the use of a continuously extruded gasket instead of the more costly molded gasket for cabinet gasketing.

Visibility

Improved visibility of operations was achieved by enlarging the glass area in each hood and by replacing plastic with safety glass which provided added strength and resisted scratches on the window surfaces.

Cleaning

After sand blasting of stainless steel hood surfaces failed to give the required finish, it was decided that the use of stainless steel with a pre-polished mill surface would facilitate detection of contamination and the cleaning of the hoods.

Glove Ports

The operation of "C" Line was facilitated by specifying optimum cabinet depth and glove port dimensions. The slightly oval glove ports were designed to provide lateral freedom of the operators arms as they perform each of the manual operations through rubber gloves.

The rubber gloves within the glove ports are similar to those used at Los Alamos. The hazardous nature of the product made it extremely unwise to consider procuring these gloves from any source other than that used by Los Alamos. The rubber glove design had been patented by the University of California and du Pont secured permission from this institution before any manufacturer was released to fabricate the gloves.

Entry Station (Hood #1)

The entry station, an original concept of the Mechanical Development Laboratory and the Design Division, was included in the "C" Line to obtain positive protection against the escape of particulate contaminants, to minimize the need for extensive bag port operations, and to reduce dilution and substantial loss of inert gas.

Experimental models were used to develop the sliding doors which were designed with cam controlled locks and releases to facilitate opening and closing and to protect the sealing gasket from wear due to abrasion.

Casting Station (Hoods #3, 4 & 5)

The two casting furnaces in "C" Line were made to du Pont specifications by the Consolidated Vacuum Corporation. Initially, it was planned to have eight casting furnaces serving two "C" Lines. However, in September 1951, the requirements were reduced to two furnaces for each line when Los Alamos authorized an increase in the size of the plutonium ingots. The number of furnaces was reduced again in November, 1951, when the AEC requested that Building #235-F house only one "C" Line. Once the number had been settled, it was determined to install one conventional furnace similar to the LA and Hanford units and one National Research Corporation furnace in the SRP "C" Line. Eventually, however, the conventional type was adopted because it was the best proven design. Except for size, the furnaces developed by CVC are similar to those in use at Los Alamos and Hanford.

Other work which assisted in the attainment of maximum operating efficiency was the development of a furnace flexible enough to handle various sized crucibles. As the design progressed, it became evident that various sized crucibles would be used in the casting operation. Design flexibility was obtained by extending the furnace bottom 6 inches and providing a removable dummy insert with each furnace. This change permitted the Savannah River Plant type furnaces to be similar to the LA and Hanford units by providing a minimum height of 12 inches and a maximum of 18 inches.

Parting Station (Hood #6)

A mechanical saw for parting ingots was developed by the Mechanical Development Laboratory to overcome the hazardous and time-consuming manual methods used at other locations.

At one point in design it was believed that the parting operation could be improved by replacing the hack saw with an automatic shear being developed by the General Engineering Laboratory at Schenectady, N. Y. Although space was provided for the shear in Hood #6, it was not installed at the Savannah River Plant because the machine's complex design demonstrated the potential need for constant maintenance.

Pressing Station (Hoods #10, 11, 13, 14, 15, 15-1/2, 16)

The basic design principle of the pressing station was different from that of any existing facilities in that the pressing operation was completely contained within the hood and mechanical facilities were provided to assist in handling heavy equipment safely. Emphasis was placed on keeping the mechanical equipment as simple as possible to avoid maintenance. Included with this hood is a special hooded entry air lock, a monorail hoist, a modified design of the Los Alamos die can and provision for the use of a breach lock to permit one of the two hydraulic presses to remain in a cold zone, while the other is cabinetized for pressing material.

Entry Hood

The special entry hood, a new development for SRP, was designed with interlocking doors similar to those in Station #1, which enabled the empty die can to be inserted in the main cabinet (Hoods #10, 13, 16) to initiate the operations of the Pressing Station.

Overhead Conveyor

The overhead conveyor was selected instead of the Hanford roller conveyor because it eliminated manual handling of the assembled can and its location facilitated cleaning of the bottom of the hood.

Die Can

The Hanford die can had heating coils on the inside. The Los Alamos design was used, together with a Loftus induction furnace, to provide heat for bringing the die to operating temperature. This change reduced the weight of the can, simplified utility connections, and eliminated the problem of maintenance of heating coils.

Presses

The two hydraulic presses in "C" Line were designed similar to those in use at Los Alamos. However, these units were arranged and used differently than the open units at Los Alamos. At the Savannah River Plant, one enclosed press was used for metal shaping while the second, an out-of-line unit, calibrated dies and cans in order to control the amount of heat applied to the plutonium. Should it become necessary to use the second press for metal shaping, the piece may be removed through a breech-lock door similar in design to those at Los Alamos.

Blasting Station (Hood #18)

Equipment at this station was developed by the Mechanical Development Laboratory with assistance from the Engineering Research Laboratory and specialists from other companies. In some cases, commercial components were used, but early attempts to procure modified commercial sand blasting machinery failed and it became necessary to design special facilities for the Savannah River Plant.

Of MDL origin, the major improvement at the grit blasting station turned the piece throughout the operation. This eliminated the shortcomings of a manual operation because it prevented insufficient or excessive blasting and the danger of grit penetrating the rubber gloves.

In addition, silica carbide, Hanford's cleaning compound, was replaced with magnesium oxide because it was believed that plutonium would be recoverable from the MgO residue sand.

Filtering Station (Hood #19)

The filtering station at SRP was more refined than similar facilities at Hanford and Los Alamos in order to prevent pressurization of the grit blasting cabinet, provide dust control, and increase the operating life of the AEC Type 1 particulate filters.

Transfer Station (Hood #21)

The transfer operation was designed so that a piece could be removed from a highly contaminated zone to the coating operation without taking small quantities of finely divided particulate matter with it. This made it possible to keep contamination in the coating operation to a minimum.

The equipment designed for these operations consists of an alcohol trough to store the piece until it is lifted on a carrier to a vessel of alcohol and a screw-type conveyor to

feed the coating units from the rear. After coating, the piece moves along the front of "C" Line to the inspection station in Hood #26.

Trough

The alcohol trough between Hoods #20 and 21 was adopted because engineering analysis showed it to be less complicated and more effective than others considered during development.

Conveyor

Initially both chain and screw-type conveyors were considered by the Mechanical Development Laboratory for the transfer station. However, the former was rejected because it was considered too difficult to maintain or replace and might gather particulate contamination. The screw-type was adopted because it met space limitations and material requirements, and facilitated maintenance.

In addition to the problem of selection, the 27-foot length of the conveyor necessitated building the screw in sections. This required that the conveyor be modified so that each section would permit smooth transfer and removability for cleaning and repair.

Coating Station (Hoods #22, 23, 24, 25)

The Mechanical Development Laboratory improved the design of the X-gas facilities at Los Alamos and Hanford by providing more efficient and safer operation for the Savannah River Plant.

Greater operational efficiency was achieved by developing an improved bell jar and employing hydraulic pressure to operate the Hanford nine-point tripod holder. The induction coil-type bell jar developed applies heat more uniformly to the metal, while the hydraulic controls insure smoother rotation and uniform coating of the piece.

Safer coating operations were accomplished by the development of a multi-zoned hood and the adoption of the Hanford design for cylinder storage and piping.

Multi-Zoned Hoods

The early concept of designing the coating hoods to control contamination originated from joint discussion between du Pont and Los Alamos personnel. The spread of particulate contamination was minimized by combining a multi-zoned hood to isolate contaminated and uncontaminated areas with ventilation designed to produce air flow from the uncontaminated area through the contaminated areas to the exhaust.

Cylinder Storage and Piping

Hanford design was used because it was applicable not only to the bulk storage of full cylinders at normal air conditioning temperatures, but also provided a tight enclosure for working storage and manifold cylinders. The design also made use of double jacketed lines equipped for ease in maintenance or connecting to a new cylinder, and included the installation of taps in the line jackets and storage cabinets to provide for monitoring instruments.

Instrumentation

Instrumentation problems of the "C" Line were concerned principally with cabinet ventilation and the measurement of pressures required by the plating operation in the X-gas units. Control of cabinet ventilation was solved by the use of instrumentation similar to that employed on the dry cabinets of "B" Line. Pressure measurement of the plating operation was accomplished by the use of an ion chamber selected because it provided a wider range of measurement, linearity of signal record, and could be housed in a metal chamber for safe operation.

General Design Problems

The remaining stations of this facility were designed to provide maximum operating convenience and simplification as well as a more compact arrangement, improved equipment, and safer design. For example, the weighing station (Hood #2) was designed with a standard hood enclosing a second hood which in turn covers the scale. Operational convenience was provided by dividing the balance hood doors and mounting the unit on a platform, both changes facilitating the handling of the piece and the observation of the scale. The double weighing stations (Hoods #7 and 20) were simplified by the addition of mechanical linkage to raise and lower the fluid vessel. This arrangement was more compact and permitted an additional scale to be fitted into a standard hood. The vibration and uncleanness of Hanford's "upside-down" type of wood cutting lathe were eliminated in the turning station (Hoods #8 and 9) through the use of metal turning lathes secured to the floor of the hood and with a stainless steel sheath inserted beneath the lathe bed to recover the turnings. In addition, the cleaning and stripping station (Hood #17) was equipped with a small still to keep the alcohol clean so that the plutonium pieces would remain free of foreign matter. The inspection station (Hood #26) has an open front to facilitate both visual inspection and manual transfer of the coated piece, and the buffing station (Hood #27) is enclosed in order to contain and dispose of dusts and to provide maximum protection for the operator in the event that the coating on the piece breaks during buffing.

The Mechanical Development Laboratory was responsible for inspection of the "C" Line equipment before shipment to the site, advising on fabrication methods and minor design changes. At the plant, MDL "debugged" both the "C" Line components fabricated at Wilmington Shops and the commercial equipment provided by other firms, and assisted with final testing of the complete facilities.

General Safety Problems

The major safety problem in the design of this facility was to construct a building and develop a process which would meet du Pont's standards and assure improved contamination control, safe operation, adequate liquid waste control, and sufficient personnel protection.

Contamination Control

This problem was the first to be considered because of the high toxicity of plutonium. To avoid migration of plutonium particles, the usual design principal of zone control was followed. The building was divided into Zones #1, #2-3, and #4. Air flows are always from the clean zones to the most contaminated areas. To avoid personnel contamination the design principles of plutonium handling required the elimination of burrs and rough edges, easy cleanability of equipment and operating areas, and high levels of ventilation. Equipment was also contained within air-tight stainless steel hoods, while criticality control was attained by allowing sufficient space between storage and working areas. Moreover, an air monitoring system detects any contamination in the air, and personnel using rubber gloves are monitored also by portable "Poppy" type instruments placed every ten feet along the "C" Line.

Operations Safety

Improved operational safety of "C" Line was attained by the addition of an entry cabinet, increased visibility of the process, use of mechanical aids with an efficient rubber glove system, adequate filtering of the blasting operation and redesign of the coating station.

Entry Cabinet

The air lock in Hood #1 was designed to provide entry facilities while preventing the escape of contaminated particles to the atmosphere. In addition, development of the sliding door at this station provided a simplified means of transferral between the other cabinets of "C" Line.

Visibility

The use of larger safety glass windows in the "C" Line cabinets provided the operators with a clearer view of the process and thereby minimized the possibility of any misoperation.

Mechanical Aids and Rubber Gloves

The intelligent application of mechanical aids with rubber gloves provided safer operation by minimizing employee fatigue and yet simplified operations so that maintenance of equipment was not a major problem. The glove ports in turn were designed to give maximum reach and operational comfort.

Filtering

The filtering station (Hood #19) was improved when it was found at Hanford that the grit blasting operation was one of the greatest sources of possible contamination. The filtering facilities developed for SRP insured efficient cleansing of the piece while guaranteeing operator safety.

Coating Station

These facilities were designed to minimize any possibility of premature decomposition of the gas feeding the units, to prevent leakage of nickel carbonyl gas, and to deter the spread of contamination. Accordingly, they are of safer design than the corresponding facilities in use at Hanford. The first improvement was achieved by the use of instruments to monitor the flow of gas through the piping; the second, through leak detection with helium prior to the admission of X-gas into the pressure sealed bell jar; while the third was accomplished by the development of a hood which separates an uncoated piece from a coated component.

Liquid Waste Control

Liquid wastes from "C" Line include nitric acid, detergents, and other materials used to clean the process hoods. Liquid waste control facilities were designed to permit these low activity waste fluids to flow from the floor drains into a stainless steel retention tank enclosed in a concrete pit, from which the liquids are pumped to a truck loading station. Final disposal of these wastes is accomplished through the waste handling facilities in Building #211-F.

Personnel Protection

Design criteria specified that all personnel working in the process area wear special protective clothing designed to prevent contamination or spread of contamination outside of the hoods. In addition, assault and fresh air masks were

specified to assure operator safety. Protection from any electrical fires due to faulty equipment was also provided by adequately situated fire extinguishers.

DRAWINGS

W-146516	First Floor Equipment Arrangement.
W-146618	Equip. Arrgt., Sections.
W-146617	Second Floor Equip. Arrgt.
W-146615	First Floor Plan
W-146616	Roof Plan, and details.
W-146745	Second Floor Plan.
W-146746	Stair Details.
W-147559	C Line Equip. Arrgt.
W-130717	C Line Schematic Arrgt.

BUILDING #241-F - WASTE DISPOSAL (LIQUID)

FUNCTION

Building #241-F is an underground facility for the semi-permanent storage of radioactive liquid process wastes from the #200-F Area. Liquid wastes stored at Building #241-F flow by gravity through Building #805-F underground stainless steel lines from Buildings #211-F and #221-F.

PRINCIPAL COMPONENTS

Diversion Box

This is a compartmented concrete box in which remotely made pipe line connections direct waste to the proper storage tank. Three compartments contain inlet, outlet, and cross-over piping and the "connector" nozzles. A fourth compartment is used for the storage of contaminated pipe jumpers. Two concrete-encased stainless steel lines connect the diversion box to each storage tank.

Storage Tanks

Eight 750,000-gallon welded steel tanks are enclosed in eight separate concrete enclosures which are buried under a

minimum of nine feet of earth. A 10,000-gallon stainless steel catch tank, located inside a concrete vault, collects any leakage from the Building #241-F and #805 liquid waste piping system as well as any ground water leakage into this system.

Cooling Coils

Four of the eight storage tanks were initially equipped with both vertical and horizontal cooling coils. In 1955, it was decided to equip the other four tanks with coils to prevent stored wastes from heating to excessive temperatures. Each tank equipped with coils has an installed spare set of coils for use in the event a regularly used coil should fail.

Pump House

This building houses the pumps and heat exchangers which, with the cooling coils, form a closed system to cool the waste stored in the underground tanks. Water in this closed system is pumped through the cooling coils in the tanks and then through heat exchangers, which are cooled by well water. Upon leaving the heat exchangers this well water is used as make-up for the #200-F Area cooling tower Building #285-F. The piping within the pump house is arranged so that, in an emergency, the well water may be run directly through the cooling coils.

This facility also houses chemical feed equipment for adding corrosion inhibitors to the make-up water in the closed cooling water system.

Vent Condensers

Initially, one water-cooled vent condenser, with an attached particulate matter filter was installed on each of the four tanks equipped with cooling coils. Moreover, provisions were also made for the installation of two additional condensers and filters per tank. In 1955, it was decided to add one condenser and filter to all tanks not previously equipped.

Valve Houses

A Class III prefabricated valve house was provided for each of the four tanks which were equipped with cooling coils. In 1955 each of the remaining four tanks was also equipped with cooling coils and a valve house.

Air Heaters

For each tank, air heating equipment was installed above ground on a concrete slab to maintain the air above the dew

point in the annular space between the inner steel tank and its outer concrete encasement.

BUILDING FLOOR SPACE

Approx. Sq. Ft.

Pump House

714

BUILDING DETAILS

Pump House

Class - I.

Size - Single story, rectangular, approximately 23 ft. wide by 36 ft. long by 23 ft. high.

Area - 850 sq. ft.

Volume - 19,600 cu. ft.

CONSTRUCTION DETAILS

Foundations - Reinforced concrete with spread footings.

Superstructure - Reinforced concrete walls and roof, with two coats of waterproofing over roof surface. The floor is concrete with no covering. Doors are hollow metal.

Heating and Ventilation - Supply air is heated electrically; a direct-drive propeller fan exhausts air through louvers in the building wall.

Lighting - Incandescent.

EQUIPMENT

Diversion Box

The diversion box, of reinforced concrete with removable concrete covers, contains four compartments of varying dimensions, the maximum width being approximately 36 ft., and the maximum depth approximately 26 ft. It is supported on reinforced concrete piers plus timber piling, with concrete encasement for the drain lines supported on timber piling only. Stub pipe ends were provided and blanked off to permit installation and use of another diversion box in the future.

Storage Tanks

- 8 Tanks, each 750,000-gallon cap, welded carbon steel approximately 76 ft. in diameter by 24 ft. high.

12 Steel columns per tank filled with concrete and integral with each tank.

1 Steel catch pan for each tank.

Cooling Coils

The vertical and horizontal cooling coils consist of approximately 15,000 lin. ft. of 2 in. steel pipe per tank.

Pump House

3 Pumps, each 325 g.p.m., 145 t.d.h., with 3600 r.p.m., 480 v. 3 ph., 60 cycle motors.

1 3-Stage water cooler.

1 Chemical feeder.

1 Surge tank, 4 ft. by 6 ft.

Valve Houses

Class III prefabricated shelters, each mounted on a concrete pad are provided for each tank equipped with coils.

Air Heaters

Each of the eight air heaters is mounted on a steel framework and stands, unboxed, on a concrete pad. A centrifugal fan recirculates steam heated air through ducts to maintain the air above the dew point in the annular space between the steel tank and its concrete encasement.

Instrumentation

The instrumentation consists mainly of thermocouples, temperature recorders and level indicators for the tanks. The cooling water of the closed system is radiation-monitored by an ion chamber at the inlet of the cooling water pumps. A "fishing reel" type electrode device is used for level measurements inside the underground tanks and a ceramic-beaded electrode "necklace" monitors leakage into the catch pan. The electrode "necklace" lies in the tank catch pan and delivers a signal on as little as 1/4 in. of liquid at any point in the pan. Monitoring wells were installed outside of the tanks at Building #241-F to detect any leakage from tanks to surrounding soil.

Miscellaneous Construction Features

The entire area of Building #241-F, approximately 330 ft.

wide by 600 ft. long, is surrounded by a fence and is illuminated by floodlights mounted above ground. The ground surface above the tanks is paved with a macadam surface.

DESCRIPTION OF PROCESS

Building #241-F stores concentrated wastes such as the coating solution from the dissolver and the bottoms from the high activity, low activity, rerun and laboratory waste evaporators in Building #221-F. These tanks also receive the concentrate resulting from the operation of the general purpose evaporators in Building #211-F.

These liquids are segregated into "coating solution" and "general" waste streams and discharged into two of the four concrete-encased stainless steel headers leaving Building #221-F. Alternately the wastes may be discharged into the two spare stainless steel headers leaving Building #221-F. The wastes flow from Building #221-F through concrete-encased lines to the diversion box from which they can be directed to any of the waste storage tanks of Building #241-F. The concrete encasements surrounding the lines to and from the diversion box are sloped in such a manner that any leakage flows to the low end of the pipe trench and thence to the drainage catch tank. After monitoring, the contents of this catch tank are jettied to the storm sewer or, if above radioactive tolerance, it is either jettied into one of the waste storage tanks via the diversion box, or transported by tank truck to Building #211-F for concentration by the general purpose evaporators.

