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Section 3 of 5

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provides eight duplicates of the positioning frames used for the eight types of columns used in the 202-S Building.

3.07 Fan House and Process Stack, Building 291-S

This building provides the equipment for handling the ventilation exhaust from the 202-S Building and for diluting the Dissolver off-gas before release to the atmosphere.

3.08 "Hot" Waste Lines, 240-S

Buried stainless steel lines are provided for routing "hot" waste solutions from the 202-S Building to the Waste Cribs, 216-S, or to the Underground Storage Tank Farm, 241-S.

3.09 Underground Storage Tank Farm, 241-S

Storage facilities for the highly radioactive wastes from the 202-S Building are provided in the Underground Storage Tank Farm.

3.10 Retention Basin, 207-S

The Retention Basin provides emergency hold-up storage for the innocuous process wastes, cooling water, and steam condensate from the 202-S Building. These wastes are monitored for the presence of radioactivity as they enter the Retention Basin.

3.11 Waste Cribs, 216-S

The Waste Cribs provide facilities for the disposal of condensates from the 202-S Building.

3.12 Laboratory Building, 222-S

The Laboratory Building houses laboratories for process analytical control, plant assistance to the Redox and TBP Plants, and research facilities for work of a plant assistance nature.

3.13 Waste Disposal Building, 219-S

This building provides facilities for the disposal of radioactive wastes from the 222-S Building.

3.14 Dry Waste Vault, 232-S

The Dry Waste Vault provides disposal storage space for dry radioactive wastes from 222-S Building which are too contaminated to send to the burial ground.

3.15 200 West Area Facilities

The 200 West Area facilities which serve the Redox Plant are listed below:

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284-W -- 2400-Volt Emergency Generator
2607-W -- Sanitary Waste Disposal System
2702-S -- "S" Area Badge House
2501-W -- Fence and Road Lighting
2503-W -- Electrical Distribution System
2505-W -- Fire Alarm System
2506-W -- Telephone System
2601-W -- Railroad System
2603-W -- Roads and Walks
2605-W -- Fences and Guard Towers
2801-W -- Overhead Pipe Support System
2802-W -- Steam Distribution System
2803-W -- Compressed-Air Distribution System
2901-W -- Water Distribution System
2903-W -- Sanitary Sewer System
2904-W -- Process Sewer System
2508-W -- Recovered-Metal Transfer Line

B. REDOX PROCESSING BUILDING, 202-S

1. General Building Layout

The Redox Processing Building, 202-S, is a reinforced concrete building consisting of two main structural components, the canyon area and the silo area. The core of the canyon area is a process section which operates at very high levels of radioactivity; this section is separated from canyon service areas by massive concrete shielding and is operated and maintained remotely. The silo area is located at the west end of the canyon. The most important section of the silo area is that "hot" process portion which is specifically designed for housing the long extraction columns in a manner such that the column solutions will cascade from one column to the next in a particular cycle. (See Chapter V.) The "hot" portions of the silo area are also operated and maintained remotely and are separated from silo service areas by concrete shielding.

The Processing Building is 467 ft. 6 in. long and 161 ft. wide; the canyon area is 82 ft. 9 in. high (60 ft. above grade), and the silo area height is 131 ft. 10 in. (117 ft. above grade). An exterior view of the building is shown in Figure XI-4.

The building divides naturally, from the process point of view, into canyon and silo areas. The canyon, lying on an east-west axis, contains all of the equipment for preparation of radioactive column feeds; for solvent distillation, waste concentration and neutralization; and for treatment of process gaseous wastes.

Operating, Pipe, and Sample Galleries are located on the north and south sides of the Canyon. A Storage Gallery is under the South Sample Gallery. Adjacent to the Column Shaft in the Silo are five aqueous make-up levels, and above the Column Shaft are the Crane Level, Operating and Sample Gallery Level, and Feed Tank Level. Service areas of the building are located on the north, west, and south sides of the building. Service

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area facilities include offices, lunchroom, locker rooms, compressor room, battery room, electrical panel rooms, shops, chemical storage space, and blower rooms.

Building plan views, at five different levels, are shown on Figures XI-5, XI-6, and XI-7. Longitudinal sections through the building are presented by Figure XI-8. Several voids in the building structure are shown by this figure. Such voids came into being because their location is such that the space is not usable, while at the same time there was no point in filling them with concrete. One of the voids is located above the waste tunnel, another below it, a third beneath the Cross-Canyon Sample Passage, and a fourth near the base of the Column Shaft adjacent to Elevator Shaft No. 2.

The location of all major equipment pieces in the Canyon, Silo, Operating Galleries, and Aqueous Make-Up Levels is shown on Figure XI-9.

2. Canyon

2.1 General description

The Canyon is arranged with two parallel rows of equipment cells running east and west, separated by a pipe tunnel. Heavy concrete shielding walls, 5 ft. thick on the north and 5 ft. 6 in. thick on the south, separate the cells from the Pipe and Sample Galleries. Light concrete shielding walls, 1 ft. 6 in. thick, separate the Pipe Tunnel from the cells. The cells are separated by concrete shielding walls, 4 ft. 6 in. or 5 ft. 6 in. thick. At the east end of the cell rows a Cross-Canyon Passage at Pipe Gallery Level and a Sample Passage at Sample Gallery Level connect the north and south galleries. The Railroad Tunnel, which is used for bringing in casks of irradiated uranium and removing equipment from the Canyon, is adjacent to the Cross-Canyon Passage. A Remote Shop and a Decontamination Room are located at the east end of the Canyon on the cell floor level. The SWP Lobby and H. I. Storage Room are above the Decontamination Room at Pipe Gallery Level. The Crane Maintenance Platform is located above the SWP Lobby and H. I. Storage Room at Crane Cab Gallery Level.

Plan views of the Canyon at various levels are shown by Figures XI-5, XI-6, and XI-7. Canyon cross-sections are shown on Figure XI-10.

There are nine cells in the Canyon designated by letter as follows:

Cell A -- Dissolver Cell,
Cell B -- Dissolver Cell,
Cell C -- Dissolver Cell,
Cell D -- Waste Treatment Cell,
Cell E -- North Extraction Cell,
Cell F -- South Extraction Cell,
Cell G -- Organic Recovery Cell,
Cell H -- Metal Solution Preparation Cell, and
Cell J -- Filter Cell.

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Removable concrete cover blocks, 4 ft. thick, stepped on the sides to eliminate a direct air path for radiation (Figure XI-8), form the Canyon deck above the cells. The Pipe Tunnel is sealed off, providing a convenient aisle for setting the cell cover blocks while maintenance work is in progress. The Exhaust Air Tunnel which carries ventilation air out of the Canyon is located below the Pipe Tunnel.

2.2 Canyon piping

Most intra-cell solution transfers are made through pipe jumpers within the cell. All inter-cell solution transfers are routed through Pipe Tunnel lines which terminate in connectors on the tunnel wall of the cells. Connections between vessels in the cells and gallery tanks and instruments are made through connectors mounted on the gallery walls of the cells. Piping diagrams and wall patterns for all cells are shown on Figures XI-11 to XI-32; since the piping in Cells B and C is similar to Cell A, only Cell A diagrams are included. A schematic piping diagram of the Pipe Tunnel is given on Figures XI-33 and XI-34.

2.3 Canyon water fog system

Although the solvent, hexone, is flammable, the possibility of ignition of this material is extremely remote because of safeguards built into the plant (see Chapter XXIV). A water-fog fire-fighting system is provided in the Canyon and Silo to control fires should any ever occur.

Water fog protection is provided for all of the cells in which hexone of hexone saturated aqueous solutions are processed. The cells equipped with water fog systems are:

Cell D -- Waste Treatment Cell,
Cell E -- North Extraction Cell,
Cell F -- South Extraction Cell, and
Cell G -- Organic Recovery Cell.

Each of these cells is equipped with a number of equally spaced, recessed, water fog spray nozzles located high on the walls adjacent to the pipe tunnel and the galleries. In operation, a fine, dense, water mist blankets the cell and smothers any fire. The number of nozzles in each cell is given below:

Cell D --	Gallery Wall	10 nozzles
	Tunnel Wall	9 nozzles
Cell E --	Gallery Wall	7 nozzles
	Tunnel Wall	7 nozzles
Cell F --	Gallery Wall	9 nozzles
	Tunnel Wall	9 nozzles
Cell G --	Gallery Wall	4 nozzles
	Tunnel Wall	3 nozzles

The water fog system in each cell is supplied with raw water from the Operating Gallery through a control valve located at the cell panel board The water fog system is turned on at the discretion of the operator upon receiving an indication of fire.

All of the water fog systems are supplied by the 4-in. water fog supply header. This supply header is separate from the 12-in. raw-water loop header. However, its normal supply is from the raw water header by two direct-connecting lines, each containing check valves to prevent reverse flow in the event of failure of the raw water supply. Provision is made to supply the 4-in. water fog header from the 50,000-gal. elevated filtered-water tank by pumping water into the fog system with a pump truck. This system is provided since it is undesirable to install a permanent connection between the raw water and filtered water systems, and it is desirable to have available the protection of the elevated filtered-water tank.

Fire-detecting thermal switches are installed in electrical jumpers to tanks in Cells D, E, F, and G. Upon activation, those thermal switches close an alarm circuit which actuates visual and audible alarms at the associated panel board and in the Dispatcher's Office. Each equipment piece has at least one fire-detecting thermal switch on or near it for quick fire detection.

2.4 Inert-gas vent system

All vessels in Cells D, E, F, and G, and in the Silo are connected to the inert-gas vent header. The inert-gas blanketing system operates at a negative pressure and is supplied with inert gas in the Silo by two bleed lines from the high-pressure inert-gas header. The bleed rate at each connection is measured by a rotameter with a range of 1 to 10 std. cu. ft./hr. The high-pressure inert-gas header also supplied liquid-level indication bubblers, sampler jets, and gas for jet purging after transfers.

The inert-gas vent header is located in the Pipe Trench. From the inert-gas vent header the inert gas is drawn through the Vessel Vent Filter, J-3, and blown to the Process Stack, 291-S, by a steam jet. A vacuum relief valve is connected to the vent header in Cell J ahead of the filter. When the vacuum in the inert-gas vent header exceeds 10 in. water gage, the vacuum relief valve admits air to the line at a point just before connection to the filter.

When transfers are made between tanks on the inert-gas vent system the gas required by the tank being emptied will be supplied largely by reverse flow from the tank being filled. When transfers are made from vessels in the inert-gas vent system to vessels in another vent system, additional inert gas is required to replace the liquid transferred out. This additional inert gas is supplied by interlocking of the air control on those jets which transfer solution out of the system with air-controlled valves on the inert-gas supply, resulting in the introduction of sufficient inert gas into the inert-gas vent system to make up the deficiency.

2.5 Canyon electrical equipment

Two types of electrical equipment are used in the Canyon. Below the Crane Level and in the cells all of the electrical equipment is approved by Underwriter's Laboratories for use in Class I, Group D, locations. At Crane Level and above the electrical equipment is of totally enclosed design. All of the conduit and wiring in the Canyon meets National Electrical Code specifications for Class I, Division 1, locations.

Definitions of these locations are as follows:

Class I -- Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

Division 1 -- Those Class I locations where hazardous concentrations exist continuously or intermittently under normal operating conditions.

Group D -- Those Class I locations where the atmosphere may contain gasoline, petroleum, naptha, alcohols, acetone, lacquer, solvent vapors, or natural gas.

Special incandescent lighting fixtures are provided in the Canyon, to prevent dropping of light bulbs onto the Canyon deck or into the cells. This lighting system gives an intensity of 5 to 10 ft.-candles at deck level. Floodlights on the Canyon Crane are of the same type, and provide an intensity of 120 ft.-candles directly under the Crane.

2.6 Explosimeter sampling points and lines

It is desirable to check periodically the atmosphere in the cells for the presence of hexone vapor. Lines from the sampling points over each sump terminate in the Sample Gallery. Portable explosimeters, which can be connected to the sample lines in the Sample Gallery, are provided to check for the presence of hexone in the atmosphere of the cells.

2.7 Cell sprays

All cells, the Pipe Trench, and the Silo Column Shaft are equipped with wash-down spray nozzles, equally spaced and 3 ft. 9 in. above the floor. The sprays are provided to flush down the floors for clean-up, and for leak detection. Each sump drainage area has a separate wash-down system. The Pipe Tunnel floor is segmented by curbs so that separate portions of the trench can be flushed and drained to individual sumps.

The cell wash-down systems are supplied directly from the raw-water loop header which is located in the Pipe Galleries. The operating valves for these systems are all located in the Pipe Galleries.

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3. Silo

3.1 General description

The Silo, at the west end of the building, is 131 ft. 10 in. high, 83 ft. 6 in. long, and 41 ft. wide (Figures XI-4, XI-5, XI-6, and XI-7). The Silo consists of a process area and an operating area. The Column Shaft is the process area; it has 3 ft. 6 in. thick concrete shielding walls on the west, south, and east sides, and a 1 ft. 6 in. thick concrete wall on the north side. The Column Shaft is 85 ft. 9 in. high, 11 ft. 6 in. wide, and 69 ft. long. The entrance to the Column Removal Tunnel, which is used for removing and bringing in solvent-extraction columns, is located on the north side near the floor of the Column Shaft. There are eight levels in the operating area of the Silo. The first five are the Aqueous Make-Up Levels and each level has a floor area of 1200 sq. ft. The sixth level is occupied by the Silo Crane. The Silo Operating Gallery, with a floor area of 2133 sq. ft., and the Silo Sample Gallery, with a floor area of 880 sq. ft., make up the seventh level. Blower Room No. 4 and the Feed Tank Area, with a floor area of 1874 sq. ft., are on the eighth level.

Two elevators are provided for the Silo. Elevator No. 1, the freight elevator, is on the west side and serves all levels of the Silo and the Chemical Storage Room in the West Service Area. Elevator No. 2, the SWP elevator, is on the north side and is used as the normal route to the Silo Sample Gallery from the North Sample Gallery.

Two vertical pipe shafts provide convenient routes for service and "cold" process piping to the Aqueous Make-Up Levels, Silo Operating Gallery, and Feed Tank Area. No. 1 Pipe Shaft is on the west wall of the Silo and No. 2 Pipe Shaft is on the north wall. Since No. 2 Pipe Shaft contains the transfer line for treated hexone from the 276-S Building to the Organic Head Tank, 804, a spray nozzle is installed at the top of the shaft. Plan and section views of the Silo are shown by Figures XI-35 and XI-36.

3.2 Silo piping

Process piping in the Column Shaft consists of jumpers with remote maintenance connectors identical to those used throughout the Canyon. Piping arrangement in the Column Shaft is shown in Figure XI-37.

3.3 Silo viewing windows

Sixteen viewing windows are installed in the wall between the Column Shaft and the Aqueous Make-Up Levels. Another viewing window is located in the north wall of the Column Shaft at Operating Gallery Level. These windows allow observation of the extraction columns and associated equipment in the Column Shaft for leak detection and remote maintenance. Portable controls for the Silo Crane can be used at all of the viewing windows for remote maintenance operations in the Column Shaft.

The viewing windows are arranged in a pattern that provides a complete view of the equipment, connectors, and piping in the Shaft. The placement

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of the viewing windows is indicated by Figure XI-38.

The windows are built-up of leaded glass layers to the thickness required to give adequate shielding for long period observation. The glass layers are spaced slightly and the space is filled with mineral oil to prevent internal reflections. The glass is of special composition to reduce discoloration by radiation and to minimize the refraction spectrum caused by light passing through the glass at an angle.

Viewing windows are 3 ft. high and 3 ft. 4 in. wide. Eight of the windows are 3 ft. thick and nine are 1 ft. 8 in. thick. The thicker windows are required in some locations to give adequate shielding.

Filler oil may be drained and the windows disassembled from the gallery side to clean or replace the glass. Lead shields are provided for covering the window parts when such maintenance work is done. The window frame sides are stepped to prevent passage of direct beam radiation.

3.4 Silo water fog system

Water-fog fire-control protection is provided in the Column Shaft and the Organic Head Tank Enclosure.

Thirty-two water fog nozzles are recessed in the west wall of the Column Shaft and directed at the columns mounted on the east wall. These nozzles are arranged in four horizontal rows; a row of 8 nozzles is located 25 ft. from the floor, a row of 7 is 48 ft. from the floor, a row of 8 is 68 ft. from the floor, and the last row of 9 is 83 ft. from the floor.

Eight water fog nozzles are installed in the Organic Head Tank Enclosure. Near the floor, at each corner, is a nozzle pointed toward the center of the enclosure and upward at an angle of 45°. At the ceiling, in each corner, is a nozzle pointed toward the center of the enclosure and downward at an angle of 45°.

Fire-detecting thermal switches are installed in temperature jumpers to equipment in the Column Shaft. Upon activation, these thermal switches close an alarm circuit which actuates audible and visual alarms in the Silo Operating Gallery and the Dispatcher's Office. Two fire-detection units are located in the ceiling of the Organic Head Tank Enclosure and five units in the ceiling of the Silo Sample Gallery.

3.5 Silo electrical equipment

Electrical equipment in the Silo Column Shaft, Silo Sample Gallery, Pipe Shaft No. 2, and Silo Feed Tank Area is approved by the Underwriter's Laboratories, Inc., for use in Class I, Group D, locations.

Incandescent lighting fixtures in the Column Shaft meet Class I, Group D, requirements and provide 40 to 50 ft.-candles intensity at the columns. These lights are recessed in the Aqueous Make-Up wall and are built into shielding plugs that are removable for bulb replacement. Floodlights are mounted on the Silo Crane to augment this illumination.

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4. Product Removal Cage

The Product Removal Cage is an "L"-shaped enclosure located in the west end of the North Sample Gallery (Figure XI-5). The long (north) side of the cage is about 21 ft. long by 5 ft. wide, and the short (west) side is approximately 11 ft. long by 5 ft. wide. Since no fission product radiation problem is presented, the cage consists only of a stainless steel framework covered with transparent lucite panels. Operation of the equipment within the enclosure is conducted from outside the cage by means of extension handles on valves. However, maintenance of equipment, when required, is accomplished on a direct contact basis. Equipment arrangement plan and elevation views are shown in Figures XI-39 and XI-40.

5. Galleries

5.1 General description

Several galleries are located outside of the north and south walls of the Canyon proper. Storage, Sample, Pipe, Operating, and Crane Cab Galleries are located at progressively higher levels at the south side of the Canyon, while Sample, Pipe, and Operating Galleries are on the north side. The south galleries are 12 ft. 8 in. wide, and each has a floor area of about 4000 sq. ft. The North Operating and Pipe Galleries are 18 ft. wide, and the Sample Gallery is 19 ft. 4 in. wide, corresponding to floor areas of 5600 sq. ft. and 6000 sq. ft., respectively. Details of the galleries and their relation to the rest of the building are shown by Figures XI-5, XI-6, XI-7, and XI-8, and XI-10. Arrangement of equipment in the Operating Galleries is shown in Figure XI-9.

Two 50 h.p., 550 std. cu. ft./min. capacity Worthington piston pumps are located in the South Sample Gallery. These pumps are used to draw building air samples for the H.I. Sniffer System.

All of the piping is located in the galleries to facilitate control of the canyon vessels. The piping diagrams for the north and south galleries is shown on Figures XI-41 to XI-44. The piping diagram for the Silo Galleries is shown on Figure XI-45.

5.2 Raw water service

Raw water at 100 lb./sq.in.ga. is supplied to the Redox area from Building 282-W by a 20-in.underground line. This line splits into two 12-in. lines which enter the 202-S Building at the northwest and southeast corners of the building to supply the 12-in. raw-water loop header. This loop header passes through the South Pipe Gallery, the Cross-Canyon Passage, the North Pipe Gallery, the Chemical Storage Room, and the corridor around the Dispatcher's Office. A 3-in. branch line is routed up the No. 1 Pipe Shaft to the Fifth Aqueous Make-Up Level.

Branch lines from the header to the Operating Gallery control valves supply water to the cell vessels, jackets, and coils.

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Raw water to the individual sampling boxes is supplied through branch headers running the length of the Sample Galleries.

5.3 Filtered water service

Filtered (sanitary) water is used in the 202-S Building for safety showers, operating area floor washdown, drinking, and toilet facilities. The filtered water is supplied to the Redox Area by a 12-in. line from the Power House, 282-W. This line divides to enter the 202-S Building at the northwest and southeast corners to supply the 4-in. loop header. The loop header passes through the South Pipe Gallery, the Cross-Canyon Passage, the North Pipe Gallery, the Chemical Storage Room, and the corridor around the Dispatcher's Office. A 4-in. branch line, via the No. 1 Pipe Shaft, supplies the Aqueous Make-Up Levels of the Silo.

A 50,000-gal. elevated water tank, located near the southwest corner of the 202-S Building, provides an emergency supply of filtered water.

5.4 Demineralized water service

Demineralized water is provided for make-up of all process solutions to prevent interference by foreign ions. The demineralized water is produced in two demineralizer units, of the Permutit type, located on the Second Aqueous Make-Up Level. The capacity of each of these units is approximately 1000 gal/hr. Sulfuric acid and sodium hydroxide are used as regenerative chemicals for these units.

The demineralized water will normally meet the following specifications:

Total hardness (as $CaCO_3$)	0-2 p.p.m.
Calcium (as $CaCO_3$)	0-1 p.p.m.
Magnesium	0-1 p.p.m.
Sodium	1-2 p.p.m.
Total Cations	1-4 p.p.m.
Chlorides	0-1 p.p.m.
Sulfates	0-1 p.p.m.
Bicarbonates	1-2 p.p.m.
Total Anions	1-4 p.p.m.
Total Dissolved Solids	1-4.5 p.p.m.
Silica (as SiO_2)	7.5 p.p.m.
pH	5-8

The demineralized water is stored in a 15,000-gal. aluminum tank, SW-131, located in the Chemical Tank Farm, 211-S. This treated water is pumped automatically to a 2,500-gal. aluminum head tank, 602, as called for by automatic level controls. Four separate headers from the head tank serve the following areas:

Aqueous Make-Up Levels,
Silo Operating Gallery,
North Operating Gallery, and
South Operating Gallery

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5.5 Steam service

A 10-in line from the Power House, 282-W, supplies 225 lb./sq.in.ga. steam to the Redox Area. This line divides to enter the Pipe Galleries at the northwest and southeast corners of the building. The pressure is reduced to 100 lb./sq.in.ga. at two pressure-reducing stations in the Pipe Galleries. The 6-in.steam loop header passes through the South Pipe Gallery, the Cross-Canyon Passage, the North Pipe Gallery, the Chemical Storage Room, and the corridor around the Dispatcher's Office. Low-pressure, 15 lb./sq.in.ga., steam is supplied by pressure-reducing stations which feed sub-headers. Steam to the Aqueous Make-Up Levels is supplied by a 3-in. branch line through No. 1 Pipe Shaft.

Cell equipment operating continuously is supplied directly from the steam loop header. Equipment operated intermittently through gang valves is supplied by sub-headers.

Condensate from the steam supply system is drawn off through steam traps to the condensate headers which empty into the chemical sewer near the mid-point of the galleries.

Steam at 100 lb./sq.in.ga. is supplied to jets, evaporator coils, and tank coils. Fifteen lb./sq.in.ga. steam is used in the Dissolver coils and tank jackets.

5.6 Compressed air service

5.61 Service air

Service air at 100 lb./sq.in.ga. is supplied by two 1000 std. cu. ft./min. Ingersoll-Rand Compound Duplex Compressors, driven by 225-horsepower electric motors, located in the compressor room in the South Service Area. Air flows from the compressors through an aftercooler and moisture-oil separators into a 34-in. by 14-ft. air receiver (222 cu. ft. capacity). From the receiver the air passes through oil-vapor filters to the 3-in loop header which passes through the South Operating Gallery, the Cross-Canyon Passage, the North Operating Gallery, the Chemical Storage Room, and the corridor around the Dispatcher's Office. Service air to the Aqueous Make-Up Levels is supplied through a branch line via No. 1 Pipe Shaft. A branch header near the southeast corner of the building supplies the Laboratory Building, 222-S, and the Fan House, 291-S.

Service air is used in blowing those transfer jets which handle solutions having no organic content, in operating the process tank vent jets in the event of steam failure, in blowing steam sparger lines to prevent suck-back, and in blowing water from tank jackets or coils to prevent "water hammer" upon introduction of steam to the jacket or coil.

5.62 Instrument air

Instrument air at 100 lb./sq.in.ga. is supplied by an Ingersoll-Rand, single-stage, double-acting compressor of 150 std. cu.ft./min. capacity, driven by a 40-horsepower electric motor, and located in the compressor room in the South Service Area. The air flows from the compressor through

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an aftercooler and separator into a 34-cu. ft. receiver. The air then passes through oil-vapor filters and two regenerative-type dryers, operating in parallel, to the 1-in. loop header. This loop header passes through the South Operating Gallery, around the Dispatcher's Office, up No. 1 Pipe Shaft to the Fifth Aqueous Make-Up Level, down No. 2 Pipe Shaft to the North Operating Gallery, and through the Cross-Canyon Passage.

The instrument air compressor is on the emergency power circuit and in the event of equipment failure, instrument air will be supplied from the service air receiver.

Instrument air is used to operate diaphragm valves and to serve liquid-level instrumentation in aqueous make-up and operating-gallery feed tanks.

5.7 Inert-gas distribution

The 2-in. inert-gas loop header passes through the South Pipe Gallery, the Cross-Canyon Passage, the North Pipe Gallery, the Chemical Storage Room, and the corridor around the Dispatcher's Office. Branch headers from the loop near the west end of the Pipe Galleries feed the North and South Sample Galleries. The Silo Sample Gallery is fed by a loop from the pipe galleries and a branch line from this loop serves the ferrous sulfamate tanks on the Fifth Aqueous Make-Up Level.

Instrument inert gas is taken from the inert-gas system at 100 lb./sq. in.ga. immediately after the oil-vapor filters, reduced to 15 lb./sq.in., humidified to 80% relative humidity, and passed into the 15-lb./sq.in.inert-gas receiver. The 1-1/2 in. instrument inert-gas loop header is supplied by the 15-lb./sq.in.ga. inert-gas receiver and passes through the South Operating Gallery, up No. 1 Pipe Shaft from the Third Level to the Fifth Level of Aqueous Make-Up, down No. 2 Pipe Shaft, through the North Operating Gallery, and the Cross-Canyon Passage.

Instrument inert gas is used in instrument bubbler lines for liquid-level measurements in process vessels, except those in aqueous make-up chemical solution tanks.

6. Electric Power Distribution

6.1 General

Electric power is supplied to the Redox Area by two separate 13.8-kv. power lines, each supplying a 13.8/2.4-kv. transformer. These two main transformers normally operate at half load to supply separate 2.4-kv. busses. Each of the main transformers is capable of handling the total load, thus allowing one main transformer or line to be removed from service without interrupting power to any 2.4-kv. circuits.

An emergency source of locally generated 2.4-kv. power is available at all times. The emergency 2.4-kv. bus is normally energized by one of the main 13.8/2.4-kv. transformers. In case of power failure on this bus, the load is transferred automatically to the 2.4-kv. emergency power line.

Two 2.4kv./480v. substations are designed in a similar manner, with two transformers normally operated at half load. Each transformer alone is capable of carrying the full load of the substation. Automatic switching will transfer the essential load to the emergency 2.4kv./480v. transformer in each substation.

6.2 Details of system

6.21 Main power supply

The main power supply to the Redox Area is carried by two 13.8-kv. lines, 22 W and 32 W, to the switching station just north of the 202-S Building (Figure XI-3). From the switching station two 13.8-kv. feeders run underground to the two main 13.8/2.4-kv. transformers.

6.22 Main 13.8/2.4-kv. transformers

The two main 13.8/2.4-kv. transformers are rated at 2500 kva., oil filled, and fan cooled. They are located on concrete pads outside Cable Room No. 1.

6.23 Emergency 2.4-kv. power supply

Power for the 2.4-kv. emergency system is generated by a 750-kw. turbogenerator located in the Boiler House, 284-W.

6.24 2.4kv./480v. transformers

The 2.4kv./480v. substations are located just outside Cable Rooms No. 2 and 3. Two 500-kva. transformers for normal service and one 225-kva. transformer for emergency service are in the North Substation.

6.25 Emergency circuits

Failure of the 13.8-kv. main power supply results in complete electrical outage for about 15 seconds until the emergency turbogenerator reaches full-load speed when emergency circuits are automatically energized. Batteries, located in the Battery Room, supply power for limited emergency lighting during the 15-second outage. The emergency circuits are listed below:

From the 2.4-kv. Emergency Bus:

Fence and Guard Tower lighting, and emergency lighting of 222-S Building.

From North Substation 2.4kv./480v. emergency transformer:

276-S Building emergency lighting, Beckman instrument supply to Silo and North Operating Gallery, Building 291-S, north transformer cooling fans, battery motor-generator, emergency lighting, operating instruments in the Silo and North Operating Gallery, and D-8 Neutralizer Tank agitator.

From South Substation 2.4kv./480v. emergency transformer:

Breathing air compressor, inert-gas compressor, instrument-air compressor, instrument-air drier, air-sampling vacuum pump, inert-gas generator, Beckman instrument supply to SWP Lobby and South Operating Gallery, emergency lighting, operating instruments in South Operating Gallery, south transformer cooling fans, and H-2 Centrifuge.

7. Inert-Gas Generator

Inert gas is used in the 202-S Building to blanket those vessels in which organic solutions or organic saturated aqueous solutions are processed. The inert gas is supplied by inert-gas generators which burn propane and air to produce a chemically inert gas. The inert gas produced has approximately the following composition:

N_2	87-88%
CO_2	10-12%
CO	1% max.
O_2	0.5% max.
H_2O	1% max.

The inert-gas generators are located in a small building just outside the compressor room on the south side of the 202-S Building. Two gas generators are provided, one for normal operation and the other as a spare. Each of these burners has a capacity of 12,000 std. cu.ft./hr. Each gas generator consists of a burner which gives complete combustion of the propane and oxygen in the air, a spray cooler, and a moisture separator.

The gas from the generators is received in a low pressure 2000 cu. ft., dry-seal type, gas holder which is located just outside the Inert-Gas Generator Shed.

This low-pressure gas holder feeds a 200 cu. ft./min. compressor which delivers the gas at 100 lb./sq.in.ga. to an aftercooler separator. A spare compressor and aftercooler separator are provided. These compressors and aftercoolers are located in the Compressor Room.

Inert gas at 100 lb./sq.in.ga. flows from the aftercooler separator to the high-pressure storage tank which is located outside the 202-S Building adjacent to the low-pressure gas holder. The capacity of the high-pressure storage tank is 1160 cu.ft. Inert gas is supplied to the 100 lb./sq.in.ga. inert-gas loop header and the 15 lb./sq.in.ga. instrument inert-gas system from the high-pressure storage tank.

The plan of the Inert-Gas Generator Shed showing the equipment arrangement is shown in Figure XI-46.

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8. Service Areas

8.1 South Service Area

The South Service Area houses offices, lunchroom, conference room, Men's locker room, women's lounge, Survey Room, Instrument Shops, Process Blower Room, Compressor Room, and South 480-Volt Switchgear Room. This area is shown in Figure XI-6.

The SWP Change Room, air lock, and SWP Lobby are at the east end of the South Pipe Gallery. Arrangement of these facilities is shown on Figures XI-5 and XI-6.

8.2 North Service Area

The North Service Area houses the 2.4-kv. Switchgear Room, Battery Room, North 480-Volt Switchgear Room, and Electric Shop and Office. The plan of this area is presented in Figure XI-6.

9. Ventilation

9.1 General

The ventilation system is designed to provide controlled and constant pressure areas to insure that normal work areas are at all times free of potentially contaminated air from special hazards zones.

Ventilation of the building is accomplished by two parallel systems, process and service. These two systems are supplied and exhausted separately. The only direct connections between the two systems are the Canyon Emergency Exit Door and the entrance to the Silo Crane Gallery. Pressures of the two systems are regulated to give a higher pressure in the service areas than in the process areas. This results in air flow from the service areas to the process area when either of the two doors mentioned above is opened. The ventilation system of the building is shown in perspective cutaway on Figure XI-47.

A schematic diagram of the 202-S Building ventilation system is shown on Figure XI-48. This diagram indicates the supply source, the air changes per hour, the pressure, direction of flow of air, and the exhausting method for all areas of the building.

9.2 Ventilation equipment

9.21 Blower Room No. 1 (Process Blower Room)

Three units each consisting of an air filter, washer, preheater, and blower are installed in Blower Room No. 1, which is located in the South Service Area at Pipe Gallery Level. Each of the blowers has a capacity of 26,150 cu.ft./min. The washer spray pumps, 909 A, B, and C, are Ingersoll-Rand, No. 2-UV, water pumps, 225-gal./min. 80-ft. head, driven by a General Electric 7-1/2 h.p., type K, 3450-rpm., splash-proof, electric motor. Ductwork conducts the treated air through unit reheaters to various discharge points in the process areas (see Figure XI-48).

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9.22 Blower Room No. 2

Blower Room No. 2 is located at Pipe Gallery Level in the North Service Area. One unit, consisting of an air filter, washer, preheater, and blower, is located there. The blower has a capacity of 29,400 cu.ft./min. The washer spray pump, 909 D, is identical to the pumps used in Blower Room No. 1. Figure XI-48 shows the areas serviced by this unit.

9.23 Blower Room No. 3

Blower Room No. 3 is located on the Operating Gallery level in the South Service Area. One unit, consisting of an air filter, washer, preheater, and blower, is located there. The blower has a capacity of 22,300 cu. ft./min. The washer spray pump is identical to those used in Blower Room No. 1. The five zones supplied by this unit are shown on Figure XI-48.

9.24 Blower Room No. 4

No. 4 Blower Room, on the top floor of the Silo, contains an air conditioning unit with a blower of 14,640 cu. ft./min. capacity. The washer spray pump is a 108-gal./min., 80-ft. head, water pump, driven by a 3450 rpm., 5 h.p., type K, splash-proof, electric motor. The zones supplied by this unit are shown on Figure XI-48.

9.25 Blower Room No. 5

Blower Room No. 5 is located in the South Service Area on the Operating Gallery Level. The air conditioning unit has a supply blower of 14,640 cu. ft./min. and uses a washer spray pump of the same characteristics as the one in Blower Room No. 4. It supplies 5 zones which are shown on Figure XI-48.

C. OUTSIDE FACILITIES

1. Chemical Tank Farm, 211-S

1.1 General

Large quantities of acid, caustic, and aluminum nitrate solution are consumed in the Redox Plant. Storage facilities for these materials are located in the Chemical Tank Farm, 211-S, which is located west of the 202-S Building (Figure XI-3).

Tanks located in the Chemical Tank Farm, their use, capacities, and material of construction are given below:

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Tank No.	Service	Capacity	Material of Construction
SQ-101	50% NaOH	99,000 gal.	Mild Steel
SQ-102	50% NaOH	99,000 gal.	Mild Steel
SS-111	72% $Al(NO_3)_3 \cdot 9H_2O$	149,000 gal.	Mild Steel, Tygon Lined
SS-112	" "	149,000 gal.	" " " "
SS-113	" "	149,000 gal.	" " " "
SS-114	" "	4,300 gal.	Type 309 Stainless Steel
SA-121	60% HNO_3	15,000 gal.	Type 347 Stainless Steel
SA-122	"	41,000 gal.	" " " "
SA-123	"	41,000 gal.	" " " "
SA-124	"	4,300 gal.	Type 309 Stainless Steel
SW-131	Demin. Water	15,000 gal.	Aluminum

Arrangement of the Chemical Tank Farm is shown on Figure XI-49.

Storage capacity to meet requirements for 60 days is provided for 50% NaOH and 60% HNO_3, based on processing 5000 lb. uranium/day. Aluminum nitrate storage capacity will meet requirements for 4 months at a processing rate of 5000 lb. uranium/day. All figures quoted are for 3-cycle operation.

1.2 Description of facilities

Sodium hydroxide received in tank cars is unloaded at Car Spot No. 1. The caustic storage tanks, SQ-101 and SQ-102 are provided with steam coils and lagged because of the relatively high freezing point of 50% NaOH. Caustic pumps and lines are steam traced to prevent freezing of the 50% NaOH.

Nitric acid is received in tank cars which are unloaded to SA-121 from Car Spot No. 2 or in tank trucks which are unloaded to SA-124 from an unloading spot near Car Spot No. 1. All of the nitric acid handling equipment is constructed of stainless steel.

Aluminum nitrate solution is received in tank trucks. The aluminum nitrate solution is pumped from the truck to the Receiving and Sampling Tank, SS-114, where it is held until an acceptance analysis of the shipment is completed. Off-standard material can be pumped back to the tank truck. From SS-114 the aluminum nitrate is pumped to the storage tanks, SS-111, SS-112, and SS-113. These storage tanks are protected from freezing by steam coils. Pumps and lines are steam traced. Aluminum nitrate pumps and lines are constructed of stainless steel.

Demineralized water is produced in the 202-S Building and stored in the Demineralized Water Storage Tank, SW-131. Tank SW-131 is provided with a steam coil to prevent freezing of the water. The pump and lines are steam traced. Lines for demineralized water are aluminum with stainless steel valves.

2. Solvent Treatment and Storage Building, 276-S

The 276-S facility houses equipment for the storage of raw hexone and the chemical treatment of new and recycled hexone. The storage tanks are located north of the 276-S Building (see Figure XI-50). The two storage tanks, SO-141 and SO-142, are buried to minimize the effect of atmospheric temperature variation. Each of the storage tanks has a capacity of 21,500 gal. The tanks are vented to atmosphere through flame checks.

The 276-S Building is 43 ft. 2 in. wide and 58 ft. long; it is constructed of reinforced concrete, steel framing, and corrugated asbestos siding and roofing. The two sections of the building, the Process Area and the Operating Area, are separated by a 2-ft. thick concrete wall. The Process Area is 58 ft. long and 26 ft. wide, with 2-ft. thick concrete walls on the ends and the side next to the Operating Area. The other wall of the Process Area is covered with corrugated asbestos siding. The Operating Area is 58 ft. long and 15 ft. wide, and has a steel framework covered with corrugated asbestos siding. There are no connecting doors between the two sides of the building; all doors open to the outside. Valves located in the Process Area are operated by extension handles extending through the concrete wall to the Operating Area. The sump in the floor of the Process Area is emptied by a jet. Normally this jet discharges to the crib located west of 276-S Building, but may discharge to the Organic Treatment Tank, O-2, for organic recovery. This sump is equipped with a decanting overflow which is designed to start overflowing to the crib when the Process Area is flooded with about 30,000 gal. of liquid.

There are three tanks in the Process Area, the Organic Receiver Tank, O-1, the Organic Sampler and Treatment Tank, O-2, and the Organic Header Feed Tank, O-3. The Organic Treatment Addition Tank, O-2A, is located in a pit at the west end of the Operating Area.

Waste wash solutions from the Organic Treatment Tank are pumped to a crib located west of the 276-S Building. This crib receives waste from the 276-S Building and the 203-S Building.

The arrangement of the equipment in the 276-S Building is shown on Figure XI-50.

The three tanks in the Process Area are blanketed with inert gas supplied by a pressure-reducing valve which discharges inert gas at a pressure of 15 in. of water, gage, into the vent header, by instrument dip tubes, and by the sampler on Tank O-2. Each tank is vented to the vent header through a flame arrestor. The vent header, in turn, vents to the atmosphere through a seal pot.

All electrical equipment in the Process Area is approved by Underwriter's Laboratories for use in Class I, Group D, locations.

The two sides of the building are separately ventilated. The Process Area is ventilated by two exhaust fans mounted on the roof. Each of these fans has a 4400 cu. ft./min. capacity, which results in one air change per minute in the Process Area. The intakes of the exhaust ducts are located

near the floor to facilitate the removal of heavier-than-air solvent vapors. The Operating Area of the building is ventilated by an exhaust fan on the roof. The capacity of this fan is 1000 cu.ft./min. The intake point is near the bottom of the pit at the west end of the Operating Area.

Two unit heaters, with steam coil and fan, heat the air in the Process Area by circulating it past the coil. One large heater installed in the intake duct to the Operating Area heats the fresh air from the outside. An evaporative cooler supplies cool air to the Operating Area during hot weather.

An automatic water-fog fire-protection system is installed in the 276-S Building. The fire-detection system employs small pressurized air lines leading to thermal detectors. In the event of fire the thermal detector melts releasing the pressure which in turn opens the valve in the supply line to the fog nozzles and actuates the alarm system. An alarm and light are located outside the 276-S Building; a pilot light is located in the Dispatcher's Office in 202-S Building, and an alarm signal is relayed to the 200 West Area Fire Station. The exhaust fans are shut off automatically when the water fog system is actuated.

3. Decontaminated UNH Storage, 203-S

Decontaminated UNH solution is stored temporarily in the 203-S Area before transfer to the 203-U Building. The 203-S Area consiste of two stainless steel storage tanks, SU-151 and SU-152, mounted in an open concrete pit north of the 276-S Area (see Figure XI-3). Each of these tanks has a capacity of 4800 gal. The tanks have partial steam jackets to prevent freezing of the UNH solution. All process lines to the 203-S Area are steam traced. The 2-in. overland line from 203-S to 203-U is lagged and electrically heated to prevent freezing of the solution.

The two tanks are interconnected at the bottom, permitting free flow between tanks. They are vented through a common filter which prevents the spread of uranium contamination. A temperature controller supplies steam to the tank jackets to maintain the solution temperature above 50°F.

A sump located in the center of the concrete pit is emptied by a jet which discharges to the 276-S Building Crib.

4. Propane Storage Area, 2726-S

The Propane Storage Area, 2726-S, is located southeast of the 202-S Building, outside of the Redox Area fence. Two 6500 gal. storage tanks, SG-161 and SG-162, and a pump, PG-1, are located in the area. Each tank is equipped with an electric vaporizer unit.

Propane is delivered by tank trucks which can be unloaded by either the tank-truck pump or pump PG-1. The side-arm natural-circulation vaporizers are electrically heated, and a pressure switch on each tank controls the heating element of its vaporizer.

The system is designed to operate at a minimum pressure of 40 lb./sq.

in.ga. Only during very cold weather (below 20 to 30°F.) will operation of the vaporizers be necessary. A pressure-reducing station reduces the line pressure to 10 lb./sq.in.ga. to eliminate condensation in the underground line to the Inert-Gas Generators and the 222-S Building.

Safety valves are provided on the tanks and vaporizers. All of the equipment is electrically grounded. A fireproof sunshade roof is erected over the storage tanks. Excess flow check valves are provided where required by National Board of Fire Underwriter's standards.

D. WASTE FACILITIES

1. Retention Basin, 207-S

The Process Sewer, which handles only steam condensate and cooling water from process vessels, empties into the Retention Basin, 207-S, a 130-ft. square by about 6-3/4 ft. deep concrete receptacle. Since there is a possibility that radioactive material may get into this waste through a leak in a "hot" tank jacket or coil, provision is made to check for the presence of radioactivity before disposal into the ground. Water from the Retention Basin is discharged to an open pond southwest of the Redox Area. The location of the Retention Basin and open pond are shown in Figure XI-2.

Normally water flows through the Retention Basin with a very small holdup. The outlet gate is closed only when the continuous monitoring instrument on the inlet to the basin indicates the presence of above-tolerance radioactivity. The capacity of the basin is 850,000 gal., about 7 hours holdup under 3 cycle process operation.

The plan and details of the Retention Basin are shown on Figure XI-51.

2. Diversion Boxes

Liquid process wastes from the 202-S Building are routed to the Waste Cribs and the Underground Waste Storage Tank Farm through a Diversion Box, 240-S-151, located north of 202-S Building. A second Diversion Box, 241-S-151, through which wastes are routed to the Cribs or the desired point in the Tank Farm, is located near the 241-S Tank Farm.

2.1 Diversion Box 240-S-151

Diversion Box 240-S-151 (Figure XI-52) is a concrete pit 56 ft. long and 23 ft. 6 in. wide, divided into two sections. One section consists of two rows of nozzles, the inlet nozzles in the upper row and the outlet nozzle in the lower row as shown in Figure XI-52. The other section contains the piping to the nozzles. The box is covered with concrete blocks that can be removed by a motor crane.

All of the waste lines leaving the 202-S Building through the Waste Tunnel are connected to the 240-S-151 Diversion Box. Connections between the upper row, inlet, nozzles and the lower row, outlet, nozzles are made by jumper. Space is provided for the storage of spare jumpers. A catch

tank, 240-S-302, receives all drainage from the Diversion Box, thus providing a convenient method of leak detection. The Catch Tank is emptied by a jet connected to an inlet nozzle in the Diversion Box. By use of jumpers the solution in the Catch Tank may be disposed of to an appropriate point in the waste system.

Spare lines are installed in the Waste Tunnel from the 202-S Building and are connected to inlet nozzles in the Diversion Box. The waste line encasement to the 241-S Tank Farm has nine lines, with six in use and three spares. There are five additional stubs connected to outlet nozzles for future lines to 241-S. Six other stubs are provided for connection to a future tank farm.

2.2 Diversion Box, 241-S-151

Diversion Box, 241-S-151, (Figure XI-53), is a concrete pit 56 ft. long and 23 ft. 6 in. wide. Arrangement and details of this Diversion Box are similar to the 240-S-151 Diversion Box.

Nine inlet lines from the 240-S-151 Diversion Box are installed and there are five inlet stubs for connection to future lines from 240-S-151. In addition there are three inlet stubs for possible future lines from 241-U Tank Farm.

Eight outlet lines to the Underground Waste Tank Farm are installed, a line and a spare to the first tank of each cascade. There are eight outlet stubs for connection to a future tank farm. One outlet line and two outlet stubs are provided for connection to the Waste Cribs, 216-S.

3. Waste Cribs, 216-S

The Waste Cribs, 216-S, are used for the disposal of evaporator condensate and cell drainage from the sumps which meets the cribbing tolerance. A discussion of cribbing tolerance is given in Chapter X.

The two cribs, operating in series, are 12 ft. by 12 ft. by 9 ft. high. They are constructed of wooden ties with wooden covers. The cribs are about 21 ft. below grade, resting on a backfill of screened 1/2-in. and larger gravel. In addition the ground below each crib has been excavated to a depth of 12 ft. and filled with coarse aggregate. Two risers are provided for each crib, one for liquid-level measurement and the other for a vent equipped with a filter. Construction of the Waste Cribs is illustrated by Figure XI-54.

4. Underground Waste Storage Tank Farm, 241-S

Twelve 75-ft. diameter storage tanks are located in the Underground Waste Storage Tank Farm. These tanks are arranged in four cascades of three tanks each. The first tank in a cascade is equipped with two air condensers and the second and third tanks each with one air condenser. The plan and section of the Tank Farm are shown on Figure XI-55.

The 75-ft. diameter tanks have a capacity of about 750,000 gal. each,

and a total capacity of 9,000,000 gal. This Tank Farm will ppovide waste storage for a minimum of about three years, depending on the number of decontamination cycles required for producing a satisfactory product.

The tanks are constructed of concrete with a mild steel liner. Details of tank construction are shown on Figure XI-56.

A Catch Tank, 241-S-302B, is located at the northeast corner of the Tank Farm adjacent to Tank 101. This Catch Tank collects drainage from the line encasements serving the Tank Farm. It is emptied by a jet which discharges into the Catch Tank, 241-S-302A, which is located adjacent to 241-S-151 Diversion Box.

5. Sand Filter and Stack, 291-S

The 291-S Area which contains the exhaust ventilation equipment for the Process Area of 202-S Building, is located northeast of the 202-S Building. This location minimizes the effects of wind currents (from the westerly prevailing winds) on operation of the stack.

The purpose of the Sand Filter and Stack is fourfold: to dispose of Dissolver off-gas safely; to exhaust air adquately from the Process Area of the 202-S Building; to clean up this exhaust air preparatory to its discharge to the atmosphere; and to discharge the exhaust air and Dissolver off-gas to the atmosphere at a velocity and altitude sufficient to eliminate hazards to personnel. A cutaway view of the Sand Filter and Stack is shown on Figure XI-57.

5.1 Sand Filter

The Sand Filter removes radioactive particles from the exhaust ventilation air before the air is discharged to the atmosphere. The unit consists of layers of sand and gravel in a concrete shell equipped with air distribution tiles. There are seven layers of material decreasing in particle size from coarse gravel, 2 to 3-1/2 in., on the bottom layer to the top layer of sand, 30 mesh. All of the material is selected for its resistance to nitric acid and freedom from silt, organic matter, and shale.

The Sand Filter is sized to handle tho ventilating air at a linear velocity of 5 ft./min. and a pressure drop through the filter of approximately 7 in. of water under normal operation. A by-pass damper system of the filter outlet is included so that the inlet plenum of the filter can be used as a by-pass duct after the filter is roplaced by a future installation.

Monitoring tubes extend into the sand layers so that radioactivity measurements can be taken from the top of the filter. Facilities are installed for checking the pressure drop across various filtering layers. Condensation within the filter layers has an adverse effect on the filter's efficiency and increases pressure drop across the filter; therefore, a humidity analyzer recorder on the 202-S Building Air Tunnel is located in the South Sample Gallery as an aid to control.

5.2 Fan House

The Fan House contains the exhaust blowers for the 202-S Process Area ventilation system. There are three stainless steel blowers, of identical design, installed in parallel. The load is normally carried by two of the blowers, driven by electric motors. Each of these blowers has a capacity of 20,000 cu.ft./min. The third blower is an emergency standby unit, powered by a direct-coupled steam turbine. Its capacity is approximately 40,000 cu.ft./min. The increased capacity is obtained by driving the turbine-powered unit at a higher operating speed than the electrically driven units. This emergency fan automatically goes into operation when the static pressure in the air duct to the sand filter rises to a predetermined level. The blowers and motors are lubricated through remote connections located inside the 291-S Building.

5.3 Jet Control House

The jets for the Vessel Vent Systems and the diaphragm operated steam and air valves to these jets are housed in the Jet Control House. The Drain Seal Tank, Tank 291, is also located here. The function of the Drain Seal Tank is to receive condensate, via drip line at suction side of the jets, from the vessel vent lines. Removal of condensate improves the efficiency of the vent jets.

5.4 Process Stack

The Process Stack is 200 ft. high above grade. It is constructed of reinforced concrete, with a free-standing stainless steel liner, 3 ft. 9 in. inside diameter. The liner is capped at the top to cover the annulus between the stack and liner. A dished head, anchored to the base of the stack, is welded to the base of the liner. The stainless steel inlet breeching is welded to the stack liner and enters the stack on a 45° angle.

Stack-gas sampling points are located at the top and bottom of the stack.

Spray rings are installed at three levels for washing down the inside of the liner. Condensate accumulation is drained from the stack liner and the annulus to the Drain Seal Tank, Tank 291.

E. LABORATORY BUILDING

1. Layout

The Redox and TBP Analytical and Plant Assistance Laboratory, 222-S, is a concrete and steel two-story building 322 feet long by 107 feet wide, located in the "S" Area south of the Redox Processing Building, 202-S. The plot plan is shown in Figure XI-3.

The functions of the laboratory are to provide (a) routine chemical and radiochemical analyses of samples, and (b) non-routine experimentation of a plant assistance nature for the Redox Production Plant, the TBP Production Plant, and the Hot Semiworks.

The two floors above ground, plus the subterranean counting room, instrument shop and service tunnels, comprise approximately 60,900 square feet of space, divided as follows:

Working Laboratory Space	10,600 sq. ft.
Office Space	1,600 sq. ft.
Utilities	10,600 sq. ft.
Supplementing Facilities	4,100 sq. ft.
Non-Working and Equipment Space (ventilation equipment and ductwork, electrical distribution equipment, hollow walls, corridors, and stairs)	34,000 sq. ft.

The basement, service tunnels, and first floor plan views, are given in Figure XI-58, in which the rooms, offices, and laboratories are numbered and their designations noted. The plan at the second floor is not included, since with exception of the ventilation ductwork and equipment space, the only services located on this floor are a maintenance shop and office, an electrical-control station, and a general storeroom. Reference prints are listed at the end of this chapter.

The Analytical Laboratories, 4-A through 4-M, are designed with maximum flexibility to meet the varied requirements of the Redox and TBP Plants for routine control and special analyses. As a consequence of the need for special sample evaluation, Rooms 2-H and 4-Q have been provided for fluorimeter and X-ray photometer work, respectively.

The Plant Assistance Laboratories, 4-N, 4-P, 4-S, and 4-V, are designed for work of a plant service or process improvement nature. The supporting facilities, 4-R, 4-U, and 4-T (solution make-up, special apparatus, and storage rooms, respectively) are essential to the work performed in these laboratories.

Facilities for control, research, and development work at higher levels of radioactivity than have heretofore been possible at Hanford Works, have been provided in the multicurie wing of the 222-S Building. This wing of the building (see Figure XI-58) is normally entered at one point only, through air locks and a change room. Utilities and supporting facilities for these laboratories are grouped with them in the isolated wing even though some, such as the sample storage room and decontamination room, are duplicated in the main laboratory section. This duplication is necessitated by the sharp difference in radioactivity levels in the two parts of the building.

Supporting facilities in the 222-S Building are of the usual type for plant service work, providing rooms to serve the building and house the personnel who serve the building as a whole. These facilities and allocated areas are designated in Figure XI-58.

2. Utilities

Twelve different utilities and services such as water, compressed air,

and vacuum, which are available in the laboratories of 222-S, are presented in tabular form on Figure XI-58. The number of outlets per room for each service available is indicated under the type of service. In addition to the twelve listed in the table, two special services are provided: methane is piped to the basement counting room from the outside storage cylinders for the operation of the radiation counters; and concentrated nitric acid is supplied by gravity to Room 2-B-2 from an outside storage source for use in equipment decontamination.

The special purpose electrical services supplied to the laboratories, are shown in Figure XI-59, and the ventilation air supply and exhaust system in Figures XI-60 and XI-61.

2.1 Gases

The special gases, hydrogen, nitrogen, oxygen, and methane, are piped into the laboratories from cylinders stored outside the building. Spare gas lines are installed in the laboratories, and are to be supplied from size B cylinders which can be mounted directly in the pipe chase at the rear of the laboratory benches. Propane is piped into the building from the central storage tank in the "S" Area.

2.2 Steam

Steam, piped into the laboratories as indicated, is taken from the area grid supply, and is reduced through two pressure-reducing valve stations to 25 pounds per square inch gage for laboratory use, heating systems, and the hot water heater.

2.3 Distilled water

Distilled water is furnished by a 75-gallon per hour still supplying a 500-gallon tin-lined storage tank, located in the second floor equipment space. It is fed to the laboratories by gravity through aluminum tubing.

2.4 Drinking water

Cold drinking water is taken from the area mains at 100 pounds per square inch gage and is reduced to 35 pounds per square inch gage to supply drinking fountains, showers, and sanitary services. Hot water is obtained from a circulatory-type steam heater, located in the second floor equipment space.