At the diversion box the entering lines may be connected to the various outgoing lines by pipe jumpers and connectors. There, jumpers are installed or removed remotely by an operator using a crawler crane with the aid of mirrors and a suspended impact wrench. The diversion box is equipped with Spraco nozzles so that all pipe jumpers, nozzles and connectors, and the inside surfaces of the box can be sprayed with acid or alkaline solution to reduce their contamination. Spare inlet and outlet nozzles are provided to allow the connection of future lines in the event of failure of any of the existing lines and to permit wastes to be directed through a new future diversion box to a future set of tanks. A jumper storage box is located next to the diversion box to store spare jumpers.

Liquid wastes received at the diversion box are directed to the underground tanks in accordance with a prearranged segregation plan. In the tanks the cooling coils and water-cooled reflux condensers remove the heat generated during the decay of fission products. The condensers supplement the cooling coils and condense and reflux any vapors formed. Filters at the outlet of these condensers intercept any particulate

matter prior to release of any uncondensed inert gas to the atmosphere. In addition, the steel catch pan inserted between the steel bottom and concrete base of each tank retains any leakage. Four risers extend above the annular space to grade; any one of these can be used to install a jet to pump liquid out of the pan. Spare risers on each tank serve for future liquid transfer, agitation, sampling, or instrumentation requirements.

The facilities supplementing the four tanks initially equipped with cooling coils included a pump house and four valve houses.

Pump House

The closed cooling water system, originating in the pump house, circulates water from the heat exchanger, through the vent condenser and tank coils back to the heat exchanger for heat removal. A chromate inhibitor is added to the circulating water. Cooling water for the heat exchanger is supplied from a well on a once-through basis. This once-through cooling water discharges to Building #285-F Cooling Tower as make-up. A second well, with pumps and pipe line, is provided as a complete emergency back-up for the main well source; pumps on this system can be supplied with emergency power.

Valve Houses

Inlet and outlet valves are installed in the valve houses for controlling the number and location of coils in use and so that coils may be tested periodically for leaks. A relief valve also is provided around each outlet valve to prevent an excessive pressure build-up in the coil due to thermal changes, in the event that both the inlet and outlet valves on a coil are closed inadvertently.

In addition to the valves, these four prefabricated structures house telephones and are used to store portable pH meters and electrodes, spare connectors for the diversion box, small portable tools, packing for valves, small shielded containers used in transporting waste samples, protective clothing, masks, rain clothing, radiation counters, and spare instruments.

All eight tanks in Building #241-F are provided with exterior air heaters to keep the air in the annular space above the dew point and retard rust formation. A relative humidity of approximately 30% is maintained in the annular space between the steel tank and the concrete encasement.

Electric power for Building #241-F is supplied via overhead lines at 480 volts from a substation near Building #717-F.

Taps are provided at the pump house and waste storage tanks for power and for lighting all facilities, and at the diversion box for operating the impact wrench. Motor starting equipment for the pump motors is housed in the pump house, while similar equipment for the waste storage tank area is of the outdoor oil-immersed type.

DEVELOPMENT OF DESIGN

The Savannah waste storage facilities, designed through the joint efforts of Blaw-Knox and du Pont, were to be modeled initially after the original waste tank farm at Hanford. However, site conditions, the requirement for blast resistance, and the higher radioactive content of the waste liquid at Savannah River, led to modifications and changes in design of the components to assure safe and efficient handling and storage of the concentrated wastes from Building #221-F and #211-F.

Evolution of Design

At the beginning of design, the location of a centralized storage facility midway between the F and H Areas to serve both areas was studied but found to be impractical. Gravity flow through lines on a 1-1/2 per cent grade had been established as a design requirement and in any centralized plan the lines would not only be long but also carried, in some locations, to a considerable depth. These considerations, plus the fact that a number of auxiliary services would have to be extended to serve the area, led to the decision to install separate waste facilities. Eight tanks were to be installed initially in the F Area and four in the H Area.

After study of outside waste line alternatives, it was decided that the required flexibility and economy could be best achieved by using four headers to transfer liquids from Building #221-F to a diversion box at Building #241-F from which concentrated wastes could be directed to the proper storage tanks. Two of these four headers are installed spares; vessels at Building #221-F are piped both to the two regular waste lines and also to the two spare waste lines.

Design Problems

The major problems in the design of these waste storage facilities included (1) the selection of a suitable location, (2) the development of adequate design for the diversion box, waste storage tanks, and instrumentation, and (3) the adoption of an over-all design which would allow for possible expansion as well as changes in scope of work.

Location of Tanks

Three important factors influenced the selection of a location for the storage tanks in the F Area; proximity to Bldg. #221, gravity flow, and topography. It was naturally desirable to have the tanks near the Canyon Building, source of most of the wastes to be stored; but at the same time it was necessary to keep the waste facilities safely segregated and in an area containing space for expansion. The location selected is approximately 1000 feet from Bldg. #221. To meet the requirements for gravity flow, it was economically advantageous to choose a site where the terrain intervening between it and the Canyon Building would present no exceptional problems in securing the necessary line slope. Finally, and perhaps most important, it was desirable to so place the tanks that any contaminated leakage would seep into a stream flowing into the river below the plant main pump house intakes. Actually, the design of the tanks made dangerous leaks highly improbable but the remote possibility of a catastrophe was taken into consideration in their location. In such an event, any released wastes will flow into Four Mile Creek and into the river downstream from the pump houses.

Diversion Box and Waste Storage Tanks

The diversion box and waste storage tanks, being the major components of Building #241-F, required the primary design effort.

Diversion box design is almost identical to that used at Hanford. Higher earth pressure at SRP, however, necessitated thicker walls, and soil conditions dictated that the diversion box be supported by a substructure of beams, piers, and concrete slabs. Ground water conditions also dictated waterproofing at the Savannah River Plant.

It was decided, initially, that the design of one of the Hanford types of diversion boxes should be modified to incorporate a different nozzle arrangement, permitting fewer jumpers and more combinations for nozzle hook-up. This layout would have provided inlet connections on the wall and outlet connections on the floor of the diversion box. However, this arrangement with the outlet nozzles located in the bottom of the box, presented the undesirable possibility of guide rods, guide hooks, cables and other tools being dropped during a jumper change and becoming fouled with the outlet nozzles. The piping for this scheme was also somewhat more complicated than that in the Hanford type diversion box. For these reasons, the present design was evolved, resembling more closely one of the Hanford boxes.

Late in 1954, the design of jumper piping of the diversion box was modified to remove interferences so that dummy connectors instead of dummy covers could be used to blank all unused

nozzles. This change was made because the dummy connectors provided a more positive closure against leakage.

The problems encountered in designing the waste storage tanks included both the selection of the type of tank and the design of the cooling coils and vent condensers.

Tank Design

Geologic and ground water conditions present at the Savannah River site necessitated the development of a new tank design and its concrete encasement.

The shape, size, capacity, and materials of construction for tanks were agreed upon after intensive study and analysis of different tank designs showed that a concrete enclosed, 750,000-gallon, vertical cylindrical tank was the most practical design to meet the SRP site conditions and blast resistant requirement. Metal thicknesses for the carbon steel tanks and carbon steel coils were selected, based on reasonable tank life and on corrosion tests using simulated waste solutions. Corrosion of the exterior of the 750,000-gallon tanks is minimized by maintaining the air above the dew point in the space between the steel tank and the concrete enclosure. If, after an extended period of time, the tanks leak due to corrosion, it will be necessary to build additional replacement tanks and transfer the liquid waste from the leaking tank.

Premature leakage was minimized by extreme care in welding and by the radiographing of all weld seams. Use of the catch pan also tolerates tank leakage for a period of time prior to permanently taking the tanks out of liquid waste service.

In 1953-1954 development work was undertaken at the Hanford Redox Plant to concentrate waste solutions in a 750,000-gallon tank equipped with water cooled condensers but with no cooling coils in the tank. During this work "bumping", the sudden evolution of large amounts of steam, occurred at times within the tank. After further investigation at the Redox Plant and the Brookhaven National Laboratory it was determined by the end of 1954 that "bumping" was due to internal heating of the sludge layer by fission products at a rate faster than internal heating of the supernate layer. After a substantial temperature differential had developed, any triggering action such as the addition of a batch of waste or the lowering of a thermometer into the tank could cause intermixing of the relatively hot sludge with the relatively cool supernate producing steam and turbulence. This turbulence then released more steam which created more turbulence, and finally, the rapid evolution of large quantities of steam within the tank.

In July, 1954, pending further study of the problem, it was decided to supply the first tank to be filled at SRP with overpressure and vacuum protection. This vessel was also equipped, as a precautionary measure, with valves to facilitate the future addition of more condensers and filters, thermocouples, microphones and vacuum and pressure recorders.

In 1955, it was decided to equip all SRP waste tanks with cooling coils, condensers and filters, together with some auxiliary process control equipment.

Cooling Coils

Cooling coils were found necessary on these storage tanks because the radioactive waste at Savannah is concentrated before it is stored, resulting in the generation of greater heat than was encountered on original tanks at Hanford, which had no coils.

The SRP tank cooling coils serve to remove the heat generated by the decay of fission products. The vertical coils, arranged on a four-foot equilateral spacing with each element provided with a spare, are installed to remove the heat generated while the tank fills. The horizontal coils on the bottom of the tank remove the heat generated at low levels before sufficient surface of the vertical coils is covered.

Initially, a retention basin was under consideration to hold the coil cooling water for monitoring. However, it was found to be more economical to supplant this method with a closed cooling system plus a heat exchanger. With this system possibility of contamination in the cooling water is very remote. The once-through well water carrying heat away from the exchanger is monitored as a precaution at Building #284-F.

Vent Condensers

Originally the vent condensers on the waste storage tanks were to be air-cooled. As design progressed, however, it was decided that they should be water-cooled because of the considerable savings in the first cost of equipment.

In addition to the waste storage tanks, a concrete-encased stainless steel catch tank was specified to collect any drainage of radioactive liquids from the diversion box and concrete pipe encasement, or ground water seepage into the box and piping encasements. Underground water conditions at the Savannah River Plant are conducive to water seepage and this condition required special protective measures. The concrete encasement enclosing the catch tank also presented the problem of designing roof slabs to permit remote maintenance, a concrete saddle to support the tank plus straps to anchor the tank in the

event the encasement filled with water.

Instrumentation

Initial designs of the "fishing reel" device used to measure liquid levels in the underground storage tanks, were obtained from Hanford but after a review the design was found inadequate for Savannah River service. However, new designs were prepared which improved the device by providing adequate closure of its electrical circuit, good bearings for the reel and a safe closure for the reel wire from which the weight is suspended. This closure includes a mercury seal.

A problem also arose in the "necklace" alarm, designed to detect any liquid leaks from the storage vessels, from the requirement of the original design to maintain a current path between the electrode and the catch-pan wall. The bituminous coating added to the inside of the catch-pan required the inclusion of a second electrode wire for completing the electrical circuit.

Numerous thermocouples with recorders were installed as part of initial design for study of waste temperatures in the first two tanks to be filled. In addition, a high waste temperature alarm was provided at the Building #221-F Dispatchers Office so that prompt measures could be taken by supervision when such emergencies occur. Decision to install this alarm was influenced by the decision to install initially only one filter and condenser capacity of 1,700,000 B.t.u./hr. capacity per tank.

Expansion

Future physical expansion and increases in the scope of these facilities were initially taken into consideration in designing the entire waste storage area. Space was allocated for another diversion box and the waste storage tanks not equipped with cooling coils and vent condensers were designed so that these auxiliaries might be added before use. Moreover, early in design, the location of the waste storage facilities was selected to provide future space for the addition of waste treatment facilities. The eventual development of a method for concentration of radioactive wastes was considered together with the possibility of recovering potentially valuable elements in the liquid wastes.

General Safety Problems

Due to the topography and ground water conditions in the liquid waste storage area, the hazard of outward leakage was a basic safety consideration. At Savannah, the water table is

such that the ground water level is close to the bottom of the F Area tanks. In spite of the fact that the soil is of such a nature that it would absorb some of the radioactivity in the event of tank leakage, the water table made it imperative that every precaution be taken in design to prevent any leakage from the tanks flowing to any nearby surface or underground stream which would then contaminate the Savannah River. It was also desirable that the release of any such contamination if it should occur, should be downstream of SRP water intake.

The catch pan underneath the tanks is designed to detect, collect and permit disposal of any leakage before it can reach the surrounding earth. The annular space outside the steel tank and inside the concrete encasement is heated to minimize corrosion of the outside surface of the 750,000 gallon steel tank caused by water vapor in the air. All of these features were incorporated in the design of the tank to prolong the containment of the radioactive liquid and to prevent future contamination of the surrounding area.

DRAWINGS

W-146298 Equipment Arrangement

W-145573 Waste Storage Tanks - General Arrangement and Construction Details - Concrete & Steel.

W-145379 75' Dia. Steel Tank Details.

W-145367 Steel Pan Plate Details.

W-146625 Plan of 75' Dia. Tank.

W-145225 Design of Concrete Tank.

W-145974 Pump House Equipment Arrangement.

W-148124 Pump House Superstructure, Concrete and Arch.

W-148243 Valve Box Building Foundation and Dehumidifier Pan, Concrete and Steel.

W-146968 Diversion Box, General Arrgt.
Const. Det., Concrete and Steel.

W-147043 Diversion Box, Plan and Sections.

W-146851 Dehumidifier and Valve Box House, Equip. Arrgt.

E-129961 Drainage Catch Tank.

Specification 3206 - Specification for Waste Disposal Tank

BUILDING #241-H - WASTE DISPOSAL (LIQUID)

Only four tanks were authorized for Building #241-H by the original scope of work, with space to be provided for four others if needed later. Tanks erected initially are physically identical to those in Building #241-F, but only two are equipped with cooling coils and provided with valve houses.

The installation of four additional tanks to handle an increase in liquid wastes, expected as a result of increased throughput in the #200-H Area, was approved by the AEC in August 1954. The new tanks are 85 feet in diameter and 27 feet high with a capacity of 1,070,000 gallons each. This redesign was based on a re-evaluation of the economics of tank design taking into consideration the experience gained in designing and building the initial tanks, and including new data from Hanford Redox operations and from laboratory studies at SRP. It included structural compensation for the increased temperatures in the sludge layer on the bottom of the tank; the desirability of placing the bottom of the tank above the ground water level; and the necessity for keeping the liquid level in the tank at grade level or below. The tank diameter represents an economical size based on these design conditions. In this redesign a center column was adopted to permit the tank bottom to expand and contract freely. Because of the relative elevations of the tanks and the process building in which the wastes originate, it was necessary to include a pump pit adjacent to the tank farm to elevate the wastes, flowing by gravity from the process buildings, to the level of the tanks.

These tanks have carbon steel walls ranging in thickness from 5/8 in. at the top to 7/8 in. at the knuckle, and a top and bottom of 1/2 in. carbon steel. Each tank is set in a steel saucer or catch pan, 90 feet in diameter by 5 feet high, which is also fabricated from 1/2 in. steel.

The surrounding concrete shell has walls 2 ft. 9 in. thick, a top 3 ft. 9 in. thick, and a floor stepped from 3 ft. 6 in. to 5 ft. 4 in. at the center.

Six heaters are provided for the annular space between each steel tank and its encasement. Other auxiliary items such as cooling coils, vent filters, condensers, a valve house and instrumentation are provided for each tank.

Adoption of this tank design and pump pit resulted in economies due to reduced earth excavation, reduced expenditure for waterproofing, and the elimination of ground dewatering during the construction period.

A pump pit located at the south end of the four original tanks receives liquid wastes from the existing waste lines and elevates these to the four new storage tanks.

Among the major differences between the waste tank facilities in the two areas is a modification in the Building #241-H diversion box. It was moved 25 feet further away from the tanks than originally contemplated so that it could be supported on solid earth. In addition, the walls of the box have been lowered 12 feet by reducing the grade in the surrounding area. These changes reduced the difficulty in changing jumpers during maintenance and eliminated the need for expensive piling under the diversion box. For jumper handling, a 25-ton "Moto Crane" is used. This has at the upper end of its main boom a circular crane carrying a 1-ton electric hoist, a 1-ton traversing hoist and a powered indexing hook from which an impact wrench can be suspended. A boom mirror gives the crane operator a plan view of the pit, and a portable mirror on a stand on the opposite side of the pit gives him a perspective view of the pit. A single crane unit was purchased for use in both the "F" and "H" Areas.

PUMPS

Soon after design of the waste disposal facilities in the #200-H Area began, general agreement was reached that the volume of liquid wastes to be handled could be reduced if pumps were used instead of jets to transfer the solutions from one point to another. Although they are efficient and reliable, jets increase solution volume because of the condensate of steam. Consequently, plans were made to investigate and develop a waste pump for use in the pump pit of Building #241-H.

To meet operating requirements the pump had to be designed to render trouble-free service for many years since radioactive contamination would make maintenance impossible and replacement difficult. A large, vertical, submerged type of pump was required with no packing gland or mechanical seals, no bearings submerged in the liquid, and a lubrication system protected from deterioration or contamination. The motor rotor was to be located on the pump shaft to eliminate the two motor bearings.

A survey of available commercial designs revealed nothing suitable. Therefore, an original design was developed, a prototype fabricated and tests conducted under actual operating conditions in Building #241-H.

It was generally agreed that to design a pump that could operate for as much as 25 years without maintenance, particular attention had to be given to bearing design. For that reason, seven of the outstanding bearing manufacturers were

consulted and their opinions evaluated. At the same time the pump design proposed by du Pont was discussed and opinions solicited on possible design improvements and material substitutions.

A solution to the bearing problem was found in the use of equalizing shoe-type bearings. An 8-inch spherical Kingsbury thrust bearing was used for the upper bearing to take thrust and radial load and an 8-1/2 inch Kingsbury cylindrical tilting shoe bearing was used at the lower end of the shaft to take radial loads and restrict shaft whirl or whip.

Pump components were fabricated at the du Pont Company Wilmington Shops, and the unit assembled in the field where special care was taken to exclude dirt and to balance the rotating parts dynamically. The pump has a capacity of 150 g.p.m. with a 130 foot head.

By early part of 1956 the prototype was ready for testing and three additional pumps had been ordered for installation in Building #241-H.

DRAWINGS

- W-148296 - Equipment Arrangement
- W-148856 - Equipment Arrangement - Pump House
- W-146851 - Equipment Arrangement - Dehumidifier and Valve Box House
- W-145367 - Steel Pan Details
- W-145379 - 75 ft. Dia. Steel Tank Details.
- W-145573 - Gen. Arrgt. & Constr. Details - Concrete Tank
- W-148228 - Waste Line Encasement - Plan & Sections
- W-147544 - Diversion Box - Gen. Arrgt. & Constr. Details
- W-162697 - Equipment Arrgt. - Pumping Facilities
- W-144108 - Pressure and Vacuum System Arrgt.
- Specification 3206 - Specification for Waste Disposal Tanks

BUILDING #291-F - CANYON STACK

FUNCTION

This stack discharges to the atmosphere the exhaust air from Building #221-F and the exhaust from tank vents in Building #211-F.

PRINCIPAL COMPONENTS AND PROCESS

Stack

The stack consists of a concrete outer cylinder and a concentric acid-proof brick liner separated by an air space. Exhaust air and ventage from Buildings #221-F and #211-F are conducted to the stack through an underground duct from the fan houses #292-F and #292-1F, and discharge through the inner stack to the atmosphere.

Foundation

The stack is supported on a concrete foundation on which a stainless steel pan and sump are installed to collect condensate formed within the stack. The sump drains to a catch tank, located in a concrete pit adjacent to the stack foundation, while the sump overflow line drains to an emergency catch tank. The quantity of liquid within the catch tanks is registered on a level indicator system, and gang valve assembly jets transfer this liquid to Building #211-F for concentration and disposal.

Breeching

The breeching consists of a circular stainless steel duct fastened to metal inserts on the stack opening and curves downward to connect to the underground concrete duct through which exhaust air is discharged from Building #292-F. Armor plate is mounted on this breeching on the top and both sides for blast protection.

Six openings are provided in the breeching to receive dissolver off-gas from Building #221-F "A" Line, and absorber by-pass gas. Two additional blanked openings are provided for future use. Steam jets are located outside the breeching armor plate, two being arranged so that, in the event the Building #292-F off-gas blowers are inoperable, off-gas from the coating solution operation may be by-passed to the jets and thereby to the stack. A similar arrangement with other jets permits Building #221-F dissolver off-gas and "A" Line denitration off-gas to be by-passed around the "A" Line absorber.

A concrete sump is located at the low point of the main

concrete exhaust duct to collect drainage. A jet and gang valve assembly is provided for discharging this waste to Building #211-F through the #805-F process lines.

BUILDING AND CONSTRUCTION DETAILS

Stack

The stack is approximately 200 ft. high, the reinforced concrete outer stack having an inside diameter of approximately 16 ft. at the bottom and decreasing to approximately 12 ft. at the top. Stack thickness varies from 11 in. at the bottom to 6 in. at the top. The top 50 ft. of the exterior and all of the interior of the stack are painted.

The acid-proof brick inner stack (liner) has a continuous 10 ft. ID from top to bottom and is reinforced by bands of 3 in. by 3/8-in. stainless steel on 10 ft. centers. A stainless steel cap seals the air space at the top between the liner and outer stack.

Lightning protection is provided by four 3/4 in. air terminals extending above the stack. These are bonded together and to a 1/2 in. downleading cable, the top 25 ft. lead covered, which is permanently grounded at the stack base.

Gas sampler pipes are inserted in the stack 4 ft. from the top and 50 ft. from the bottom. The outer stack also contains four 6 in. diameter holes located 2 ft. above the foundation.

Foundation

The reinforced concrete foundation is octagonal in shape, with the top near grade level. The lower base is approximately 33 ft. in diameter and 5 ft. thick. The upper part of the foundation is 20 ft. in diameter and 3 ft. thick. A stainless steel pan on top of the foundation inside the stack is set on an acid-proof brick floor, with a 5 ft. diameter sump in the center. A 3 in. sump drain and a 3 in. sump overflow line allow liquid to drain to a 1200-gallon catch tank and 100-gallon emergency catch tank respectively. Both tanks are of stainless steel and are set in a concrete pit.

Breeching

The breeching is 3/16 in. stainless steel, with 1/2 in. thick carbon steel covering the top and sides. A door in the armor plate permits access to the breeching.

The breeching openings, other than the main exhaust duct,

consists of four 4-in. and two 6-in. stainless steel lines, which pass through the armor plate and breeching and discharge into the base of the stack.

EQUIPMENT

- 1 1200-gallon stainless steel catch tank.
- 1 100-gallon stainless steel emergency catch tank.
- 3 Process waste jet syphons.
- 4 Air purge assemblies

Gas sample tubes (pipes - installed in stack).

Pressure and level instruments.

DEVELOPMENT OF DESIGN

In order to dissipate the filtered gases from Building #221-F to the atmosphere, a vent stack approximately 200 ft. high was specified. This type of facility and its design was based on a corresponding installation at the Hanford Engineer Works. Whereas the corresponding Hanford stack was sized to handle gases at a rate of 40,000 c.f.m., the Savannah River Plant canyon stack was designed to dispose of gases at a rate of 200,000 c.f.m.

Piping from Building #221-F to this stack includes a bypass line from the dissolver off-gas line, provided to permit emergency operation of the dissolvers in the event of failure of the off-gas processing equipment.

Rough drafts of specifications for the stack included two types of liners: one of stainless steel construction, the other of acid-proof brick. However, it was decided to use the Hanford type acid-proof brick stack liner on the basis of lower cost. This liner, annulus and outer stack were topped with a stainless steel cap to prevent storm water from entering the annulus. The liner, which is free standing, was designed to support its own weight without lateral or vertical support.

Stainless steel breeching was specified because of the corrosive nature of the gases handled. To provide drainage in the breeching away from the stack, the breeching was designed to enter the stack at a 1 per cent slope. From the stack, it turns upward to enter the liner at an angle of 45°.

In order to monitor radioactive iodine (I^{131}) in the stack gases, horizontal piping was installed at various levels in the stack. This piping extends through the stack liner (and)

and runs to a radioactive monitoring device located in Building #292-F. Stack gas samples for monitoring are drawn from the stack at the rate of 1.5 c.f.m. through this piping by means of steam jets located in Building #292-F.

After the stack had been erected, consideration was given to the development of a means of disposal of NH_3 fumes other than through the stack as designed. Hanford experience indicated that NH_3 fumes from the canyon dissolvers tend to form a nitrate deposit in the concrete stack which, in time, sloughs off. To prevent future damage to the stack through such a reaction, and to avoid the possible dispersion of radioactive stack particles throughout the surrounding area, it was proposed that a stainless steel pipe should vent the gases from the #221-F canyon dissolvers, this pipe to be erected beside the stack and secured to it. The dissolver off-gas line from Building #221-F would then be disengaged from the stack opening as designed, and tied into this stainless steel vent pipe. Such an arrangement would prevent the reactant NH_3 fumes from mixing with the other gases vented through the stack. However, this proposal was discarded when it was concluded that the intermittent injection of dissolver NH_3 fumes into the stack gases would be so diluted as to make the formation of nitrates in the stack a matter of no great concern.

DRAWINGS

- W-157411 Architectural - Plans, Elevations, and Sections
- W-157410 Structural - Foundation Plan and Details
- W-157409 Process - Plumbing and H&V - Plan and Details

BUILDING #291-H - CANYON STACK

This stack is identical to that of Building #291-F, discharging exhaust air from Building #221-H and the tank vents of Building #211-H to the atmosphere.

DRAWINGS

- W-157925 Plans, Elevations and Sections
- W-157926 Architectural Details

BUILDING #292-F - FAN HOUSEFUNCTION

Building #292-F houses the fans which exhaust air from the process and service areas in Building #221-F. Filters are provided in this building for filtering recycle vent air and the exhaust air from the central portion of Building #221-F.

PRINCIPAL COMPONENTS AND PROCESSExhaust Fan Area

This area contains equipment for exhausting canyon cooling air, central portion ventilating air, coating solution off-gas "B" Line process ventilation air, and the recycle system air. This area also contains heaters for heating recycle system air above its dew point so that condensate is not filtered out. Electrical equipment, a motor control center, and a diesel-powered generator for emergency power are also located in this area.

Filter Area

There are two filter arrangements. One is located in an enclosed pit outside and adjacent to the main building to filter heated recycle air; the other is located on the main floor and occupies one end of the building to filter air from the center section of Building #221.

Tunnels

Beneath the main floor of the fan house are tunnels for the central portion exhaust air and the canyon cooling air. The "B" Line exhaust air, the recycle exhaust air, and the process vessel exhaust air enter the fan house through stainless steel pipe lines. All air exhausted through the fans in this fan house is discharged through a common tunnel to the stack, Building #291-F, where it is discharged to the atmosphere.

BUILDING FLOOR SPACE

	<u>Approx. Sq. Ft.</u>
Blower Area	10,200
Recycle Filter Pit	180
Central Air Exhaust Including Mezzanine	<u>2,715</u>
Total (Tunnels not included)	13,095

BUILDING DETAILS

Class - I

Size - This is a one-story rectangular building, approximately 63 ft. wide by 192 ft. long with an 8 ft. wide by 29 ft. long addition on the north end. The building is 17 ft. high from top of floor to top of flat roof. A filter pit, approximately 7 ft. wide by 34 ft. long by 10 ft. deep, adjoins the building at the southwest. A mezzanine floor extends across the width of the main building for a distance of 21 ft. at the north end and into the addition.

Area 13,865 sq. ft.

Volume 316,815 cu. ft.

(These figures include the tunnels beneath the building.)

CONSTRUCTION DETAILS

Foundations

Foundations are of reinforced concrete with spread footings. The exterior surfaces of the concrete tunnels which are in contact with earth are covered with two-ply water-proofing and insulating board.

All interior concrete surfaces within the filter areas and in the tunnels to the stack are painted with Amercoat, as is the floor and wall around the recycle exhaust fans.

Superstructure

All exterior and interior walls, floors and ceilings are of concrete. There are no windows. A 10 ft. by 12 ft. roll-up metal door is provided at the south end and one swinging hollow metal door at the north end. A concrete wall is installed within the blower room opposite the roll-up door for blast resistance. Lighting is incandescent.

Roof

The roof is a reinforced concrete slab with insulation and built-up roofing. Reinforced concrete blast resistant ventilation hoods are provided on the roof.

EQUIPMENT

120 Chemical Warfare Service filters

2 Fiber glass filters.

- 3 Exhausters and motors, 150 hp.
- 2 Exhausters and motors, 15 hp.
- 3 Exhausters and motors, 50 hp.
- 2 Exhausters and motors, 25 hp.

Static pressure indicators

Motor control centers

Unit substation

Transformers

- 1 Crane 7-1/2-ton capacity
- 1 600 kw. Diesel generator unit

Sampling system

- 3 Beckman amplifiers and HM chambers (monitoring equipment)

Storage cabinets

Stainless steel pipe and fittings

Butterfly dampers

Heating coils

Diesel fuel storage tank, 12,000-gallon

Instrumentation

All fan units have low pressure suction switches which energize an electrical interlock system for starting a spare fan and giving an alarm signal in the Building #221-F dispatcher's office. Differential and static pressure indicators are provided for each fan and filter unit.

Three Beckman amplifiers and HM chambers are installed to monitor the level of radiation within the general working area of Building #292-F. This equipment measures the intensity of radiation existing within this area and transmits these measurements to recorders located in the dispatcher's office in Building #221-F.

Radioactive iodine monitoring facilities are also installed in Building #292-F for the continuous monitoring

facilities of the stack gas samples from Building #291. This equipment consists of two small stainless steel tanks, an agitator, two small pumps, a radiation instrument, a scrubber tank, and piping.

Electrical

Power is supplied to Building #292-F through an underground 13.8 kv. cable. This high voltage is reduced to 480 volts by a 750-kv.-a. dry-type transformer load center located within the building. A power subfeeder from Building #292-F also supplies Building #294-F. Dry-type transformers further reduce the voltage to 120/208 volt, 3-phase, for incandescent lighting service. Emergency electrical power is supplied by a 600 kw. diesel generator set which automatically starts up on loss of normal power. Emergency power subfeeders supply Buildings #221-F "A" Line, #281-F and #284-F through underground cables. An emergency power feeder is provided between Building #292-F emergency bus and Building #221-F bus. Reduced voltage starters were provided for 150 hp. exhaust fans and all of the larger fan controls included time delay in starting so that the emergency generator could maintain voltage. Groups of fans for each service were interlocked so that under emergency conditions, only necessary equipment is kept running. Loudspeakers for the area safety alarm system are located throughout the building.

DEVELOPMENT OF DESIGN

The principal factors affecting the design of this facility were: (1) the necessity for blast resistant construction; (2) the radioactive nature of the gases drawn from Building #221-F for discharge through the canyon stack; and (3) the necessity for complete removal of minute radioactive particles from these gases.

The original Blaw-Knox design of this facility involved a concrete blast resistant building, approximately 86 ft. by 186 ft. by 15 ft. high, divided into a filter area and an exhaust area. The filter area was designed to draw air from the central and process aisles of Building #221-F, passing it through filters prior to exhausting it to the canyon stack. This filter area was designed with removable concrete roof slabs to be lifted by a traveling overhead crane. The exhaust area was designed for the blowers exhausting air from the central and process aisles, the recycle vent header exhausters, the "B" Line vent exhausters, and the electrical control center. As all exhaust fans were intended to run continuously, power was required even during emergency periods. A 600 kw. emergency diesel generator unit was installed for this purpose.

In early 1952, the design of this facility was altered to a similar, but smaller blast resistant building and the equipment was revised to include sand filters which were placed in a separate structure, Bldg. #294-F.

The filter installation includes both interior and exterior facilities. Chemical Warfare Service filters are provided inside the building for filtering central exhaust air. Moreover, provisions have been made also to install roughing filters, if needed, within the building. Outside of Building #292-F the recycle system filters are located in a concrete pit. These are designed for remote removal.

Concrete tunnels were designed to channel central and canyon cooling air from Building #221-F to the fan house and filter areas. Stainless steel ducts were provided to convey gases to the fan house and stack from the "B" Line, process vent header, and recycle vent system. A discharge tunnel from the fan house to the canyon stack is also provided.

At this stage of development (April, 1952) responsibility was transferred from Blaw-Knox to Voorhees, Walker, Foley & Smith, who completed the design work.

In 1954, after this Fan House had been completed, two design changes were made which affected its layout.

First, two process vent header exhaust fans, with auxiliaries, were removed and relocated to a new Class I structure designated Building #292-1F. This change became necessary when it was decided that these fans might become contaminated and could affect the other facilities of Building #292-F. Relocation of these fans in a separate building also permitted the discharge to either the canyon stack or the sand filter.

Secondly, iodine monitoring facilities were added at the south end of the Fan House to permit a continuous indication of the radioactive iodine level in the exhaust from Building #291 Stack. The equipment installed withdraws samples from the stack, scrubs the sample with caustic, measures the activity of the waste caustic, and records it in the control room of Building #221-F. Design of this monitoring assembly was based on similar equipment in operation at Hanford. A subsequent review led to the consideration of redesigning the caustic scrubber or of abandoning this method in favor of direct monitoring by scintillation counter. However, alternate methods were rejected for economy reasons inasmuch as this system had proved operable at Hanford.

DRAWINGS

- W-157421 Architectural, Main Floor Plan.
- W-157422 Architectural, Roof Plan and Schedules.
- W-157423 Architectural, Elevations.
- W-157429 Heating and Ventilating, Main Floor Plan.
- W-157430 Heating and Ventilating, Lower Floor Plan.

BUILDING #292-H - FAN HOUSE

Facilities identical to those housed in Building #292-F are contained in this building, except that the Class I structure, itself, is smaller and several pieces of equipment are located outdoors on concrete pads. Emergency equipment and that requiring blast protection is located indoors and the two central air fans, two canyon ventilating fans and the "B" Line exhaust fan are placed outdoors.

Two additional and important changes were made. Blast doors were installed in the intake and exhaust tunnels to isolate from the ventilating system any rupture that might occur in the tunnels. Also, a remote control system was installed to permit operation of the blast doors and the inside and outside fans from the dispatcher's office in Building #221-H.

By this altered design, the quantity of reinforced concrete required for construction was substantially reduced.

DRAWINGS

- W-157680 Underslab Plan
- W-157681 Main Floor Plan
- W-157682 Roof Plan and Schedules
- W-157683 Elevations
- W-157684 Sections
- W-157688 Electrical - Equipment Wiring Diagrams and Sections, Sheet 1.
- W-157689 Electrical - Equipment Wiring Diagrams and Sections, Sheet 2.

BUILDING #292-1F - FAN HOUSE

FUNCTION

This building houses the process vent exhaust fans which were relocated from Building #292-F to remove potentially contaminated equipment from a clean area while providing ability to discharge vent gas into the sand filter tunnel.

PRINCIPAL COMPONENTS

The building, located approximately 81 ft. north of Building #292-F, houses two process vent header exhaust fans together with the necessary fan auxiliaries and duct work.

BUILDING FLOOR SPACE

Fan House - 425.5 sq. ft.

CONSTRUCTION DETAILS

Class - I

Size - This building is a one story rectangular structure approximately 26 ft. long by 21 ft. wide over-all. The main portion of the roof is 11 ft. high from top of the low point of floor to top of roof. There is a concrete landing and stairway along the south side of the building to the main floor. The roof over the stair tower is 5 ft. wide. Beginning 19 ft. west of the east wall the roof runs level at the building roof elevation toward the east approximately 13 ft. and then slopes upward toward the east to an elevation of approximately 9 ft. above the building roof. From that point it extends approximately 7 ft. east and level. Located on the permanent roof slab is a concrete blast tee for the ventilating air intake. This building is so located that Building #292-F intake and exhaust tunnels also serve as its intake and exhaust facilities.

Area 670 sq. ft.

Volume 7225 cu. ft.

Foundations - Existing tunnels

Superstructure - Reinforced concrete walls and roof slab (part removable.) All exterior and interior walls, floors and ceilings are concrete. There are no windows.

Lighting - Incandescent

EQUIPMENT

2 Vent header exhaust fans, each with a 50 hp. motor.

Instrumentation

One of these fans is an operating spare. The installation is provided with an electrical interlock system for starting the standby fan. Each fan also is equipped with a low pressure suction switch which energizes an alarm signal in the Building #221-F dispatcher's office.

DESCRIPTION OF PROCESS

Exhaust from the process vent system in Building #221-F is conducted to Building #292-1F where, depending on the level of radioactivity, the fans discharge it to either the sand filter or to the canyon stack. Pneumatic controls are provided in Building #292-F to direct the discharge in either of the above directions.

DEVELOPMENT OF DESIGN

Building #292-1F was added when a review of design indicated that the process vent header exhaust fans should be relocated in a new structure in order to eliminate a possible source of contamination in the original fan house.

The new fan house, of Class I construction, provides for two individual fan rooms each having access from a common stairwell. A portion of the roof consists of removable slabs which permit access to the building when it becomes necessary to install, maintain, or replace the fans. A blast tee has been provided for the entrance of cooling air, while an opening in the building wall allows this air to be discharged into the central air exhaust tunnel serving Building #221-F.

In addition to the installation of the two process vent exhaust fans and their auxiliaries, it was necessary to install an 18-inch stainless steel discharge duct through the roof of the existing canyon exhaust air tunnel and provide opening in the west wall of Building #292-1F to connect two stainless steel lines to the existing duct.

DRAWINGS

W-144115 Concrete Plan and Details

W-142377 Heating and Ventilating Plan and Sections

BUILDING #292-1H - FAN HOUSE

This fan house contains equipment identical to that in Building #292-1F but, for a more efficient layout, it was housed in a structure 18 feet wide by 34 feet long. Also, the structure itself is closer to Building #292 than is the case in the F Area.

DRAWINGS

W-144356 Concrete

W-144349 Heating and Ventilating

W-157677 Tunnel Plan

BUILDING #293-F - METALLURGICAL BUILDING STACK

FUNCTION

This stack discharges the exhaust air from Building #235-F to the atmosphere.

PRINCIPAL COMPONENTS

Of reinforced concrete, this cylindrical stack is supported on an octagonal foundation. It contains no liner or equipment and is unpainted, having only a reinforced concrete duct as a breeching for the exhaust air from Building #235-F. This duct leaves Building #235-F below grade and slopes upward until it is entirely above grade where it enters the stack. Dual ducts are provided from the face of Building #235-F for about two-thirds of the distance to the stack, at which point they merge into a single duct. The larger of the dual ducts is for general exhaust, while a separate, smaller one was provided for "C" Line exhaust.

BUILDING AND CONSTRUCTION DETAILS

Stack

The stack measures approximately 75 ft. in height by 4 ft. in diameter at the top, increasing in diameter toward the bottom where a carbon steel breeching opening is installed about 3 ft. above grade. Lightning protection is provided by three 1/2 in. copper air terminals which extend above the stack and are bonded together and to ground cables.

Foundation

The octagonal foundation is 14 ft. wide at the base and has an over-all height of approximately 7 ft., with all but the top 8 in. below grade. A 3 ft. square opening, having a depth of 2 ft., is located in the top of the foundation beneath the stack center line.

Intake Duct

The intake duct has an over-all width of approximately 12 ft. at the Building #235-F end and 5 ft. at the stack end. The height of the duct is approximately 3 ft. at the Building #235-F end, with the building foundation being the bottom of the duct. The interiors are lined with sheet metal which was used as a form during construction and left in place. The lining has no function since corrosion is no problem. At the intake end, both are 2 ft. high. The "C" Line opening is 1 ft. wide while the general air duct opening is 8 ft. wide. These ducts slope upward and merge into a single duct approximately 3 ft. wide by 4 ft. high where it enters the stack.