2.5 Compressed air

Compressed air at 100 pounds per square inch gage is brought from the 202-S Building, and is available through two pressure-reducing valve stations at 90 pounds per square inch gage and 25 pounds per square inch gage for laboratory services, as indicated.

2.6 Vacuum

House vacuum is provided for the Plant Assistance and Analytical

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Laboratories by two pumps located in a room off the service tunnel under the multicurie wing, with traps placed ahead of the pumps and in the laboratory feeder lines. Traps will also be installed, as needed, at all work stations. Vacuum is provided for the multicurie wing by a separate system with a pump located in the service tunnel as shown on the drawings. Two additional interconnected vacuum pumps supply the H.I. air-sampler system which is a permanent installation with sampling ports in the ventilation ducts, laboratories, and other strategic locations, as indicated. All air is exhausted through Chemical Warfare Service filters to the building stack.

2.7 CO_2 fire extinguishers

Room 2-E, sample storage, is provided with a CO_2 fire extinguisher system for blanket coverage with fixed pipe installation from manifolds, in accordance with the National Board of Fire Underwriters' codes governing such installations. The remainder of the building is supplied with both 10-pound and 75-pound portable extinguishers.

2.8 Electrical supply

There are two separate and distinct electrical systems in the building, both having the same current characteristics. They are "normal" and "emergency". Current is brought into the building through two separate 3-wire services, providing 480-volt, 3-phase, 60-cycle current for power distribution. Through banks of transformers in the equipment rooms, 120/208-volt, 4-wire, 3-phase, 60-cycle current is supplied for lighting and laboratory outlets. Isolated voltage power supply for interference-free operation of counting instruments and radiation-detecting instruments is supplied to the counting room and building vestibule through a special 208/120-volt isolating transformer; no other equipment operates off this line.

Approximately 20 per cent of all lighting as well as exit lights and fire alarm power, is automatically transferred to the emergency system in the event of a power failure, to permit continuation of uninterruptable work, safe orderly evacuation, etc. Lighting circuits, other than those controlled from the bussway and contactor areas, are fed from circuit-breaker-type load centers placed in easily accessible locations.

The normal service lighting and receptacles in the Plant Assistance and Analytical Laboratories, are individually switched in locations outside and adjacent to the room doors, so that these services may be cut off in the event of local emergencies.

The solution make-up room, 1-K, in the multicurie wing, and the sample storage room, 2-E, are completely equipped with explosion-proof electrical outlets, in view of the flammable nature of solutions which may be handled and stored in these locations.

2.9 Ventilation

The supply of air for 222-S offices and laboratories is heated in the winter season by pre-heat coils, and is cooled in the summer by the water-

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wash evaporative method. The maximum and minimum temperatures are 80° and 70°F. for summer and winter, respectively. The basement counting room and instrument shop constitute an exception to this general supply system, being on a constant-temperature, constant-humidity conditioned-air unit which maintains the temperature of 75°F 2°F., and the relative humidity at 40 ± 2 per cent. Make-up air in this system is approximately 10 per cent, with 90 per cent recirculation during normal operation.

The supply air for the Plant Assistance and Analytical Laboratory section, is treated for four parallel sets of apparatus consisting of filters, coils, washers, and fan. Each fan has a capacity of one-third of the design load with three in normal use and one standby. Each set discharges air into a common plenum connected to the main supply ducts to the various parts of the building.

The distribution of air to (and exhaust from) offices, corridors, and Laboratories, is shown in Figures XI-60 and XI-61. In addition to the diffusers and grilles, Laboratories 4-A through 4-V, 2-B-1, 2-B-2, and 2-H, are also supplied through ventilating-type perforated ceilings.

The supply air to the multicurie wing is distributed in the same fashion as above, furnished by the same fans to a common plenum. Additional air, however, is introduced to the multicurie laboratories by means of wall-mounted registers.

All exhaust air vented from the laboratories passes through Chemical Warfare Service filters before entering the exhaust system and thence through exhaust fans to the building stack. There are four exhaust fans, with three in normal service and one standby. Air is exhausted from the laboratories via hoods, canopies, and auxiliary exhausts, automatically controlled by velocity pressure regulators to maintain constant throughput conditions.

All fans operate off the normal electrical power supply, and in the event of a main power failure, the supply and exhaust fans are so arranged and controlled that one or more supply fans, as designated, and one or more exhaust fans, as designated, will operate to deliver a minimum of 25 per cent of normal air supply to the laboratory areas, when power is supplied from the emergency turbogenerator.

3. Waste Disposal Facilities

Wastes from 222-S include the usual innocuous aqueous, slightly contaminated aqueous, and highly radioactive aqueous solutions, and in addition, special organic wastes, both radioactive and non-radioactive. The three-part disposal system, designated as 219-S, and wastes handled in it, are described in detail in Chapter X.

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REFERENCES

1. Plant
See reference drawings indicated on Figures XI-1 to XI-57.

2. Laboratory
(1) HDC-1781, Supplemental Project Proposal for Redox Analytical and Plant Assistance Laboratory. W. E. Johnson. 5-22-50.

(2) HW-3905, Specifications for Redox Analytical and Plant Assistance Laboratory. J. Gordon Turnbull. 6-21-49.

(3) H-11-4428 -- 1 First Floor Plan, Analytical Laboratory.

(4) H-11-4428 -- 2 First Floor Plan and Room Schedule, Multicurie Wing.

(5) H-11-4428 -- 3 Equipment Room Floor Plan.

(6) H-11-4428 -- 5 Elevations and Sections.

(7) H-11-4429 -- 1 Foundation and Tunnel Plan, Analytical Laboratory.

(8) H-11-4429 -- 2 Foundation and Tunnel Plan, Multicurie Wing.

(9) H-11-4431 -- 1 Service Tunnel, Analytical Laboratory Plumbing.

(10) H-11-4431 -- 22 Service Tunnel, Counting Room, Multicurie Wing Plumbing.

(11) H-11-4433 -- 6 Supply Air System and Details.

(12) H-11-4433 -- 7 Exhaust Air System and Details.

(13) H-11-4434 -- 7 Receptacles and Miscellaneous Power, First Floor, Analytical Laboratory.

(14) H-11-4434 --10 Receptacles and Miscellaneous Power, First Floor Multicurie Wing.

(15) H-11-4474 -- 1 Laboratory Equipment Services Layout, Analytical Laboratory.

(16) H-11-4474 -- 2 Laboratory Equipment Services Layout, Multicurie Wing.

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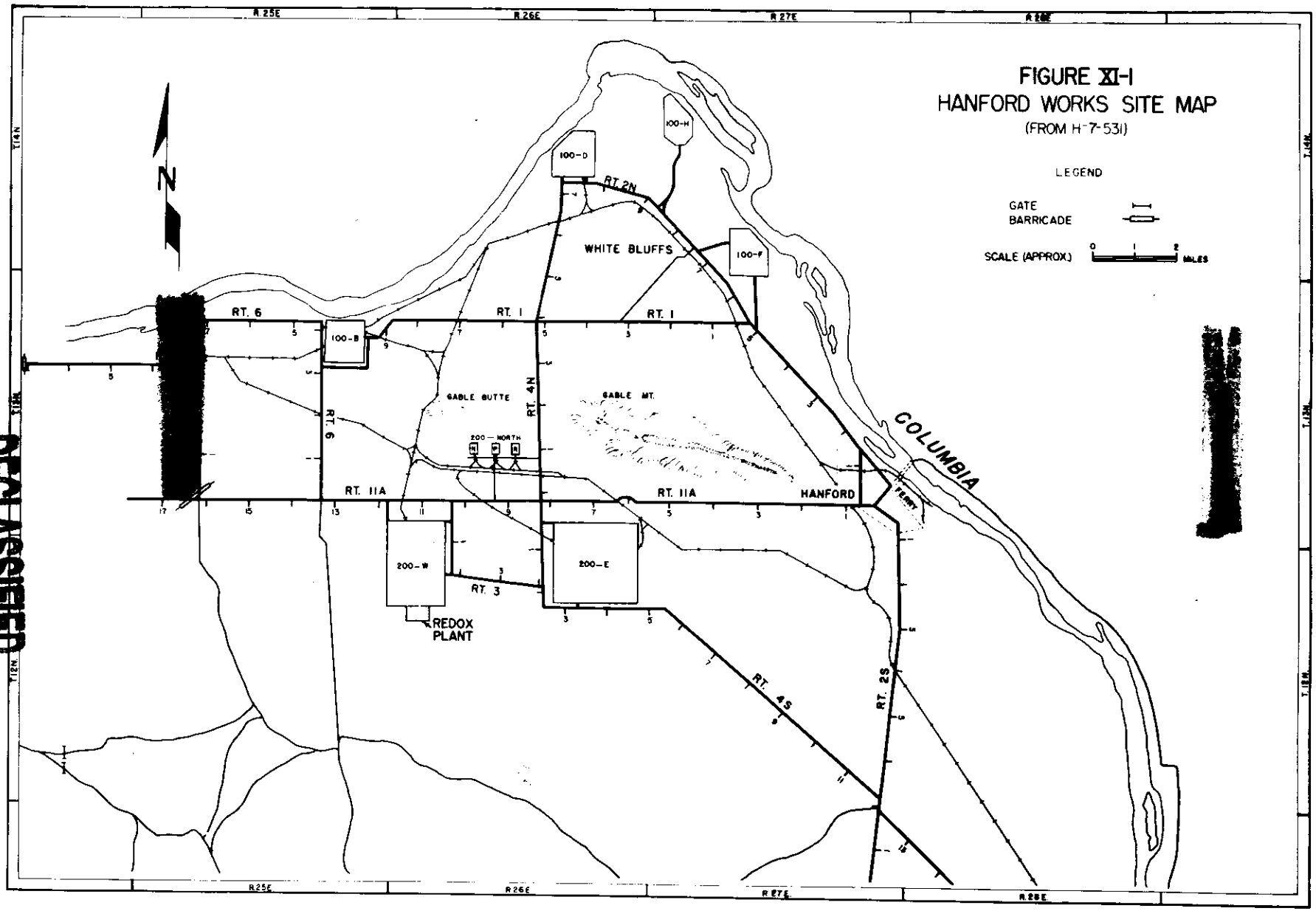

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FIGURE XI-I

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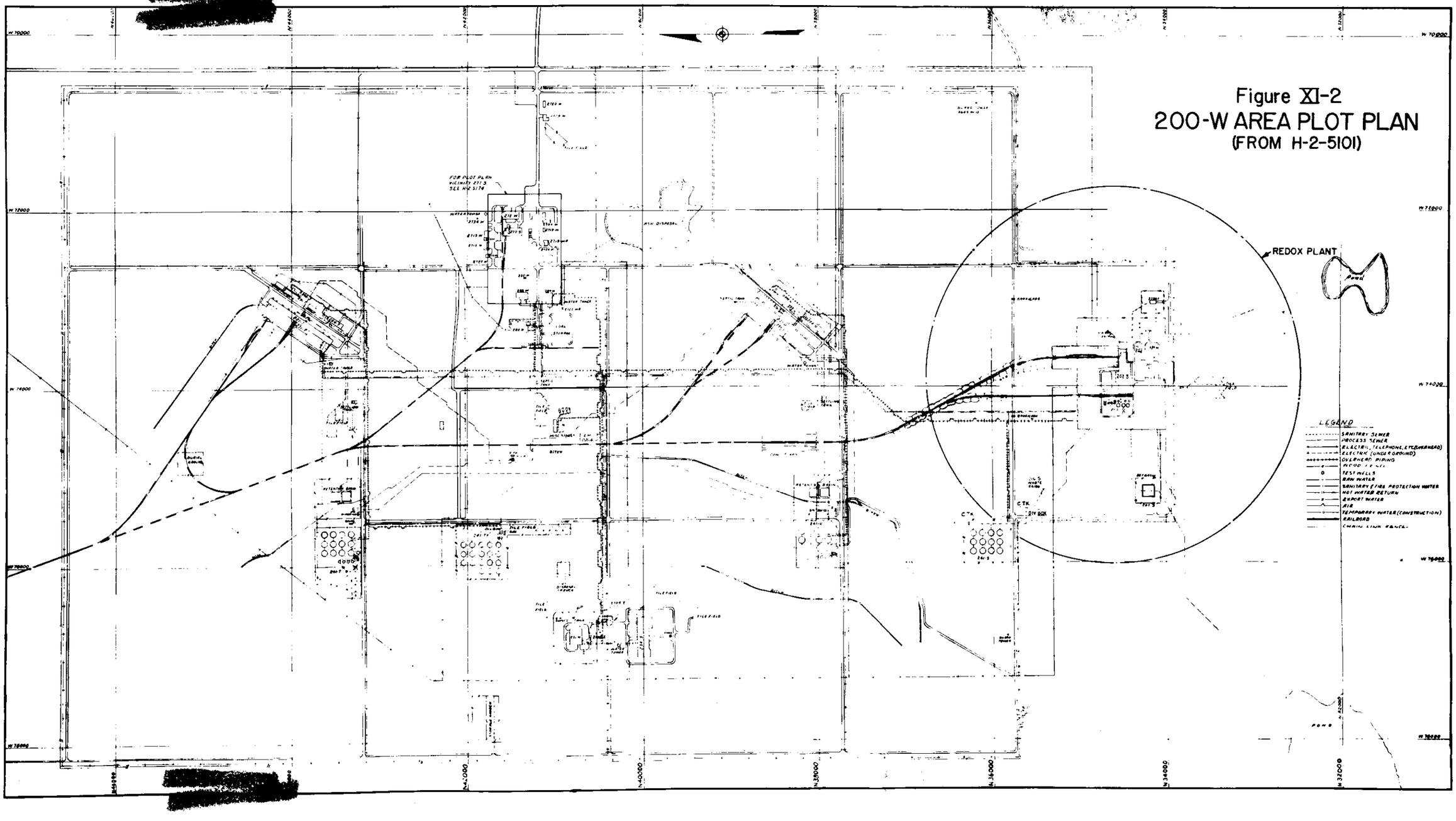

Figure XI-2
200-W AREA PLOT PLAN
(FROM H-2-5101)

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Figure XI-3
REDOX AREA PLOT PLAN
(FROM H-2-5140)

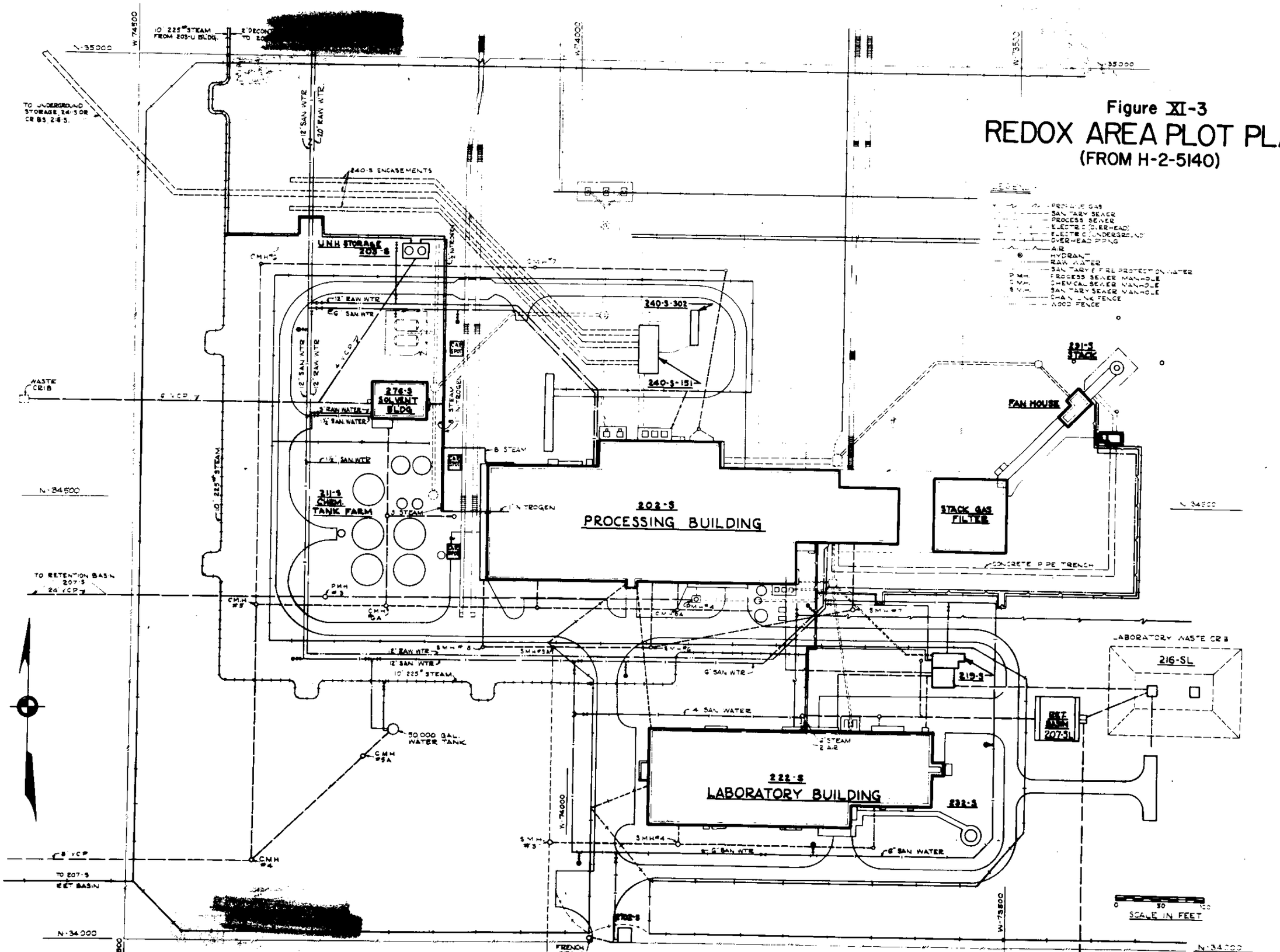

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FIGURE XI-4 REDOX PROCESS BUILDING. (FROM KLX 15-TR-135)

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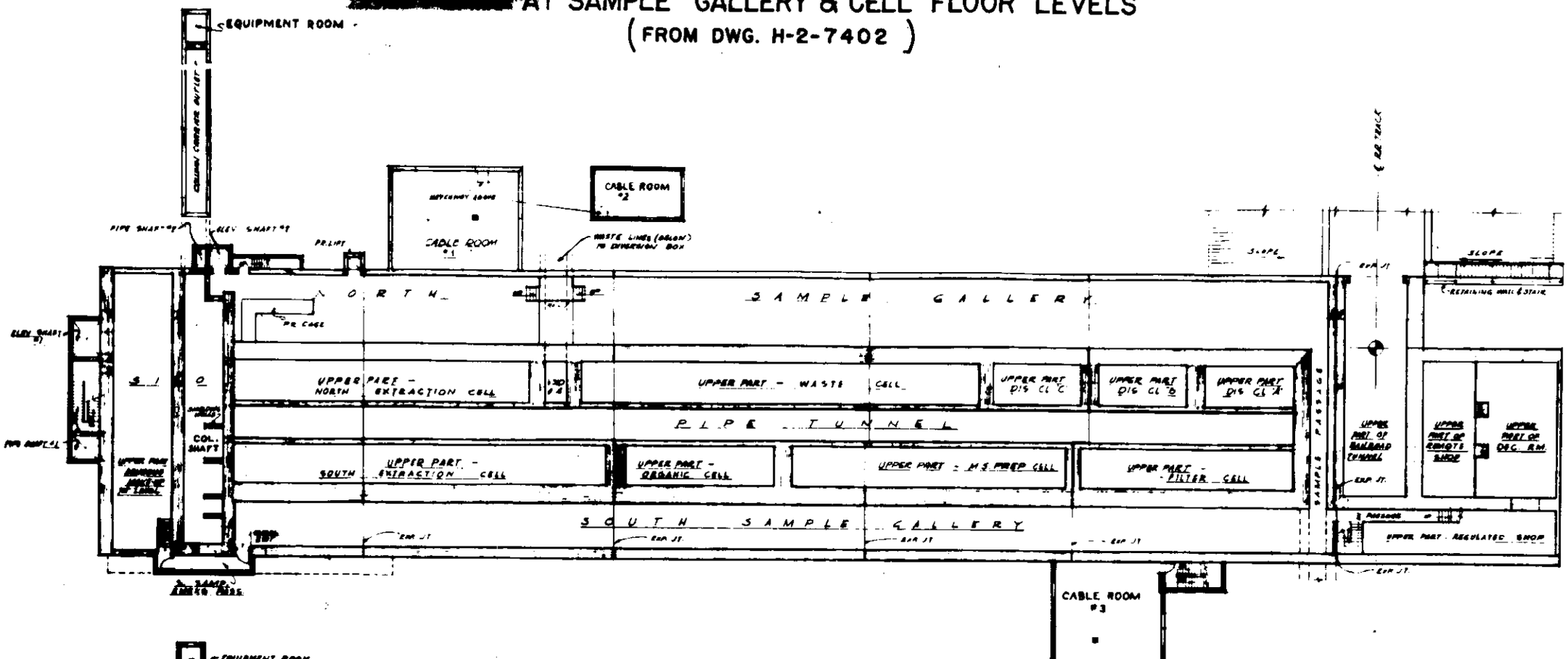
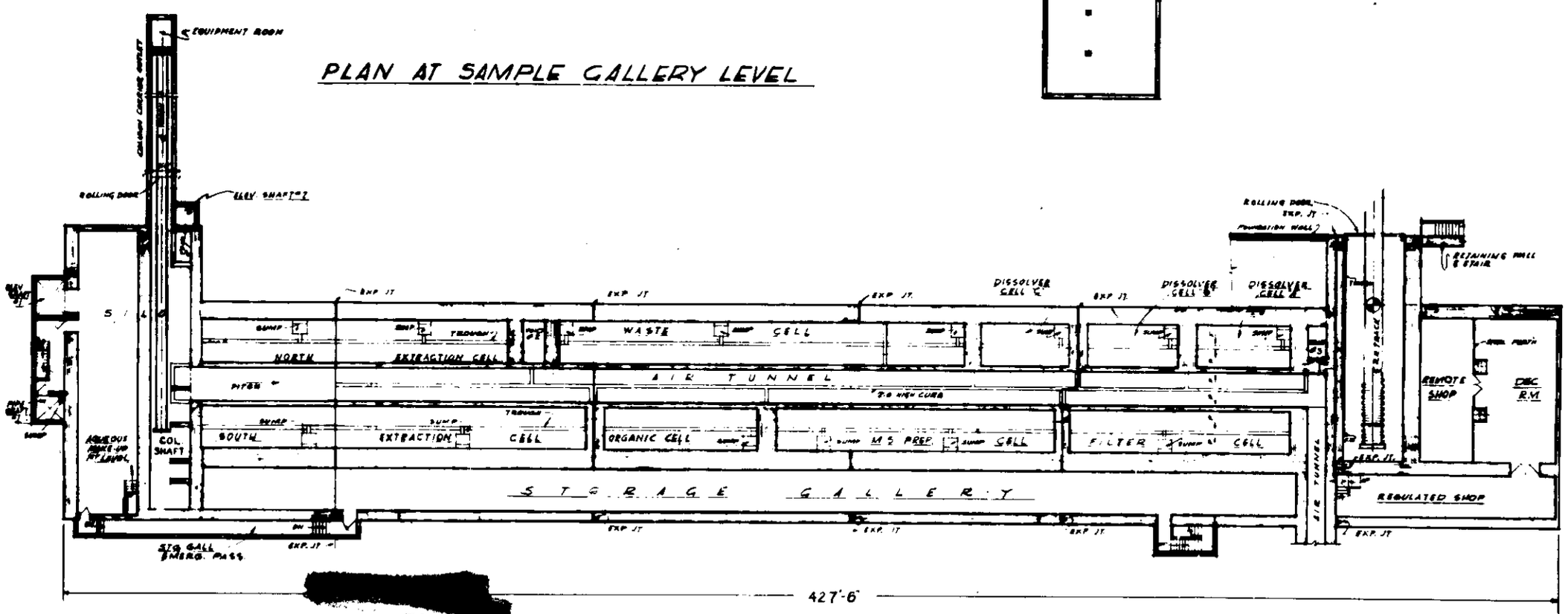
FIGURE XI-5

[redacted] AT SAMPLE GALLERY & CELL FLOOR LEVELS

(FROM DWG. H-2-7402)



PLAN AT SAMPLE GALLERY LEVEL



PLAN AT CELL FLOOR LEVEL

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FIGURE XI-6
PLAN AT PIPE GALLERY LEVEL
(FROM DWG. H-2-7403)

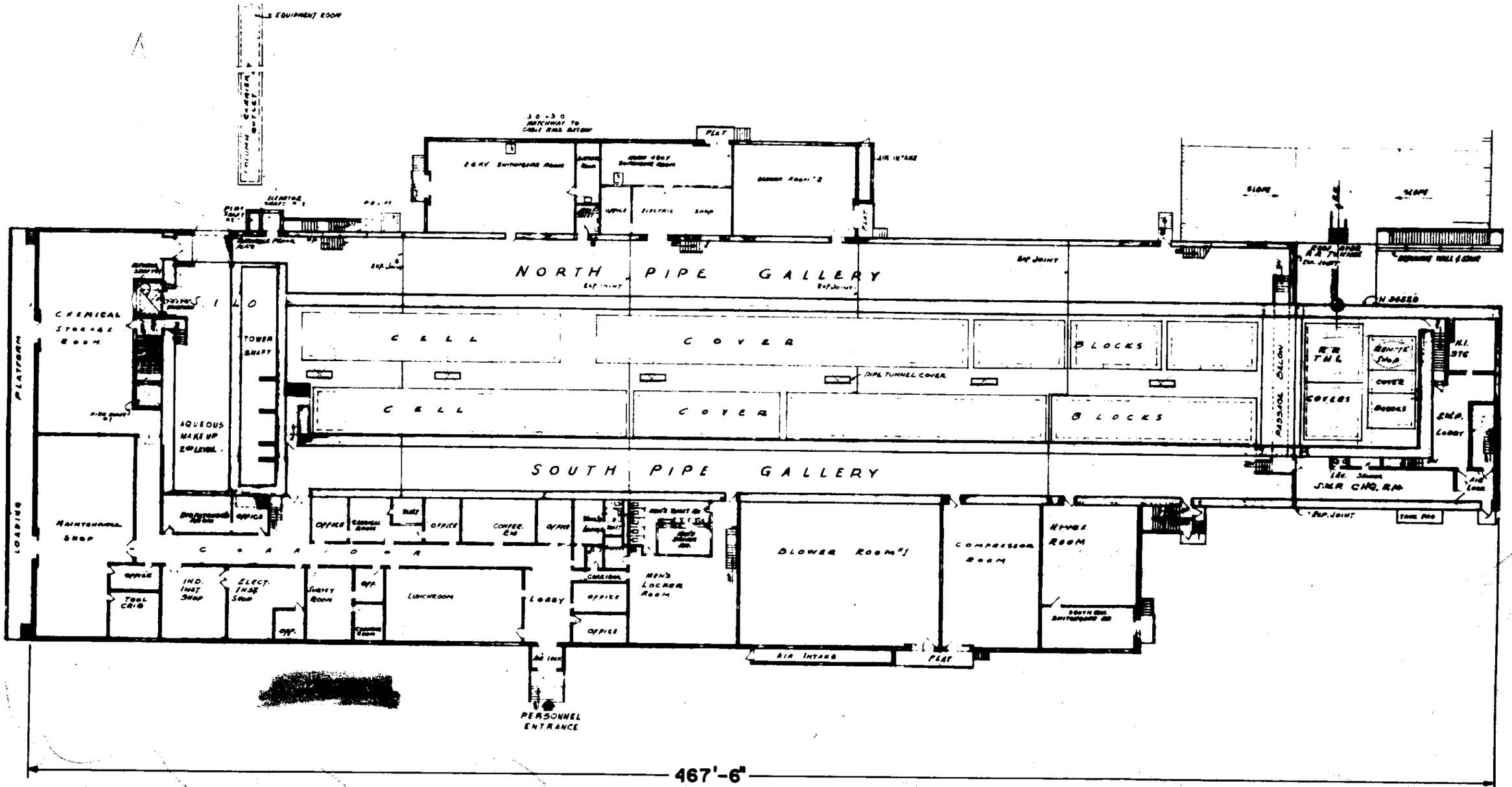

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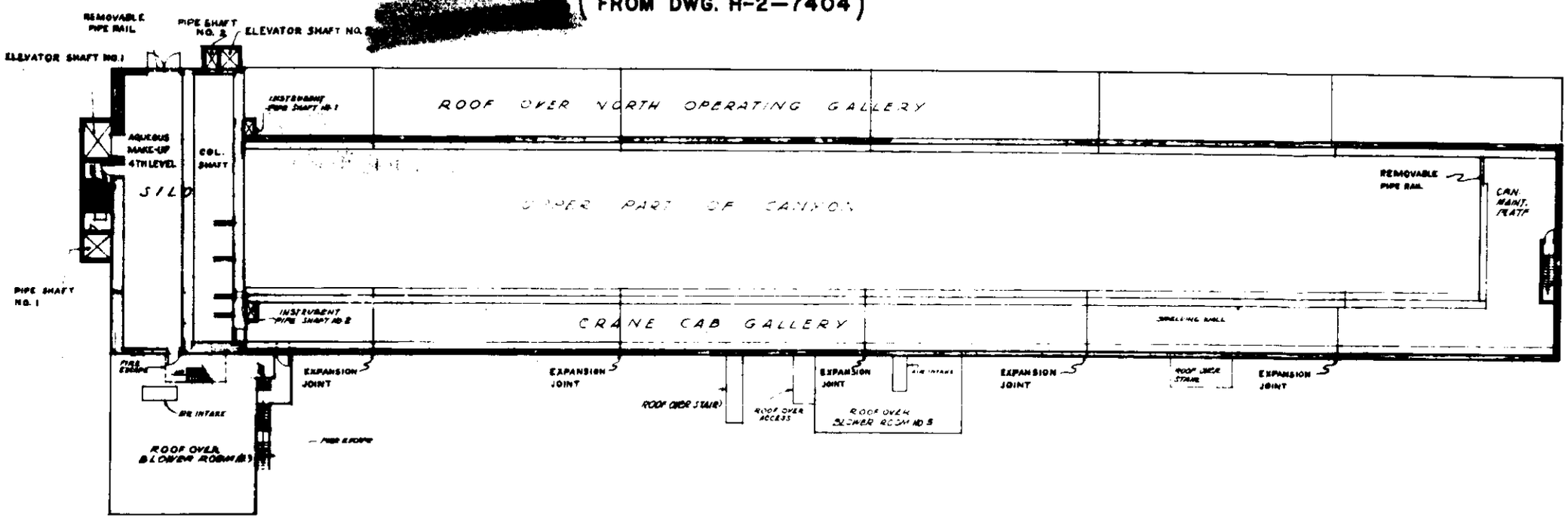
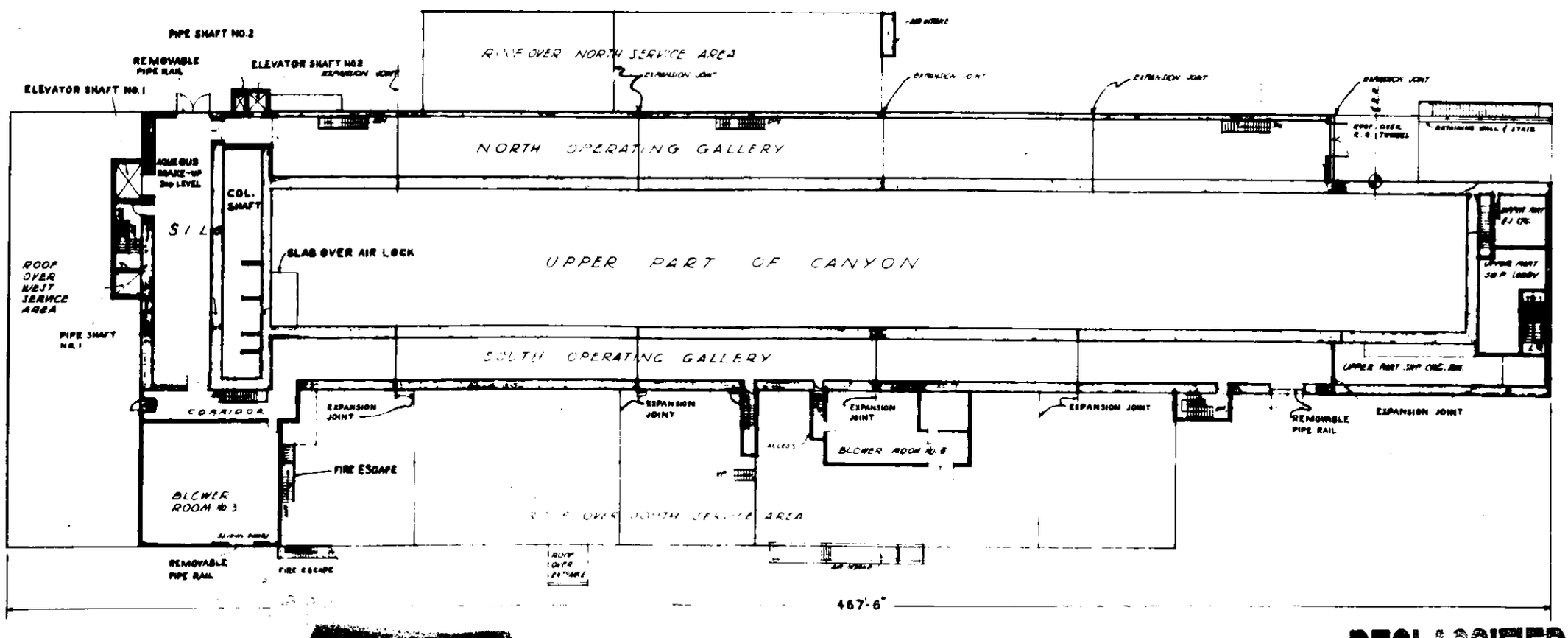
FIGURE XI-7
PLANS AT OPERATING GALLERY & CRANE CAB GALLERY LEVELS
[redacted] (FROM DWG. H-2-7404)



PLAN ABOVE CAB GALLERY LEVEL



[redacted] PLAN AT OPERATING GALLERY LEVEL

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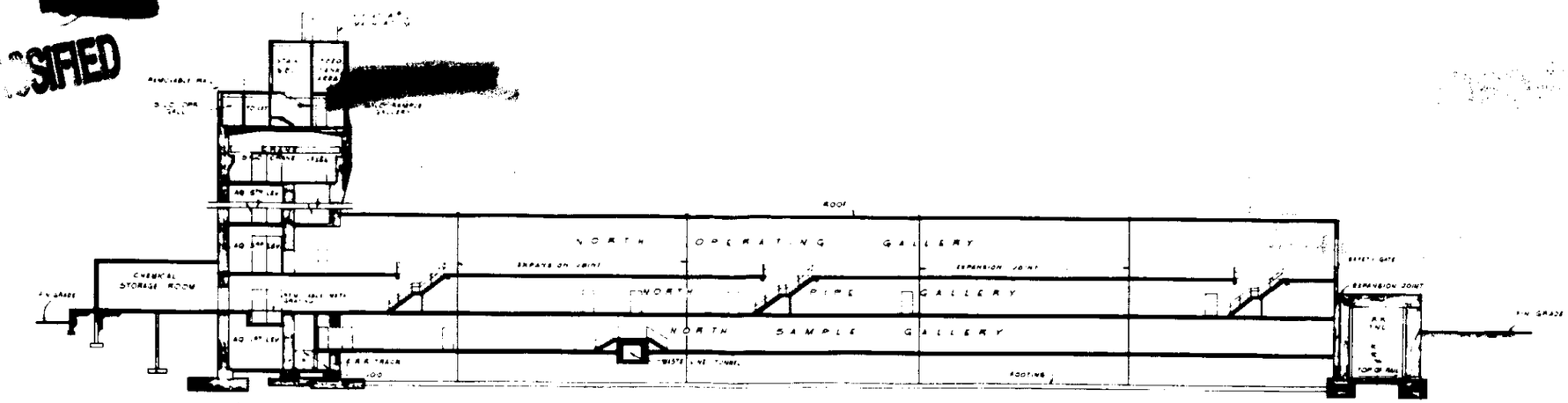
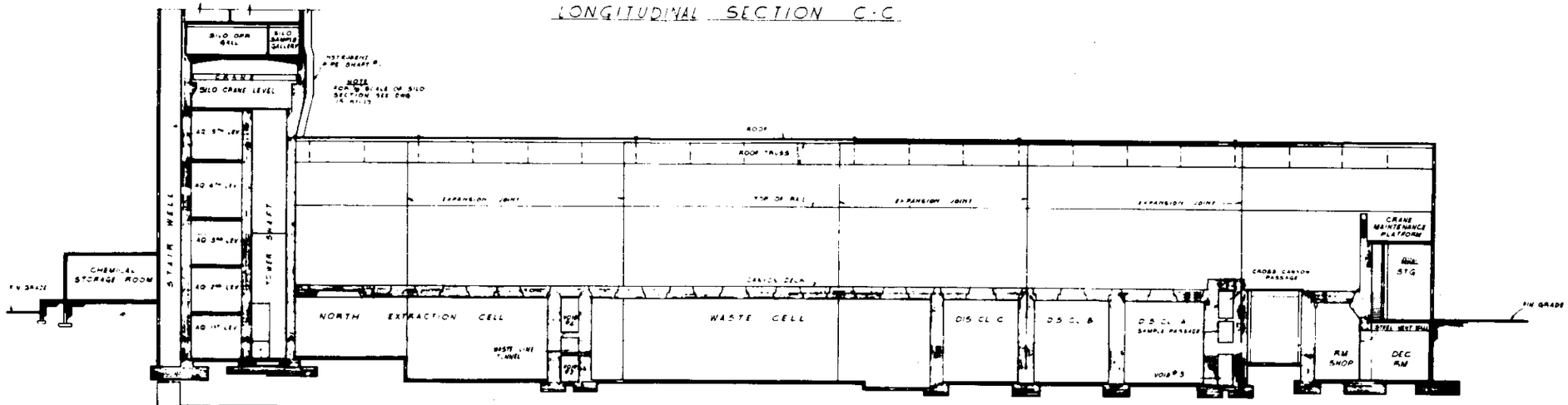
FIGURE XI-8

LONGITUDINAL SECTIONS

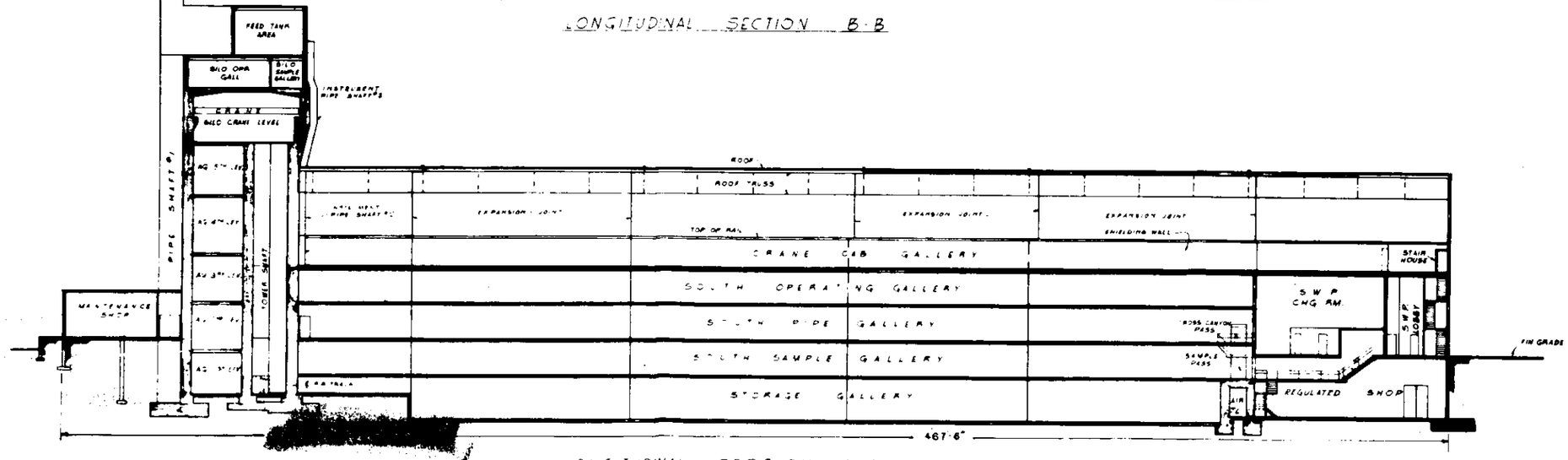
(FROM DWG. H-2-7405)



LONGITUDINAL SECTION C-C



LONGITUDINAL SECTION B-B



LONGITUDINAL SECTION A-A

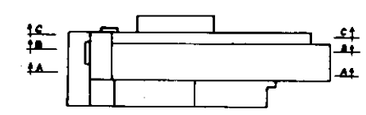


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FIGURE XI-9
PROCESS EQUIPMENT ARRANGEMENT
202-S BUILDING
(FROM H-2-8010)

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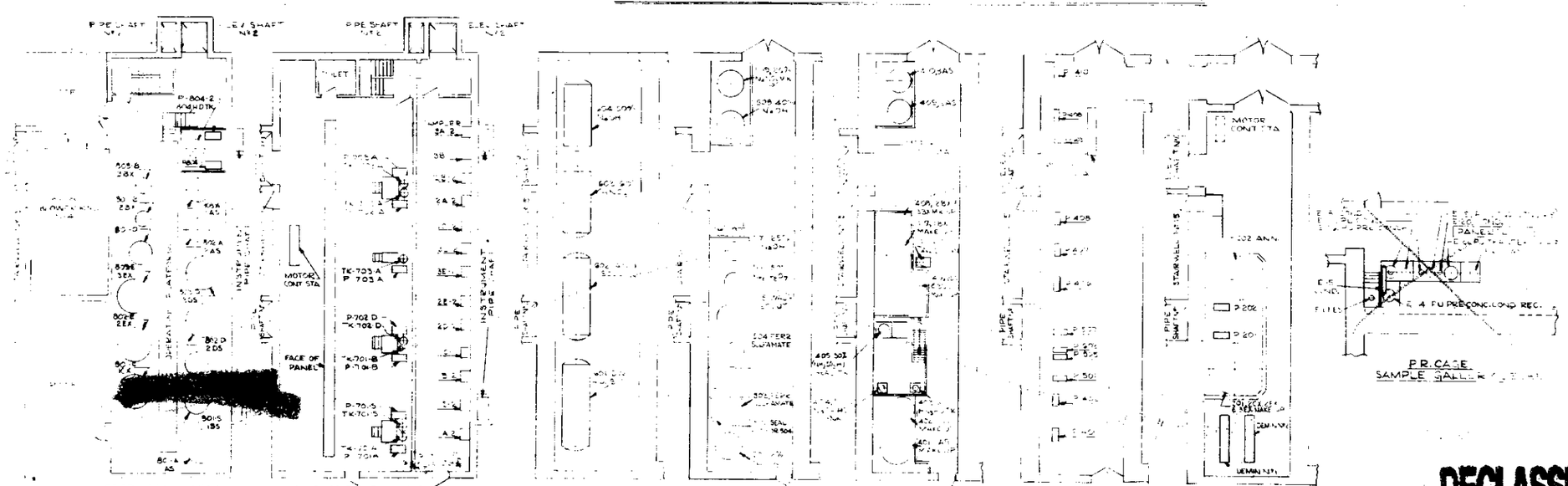

SILO PROCESSING LEVELS

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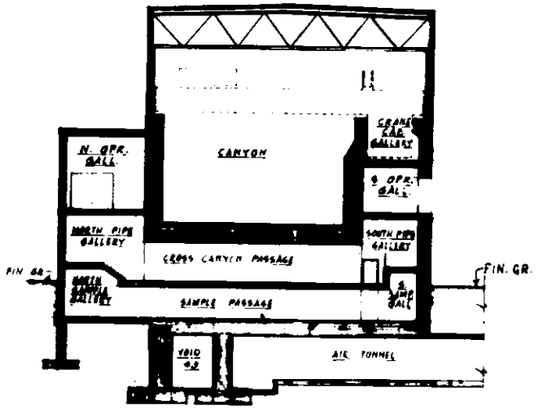
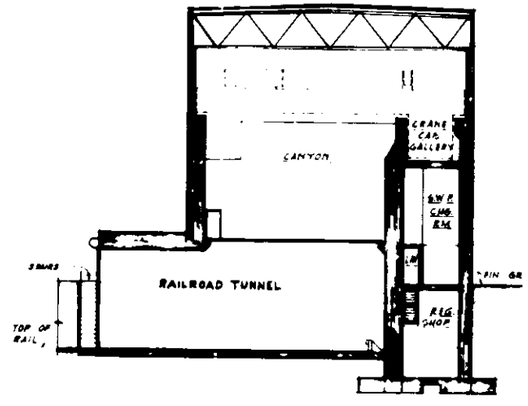
FIGURE XI-10
MISCELLANEOUS CANYON CROSS-SECTIONS
(FROM DWG. H-2-7407)



SECTION AT
CANYON CROSS PASSAGES



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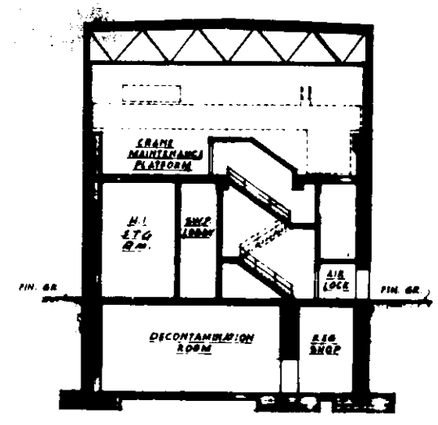
RAILROAD TUNNEL



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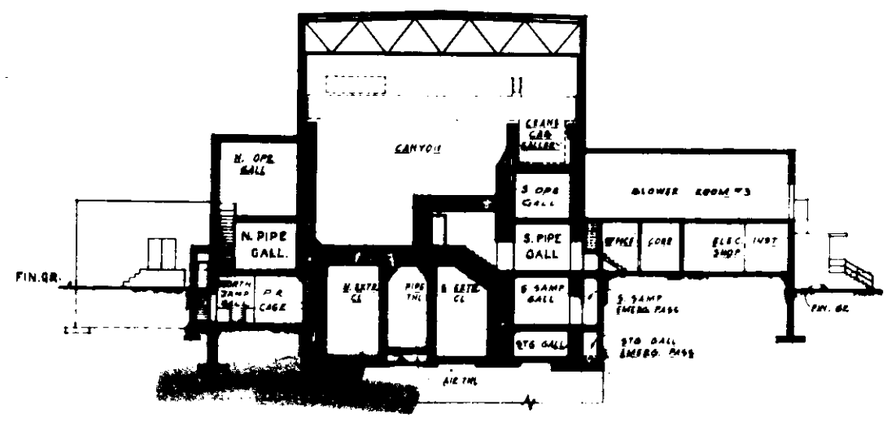
CRANE MAINTENANCE PLATFORM



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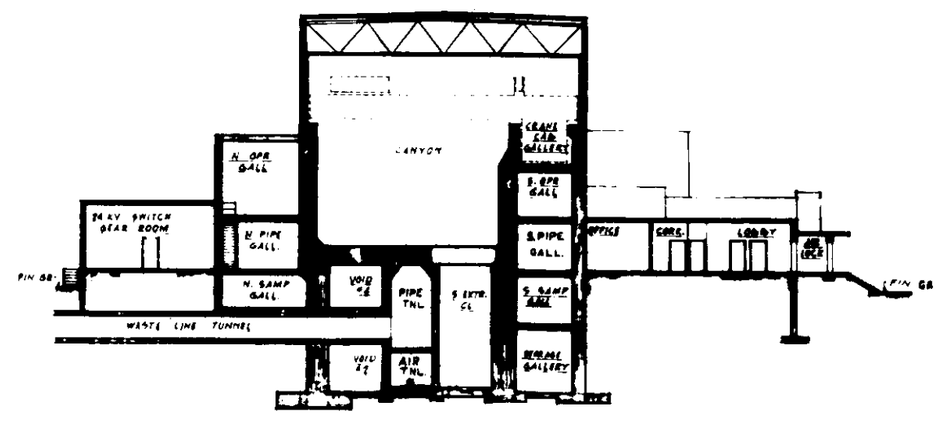
CANYON EMERGENCY EXIT



SECTION AT
WASTE LINE TUNNEL

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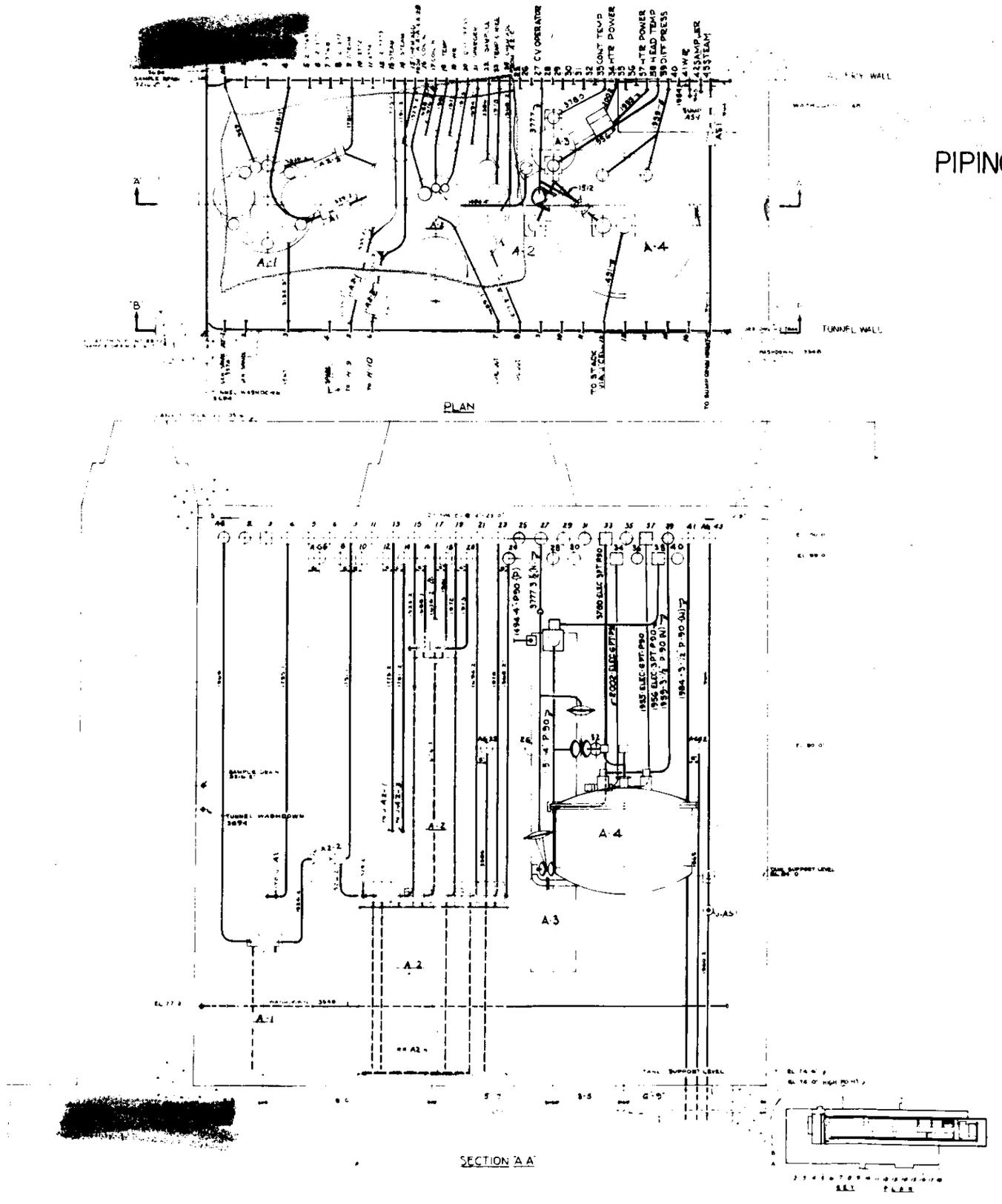

FIGURE XI-11
PIPING DIAGRAM & WALL PATTERN
CELL "A"
GALLERY WALL
(FROM DWGS. H-2-5474 & H-2-5474)

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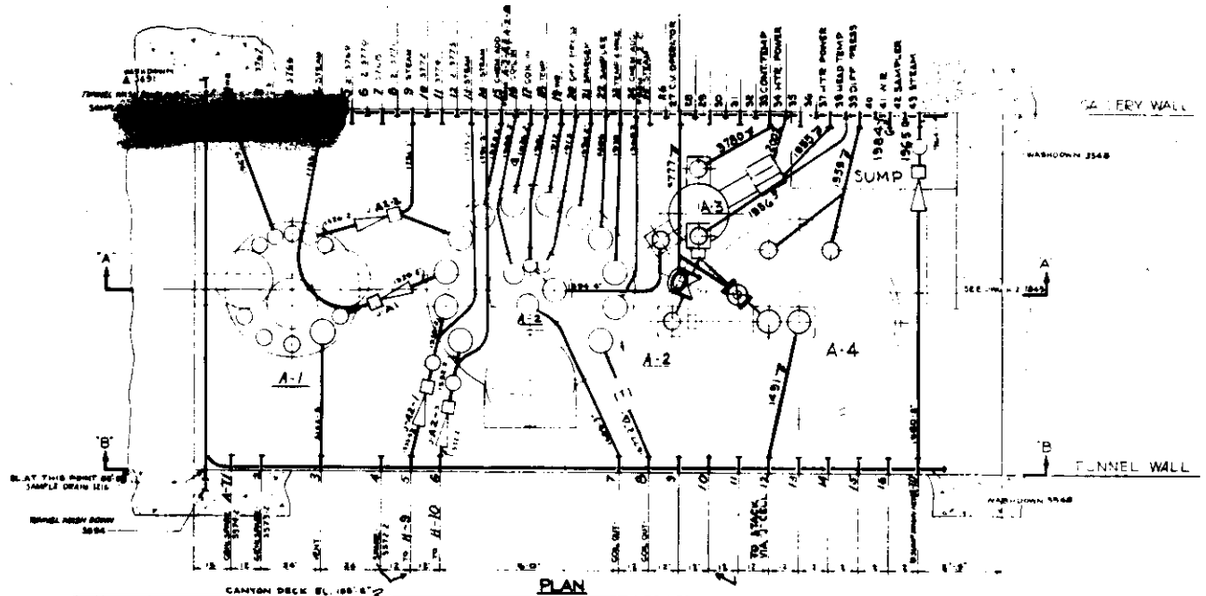

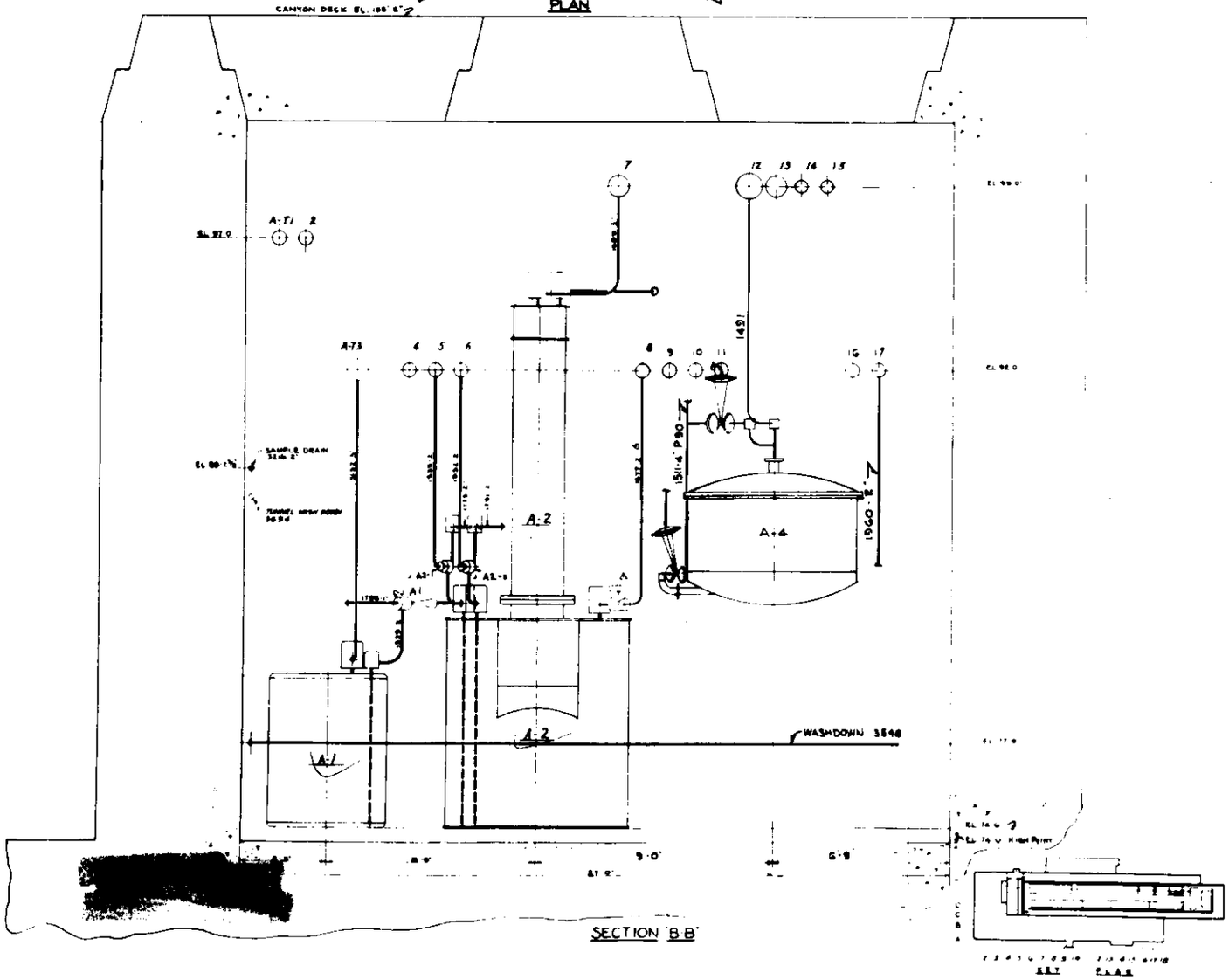

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FIGURE XI-12
PIPING DIAGRAM & WALL PATTERN
CELL "A"
TUNNEL WALL

(FROM DWGS H-2-5474 & H-2-5474)

LEGEND

EQUIP. Nº	IDENTIFICATION
A-1	RINSE TANK
A-2	DISSOLVER
A-3	OFF-GAS HTR / SILVER REACTOR
A-4	OFF-GAS FILTER.