DEVELOPMENT

This facility was provided to exhaust filtered air from the Metallurgical Building, where the possibility of toxic contamination exists. The stack and component facilities were designed to handle gases at the rate of 22,000 c.f.m. In order to provide drainage away from the stack, the breeching was designed to enter the stack at a 1 per cent slope. In addition to the specific considerations of the nature and volume of gases to be exhausted, this facility was designed in accordance with the "Tentative Specifications for the Design and Construction of Reinforced Concrete Chimneys" of the American Concrete Institute.

DRAWINGS

W-148170 Equipment Arrangement, Stack.

W-148234 Structural, Intake Duct, Plans & Details.

BUILDING #294-F - SAND FILTERS

FUNCTION

This filter removes the radioactive particulate matter from the canyon cooling air before it passes through exhaust fans to the stack. Concrete tunnels are employed to conduct Bldg. 221-F exhaust air to the filters.

PRINCIPAL COMPONENTS AND PROCESS

Sand Filters

The sand filter structure is of reinforced concrete below grade. Process air enters through a supply tunnel from Bldg. #221-F is filtered, passes through the process air return tunnel to the Fan House, Building #292-F, and then to the Stack, Building #291-F, where it is discharged to the atmosphere.

Branching off the supply tunnel at right angles are twelve small distribution tunnels which feed the air underneath the filter bed. Along the top of these distribution tunnels are slotted precast concrete covers through which the air passes up into a tile field which diffuses it evenly under the entire filter area.

Above the tile field are seven graded layers of gravel and sand which filter out radioactive particulate matter as the air rises through the bed into the space above. After this filtering the air passes to the return tunnel along the opposite side of the sand filter from the supply tunnel.

By-Pass Tunnel

This tunnel, which is normally closed, connects the supply tunnel with the return tunnel so that process air can be by-passed around the sand filter if desired.

Central Air Tunnel

The central air tunnel adjoins the canyon cooling air supply tunnel, thus a common wall separates the two tunnels for part of their length. The central air tunnel, however, crosses over the canyon cooling air tunnel to the Fan House, Building #292-F, where the air is filtered.

Trench for Stainless Steel Pipes

Exhaust air from #221-F "B" Line, #221-F process vent header, and recycle systems passes through stainless steel vent header lines, two of which are in the canyon cooling air

tunnel, and one in the central air tunnel for part of their length. These lines pass out of the tunnels through the tunnel roofs into a concrete trench which encloses them for their remaining length to the Fan House Building #292-F.

BUILDING FLOOR SPACE

Approx. Sq. Ft.

Sand Filter

23,100

BUILDING DETAILS

Class - I

Size - Rectangular, approximately 100 ft. wide by 240 ft. long by 17 ft. deep.

The twelve distribution tunnels are each approximately 4 ft. by 5 ft. by 88 ft. long, and are sloped toward the supply tunnel.

Area - 24,000 sq. ft.

Volume - 549,800 cu. ft.

CONSTRUCTION DETAILS

Foundations - Reinforced concrete with spread footings.

Superstructure - Reinforced concrete with all exterior surfaces in contact with soil covered with two-ply membrane waterproofing and insulating board.

Interior Walls - Reinforced concrete.

Roof - Reinforced concrete 9 in. thick, supported by the exterior walls and forty-four reinforced concrete columns evenly spaced throughout the filter area. Sixty removable precast concrete covers form the roof and are covered with built-up roofing.

Floor - Reinforced concrete with slotted precast concrete covers over the distribution tunnels.

Filter Bed - A die-formed clay tile field above which are seven graded layers of gravel and sand, the layers varying in thickness from 6 in. to 3 ft., making a total bed thickness of 8 ft. 6 in.

EQUIPMENT

Stainless steel pipe and fittings.

2 - Steam syphon ejectors.

- 2 - Pressure reducing valves.
- 2 - Pressure relief valves.
- 2 - Pressure gauges.

Instrumentation

The pressure drop across a portion of the filter bed may be measured with portable draft gauges. Sleeves with portable monitoring equipment are installed in the filter, and the inlet and outlet ducts are equipped with sampling systems using filter paper for monitoring purposes.

DEVELOPMENT OF DESIGN

The original scope of work for the #200 Areas specified that the air exhausted from the canyons and center section of Building #221 was to be filtered to remove any radioactive particulate matter before being discharged up the stack (Building #291). Early layouts indicated that space would be available within the canyon areas to accommodate these filters. Since, under such an arrangement, the canyon cranes could be used to remotely handle the filters, various types of replaceable filters were considered.

As design and layout of the process equipment progressed, however, it became evident that there would not be sufficient space available to accommodate a filter installation within the Building #221 canyons. Therefore, a layout study was made to locate the filters and exhaust fans in a separate structure, Building #292-F. In order to replace filters in this new building, it would have been necessary to install another remotely operated crane. Remote handling of filters by means of such a crane presented many problems, all of which added materially to the cost of the installation. Another development which further complicated the design was the requirement for filters to withstand possible acid conditions.

Since it was evident that filters must be located elsewhere than in Building #221-F, and since they could not be replaced economically without an elaborate crane installation, consideration was given to a permanent type of filter installation - one which could be used until it was necessary to seal it off, but which would be retained in place after a duplicate adjacent facility had been built and put into operation.

A review of AEC installations established that Hanford had developed the most complete data on permanent type filters, having had experimental and actual operating experience with both sand and fiberglas filters in connection with gas filtration. However, the sand filter installation in operation at

Hanford, although large, was only about one-quarter the size that would be required at SRP, while the Hanford fiberglass installations were considerably smaller than the sand filter.

When it was determined that a separate permanent installation would be required at SRP to filter the canyon air, a consultant, Dr. C. E. Lapple of Ohio State University, was retained by du Pont. Dr. Lapple recommended a filter bed composed of glass or synthetic fibers as offering a sound engineering solution to the problem of removing radioactive particulate matter from the canyon air. It was his opinion that such a filter could be constructed at considerably less cost than a sand filter for the same air handling capacity, and with an equal or better life span.

Du Pont Design investigated the problem of sand filters versus fiberglass filters with Operations (AED) with the result that it was mutually decided to proceed with the design of Building #294-F on the basis of sand filters, for the following reasons.

1. Several large sand filters had been built successfully at Hanford and several years of satisfactory operating experience were available on which to base the design of a similar facility at SRP.
2. Complete, proven details of construction were available for use in designing a larger size sand filter unit as required at SRP.
3. Current information indicated that sand filters possessed greater mechanical stability than fibrous filters, and the larger volume of the sand filters produced an added safety factor.
4. The cost of a fiberglass filter installation of the required size was dependent upon details which had yet to be developed and proven, whereas sand filter costs had been established.
5. A decided difference of professional opinion existed as to the limits and life of sand filters versus fiberglass filters.
6. Space had been reserved for three sand filters, (two for future use) but this space was planned so that a different type of filter could be built in the future if its superiority was proven.

It was concluded by du Pont that the facts developed to date did not justify the installation, on an experimental basis, of a large fiberglass filtration unit of the size required in

in the #200 Areas. Design, however, recommended that research should be continued on the application of fiberglass and other possible materials to the filtration of aerosols from gas streams; also, that consideration and study be directed toward the possible decontamination, removal and replacement of sand media beds in existing filters. Should some suitable method for decontamination be developed, the investment in the chamber construction could be salvaged instead of expending funds for additional complete filter facilities.

Design of Building #294-F, therefore, was based on the Hanford installation which involved the removal of particulate matter from an air stream using sand as a filter medium. Apart from the necessity for effective filtration, other primary design considerations in the development of this facility were minimum pressure drop and maximum operating life.

The Hanford specifications for the SRP requirements were modified by Dr. Lapple and further refined by du Pont. A rectangular sand filter unit, approximately 100 ft. wide by 240 ft. long by 17 ft. deep, was designed with seven layers of filter media, graduating upward from coarse gravel to fine sand.

The basic specifications for the sand and gravel were that these elements be clean, dry, acid resistant, and of certain general sizes. To reduce these specifications to definite values and types of sand and gravel, and to locate suppliers who could furnish materials meeting such exacting specifications, required considerable investigation on the part of du Pont. The filter media was then arranged in stratified layers and carefully packed to allow maximum filtration with minimum pressure drop in the air stream flowing through the filter bed.

Provisions were made for two future sand filter units beside the one installed. When, after a period of years, the unit in operation becomes ineffective as a gas filter due to plugging and resulting excessive pressure drop, a new filter unit can be installed adjacent to the defective unit and the canyon air directed to the new filter bed.

DRAWINGS

- W-157439 Structural, Concrete Tunnel Plan.
- W-157441 Architectural, Floor Plan.
- W-157442 Architectural, Typical Bays.
- W-157443 Architectural, Roof Plan.
- W-157444 Architectural, Elevations.
- W-157445 Architectural, Sections.

BUILDING #294-H - SAND FILTER

The H Area filter is identical to and serves the same purpose as that in Building #294-F in that it removes radioactive particulate matter from ventilation air exhausted from the canyon.

DRAWINGS

W-157441 Floor Plan

W-157444 Elevations

W-157445 Sections

BUILDING #295-F - MANUFACTURING BUILDING STACK

FUNCTION

This stack discharges exhaust air from Building #232-F to the atmosphere.

PRINCIPAL COMPONENTS AND PROCESS

The stack is a tapered reinforced concrete structure erected upon a reinforced concrete foundation. Stainless steel ductwork is employed as breeching between Building #232-F and the stack.

BUILDING AND CONSTRUCTION DETAILS

Foundation

The foundation is octagonal in shape and constructed of reinforced concrete, all but the top 8 in. being below grade. The upper part of the foundation is round and 13 ft. in diameter.

Stack

The stack is 200 ft. high and tapers from an ID of 7 ft. at the bottom to an ID of approximately 4 ft. at the top. The wall thickness varies from 6 in. at the top to 17 in. at the bottom. Lightning protection is provided by four 3/4 in. diameter air terminals on top of the stack. These are bonded together and to a 1/2 in. downleading cable, the top 25 ft. lead covered, which is permanently grounded.

The breeching opening in the stack is approximately 4 ft. wide by 5 ft. high, the bottom being 2 ft. above the foundation.

Breeching

The breeching is constructed of stainless steel and is secured to malleable iron inserts installed in the stack breeching opening.

DEVELOPMENT OF DESIGN

In order to discharge to atmosphere the exhaust air from Building #232-F which might have been in contact with radioactive materials, a vent stack approximately 200 ft. high was specified for erection near the building. No stack liner was required, and the same design specifications applied to this stack as to Building #291-F. Few changes were made in the original design except that an access door was eliminated.

DRAWINGS

- W-156677 Concrete - Foundation Plan & Details.
- W-156678 Architectural - Plan, Elevation & Details.
- W-155980 Heating & Ventilating - Breeching Details.

BUILDING #295-H - MANUFACTURING BUILDING STACK

In design, this stack is similar to that of Building #295-F except that air is exhausted to the atmosphere through an underground, reinforced concrete duct which extends upward through the foundation to the stack. In the "F" Area the exhaust duct is of stainless steel and enters the stack above the foundation.

The Building #295-H duct was not installed since Building #232-H was placed on a standby basis and will not immediately be used as a production facility. In the H Area, six 3-inch stainless steel sleeves were added to facilitate sampling of the exhaust. This design feature was not included in the F Area.

DRAWINGS

- W-159595 Foundation and Breeching
- BPF-207845 Stack Details

BUILDING #805-F - PROCESS LINES

FUNCTION

These pipe lines were designed to convey radioactive liquid wastes to points of disposal.

PRINCIPAL COMPONENTS

Four 3 in. stainless steel lines which carry radioactive liquid waste from Building #221-F to Building #241-F.

Four stainless steel lines which carry radioactive liquid waste from Building #772-F to Building #211-F. Two of these lines are 3 in. and two are 2 in. in diameter.

Two stainless steel lines which carry radioactive liquid waste from Building #723-F to Building #211-F. One of these is 3 in. and the other 2 in. in diameter.

Six stainless steel lines which convey radioactive liquid waste from the building #291-F catch tank and entrance tunnel and the air tunnels which enter and leave Building #294-F to Building #221-F. This liquid waste originates as condensate from the exhaust gases in these facilities and from rain water entering the stack, Building #291-F. (All the above lines are enclosed in separate box-type concrete structures.)

Vitrified pipe which carries mildly radioactive liquid waste from Building #211-F to earth seepage basins outside the #200-F Area.

CONSTRUCTION DETAILS

Lines from #221-F to #241-F

There are four, 3 in., type 304 ELC stainless steel lines. Each is approximately 1500 feet in length with all joints welded and radiographed. For a distance of approximately 150 feet at the Building #241-F diversion box end of these lines, seven extra lines of similar size and material are provided for possible future use.

The encasement consists of reinforced concrete with a removable reinforced concrete cover. Five-ply fabric waterproofing membrane encloses the concrete and 1" cement plaster covers the membrane. The encasement has an average depth of about 16 feet below grade.

The pipe is supported within the concrete enclosure on porcelain sleeves to permit free expansion and contraction.

The greater part of the encasement is supported by undisturbed earth over which a 4 in. reinforced concrete slab has been laid. Near Building #241-F, where the encasement passes through earth previously disturbed for the storage tank excavation, timber piling is used to provide support.

Lines From #772-F to #211-F

There are two 3 in. and two 2 in. Type 304 ELC stainless steel lines of all-welded construction. Each line is approximately 350 feet in length.

The encasement construction is similar to that described above, except that, for a distance of 139 feet on a line with Bldg. #221-F, a somewhat heavier concrete encasement is used so that shielding is provided in case the area should be excavated for expansion of Building #221-F. In that event, this portion of the encasement would become part of the building mat. About 70 per cent of the encasement is approximately 18 feet below grade, while the remainder slopes upward to a point about 6 feet below grade.

Pipe Supports are the same as for lines from Bldg. #221-F to #241-F.

The lines are supported by a reinforced concrete slab on undisturbed earth. No piling is used.

Lines From #723-F to #211-F

One line is 3 in. in diameter, the other 2 in. in diameter and both are of Type 304 ELC stainless steel of all welded construction, each being approximately 180 feet in length.

Concrete Encasement - Same as for lines from Bldg. #221-F to #241-F.

Depth of encasement is about 4 feet.

Pipe Supports - Same as for lines from Bldg. #221-F to #241-F.

Encasement Support - Same as for lines from Bldg. #772-F to #211-F.

Lines From #291-F and #294-F to #221-F

Pipe - Type 304 ELC stainless steel; three are 3 in. pipe and three are 2 in. pipe.

Concrete Encasement - Same as for lines from Bldg. #221-F to #241-F.

Pipe Supports - Same as for lines from Bldg. #221-F to #241-F.

Encasement Support - Same as for lines from Bldg. #772-F to #211-F.

Pipe From Bldg. #211-F to Disposal Area

Consists of 6, 8, and 12-in. vitrified pipe, 12, 18, 24 and 36-in. reinforced concrete pipe, and 24-in. cast iron pipe.

6 Std. C-8-B Manholes, from 5' to 12' deep.

12 Sts. C-2-B Manholes, from 5' to 24' deep.

3 Std. C-1-C Concrete headwalls.

DEVELOPMENT OF DESIGN

The first category includes various sizes of underground concrete-encased stainless steel pipe which convey highly radioactive liquid wastes from Buildings #221, #772, #723, #291, and #294-F to such buildings as #241, #211, or #221-F. In addition, two concrete enclosed stainless steel stubs have been added to the waste lines at the southeast corner of Building #221-F. These lines have been capped and are provided as future connections for "A" Line liquid waste material.

The second category is composed of various sizes of vitrified and reinforced concrete pipe which carries all mildly contaminated effluent to earth seepage basins outside the #200 Area.

Both types of waste lines, based on the design of similar facilities at Hanford, were developed to meet the specific design requirements of the #200-F Area.

The most difficult problem encountered in this development was the design of the stainless steel lines to handle the radioactive liquid wastes. These lines, designed for gravity flow, were laid in underground sloped encasements to provide physical protection, to contain any possible leakage, and to prevent corrosion due to electrolytic or chemical factors. Moreover, these concrete encased lines required the support of suitably spaced porcelain sleeves, so designed to permit free movement of each line during expansion. In addition, vertical test risers to grade were provided from the concrete encasements to permit monitoring for leakage and temperature.

In connection with the over-all design, it was originally intended to Amercoat the interior of the concrete encasement in addition to application of a water-seal to its exterior. After investigation in April 1953, it was decided to eliminate Amercoating of the encasement interior because no specific

advantage could be cited and, therefore, the treatment was deleted for economy reasons.

General Safety Problems

The principal safety problem connected with this facility was the development of a dependable leak-proof design for all piping handling radioactive liquid wastes. This was achieved by adhering to strict welding specifications, including the use of 100 per cent X-rayed pipe, enclosing the lines in underground encasements and retarding corrosion by the use of stainless steel pipe.

DRAWINGS

Map 3302 - Sheets 853, 854 and 884 - Topographic.

Map 3320 - Sheets 854, 884 - Outside Lines Process Sewers.

Specification 3020

W-147960 - Waste Line Enc. Bldg. #221 to Diversion Box.

W-148115 - Waste Line Enc. Bldg. #221 to Diversion Box.

W-148227 - Waste Line Enc. Bldg. #772 to Building #211.

W-148235 - Waste Line Enc. Bldg. #723 to Building #211.

W-149650 - Waste Line Enc. Bldg. #291 to Building #221.

BUILDING #805-H - PROCESS LINES

Building #805-H is similar to Building #805-F but does not include waste lines from Buildings #772 and #723 since no area control laboratory or laundry facilities exist in the H Area.

DRAWINGS

Map 3302 - Sheets 766, 795, 796, 826 - Topographic Map

Map 3309 - Sheets 766, 795, 796, 826 - Outside Lines

Map 3320 - Sheets 766, 796, 826 - Outside Lines

Specification 3020

D-116763 - Sections & Details between Bldgs. #221-H & 241-H.

- W-148859 - Waste Line Encasement, Building #221-H to Diversion Box.
- W-149442 - Waste Line Encasement, Building #221-H to Diversion Box.
- W-158087 - Retention Tank - Concrete Encasement
- W-149827 - Waste Line Encasement, Bldgs. #291-H to 221-H.

VII - SUPPORTING FACILITIES - #200-F & H AREAS

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VII - SUPPORTING FACILITIES - #200-F&H AREAS

PERSONNEL AND SERVICE FACILITIES

BUILDING #701-1F - MAIN GATE HOUSE AND PATROL HEADQUARTERS

FUNCTION

This building houses the patrolmen of the #200-F Area and also serves as a control point for personnel and vehicular traffic to and from the area. This facility, operated on a three-shift basis, is employed to issue and process personnel health meters and also contains such normal and emergency equipment as fire alarm recorders, blackout and public address systems, and radio and telephone communications.

In the event that the main patrol headquarters, Building #702-A, becomes inoperable, this building will become the emergency control center for the entire Savannah River Plant. Under the latter condition a conference room is available for the use of plant management during disaster control, and U. S. Army teletype transmission equipment is provided but is controlled from the #700-A Area Patrol Headquarters Building. However, this transmitter can be controlled from Building #701-1F for hand code transmission. This gate house is also provided with an emergency receiver for code reception and local or area radio transmitter designed to service the transportation, health physics and patrol requirements of the entire project.

That section of the building to be utilized for emergency use is of Class I construction for resistance to bomb blast. Protection against gamma rays is provided for both the conference room and the emergency control room through the installation of shielding walls and roof. The rest of the building, designed for normal use, is of Class III construction.

PRINCIPAL COMPONENTS

The Class III section of the building houses the patrol, traffic control and Health Physics operations. An office for the guard captain, a mustering area, and locker and toilet facilities for a guard force of approximately 100 men are provided for the security patrol group. A two-lane vehicular entrance and a four-lane personnel entrance, the latter with two intervening badge counters designed to handle approximately 750 men per shift, are provided for traffic control. A health meter laboratory, a small office,

and separate toilet facilities are provided for the Health Physics section engaged in processing and issuing health physics instruments. These meters are repaired in Building #735-A and calibrated in Building #736-A, but a work area for testing and a power supply for instrumentation are also provided here.