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FIG.-XI-13

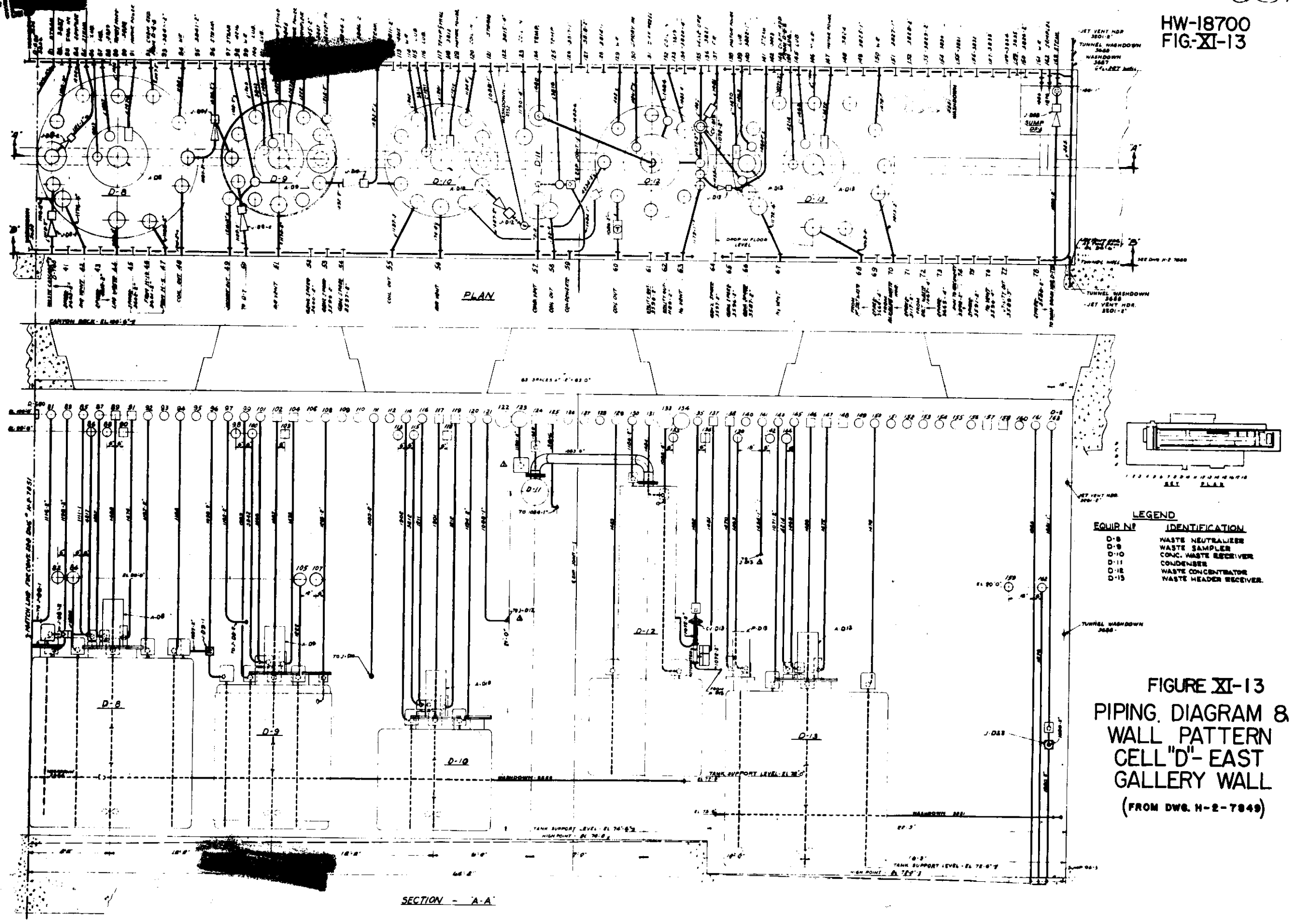

FIGURE XI-13
PIPING DIAGRAM & WALL PATTERN CELL "D"- EAST GALLERY WALL
(FROM DWG. H-2-7849)

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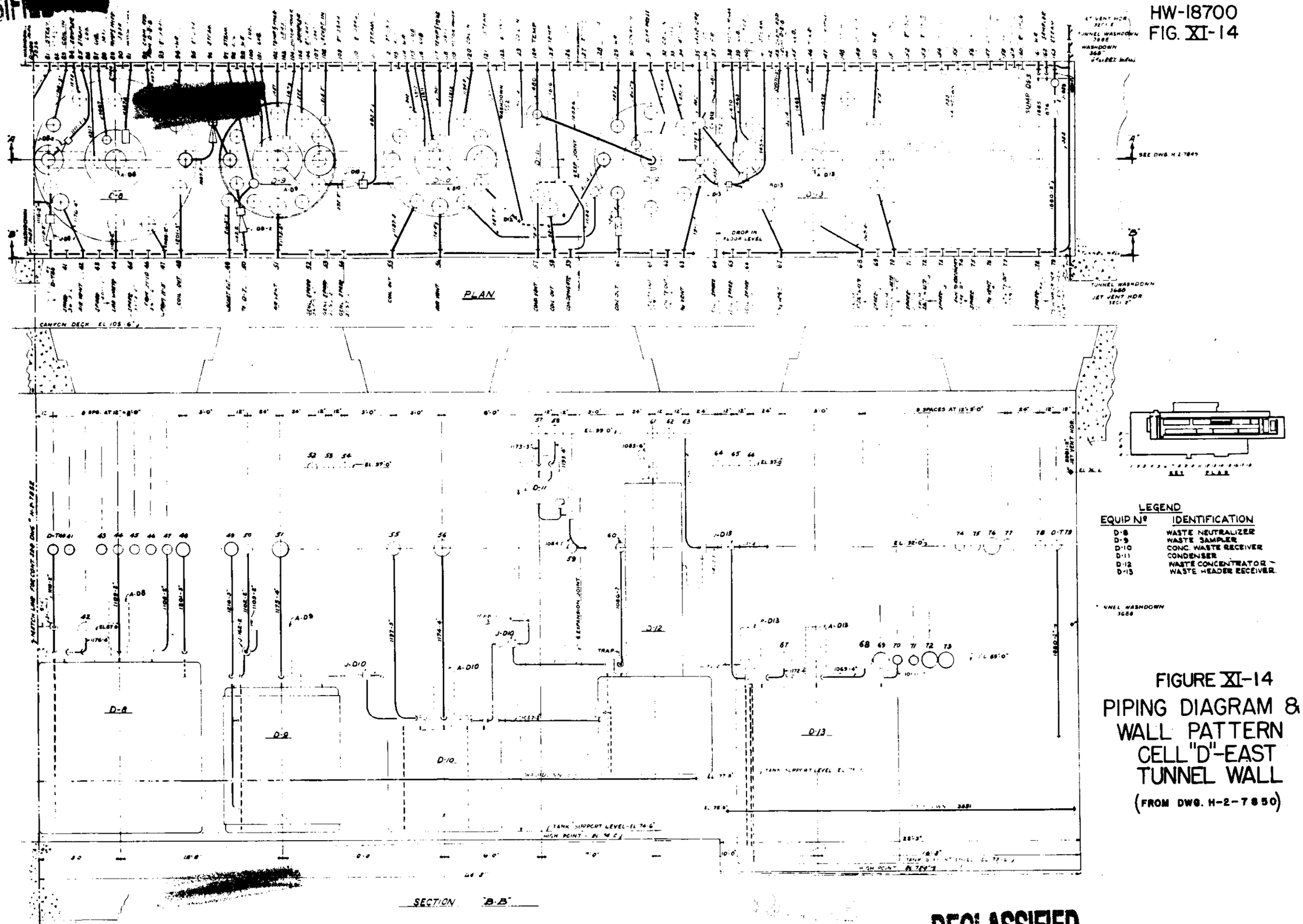

FIGURE XI-14
PIPING DIAGRAM & WALL PATTERN CELL "D"-EAST TUNNEL WALL
(FROM DWG. H-2-7850)

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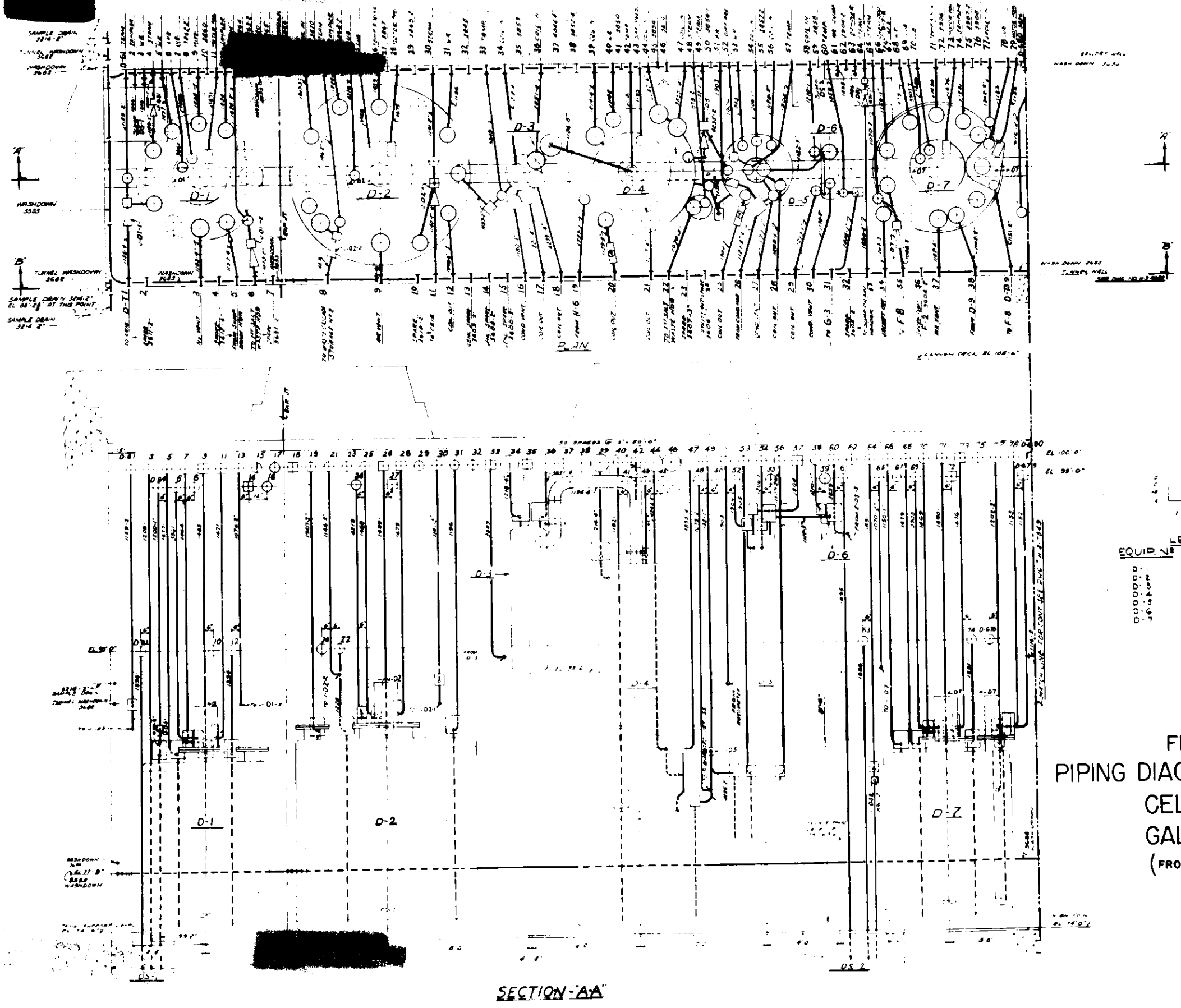

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LEGEND

EQUIP. Nº	IDENTIFICATION
D-1	SUMP DRAIN COLLECTION TANK
D-2	CONDENSATE RECEIVER
D-3	CONDENSER
D-4	CONDENSATE EVAPORATOR
D-5	CONDENSATE STRIPPER
D-6	CONDENSER
D-7	REWORK ADJUSTMENT TANK

FIGURE XI-15
PIPING DIAGRAM & WALL PATTERN
CELL "D"-WEST
GALLERY WALL
(FROM DWG. H-2-7851)

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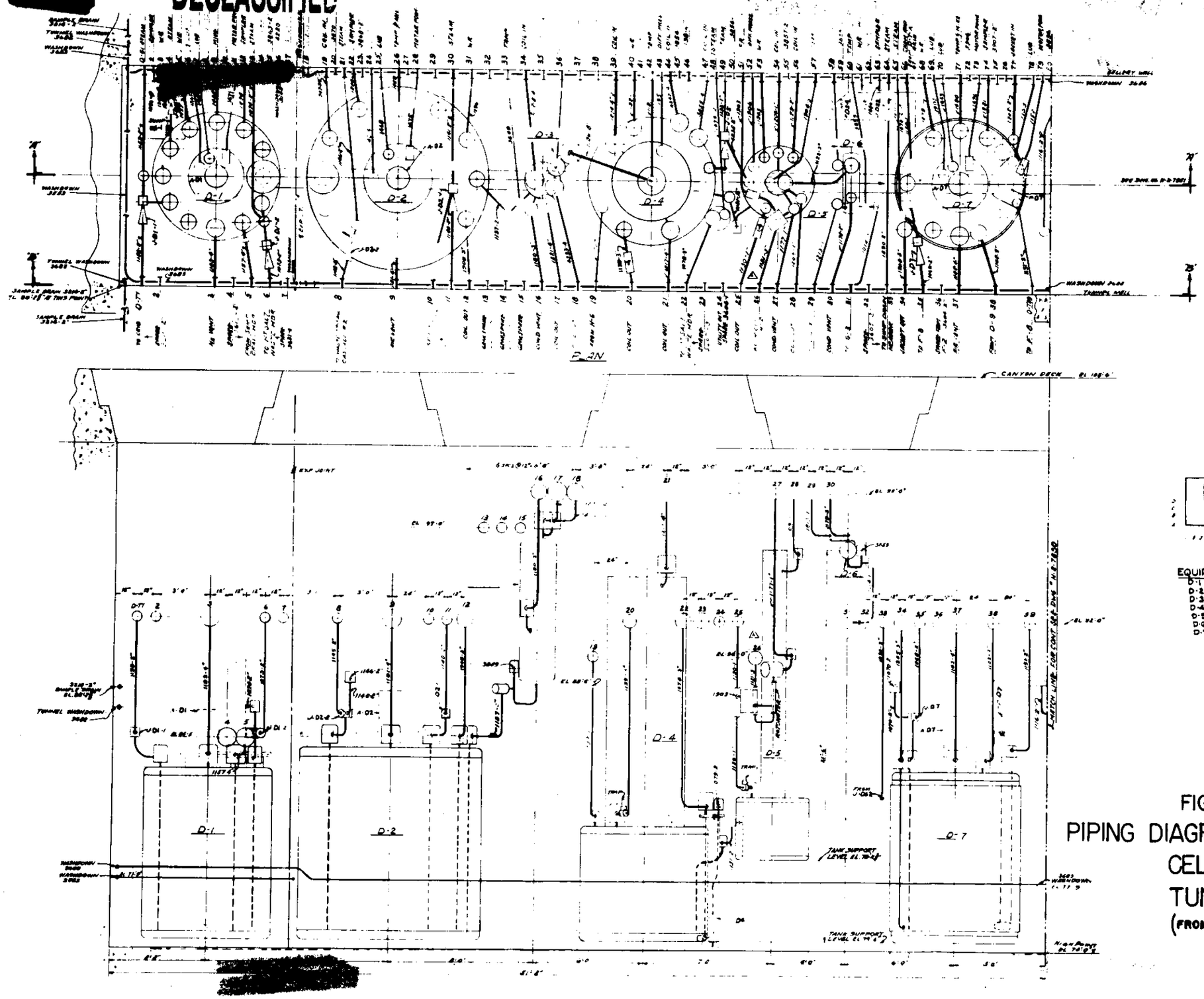

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EQUIP Nº	IDENTIFICATION
D-1	SUMP DRAIN COLLECTION TANK
D-2	CONDENSATE RECEIVER
D-3	CONDENSER
D-4	CONDENSATE EVAPORATOR
D-5	CONDENSATE STRIPPER
D-6	CONDENSER
D-7	REWORK ADJUSTMENT TANK

FIGURE XI-16
PIPING DIAGRAM & WALL PATTERN
CELL "D"-WEST
TUNNEL WALL
(FROM DWG. H-2-7852)

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FIG.-XI-17

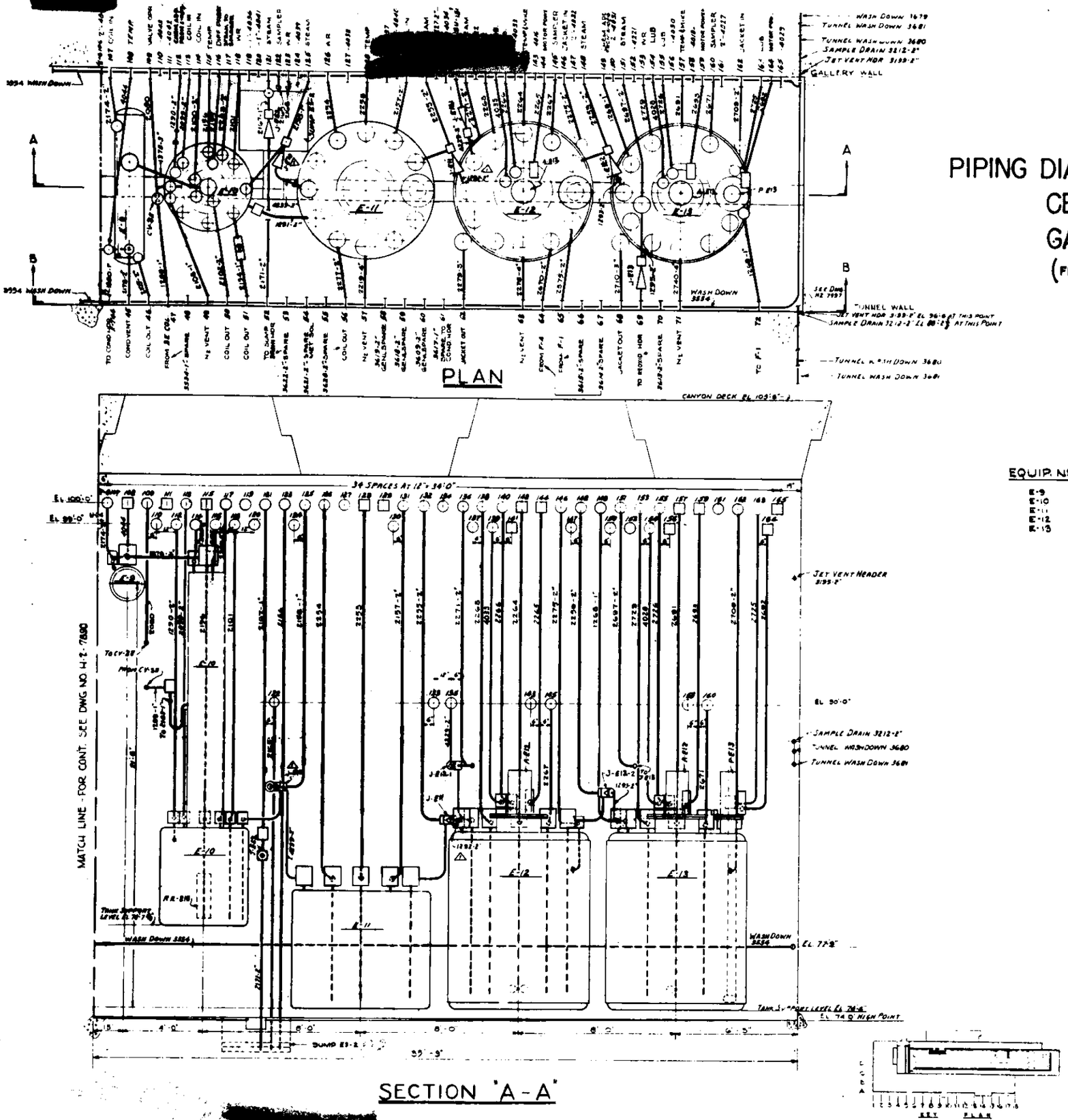

FIGURE XI-17
PIPING DIAGRAM & WALL PATTERN
CELL "E"-EAST
GALLERY WALL
(FROM DWG. H-2-7853)

LEGEND

EQUIP. Nº	IDENTIFICATION
E-9	CONDENSER
E-10	SEU CONCENTRATOR
E-11	SEU CONC. RECEIVER
E-12	SEU SAMPLER
E-13	REWORK 2DF TANK.

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FIG. XI-18

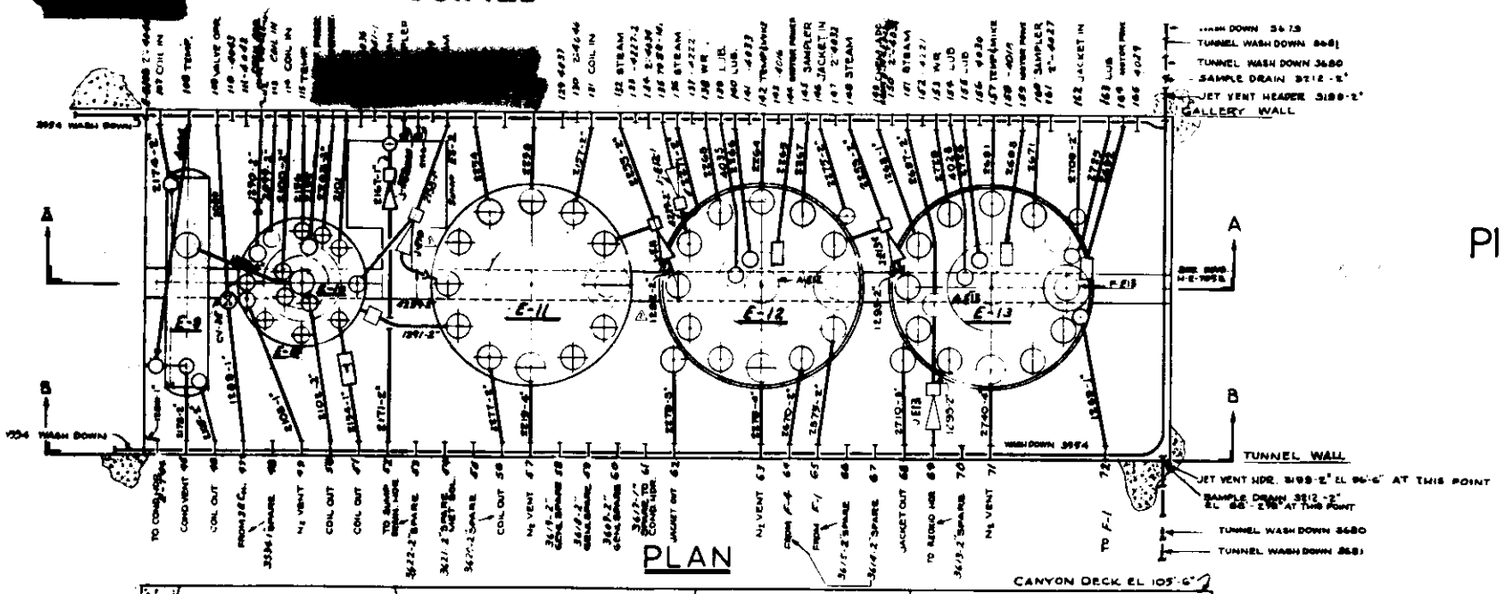
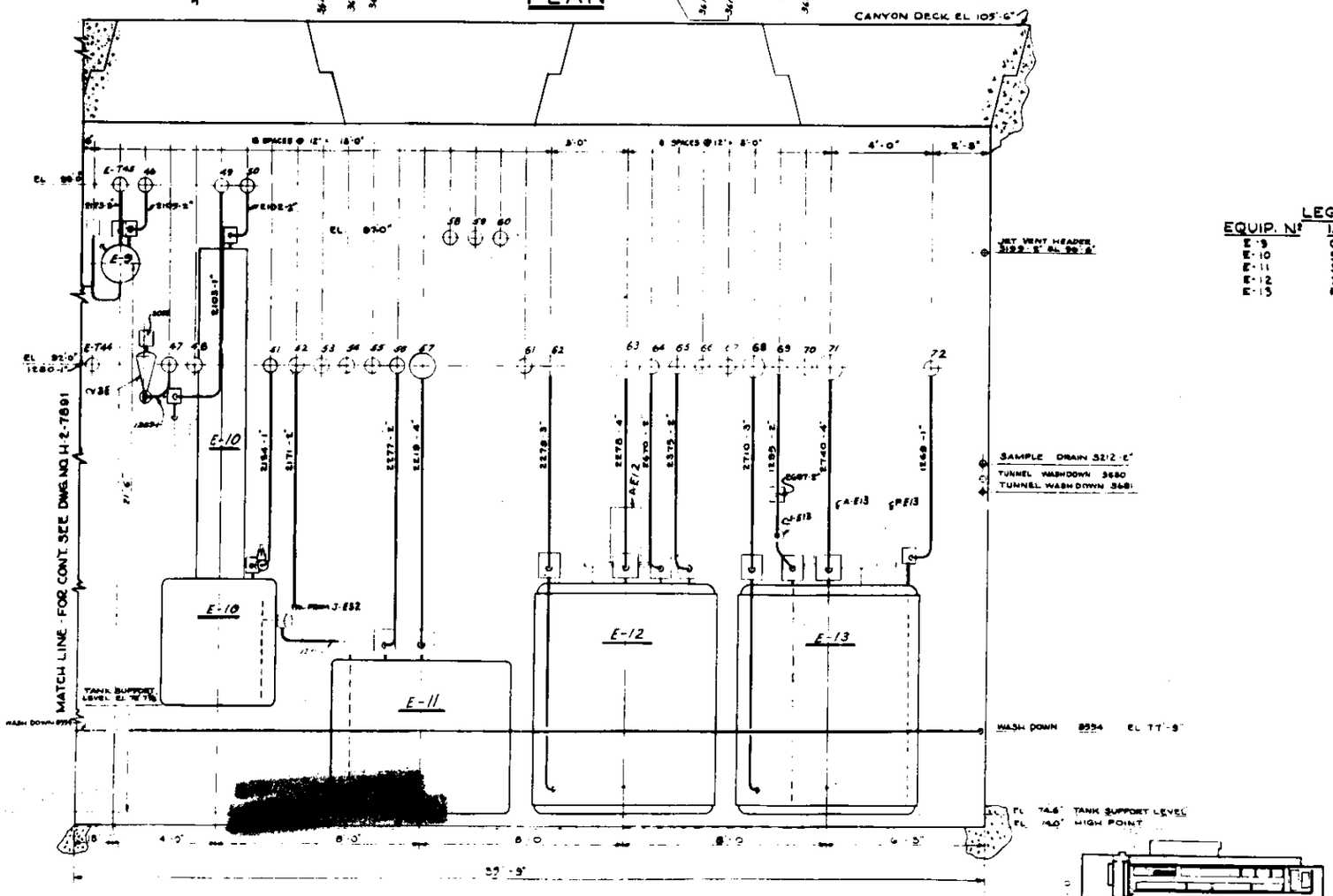


FIGURE XI-18
PIPING DIAGRAM & WALL PATTERN
CELL "E"-EAST
TUNNEL WALL
(FROM DWG. H-2-7997)



SECTION 'B - B'

LEGEND

EQUIP. Nº	IDENTIFICATION
E-9	CONDENSER
E-10	SEU CONCENTRATOR
E-11	SEU CONC. RECEIVER
E-12	SEU SAMPLER
E-13	REWORK 20F TANK.

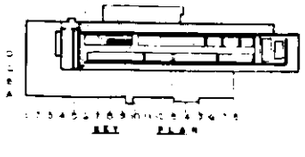


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FIG. XI-19

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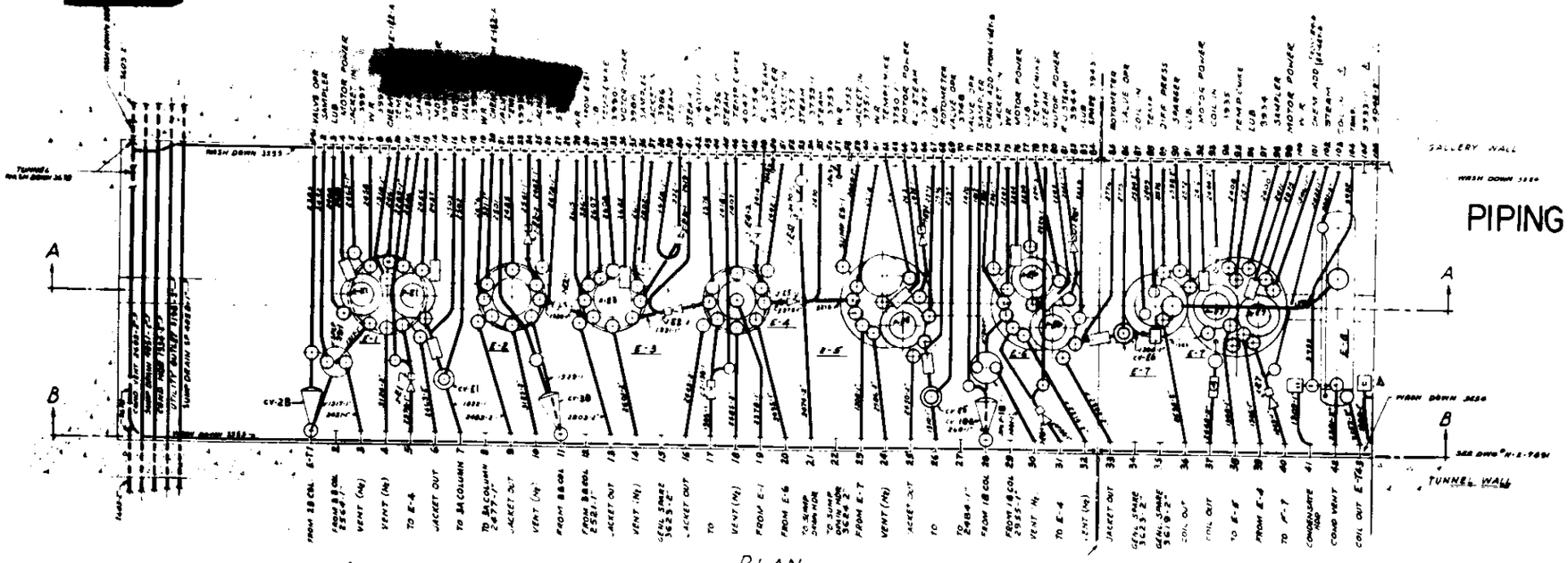


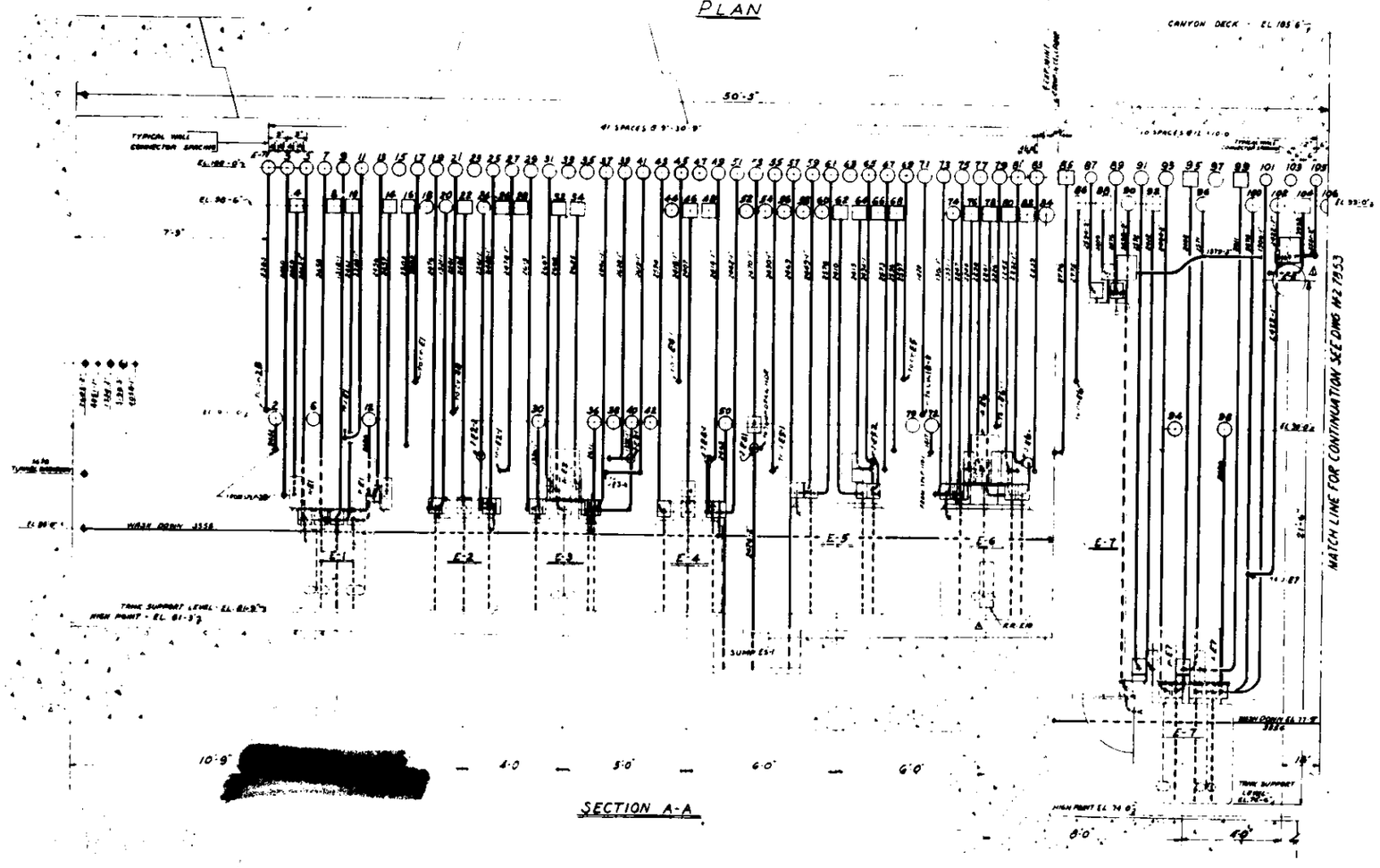
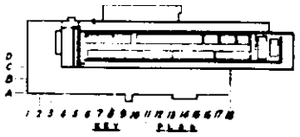


FIGURE XI-19
PIPING DIAGRAM & WALL PATTERN
CELL "E" - WEST
GALLERY WALL
(FROM DWG. H-2-7890)



LEGEND

EQUIP Nº	IDENTIFICATION
E-1	3A FEED TANK
E-2	3BP RECEIVER
E-3	3BP SAMPLER
E-4	3BP REWORK
E-5	1A FEED TANK
E-6	1BP RECEIVER
E-7	CROSS-OVER OXIDIZER
E-8	CONDENSER.

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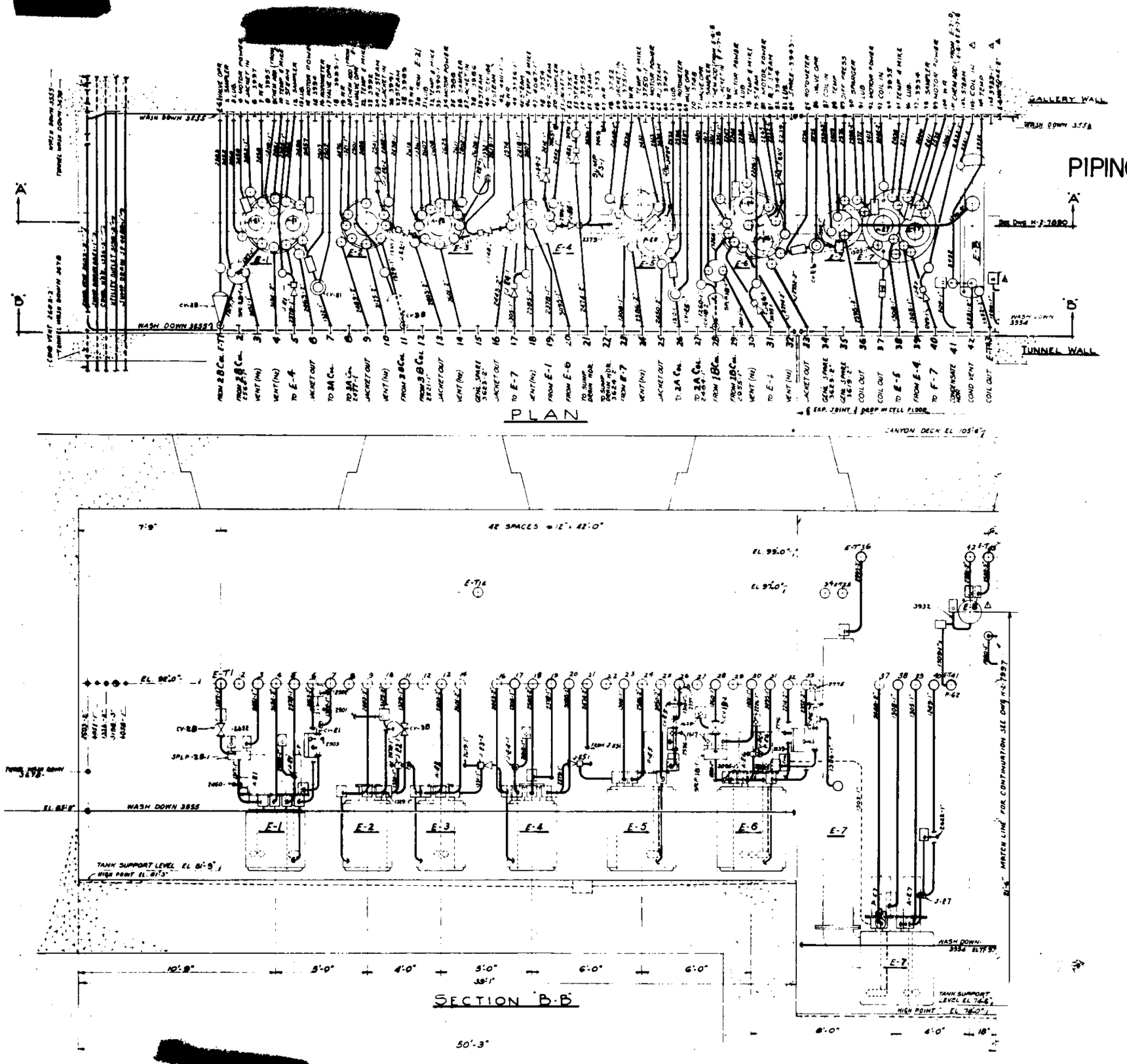
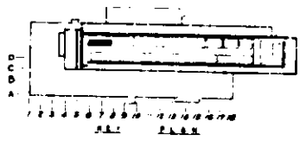
FIGURE XI-20
PIPING DIAGRAM & WALL PATTERN CELL "E"-WEST TUNNEL WALL
(FROM DWG. H-2-7891)





LEGEND

EQUIP Nº	IDENTIFICATION
E-1	3A FEED TANK
E-2	3BP RECEIVER
E-3	3BP SAMPLER
E-4	3BP REWORK
E-5	2A FEED TANK
E-6	1BP RECEIVER
E-7	CROSSOVER OXIDIZER
E-8	CONDENSER.

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FIG. XI-21

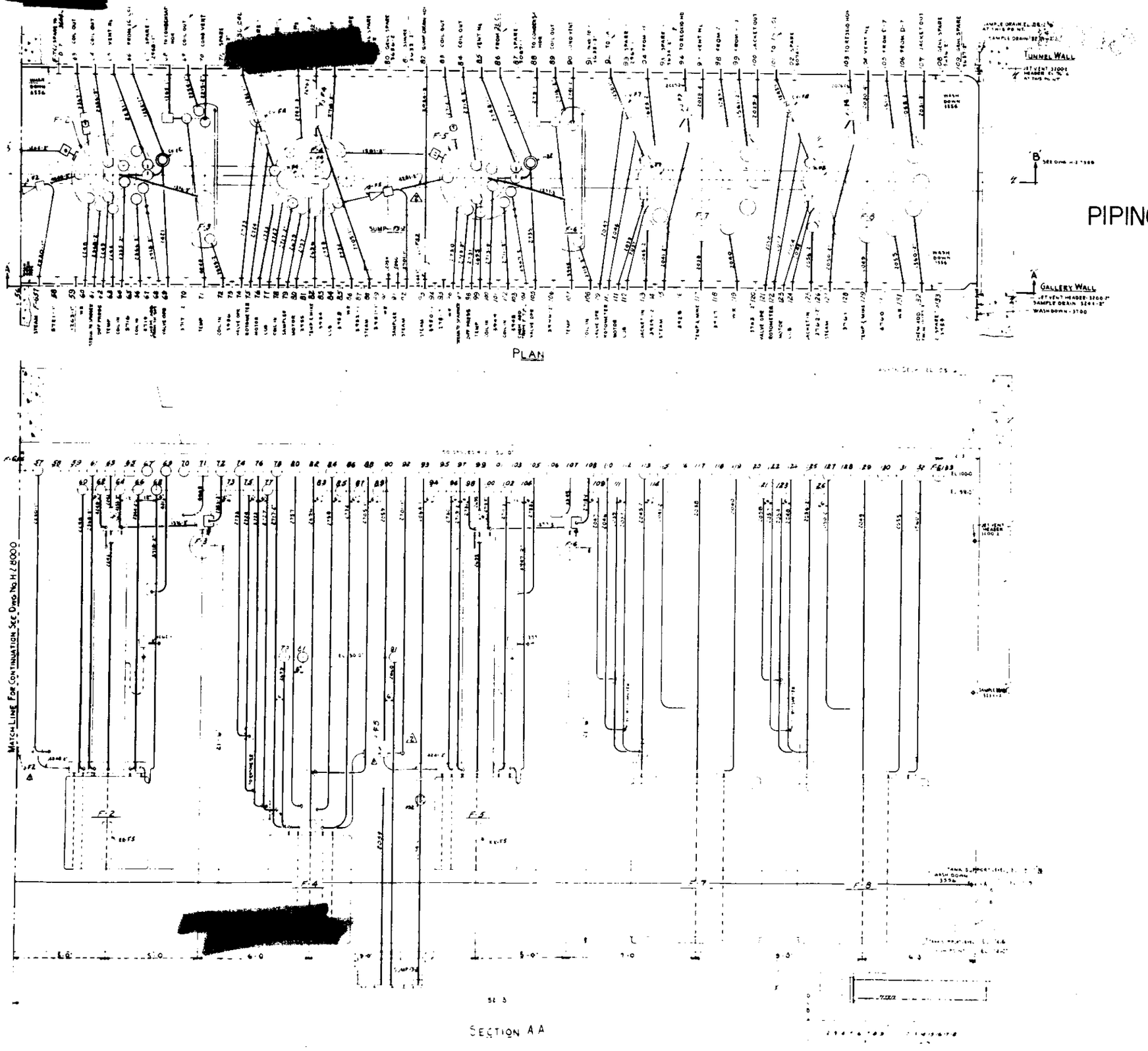

FIGURE XI-21
PIPING DIAGRAM & WALL PATTERN
CELL "F" EAST
GALLERY WALL
(FROM DWG. H-2-7996)

LEGEND

EQUIP. Nº	IDENTIFICATION
F-2	1CU CONCENTRATOR
F-3	CONDENSER
F-4	3D FEED TANK
F-5	2CU CONCENTRATOR
F-6	CONDENSER
F-7	1A FEED TANK
F-8	1S FEED TANK

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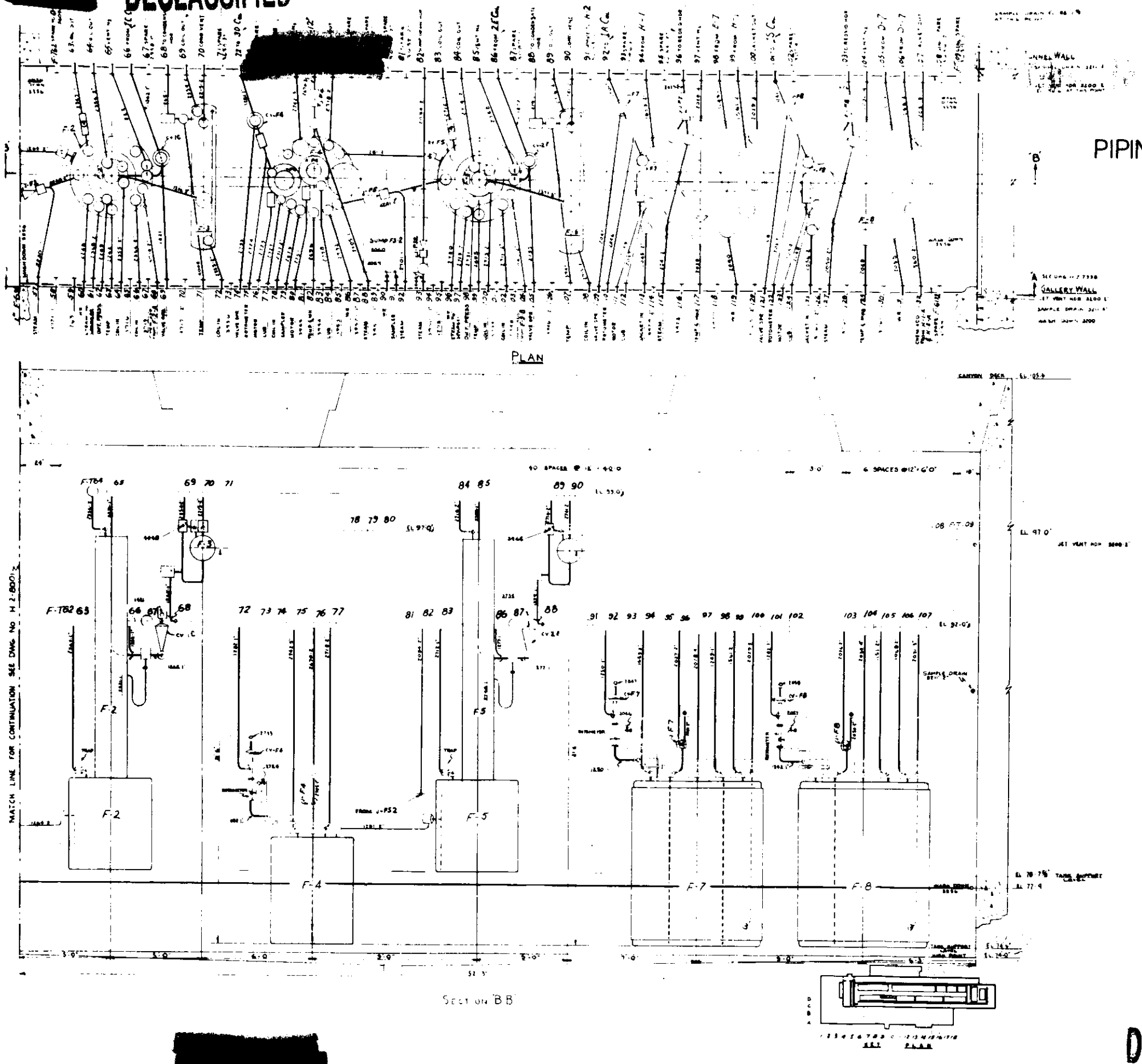

FIGURE XI-22
PIPING DIAGRAM & WALL PATTERN
CELL "F"-EAST
TUNNEL WALL
(FROM DWG. H-2-7999)

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VALVES & SAMPLE POTS

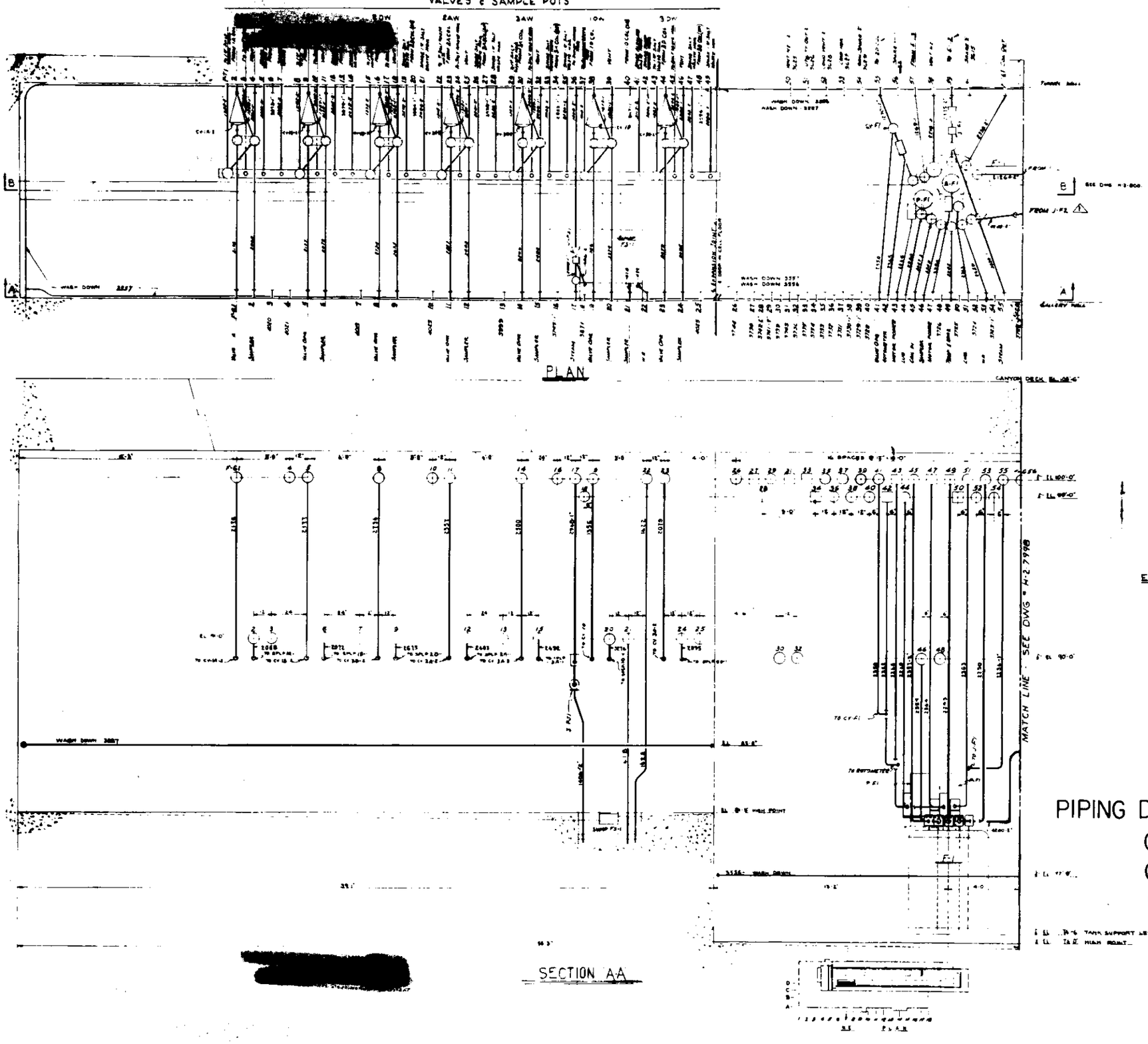

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FIGURE XI-23
PIPING DIAGRAM & WALL PATTERN
CELL "F" - WEST
GALLERY WALL
(FROM DWG. H-2-8000)

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FIG. XI-25

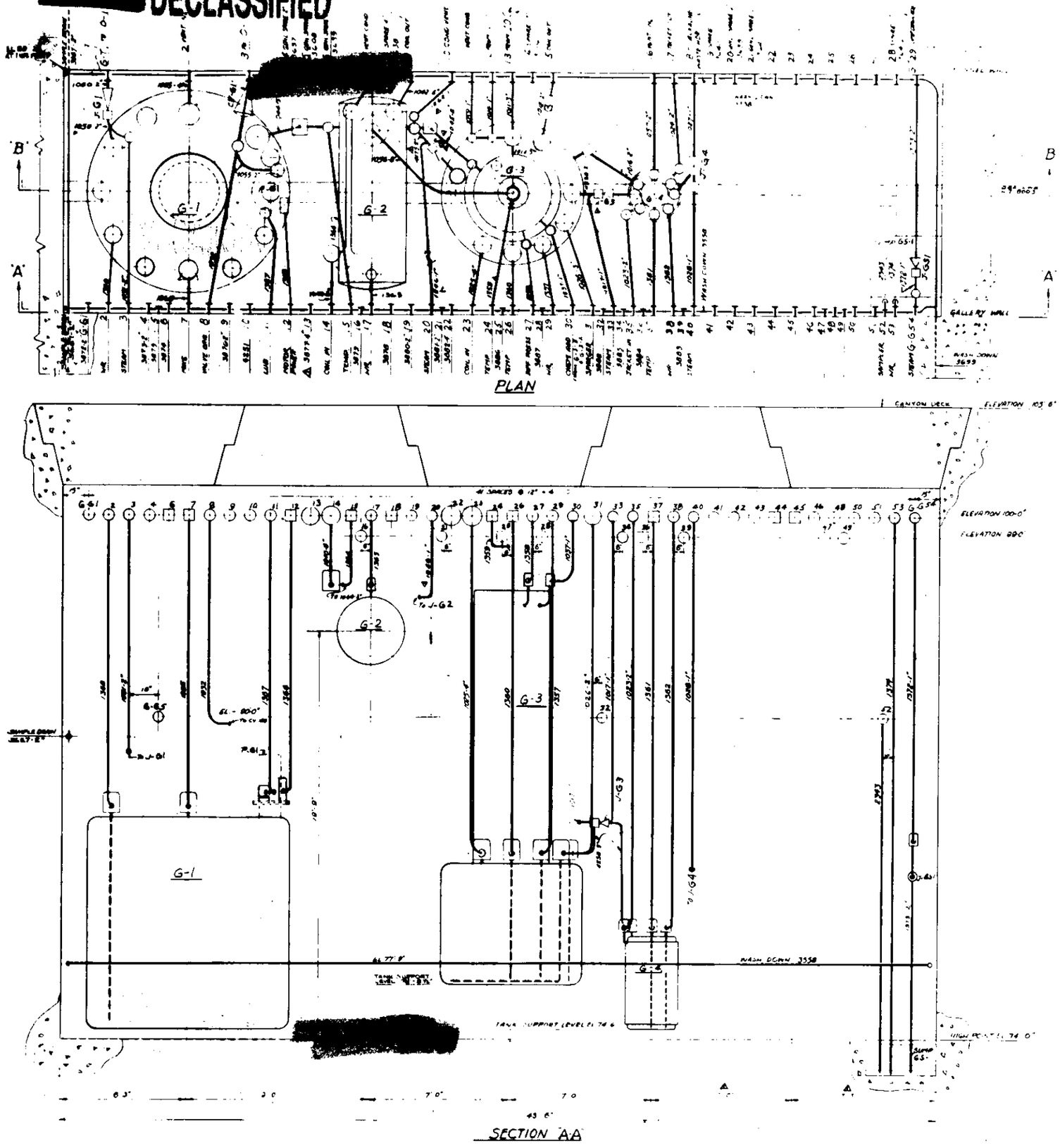

FIGURE XI-25
PIPING DIAGRAM & WALL PATTERN
CELL "G"
GALLERY WALL
(FROM DWGS. H-2-8002 & H-2-5470)

LEGEND

EQUIP Nº	IDENTIFICATION
G-1	ORGANIC SURGE TANK
G-2	CONDENSER & PHASE SEPARATOR
G-3	ORGANIC STILL
G-4	ORGANIC WASTE RECEIVER

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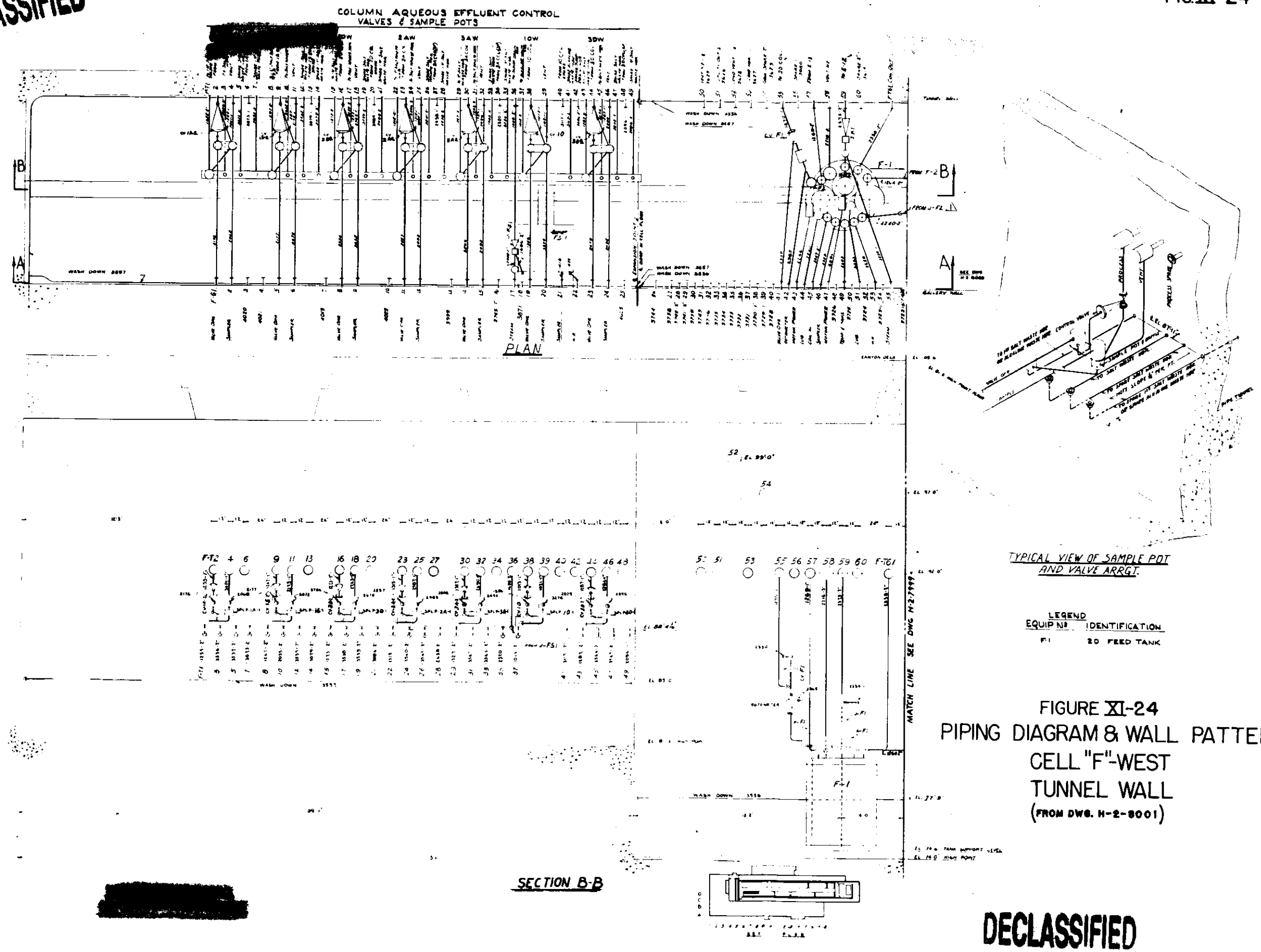

FIGURE XI-24
PIPING DIAGRAM & WALL PATTERN
CELL "F"-WEST
TUNNEL WALL
(FROM DWG. H-2-8001)

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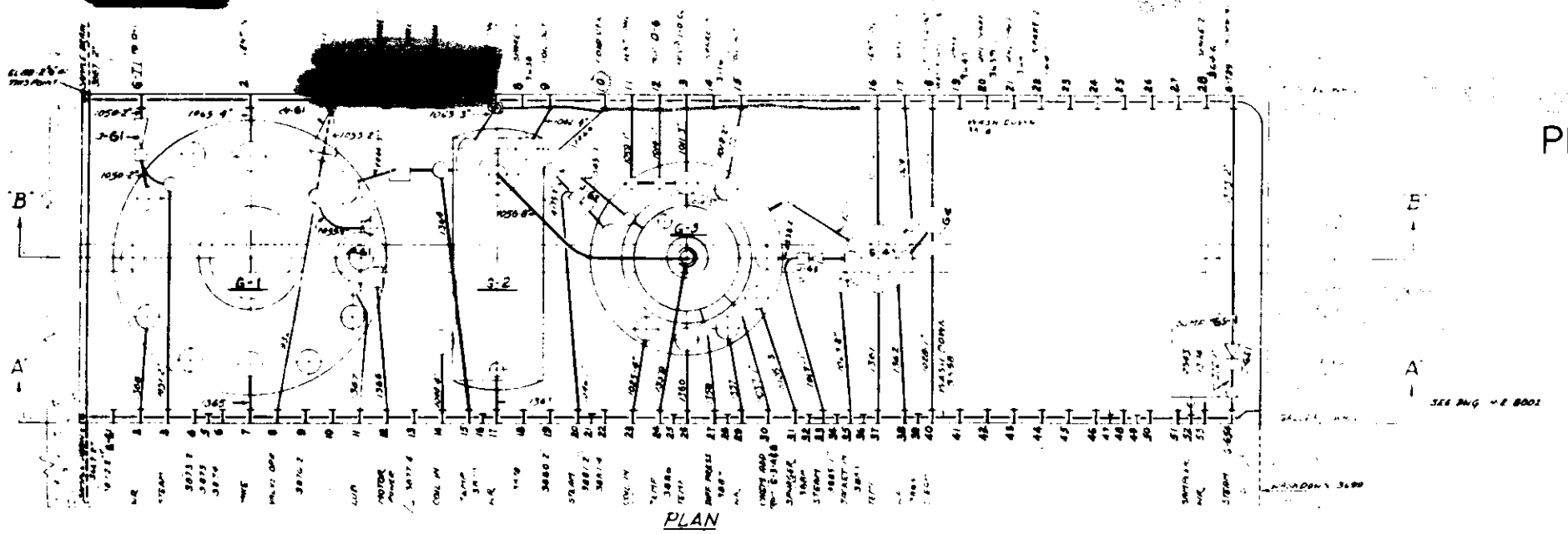
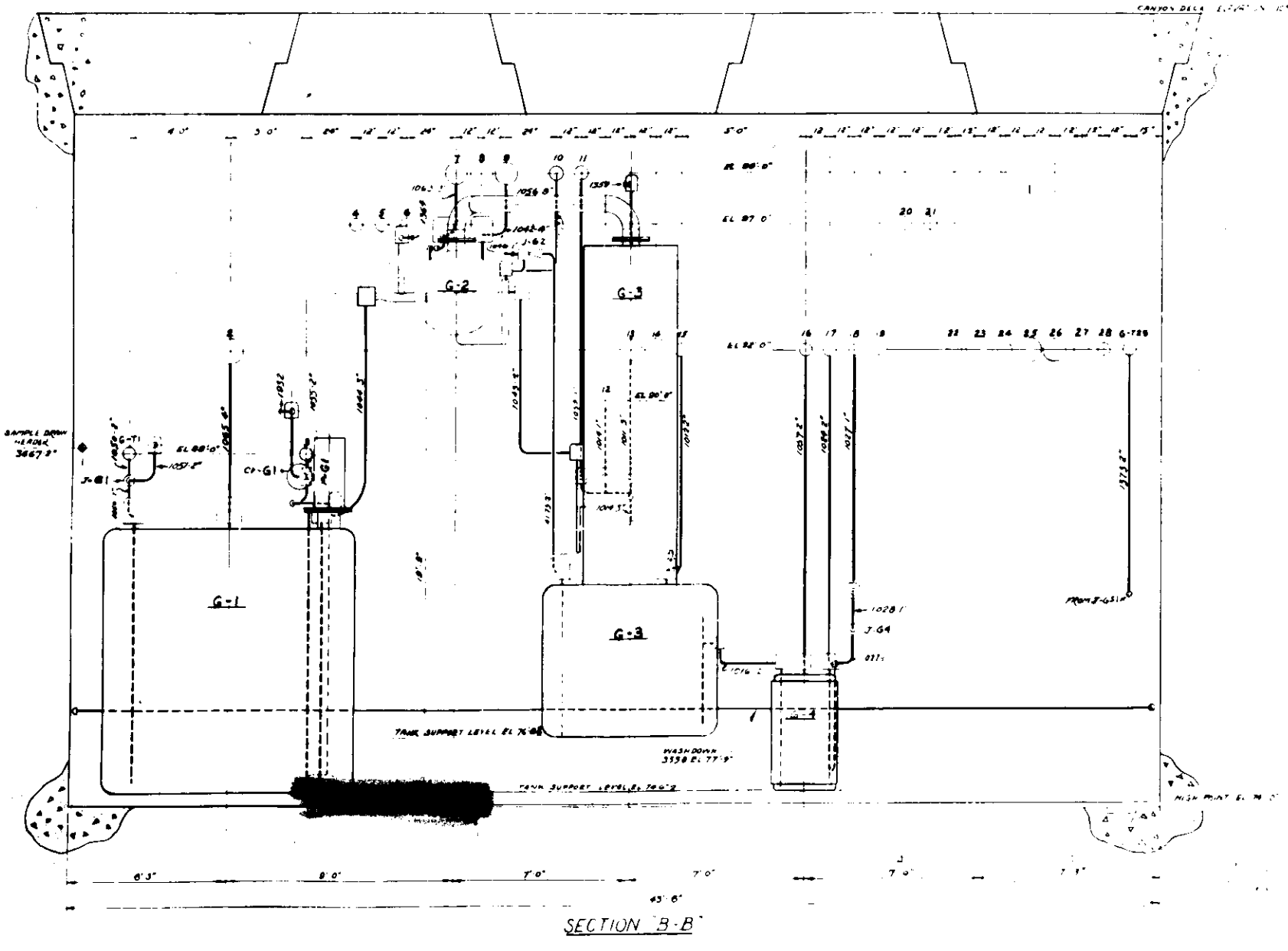
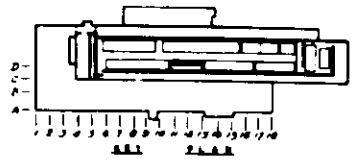
FIGURE XI-26
PIPING DIAGRAM & WALL PATTERN
CELL "G"
TUNNEL WALL

(FROM DWGS. H-2-8003 & H-2-5470)







LEGEND

EQUIP Nº	IDENTIFICATION
G-1	ORGANIC SURGE TANK
G-2	CONDENSER & PHASE SEPARATOR
G-3	ORGANIC STILL
G-4	ORGANIC WASTE RECEIVER

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FIG. XI-27

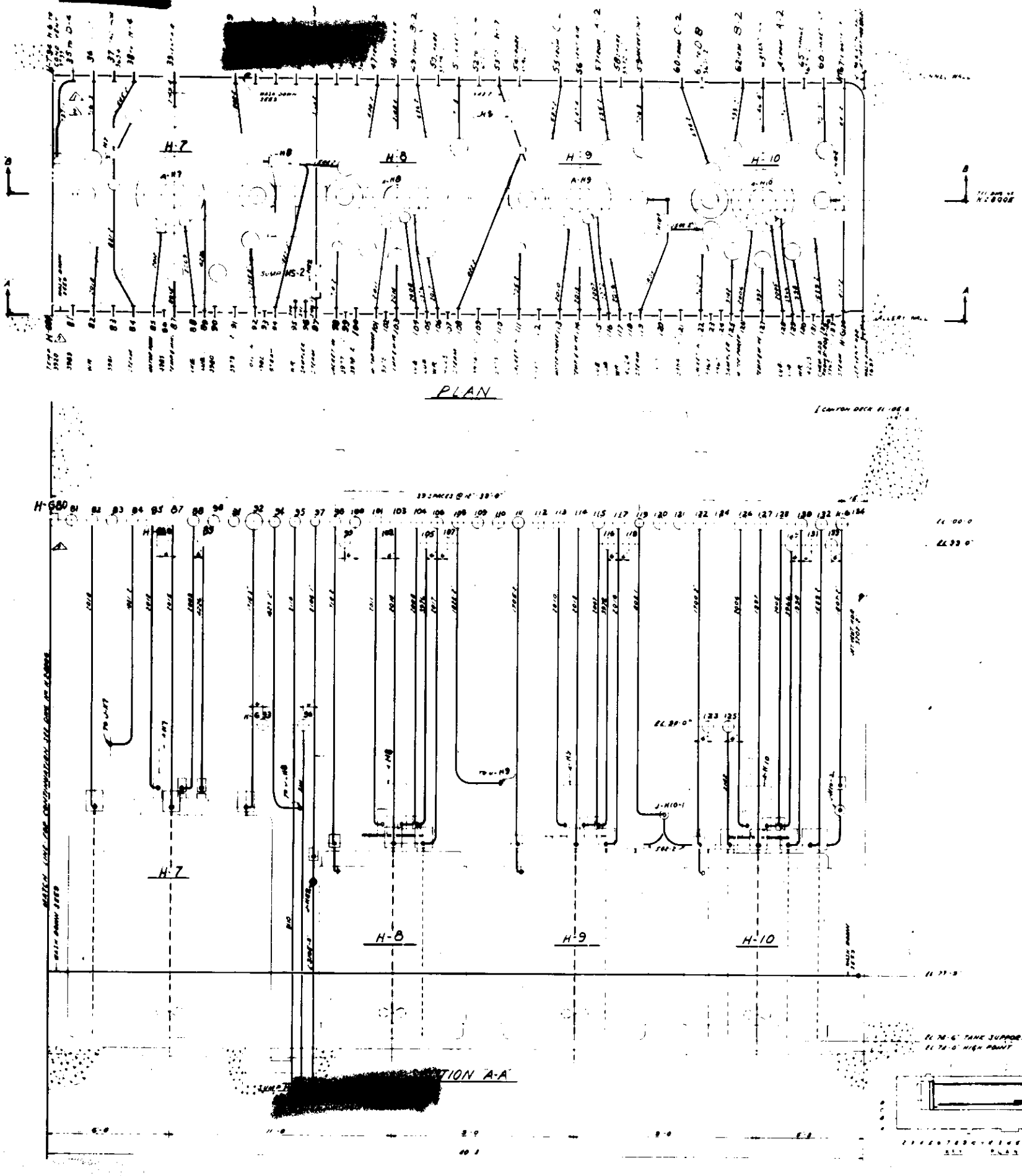

FIGURE XI-27
PIPING DIAGRAM & WALL PATTERN
CELL "H"-EAST
GALLERY WALL
(FROM DWG. H-2-8004)

LEGEND

EQUIP. Nº	IDENTIFICATION
H-7	METAL SOLUTION STORAGE
H-8	METAL SOLUTION STORAGE
H-9	METAL SOLUTION STORAGE
H-10	DISSOLVER WASTE TANK

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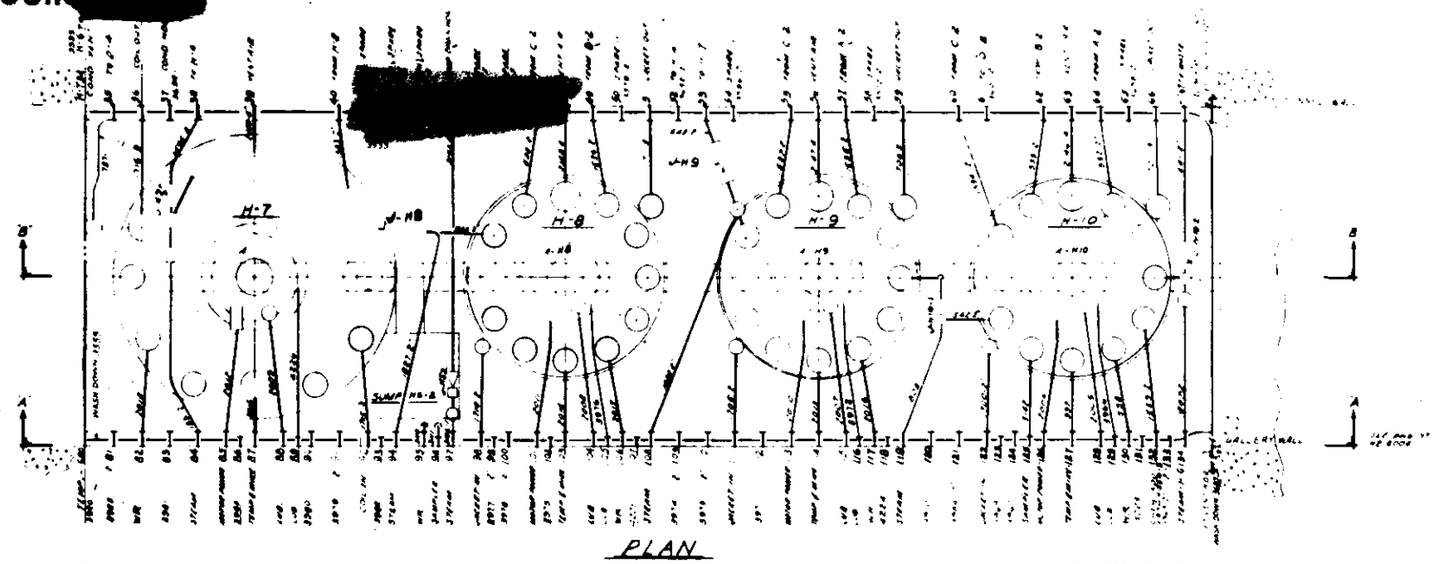

FIGURE XI-28
PIPING DIAGRAM & WALL PATTERN
CELL "H"-EAST
TUNNEL WALL
(FROM DWG. H-2-8005)

LEGEND

EQUIP Nº	IDENTIFICATION
H-7	METAL SOLUTION STORAGE
H-8	METAL SOLUTION STORAGE
H-9	METAL SOLUTION STORAGE
H-10	DISSOLVER WASTE TANK

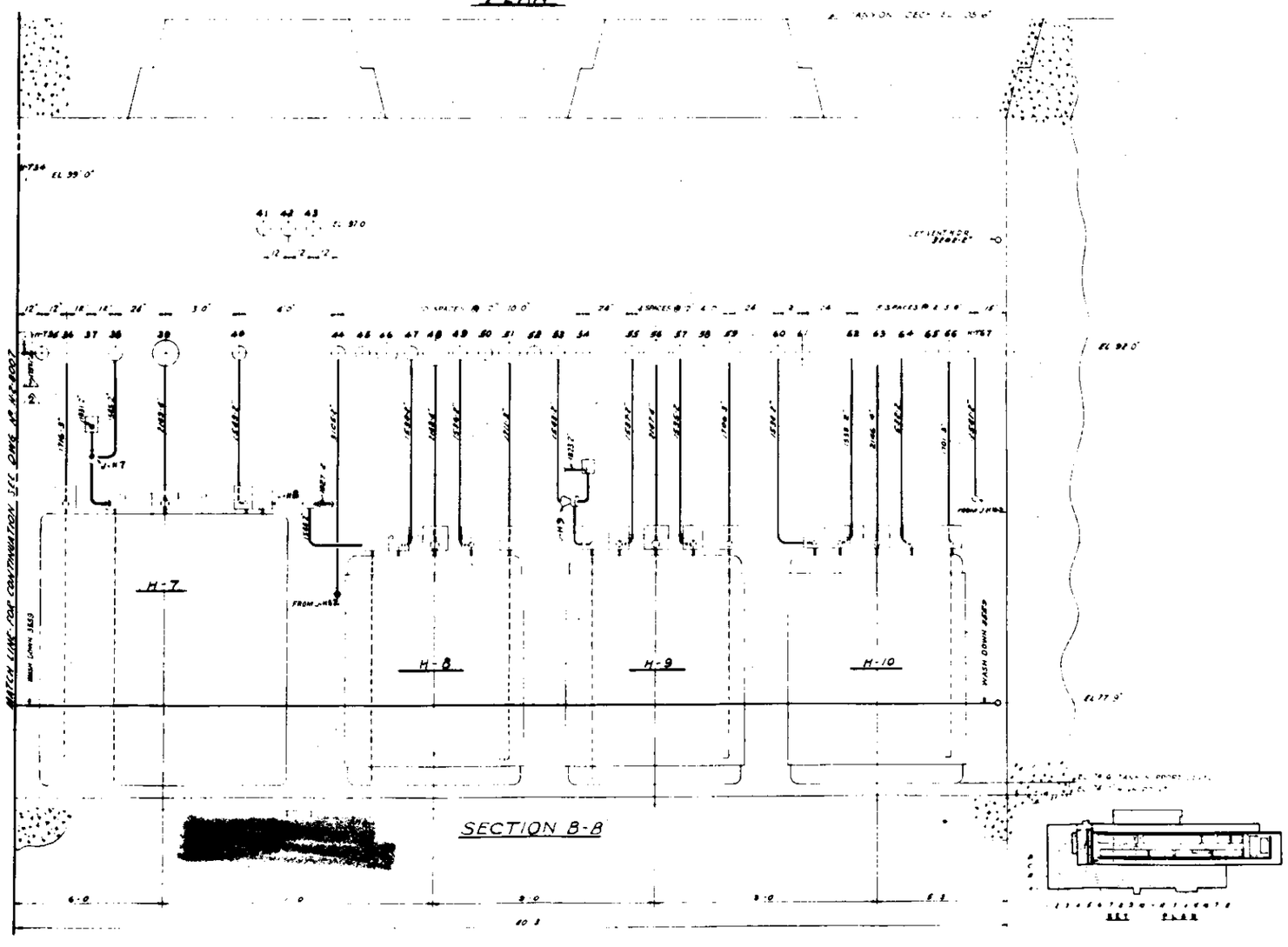

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FIG. XI-29

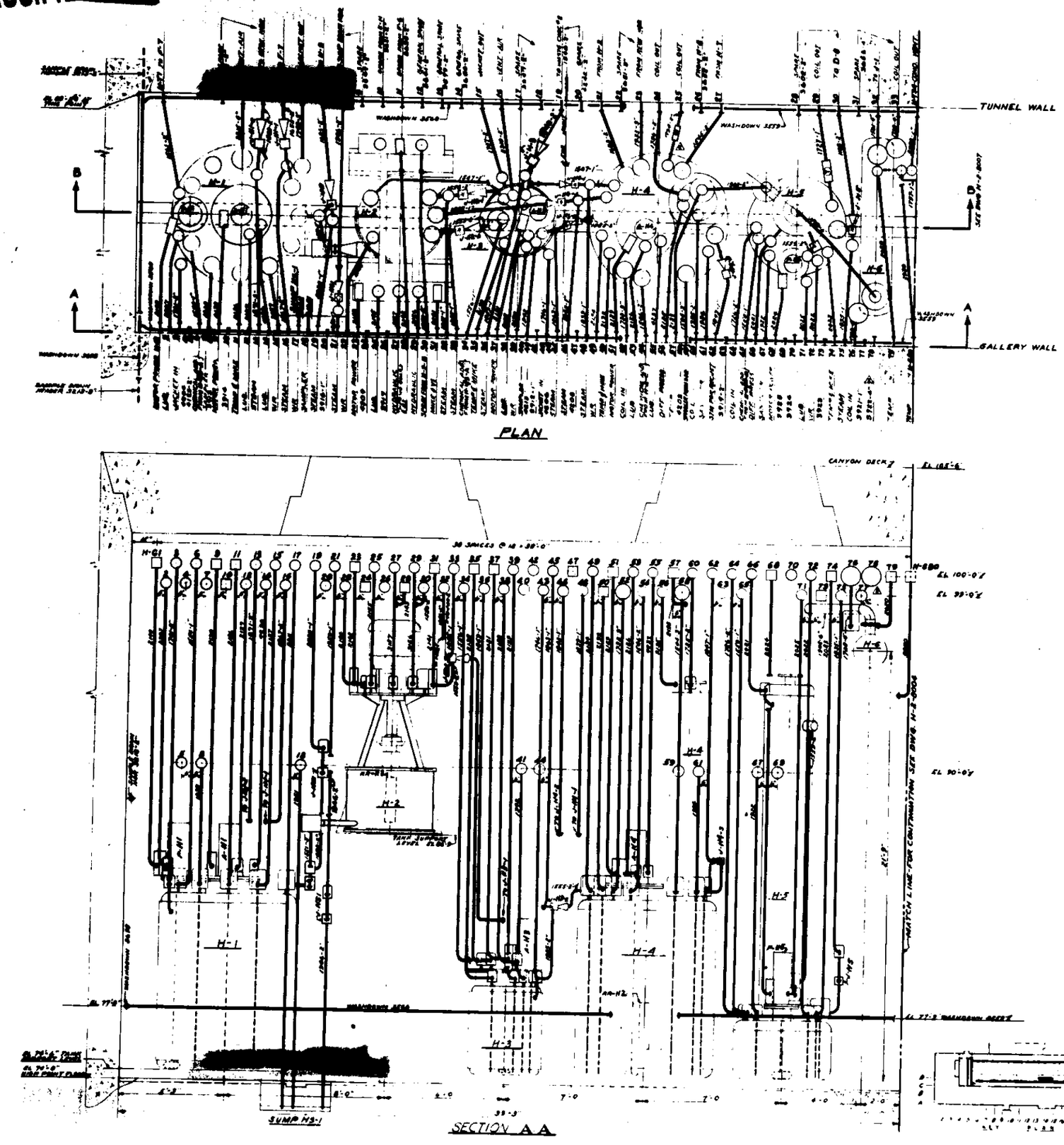

FIGURE XI-29
PIPING DIAGRAM & WALL PATTERN
CELL "H"-WEST
GALLERY WALL
(FROM DWGS. H-2-8006 & H-2-5471)

LEGEND

EQUIP NO	IDENTIFICATION
H-1	IAF MAKE-UP TANK
H-2	CENTRIFUGE
H-3	SLURRY WASTE RECEIVER
H-4	OXIDIZER
H-5	RUTHENIUM SCRUBBER
H-6	CONDENSER

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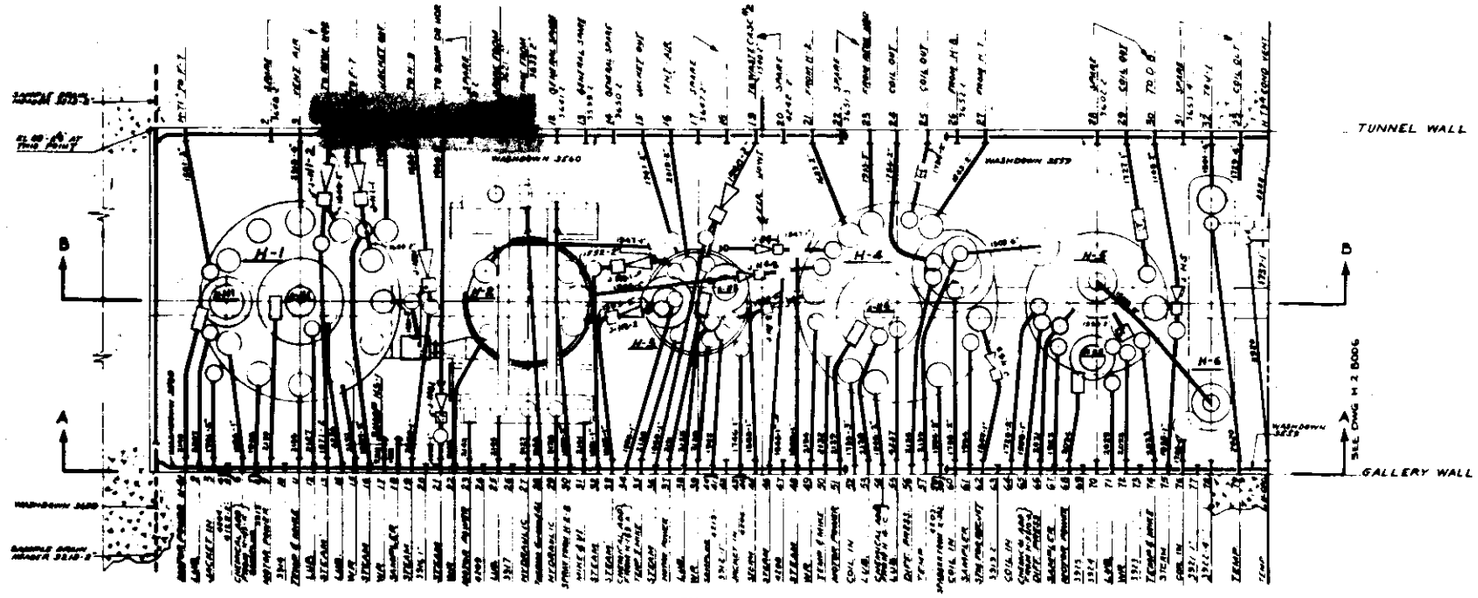

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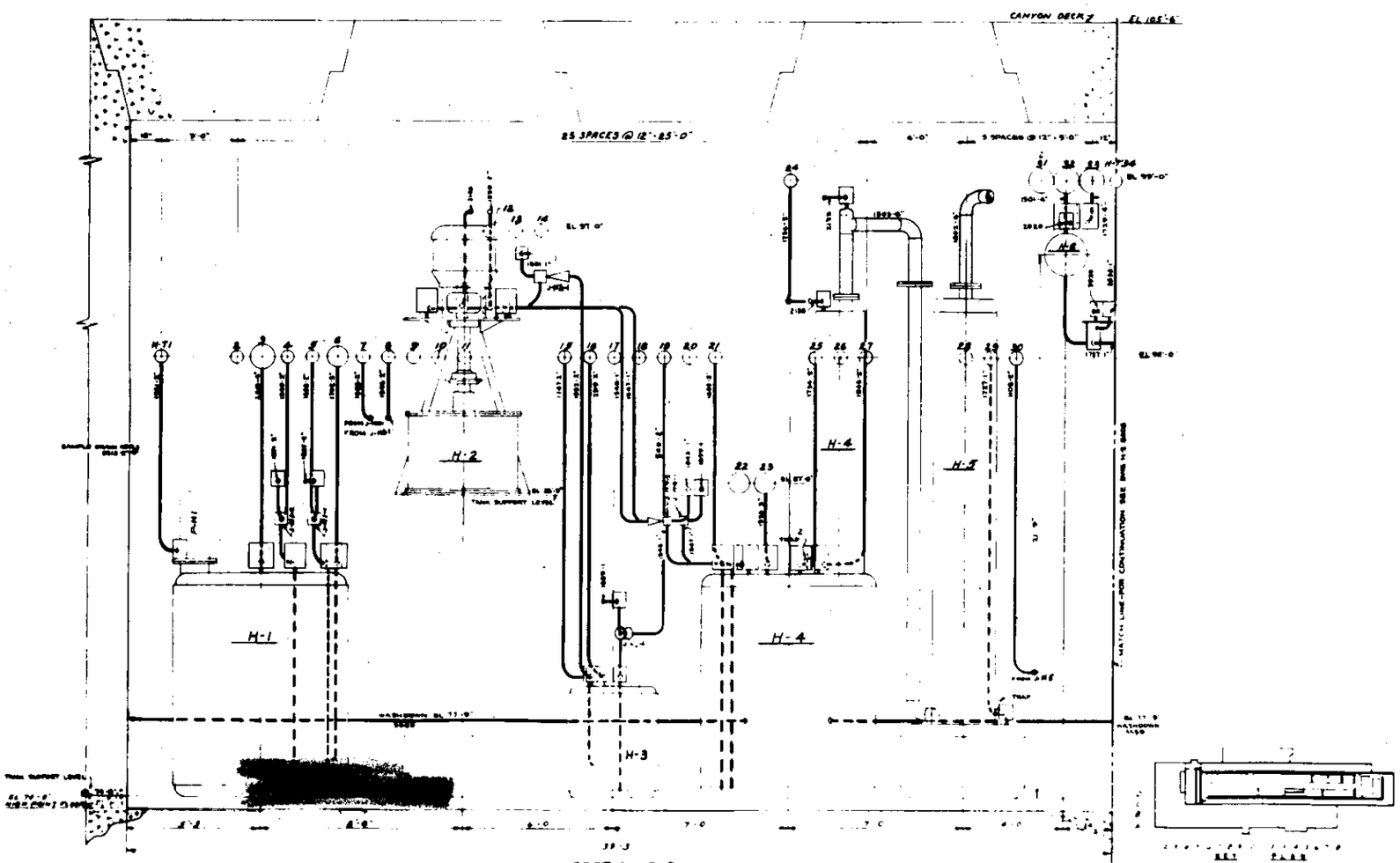

SECTION B-B

FIGURE XI-30
PIPING DIAGRAM & WALL PATTERN
CELL "H"-WEST
TUNNEL WALL
(FROM DWGS. H-2-8007 & H-2-5471)

LEGEND

EQUIP Nº	IDENTIFICATION
H-1	IAF MAKE UP TANK
H-2	CENTRIFUGE
H-3	SLURRY WASTE RECEIVER
H-4	OXIDIZER
H-5	RUTHENIUM SCRUBBER
H-6	CONDENSER

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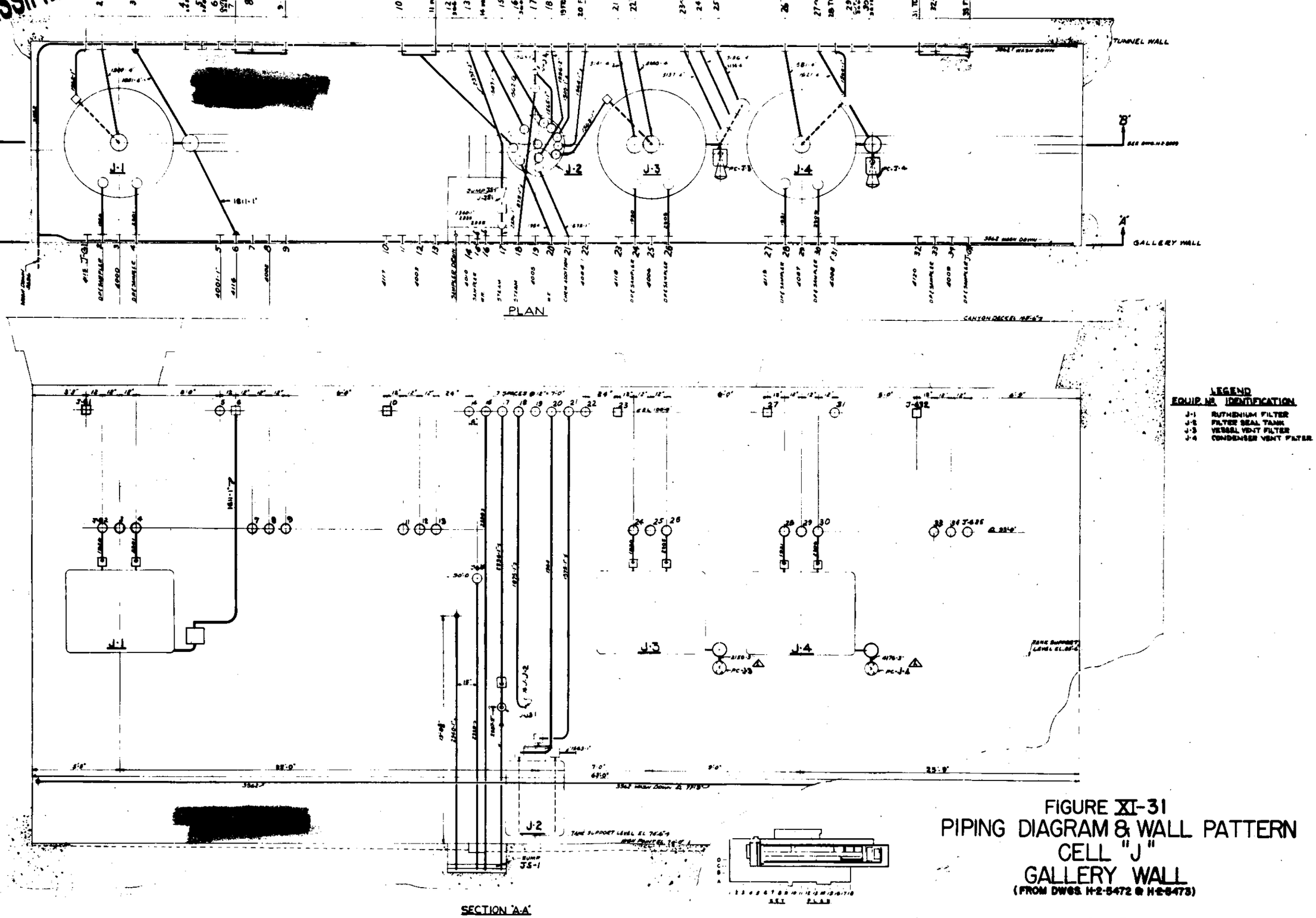

FIGURE XI-31
PIPING DIAGRAM & WALL PATTERN
CELL "J"
GALLERY WALL
(FROM DWGS. H-2-5472 & H-2-5473)

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FIG. XI-32

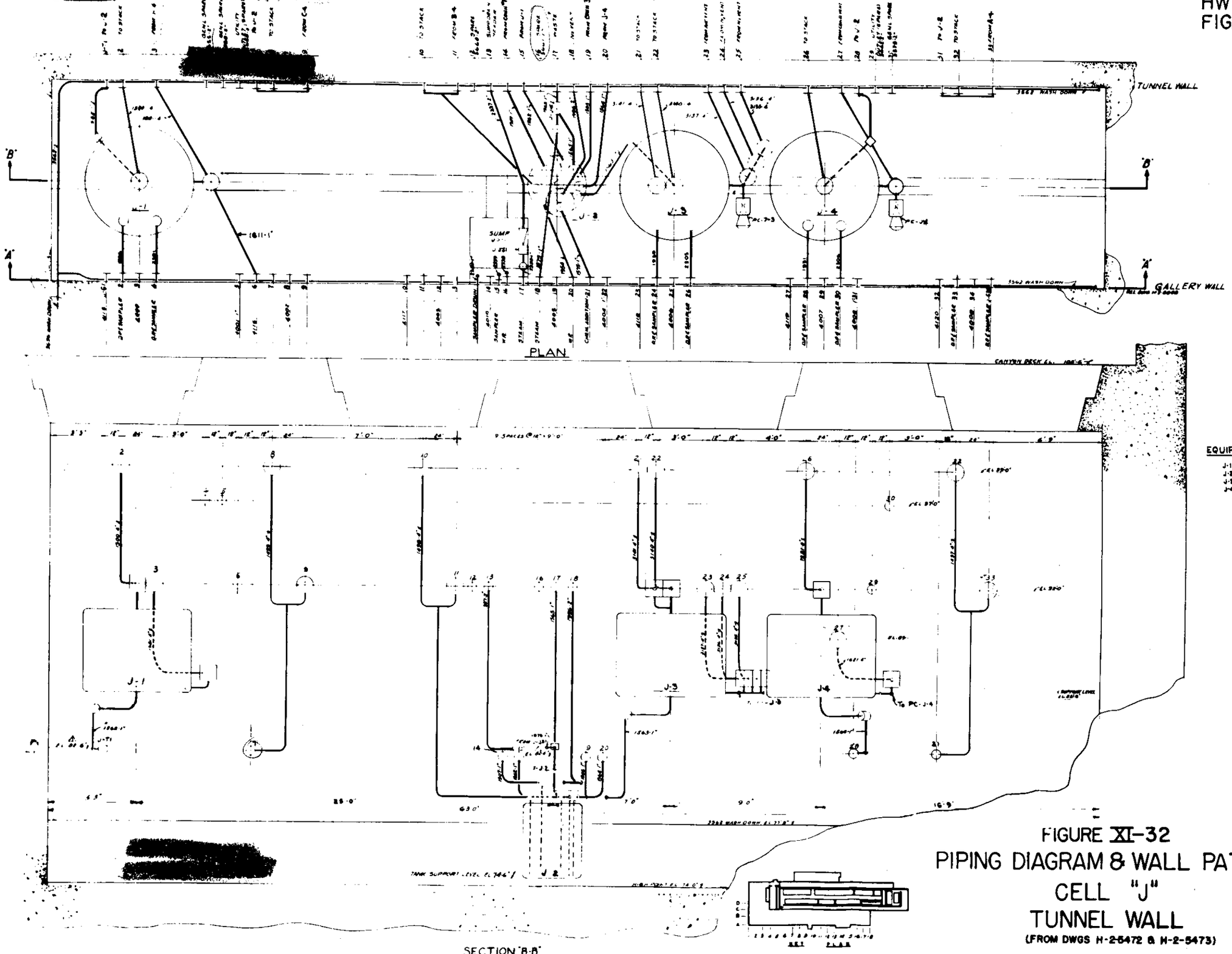

FIGURE XI-32
PIPING DIAGRAM & WALL PATTERN
CELL "J"
TUNNEL WALL
(FROM DWGS H-2-5472 & H-2-5473)

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FIG. XI-33

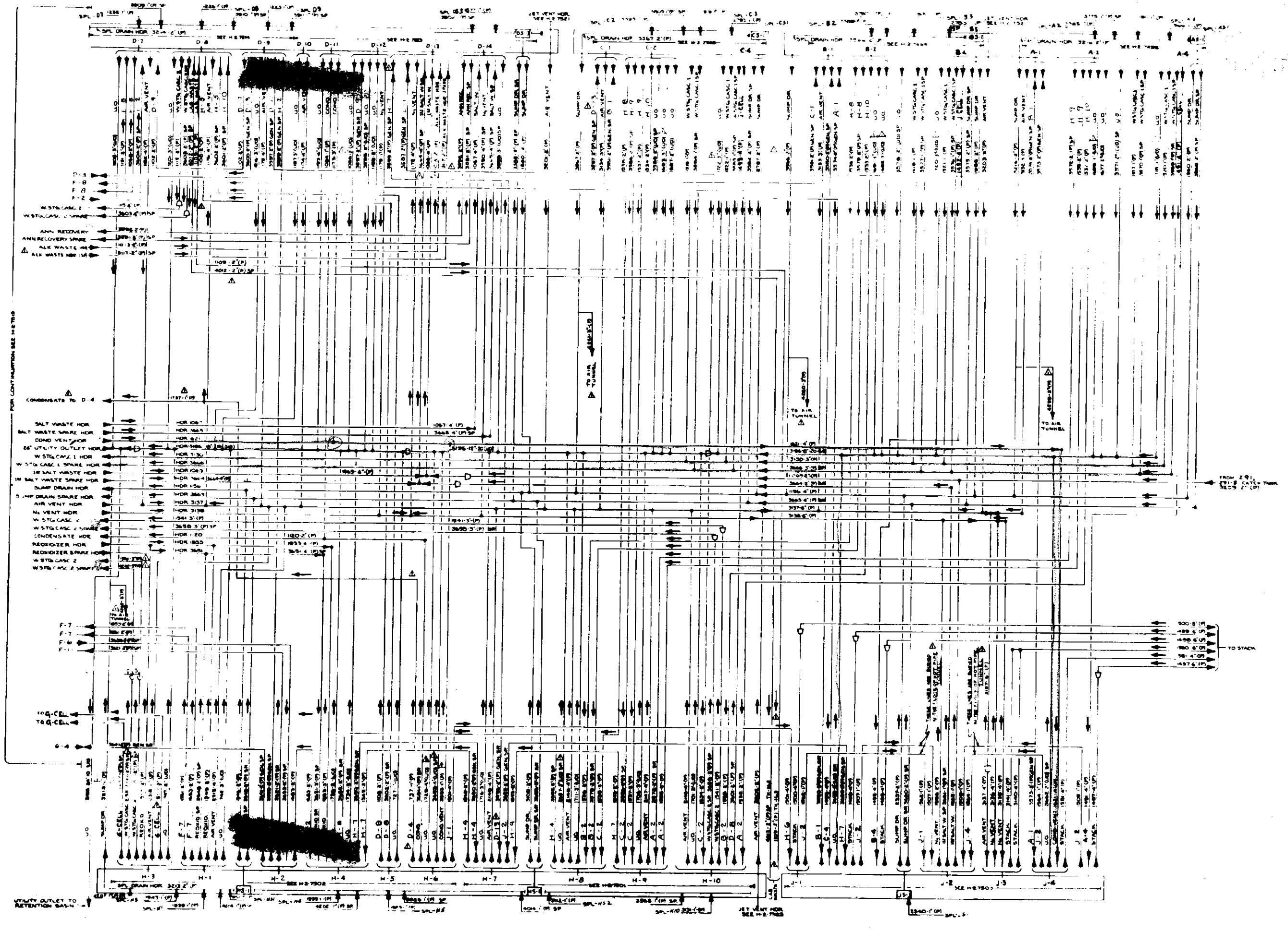

FIGURE XI-33
PIPE TUNNEL PIPING DIAGRAM
— EAST END —
(BASED UPON H-2-7522)

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FIG. XI-34

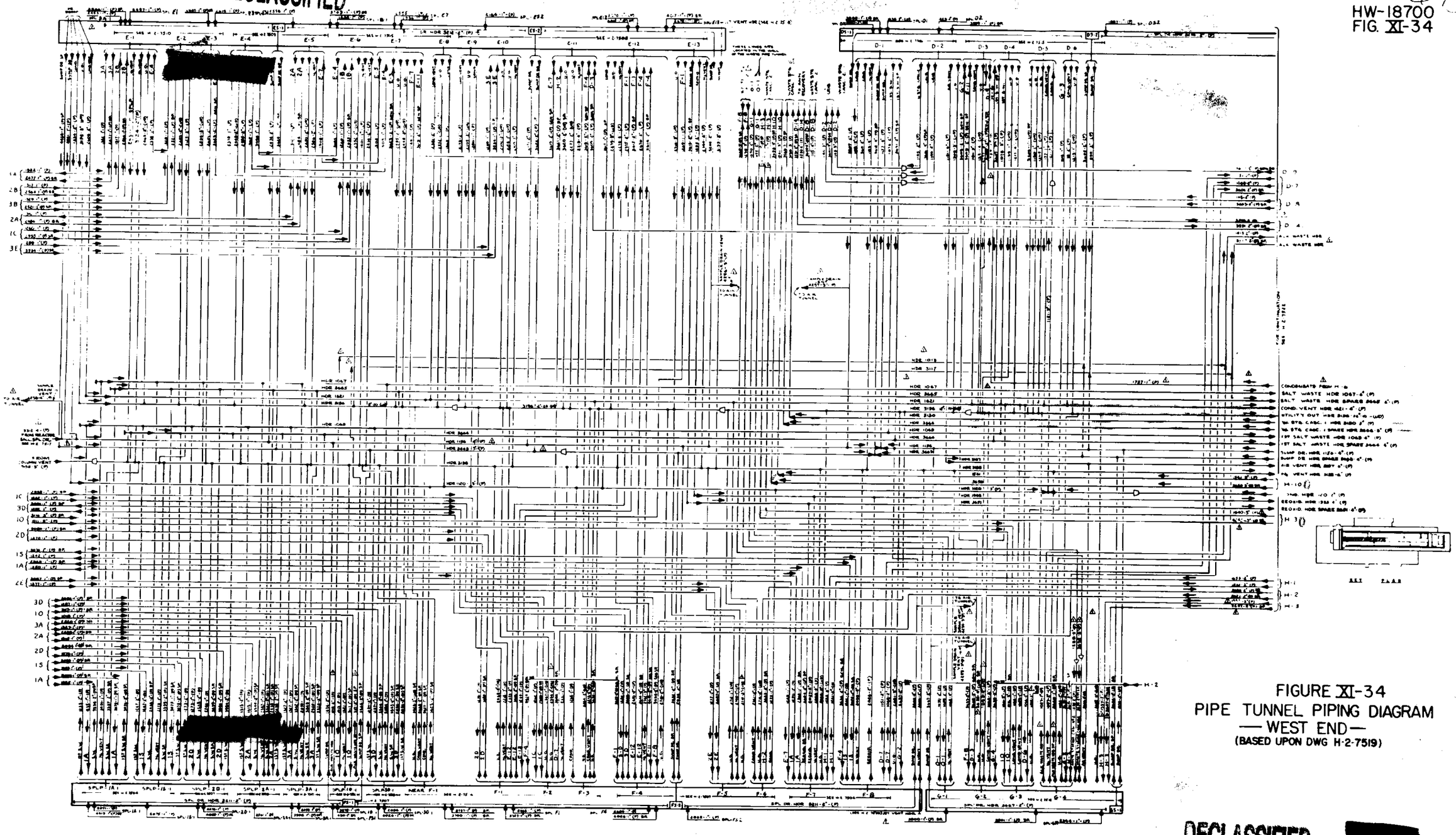

FIGURE XI-34
PIPE TUNNEL PIPING DIAGRAM
— WEST END —
(BASED UPON DWG H-2-7519)