A telephone exchange, an emergency control center, the conference room and a utilities room are located in the Class I wing of the building. The telephone exchange is a satellite system requiring no operating personnel. Calls may be placed within area and plant limits, but outside calls to and from the reservation are routed through the central exchange in Building #720-A. The basic equipment and controls for radio communications, blackout and public address systems are housed in this wing. A dual set of controls for normal use and the fire alarm recorder are installed in the Class III wing. An electric generator for emergency power supply is located in a small Class I structure adjacent to the Class I wing.

BUILDING FLOOR SPACE

<u>Class I</u>	<u>Approx. Sq. Ft.</u>
Telephone Exchange	465
Emergency Control Center	165
Conference Room	165
Utilities Room	275
 <u>Class III</u>	
Badge Alley	895
Offices	530
Health Physics Laboratory	250
Toilet Room	80
Lunch and Assembly Area	180
Locker and Toilet Room	1440

BUILDING DETAILS

The Class I wing is approximately 25 ft. wide by 75 ft. long by 11 ft. high from the floor to the top of the flat roof slab. The adjoining Class I generator housing is approximately 8 ft. by 15 ft. by 8 ft. to the top of the roof slab. The total area for this section is 2050 sq. ft. and the total volume, 25,400 cubic feet.

The Class III wing is approximately 38 ft. wide by 107 ft. long by 11 ft. high from the floor to the top of the flat roof slab. The total area for this section is 4030 square feet and the total volume is 47,695 cubic feet.

CONSTRUCTION DETAILS

The building has reinforced concrete foundations with spread footings and a concrete floor.

The walls and roof of the Class I wing are of reinforced concrete, with interior partitions of concrete baffle construction. The ceiling is the exposed under side of the roof structure. Doors in this area are of hollow metal and there are no windows. Roofing is built-up.

The Class III section has a structural steel frame with web roof joists and a concrete roof slab on rib lath. Exterior walls of this wing are sheathed with corrugated asbestos board, while interior partitions and the interiors of exterior walls are of flat cement asbestos board on steel studs.

Toilet rooms walls have a concrete wainscot to a height of 4 ft., with flat cement asbestos board above this level. The inside walls in the shower room are of concrete faced with ceramic tile to a height of 7 ft. The ceiling of this section is flat cement asbestos board; doors are hollow metal, windows are steel double hung, and roofing is built-up.

Walls and ceiling in the telephone exchange have an asbestos board finish over wall insulation, and this same treatment is applied to a height of 6 ft. in other parts of the Class I section and on the interior walls of the health meters laboratory. The floor is covered with asphalt tile in the offices, corridors, and laboratory of the Class III section and in the telephone exchange of the Class I section.

Heating in the Class I structure is supplied by forced air through ducts in conjunction with the air conditioning system, and by the same means in the health instruments laboratory. Unit heaters are installed in the badge alley. All other areas in the Class III section are heated by forced air through ducts. The steam source for these heating services is the area power house. The Class I area and the laboratory are air conditioned by self-contained units. Fans on the roof maintain an air exhaust through ducts from the Class I wing, and from the locker room, toilets, and corridor in the Class III area. Fluorescent lighting is installed in the offices, the badge alley, the laboratory and the emergency control center. The remaining areas have incandescent lighting.

EQUIPMENT

U. S. Army teletype transmitter and emergency receiver.

Radio receiving and sending equipment, 30-watt capacity.

Fire alarm recorder, blackout and public address system controls.

Telephone exchange, 300 lines capacity.

Electric power generator, 20 kw. 120 v. diesel-driven.

Two self-contained air conditioning units.

Air supply and exhaust fans, air heating units, duct work.

Conventional office furniture.

Guns and cabinets.

100 Lockers with benches.

Tables and chairs.

2 Badge counters.

Minor equipment for processing health meters.

DEVELOPMENT OF DESIGN

Design criteria required that the structure housing the telephone exchange and the emergency control center should be of Class I construction since these facilities had to be in a permanent structure which would be habitable during a disaster. A Class III structure was suitable, however, for the normal security and patrol functions.

On September 2, 1954, it was decided to effect alterations in the floor plan of this building to provide laundry handling facilities which were not originally contemplated. Changes incurred alterations to the north and west walls of the building, the relocation of two doors and two windows, plus the addition of one door and the removal of one window, and the necessary steel framing. The existing badge room was reduced in size by the introduction of interior partitions to provide two offices, for the supervisor and shift supervisor. The original supervisor's office was converted into the required laundry room.

DRAWINGS

- W-156681 - Floor Plan and Toilet Layout.
- W-156683 - Elevations and Sections.

BUILDING #701-1H - MAIN GATE HOUSE AND PATROL HEADQUARTERS

FUNCTION

This building houses the central headquarters for the area patrolmen, and the normal and emergency control equipment including fire alarm recording, blackout and public address systems, and radio and telephone communications facilities. Facilities are also provided for processing and issuing personnel health meters. This is the primary control point for personnel and vehicular traffic in and out of the area, except during shift changes.

One section of the building, of Class I construction, is to provide protection against gamma rays and to furnish emergency shelter to assure continued operation of vital communication facilities during disaster control. The remainder of the building is for normal use and is of Class III construction.

Building operation is on a three-shift basis.

PRINCIPAL COMPONENTS

The location of this gate house provides security control over a two-lane vehicular entrance to the area. As a part of the structure there are two pedestrian entrance lanes, designed to handle 175 persons per shift, with a badge issuing counter between them.

The area for testing health meters is composed of a Health Physics Laboratory, a small office, and a work bench and power supply for instrumentation. These, and the patrol facilities consisting of patrol offices, a mustering area, locker and toilet rooms for approximately 60 men, and uniform storage space, are in the Class III section of the building.

The emergency control and communications equipment are located in the Class I portion of the building. Here is situated a satellite telephone exchange which automatically handles calls both within the area and over the plant. The basic equipment for radio communications, blackout, public address system and controls are also housed in the Class I structure. A dual set of controls for normal use, together with a fire alarm recorder, are located in the Class III section.

BUILDING FLOOR SPACE

<u>Class I</u>	<u>Approx. Sq. Ft.</u>
Telephone Exchange	350
Emergency Control Center	180
Utilities Room	160
 <u>Class III</u>	
Badge Alley	190
Offices	450
Health Meter Laboratory	95
Toilets	200
Utilities Room	170
Lunch Room and Assembly Area	295
Locker Room	635
Clothes Storage Room	155
Unallocated Space	360

BUILDING DETAILS

The Class I section is approximately 23 ft. wide by 51 ft. long by 11 ft. high from the floor to the top of the flat concrete roof slab. The adjoining Class I generator housing is approximately 8 ft. square by 8 ft. high.

The Class III area is approximately 48 ft. wide by 64 ft. long by 11 ft. high from the floor to the top of the flat roof slab. The building area is approximately 4150 square feet and the volume, 55,000 cubic feet.

CONSTRUCTION DETAILS

The building has reinforced concrete foundations with spread footings and concrete floor. The Class I wing has reinforced concrete walls and roof, and interior partitions of concrete baffle construction. The ceiling is formed by the exposed underside of the roof structure. Doors in this area are hollow metal and there are no exterior windows. Roofing is built-up.

The Class III section has a structural steel frame with web roof joists supporting a concrete roof slab on riblath. Exterior walls of this portion of the building are of corrugated asbestos board. Interior partitions, and the interior of exterior walls, are of flat cement asbestos board on steel studs. Toilet room walls are concrete to a height of 4 ft. with flat cement asbestos board on walls above this level and on the ceiling. Doors are hollow metal and double hung window sash is steel. Roofing is built-up.

Exterior walls and roof in the telephone section are sheathed with asbestos board over wall insulation. This same treatment is carried to a height of 6 ft. in other parts of the Class I section and on the interior walls of the health meter laboratory. The concrete floor is covered with asphalt tile in all offices and corridors, in the health meter laboratory of the Class III section, and in the telephone exchange in the Class I area.

Heating in the Class I wing is supplied by forced air through ducts in conjunction with an air conditioning system. The same means of heating is provided in the health instruments laboratory. Unit heaters are installed in the badge alley. All other areas in the Class III section are heated by forced air through ducts. The steam source for these heating services is the area power house. The Class I section and the health meter laboratory are air conditioned by self contained units. Fans on the roof maintain an air exhaust through ducts from the Class I area, the locker room, toilets, and the Class III area corridor. Fluorescent lighting is installed in the office, badge alley, health meter laboratory and the emergency control center. All remaining areas have incandescent lighting.

EQUIPMENT

Radio receiving and sending equipment, 30-watt capacity.

Fire alarm recorder, blackout and public address system controls.

Telephone exchange, 100-line capacity.

Electric power generator, diesel-driven, 3.5 kw. 120 v.

Air conditioning units, self-contained, two.

Air supply and exhaust fans, air heating units, duct work.

Conventional office furniture.

Guns and cabinets.

Lockers with benches, 61.

Lunch facilities.

Badge counter.

Minor equipment for processing health meters.

DEVELOPMENT OF DESIGN

A separate facility, designated Building #702, to house the area telephone exchange equipment and an emergency control center, was originally included in the preliminary scope of design for the Savannah River Plant. On August 31, 1951, it was decided to delete this building and to incorporate its facilities in a wing to be added to Building #701-1. The combination was effected at the Savannah River Plant as a result of a study of the separate facilities provided for the two operations at Hanford. It was decided that the emergency control centers should be more readily accessible to the radio control operators, who are normally located in the patrol and security buildings, in the event disaster control operation should become necessary.

Design criteria required that the housing of the telephone exchange and the emergency control center be of Class I construction since these facilities had to be habitable during disaster control. Class III construction, however, was suitable for the normal security and patrol functions. The obvious solution was the specification of a Class I wing for the communications operations attached to a Class III structure for the operational security facilities. In addition to meeting these two basic requirements, Class I construction provided a bomb shelter and protection against gamma ray contamination for building personnel.

Some time after acceptance and occupancy of this building by the Operations Department, it was found advisable to make certain revisions and alterations in the locations of some of the building functions to provide facilities for storing the uniforms used by patrol groups. This uniform control consists of checking, storing and issuing the uniforms before and after dry cleaning. Storage space was also provided for an adequate supply of boots and raincoats.

The rearrangement of building floor space involved only a few structural changes. The long, narrow badge alley was divided by a partition. Two windows in the outside wall were removed and the openings closed. A double doorway was installed in the smaller room to provide an exit to Building #701-4H. The original Health Physics Laboratory office was converted into a Health Physics Laboratory. Two laboratory tables were installed and electric and air conditioning services were supplied. The former Health Physics Laboratory was converted to an office for area and patrol supervision. A door was installed from this area to the central corridor and electric and telephone facilities were furnished. The office adjacent to the assembly area was converted into a clothes storage room by the addition of clothes racks, storage cabinets and a clothes hamper.

DRAWINGS

W-156134 - Plans and Sections
W-156136 - Elevations

BUILDING #701-2F - GATE HOUSE

FUNCTION

This facility provides a security check point for personnel and vehicular traffic entering the security zone of Building #221-F. It also furnishes weather protection for the guards on duty at this entrance.

PRINCIPAL COMPONENTS

This single story, one room gate house, is divided by a badge counter running the length of the building.

BUILDING DETAILS

The structure is approximately 13 ft. wide by 17 ft. long and 9 ft. high. The floor area is approximately 220 square feet and the volume is approximately 2000 cu. ft.

CONSTRUCTION DETAILS

Building foundations are of reinforced concrete with wall footings. The frame is wood, and exterior walls are sheathed with corrugated cement asbestos siding. Interior walls and ceiling are faced with flat cement asbestos board. The flat, built-up roof extends 2 ft. on all sides to form a protective overhang. The floor is a 4 in. concrete slab. Unit electric heaters are furnished and lighting is incandescent. Windows are double hung wood sash, and the wood doors at each end of the badge alley have top panels of glass.

DEVELOPMENT OF DESIGN

This building was designed originally as a smaller gate house with two outside personnel passages defined by handrails and served by pass-through windows. Later the layout was redesigned and the larger gate house with the interior badge alley was substituted to facilitate the positive identification of all personnel using the area. This system of individual security checking provides a more direct and effective control over all persons entering these exclusion areas.

EQUIPMENT

- 1 - Transformer, 9 kv.-a.
- 1 - Electric heater, 7.5 kw.
- 1 - Lighting panel
- 1 - Electric water cooler
- 1 - Badge counter

Office furniture

DRAWING

W-160645 - Plans, Elevation and Sections

BUILDING #701-2H - GATE HOUSE

This is a duplicate of Building #701-2F.

DRAWING

W-160646 - Plans, Sections and Elevations.

BUILDING #701-3H - GATE HOUSE

This is a duplicate of Building #701-2H.

DRAWING

W-161926 - Plans, Sections and Elevations.

BUILDING #701-4F - GATE HOUSE

FUNCTION

This facility provides a check point for personnel and vehicular traffic to the security zone of Buildings #232-F and #235-F.

PRINCIPAL COMPONENTS

This is a one story building located between a two-lane vehicle and personnel passage.

BUILDING DETAILS

A single-story Class III structure, the building is approximately 10 ft. wide by 15 ft. long by 9 ft. high from the floor to the top of the roof sheathing. The roof overhangs 2 ft. on the long sides. The total building area is 150 square feet and the volume 1375 cubic feet.

CONSTRUCTION DETAILS

Building foundations are of reinforced concrete with wall footing. The wood frame and the roof, wood on wood joists, are all treated for fire resistance. The exterior walls are sheathed with corrugated cement asbestos board on wood studs. The interior of exterior walls is faced with flat cement asbestos board and the same material forms the ceiling on the bottom of the roof joists. The wood door has a glass panel and pass through windows open on to the personnel passages on either side of the building. The sash is wood, double-hung. Roofing is built-up, and exterior walls and ceiling have batt-type insulation. There is no covering on the concrete slab floor. Heating is provided by an electric unit heater, and lighting is incandescent.

EQUIPMENT

A minimum of conventional office furniture.

1 Electric heater, 7.5 kw.

1 Transformer, 9 kv.-a.

1 Electric water cooler.

DRAWING

W-157899 - Plans, Sections and Elevations.

BUILDING #701-4H - GATE HOUSE

FUNCTION

This auxiliary gate house provides a control point for security checking of personnel and vehicular traffic during shift changes at the entrance to the area. At times other than shift changes security control is maintained at the #701-1H Gate House.

PRINCIPAL COMPONENTS

The installation consists of a sentry-box type gate house located in the center of a two-lane vehicle entrance. There is a single personnel control lane outside the building.

BUILDING DETAILS

A one-story, Class III structure, the dimensions are approximately 8 ft. by 8 ft. by 9 ft. high from the floor to the top of the flat roof. The area is approximately 64 square feet and the volume, 590 cubic feet.

CONSTRUCTION DETAILS

The foundations are of reinforced concrete with wall footings. The wood frame and the wood roof are treated for fire resistance. Exterior walls are corrugated cement asbestos board. The interior walls and the ceiling are finished with flat cement asbestos board. Doors and the double-hung sash are wood. The flat built-up roof has a 2 ft. overhang on three sides and a 6 ft. overhang on the remaining side. Exterior walls and the ceiling are insulated. There is no covering on the concrete floor. Heating is provided by a unit heater, lighting is incandescent.

EQUIPMENT

Wall hung desk.

Electric heater, 4 kw., and contactor, 3 p., 208 v.,

Coil "0".

Electric fan.

CO₂ Extinguisher 20 lb.

DRAWING

W-161182 - Plans, Sections and Elevations.

BUILDING #701-5F - GATE HOUSE

FUNCTION

This building provides a security check point for personnel and vehicular traffic to the security zone for Building #217-F.

PRINCIPAL COMPONENTS

This is a one story guard house located just inside the inner exclusion fence on the west side of a two lane vehicle entrance. In addition to the single guard room there is a small toilet room. An emergency generator near this gate house provides emergency power for electric services.

BUILDING DETAILS

This building is a single story, Class III structure, approximately 14 ft. wide by 15 ft. long by 8 ft. from the floor to the top of the built-up roof. A 3 ft. roof overhang on all sides shields the interior from direct sunlight. The total building area is 228 square feet and the total volume is 2426 cubic feet.

CONSTRUCTION DETAILS

Building foundations are of reinforced concrete with wall footings. The exterior walls are reinforced concrete to a height of 3 ft. Above this the building frame is wood studding sheathed with cement asbestos board. The interior of exterior walls, the ceiling and the partitions around the toilet room are of flat cement asbestos board. The wood door has a glass panel and sash is wood, double-hung. Insulation is installed in the walls and ceiling. The floor is exposed concrete. Heating is provided by an electric heater and lighting is incandescent. The emergency generator, located on a concrete pad, is about 4 ft. wide by 5 ft. long by 4 ft. high, with corrugated sheet metal sides on a steel angle frame. The galvanized corrugated metal roof is hinged and a double swing door provides access to equipment.

EQUIPMENT

Alarm enunciator panel.

Electronic equipment for fence alarm system.

Short wave radio transceiver.

Two telephones.

Cabinet for two riot guns.

Locker for "foul weather" clothing.

Water cooler.

Electric heaters.

Hot water heater.

Fire extinguisher.

Office furniture.

1 Blower heater, 10-kw. 208-v.

1 Blackout pilot relay.

1 Terminal block, 12 circuits.

1 Transformer 3-phase, 480/208-120-v.

1 Intrusion detection system.

1 Emergency generator.

1 Battery.

DEVELOPMENT OF DESIGN

Requisites affecting the design of this gate house were a 360° visibility from the windows on all four sides of the building, concrete building walls to a height of not more than 4 ft. above the floor level to provide added protection for the guards, and a 3 ft. roof overhang to give protection from the sun since window shades are not used. An emergency power source was another important requirement.

DRAWINGS

W-157599 - Plans, Elevations and Details

Map 3305 - Sheet 884.

BUILDING #701-6F - GATE HOUSE

FUNCTION

This gate house, situated adjacent to Building #701-1F, provides facilities for the control of vehicular and personnel traffic at the entrance to the #200-F Area except during shift changes.

PRINCIPAL COMPONENTS

The facility consists of a small, one room gate house.

BUILDING DETAILS

A one story Class III structure, 6 ft. by 10 ft., the building has a total area of 60 square feet and a volume of 600 cubic feet.

CONSTRUCTION DETAILS

The building foundations are reinforced concrete with wall footings. The wood framing members are sheathed with corrugated cement asbestos on the exterior, with interior walls and ceiling covered with flat cement asbestos board. Doors are wood, one being a swinging door and the other a sliding door with closure and holder fixtures. The window sash is wood, double hung. The building has a 20-year bonded roof, with fibre glass bats installed between wall studs and ceiling joists for insulation. The concrete floor has a Class II finish with no covering.

Heating is provided by an electric radiant heating panel. Lighting is incandescent.

EQUIPMENT

Conventional non-operating equipment.

DRAWING

W-161237 - Arch., Conc., Electrical, Heating-Plans, Sections, Elevs., Details.

BUILDING #704-F - AREA ADMINISTRATION AND FIRST AID BUILDING

FUNCTION

This building is the administrative headquarters for the #200-F Area, providing office facilities for operating and maintenance personnel. The area cafeteria and first aid center are also located here.

PRINCIPAL COMPONENTS

Twenty-one offices, a mail room and file space, a conference room which will accommodate fifty people, and toilet facilities for fifty employees are provided in the administrative section of the building.

The medical section consists of a waiting room, two treatment rooms, a doctor's office, a medical laboratory, and toilet and rest room facilities. This section is equipped only for the treatment of minor injuries and first aid cases.

The cafeteria is designed only to serve food which is prepared in and received from the main cafeteria, Building #708-A. However, it is equipped to prepare griddle items and short orders. There is a main eating area accommodating 148 persons and a smaller area with 24 seats for janitors. About 300 employees can be served during each shift. Dish-washing facilities are provided, and there are vending machines for candy, soft drinks, cigarettes and similar articles.

A mechanical utilities room between the cafeteria and the conference room houses the bulk of the air conditioning equipment for these two areas.

BUILDING FLOOR SPACE

<u>Administrative Section</u>	<u>Approx. Sq. Ft.</u>
Offices (21)	3200
Conference Room	510
Mail and Files	450
Office and Toilets and Rest Room	460
<u>Medical Area</u>	940
<u>Cafeteria</u>	3900
Toilets	260
<u>Mechanical Utilities Room Appr.</u>	370

BUILDING DETAILS

A single story, ell-shaped, Class III structure, the long wing of the building is approximately 39 ft. wide by 248 ft. long and houses the administrative and medical sections. The cafeteria wing is 43 ft. wide by 52 ft. long, and the equipment room, extending out from the inside angle of the ell, is 16 ft. wide by 23 ft. long. The top of the roof slab is approximately 12 ft. above the floor in the cafeteria and utility room.

The total area of the building is 12,141 square feet and the volume is 179,622 cubic feet.

CONSTRUCTION DETAILS

Building foundations are of reinforced concrete with spread footings. The structural steel frame is sheathed with corrugated cement asbestos for exterior walls, and the interior partitions and the interior of exterior walls are sheathed with flat cement asbestos board on steel studs. Toilet room walls are of concrete to a height of 4 ft., with cement asbestos board above this level. The suspended ceiling

is finished with cement asbestos board in the office area and with perforated cement asbestos board backed with insulation in the medical section, the conference room and the cafeteria. The roof is of open-web steel joists, with precast concrete roof slabs on rib lath. Roofing is built-up and the roof, exterior walls and the walls of toilets and rest rooms are insulated. Doors are hollow metal and sash is steel, double hung, except in the air-conditioned cafeteria where windows have fixed sash. The concrete floor is covered with asphalt tile in the offices, corridors, medical section and cafeteria and lunch room. Floors in the dishwashing area and behind the serving counter in the cafeteria are of quarry tile.

Heating is supplied from fin-tube radiators in the offices, medical section and conference room, and by forced air through heaters, in conjunction with the air conditioning system, in the cafeteria. The steam source for these services is the area power house. The conference room, medical section and cafeteria are air conditioned. Air exhaust is maintained through ducts and fans from the toilets, service area and dishwashing area, and through roof ventilators from the corridors.

Fluorescent lighting is installed in the offices, conference room, file room, medical section, serving and dishwashing areas in the cafeteria and the service area. The lighting in all other areas, including toilet rooms and corridors, is incandescent.

EQUIPMENT

Offices

Conventional office furniture.

Conference room has facilities for 50 people.

Medical Section

Table and equipment for examinations and for treatment of minor injuries.

Scales.

Diathermy machine, resuscitator, aspirator.

Package air conditioning unit, 8-ton capacity, with duct work.

Cafeteria

Serving counter with tray rail and auxiliary equipment.

Cashiers section.

Display shelves.

Dishwasher.

Refrigerator.

Garbage disposal unit.

Griddle and hood.

Dish trucks.

Food truck.

Toaster.

Ice cube maker.

15 Tables, seats attached, for 10 people each.

3 Tables, seats attached, for 8 people each.

Mech. Utilities Room

1 Package air conditioning unit 5-ton and ductwork
for the conference room.

1 Air conditioning and refrigeration condensing unit.

1 Hot water tank, 300 g.p.h.

Heating and Ventilating

In addition to the equipment in the Utility Room there
is the following variously located:

1 Outdoor cooling tower and pump, 178 g.p.m., 62-ton.

4 Motor-driven roof ventilators, 3200 c.f.m. each.

3 Exhaust fans, 821, 1285 and 4300 c.f.m. capacity.

DEVELOPMENT OF DESIGN

The expendability of this structure in the event of bomb blast and the permanence, fire resistance and minimum missile effect of the materials of construction were basic factors affecting its design. In addition, the design was influenced by the several operations to be performed here. Offices for the administrative group and facilities for first aid requirements were accommodated in a long wing and the cafeteria in a wing at one end of the long section of the building.

DRAWINGS

W-157027 - Floor Plan.
W-157029 - Elevations.

BUILDING #704-H - AREA ADMINISTRATION AND FIRST AID BUILDING

FUNCTION

This building is the area administrative headquarters. Office facilities are provided for operating and maintenance personnel. The area cafeteria and first aid center are also located here.

PRINCIPAL COMPONENTS

Eleven offices, a mail room and file space, and a conference room which will accommodate twenty persons are provided in the administrative section of the building.

The medical section consists of a waiting room, two treatment rooms, a doctor's office, medical laboratory and toilet and rest room facilities.

The cafeteria is designed only to serve food which is prepared in and received from the main cafeteria. However, it is equipped to prepare griddle items and short orders. A main eating space with seventy seats is provided and there is a smaller eating area with a seating capacity of twenty four for janitors. Approximately 150 employees can be served per shift. Dishwashing facilities are installed and there are vending machines for candy, soft drinks and cigarettes.

BUILDING FLOOR SPACE

<u>Administrative</u>	<u>Approx. Sq. Ft.</u>
Offices	1660
Conference Room	290
Mail Room and Files	305
Office, Toilets and Rest Rooms	265

<u>Medical Area</u>	900
<u>Cafeteria</u>	2110
Toilets	130

BUILDING DETAILS

A single story, Class III structure, the building is approximately 38 ft. by 181 ft. out to out of walls, by 12 ft. high from the floor to the top of the flat roof. The building area is approximately 7000 square feet, the volume 83,000 cubic feet.

CONSTRUCTION DETAILS

Building foundations are of reinforced concrete with spread footings. The structural steel frame is sheathed with corrugated cement asbestos for exterior walls, and the interior partitions and interiors of exterior walls are sheathed with flat cement asbestos board. Toilet room walls are concrete to a height of 4 ft. with cement asbestos board above this level. The suspended ceiling is finished with cement asbestos board in the office areas, perforated cement asbestos board backed with insulation in the medical section, conference room and the cafeteria. The roof is a concrete slab on rib-lath. Doors are hollow metal and sash is double hung steel. Roofing is built-up and the roof, exterior walls and the walls of toilets and rest rooms are insulated. The concrete floor is covered with asphalt tile in the offices, corridors, medical section and the cafeteria and lunch room. Quarry tile is laid in the dishwashing area and behind the counter of the serving area. Heating is supplied from fin-tube radiators in offices, the medical section and the conference room, by forced air through heaters in conjunction with the air conditioning system in the cafeteria. The steam source for these services is the area power house. The conference room, medical section and cafeteria are air conditioned. Air exhaust is maintained through ducts and fans from toilets, the serving and dishwashing areas of the cafeteria and the corridor. Lighting is fluorescent in the offices, conference room, file and mail room, medical area, and the serving and dishwashing sections of the cafeteria. In all other areas it is incandescent.

EQUIPMENT

Offices

Conventional office furniture.

Medical Section

Table and equipment for examination and for treatment of minor injuries.

Scales

Diathermy Machine

Resuscitator

Aspirator

Cafeteria

Serving counter with tray rail and auxiliary equipment

Cashier's section

Display shelves

Garbage disposal unit

Griddle and hood

Dishwasher

Refrigerator

Toaster

Ice cube maker

Tables

Dish trucks

Food truck

Two package air conditioning units and ductwork, 1200 and 2200 c.f.m. capacity for conference room and medical section respectively.

Air conditioning and refrigeration condensing unit, 24-ton capacity, and ductwork for cafeteria.

Outdoor cooling tower and pump, 36-ton capacity, 115 g.p.m. with condenser and water pump.

Hot water tank, 220-gallon capacity.

Three motor driven roof ventilators, 2000 c.f.m. each.

Four exhaust fans, 340, 420, 1750 and 2740 c.f.m. capacity, and ductwork.

Two cabinet heaters, 31,500 B.t.u. capacity each.

DEVELOPMENT OF DESIGN

The expandability of this structure in the event of bomb blast and the permanence, fire resistance and minimum missile effect of materials of construction were basic factors affecting its design. In addition, the design was influenced by the several operations to be performed here. Offices for the administrative group and facilities for first aid requirements were accommodated in one area and the cafeteria was placed at the other end of the building.

DRAWINGS

W-157050 - Floor Plan

W-157052 - Elevations

BUILDING #707-1F - "A" LINE CHANGE HOUSE

FUNCTION

This facility was included in the scope of work for Project 8980 to serve as a regulated change house, to supply clothing for work in Radiation Danger Zones, and to implement the prevention of spreading contamination by or to personnel.

PRINCIPAL COMPONENTS

Clean Locker Room

Regulated Locker Room

Monitoring Room

Soiled Laundry Room

Clean Laundry St'ge & Dispensing Room

Men's Wash Room

Women's Rest Room

Lunch Room

Three Offices

Health Physics Office

BUILDING DETAILS

This single story Class IV structure is approximately 36 ft. wide by 108 ft. long by 16 ft. high and contains 3820 sq. ft. of floor space and 33,750 cu. ft.

CONSTRUCTION DETAILS

Previously a prefabricated Butler building used by Construction, the sheet metal covered steel frame is erected on a concrete slab supported on continuous outside-wall footings. The interior partitions are of gypsum wall board on wood studs, with the ceilings formed of gypsum board on wood joists.

Heating is supplied by both steam radiation and unit heaters, with the lunch room and all offices being air conditioned. Air exhaust ventilation is supplied by roof ventilators, and the building is provided with fluorescent lighting.

EQUIPMENT

Alpha scintillation counters (2)

Beta gamma hand and foot counters (2)

Lockers in change rooms

Office, rest room, and lunch room furniture

DRAWINGS

W-162758 - Floor Plan & Details

W-162762 - Foundation Plan & Details, Concrete &
Electrical Grounding

W-162763 - Elevations

BUILDING #707-2F - "A" LINE REGULATED SHOP

FUNCTION

This facility was included in the scope of work for Project 8980 to serve as a regulated shop for maintenance work on slightly contaminated equipment from both "A" Line and Building #211-F.

PRINCIPAL COMPONENTS

Maintenance Shop

Electric Shop

Instrument Shop

BUILDING DETAILS

The single story Class III structure is approximately 27 ft. wide by 53 ft. long and contains 1420 sq. ft. of floor space and 18,500 cu. ft.

CONSTRUCTION DETAILS

The steel frame structure sheathed with corrugated asbestos is erected on a concrete slab with continuous wall footings. The flat roof is a concrete slab finished with built-up roofing.

Heating is furnished by blast type steam unit heaters. Air exhaust is provided through roof ventilators with powered fans, and the building is equipped with fluorescent lighting.

EQUIPMENT

Normal non-operating shop equipment.

DRAWING

W-162740 - Arch., Steel and Concrete.

BUILDING #711-F - STEEL AND PIPE STORAGE

FUNCTION

This facility provides a sheltered storage space for pipe, large valves, steel bars, small shapes, and sheet metal. It is located near the area maintenance shop, Building #717-F.

PRINCIPAL COMPONENTS

The plan comprises a roofed-over area, open on two sides, for the storage of steel stock and pipe, and two areas enclosed on three sides - one for sheet metal and one for large valves.

BUILDING FLOOR SPACE

Approx. Sq. Ft.

Steel stock and pipe storage	440
Sheet metal storage	50
Valve storage	140

BUILDING DETAILS

Of single story, Class III construction, approximately 20 ft. by 34 ft., the building is 11 ft. high from the floor to the top of the flat roof which extends to form a 4 ft. overhang on two sides and one end. The total area is 680 square feet and the total volume is 8280 cubic feet.

CONSTRUCTION DETAILS

With foundation walls of reinforced concrete, the structure is of wood frame treated for fire resistance. Exterior walls and interior partitions are of corrugated cement asbestos board on wood studs left exposed on the interior of exterior walls and on one side of interior partitions. The ceiling is formed by the exposed underside of the roof sheathing. Roofing is built-up and the floor is a concrete slab. Lighting is incandescent. There are no doors or windows.

EQUIPMENT

Storage racks for steel stock, pipe, etc., and sheet metal.

DEVELOPMENT OF DESIGN

The development of the design for this structure was governed only by its classification as expendable and by its function as a storage facility.

DRAWING

W-155286 - Plan, Elevations and Sections.

BUILDING #717-F - AREA SHOPS AND MOCK-UP BUILDING

FUNCTION

Shop facilities for routine maintenance and inspection work for both the #200-F&H Areas, and fit-up and assembly facilities for certain operating equipment in Buildings #221-F&H, #241-F&H, and #105-CKLP&R, are provided in this building. During the construction period the entire shop was utilized by Construction for the mock-up of operating equipment in the buildings listed above.

The building also has a combination tool room and stores. Gasoline and tire service for area vehicles is provided from a service island located near the shop section.

PRINCIPAL COMPONENTS

The building is composed of two bays running the length of the structure. The high bay contains canyon pre-assembly facilities, a forge, and a welding and pipe shop. In the low bay are four offices, toilets and change room facilities, machine and electric shops, a mechanical equipment room, a combination conference and lunch room and a separate small lunch room for janitors. Also located here are a stock room, and a tool room and stores area which functions as the receiving and distribution center for material from the Central Stores Building.

The mock-up facilities in the high bay are patterned exactly after the layout in the canyons of the #221 Buildings including the slope of the floor, pipe nozzle locations and the equipment positioning guides. This made it possible, while the #221 Buildings were under construction, and in a clean location convenient to tools and material, to fit and assemble all canyon equipment and pipe jumper assemblies and to take measurements with the assurance that all equipment could be installed or replaced in the #221 Buildings by remote operations. After start-up, all new installations and replacements of process equipment will be "mocked up" in this building.

The mechanical equipment room houses heating and ventilating equipment to provide 100 per cent filtered air. Air conditioning equipment, set on concrete foundations but unhoused, is located outside of the building and adjacent to the mechanical equipment room. There is also a roofed-over gas storage shed for oxygen and acetylene cylinders outside of the building proper but attached to it at the welding and pipe shops. Air locks are provided at the three most commonly used building entrances.

BUILDING FLOOR SPACE

<u>Administrative</u>	<u>Approx. Sq. Ft.</u>
Offices (4)	636
Women's Toilet and Rest Room	111
<u>Conference and Lunch Rooms</u>	815
<u>Locker, Toilet and Shower Rooms</u>	1739
<u>Mechanical Equipment Room</u>	895

Shops

Shop Offices (4)	338
Stock Room	1,170
Shop Area (Including mock-up area)	20,882

Air Locks and Corridors

565

Outside Areas

Roofed-over Gas Cylinder Storage Shed	332
Air Conditioning Equipment Area	310

BUILDING DETAILS

This building is of Class III construction. The high bay, required to permit handling of canyon vessels and equipment into and out of the mock-up frame, is approximately 283 ft. long by 64 ft. wide and the low bay is approximately 242 ft. long by 39 ft. wide. The high bay has a double pitched roof 65 ft. high to the eave and 70 ft. to the ridge. The low bay has a lean-to type roof with an average height of 21 ft. An air lock, with a lean-to roof is located on the opposite side of the high bay and is approximately 14 ft. square by 13 ft. average height. The total building area is 27,640 square feet and the total volume is 1,465,000 cubic feet.

CONSTRUCTION DETAILS

Building foundations are of reinforced concrete with spread footings. The structural steel frame with trussed roof is sheathed with corrugated cement asbestos board. Interior partitions are of flat cement asbestos board. Walls on the shop side have a masonite wainscot and those in the blacksmith shop have masonite wainscoting on both sides. Toilet room walls are of concrete to a height of 4 ft. with wallboard above. Suspended ceilings are installed in the blacksmith shop, the administrative offices, the locker rooms and lunch rooms. Doors are hollow metal, except for the railroad and truck entrances which have rolling steel doors. There are no windows. The roof, exterior walls and walls of the toilet and rest rooms are insulated. The concrete floor is exposed except in the lunchrooms where greaseproof, asphalt tile is installed.

Heating is supplied by unit heaters in the four shop offices, and by forced air through steam heaters and ductwork in the remainder of the building. The steam source for these services is the area power house. The lunch rooms and conference room are air conditioned. The entire building was air conditioned during the time it was used for mock-up

purposes by the construction force, the conditioned air being conveyed through the heating ducts. The compressors for this system were located on a concrete slab outside of this building and were removed when construction was completed.

Air exhaust is maintained in the blacksmith shop by means of a flue over the forge and by a wall exhaust fan for the rest of this shop. The pipe and welding shop has a fume exhaust system with collector hoods. Gravity roof ventilators are located over shop areas, and powered roof ventilators are installed over mechanical equipment and the locker and lunch rooms.

Lighting in the offices and conference room is fluorescent. In the remainder of the building it is incandescent.

EQUIPMENT

Offices

Conventional office furniture.

Conference and Lunch Rooms

Arm chairs, refrigerator, sink, hot plate, and lunch box rack.

Locker Rooms

Conventional equipment

Mechanical Equipment Room

Air conditioning unit for conference and lunch rooms.
Conventional air heating and ventilating equipment.

Shops

Standard equipment for machine, millwright, pipe, welding, electrical and forge shops. Such items as lathes, presses, grinders, shaper, milling machine, forge, work benches, pipe benders, jib cranes and hoists and welding machines. A monorail is included also, as well as a plant air compressor.

The automotive service area is equipped with air compressor, gasoline dispensing pump, gasoline storage tank, and auxiliary equipment for oil, air and water dispensing.

Specialized shop equipment includes the steel mock-up frame with nozzles attached to machined beams, dimensionally duplicating certain areas in Buildings #105-CKI.P&R, #221 and #241-F&H and the steel framework dimensionally duplicating the Building #221-F&H rack jumper piping. Other specialized equipment includes the 15-ton and 5-ton cranes, pipe and electrical connectors, impact wrenches, lifting yokes, pipe and vessel transporting racks and covers, and the vessel bottom grinding rig.

The 5-ton crane was provided for construction use only. Also, of the thirteen sections of mock-up frame provided during the construction period, only five were retained for maintenance purposes when construction was completed.

Instrumentation

The instrumentation for this building consists primarily of that required in the thirteen mock-up positions for checking process vessels prior to installation in "hot" process areas. The instrumentation includes pressure gauges, manometers, temperature recorders, steam pressure regulators and other instruments required for testing the following:

1. Level and specific gravity dip tubes, for leaks;
2. Resistance thermometers and wells, for leaks and electrical continuity;
3. Steam actuated pumping jets;
4. Microphones in jumpers where required; and
5. Centrifuges, for wobble.

Electrical

Power is supplied from outdoor substation on the north side of the building by means of two underground 480-volt feeders. This voltage is reduced 120/208 volts, 3-phase for lighting service. Lighting in high bay area is a combination of incandescent and mercury vapor type. Office lighting is fluorescent. Electrical control facilities for mock-up area closely followed those for Building #221-F.

DEVELOPMENT OF DESIGN

Class I construction was considered for this facility in the early stages of design, but Class III was eventually specified for reasons of economy.

Two requirements of particular significance affected the design of the building. Primarily, the mock-up facilities were required to exactly duplicate the comparable equipment in the canyon areas of the #221 Buildings. After start up of the areas all maintenance work involving vessel and jumper replacement must be done with the same precision. The other requirement was to provide a ventilating system which would keep the area free from dust and dirt. To achieve this, adequate filtered forced air ventilation is provided since the pre-assembled vessels must be cleaned and sealed from atmospheric contamination prior to their transfer from this building for installation in the operating buildings.

Similar facilities at Hanford provided a basis for comparison and a source of extensive information which was utilized in the design of the SRP building. The corresponding facility at Hanford is of basically the same design as the building at the Savannah River Plant to the extent that each is composed of two bays housing facilities for mock-up operations and for routine maintenance and inspection work. The major difference between these two facilities consists mainly in the materials of construction. Wood framing was used in the low bay of the Hanford Building and windows were installed in the Building. The Savannah River Plant building has structural steel framing; and with the forced air ventilating system, windows were deleted.