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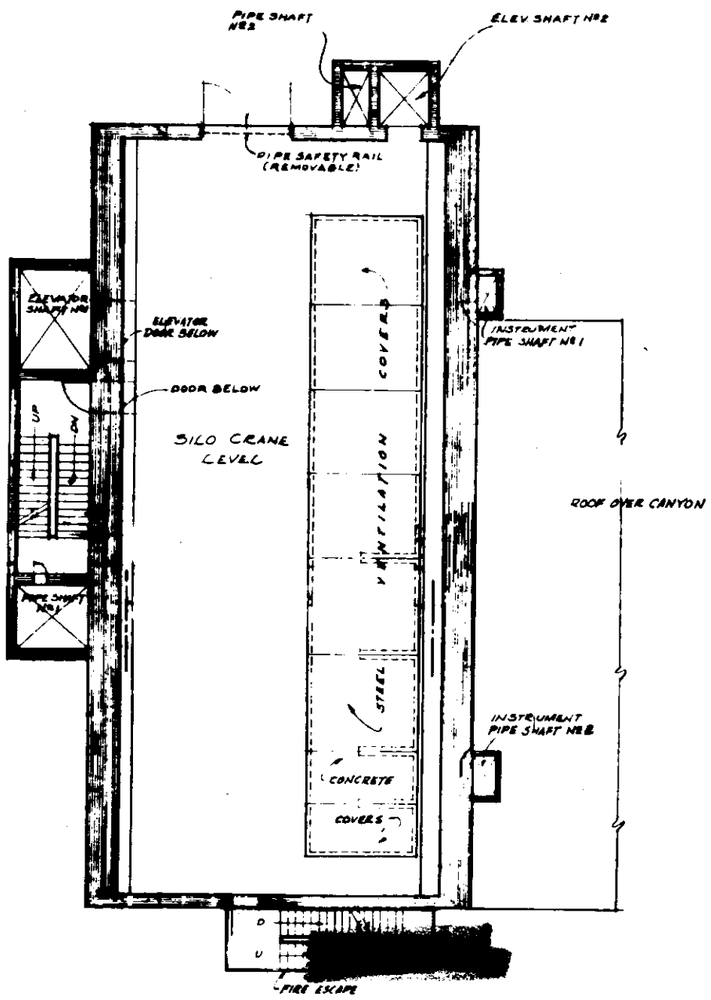
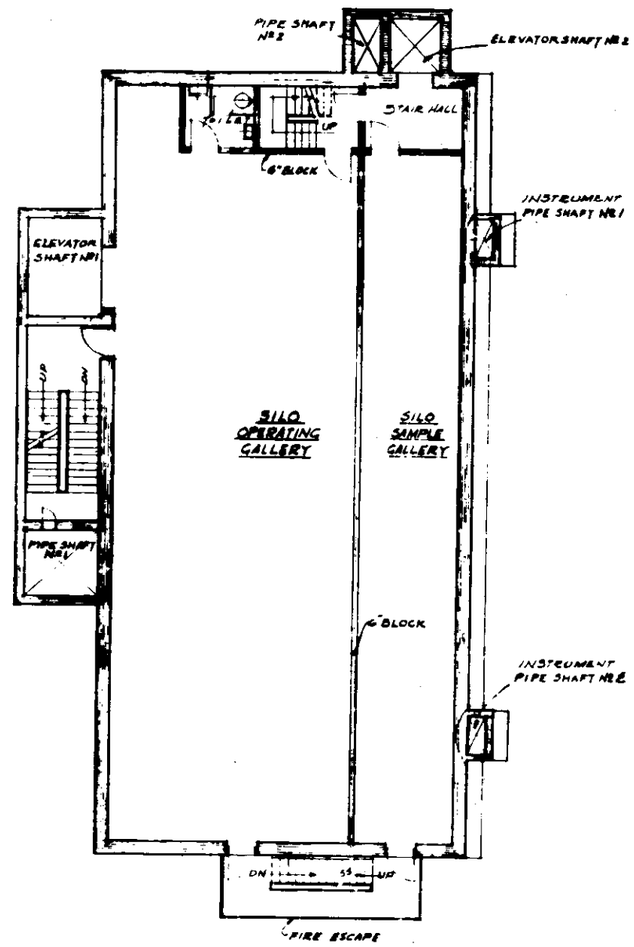
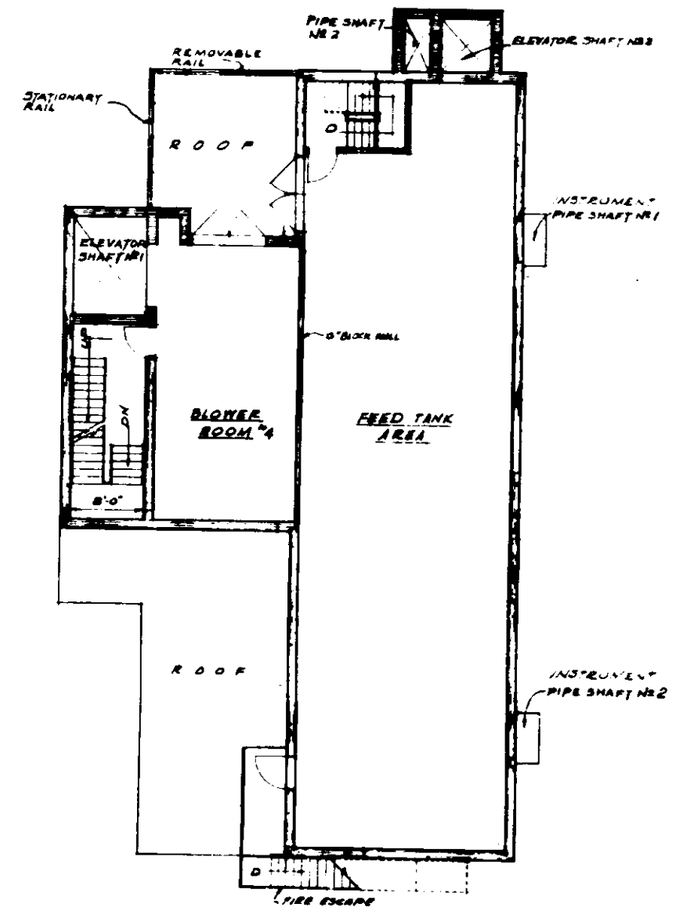
FIGURE XI-35
SILO PLANS
(FROM DWG. H-2-7408)



PLAN AT SILO CRANE LEVEL



PLAN AT SILO SAMPLE GALLERY



PLAN AT FEED TANK AREA

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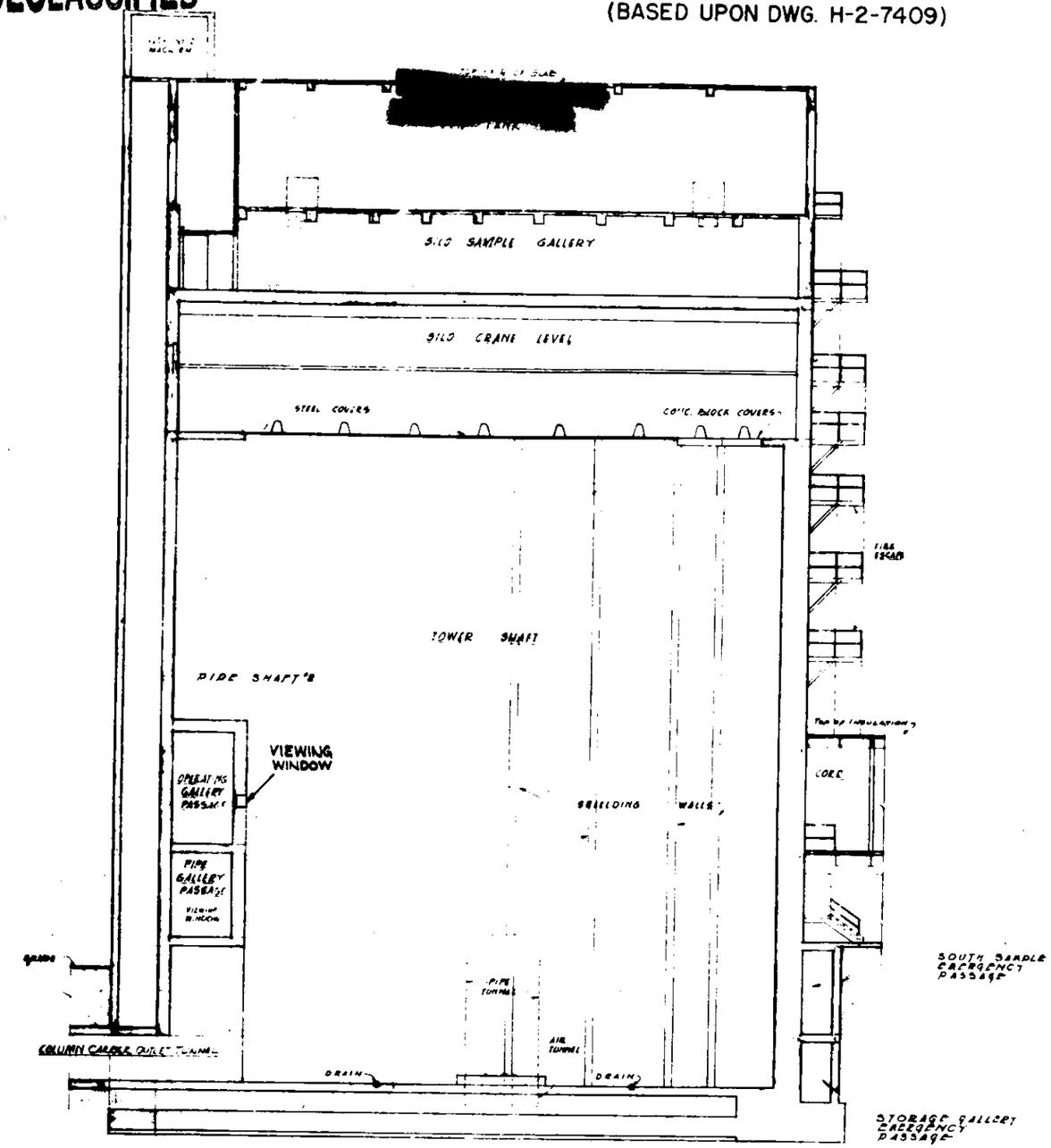
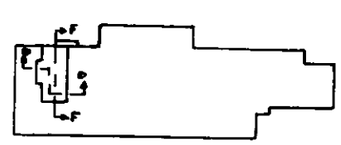
FIGURE XI-36
SILO CROSS SECTIONS
(BASED UPON DWG. H-2-7409)



SECTION F - F



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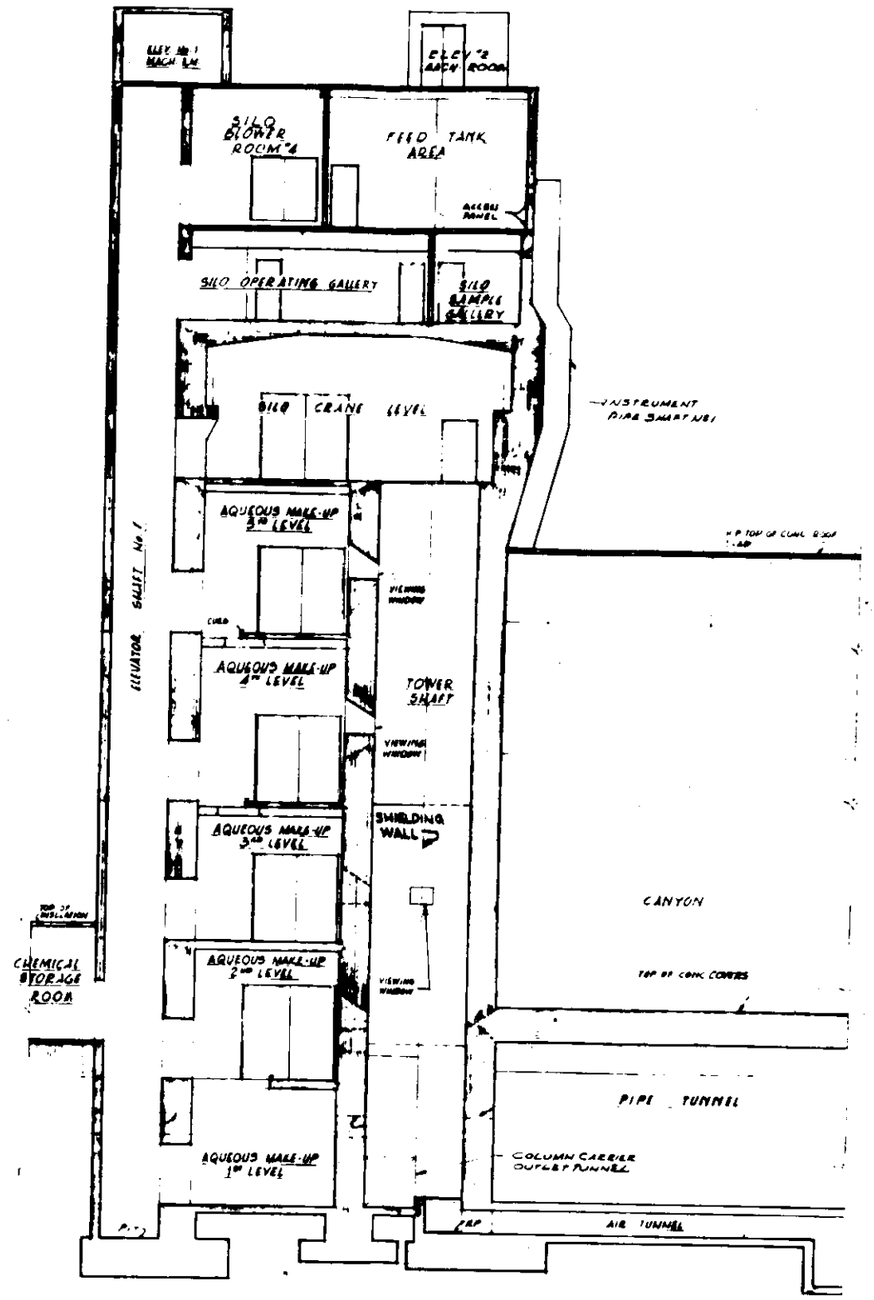

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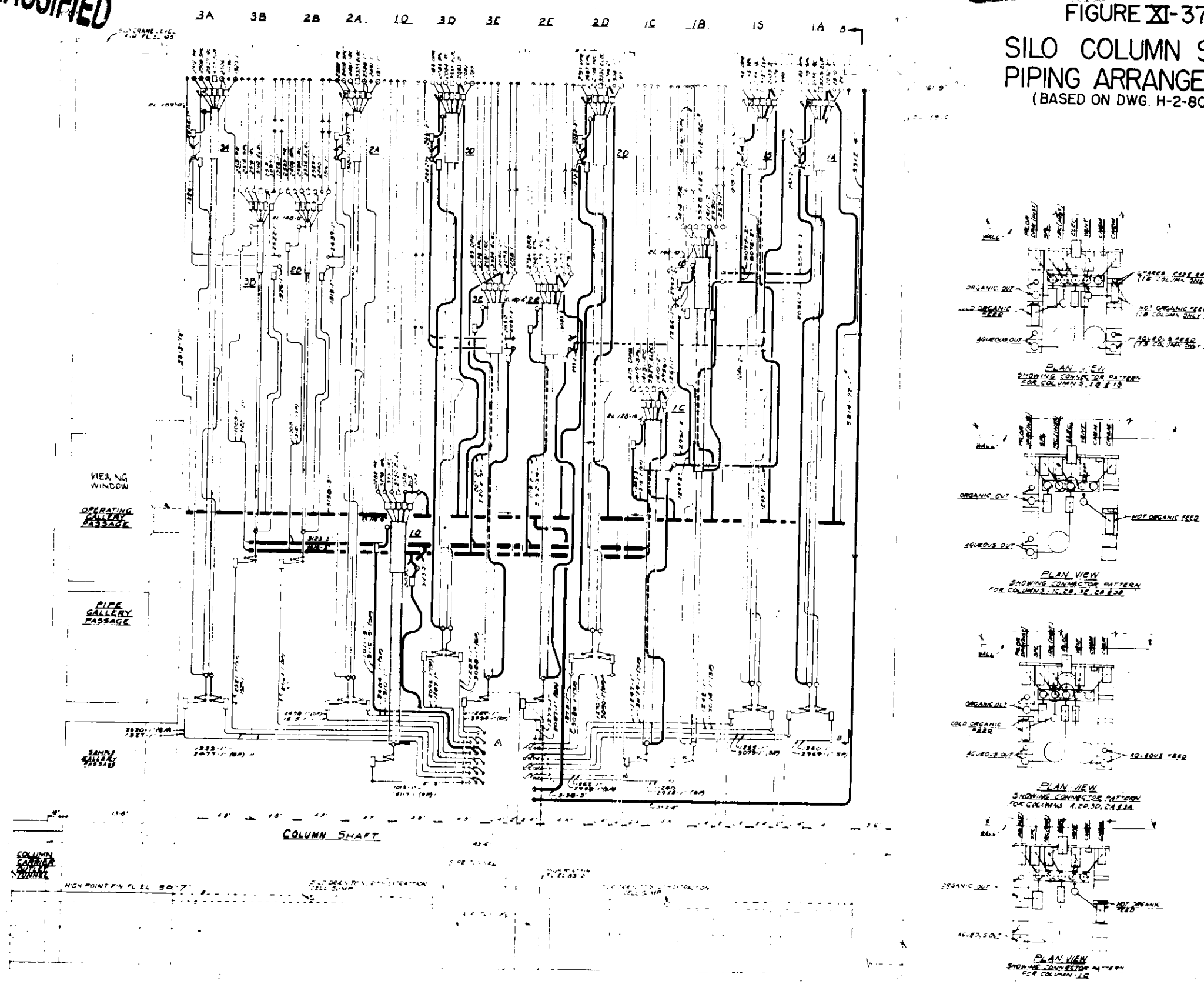
FIGURE XI-37

SILO COLUMN SHAFT PIPING ARRANGEMENT

(BASED ON DWG. H-2-8018)



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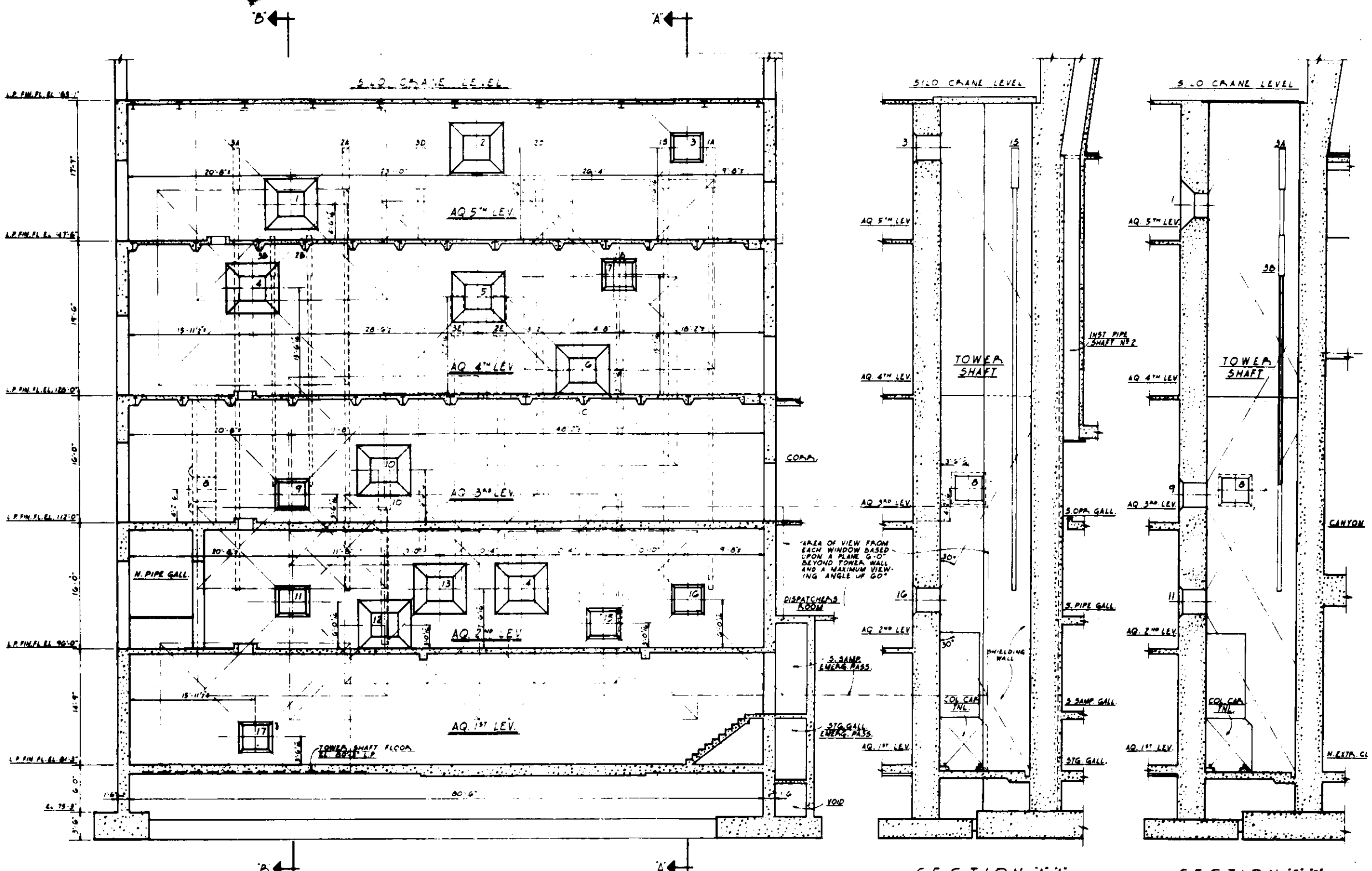

SE[redacted]NCH AQUEOUS MAKE-UP LEVELS
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NOTE: DIMENSIONS THAT ARE ± ARE ± BY ONE SIXTEENTH OF AN INCH.

SECTION "A-A"
SECTION THRU THICK VIEWING WINDOWS

SECTION "B-B"
SECTION THRU TYPICAL VIEWING WINDOWS

FIGURE XI-38
SILO VIEWING WINDOW PLACEMENT
(FROM DWG. H-2-8640)

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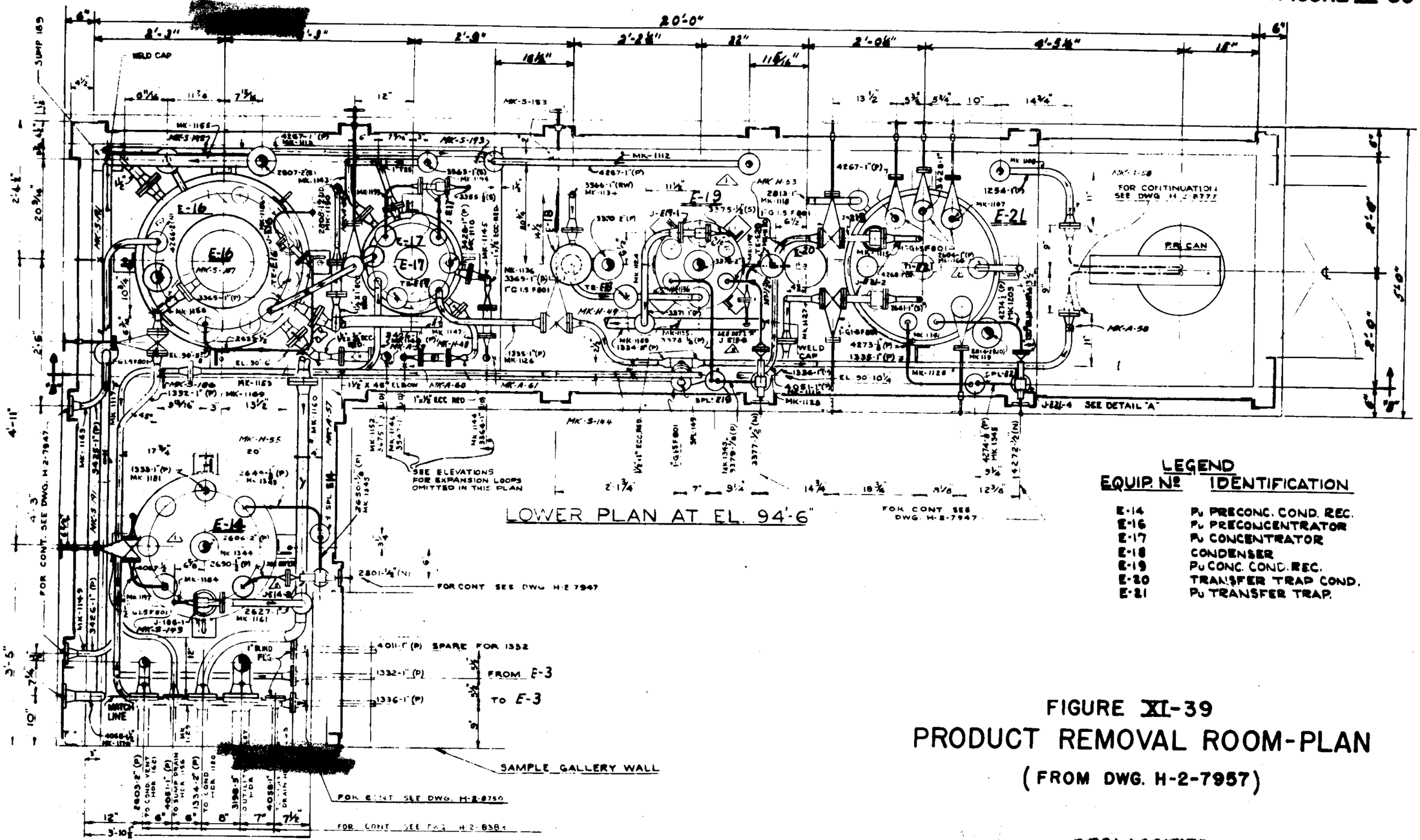

FIGURE XI-39
PRODUCT REMOVAL ROOM-PLAN
(FROM DWG. H-2-7957)

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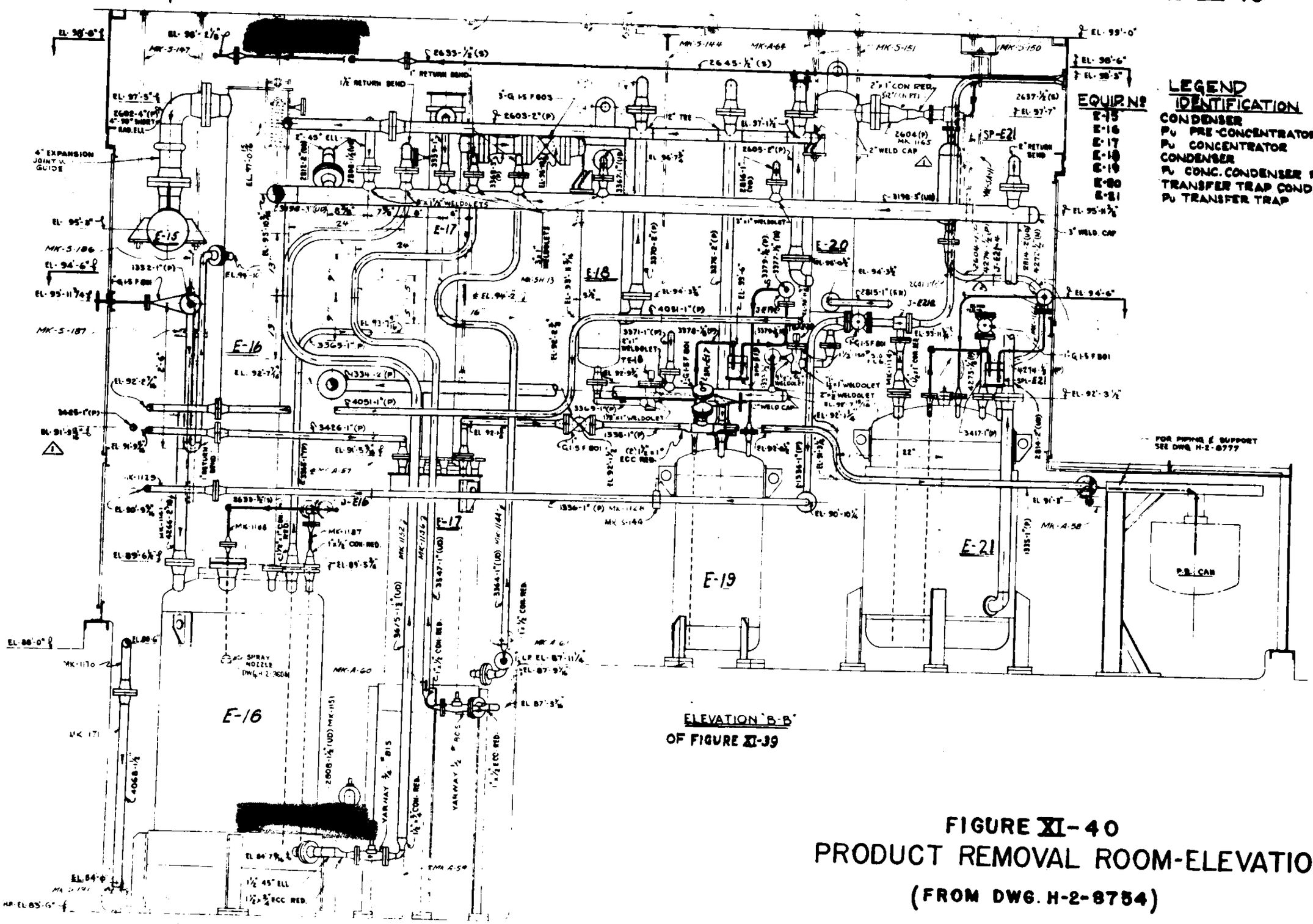

ELEVATION "B-B"
OF FIGURE XI-39

FIGURE XI-40
PRODUCT REMOVAL ROOM-ELEVATION
(FROM DWG. H-2-8754)

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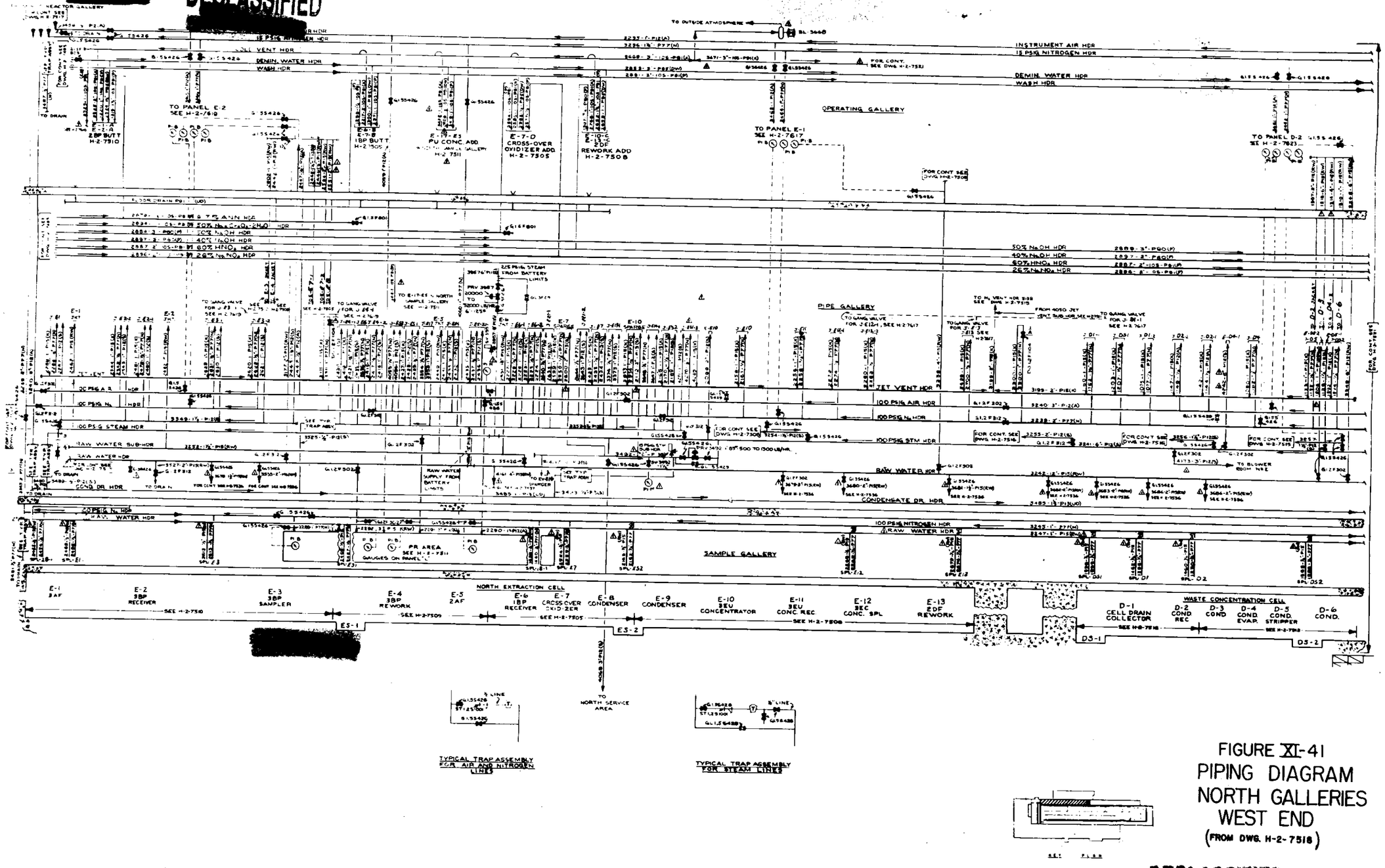

FIGURE XI-41
PIPING DIAGRAM
NORTH GALLERIES
WEST END
(FROM DWG. H-2-7518)

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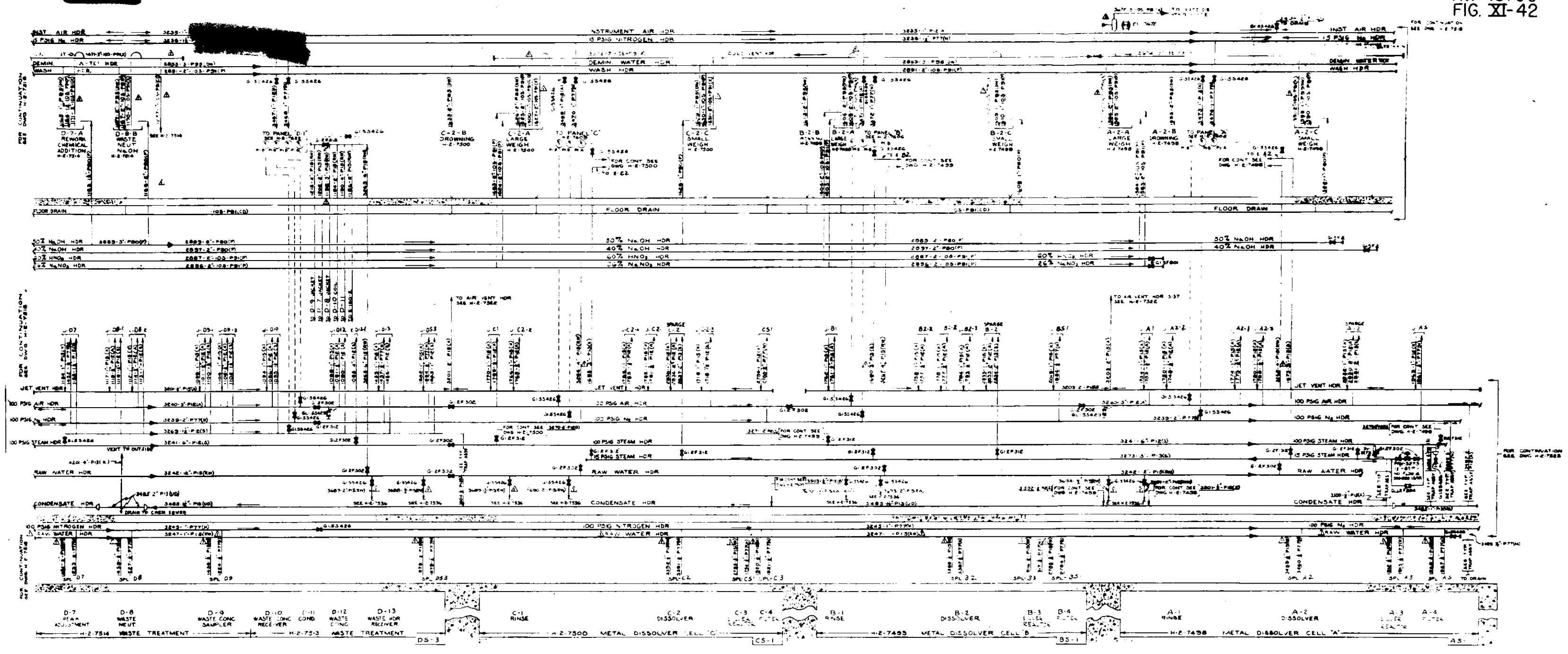

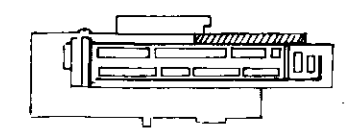

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FIGURE XI-42

PIPING DIAGRAM—NORTH GALLERIES—EAST END

(BASED ON DWG. H-2-7521)

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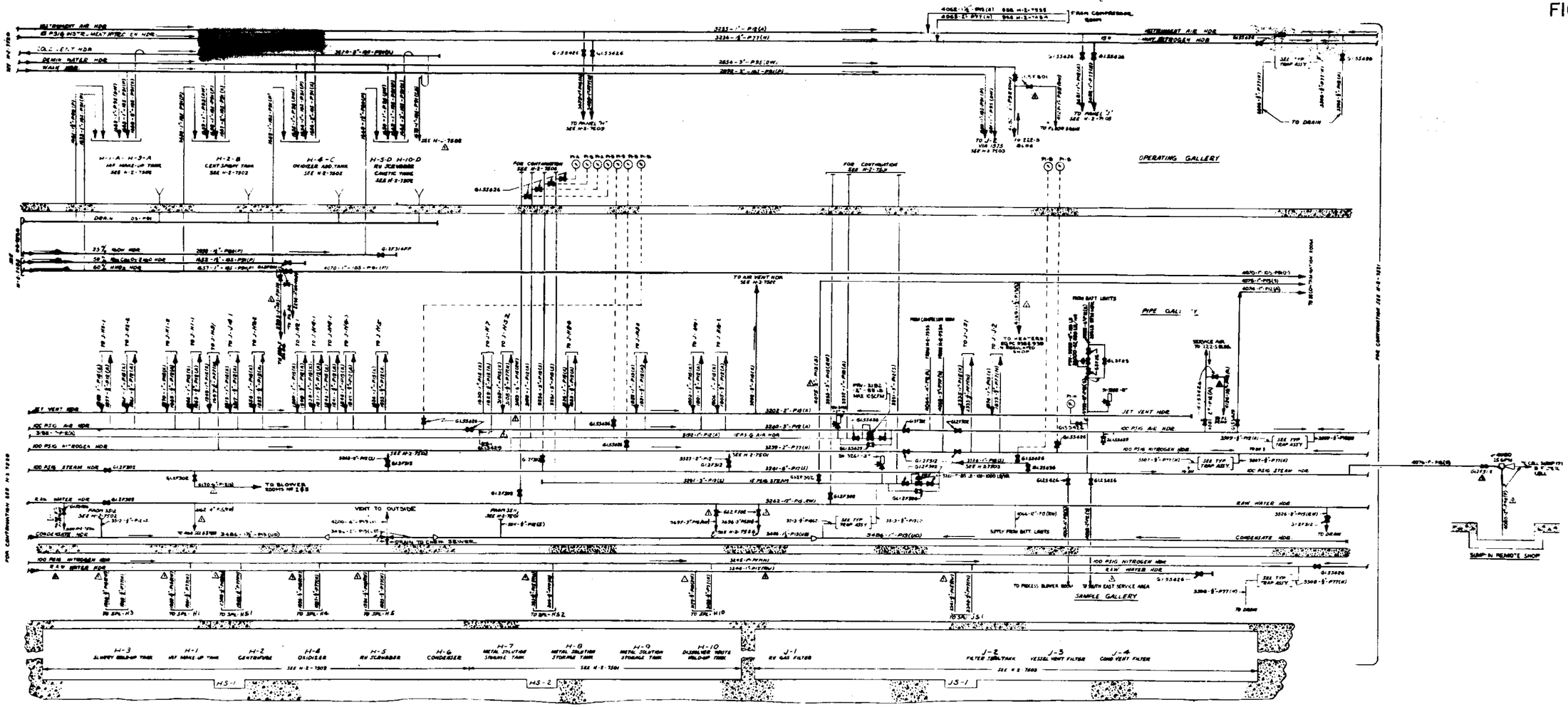

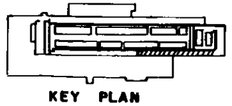

KEY PLAN

FIGURE XI-43

PIPING DIAGRAM—SOUTH GALLERIES-EAST END

(BASED UPON DWG. H-2-7523)

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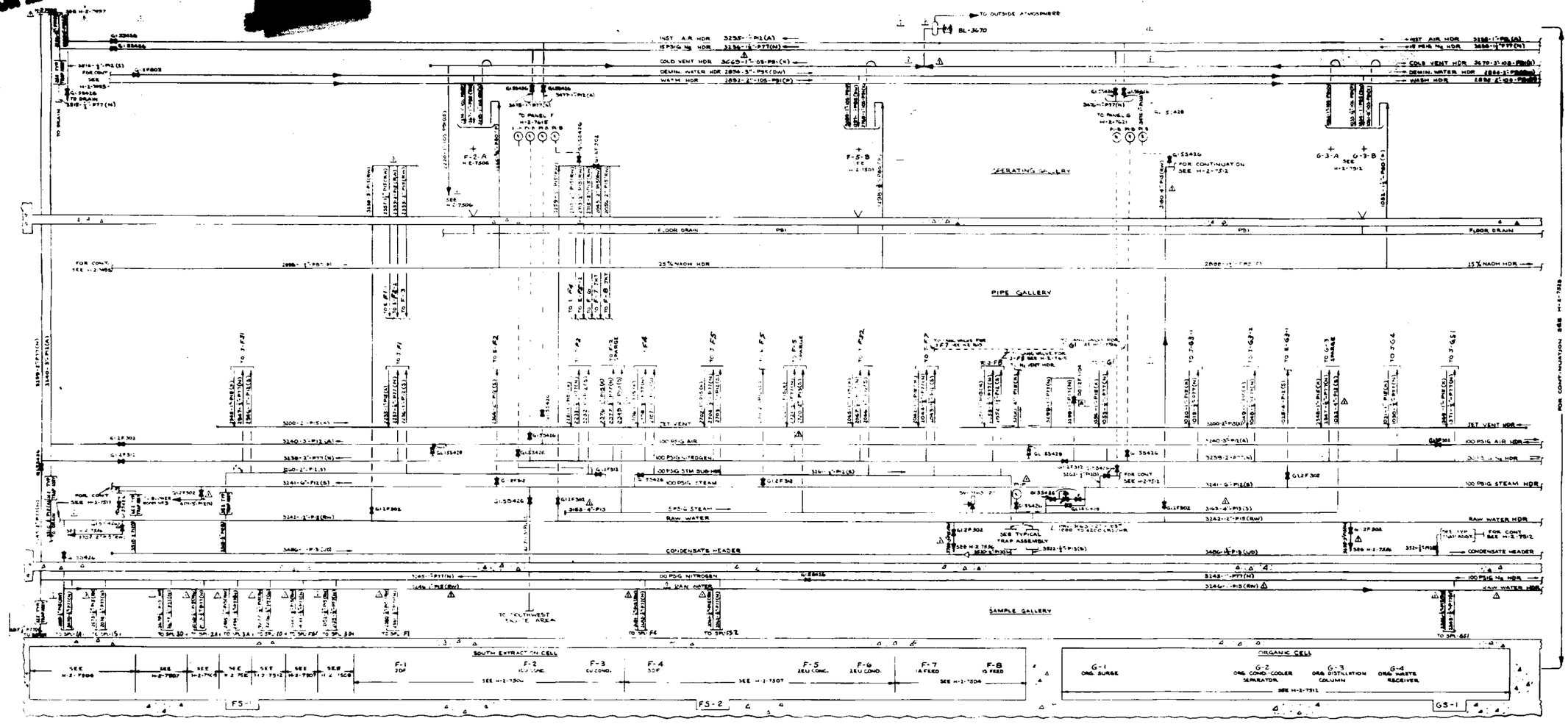

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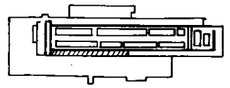
FIGURE XI-44

PIPING DIAGRAM-SOUTH GALLERIES-WEST END

(BASED UPON DWG. H-2-7520)



KEY PLAN

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FIG. IX-44

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FIG. XI-45

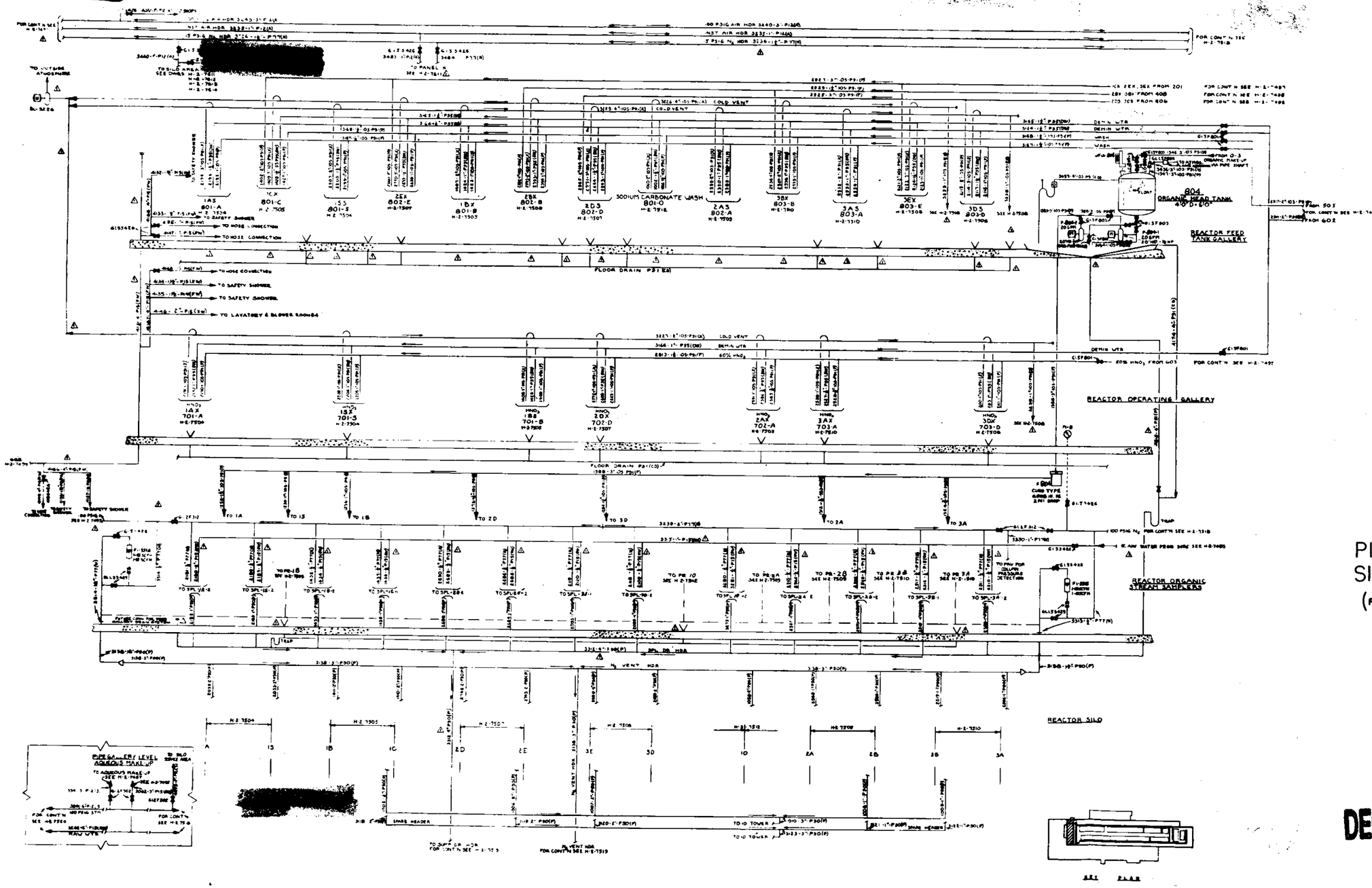

FIGURE XI-45

PIPING DIAGRAM
SILO GALLERIES

(FROM DWG. H-2-7517)

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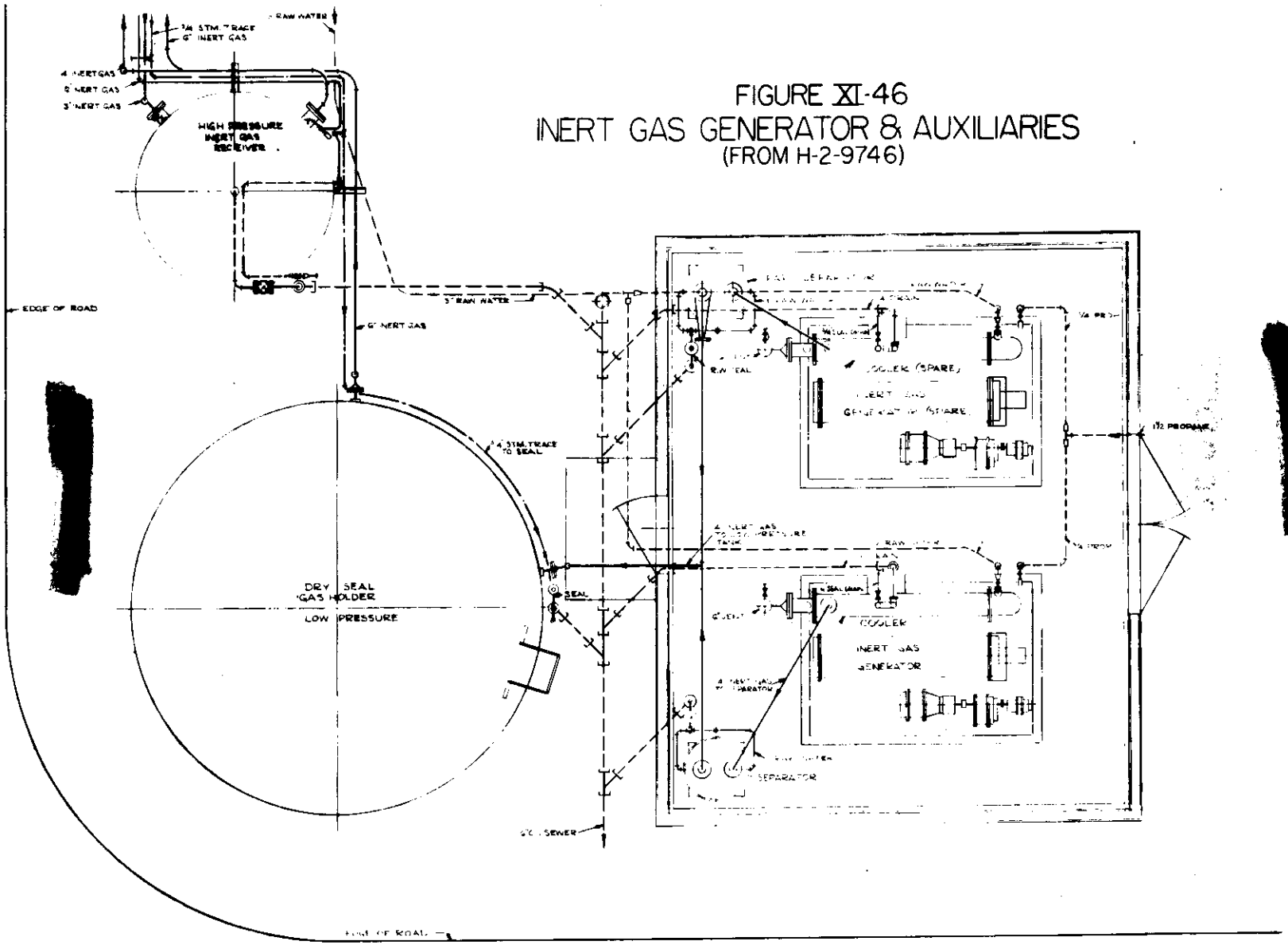

FIGURE XI-46
INERT GAS GENERATOR & AUXILIARIES
(FROM H-2-9746)

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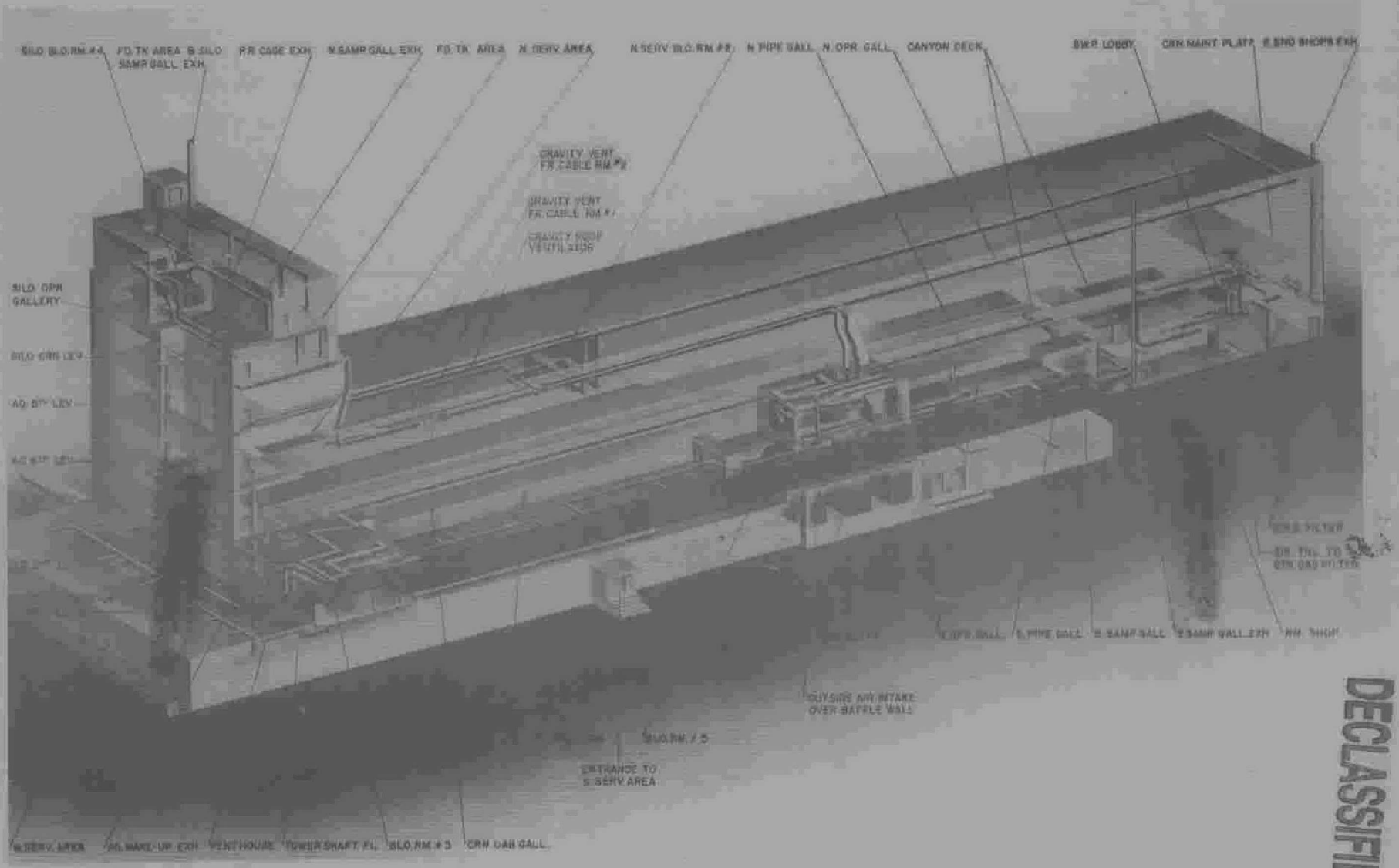

FIGURE XI-47 202-S BUILDING VENTILATION. (FROM KLX 15-TR-152)

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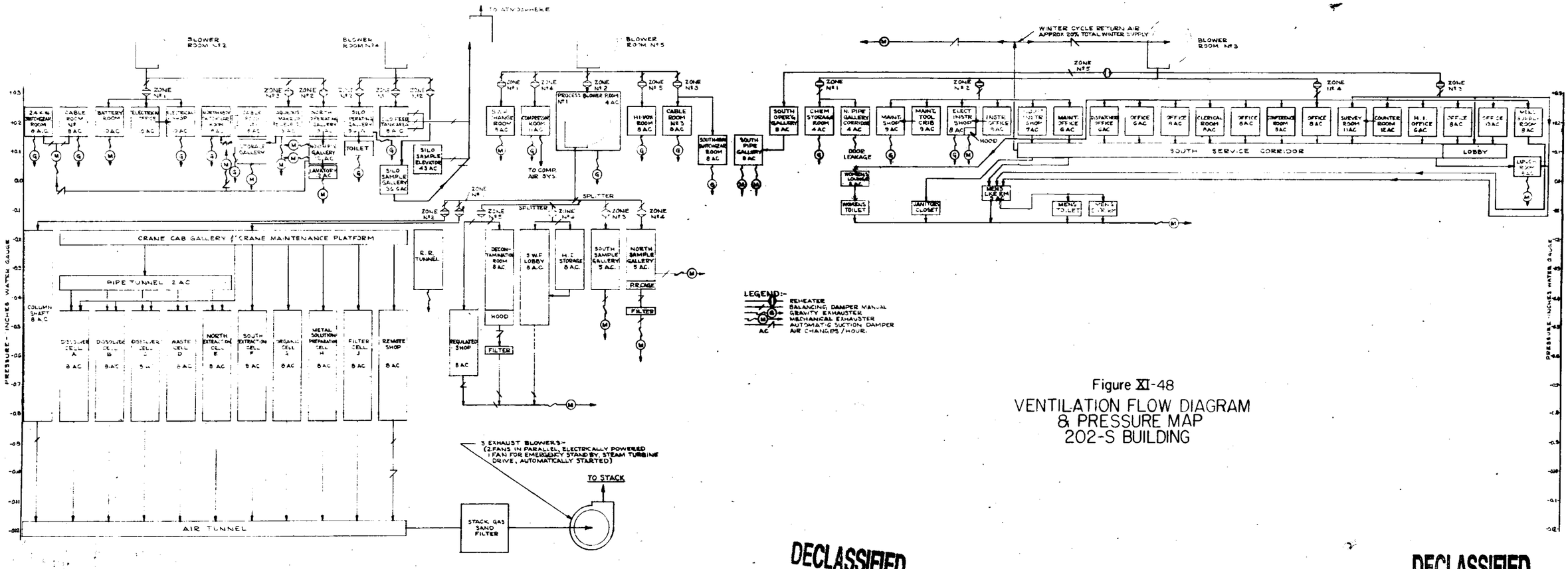

Figure XI-48
VENTILATION FLOW DIAGRAM
& PRESSURE MAP
202-S BUILDING

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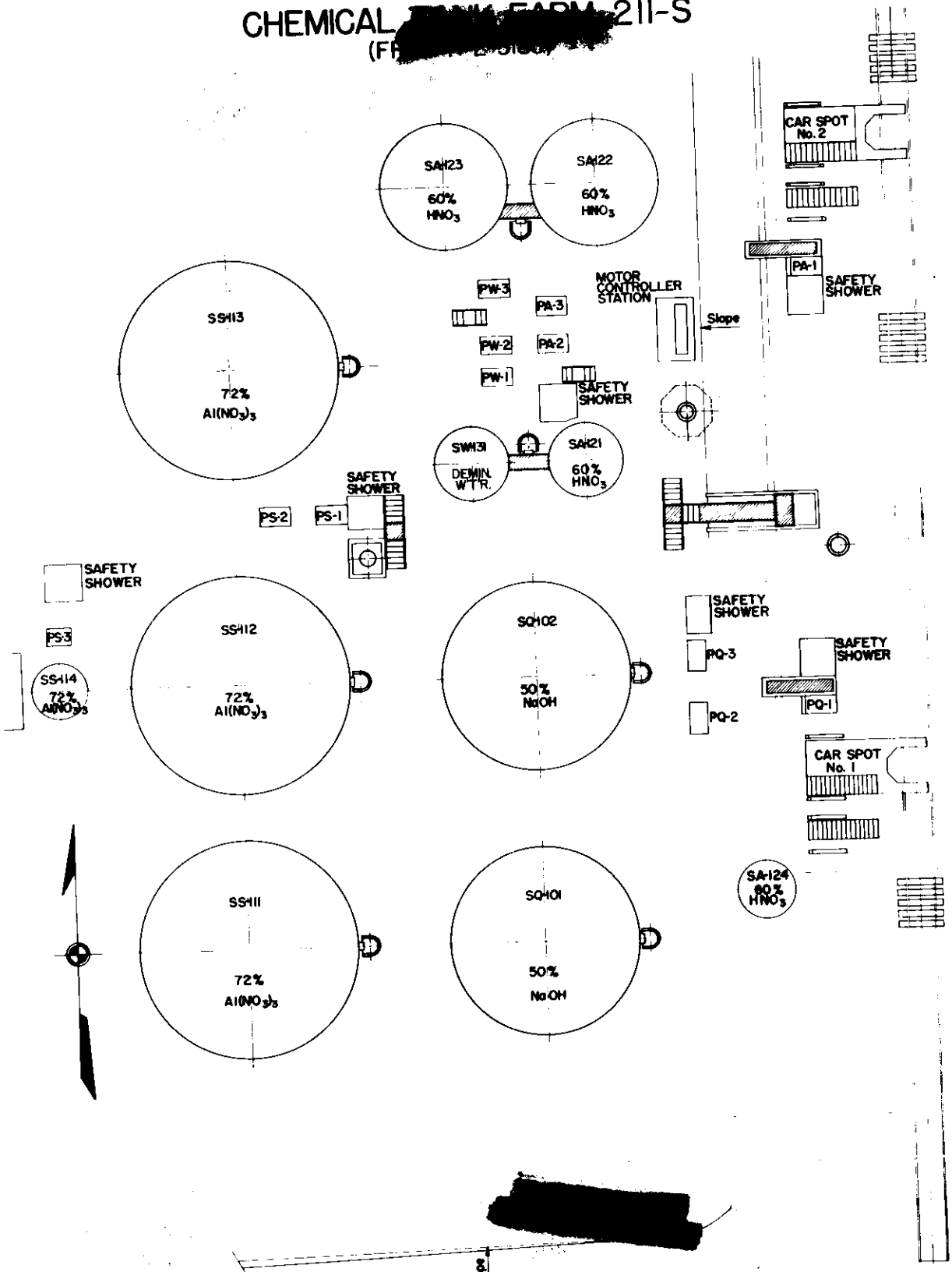
FIGURE XI-49
CHEMICAL [redacted] 211-S
(F[redacted])



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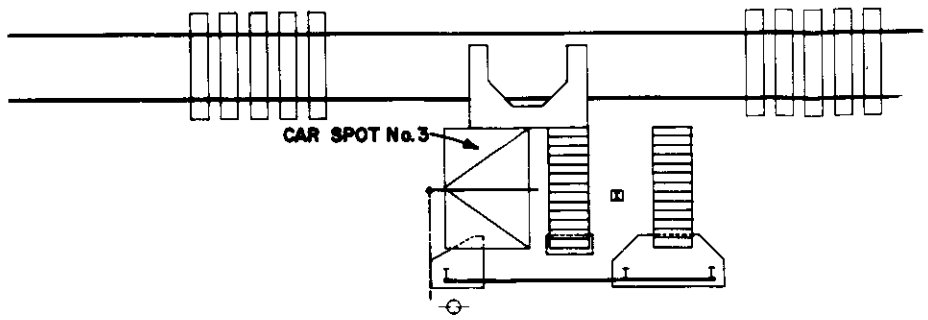
FIG[redacted]

SOLVENT TREATMENT B'L'D'G. 276-S
(FROM H-2-5368)



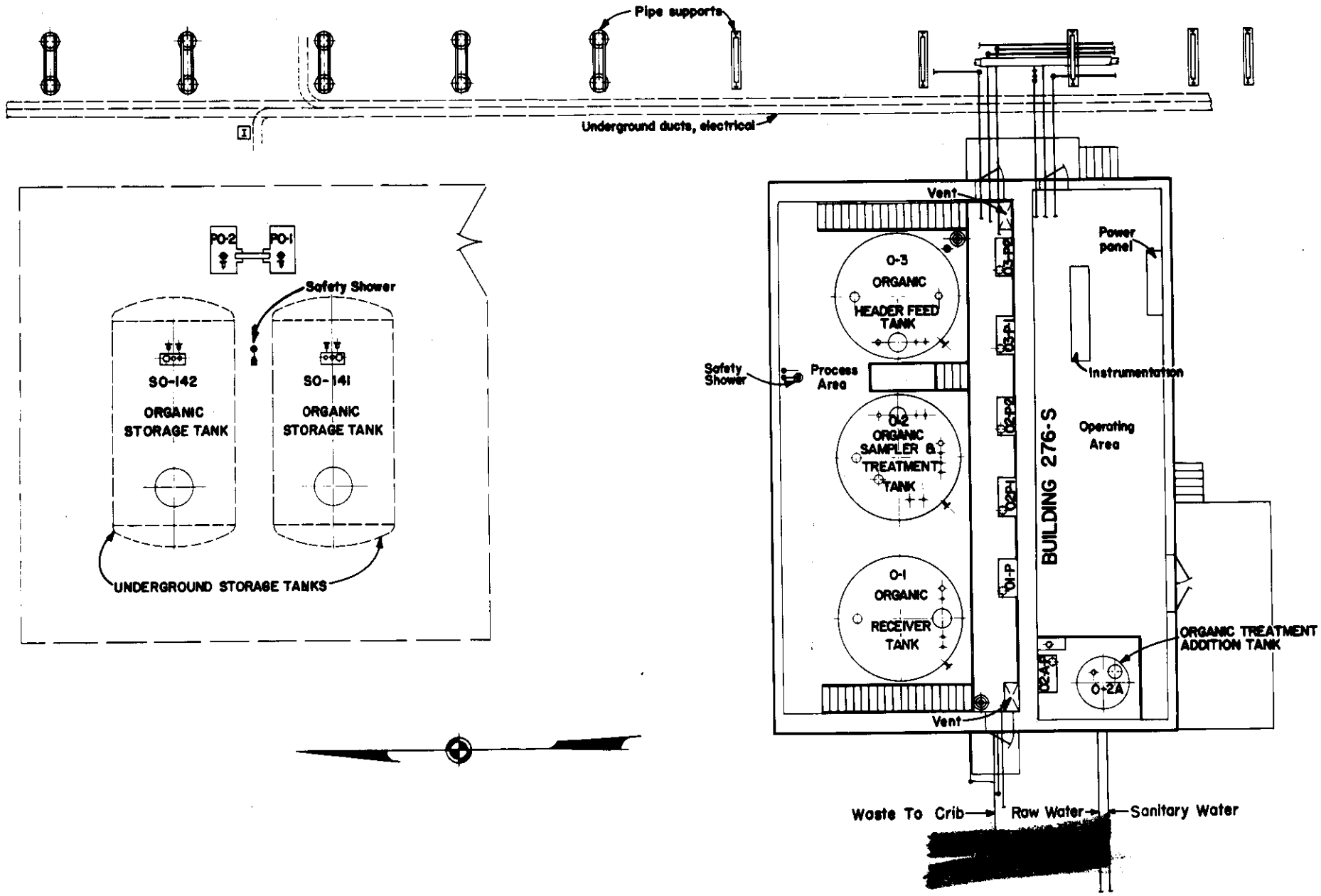


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FIGURE XI-51
RETENTION BASIN
207-S

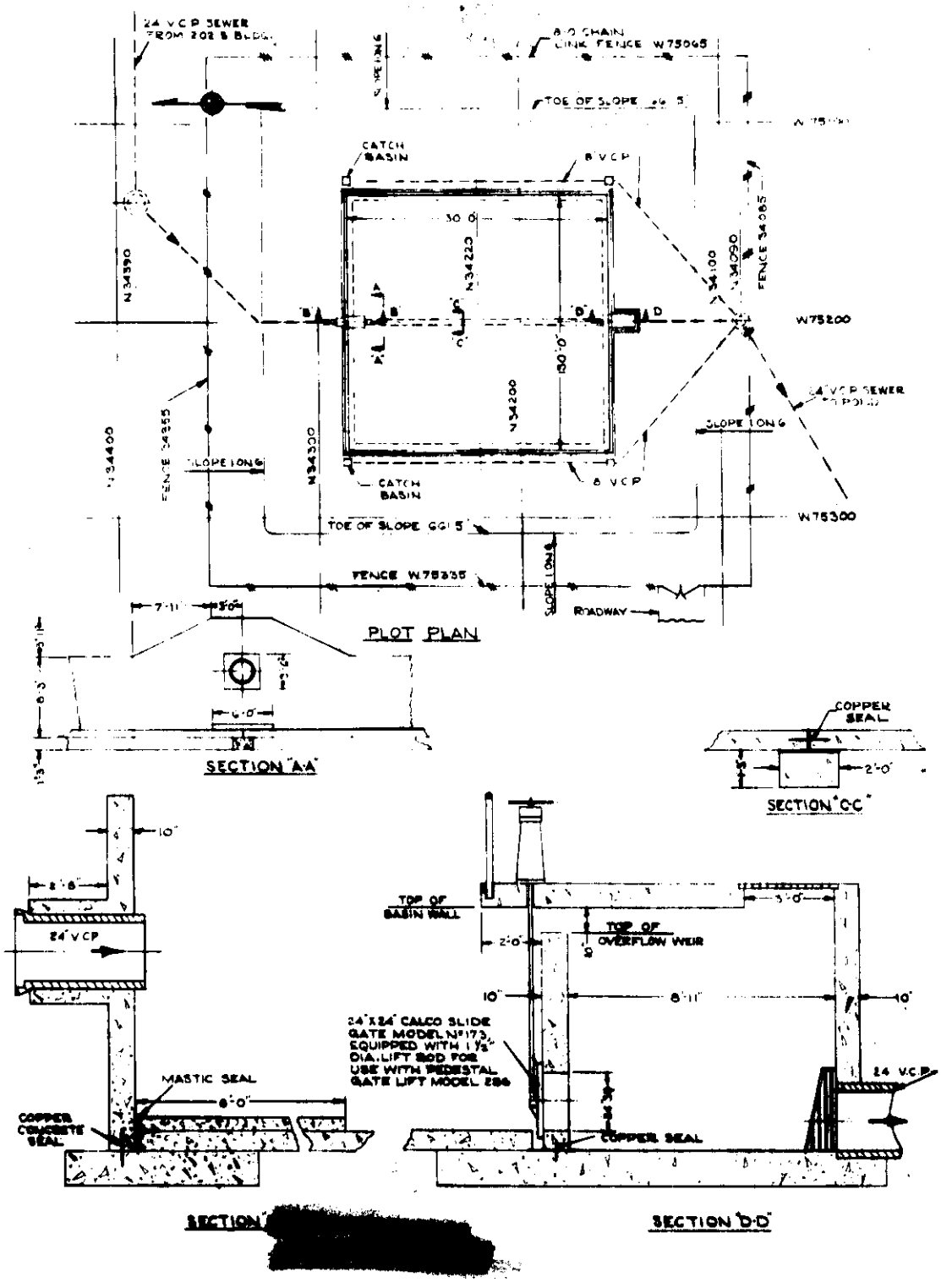

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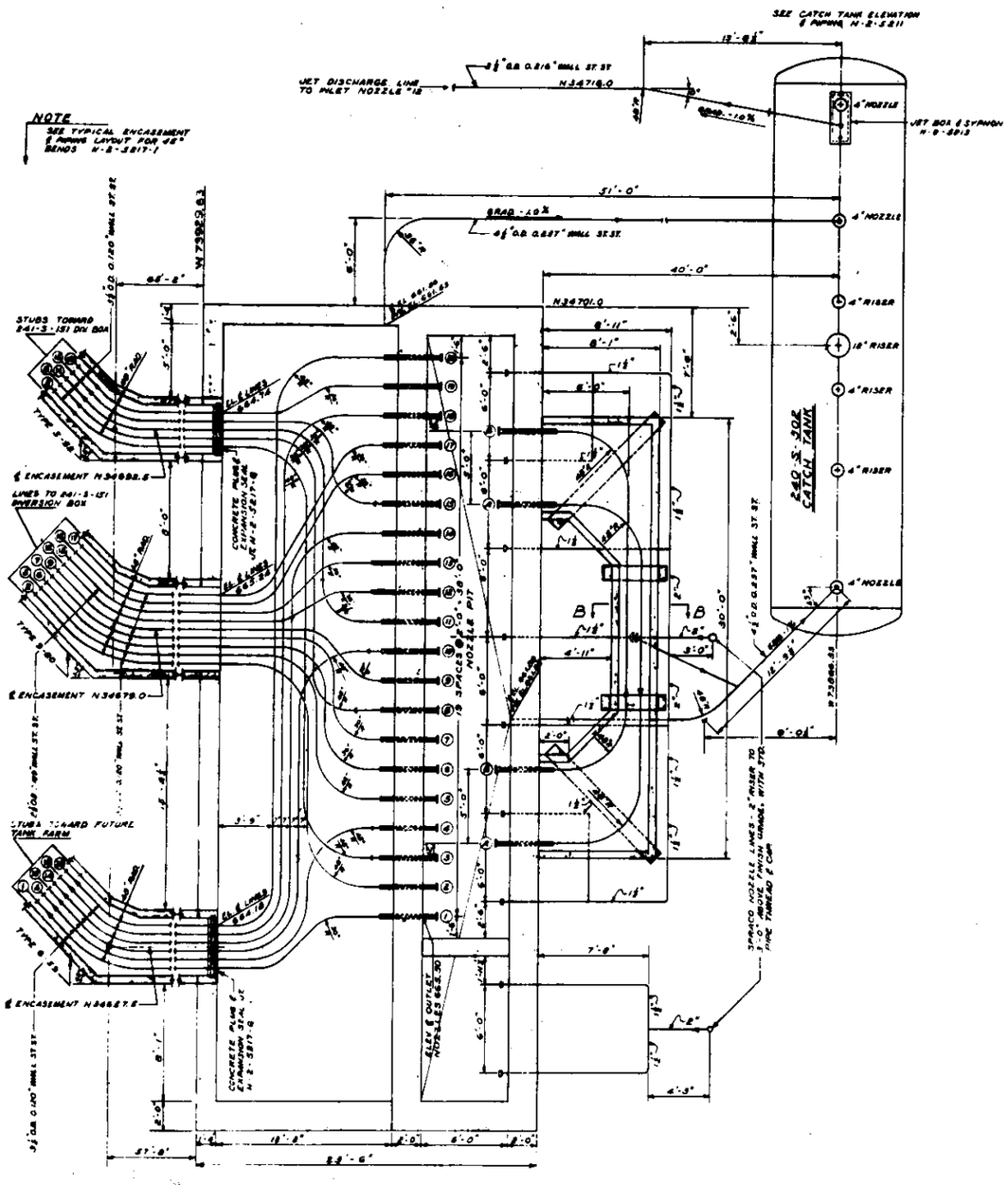
FIGURE XI-52
DIVERSION BOX, 240-S-151 PIPING DIAGRAM
(FROM DWG. H-2-5204 SH-1)



PLAN OF OUTLETS

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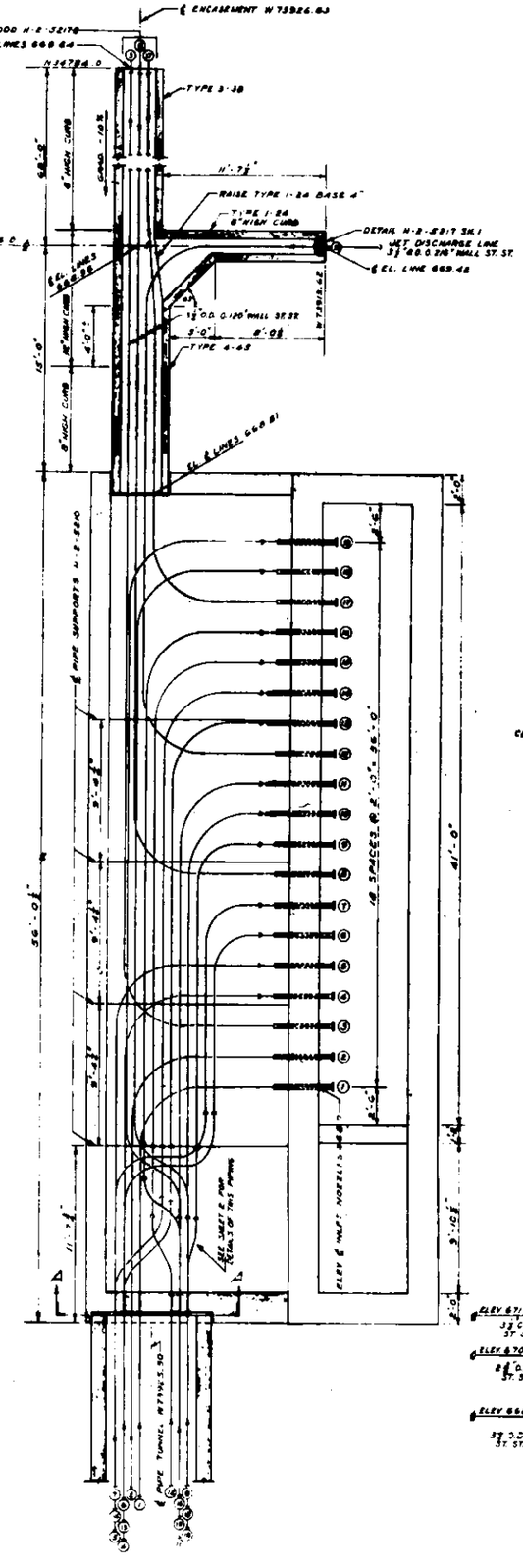
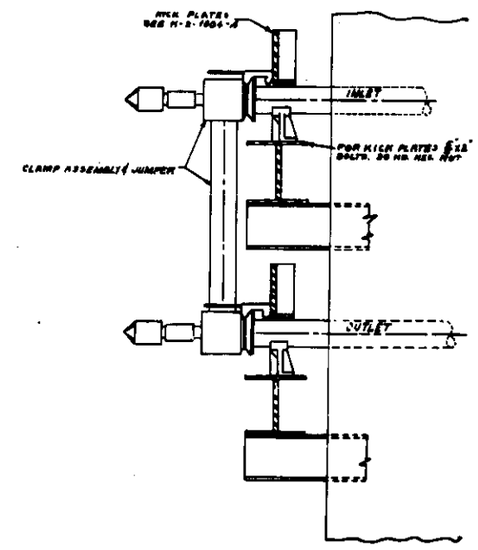
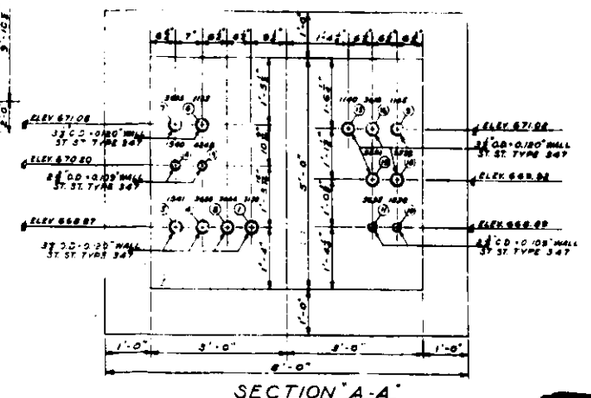


PLAN OF INLETS



FINAL ARRANGEMENT SECTION



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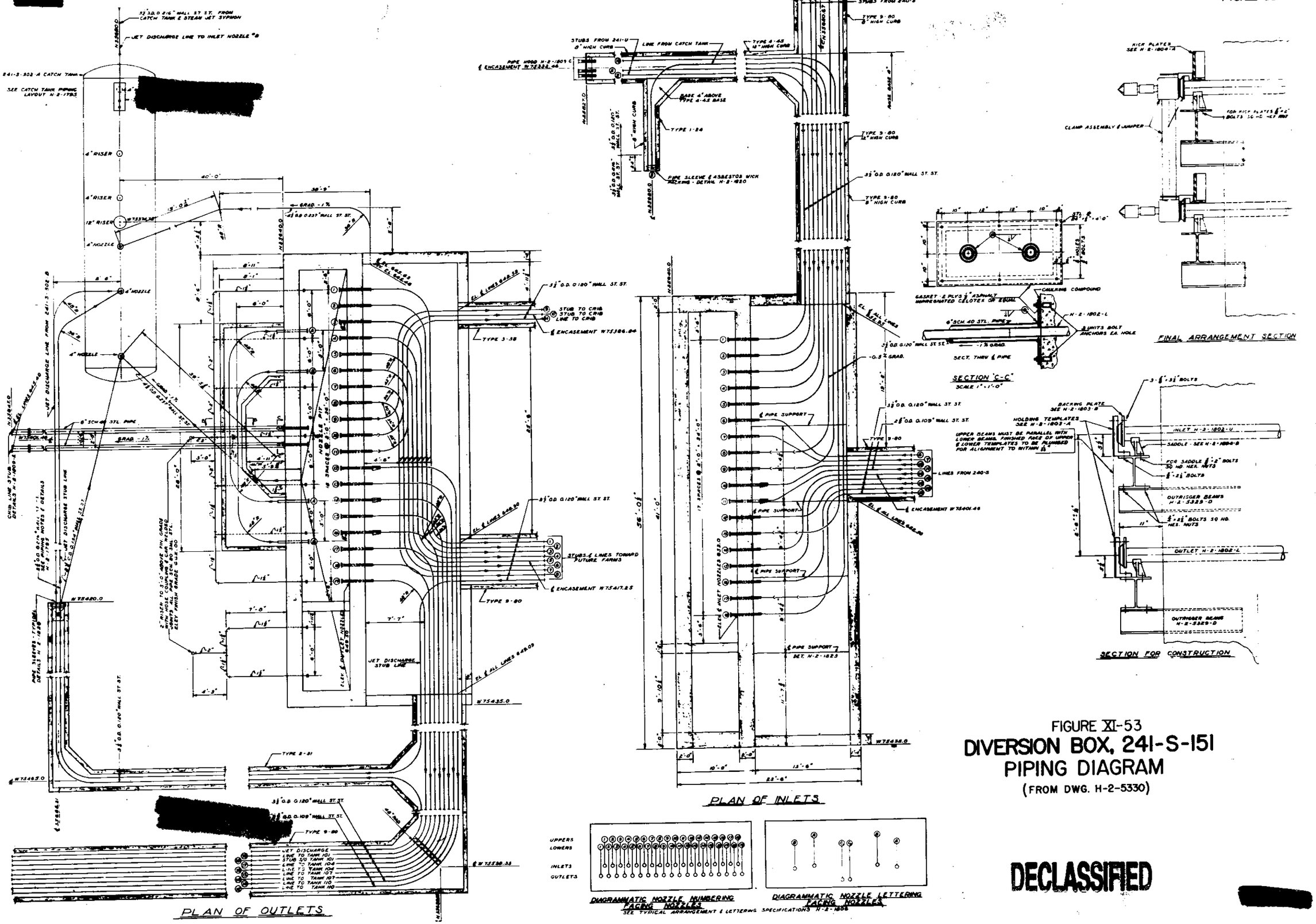

FIGURE XI-53
DIVERSION BOX, 241-S-151
PIPING DIAGRAM
(FROM DWG. H-2-5330)

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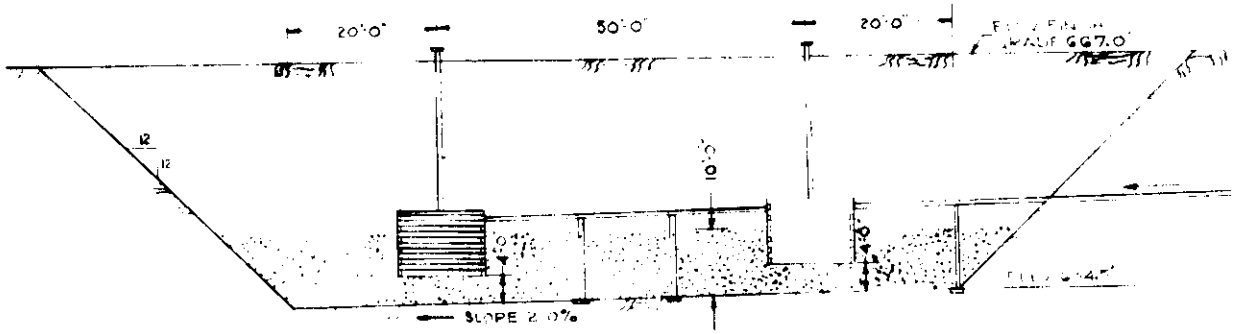
FIGURE XI-54

WASTE CRIB
216-S BUILDING



LONGITUDINAL SECTION
(FROM ~2-8-5)

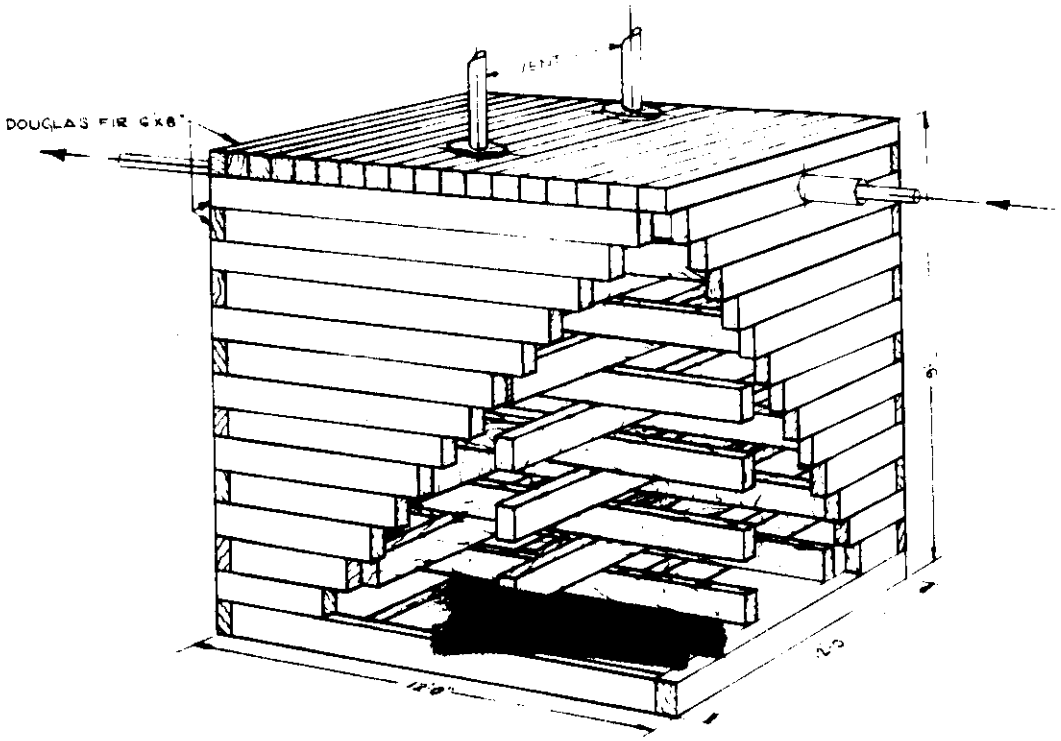


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FIGURE XI-55
WASTE STORAGE TANK FARM

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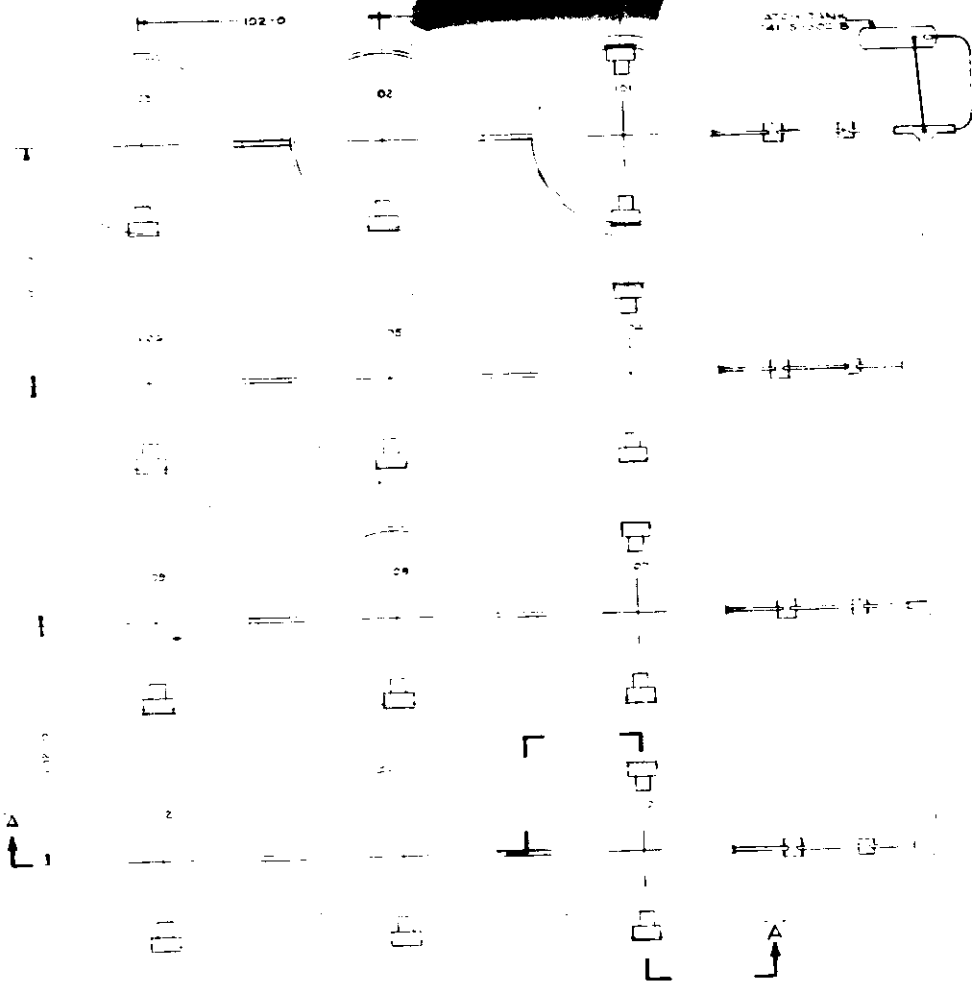

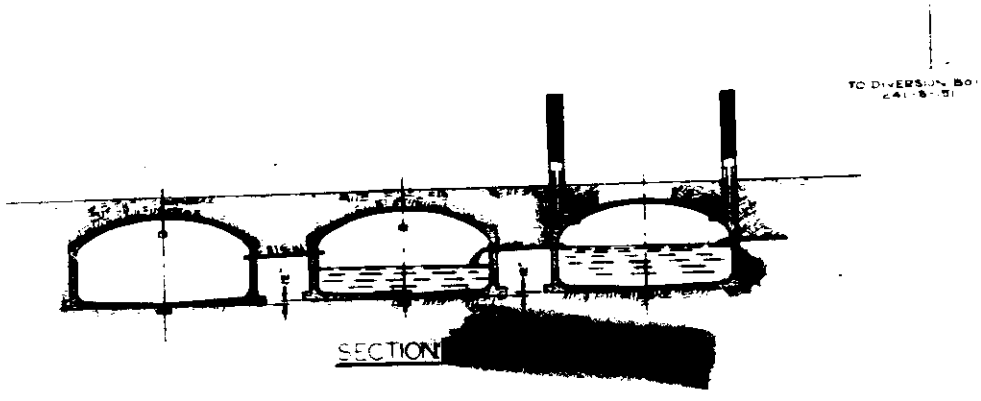

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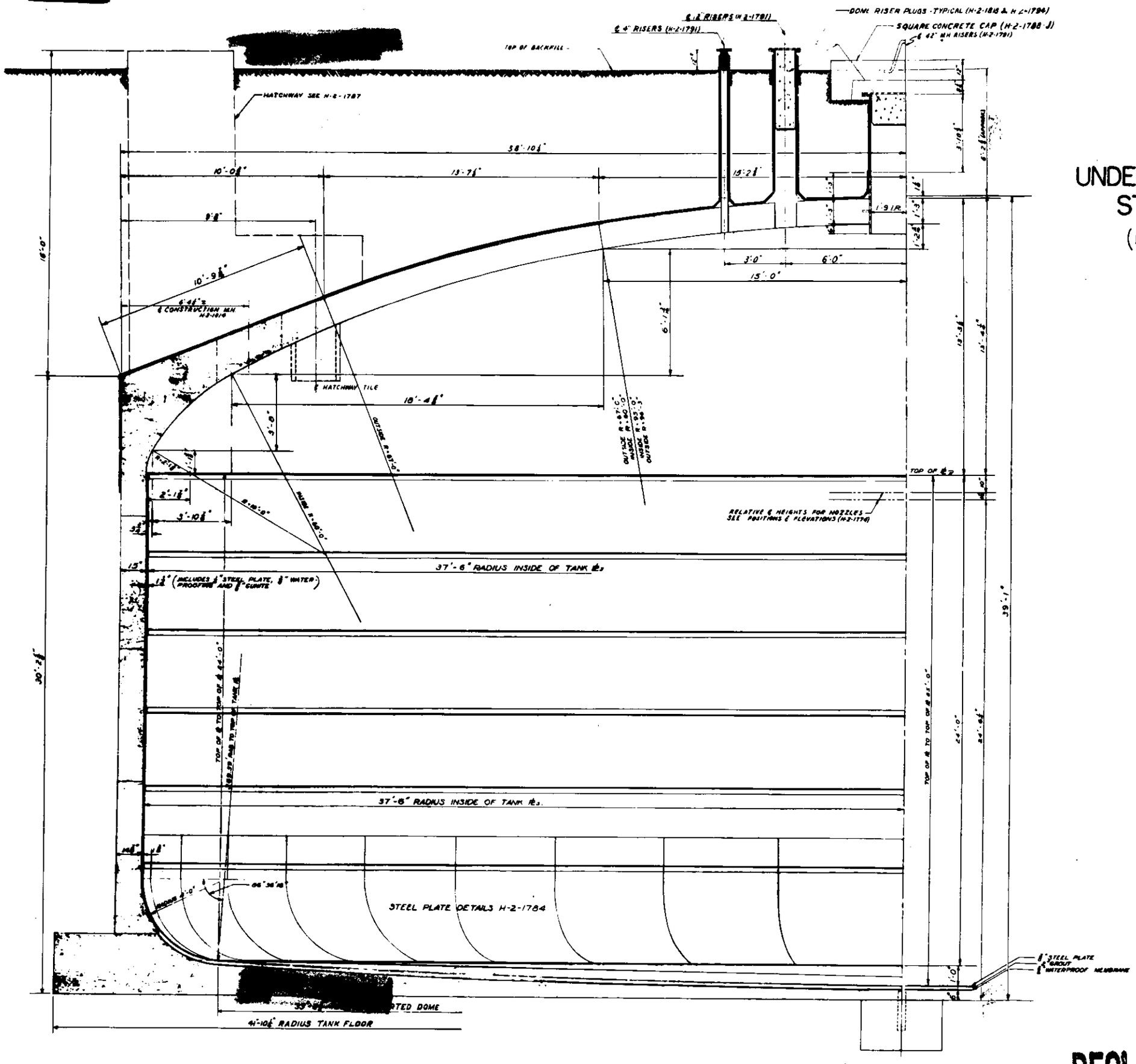

FIGURE XI-56
UNDERGROUND WASTE
STORAGE TANK
(FROM DWG. H-2-1873)

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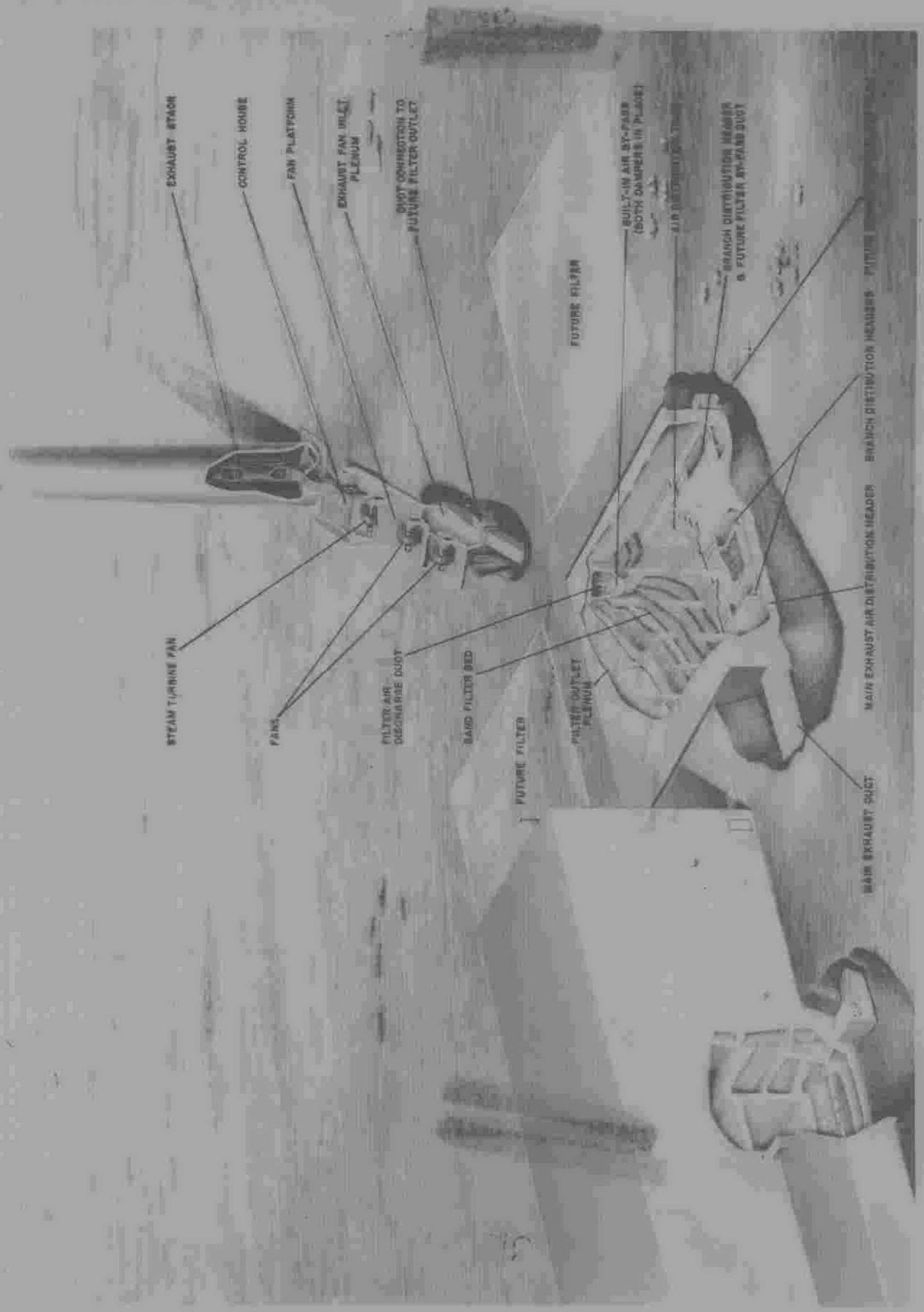

FIGURE XI-57 SANDFILTER & STACK. (FROM KLX 15-TR-153)

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[redacted] SERVICE OUTLETS

HW-18700
FIG. XI-58

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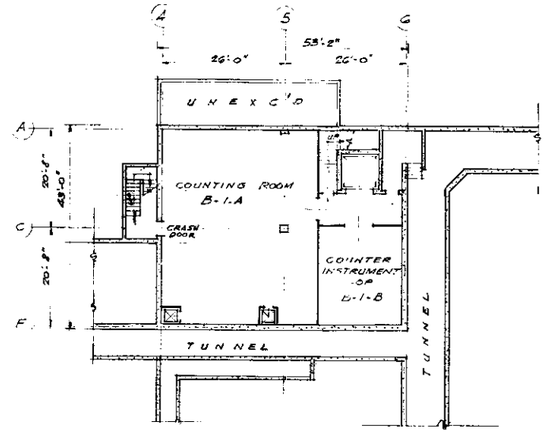
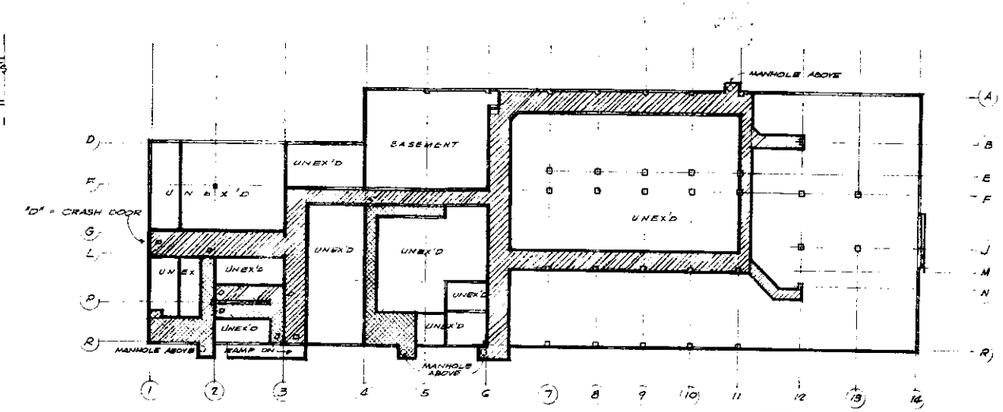
Room #	Pot. water, hot	Pot. water, cold	Distilled water	Compressed air, 25#	Compressed air, 50#	Low pressure [redacted]	Hydrogen	Nitrogen	Oxygen	Propane	Vacuum	Spare
1A	2	4	1	2	-	-	-	-	-	1	2	-
1B	-	1	-	1	-	-	-	-	-	1	1	-
1E	1	5	1	1	3	3	-	3	3	4	4	7
1F	1	6	1	1	4	4	-	4	4	5	5	9
1H	1	1	-	4	-	-	2	-	4	4	2	-
1J	1	2	-	7	1	-	-	-	1	7	7	1
1K	1	2	1	5	-	-	-	-	-	7	5	1
1L	1	13	1	14	2	4	-	2	-	14	14	8
2B	2	9	-	6	-	-	-	-	-	3	6	-
2D	-	2	-	2	-	-	-	-	-	2	2	-
2H	1	5	1	3	-	-	-	-	-	3	3	2
3B	1	2	-	7	4	-	-	-	4	6	3	-
4A*	2	12	2	16	-	-	-	-	-	16	16	10
4E	1	1	-	3	-	-	3	-	3	3	3	-
4M	3	7	3	14	-	1	-	-	-	14	15	4
4W**	1	13	1	14	2	4	-	2	-	14	15	6
4Q	1	3	1	3	-	-	-	-	-	3	3	1
4R	1	1	1	5	-	-	-	-	-	5	2	-
4U	1	3	-	5	-	-	-	1	-	4	3	-
B1B	-	-	-	1	-	-	-	-	1	1	1	-

* 4B, 4C, 4D, 4E, 4J, 4K, and 4L are identical with 4A.
** 4P, 4S, and 4V are identical with 4W.