DRAWINGS

- W-145445 - Mock-up Frame - Plan and Details.
- W-145508 - Typical Cross Section Looking West.
- W-145568 - Arrangement of Equipment - Plan.
- W-145728 - Floor Plan and Details.
- W-145757 - North and East Elevation.
- W-145783 - South and West Elevation.
- W-145790 - Typical Section and Details.
- W-145910 - Sections, Doors Schedule and Details.

BUILDING #721-H - PROCESS EQUIPMENT STORAGE BUILDING

FUNCTION

This building was used for the storage of equipment purchased but not immediately installed in Building #232-H.

PRINCIPAL COMPONENTS

The structure is divided into two sections; a controlled humidity room for equipment requiring storage under dust-free specific humidity conditions of 35 per cent or less, and a room housing all dehumidification equipment except a quench tank which is installed in a pit outside the building.

BUILDING FLOOR SPACE

	<u>Approx. Sq. Ft.</u>
Controlled Humidity Storage Room	2360
Dehumidification Equipment Room	370

BUILDING DETAILS

A single story, rectangular building of Class III construction, the dimensions are approximately 36 ft. by 84 ft. Eave height is approximately 13 ft. and the ridge of the roof is approximately 19 ft. above the floor level. The building area is approximately 3460 square feet and the volume, 55,000 cubic feet.

CONSTRUCTION DETAILS

Building foundations are reinforced concrete with wall footings. The frame is prefabricated steel set on concrete piers which are approximately 33 in. above the floor slab. Exterior walls are of corrugated steel on steel girts to the top of the piers and flat sheet metal above, mounted on the steel framework. Roofing is corrugated steel. Interior partitions are gypsum wall board. In the storage room this sheathing is backed with aluminum foil and attached to wood studs. The interior of exterior walls is treated in the same manner in the storage room. The ceiling is finished with gypsum wall board with aluminum foil backing on wood rafters clipped to steel purlins in the storage room only. Doors are industrial steel and flush wood, window sash is steel. In the storage room the existing sash is sealed and walled over. Dehumidification facilities are provided only in the storage room with air exhaust maintained by roof vents in the dehumidification equipment room. Lighting is incandescent.

EQUIPMENT

- 1 - Chrysler "Airtemp" unit, 15-ton (Building #232-H excess).
- 1 - Quench tank, 18-in. o.d. by 5-ft. (Located outside).

DEVELOPMENT OF DESIGN

This building was originally a temporary construction facility and was transferred to the permanent account since it was readily adaptable to the required storage. Its conversion consisted principally of provisions for sealing the controlled humidity storage room against vapor and dust infiltration and maintaining the relative humidity in this area at 35 per cent or less.

DRAWINGS

None, except sketches attached to FDM 84-H.

BUILDING #723-F - LAUNDRY

FUNCTION

Facilities are provided in this building for laundering, decontaminating and mending protective clothing worn by process and service personnel during operations where contamination is possible. Articles treated here include shoes, boots, rubbers, hoods, jackets and trousers, coveralls, laboratory coats, shirts, aprons, laundry bags and other similar items.

This building is not used for normal laundry purposes. Items such as hospital and cafeteria garments are sent to commercial firms under service agreements by Operations.

Single-shift operation for the special decontaminating service was originally contemplated. However, if increased capacity is required in the future additional shifts may be added. There were approximately fifty male and female employees in the initial one-shift operation.

PRINCIPAL COMPONENTS

Laundry is delivered in bags by truck from the several buildings on the plant where it has been used. At the receiving room the bags and their contents are probed to make sure that no highly contaminated items, which may have been missed by the change house monitoring operations, are fed into the washers.

The pieces are then transferred to the wash room where they are sorted into five categories depending on the material composition of the piece and the building and/or the area where it has been used. Washing, extracting, tumbling and drying are done in the washroom where one washer is reserved for each of the five categories of sorted items to avoid any cross contamination. Decontamination is accomplished by the use of acid solutions in the laundry processes.

After washing and drying, the articles are moved to a monitoring room to be checked for contamination before proceeding to the mending operation or folding for storage. Material and equipment are provided for repairing worn or torn clothing and other pieces. Clean articles are folded and stored on racks prior to distribution to points of usage.

Monitoring instruments are tested and minor repairs made to this equipment in a separate room. Major repairs and calibration are done in Building #735-A and #736-A.

There is a storage room for new clothing and other items and a supply room where small amounts of acids are kept on hand. The various decontamination solutions are made up in this supply room and fed to the washers by the operators.

The electrical equipment and some heating and ventilating equipment are housed in a mechanical equipment room. Hot water tanks are placed outside of the building on a concrete pad.

Office space is provided for supervisory personnel, and there are locker and toilet facilities for male and female employees.

A special system of floor drains in the wash room conducts spilled acid solutions and contaminated wastes from the washers into waste collection tanks located in an open concrete pit outside of the building. Curbs and trenches are built into the floor in such a pattern that spilled waste from the individual washers will find its way by gravity to a designated drain line and into the tank provided for either contaminated or uncontaminated waste. Drains from areas other than the wash room and the receiving room empty into the general sewer system. The drain line, hold-up tank and washer in which nitric acid solution is used are of stainless steel.

BUILDING FLOOR SPACE

Approx. Sq. Ft.

Receiving Room	1400
Wash Room	3200
Monitoring Area	2000
Mending Area	225
Storage Area	1050

Office	160
Instrument Room	165
Stores Room	160
Locker and Rest Rooms	1500
Supply Room	160
Mechanical Equipment Room	890

BUILDING DETAILS

The laundry is a single story building of Class III construction approximately 82 ft. wide by 142 ft. long by 14 ft. from the floor to the top of the roof slab.

The total building area is 11,570 sq. ft. and the volume is 202,000 cubic feet. The exterior concrete pit housing the contaminated and uncontaminated waste tanks is approximately 28 ft. by 36 ft. by 16 ft. deep, having an area of 1029 square feet and a volume of 16,780 cubic feet. The concrete pad for the hot water tanks is approximately 19 ft. by 20 ft., with an area of 380 sq. ft.

CONSTRUCTION DETAILS

The building foundations are of reinforced concrete with spread footings. The frame is structural steel with web roof joists and the roof is a flat concrete slab on rib lath. Exterior walls are of corrugated asbestos board and interior partitions are of flat cement asbestos board on steel studs. In the toilet room the walls are of concrete to a height of 4 ft. with flat cement asbestos board above this level. The interior treatment of exterior walls consists of a Masonite wainscot to a height of approximately 5 ft. with flat cement asbestos board above this level to the ceiling. All ceilings are finished with flat cement asbestos board except in the mechanical equipment room where the roof structure is exposed. In the receiving section of the washing area and in the monitoring, mending and storage areas, the ceilings are fastened to the roof joists, while they are suspended in the remainder of the building.

Doors are of hollow metal and sash is steel, both fixed and projected. Roofing is built-up and the roof and exterior walls are insulated. The concrete floor is finished with acid-proof brick in the supply room and covered with asphalt tile in the receiving area and the women's rest rooms. Air exhaust is maintained from all areas by exhaust fans and ductwork and by the motor-driven roof ventilators.

Lighting in the monitoring, mending and storage areas and in the instrument room is fluorescent. In all other areas it is incandescent.

EQUIPMENT

Receiving Room

A "scaler" and Geiger tube for detecting beta and gamma radiation.

Wash Room

- 5 Stainless steel washers, 42" x 96", manual unloading.
- 5 Extractors, 40" manual unloading.
- 4 Tumblers, 42" x 90".
- 4 Tumblers, 36" x 20".
- 2 Soap makers, 100-gallon capacity each.
- 2 10" Stainless steel drain lines, each approximately 100' long, in a concrete trench discharging waste to storage tanks.
- 2 Stainless steel laundry tubs on casters.

Laundry trucks and canvas baskets.

Ductwork, dust separator and exhaust fan for removal of lint, etc., from the tumblers.

Monitoring

Laundry trucks, hampers, etc.

- 4 "Scalers", Geiger tubes and work tables for detecting beta - gamma radiation.
- 10 "Poppies" and work tables for detecting alpha radiation.

Mending

Two sewing machines are installed with space available for additional machines if necessary.

Facilities are also provided for the storage of incoming and outgoing clothing.

Storage Area

Tables for folding clothing.

Hampers and trucks.

Office

Conventional office furniture.

Instrument Room

3 Work benches.

1 Storage cabinet for test instrument storage.

Minor instruments for testing health meters.

Store Room

Steel bins for storage of new garments.

Locker Rooms

50 Lockers with benches.

Usual showers, Bradley wash fountains, etc.

1 Instrument for detecting beta and gamma contamination of hands and feet.

1 Instrument for detecting alpha ray contamination of the hands.

Supply Room

Steel rack for drums of acid.

Mechanical Equipment Room

3 Transformers; (1) 75 kv.-a., (1) 30 kv.-a., (1) 5 kv.-a.

Power panels, switches, meters, etc.

Air compressor, 2.7 c.f.m.

Heating equipment (included in "Heating and Ventilating").

Waste Storage

2 Stainless steel lined tanks on concrete foundations, 10,000-gallon capacity each.

2 Submerged stainless steel pumps, one for each tank and each driven with a 10 hp. vertical motor. One pump has a capacity of 170 g.p.m. against an 84 ft. head and the other 85 g.p.m. against a 112 ft. head. High and low level alarms, and pump motor controls are

installed in Buildings #723, and #211. A 2 in. and a 3 in. diameter stainless steel line conveys the waste to Building #211. A steel platform approximately 10 ft. wide by 26 ft. long is provided over the tanks for access to the pumps.

Hot Water Supply

- 2 Hot water tanks, 1500-gallon and (1) 750-gallon with circulating pumps for washers and domestic supply, respectively, are mounted on concrete foundations outdoors. A concrete pad approximately 19 ft. by 20 ft. is under the tank.

Heating and Ventilating

- 1 Industrial heater, 1,325,000 B.t.u./hr. with filters, 22,500 c.f.m. fan and ductwork.
- 1 Industrial heater, 392,000 B.t.u./hr. with filters, 6575 c.f.m. fan and ductwork.
- 1 Industrial heater, 415,000 B.t.u./hr. with filters, 6890 c.f.m. fan and ductwork.
- 13 Motor-driven roof ventilators, approximately 1700 c.f.m. capacity.

DEVELOPMENT OF DESIGN

The specialized decontamination of laundry presented several requirements which greatly influenced the design of this facility.

The possible contamination of clothing being laundered, the resultant contamination level of waste water from the washers, and acidity resulting from the solutions used in the decontamination processes, necessitated a special drainage and tank storage system. To reduce the volume of liquid wastes requiring evaporation, laundry effluent was divided into two streams, one "hot", requiring evaporation, and another "cold", to be discarded after neutralization. These streams are carried by separate lines to 10,000-gallon capacity hold-up tanks or sumps installed outside the building next to the wash room. Since most of the decontamination processes use nitric, citric, or acetic acids, the waste lines and hold-up tanks were designed to be resistant to weak solutions of these acids. A low level switch with a stainless steel rod and float was provided in each tank to stop the pump motors automatically when pumping out. This instrument was designed in such a way that either high or low level conditions would cause an alarm to sound and an indicating light to go on.

The chief safety hazard in the building is the contaminated dust and lint from clothes handled either prior to washing or possibly during and after drying. For this reason, it was determined that air in the wash room should be changed every two minutes, and air inlets and exhaust hoods were arranged to protect the areas around equipment during charging, operating, and emptying periods.

In the receiving and finishing room, and in the repair room, the air pollution problem was similar but less acute than that in the wash room. Therefore an air change once every five minutes was considered adequate for these areas. However, all of the air from the dryers is passed through lint collecting apparatus before discharge to the atmosphere. Elsewhere in the building, ventilation is based on the likelihood of air contamination from the surrounding areas plus the considerations of comfort.

A vacuum system is provided for air sampling purposes, with air samples being taken in the vicinity of each washer and dryer, at two points in the receiving room, and at two points in the finishing and repair room. An evaluation of fixed versus portable sampling equipment resulted in the choice of portable sampling facilities to meet these needs.

Heating is provided by a forced air ventilating system, with exhausts in toilets and the locker rooms. Additional summer ventilation is furnished by roof ventilators, and by windows for the offices and mending room.

DRAWINGS

- W-156065 - Ground Floor and Roof Plan.
- W-156059 - Elevations and Sections.
- W-156058 - Equipment Arrangement.
- W-156066 - Equipment Arrangement.

BUILDING #728-F - GENERAL STORAGE BUILDING

A prefabricated Butler building, formerly for use during construction of the plant, was transferred to Project 8980 for use in the storage of spare jumpers and jumper components. The structure, approximately 36 ft. wide by 109 ft. long, was adapted to storage by the installation of electrical service for lighting.

BUILDING #772-F - CONTROL LABORATORY

FUNCTION

Facilities are provided in this laboratory for the plant assistance group and for all #200 Area control processes except those in Building #232-F. Production samples from the #200 Area processes are analyzed and tested here to maintain consistent quality and to record the accountable materials used in production.

PRINCIPAL COMPONENTS

The Control Laboratory is a one-story structure with a basement service floor below grade. The main floor at grade level is arranged in four sections to accommodate the laboratories and auxiliary modules for the Building #235-F process control, Purex process control, uranium oxide process control, and plant assistance operations, respectively. There are separate change-rooms and toilet rooms for each of these four groups.

This facility is located adjacent to Building #221-F and connected to it by a covered walkway.

The laboratories, separated only by a utility corridor, are aligned back to back in two rows down the center of the main floor. On each side, opposite these laboratories and extending along the outside walls, are auxiliary modules designed for use as offices, counting rooms, storage rooms, dark rooms, glass shops and other functions complementing the laboratory operations. These modules are separated from the laboratories by personnel corridors which, with the central utility corridor, provide double exits for each laboratory. In a number of instances two or more modules of each category, laboratory and auxiliary, have been combined to provide sufficient room for either laboratory or related administrative functions which require more space than one basic unit.

Thus the width of the building, through a process control section, is divided into an auxiliary module arrangement along an outside wall, a personnel corridor, a laboratory area, the utility corridor, a second laboratory area, a second personnel corridor, and, finally, auxiliary modules along the other outside wall. This plan provided for supply services from the basement floor under each personnel corridor to the adjacent laboratory and auxiliary modules.

Process Control

Process control for Building #235-F operations is accommodated in an area at the north end of the building designed to provide fourteen laboratories and fourteen

auxiliary modules. Each of these fourteen units makes up ten laboratories and thirteen offices and supplemental facilities, respectively, for the spectrographic and chemical analyses of samples from Building #235-F. The latter consist of a dark room, a spectrographic film storage room, a spectrographic film reading room, a glass shop, a chemicals preparation laboratory, two equipment storage rooms and a sample receiving room.

Purex Process Control

Next to this process control section is an area comprised of sixteen laboratories and sixteen auxiliary modules devoted to Purex process control. Twelve laboratories, made up from sixteen basic units, are designed to carry out the chemical analyses of plutonium samples received from the #200 Area production buildings. The sixteen basic auxiliary units provide ten offices, a room for general counting purposes, a counting instrument repair room, a chemicals preparation laboratory, and a Health Physics section consisting of an office, a counting room and a laboratory.

Uranium Oxide Control

The uranium oxide control section is housed in an area consisting of twelve laboratory and twelve auxiliary units. The first twelve units make up ten laboratories designed for spectrographic and chemical analyses of uranium samples. The twelve auxiliary units make-up eleven rooms utilized as offices, an equipment storage room, a spectrographic film reading room, a spectrographic dark room, an electrode preparations room and a counting room.

Between the uranium oxide control and the Purex process control sections is an area housing the change rooms, personnel decontamination rooms, lockers, showers and toilets for the male and female laboratory employees and janitors employed on each of the operating shifts.

The uranium oxide control operations are considered as low level activity areas, while the Purex and Building #235-F process control operations are high level activity areas. The change room facilities between these two areas are divided into four sets, one for each of the four groups of employees engaged in the four laboratory operations on each shift. In turn each change room is divided into three sections consisting of a shoe locker area, a shower and wash-up area and a clothing locker area. These individual facilities are arranged to permit employees from both low level and high level activity areas to change clothes and leave the change rooms with a minimum of cross contact and interference with each other. Shoe lockers are situated in a portion of the change areas removed from the clothes lockers. Showers are located

between the shoe and clothes lockers so that personnel coming from a potentially contaminated area may place shoes in a locker provided for them, drop used garments into a clothes chute, shower and proceed directly to the clean clothes lockers. A clean clothes storage and issuing room is adjacent to the change room.

There are two core areas in the building, each equipped with an elevator. One is located in the cross corridor between the Building #235-F and the Purex process control areas and the other is in the cross corridor between the uranium oxide control section and the change rooms. In addition to the elevators, there are janitors closets, clean clothes storage and miscellaneous storage rooms and toilets located in these core areas.

Plant Assistance

The plant assistance group is housed in a unit of three laboratories and three auxiliary modules at the west end of the cross corridor between the uranium oxide control section and the change rooms.

Service Floor - Regulated Area

The below-grade service floor, reached from the outside by a ramp, is divided into regulated and non-regulated areas. The regulated portion is a shielded installation located under the high level operations of the Building #235-F and Purex process control sections and designed to house the out-flow services which may contain plutonium contamination. High and low level liquid waste drain lines, hot off-gas lines and laboratory hood exhaust, and vacuum lines are directed toward the utility corridor and into the regulated area for eventual disposition. All service headers are carried to the service floor to avoid the necessity of a loft over the laboratories. A fan and tank room, housing shielded waste tanks and exhaust blowers as well as fans and pumps, is located below grade on the east side of the building. All potentially contaminated waste from laboratory operations flows into the fan and tank room for disposition as required. Air balance in the building is such that air circulates from the auxiliary modules to the corridors and then to the laboratories. Exhaust air from the high level activity section of the building is filtered in the shielded area. Exhaust air from the laboratories passes through filters into an underfloor plenum exhaust of concrete construction, proceeds to fan and tank room and from there to an exhaust stack 75 ft. high.

An area below grade, adjacent to the east side of the main structure and on the north side of the fan and tank room, houses the tanks receiving the liquid waste of varying levels of activity. The area is designed to provide both the necessary holding-tank capacity and the shielding required to protect personnel from radiation hazards. The high level and low level waste systems are similar, each consisting of a stainless steel hold-up tank and equipment for discharging the contents to Building #211-F for disposal.

Service Floor - Non-Regulated Area

The non-regulated area on the service floor houses air intake fans, a maintenance room, an equipment assembly room, storage spaces for partially contaminated material and for uncontaminated equipment, and all services except those out-flow services which may be contaminated. Services in the non-regulated area include sanitary water, process water, compressed air, burner gas, inert gas, oxygen, methane, steam, distilled water, sanitary waste drainage, and electrical services. Gases, such as hydrogen and argon, are supplied from individual cylinders manifolded in the non-regulated area. Other facilities in this section of the building are a room for decontaminating equipment which cannot be readily cleaned in the laboratories, a room for routine general maintenance work, an assembly room for laboratory equipment, and a room for storing partially contaminated equipment.

Below grade on the west side of the building, and at the north end of the ramp to the service floor, another room holds the emergency diesel generators required for an orderly shutdown of the control laboratory without the undue spread of radioactive materials during or after an emergency.

BUILDING FLOOR SPACE

Building #235-F Process Control

Approx. Sq. Ft.

Laboratories (11)	4178
Offices (4)	684
Dark Room	171
Film Storage	171
Film Reading	171
Glass Shop	171
Equipment Storage (2)	342
Sample Receiving	171
Personnel Corridor and Stairs	2350
Utility Corridor	815

Purex Process Control

Laboratories (13)	4726
Offices (4)	684
Counting Room	684
Instrument Repair Room	171
Health Physics Office	342
Health Physics Counting Room	171
Health Physics Laboratory	342
Personnel Corridor	3100
Utility Corridor	1188

Uranium Oxide Control

Laboratories (10)	3288
Offices (6)	1026
Equipment Storage	171
Film Reading Room	171
Film Dark Room	171
Electrode Preparation Room	171
Counting Room	342
Personnel Corridor and Stairs	2510
Utility Corridor	902

Change Rooms and Personnel Decontamination

Technical Male Change Room	2030
Technical Male Decontamination Room	80
Technical Female Change Room	1879
Technical Female Decontamination Room	73
Male Janitor Change Room	554
Male Janitor Decontamination Room	79
Female Janitor Change Room	767
Female Janitor Decontamination Room	113
Personnel Corridors	1678

Cores

Core No. 1	928
Core No. 2	1038

Service Floor Regulated Area

Shielded Area	6077
Fan Room	1950

Service Floor Non-regulated Area

Decontamination Room	34,283
General Maintenance	575
Equipment Assembly	1242
Contaminated Storage	487
Equipment, Services, etc.	31,304

Waste Tank Cells

High Level Waste Cells	400
Low Level Waste Cells	536

<u>Emergency Generator Room</u>	485
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<u>Enclosed Passageway</u>	1461
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BUILDING DETAILS

The Class I building proper is a one-story and basement structure of rectangular shape approximately 113 ft. wide by 368 ft. long. The height from the finished basement service floor to the top of the main floor slab is approximately 14 ft. and from the finished main floor to the top of the roof slab approximately 14 ft. The one-story fan room projection is approximately 38 ft. wide by 53 ft. long by 22 ft. high from the finished floor to the top of the roof slab. The one-story tank cell area is a rectangular extension 32 ft. wide by 38 ft. long by 29 ft. high from the finished floor to the top of the roof slab. The one-story generator room is a rectangular projection about 20 ft. wide by 31 ft. long by 14 ft. high from the finished floor to the top of its roof slab, and the ramp approach to the service floor is 21 ft. wide by 171 ft. long.

Total floor area of the Class I structure is 87,600 square feet and the total volume is 1,305,740 cubic feet.

The Class III enclosed passageway between the Control Laboratory and Building #211-F is approximately 9 ft. wide by 167 ft. long and has an average height of 9 ft. from the finished floor to the top of the single pitch roof. Its area is 1850 square feet and volume, 18,500 cubic feet.

CONSTRUCTION DETAILS

The building footings, foundations, exterior walls and roof are of reinforced concrete. Main floor laboratories and offices have demountable steel partitions while the cores, change rooms, and ends of the building have interior partitions of flat cement asbestos board on wood studs. Interior partitions on the service floor are of demountable steel in the decontamination room and elevator vestibules, reinforced concrete in the regulated area, and diamond mesh No. 8 wire screen for restricting maintenance areas. Toilet room walls are concrete to a height of 4 ft. with flat cement asbestos board on steel studs above this level. Shower room walls are concrete to a height of 7 ft. with flat cement asbestos board on steel studs above this level.

Ceilings are suspended except in cores, change rooms and on the service floor. They are finished with flat cement asbestos board on wood framing except in the counting rooms which have perforated flat cement asbestos board with sound absorbent backing for acoustical treatment. Doors are hollow metal except for one steel rolling door at the service entrance. There are no windows. Roofing is built-up and the roof and exterior walls above grade are insulated. The concrete floors are covered with vinyl tile in the laboratory and office areas and with asphalt tile in the toilets.

The Class III enclosed passageway has reinforced concrete foundations, a structural steel frame and roof and exterior walls of corrugated cement asbestos. Doors are hollow metal and sash is projected steel. The concrete floor is finished with Amercoat paint.

Heating is supplied by forced air through heaters in conjunction with the air conditioning system for all areas on the main floor and for all areas on the service floor except the fan room and the diesel generator room. These latter areas have unit heaters. Finned radiators are installed at exit door to overcome heat losses at these points.

Air conditioning is supplied by a conventional zoned system with no recirculation. Booster coils are located in modular branches for close control of room air, maintained at 75 deg. F., plus or minus 2 degrees, and 45 per cent relative humidity, plus or minus 5 per cent, in several laboratory and auxiliary modules used as counting rooms and for spectrometer analysis. A total of 825 tons of refrigeration is provided by means of a closed chilled water system with the refrigeration compressor located in Bldg. #221-F. Requirements include 183 tons for the Building #235-F process control area, 200 tons for the Purex process control area, 170 tons for the uranium oxide control section, 55 tons for the change rooms, 5 tons for toilet areas, and 30 tons for the service floor areas including the decontamination room and piping, pump and miscellaneous losses.

All air supplied to the laboratory and auxiliary modules is exhausted from hoods or by-pass ducts in the laboratories. A central exhaust system with fans, located at the stack, is provided to serve all laboratories. CWS filters are installed at each module to remove radioactivity. Toilets and change rooms are exhausted without filtration by means of roof fans. Basement air is exhausted from the regulated areas to the stack. The fan and tank room is exhausted to the stack. The diesel generator room is exhausted through roof fans.

Fluorescent lighting fixtures are installed in all laboratories and offices except the counting rooms. In all other areas lighting is incandescent.

EQUIPMENT

Laboratories

- 7 Junior caves
- 1 Metal vault
- 8 Sample storage racks
- 1 Gas rack
- 354 Standard laboratory furniture units
- 34 Standard laboratory hoods with desk
- 77 Radio bench hoods with desk
- 4 Decontamination hood arrangements
- 12 Slurping hood dollies
- 19 Scales
- 42 Poppy units, a.c.
- 2 Emission spectograph units complete
- 1 Mass spectrometer unit complete
- 2 Standard dark room equipment sets
- 3 Film comparator densitometers
- Miscellaneous laboratory equipment and supplies

Offices

Standard office furniture

Maintenance Areas

- 22 Work benches
- 1 Welding table
- 1 Portable pipe machine
- 1 Drill press, 1/2"
- 1 Band saw, 16"

Change Room Areas

268 Clothing lockers

268 Shoe lockers

6 Laundry chutes

Mechanical Equipment

2 Diesel generator units, 100-kw.

1 Water still, 25 g.p.h.

2 Vacuum pumps, 235 c.f.m. displacement

1 Duplex sump pump, 90 g.p.m., 3 hp.

4 Duplex sump pumps, 40 g.p.m., 2 hp.

2 Chilled water pumps, 1100 g.p.m., 50 hp.

1 Pneumatic control system

4 Cen. fans, laboratory exhaust, 24,000 c.f.m.,
40 hp.

1 Cen. fan, basement regulated area exhaust,
10,000 - 20,000 c.f.m., 15 hp., 2-speed.

1 Cen. fan, change room exhaust, 2300 c.f.m.,
1/3 hp.

2 Cen. fans, change room exhaust, 3200 c.f.m.,
1/2 hp.

1 Cen. fan for basement supply, 10,000 c.f.m., 5 hp.

1 Cen. fan, corridor air supply, 2200, c.f.m., 3 hp.

1 Cen. fan, corridor air supply, 3600 c.f.m., 3 hp.

1 Cen. fan, change room supply, 8700 c.f.m., 7-1/2 hp.

1 Cen. fan, corridor air supply, 4100 c.f.m., 3 hp.

1 Cen. fan, corridor air supply, 2000 c.f.m., 1-1/2 hp.

1 Cen. fan, corridor air supply, 4300 c.f.m., 3 hp.

2 Cen. fans, (16) auxiliary module air supply, 4800
c.f.m., 5 hp.

- 2 Cen. fans, aux. module (12) air supply, 3600 c.f.m., 5 hp.
- 2 Cen. fans, lab. module (12) air supply, 5100 c.f.m., 5 hp.
- 2 Cen. fans, lab. module (14) air supply 6000 c.f.m., 7-1/2 hp.
- 2 Cen. fans, aux. module (14) air supply 4200 c.f.m., 5 hp.
- 2 Cen. fans, lab. module (16) air supply, 6800 c.f.m., 7-1/2 hp.
- 1 Cen. fan, corridor air supply, 2500 c.f.m., 3 hp.
- 3 Cen. fans, basement air supply, 5000 c.f.m., 2 hp.
- 1 Cen. fan, diesel generator room exhaust, 3000 - 4000 c.f.m., 3/4 hp.
- 2 Air conditioner units, basement area, 2500 c.f.m.
- 2 Utility fans, toilet areas exhaust, 1000 c.f.m., 2 hp.
- 1 Coaxial flow fan, basement decon. room supply, 1700 c.f.m.
- 1 Unit ventilator, fan and tank room supply, 7500 c.f.m.
- 1 Unit heater, diesel generator room.
- 1 Air-cooled air compressor, 45 c.f.m. displacement.
- 3 Pressure blowers, Health Physics air sampling system exhaust, 540 c.f.m., 7-1/2 hp.
- 4 Pressure blowers, high level and low level waste system exhaust, 100 c.f.m., 3/4 hp.
- 2 Pressure blowers, off-gas system exhaust, 1100 c.f.m., 20 hp.
- 2 Carbon ring air compressors, 140 c.f.m. displacement.

Instrumentation

Instrumentation in Building #772-F has been divided into equipment which is used for recording, warning, signalling and controlling. In addition to these, there is a system which serves the transfer interlock and another for communication.

Recording Instruments

425 All of the tanks are provided with instruments which record tank pressure, liquid level, liquid specific gravity, and liquid temperature. One common activity recorder logs the activity present in all tanks. Other recorders measure the exhaust air plenum pressure, Health Physics air pressure, building service vacuum, and the operation of the three vacuum pumps.

Alarm Instruments

All alarms energize individual lights and a common horn on the Fan and Tank Room Panel, Space 108, Space 137, or Building #211-F Panel. Alarms are installed to indicate tank transfer liquid level, tank high liquid level, instrument air failure, exhaust air plenum high pressure, off-gas exhaust high pressure, Health Physics exhaust pressure, high level and low level tanks high activity, and stack seal drain low liquid level.

Control Instruments

Each tank agitator has start and stop push buttons with red "stopped" light.

Each jet on tanks and pumps has its steam and air valve pneumatically controlled by air switches or pressure switches and a red signal light. The waste valves are controlled pneumatically with signalling lights.

The solenoid valves on the sumps and stack drains have momentary push buttons for opening them.

The following motors have red "stopped" light and stop and start push buttons; high level exhaust fans, off-gas exhaust fans, exhaust air fans, purge air fan, fan and tank room air supply fan and exhaust fan, and vacuum pumps.

Waste Transfer Interlock

The air supply to the transfer jet steam valves is controlled from Building #211-F. Solenoid valves in this air line are operated by electrical switches in Building #221-F and each tank control is equipped with an illuminated nameplate which indicates a request and subsequent approval to transfer.

Miscellaneous Equipment

In addition to the equipment indicated above, a large amount of laboratory instruments and apparatus ranging from mass spectrometers to test tubes is installed in this building. In all these instances, standard commercially available equipment was purchased.

DEVELOPMENT OF DESIGN

Since the loss of the Control Laboratory would seriously impair production at the Savannah River Plant, it was necessary to design a permanent building to house these operations and assure the uninterrupted flow of process activity. These considerations, together with the nature of the work to be done in the building and the facilities and equipment installed in it, made the provision of a Class I structure imperative.

The fundamental requirements for a laboratory in which possible, but undetermined, methods developments would be performed were the basis for a flexible design which could be adapted to necessary services and functions as those factors became evident and were incorporated in operations. The essential provisions of laboratories, auxiliary modules and change-room facilities were the basis for the initial design. Separation of the regulated areas handling plutonium analysis from the low level areas was accomplished by the physical location of the change room, lockers and shower facilities. To effect flexibility in laboratory arrangement and to provide easily decontaminated surfaces on laboratory partitions, these units are divided by removable metal partitions. Hung ceilings also are installed to decrease contamination from dust on ductwork, light fixtures, and process piping.

The presence of radioactive waste and its required safe handling were also important factors considered in the design of the Control Laboratory. Two disposal systems were installed for this operation, one for low level and the other for high level activity wastes, and including waste piping, holding tanks and steam ejectors. Gaseous exhaust from laboratory hoods passes through CWS filters and is exhausted to the atmosphere through the stack. Down draft hoods permit the disposition of both liquid and gaseous waste through the same shielded area and eliminate the necessity of a loft over the laboratories. Other gaseous waste from the laboratory is exhausted through CWS filters into the stack. Since the facility must function under any conditions, certain exhaust equipment is connected for emergency use with diesel generators and automatic switching arrangements provided to insure uninterrupted electrical power and to permit the occupancy of the building at any time.

From the start of design in July, 1951, through its successive stages of development until January, 1952, additional features were incorporated. Additional provisions included the physical arrangement of the service headers in the basement; a shielded section on the service floor under the high level activity facilities to accommodate drain lines, vacuum lines and hot off-gas lines from the laboratory areas; provision for the filtration of exhaust air from the high level section, and an air balance system directing the air flow from the auxiliary modules through the laboratories and on through CWS filters in the basement to the exhaust stack. Developments in design from the end of January through May, 1952, included the provision of vinyl tile floor covering for the main floor except in the change rooms and toilets; the establishment of an emergency power load with the determination that a minimum generation of 200 kw. would be required; changes necessary in the conception of the fan room requiring this area to be considered a regulated one; moving the load centers and electrical switchgear for fan room equipment from the fan room to a non-regulated area; and the alteration of the high level drain system to eliminate continuous static pressure in the headers by revising the design of high level cup sinks. Other revisions and additions which were incorporated in March and April, 1952, were the deletion of the central hydrogen distribution service and its replacement by localized cylinder supplies to reduce possible explosion hazards emanating from leaks in the hydrogen distribution system; the addition of a clear water (uncontaminated) drain system partially duplicating the low level drain to decrease the amount of water in the low level drain requiring special handling; alterations in locations of certain traps and piping, after a review of the laboratory model, to alleviate space congestion; and modifications to fume hoods improving the original design after the sample hood fabricated by the Wilmington Shops was tested.

In May, 1952, the lighting in the counting rooms was changed from fluorescent to incandescent. During May and June, 1952, changes also were effected in the occupancy and arrangement of furniture and equipment in the laboratories to afford a better flow of samples; a change from air cooled to water cooled equipment was made in the diesel engine room when it was determined that air cooling procedures were impractical; the diesel engine room on the service floor was enlarged by extending the outside wall to provide additional space needed to prevent crowding; and an emergency water supply was added requiring an independent header from the #200 Area water supply system to provide for water cooled equipment which would function during an emergency.

DRAWINGS

- W-156276 - Service Floor Plan - Part 1
- W-156277 - Service Floor Plan - Part 2
- W-156278 - Main Floor Plan - Part 1
- W-156279 - Main Floor Plan - Part 2
- W-156605 - Plans - Part 3
- W-156281 - Elevations and Sections
- W-155166 - Elevations
- W-155285 - Metal Partition Plan
- W-156289 - Laboratory Arrangement - Sheet #1
- W-156290 - Laboratory Arrangement - Sheet #2
- W-156291 - Laboratory Arrangement - Sheet #3
- W-156292 - Laboratory Arrangement - Sheet #4
- W-156293 - Laboratory Arrangement - Sheet #5
- W-156294 - Laboratory Arrangement - Sheet #6
- W-156696 - Miscellaneous Occupancy

ELECTRICAL FACILITIES

No electric power generation facilities are installed in the #200 Areas. Electric power requirements are supplied from the plant transmission system.

The following distribution lines and electrical installations are discussed in detail in Volume VI of this history.

- Bldg. #251-FH - Primary Substation
- Bldg. #252-FH - Distribution Substation
- Bldg. #501-FH - Fence and Road Lighting
- Bldg. #503-FH - Distribution Lines
- Bldg. #505-FH - Fire Alarm Systems
- Bldg. #506-FH - Telephone Cable and Instruments
- Bldg. #507-FH - Safety Alarm Systems

STEAM FACILITIES

The #200-F Area power house contains three 60,000 lbs./hr., 325 p.s.i.g., saturated, boiler units fired by the spreader stokers. The #200-H Area power house originally contained two units of the same type since the process steam requirements in the #200-H Area were proportionately less than in the #200-F Area. The anticipation of increased steam loads in the H Area led, in 1955, to the installation of a third 60,000 lbs./hr. boiler bringing total power house capacity up to that of Bldg. 284-F. All steam generated in these areas is for process and heating purposes only.

Each power house is provided with a railroad track siding, coal hoppers, conveyor, 400-ton capacity coal silo, and coal storage yard. Coal is fed to the stoker feeders of each boiler unit from a 3000-lb. capacity hopper.

Furnace ash from each power house is discharged from hoppers by water jets to a Jetpulsion pump, which in turn discharges through an ash sluicing line to the area ash disposal basin.

The following steam facilities are discussed in detail in Volume VI of this history.

Bldg. #284-FH - Power House
Bldg. #288-FH - Ash Disposal Basin
Bldg. #801-FH - Pipe Supports
Bldg. #802-FH - Steam Lines
Bldg. #809-FH - Ash Sluicing Lines

WATER FACILITIES

Water is supplied to each of the #200 Areas from five deep wells, each of 1000 g.p.m. capacity. To provide process cooling water requirements, a 15,000 g.p.m. capacity cooling tower is installed in the #200-F Area. A 10,000 g.p.m. capacity cooling tower was originally installed in the #200-H Area. In 1955 the capacity in the H Area was increased to a total of 15,000 g.p.m. by the addition of two 2500 g.p.m. cells. Ash sluicing water for the area power houses is also supplied from the cooling tower basins.

Water treatment facilities consist of two chemical feed buildings in each area.

Each area contains a cooling water return system for controlling the return or disposal of process cooling water exposed to the possibility of radioactive contamination in the major process buildings. Each system consists of a delaying basin, pump basin for returning uncontaminated water to the cooling tower, a retention basin for the hold-up of contaminated water, and a monitoring station. Also a segregated cooling water system is incorporated into each cooling water return system for the monitoring and disposal of cooling water used in various process vessels where a greater possibility of contamination exists. This facility consists of a monitoring station and a delaying basin. No pumping facilities are included as the water in this system is used once-through only.

The following water facilities are discussed in detail in Volume VI of this history.

Bldg. #280-1FH - Chemical Feed Building
 Bldg. #280-2FH - Chemical Feed Building
 Bldg. #281-1FH - Delaying Basin
 Bldg. #281-2FH - Pumping Basin
 Bldg. #281-3FH - Retention Basin
 Bldg. #281-4FH - Sampling House
 Bldg. #281-5FH - Delaying Basin
 Bldg. #281-6FH - Monitoring House
 Bldg. #282-FH - Reservoir and Pump House
 Bldg. #285-FH - Cooling Tower
 Bldg. #901-FH - Water Lines
 Bldg. #902-FH - Fire Lines
 Bldg. #905-FH - Wells and Pumps

GENERAL FACILITIES

A discussion of the general facilities and services of a general character throughout the entire plant, such as roads, walks, parking areas, telephone and alarm systems and other services, is contained in Volume IV of this design history. There the over-all problems and specific solutions are recorded and a more comprehensive account of their general characteristics and scope is presented.

The following general services are discussed in detail in the separate volume.

Bldg. #601-FH - Standard Gauge Track
 Bldg. #603-FH - Roads (Inc. Bridges and Culverts)
 Bldg. #604-FH - Walks
 Bldg. #605-FH - Fences
 Bldg. #607-H - Septic Tanks
 Bldg. #607-1F - Sewage Treatment Plant
 Bldg. #607-3F - Sewage Lift Station
 Bldg. #607-4F - Septic Tank
 Bldg. #607-5F - Comminutor
 Bldg. #613-FH - Parking Areas
 Bldg. #614-FH - General Monitoring Buildings
 Bldg. #619-FH - Diesel Oil Storage
 Bldg. #697-FH - Site Work and General Grading
 Bldg. #698-FH - Landscaping
 Bldg. #699-FH - Extra Machinery (For Accounting only on items Marked EM)
 Bldg. #699-1A-FH - Extra Machinery - Technical Division
 Bldg. #699-2A-FH - Extra Machinery - Works Technical
 Bldg. #709-F - Fire House
 Bldg. #732-FH - Furniture and Fixtures
 Bldg. #903-FH - Sanitary Sewers
 Bldg. #907-FH - Storm Sewers
 Bldg. #910-FH - Oil Lines