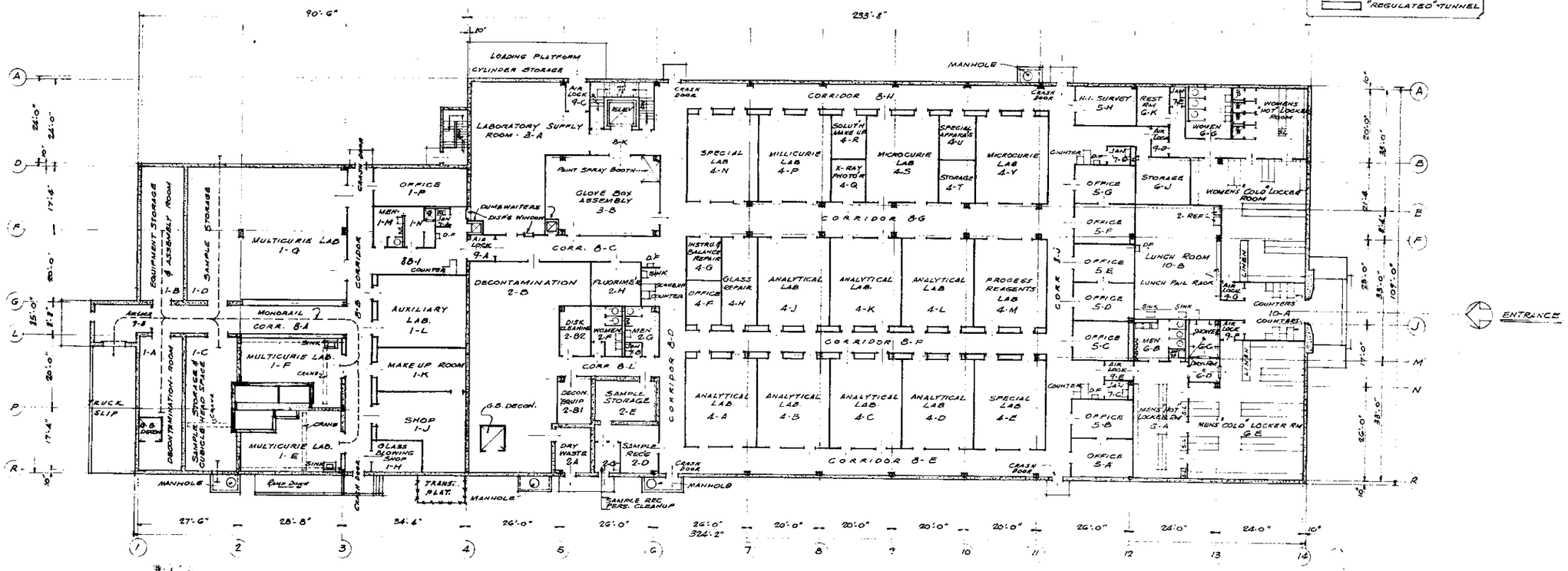


BASEMENT PLAN



PLAN OF SERVICE TUNNELS

TUNNEL LEGEND
"HOT" TUNNEL
"REGULATED" TUNNEL



FIRST FLOOR PLAN

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FIGURE XI-58
LABORATORY BUILDING 222-S
PLAN OF FIRST FLOOR,
BASEMENT, & SERVICE TUNNELS

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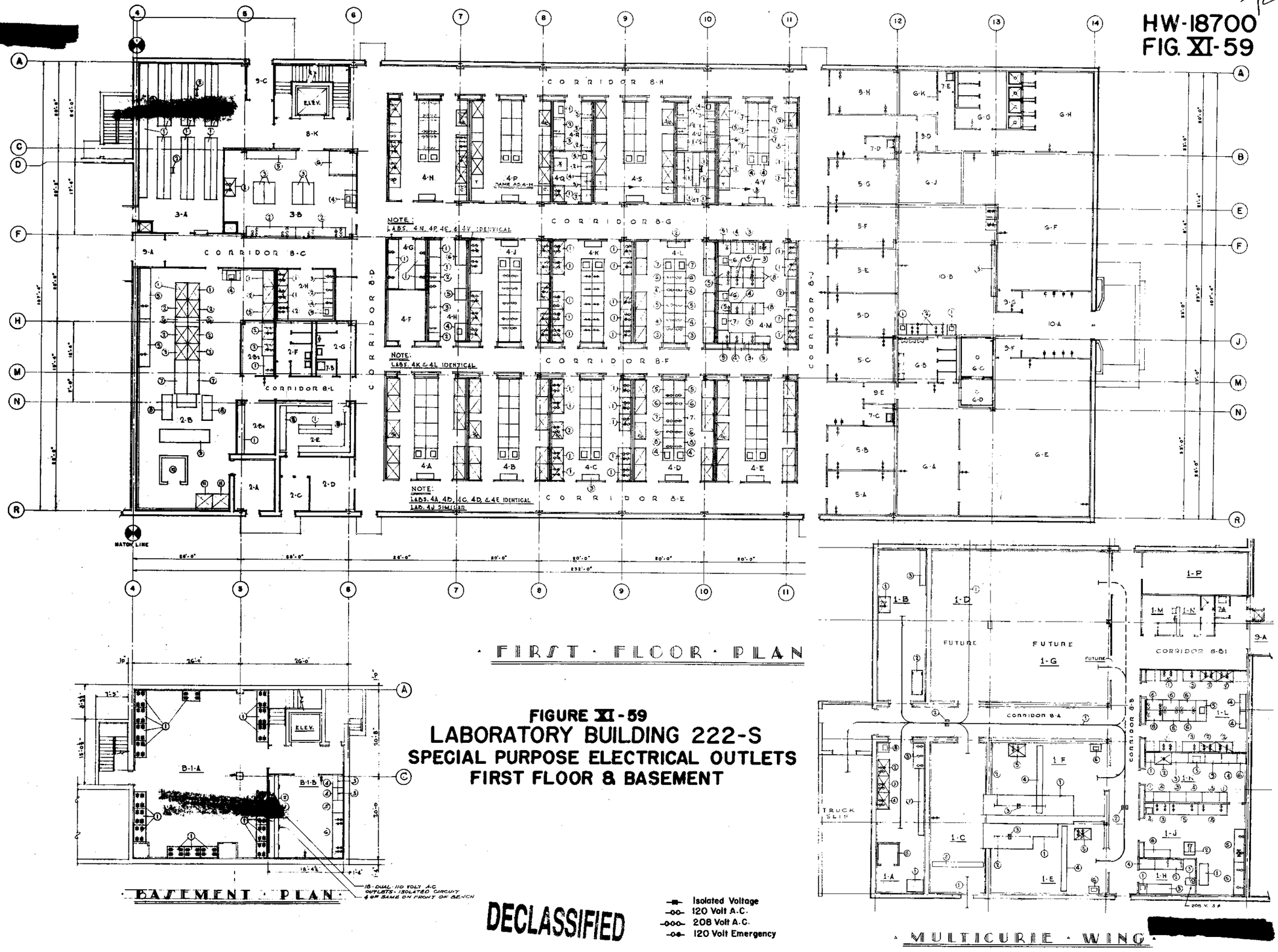

FIGURE XI-59
LABORATORY BUILDING 222-S
SPECIAL PURPOSE ELECTRICAL OUTLETS
FIRST FLOOR & BASEMENT

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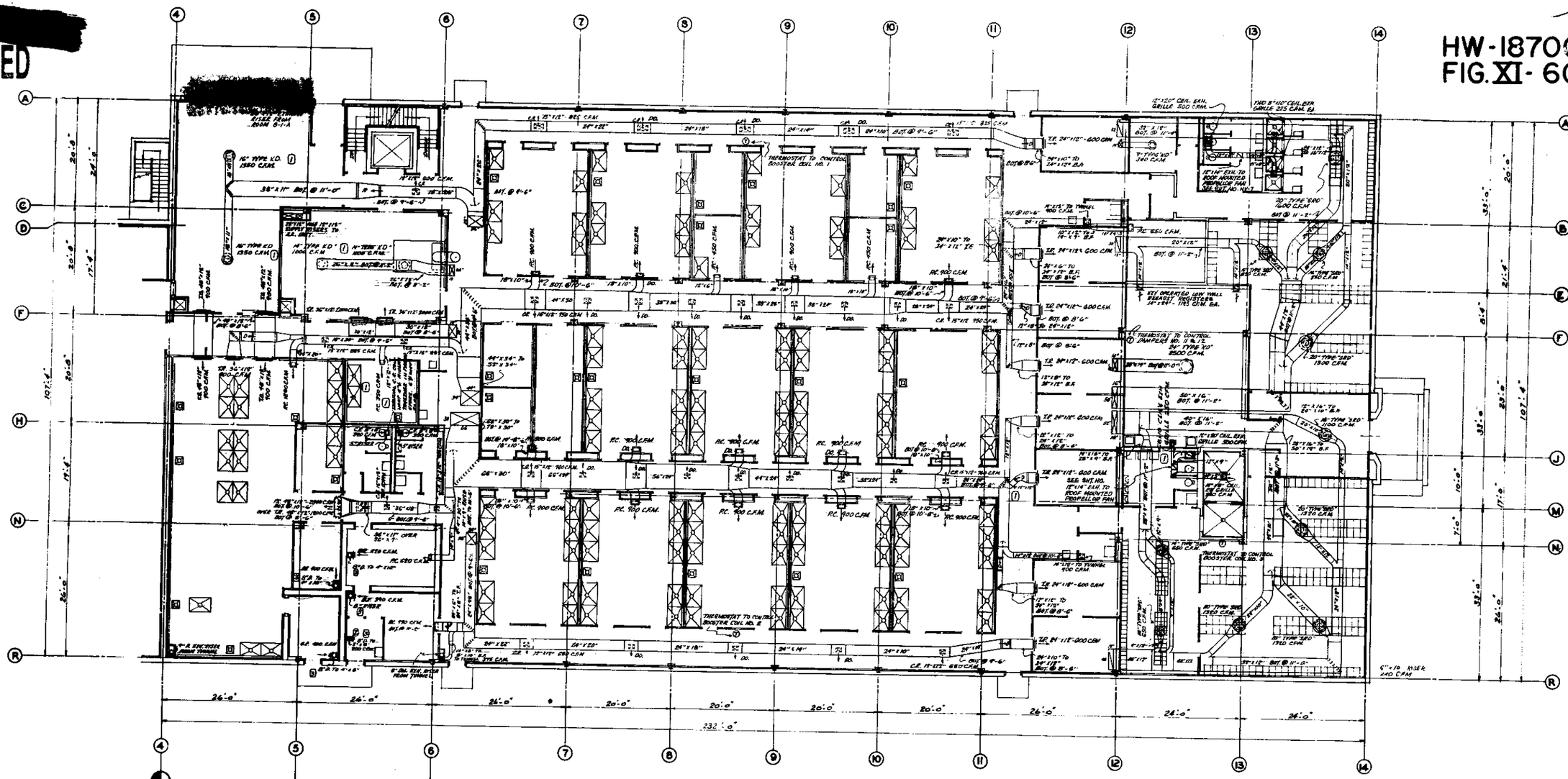
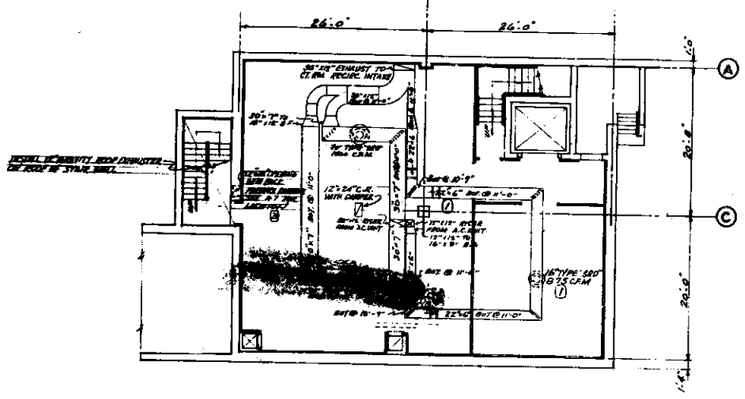
FIG. XI-60



FIRST FLOOR PLAN



PLAN - BASEMENT - ROOMS - Nº B1-A & B1-B

LEGEND

- SUPPLY RISER
- EXHAUST RISER
- CEILING REGISTER
- FILTER CANOPY & EXHAUST RISER
- FILTERED EXHAUST, AUTO. DAMP.
- PERF. CEILING OUTLET
- WALL REGISTER, AUTO. DAMP.
- WALL REGISTER, MANUAL DAMP.
- HIGH WALL REGISTER, SUPPLY

FIGURE XI-60
LABORATORY BUILDING 222-S
SUPPLY & EXHAUST AIR
FIRST FLOOR & BASEMENT

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FIG. XI-61

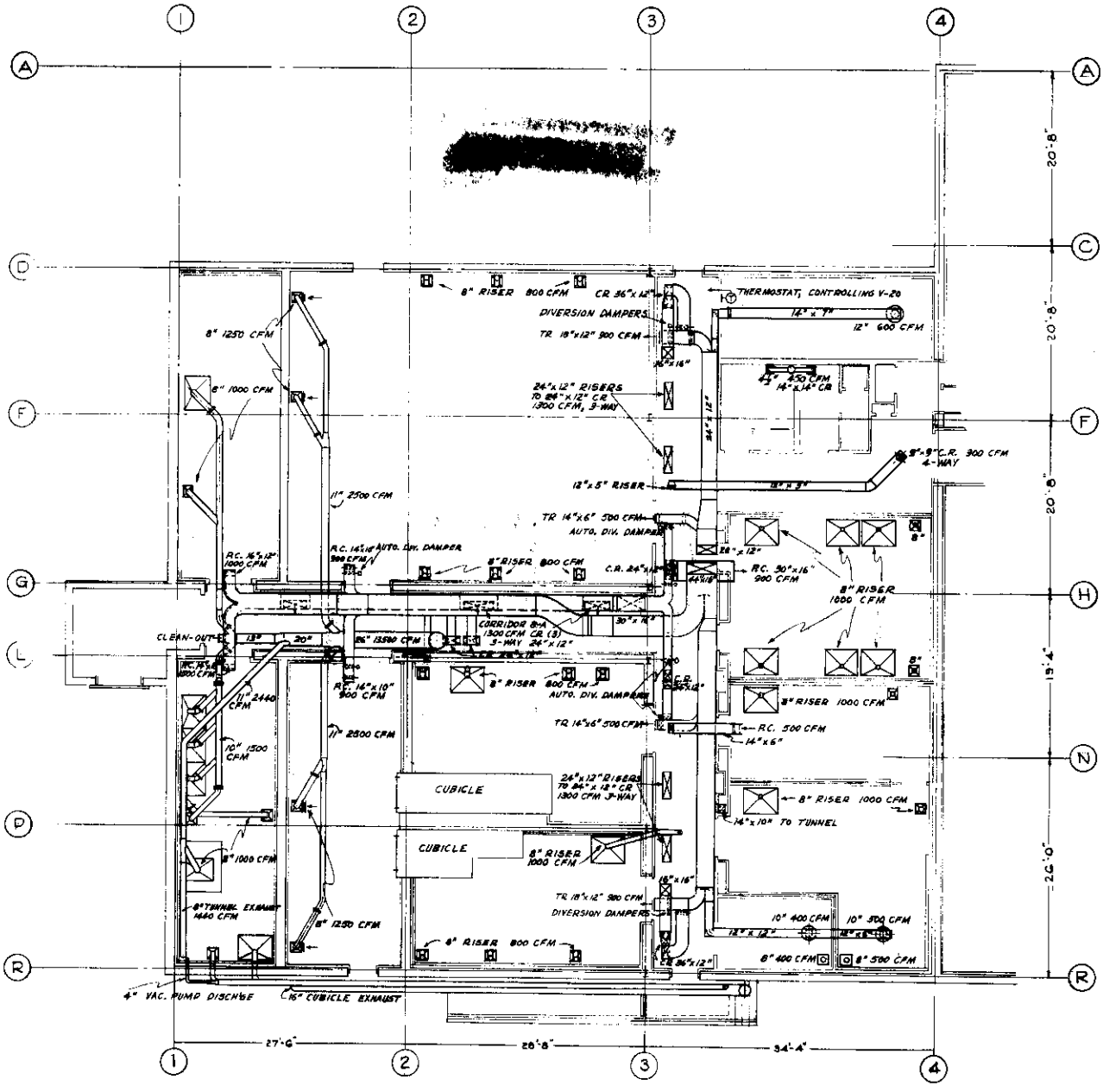

FIGURE XI-61
LABORATORY BUILDING 222-S
SUPPLY & EXHAUST AIR
MULTICURIE WING

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PART III: PLANT AND EQUIPMENT, continued

CHAPTER XII. ENGINEERING FLOW DIAGRAMS

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CHAPTER XII. ENGINEERING FLOW DIAGRAMS

A. GENERAL

1. General Design Considerations

The engineering scope of the Redox process is illustrated in Figures XII-3 through XII-21. These drawings, known as "Engineering Flow Diagrams", expand on the basic process flow depicted in the "Engineer's Flow Sketches" included in Chapters III, VI, VIII, IX, and X. The purpose of the Engineering Flow Diagrams, which were prepared prior to the detailed design effort, was to present an accurate picture of the engineering features of the process upon which plant design was to be based. During the development of these design basis plans foremost consideration was given to the radioactive properties of the materials handled, corrosiveness of the solutions, flammability of the solvent, and process continuity.

As in the existing Bismuth Phosphate process buildings, recourse to massive concrete shield walls was taken for protection of operating personnel from the hazards of radiation. All equipment that handles the radioactive materials has been placed in cells in the "hot", or canyon zone, and operated remotely by means of diverse instrumentation. Since the equipment is not readily decontaminated to allow prolonged personal contact the canyon equipment was designed for remote methods of maintenance, replacement and servicing. The corrosive properties of the chemicals used in the process dictated the use of stainless steels for fabrication of all tanks, piping, and auxiliaries essential to production continuity. Vessel venting has received individual attention. The flammability of the solvent used (see Chapter XXIV) requires a special vent system for all tanks which contain solvent or solvent vapors in order to control this hazard.

The most important factor that influenced the plant design effort is the continuous nature of the Redox process. All process streams throughout the solvent-extraction cycles and major portions of the Waste Treatment and Organic Recovery sections flow continuously. Metal feed preparation and final plutonium handling are batchwise operations. Tank sizing and placement in the cells was made, therefore, to conform with good operational control, and short-distance flow of process streams to and from the extraction battery. Some of the general design requirements with regard to equipment spacing, piping, and valving are discussed below.

2. Spare Equipment and Line Policies

No spares are installed for major equipment pieces that operate either continuously or batchwise. Provision of uninstalled spare equipment is discussed in Chapter XI. The designed capacity of the plant which allows for 20% down-time is considered adequate in lieu of installed spares. Dissolvers are the only exception to this provision for spares since their operation is subject to adverse weather conditions. One spare dissolver has been installed. One spare pipe-through-concrete line has been provided for each process transfer line to the solvent-extraction equipment and for each process return line from the extraction equipment. This in-

cludes transfers to the columns from the "cold" zone as well as those transfers confined with the "hot" zone. Wherever space is available on the gallery side, a reasonable number of spare auxiliary connectors, such as instrument, sampler, electrical, and utility have been installed through concrete. "General spares" have been provided to the pipe tunnel to lend flexibility in choice of stream routing which is not necessarily part of normal process flow. These spares also allow for contingencies arising as a result of future process changes. One set of flow control equipment consisting of a pump and associated instrumentation has been installed on each "cold" and "hot" feed stream in the process. An alternate route by jet has been provided from process vessels where a "hot" pump is the only outlet means.

3. Piping and Valving

The main process piping, utility piping, and instrumentation lines are shown in Figures XII-3 through XII-21 by means of heavy, light, and dotted lines respectively. Auxiliary line equipment such as control valves, connectors, jets, etc. are also indicated symbolically in order to illustrate the engineering design aspects. A legend of line auxiliary symbols is given on Figure XII-3. Reference should be made to the Instrument Engineering Diagrams in Chapter XIX for more specific details of instrument piping and symbols.

Process piping was sized by conventional flow-pressure-drop chart methods, and in the "hot" zone the ultimate selection of pipe based on the nearest or next largest standard connector size. Since the standard connectors range in size from 1 to 4 inches in one-inch increments, fractional pipe sizes have been avoided in order to simplify connector and remote maintenance requirements. Half-inch pipe has been used in the cells, however, for sampler, instrument, and lubrication piping. In these cases the small pipes are grouped into a bundle of three and joined at the cell walls through a two-inch connector head. Tank connectors for the three-pipe jumpers are either two or three-inch depending on tank size and nozzle layout. The selection of "hot" zone tank vent sizes was based on the gassing rate of the jets discharging to the individual tanks. In general, since the jet capacities are proportional to the tank volumes for a unit filling time, the vent sizes are grouped into 2-inch for tanks up to 4 ft. in diameter; 3-inch for tanks up to 7 ft. in diameter; and 4-inch for those larger than 7 ft.

The process addition tanks located in the "cold" zone are supplied from the appropriate chemical headers. These headers do not appear on Figures XII-3 through XII-21 but are shown schematically in Chapter XI. Demineralized water instead of filtered water is used for all process additions to avoid introduction of mineral impurities which ultimately may find their way into the final product streams. In addition to the necessary chemical and water supply, all process addition tanks are piped to receive a wash solution from the wash header. This wash solution is used to flush and decontaminate cell equipment prior to maintenance or replacement. Provisions for recirculation of this wash solution by recirculation jet and tank spray is incorporated on all unagitated vessels handling plutonium. Chemical addition lines as well as jet and coil-

steam lines entering the canyon equipment are provided with strainers.

Flow control valves are the only valves installed in the canyon area. There are no block or diversion valves in liquid process lines located within the canyon. Diversion valves are installed around the glass wool filter after the Silver Reactor in the Dissolver off-gas line. These valves allow the filter to be by-passed during the slug coating removal step, and thus prevent the deposition of ammonium nitrate (from NH_3 given off in coating removal) on the glass fibers. Chemical addition lines, since they do not enter process solutions contained in the canyon vessels, are not equipped with block valves at the shield wall. Manual block valves on instrument dip tube lines, and air-operated automatic block valves on jet or sparger gang-valve lines are installed on the "cold" side of the shield wall.

Pipe and valve codes indicated on Figures XII-3 through XII-21 are consistent with those listed in Hanford Works Specifications HW-4314, Revision No. 2, and HW-3450, Revision No. 6, respectively. Table XII-1 lists the various pipe codes employed, and explains briefly the services to which they apply. Valves are designated as to type by the prefix letters G, for gate; GL, for globe; CV, for control valve; and DO, for diaphragm-operated. The number following the prefix letters designates the working pressure; i.e., 1.2 = 125 lb./sq.in. The second letter, S or F, designates whether the valve is screwed or flanged. Thus, GL 1.5F is a flanged globe valve designed for 150 lb./sq.in. working pressure. Valve Specification HW-3450 should be referred to for further details.

4. Materials of Construction

Materials of construction for process equipment are noted on Figures XII-3 through XII-21. Vessels that are not designated are constructed from Type 347 stainless steel (or an equivalent in the 300 series stabilized toward intergranular corrosion by virtue of a Cb-Ta additive or extra low carbon content (E.L.C.)). This includes all equipment to handle radioactive material, or equipment that must be fabricated from stainless steel for process reasons. Type 347 was used since it is columbium stabilized and does not require annealing after welding. Type 309 S-Cb, which also does not require annealing, is specified for all vessels that handle process solutions at elevated temperatures, such as the Dissolvers, ICU Concentrator, etc.

The following are the most important reports on the corrosion resistance of materials of construction to Redox process solutions:

CN-1314 Progress Report Corrosion Tests, by R. S. Apple. 3-25-44.

HW-14641 Corrosion Tests on Austenitic Stainless Steels in Redox Process Streams (ANL Flowsheets), by W. W. Koenig. 10-5-49.

HW-17010 Corrosion of Austenitic Stainless Steel Type 347 in Redox Process Streams (ORNL No. 1 Flowsheet), by W. W. Koenig. 2-23-50.

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5. Equipment Designation

Process equipment pieces are shown schematically in elevation on Figures XII-3 through XII-21. Positioning of the equipment pieces on the figures does not indicate their relative locations in the building (see Chapter XI), except that all are shown on the correct side of the shield wall boundaries between the "hot" and "cold" zones.

During the design and construction of the Redox Plant all process vessels were referred to by equipment piece number. This number also appears on the major equipment pieces as placed there by the manufacturer. Since this numbering system did not lend itself to a convenient identification code, an operational marking or number was assigned to each vessel. For example, cell equipment is identified for operating purposes by assigning a unit letter and number corresponding to the cell in which the equipment piece is located, and its position with respect to other units in the same cell. The cells are lettered A through H and J counter-clockwise from the northeast corner of the canyon. The letter I has been omitted as a cell designation to avoid confusion. Equipment in each cell is numbered from west to east by units of equipment in the cell. A list of major operating equipment piece numbers and their corresponding operating numbers is given in Table XII-2.

B. METAL FEED PREPARATION

A description of the metal feed preparation procedure has been previously outlined in Chapter III. The general engineering considerations as applied to the Engineering Flow Diagrams, Fig. XII-3 to XII-7 inclusive, are discussed herewith.

1. Metal Dissolution -- Fig. XII-3, 4, 5

Three Dissolvers, together with their associated addition tanks, Rinse Tanks, and Silver Reactors, have been provided for the Redox Plant. Two of the Dissolvers, A-2 and B-2, will operate all the time with the third, C-2, acting as stand-by for adverse weather conditions or down time on another Dissolver. The two normally operated units discharge to their own Metal Solution Storage tank with the third, or spare, unit discharging to both solution storages, H-9 and H-8, Fig. XII-6. These storages are each capable of handling three Dissolver cuts. A third Metal Solution Storage, H-7, has been provided which receives from both of the individual cut tanks. Agitators are installed on the metal solution tanks to permit blending of cuts and minimize accumulation of insoluble material. The combined solution holdup provided by these three tanks is sufficient to keep the process supplied with feed for 5 to 6 days. A Dissolver Waste Tank, H-10, for coating removal wastes is provided for accountability purposes and neutralization of the 5% nitric acid wash after slug jacket removal.

2. Off-Gas Handling -- Fig. XII-3, 4, 5

Off-gases evolved during the dissolving step are passed through a

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preheater and Silver Reactor, A-3, B-3, and C-3, for removal of iodine. The gases leaving the Reactor pass through a filter capsule, and thence to the stack, using a jet as a prime mover. The preheater is required to bring the off-gases up to the desired reaction temperature (about 475°F.) before contact with the silver-nitrate-activated surfaces of the Reactor packing. The Silver Reactor is replaced as a unit whenever the iodine escape indicates a depletion of packing activity. Diversion tees have been installed in the off-gas lines in the stack jet pit to allow for possible future installation of additional off-gas treatment facilities, such as for removal of nitrogen oxides and krypton.

3. Ruthenium Removal -- Fig. XII-7

Removal of ruthenium from the Dissolver solution is accomplished by sparging the solution with air in the Oxidizer Tank, H-4, during the oxidation step. The Oxidizer is equipped with a deentrainment column for mist control while the hot volatilization of ruthenium is accomplished. A reflux coil has been provided at the top of the column for periodic packing washdown. The evolved gases are passed through the Ruthenium Scrubber column, H-5, where the ruthenium is removed by a caustic solution. Concentration of the recirculated caustic solution is maintained as uniformly as possible by means of the steam coil in the scrubber basin. Spent caustic is jetted periodically to the Waste Neutralizer, D-8, Fig. XII-19, and the scrubber system is replenished with fresh solution. The vapor line from the scrubber column is equipped with a condenser for vapor knock-down before the gases leaving the scrubber pass through a filter on their way to the stack. A seal pot is installed on the condenser in order to isolate the ruthenium vent system from the condensate header system. Water addition facilities have been provided to the oxidation tank since some water will be removed during the ruthenium volatilization step.

4. Clarification and Scavenging -- Fig. XII-7

Clarification of the metal solution, or removal of any solid scavenging material introduced to the Oxidizer for purposes of removing zirconium and niobium, is accomplished in the Centrifuge, H-2. A jet has been provided in the Centrifuge effluent line for returning cake wash solutions to the Oxidizer whenever a scavenger is used. In this manner trace quantities of fission products, as well as uranium and plutonium removed from the interstices of the centrifuge cake by the washes, are returned to the oxidation tank where they are combined with the next batch, rather than be allowed to advance with the clarified feed to the IA feed preparation step. Washed centrifuge cake is slurried to the Waste Slurry Receiver Tank, H-3, where a sample is taken for accountability purposes. A line from the Slurry Receiver Tank to the Oxidizer has been provided in the event that further washing of the slurry is necessary. The Slurry Receiver Tank is emptied by jet to the Waste Storage Cascades.

Clarified metal solution is received in the IAF Make-Up Tank, H-1, where the necessary chemical additions are made for the preparation of feed to the IA Extraction Column. The completed feed solution is transferred to the IA Feed Tank, F-7, by pump instead of jet in order to avoid dilution.

5. Rework and Alternate Routings

"General Spare" connectors have been provided in the Dissolver cells for making inter-cell transfers between A, B, C, and J Cells. Connectors are also available in the Feed Preparation Cell (H) for transfers to or from D, E, G, and J Cells.

6. Equipment Flushing Provisions

The Dissolvers, A-2, B-2, and C-2, may be flushed for decontamination purposes by adding wash solutions through their respective chemical addition weigh tanks and normal run-down lines. Disposal of the washes may be made via the Dissolver Waste Tank, H-10. A flush of any one of the Metal Solution Storage Tanks, H-9, H-8, H-7, would require the wash solution to be added through one of the Dissolvers with subsequent disposal to waste via the Oxidizer, H-4, and the Waste Slurry Receiver, H-3. The Oxidizer, Waste Slurry Receiver, Centrifuge H-2, and Ruthenium Scrubber may all be flushed independently to waste or Waste Treatment through their respective chemical addition tanks.

C. SOLVENT-EXTRACTION

A complete discussion of the solvent-extraction procedures and associated tanks and columns is given in Chapters VI, XIII, and XIV, respectively. General process engineering considerations, with specific reference to the presence and purpose of alternate pipe routings shown in Figures XII-6 through XII-14, are discussed herewith.

1. First Extraction Cycle -- Fig. XII-8, 9, 10

1.1 General

Prepared metal solution is received batchwise into IA Feed Tank F-6, and pumped to the IA Column at a controlled rate. Separation of the uranium from plutonium is accomplished in the IB Column. The organic uranium effluent cascades to the IC Column and the aqueous stream containing plutonium leaves the bottom of IB. Discussion of subsequent plutonium processing is contained in Section C3 of this chapter. Uranium is extracted from the organic stream into the aqueous phase in the IC Column. The uranium-laden aqueous stream cascades to the hexone stripping column on the ICU Concentrator, F-2. The concentrator column is equipped with a packed deentrainment section for mist control of the rising vapors before they are condensed in the ICU Concentrator Condenser, F-3. Both condensed phases leave the condenser, F-3, via the condensate header. Caustic is added to the concentrator pot continuously at a controlled rate by means of a proportioning pump. The specific gravity of the concentrate controls the steam addition rate to the pot coil. Concentrated solution overflows continuously from the concentrator pot through a vented dip leg to the 2DF Feed Tank, F-1. The vent has been provided on the dip leg to prevent syphoning of the pot contents to Tank F-1 which is at a lower level in the cell. The pot may be emptied by jetting to F-1. The overflow line is liquid sealed in F-1, and liquid-seal traps have been pro-

vided on the uranium and caustic influent lines to prevent the ICU Concentrator from venting into the nitrogen or "cold" vent header systems instead of the condenser vent system.

1.2 Rework and alternate routings

The IA Feed Tank, F-7, can be emptied by jet to the reoxidation header which returns insufficiently oxidized material to the Oxidizer for further processing. The IA Feed Tank also receives from the Cross-Over Oxidizer, E-7, in the event that a plutonium stream contains excessive quantities of uranium and further separation is required in the First Extraction Cycle.

The IS Feed Tank, F-8, functions as the feed tank for the IS (rework) Column. Chemically adjusted rework solutions are received in this tank from the waste Rework Adjustment Tank, D-7. This system may be used when excessive plutonium, or abnormally high uranium losses appear in the column waste streams. Tank F-8 may be emptied by jet to the reoxidation header should oxidation of a rework charge be required.

Both the IA and the IS Column cascade the metal-bearing stream to the IB Column; their effluent lines join into a common line before entering the IB Column. Alternate routings are available for the IS Column metal stream to either the IC or the 2E Column. These alternates may be used, by jumper change (U-5 to U-13 or U-14; see Figure XII-8), to reprocess waste streams that contain excessive quantities of uranium and allowable plutonium losses. The choice of the routing is dependent upon the fission-product decontamination required and raw chemical costs.

1.3 Equipment flushing provisions

The First Extraction Cycle columns may be flushed by adding wash solution to the "cold" zone aqueous feed tanks (e.g., IA Scrub Tank, 801-S). For the IA or the IS Column the wash may be routed directly to Waste Treatment. In the case of the IB or IC Column the wash must be routed through the between-cycle tanks to the 2A or the 2D Column, whichever applies, and thence to the Waste System. Flushing of the IA Feed Tank, F-7, or the IS Feed Tank, F-8, is accomplished via the IAF Make-Up Tank, H-1, and the Rework Adjustment Tank, D-7, respectively, and thence to the Waste System through the IA or the IS Column.

2. Second and Third Uranium Extraction Cycles-- Fig. XII-11, 12

2.1 General

The 2D Feed Tank, F-1, normally operates on liquid-level alarm control with constant agitation and coils covered to provide sufficient surface for cooling the hot effluent from the ICU Concentrator before being introduced into the 2D Column. Feed for the 2D Column is pumped from F-1 to the 2D Column at a controlled rate. The function of the Second and Third Uranium Cycles is to decontaminate the uranium sufficiently for subsequent processing. Decontamination is accomplished by two extraction and stripping cycles with concentration and chemical adjustment in the 2EU Concentrator, E-5, between cycles. The finished uranium stream is concentrated in the 3EU Concentrator, E-10, before final sampling and disposition. Operation

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of F-3 and E-10, and the function of their auxiliaries, is identical to that previously described for the ICU Concentrator, F-2. No caustic addition is made to the 3EU Concentrator, E-10.

2.2 Rework and alternate routings

The 2D Feed Tank, F-1, receives rework material from the 2D Rework Tank, E-13, in the event that a uranium stream leaving the Third Uranium Extraction Cycle must be returned to the Second Uranium Extraction Cycle for further fission-product decontamination. The contents of F-1 may be jetted through installed pipe to the 3EU Concentrator Sampler, E-12, should the fission-product decontamination achieved in the First Extraction Cycle be sufficient to allow by-passing of the Second and Third Uranium Extraction Cycles. A "General Spare" connector has been provided for routing, by jumper change (T-54 to T-78; see Fig. XII-10 and 11), the contents of F-1 to the 3D Feed Tank, F-4. This allows the Second Uranium Extraction Cycle to be by-passed and residual fission products to be removed in the Third Uranium Extraction Cycle. Thus, one or two-cycle operation is possible by making the proper routing from F-1 Tank.

No rework material is routed to the 3D Feed Tank, F-4, since the normal disposition for off-standard uranium is via the 2D Feed Tank, F-1, for reintroduction into the Second Uranium Extraction Cycle. Aside from the normal exit from the 3D Feed Tank to the 3D Column, alternate exits have been provided by jet through installed pipe or by jumper installation to "Ceneral Spare" connectors. The contents of F-4 may be jetted to the 3EU Concentrator Sampler, E-12, in the event that sufficient fission-product decontamination has been achieved in the Second Uranium Extraction Cycle to warrant by-passing of the Third Uranium Extraction Cycle. "General Spare" connectors provide alternate exit routings from F-4 to 2D Feed Tank F-1, 3EU Concentrator Receiver E-11, and IS Feed Tank F-8.

Rework uranium is received in the 2D Feed Rework Tank, E-13, from the 3EU Concentrate Sampler Tank, E-12. Chemical adjustment of the rework material is made in E-13 before being returned to either the 2D Feed Tank, F-1, or the Oxidizer, H-4. "General Spare" connectors have been provided in the vicinity of the 3EU Concentrate Sampler and the 2D Feed Rework Tank for routing material to or from D, E, F, or H Cells.

2.3 Equipment flushing provisions

The Second and Third Uranium Extraction Cycle Columns are flushed in a manner similar to that previously described for the First Extraction Cycle, except that the wash solutions are added through the applicable scrub or extractant feed tanks: 802-D or 802-E for the Second Cycle. As in the case of the IB or IC Columns, the wash from the 2E Column may be routed to Waste Treatment via between-cycle tanks and the 3E Column. A wash solution from the 3E Column would require routing through the 2DF Rework Tank, E-13, and thence to Waste Treatment via the 2D Feed Tank and the 2D Column.

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3. Second and Third Plutonium Extraction Cycles -- Fig. XII-13, 14

3.1 General -- as designed

The aqueous stream leaving the bottom of the IB Column is received in the IBP Receiver Tank, E-6. Batchwise transfer of this material is made by pump and controlled flow to the hexone stripping column on the Cross-Over Oxidizer, E-7. A steam sparge ring is provided in E-7 for start-up purposes whenever a new batch is transferred from E-6. The column functions similarly to that on the ICU Concentrator, F-2, described in Section C1 of this chapter. Overheads from the column are condensed in the Cross-Over Oxidizer Condenser, E-8, and leave via the condensate header. Oxidant is added to E-7 and oxidation is completed after several hours at an elevated temperature. Provisions have been incorporated in the IBP Receiver and Cross-Over Oxidizer system for the addition of salting solution. This facility is used only when the plutonium stream concentration for a given vessel holdup exceeds that allowed by critical mass control. The net effect of the salt solution addition is a dilution of the plutonium concentrations, and an increase in stream through-put in the Second and Third Plutonium Extraction Cycles. Tank working volumes, however, remain unchanged.

Completed oxidizer charges are cooled and transferred from E-7 by pump to the 2A Feed Tank, E-5, where the plutonium stream is pumped to the 2A Column at a controlled rate. Decontamination of the plutonium stream is accomplished by two extraction and stripping cycles. The finished plutonium is sampled and transferred to final concentration. A rework tank, 3BP Rework, E-4, has been provided at the end of the Second and Third Plutonium Extraction Cycles.

3.2 Rework and alternate routings

Alternate routings are available from the IBP Receiver, E-6. The contents of E-6 may be pumped directly to the Cross-Over Oxidizer pot, E-7, by making an in-cell jumper change. This routing would be used for low-temperature cross-over oxidation of the IBP stream under which condition steam stripping of hexone is not necessary.

The IBP stream may be jetted from E-6 to the 3BP Rework Tank, E-4. Tank E-4 also receives from the 2A Feed Tank E-5, 3A Feed Tank E-1, and 3BP Sampler Tank E-3. Material thus routed is returned to the Cross-Over Oxidizer from which vessel disposition of the rework stream is made depending upon the cause for off-standard conditions. If the plutonium stream contains excessive uranium it is returned to the IA Feed Tank, F-7, for further separation in the First Extraction Cycle. A rework plutonium stream that has not been decontaminated sufficiently is reintroduced to the Second Plutonium Decontamination Cycle from the Cross-Over Oxidizer via the 2A Feed Tank.

There are no piping provisions installed for by-passing either one of the Second or Third Plutonium Extraction Cycles. Piping changes would be required either in the cell or silo should by-passing of one of the cycles be desired. For example, an in-cell piping change to route 2A feed from the 2A Feed Tank, E-5, to the tunnel nozzle normally used for 3A Feed

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(T-7, see Fig. XII-14) would by-pass the Second Plutonium Extraction Cycle. An alternate method, and perhaps the most convenient piping-wise, would be to by-pass the Third Plutonium Extraction Cycle by routing the 2BP stream into the 3BP header (2B-L1 to 3B-L1; see Fig. XII-13 and 14) through a new jumper installed in the silo.

3.3 Equipment flushing provisions

The Second and Third Plutonium Extraction Cycle columns may be flushed by adding the wash solutions through the appropriate scrub or extractant tanks. Disposition of the wash may be made to Waste Treatment via the 2A or 3A Columns. A flush of the 3B Column would require the wash solution disposal to be made either through the plutonium concentration equipment, or through 2A Column via 3BP Rework Tank and the Cross-Over Oxidizer to the 2A Feed Tank.

3.4 Proposed design change

3.41 General

At the time of writing a process change is being proposed which will accomplish the plutonium cross-over step on a continuous basis and eliminate the cumbersome batchwise treatment now necessary by virtue of existing plant design. In order to accomplish the continuous cross-over step, new cell jumpers will have to be made to by-pass the IBP Receiver and Cross-Over Oxidizer and divert the IBP stream directly to the 2A Feed Tank. An agitator and necessary chemical addition lines will be installed in the 2A Feed Tank. These proposed piping changes, which do not appear on Figures XII-13 and 14, will allow the cross-over oxidant to be added to the 2A Feed Tank. Under this new mode of operation the aqueous stream leaving the bottom of the IB Column will be received continuously in the 2A Feed Tank, E-5. Oxidant may be added to E-5 at a controlled rate and mixed by agitation with the influent IBP stream. Oxidation will be accomplished in E-5 at normal temperatures before the plutonium stream is pumped to the 2A Column. The addition of oxidant may also be made by way of the 2A Column scrub stream instead of into E-5. Should this latter method prove feasible, oxidation of the plutonium will be accomplished in the time provided by the holdup in the 2A Column.

Provisions will be incorporated for the addition of salting solution to E-5 and used when the IBP stream concentration requires dilution in order to meet critical mass control requirements as previously described under Subsection 3.1.

Decontamination of the plutonium stream is accomplished in two extraction and stripping cycles. The rework tank, 3BP Rework, E-4, will still be provided at the end of the Second and Third Plutonium Extraction Cycles.

3.42 Rework and alternate routings

The normal disposition of a plutonium rework stream will be from the 3BP Sampler, E-3, to the 3BP Rework Tank, E-4, and then to the IBP Receiver,

E-6. Material thus routed is returned by either jet or pump to the Cross-Over Oxidizer, E-7, from which vessel disposition of the rework stream is made depending upon the cause for off-standard conditions. If the plutonium stream contains excessive uranium it is steam stripped of hexone, reoxidized, and returned to the IA Feed Tank, F-7, for further separation in the First Extraction Cycle. A rework plutonium stream that has not been decontaminated sufficiently is reintroduced to the Second Plutonium Decontamination Cycle from the Cross-Over Oxidizer via the 2A Feed Tank.

The 3BP Rework Tank, E-4, may also receive plutonium streams from the 2A Feed Tank, E-5, or the 3A Feed Tank, E-1. These routings are more for an "alternate out" convenience from these two tanks rather than a rework provision, since the chances for diversion of an off-standard stream from either the 2A or the 3A Feed Tank are extremely remote.

3.43 Equipment flushing provisions

The equipment flushing provisions are not affected by the proposed piping changes.

D. PLUTONIUM CONCENTRATION--Fig. XII-15

A complete discussion and description of the plutonium concentration procedure has been covered previously, in Chapters VI and VII. The following briefly outlines the engineering considerations that were designed into this step in the process.

The decontaminated plutonium stream is transferred by jet from the 3BP Sampler, E-3, to the hexone stripping column on the Plutonium Pre-Concentrator, E-16. Concentration of the plutonium solution is accomplished in two batchwise stages with the second stage carried out in the Plutonium Concentrator, E-17. Two stages of concentration instead of one were selected on the considerations of time required for the desired volume reduction, and small effective heat-transfer area to avoid crystallization of plutonium nitrate on the heating surface. Distillates from the evaporation steps are collected in the Plutonium Concentrator Condensate Receivers, E-14 and E-19, where they are sampled before being transferred to the Condensate Stripper Reboiler, D-5, Fig. XII-20. Transfer of solution from E-16 to E-7 is made by applying a vacuum across E-7 via the Plutonium Transfer Trap, E-21. Material is also transferred in like manner to the PR Can from E-7 after final evaporation. Inadvertent overflow of solution from the PR Can is collected in E-21 and returned to the 3BP Sampler, E-3.

A steam sparger is installed in E-16 for hexone stripping of the 3BP stream while a charge is being transferred from the 3BP Sampler, E-3, to E-16. Gate valves have been provided on the transfer lines and the vent on E-7 in order to isolate the vessels whenever an evaporation step or vacuum transfer is being made.

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E. ORGANIC RECOVERY AND MAKE-UP

Organic Recovery procedures have been covered previously in Chapter IX. General process engineering considerations are discussed herewith.

1. Organic Recovery -- Fig. XII-16

1.1 General

All hexone waste streams leaving the stripping columns in the extraction cycles are headered into the IO Extraction Column for a decontamination wash before entering the Organic Recovery System. The washed hexone flows to the Organic Distillation Column, G-3, where it is scrubbed with a 5% caustic solution to remove hexone decomposition products. Condensed overheads from the Condensate Stripper Condenser, D-6, which contain hexone are also received in the Organic Distillation Column. Hexone vapor is condensed in the Cooler-Separator, G-2, and received in the Organic Surge Tank, G-1. The water phase from the Cooler-Separator is returned to an intermediate plate in the Distillation Column. A jet has been provided on this return line for emptying the Cooler-Separator to the Organic Distillation Column pot. All influent lines to the plate column are trapped to prevent back-flow of vapor through these lines. Spent caustic solution leaves the still pot via an overflow dip leg to the Organic Waste Receiver, G-4. The still pot may also be jetted empty to G-4.

1.2 Rework and alternate routings

"General Spare" connectors have been provided in the Organic Recovery cell (G Cell) for routing material to or from D or F Cells.

1.3 Equipment flushing provisions

Flushing of the Organic Recovery systems may be accomplished through the IO Column or Organic Distillation Column chemical addition tanks. A flush introduced into the IO Column may be disposed of directly to Waste Treatment, or allowed to overflow to the Organic Distillation Column. Washes introduced into the Organic Distillation Column may be boiled or sparged, if desired, before disposal is made to Waste Treatment.

2. Organic Make-Up -- Fig. XII-17

Recovered hexone is transferred from the Organic Surge Tank, G-1, by either pump or jet to the Organic Receiver, O-1. Chemical Treatment of the recovered hexone is accomplished in the Organic Sampler and Treatment Tank, O-2. Chemical additions are made through the Organic Treatment Addition Tank, O-2A. A gauge glass and limit switch have been installed on O-2 for decanting purposes. The limit switch shuts down the decant pump whenever the liquid interface reaches the desired level. Treated hexone is received in the Organic Feed Tank, O-3, which supplies the Organic Head Tank, 804, located in the 202-S Building. Two pumps are used on the 804 Tank supply line to assure continuity of service.

All tanks located in the hexone treatment area are nitrogen blanketed

through flame arrestors. The vent system and tank overflow systems are vented to the atmosphere through seal pots to prevent excessive nitrogen loss. The entire area is diked and provided with a decanting overflow to cribs in the event that the diked area is flooded with fire water.

F. WASTE TREATMENT

Waste Treatment procedures have been discussed extensively in Chapter X. Reference is made in the following to general engineering considerations and rework facilities.

1. Salt Waste Concentration and Neutralization -- Fig. XII-18, 19

1.1 General

The salt waste streams from the Extraction Columns and aqueous wastes from the Organic Distillation Column and the IO Column flow continuously into the Waste Header Receiver, D-13. The combined wastes are pumped under flow control into the hexone stripping column on the Waste Concentrator, D-12. A bubble-cap stripping section and packed deentrainment section have been provided in the column on D-12. Water spray for periodic packing wash-down is located in the top section of D-12. Concentrated waste solution flows continuously from the pot on D-12 through a dip leg overflow to the Waste Concentrator Receiver, D-10, where the solution is agitated and cooled. The pot on D-12 may also be jetted empty to D-10. Batch transfers of the cooled waste are made from D-10 to the Waste Concentrate Sampler, D-9, where accountability samples are taken. Material that is within specification with respect to waste losses is jetted to the Waste Neutralizer, D-8. Wastes from the Ruthenium Scrubber, H-5, as well as laboratory wastes from 222-S Building are also received in D-8.

1.2 Rework and alternate routings

Neutralized wastes are jetted to the underground wastes storages from D-8. In the event that accountability sampling in D-9 shows excessive wastes losses the concentrated wastes are transferred to the Rework Adjustment Tank, D-7, where the material is adjusted chemically for feed to the IS Column via IS Feed Tank, F-8. "General Spare" connectors have been provided in the waste neutralization section of D Cell for routing material to or from C, F, or H Cells.

1.3 Equipment flushing provisions

Equipment in the Salt Waste Concentration section of Waste Treatment may be flushed by adding the wash solutions through the most convenient chemical addition tank. A flush added to the Waste Header Receiver, D-13, would ultimately be sent to the waste cascade via the Waste Concentrator and subsequent in-line tanks. A flush introduced into the Rework Adjustment Tank, D-7, would require disposal to Waste Treatment via the IS Column.

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2. Condensate Wastes - [redacted] 21

2.1 General

Overhead from the Waste Concentrator, D-12, is condensed in D-11 and flows to the condensate header. This distillate, as well as other hexone-laden distillates from the process concentrators, flows continuously into the column on the Condensate Stripper Reboiler, D-5. Hexone is stripped from the condensates and leaves the column as a hexone-water azeotrope. The azeotropic mixture is condensed in D-6, and flows to the Organic Distillation Column, G-3, where the hexone is eventually recovered. Bottoms from D-5 overflow continuously to the Condensate Evaporator Reboiler, D-4. The Reboiler, D-4, also receives condensate from the Ruthenium Scrubber Condenser, H-6. Reboiled hexone-free condensates are condensed in D-3, and received in the Condensate Receiver, D-2. Residual radioactivity of this condensate, if found by sample from D-2, determines its disposal to cribs or underground waste storage. The bottoms from D-4 are jetted periodically to the Waste Header Receiver, D-13. The frequency of these jettings is dependent upon the carry-over of radioactivity from D-3 as determined by D-2 sampling.

2.2 Rework and alternate routings

"General Spare" connectors are installed in the condensate waste treatment section of D Cell for routing material to or from E or G Cells.

2.3 Equipment flushing provisions

There is no convenient method for flushing the equipment in the Condensate Waste Section of Waste Treatment since there are no chemical-addition tanks servicing these vessels. Should a flush be required, wash solution could be piped temporarily through instrument lines to the vessel in question, boiled up, and routed to the waste cascade or sent to cribs.

3. Salt Waste Recovery -- Fig. XII-18

Space has been allocated in D Cell for the future installation of a tank to receive all salt waste streams from the Extraction Columns. The purpose of this tank (ANN Diversion Tank 188) is to divert those wastes from which aluminum nitrate may be recovered in a separate facility. This facility will probably never be installed unless the technology and economics of the recovery process appear more promising at a future date.

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PIPE CODES & SERVICE - FROM SPECIFICATION HW-4314, REV. 2

Code	Service
P-12	Steam, Compressed Air, Condensate and Exposed Water Lines -- 100 to 125 lb./sq.in. maximum working pressure. Carbon Steel.
P-13	Steam and Condensate -- 15 lb./sq.in. maximum working pressure. Carbon Steel.
P-15	Jet Vents and Raw Water -- see Code P-12
P-60	Inside Sanitary Sewer -- maximum working pressure, gravity. Carbon Steel -- Galvanized.
P-77 (P-76)	Nitrogen, Methane, Propane, Special Solvent -- 50 to 125 lb./sq.in. maximum working pressure. Carbon Steel.
P-80	Sodium Hydroxide Solution -- 100 lb./sq.in. maximum working pressure. Carbon Steel.
P-90	General Canyon Service -- Stainless Steel Type 347 (or Type 309S-Cb where specified) -- 150 lb./sq.in. maximum working pressure.
P-91	General Canyon Service -- 60% Nitric Acid -- Process and Utility -- Stainless Steel Type 347 -- 100 lb./sq.in. maximum working pressure.
P-94	Indoor Chemical Waste Lines -- Gravity Flow. Duriron.
P-95	Demineralized Water -- Distilled Water -- Aluminum Alloy 61S, 61S-T6, 63S, or 3S. -- 75 lb./sq.in. maximum working pressure.

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TABLE XII-[illegible]

LIST OF EQUIPMENT PIECE NUMBER AND CORRESPONDING OPERATING NUMBER

EQUIPMENT PIECE NUMBER	OPERATING NUMBER	FUNCTION	EQUIPMENT PIECE NUMBER	OPERATING NUMBER	FUNCTION
[redacted]					

TANK AND POTS

Tank 105 A	A-1	Dissolver Rinse Tank
Tank 101 A	A-2	Dissolver
Tank 103 A	A-3	Off-Gas Silver Reactor
-104-A	A-4	Dissolver Off-Gas Filter
Tank 105 B	B-1	Dissolver Rinse Tank
Tank 101 B	B-2	Dissolver
Tank [illegible] B	B-3	Off-Gas Silver Reactor
-104-B	B-4	Dissolver Off-Gas Filter
Tank [illegible] C	C-1	Dissolver Rinse Tank
Tank 101 C	C-2	Dissolver
Tank [illegible] C	C-3	Off-Gas Silver Reactor
-104-C	C-4	Dissolver Off-Gas Filter
Tank [illegible]	D-1	Sump Drain Col. Tank
Tank [illegible]	D-2	Condensate Rec. Splr.
Tank [illegible]	D-4	Condensate Evaporator
Tank [illegible]	D-	Condensate Stripper
Tank [illegible]	D-7	Rework Adjust. Tank
Tank [illegible]	D-8	Waste Neutralizer
Tank [illegible]	D-9	Waste Conc. Splr.
Tank [illegible]	D-10	Waste Conc. Rec.
Tank [illegible]	D-12	Waste Concentrator
Tank 144	D-13	Waste Header Rec.
Tank 140	E-1	3A Feed Tank
Tank 149	E-2	IBF Receiver
Tank [illegible]	E-3	IBF Sampler
Tank [illegible]	E-4	IBF Rework Tank
Tank 141	E-5	3A Feed Tank
Tank [illegible]	E-6	IBF Rec.
Tank [illegible]	E-7	Cross-over Oxidizer
-14[illegible]	E-10	3EU Evaporator
Tank [illegible]	E-11	3EU Conc. Rec.
Tank [illegible]	E-12	3EU Concentrate Splr.
Tank 134	E-13	Rework 3EU Tank
Tank 15[illegible]	E-14	Pu Pre-Conc. Cond. Rec.
Tank 154	E-15	Pu Pre-Concentrator
Tank [illegible]	E-17	Pu Concentrator
Tank [illegible]	E-18	Pu Conc. Cond. Rec.
Tank [illegible]	E-21	Pu Transfer Trap
Tank 1	F-1	2L Feed Tank
-1[illegible]	F-2	1CU Evaporator
Tank 12[illegible]	F-4	3D Feed Tank
-1[illegible]	F-	3EU Evaporator
Tank 11[illegible]	F-7	1A Feed Tank
Tank 1[illegible]	F-8	1B Feed Tank
Tank 1[illegible]	G-1	Organic Surge Tank
Tank 1[illegible]	G-3	Organic Still Pot
Tank 1[illegible]	G-4	Organic Waste Rec.
Tank 114	H-1	IAF Make-Up Tank
Tank 11[illegible]	H-3	Waste Slurry Rec.
Tank 1[illegible]	H-4	Oxidizer
Tank 111	H-5	Ru Scrubber
Tank 1[illegible]	H-7	Metal Sol'n. Storage
Tank 1[illegible] B	H-8	Metal Sol'n. Storage
Tank 1[illegible] A	H-9	Metal Sol'n. Storage
Tank 1[illegible]	H-10	Dissolver Waste Tank
Tank 1[illegible]	J-2	Filter Seal Tank
Tank 1[illegible]	501	Stack Drain Col. Tank

TOWERS AND COLUMNS

-102 A	A-2	Dissolver Column
-103 A	A-3	Off-Gas Scrub. Col.
-102 B	B-2	Dissolver Column
-103 B	B-3	Off-Gas Scrub. Col.
-102 C	C-2	Dissolver Column
-103 C	C-3	Off-Gas Scrub. Col.
-155	[illegible]-4	Cond. Evap.
-154	[illegible]	Cond. Strip. Col.
-1[illegible]	D-12	Waste Concentrator
-140	E-7	Cross-over Oxidizer
-134	E-10	3EU Concentrator
-185	E-16	Pu Pre-Conc. Col.
-150	E-17	Pu Conc. Col.
-123	F-2	1CU Concentrator
-129	F-5	2EU Concentrator
-15[illegible]	G-3	Organic Dist. Col.
-110	H-4	Oxidizer Col.
-111	H-5	Ru Scrubber Col.

EXCHANGERS AND CONDENSERS

-165-3	D-3	Cond. [redacted]
-154-3	D-6	Cond. [redacted]
-150-3	D-11	Waste [redacted]
-140-1	E-8	Cross-over Oxid. Cond.
-134-1	E-9	3EU Evap. Cond.
-185-1	E-15	Pu Pre-Conc. Cond.
-150-1	E-18	Pu Conc. Cond.
-152-1	E-20	Transfer Trap. Cond.
-123-1	F-3	1CU Evap. Cond.
-129-1	F-6	2EU Evap. Cond.
-155-2	G-2	Organic Dist. Col. Cond.
-111-2	H-6	Ru Scrub. Cond.

MISCELLANEOUS EQUIPMENT

SP-152	K-21	Phase Separator
G-113	H-2	Centrifuge
F-112	J-1	Ruthenium O.G. Filter
F-158	J-3	Vessel Vent Filter
F-159	J-4	Condenser Vent Filter
Tank 201	502	D.W. Head Supply Tank
Tank 202	501	AMN Sol'n. Supply Tank
Tank 203	503	50% HNO_3 Supply Tank
Tank 205	504	50% NaOH Head Supply Tk.
Tank 206	507	25% NaOH Make-up
Tank 207	506	40% NaOH Make-up
Tank 208	509	25% $NaNO_3$ Make-up
Tank 209	505	50% $Na_2Cr_2O_7$ Make-up
Tank 210	501	2% Na_2CO_3 Make-up
Tank 211	505	Wash Sol'n. Make-up
Tank 213	404	50% NaOH Head Tank
Tank 214	405	30% $Fe(NH_2SO_3H)$ Head Tk.
Tank 215	403	50% HNO_3 Head Tk.
Tank 216	402	ISS Make-up
Tank 217	401	IAS Make-up
Tank 218	407	IBX Make-up
Tank 219	406	2DS and 3DS Make-up
Tank 220	501	2CX, 2EX, and 3EX Make-up
Tank 221	408	2BX and 3BX Make-up
Tank 222	409	2AS Make-up
Tank 223	410	3AS Make-up
Tank 224	504	Ferrous Sulfamate Prop.
Tank 225	503	Ferrous Sulfamate Adjust. and Supply
Tank 226	801-S	IBS Feed
Tank 227	801-A	IAS Feed
Tank 228	801-B	IBX Feed
Tank 229	801-C	ICX Feed
Tank 230	802-D	2DS Feed
Tank 231	803-D	3DS Feed
Tank 232	802-E	2EX Feed
Tank 233	803-E	3EX Feed
Tank 234	802-B	2BX Feed
Tank 235	803-B	3BX Feed
Tank 236	802-A	2AS Feed
Tank 237	803-A	3AS Feed
Tank 238 A	A-2-B	Dissolver Drown Water Tks.
Tank 238 B	B-2-B	" " " "
Tank 238 C	C-2-B	" " "
Tank 239 A	A-2-A	Dissolver Weigh Tk. (Large)
Tank 239 B	B-2-A	" " "
Tank 239 C	C-2-A	" " "
Tank 240 A	A-2-C	" " " (Small)
Tank 240 B	B-2-C	" " "
Tank 240 C	C-2-C	" " " "
Tank 243	H-4-C	Oxidizer Addition Tank
Tank 244	H-2-B	Cent. Spray Tank
Tank 24[illegible]	B-1 & 3A	IAF Make-Up Add. Tank
Tank 24[illegible]	E-[illegible] & 10D	Ru Scrubber Caustic Tk.
Tank 247	F-2-A	1CU Conc. Add. Tk.
Tank 248	F-[illegible]-B	2EU " " "
Tank 249	E-7-D	C.O. Oxid. Add. Tk.
Tank 250	E-1 & [illegible]-A	2BF Butt Add. Tk.
Tank 251	801-O	Organic Wash Add. Tk.
Tank 252	G-3-B	Organic Dist. Col. Add. Tk. #1
Tank 253	G-3-A	Organic Dist. Col. Add. Tk. #2
Tank 254	701-A	IAX (HNO_3) Tk.
Tank 255	701-B	IBX " "
Tank 256	702-D	2DX " "
Tank 257	703-D	3DX " "
Tank 258	702-A	2AX " "
Tank 259	703-A	3AX " "
Tank 260	701-S	ISX (HNO_3) Tk.
Tank 261	D-8-B	Waste Neut. NaOH Tk.
Tank 262	D-7-A	Rework Chem. Add. Tk.
Tank 263	E-6 & 7-B	IBF Butt Tank
Tank 264	E-10 & 13-C	2DF Rework Add. Tk.
Tank 265	202	AMN Adjustment
Tank 266	804	Organic Head Tank
Tank 268	502	Seal Pot for 504
Tank 269	E-17-ES	Pu Conc. Add. Tk.
Tank 308	O-1	Organic Receiver
Tank 309	O-2	Organic Sampler & Treat.
Tank 310	O-3	Organic Feed Tk.
Tank 311	O-2A	Organic Treatment Add.

SILO COLUMNS

ET-117	IA	
[redacted] 121	IS	
[redacted] 18	IB	
[redacted]	IC	
[redacted]	2A	
[redacted] 145	3A	
143	2B	
146	3B	
126	2D	
131	3D	
127	2E	
132	3E	
154	IO	

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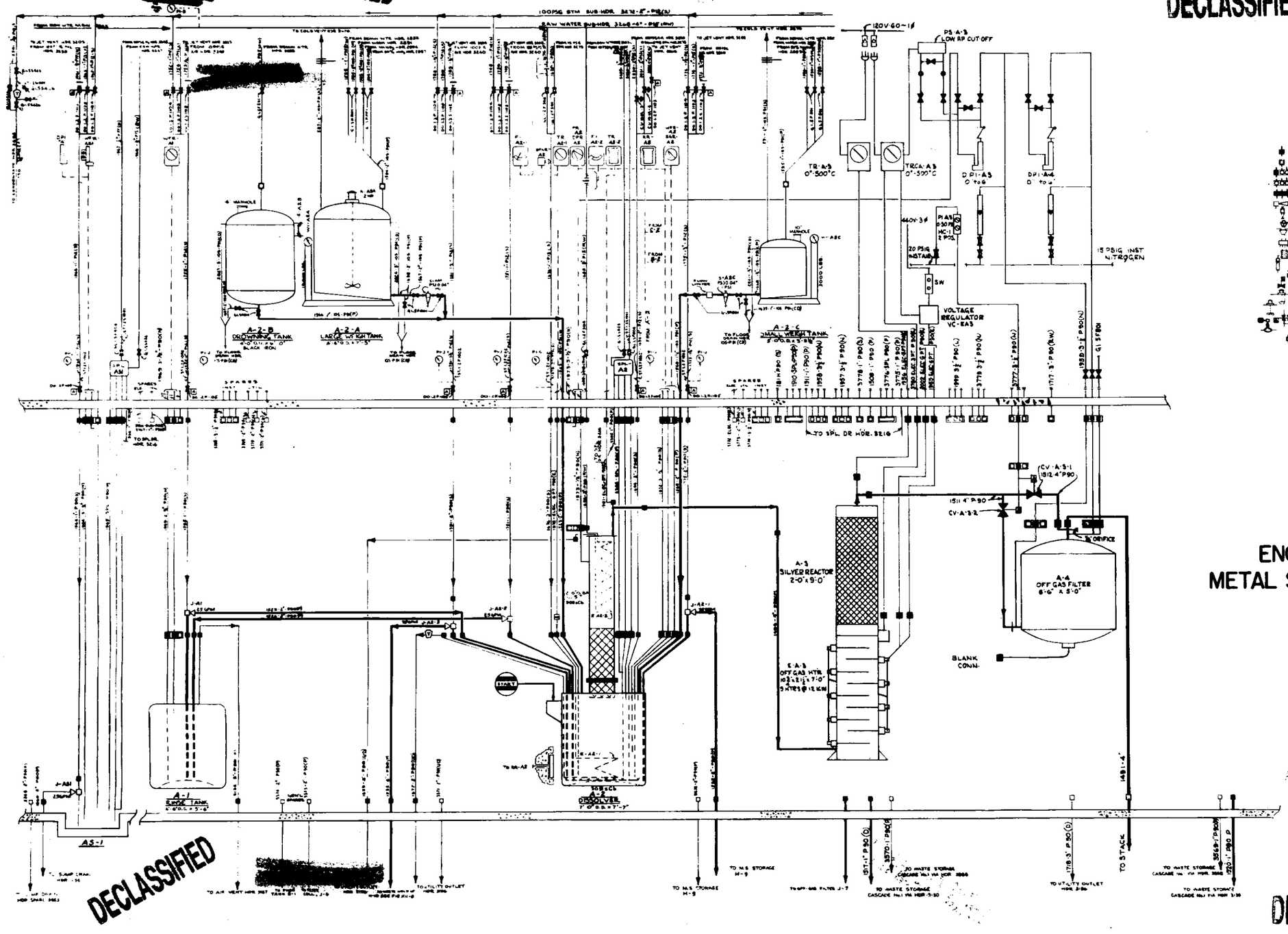

GENERAL NOTES

1. FOR PIPECODES REFER TO SPEC. HW-49-4-KEY 1
2. FOR VALVES & STRAINER CODES REFER TO SPEC. HW-54570, REV. 5.
3. ALL PIPING TO BE SCHEDULE 40 UNLESS OTHERWISE NOTED.
4. PIPING CONNECTING TO WEIGH TANKS SHALL PROVIDE APPROPRIATE FLEXIBILITY.
5. ⟶ INDICATES DIRECTION OF SLOPE OF CERTAIN HEADERS.

SYMBOL LEGEND

- PIPE CONNECTOR, OCCUPIED
- PIPE CONNECTOR, SPARE
- THREE PIPE CONNECTOR, ONE OCCUPIED
- THREE PIPE CONNECTOR, SPARE
- SAMPLER CONNECTOR, OCCUPIED
- STEAM JET
- STRAINER
- STEAM TRAP
- SAMPLERS
- SAMPLER POT
- ROTAMETER
- CONTROL VALVE
- AUTOMATIC DIAPHRAGM OPERATED VALVE
- SUBMERGED PUMP
- AGITATOR
- GANG VALVE
- PROPORTIONING VALVE
- SIGHT GLASS.

FIGURE XII-3
ENGINEERING FLOW DIAGRAM
METAL SOLUTION FEED PREPARATION
(FROM H-2-7498)

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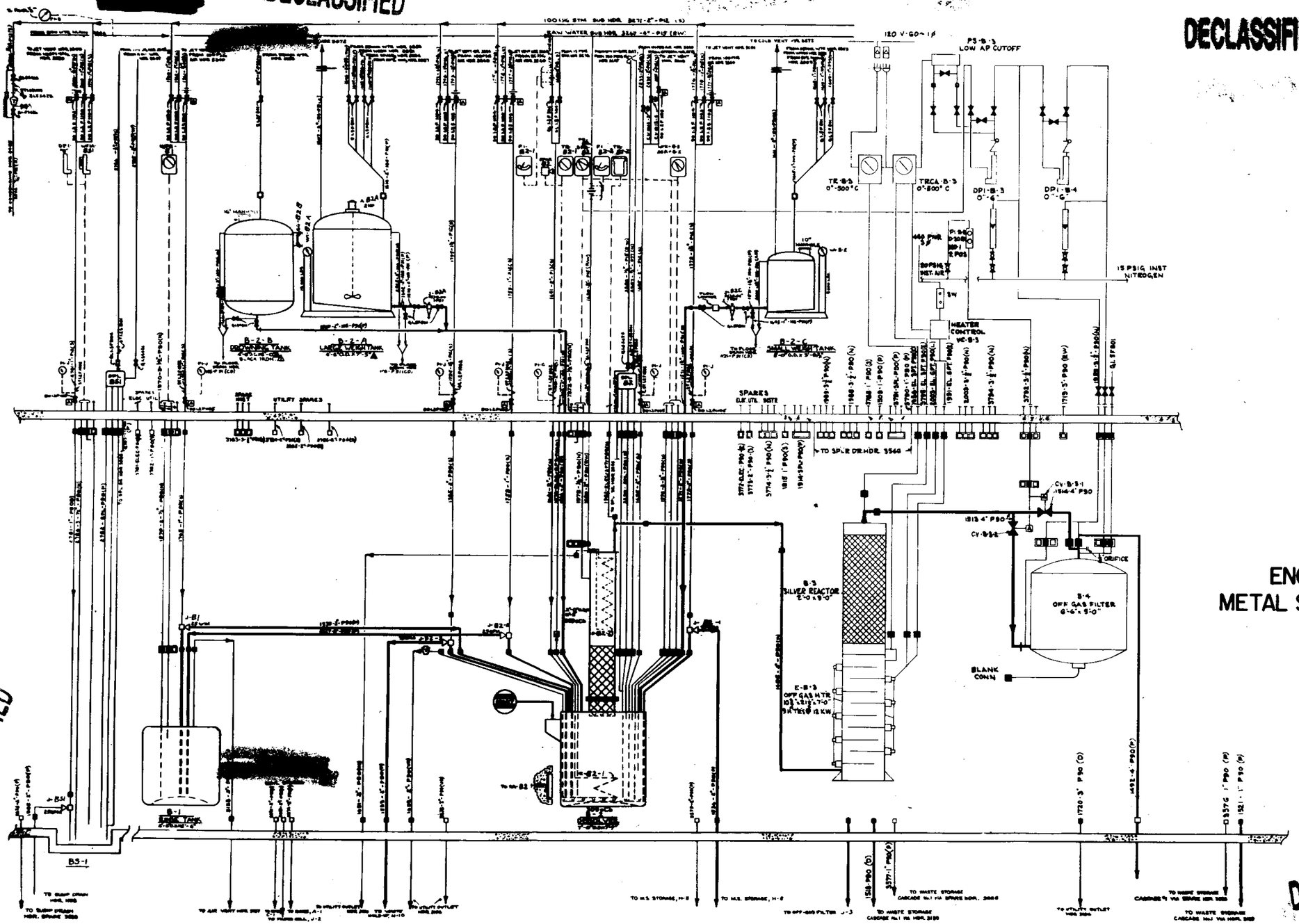

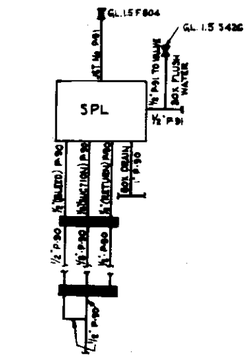

GENERAL NOTES

1. FOR P & ID SYMBOLS REFER TO SPEC. HW-18640 REV. 2
2. FOR VALVES STEMMING CODES REFER TO SPEC. HW-18640 REV. 2
3. ALL PIPING TO BE SCHEDULE 40 UNLESS OTHERWISE NOTED
4. PIPING CONNECTING TO VESSELS SHALL PROVIDE APPROPRIATE FLEXIBILITY
5. ⟶ INDICATES DIRECTION OF FLOW

FIGURE XII-4
ENGINEERING FLOW DIAGRAM
METAL SOLUTION FEED PREPARATION
(FROM H-2-7499)

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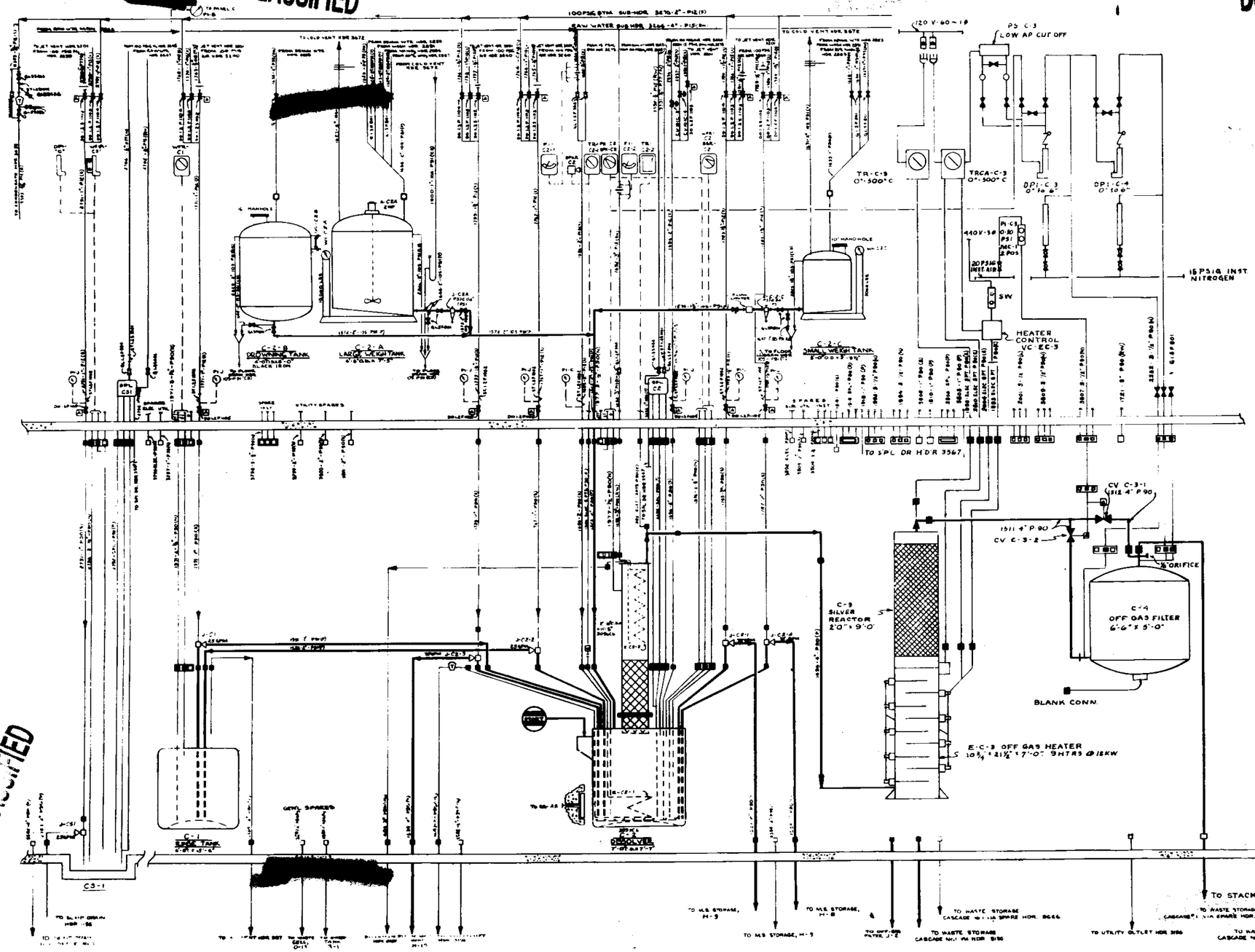

GENERAL NOTES

1. FOR P & I NG CODES REFER TO SPEC HW-65497 REV 1
2. FOR VALVE & STRAINER CODES REFER TO SPEC HW-8450 REV 4
3. ALL PIPING TO BE SCHEDULE 40 UNLESS OTHERWISE NOTED.
4. FOR TYPICAL SAMPLER SEE PIE 111-4
5. PIPING CONNECTIONS TO WEIGH TANKS SHALL PROVIDE APPROPRIATE FLEXIBILITY
6. → INDICATES DIRECTION OF SLOPE OF CERTAIN HEADERS

FIGURE XII-5
ENGINEERING FLOW DIAGRAM
METAL SOLUTION FEED PREPARATION
(FROM H-2-7500)

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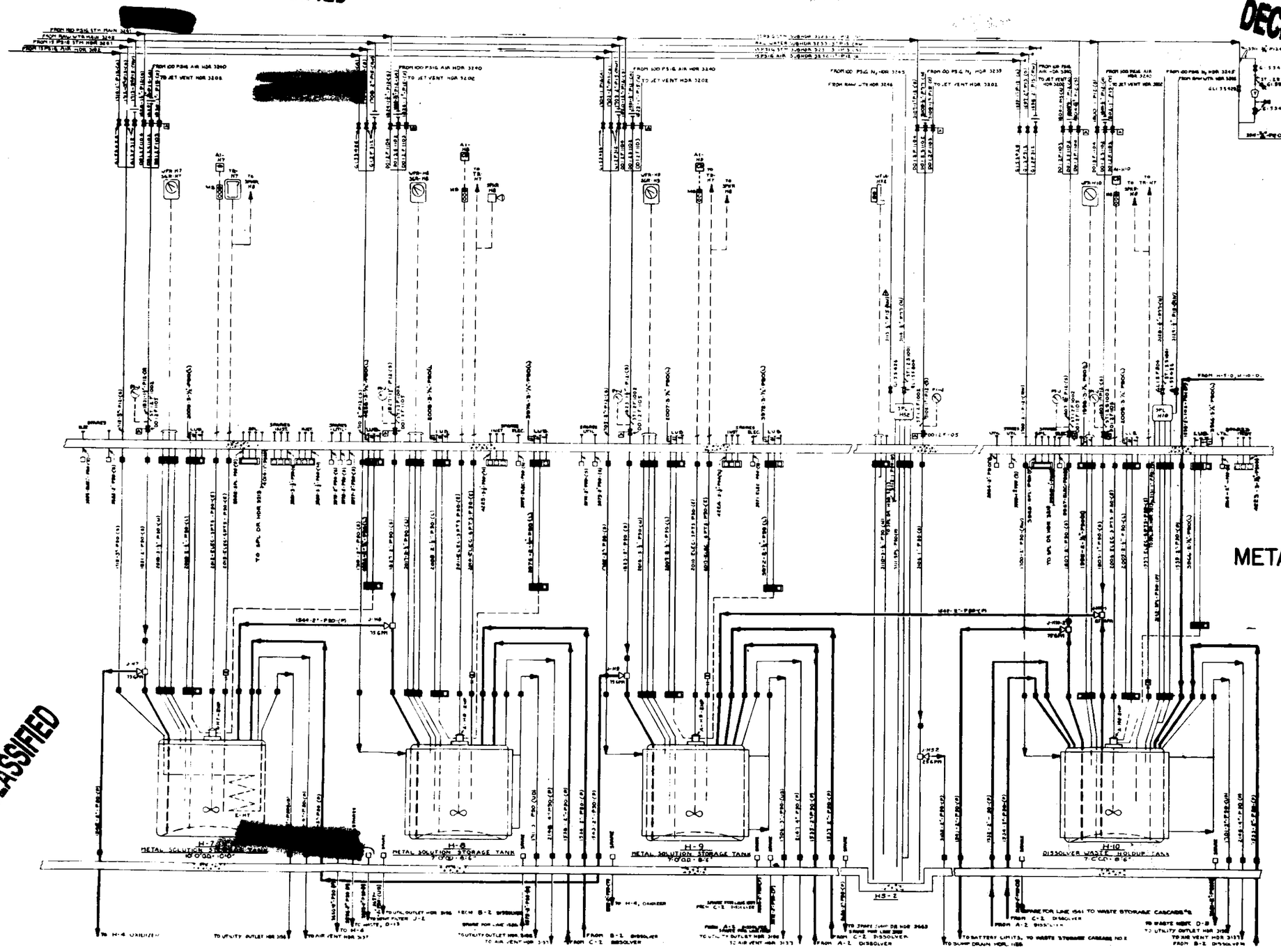

FIGURE XII-6
ENGINEERING FLOW DIAGRAM
METAL SOLUTION FEED PREPARATION
(FROM H-2-7501)

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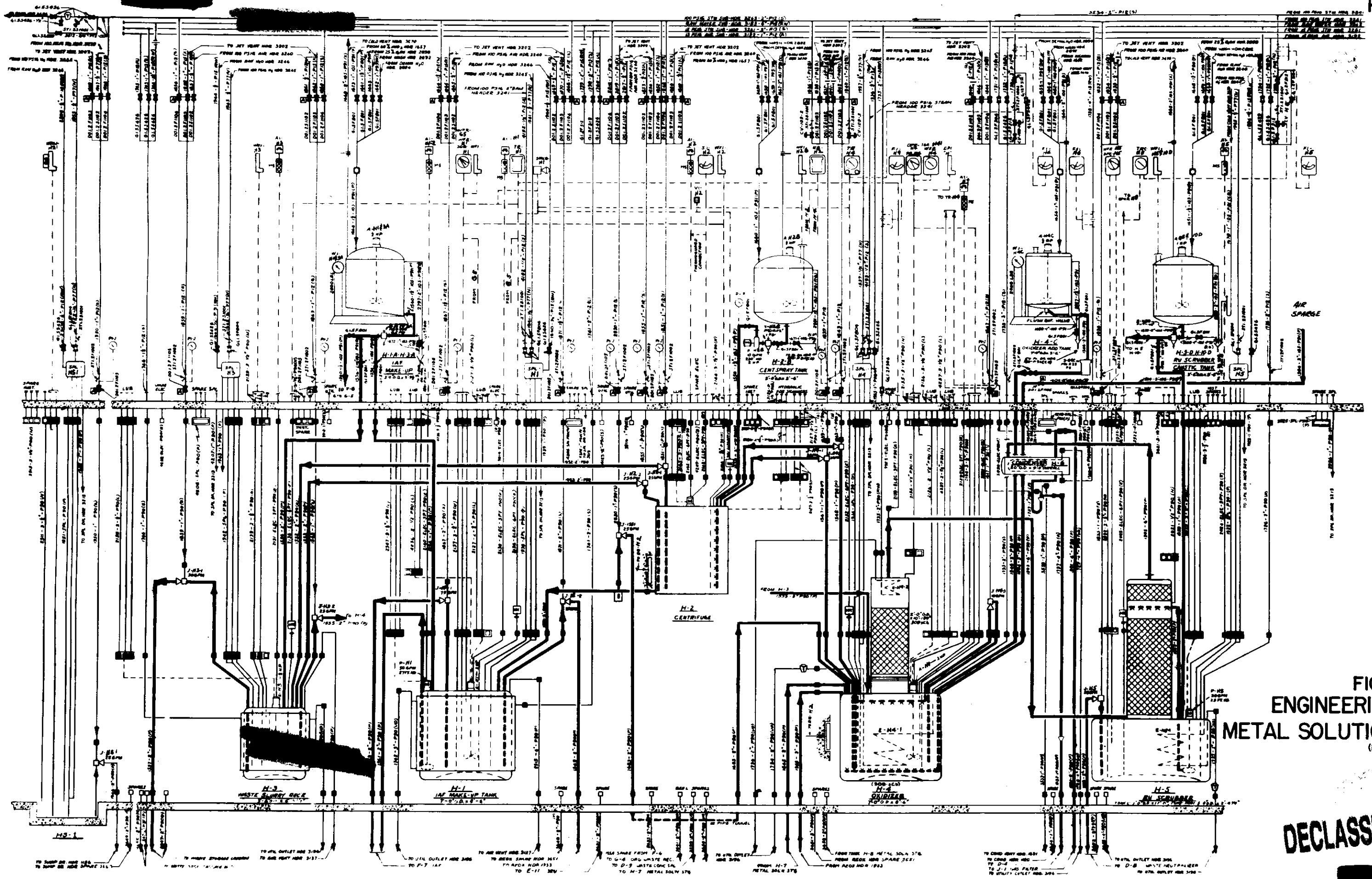

GENERAL NOTES

1. FOR PIPE CODES REFER TO SPEC. HW-6840.001
2. FOR VALVE & STRAINER CODES REFER TO SPEC. HW-3430.001 & 6
3. ALL PIPING IS TO BE SCHEDULE 80 UNLESS OTHERWISE NOTED
4. FOR TYPICAL SAMPLER SEE FIG XII-6
5. PIPING CONNECTIONS TO HIGH-TEMP. TANK PROVIDE APPROPRIATE FLEXIBILITY
6. ——— INDICATES DIRECTION OF SLOPE OF CERTAIN HEADERS

FIGURE XII-7
ENGINEERING FLOW DIAGRAM
METAL SOLUTION FEED PREPARATION
(FROM H-2-7502)

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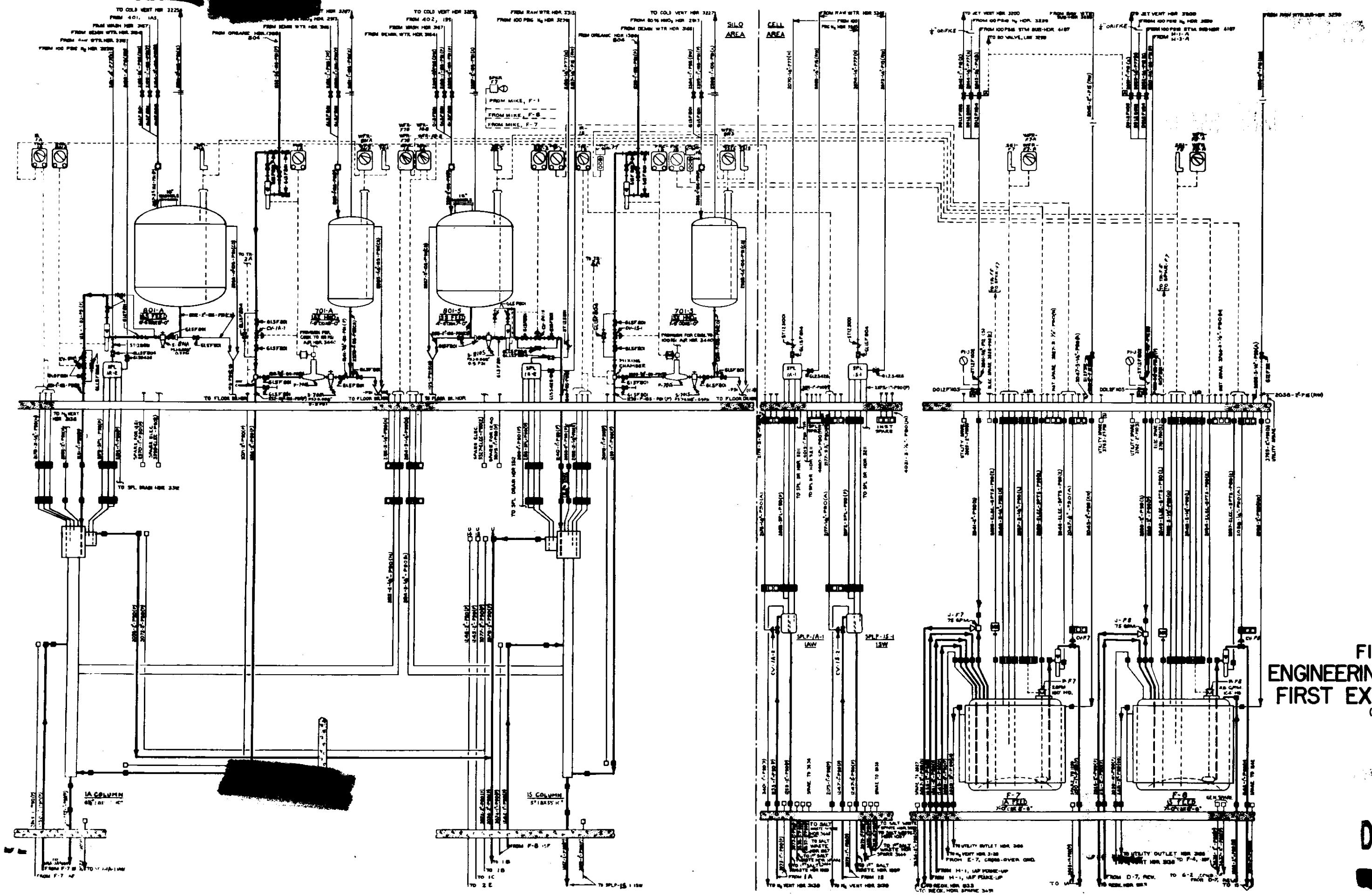

FIGURE XII-8
ENGINEERING FLOW DIAGRAM
FIRST EXTRACTION CYCLE
(FROM H-2-7504)

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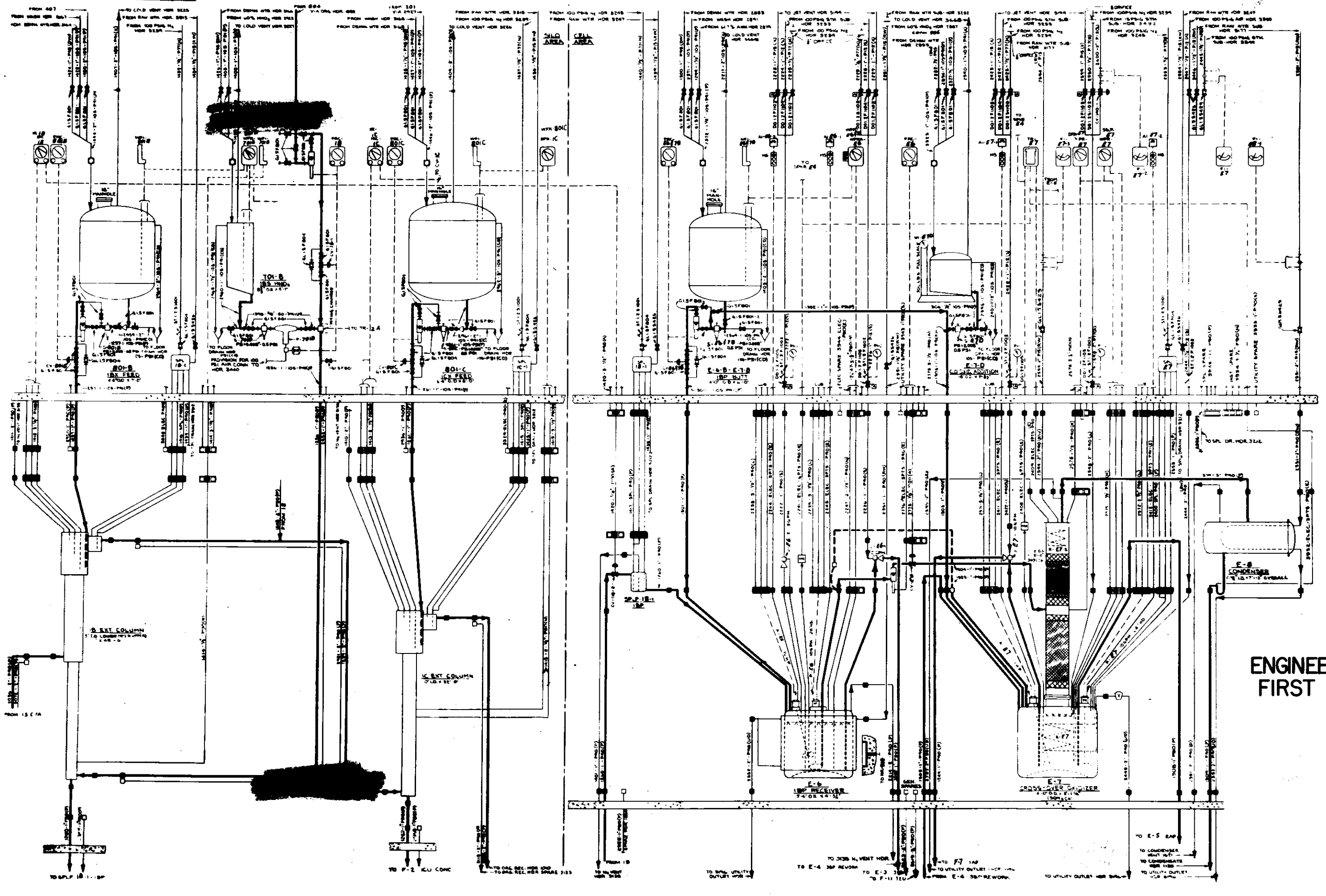

FIGURE XII-9
ENGINEERING FLOW DIAGRAM
FIRST EXTRACTION CYCLE
(FROM H-2-7505)

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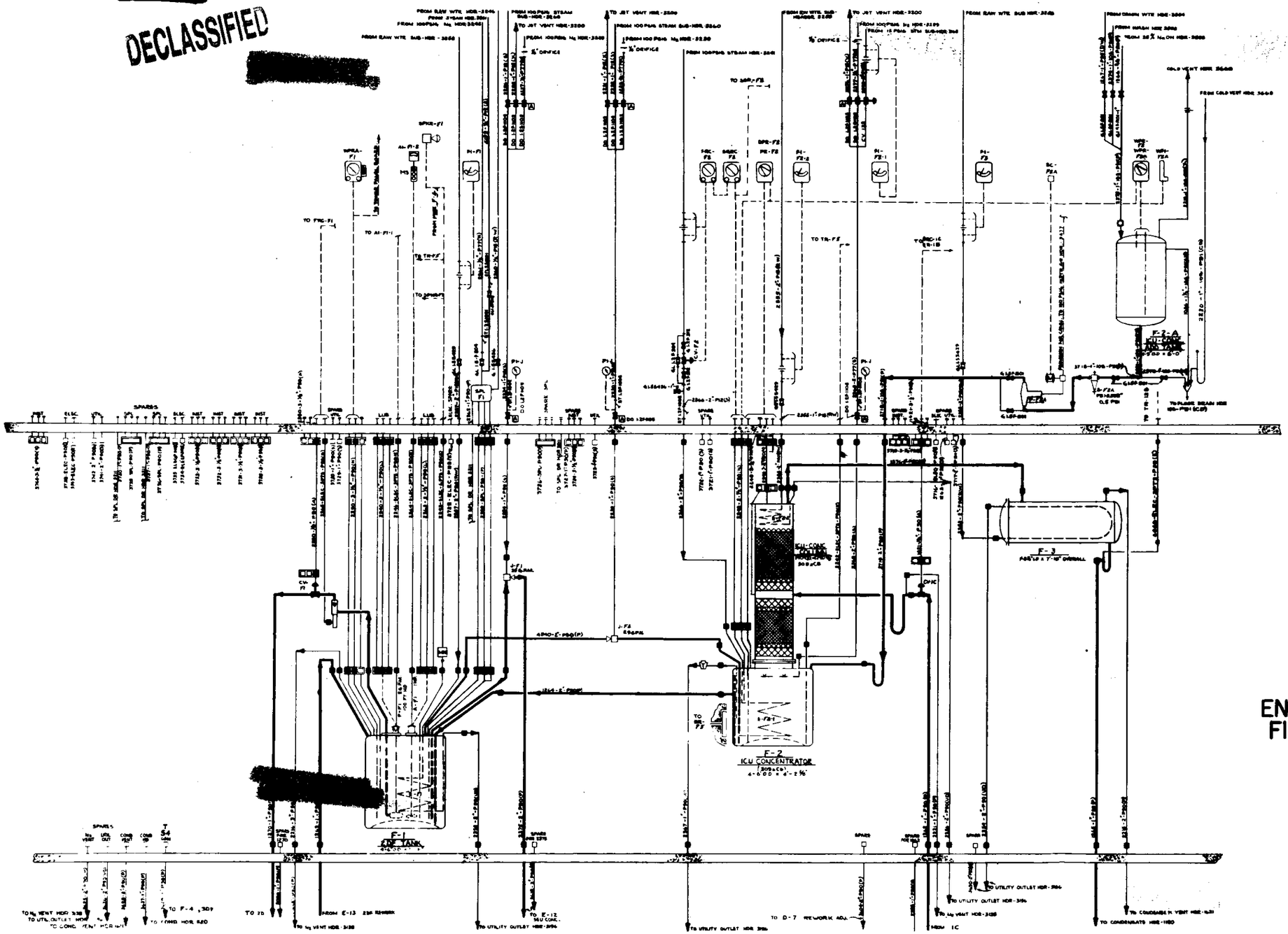

GENERAL NOTES

1 - PIPE PER CARBON STEEL TO SPEC. HW-4041 REV 1
2 - PIPE VALVES AND STRAINERS FROM ALLOYS TO SPEC. HW-2400 REV 5
3 - ALL PIPE TO BE SCHEDULE 40 UNLESS OTHERWISE NOTED

FIGURE XII-10
ENGINEERING FLOW DIAGRAM
FIRST EXTRACTION CYCLE
(FROM H-2-7506)

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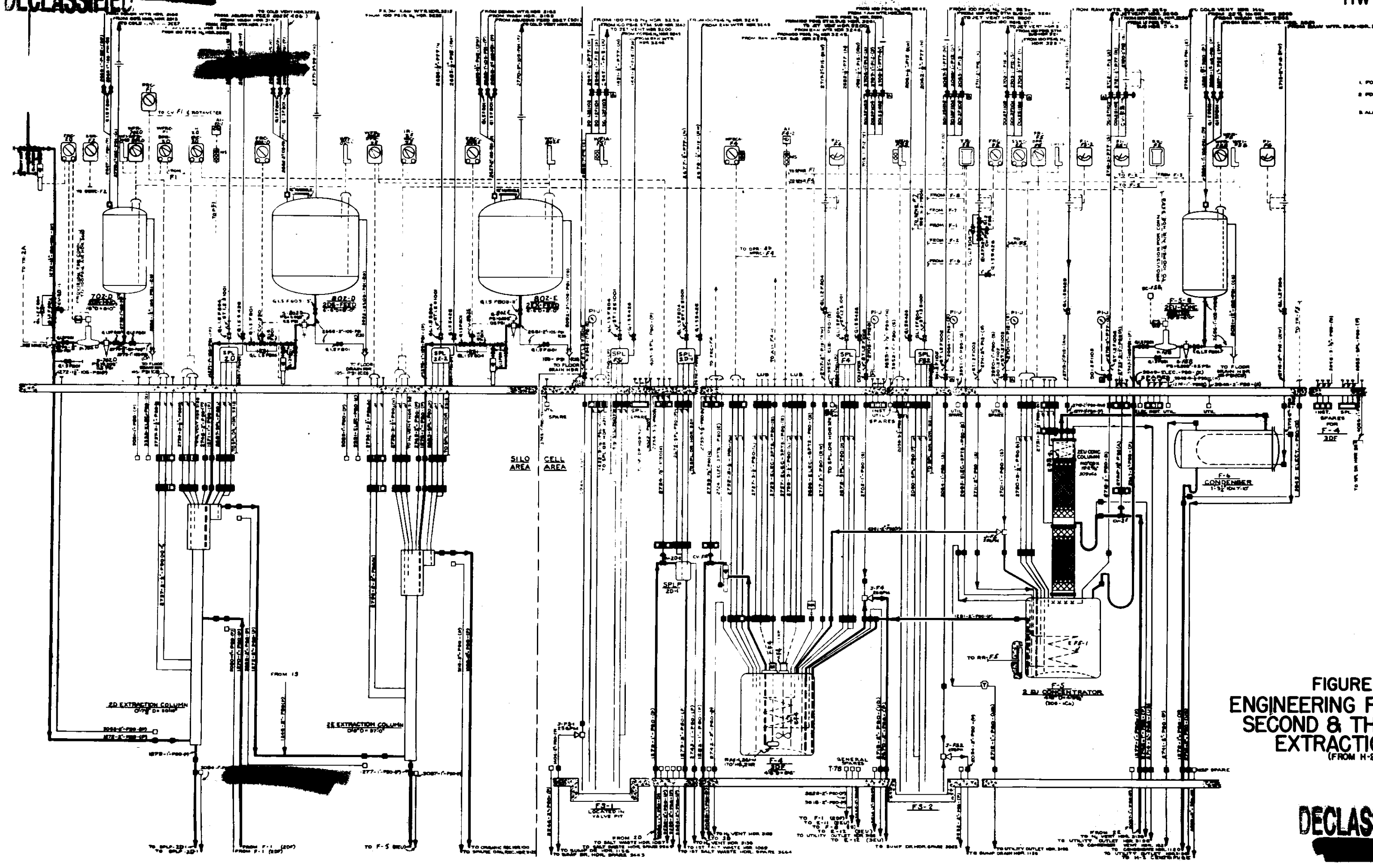

FIGURE XII-II
ENGINEERING FLOW DIAGRAM
SECOND & THIRD URANIUM
EXTRACTION CYCLE
(FROM H-2-7507)

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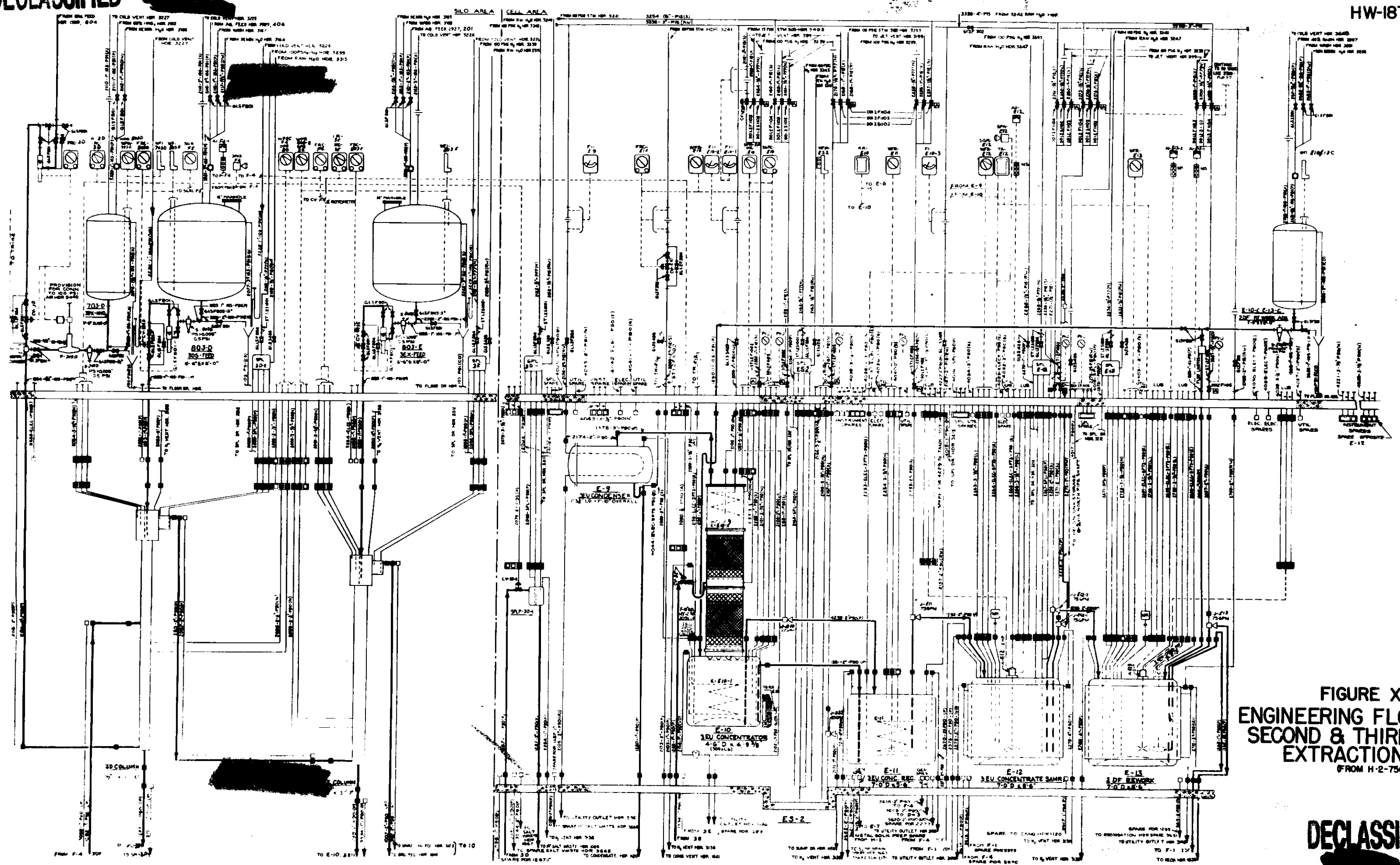

FIGURE XII-12
ENGINEERING FLOW DIAGRAM
SECOND & THIRD URANIUM
EXTRACTION CYCLE
(FROM H-2-7508)

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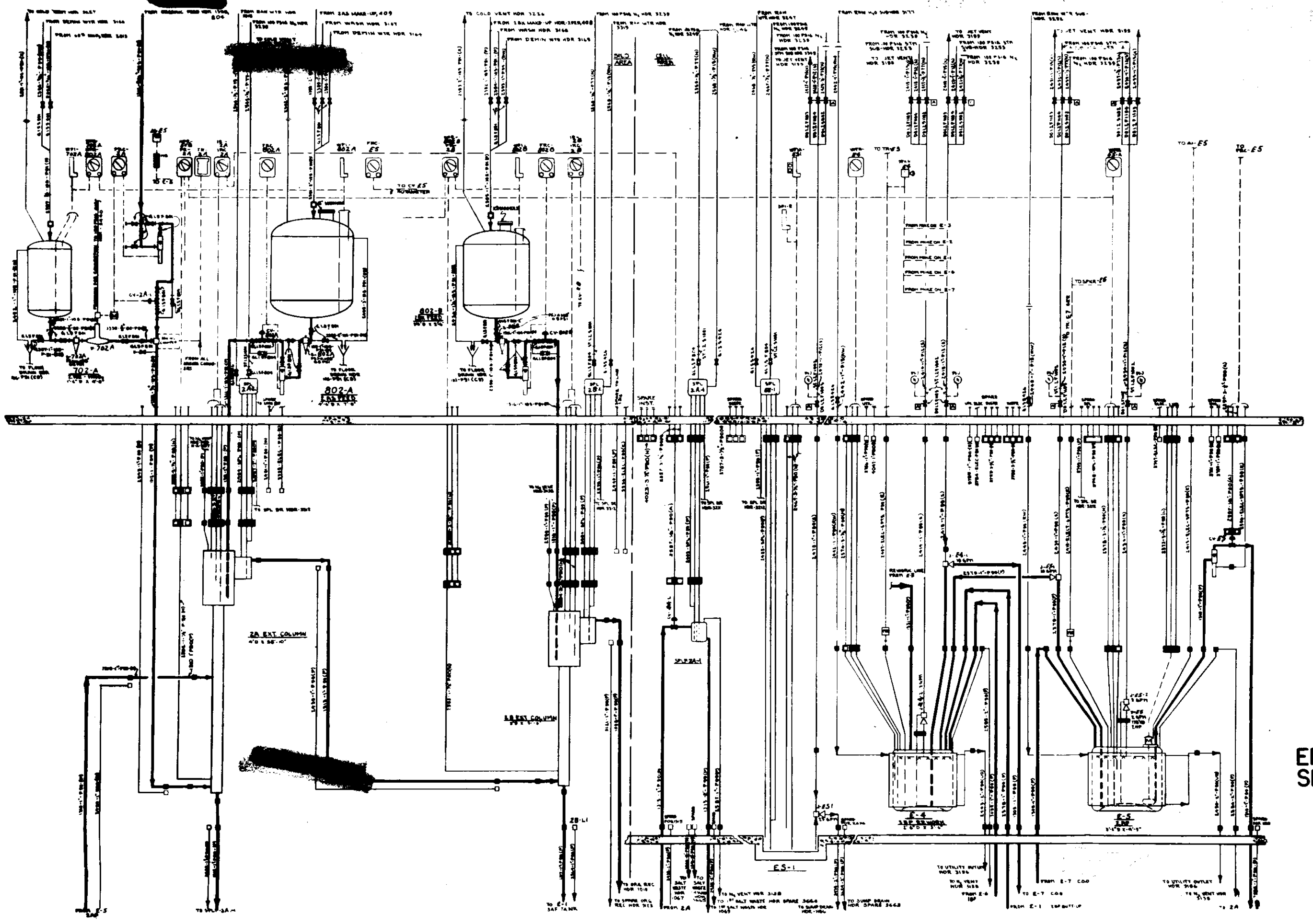

FIGURE XII-13
ENGINEERING FLOW DIAGRAM
SECOND & THIRD PLUTONIUM
EXTRACTION CYCLE
(FROM H-2-7509)

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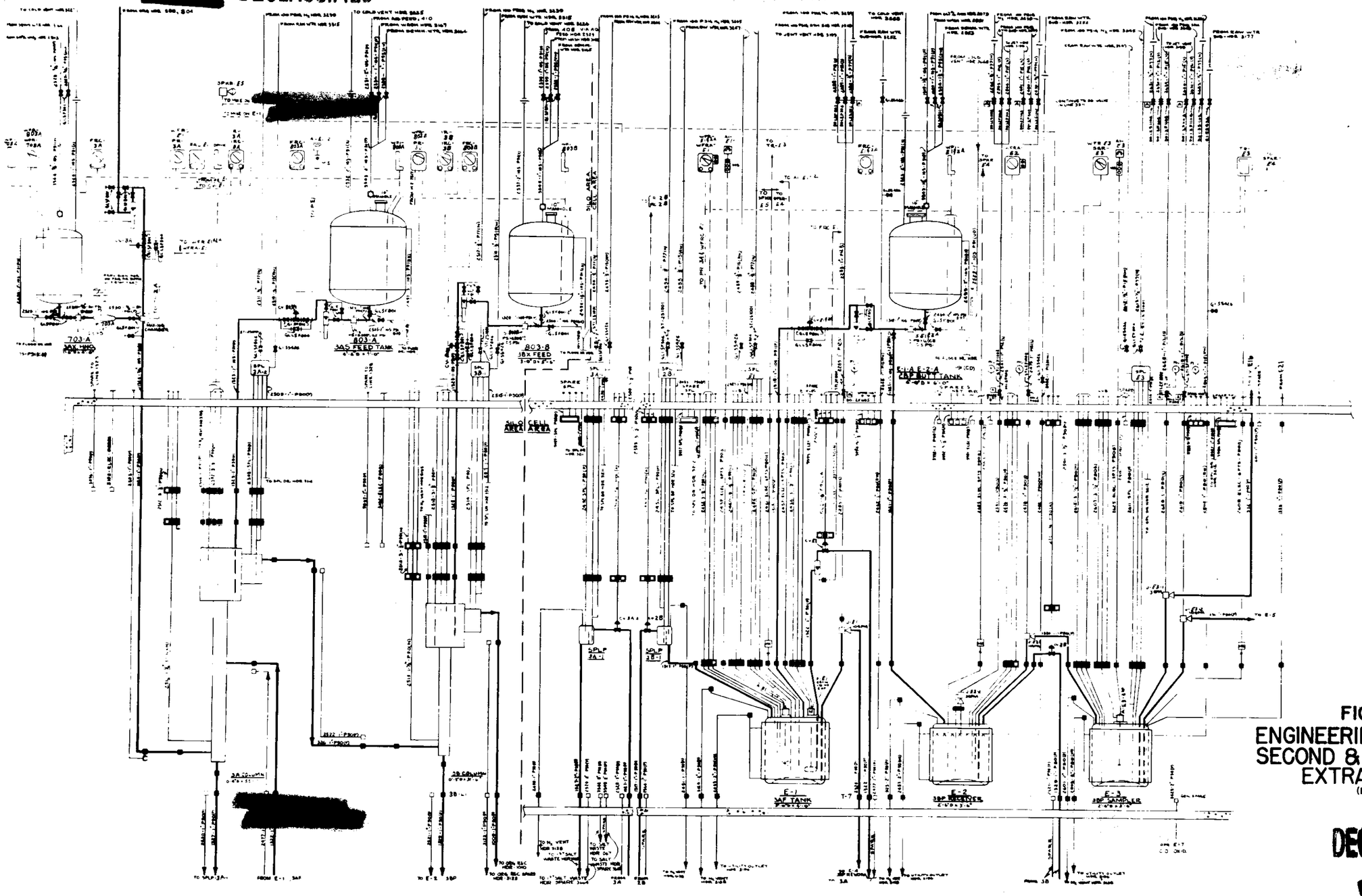

FIGURE XII-14
ENGINEERING FLOW DIAGRAM
SECOND & THIRD PLUTONIUM
EXTRACTION CYCLE
(FROM H-2-7510)

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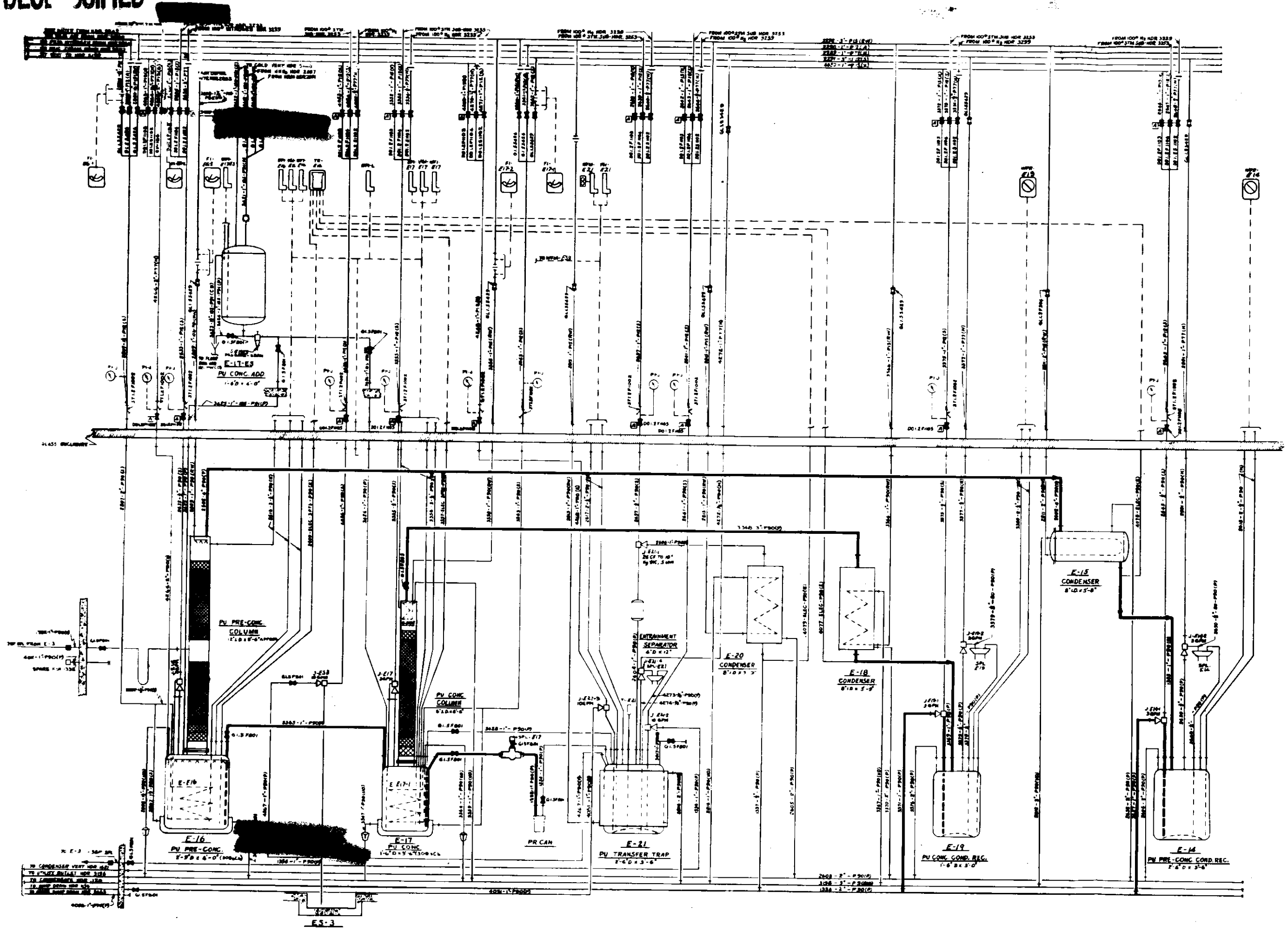

GENERAL NOTES

1. FOR PIPE DIAMETER TO SPEC. HW-[illegible]
2. FOR VALVE & STRAINER DIAMETER TO SPEC. HW-[illegible]
3. ALL PIPE TO BE SCHEDULE 80 UNLESS OTHERWISE NOTED

FIGURE XII-15
ENGINEERING FLOW DIAGRAM
SECOND & THIRD PLUTONIUM
EXTRACTION CYCLE
(FROM H-2-7511)

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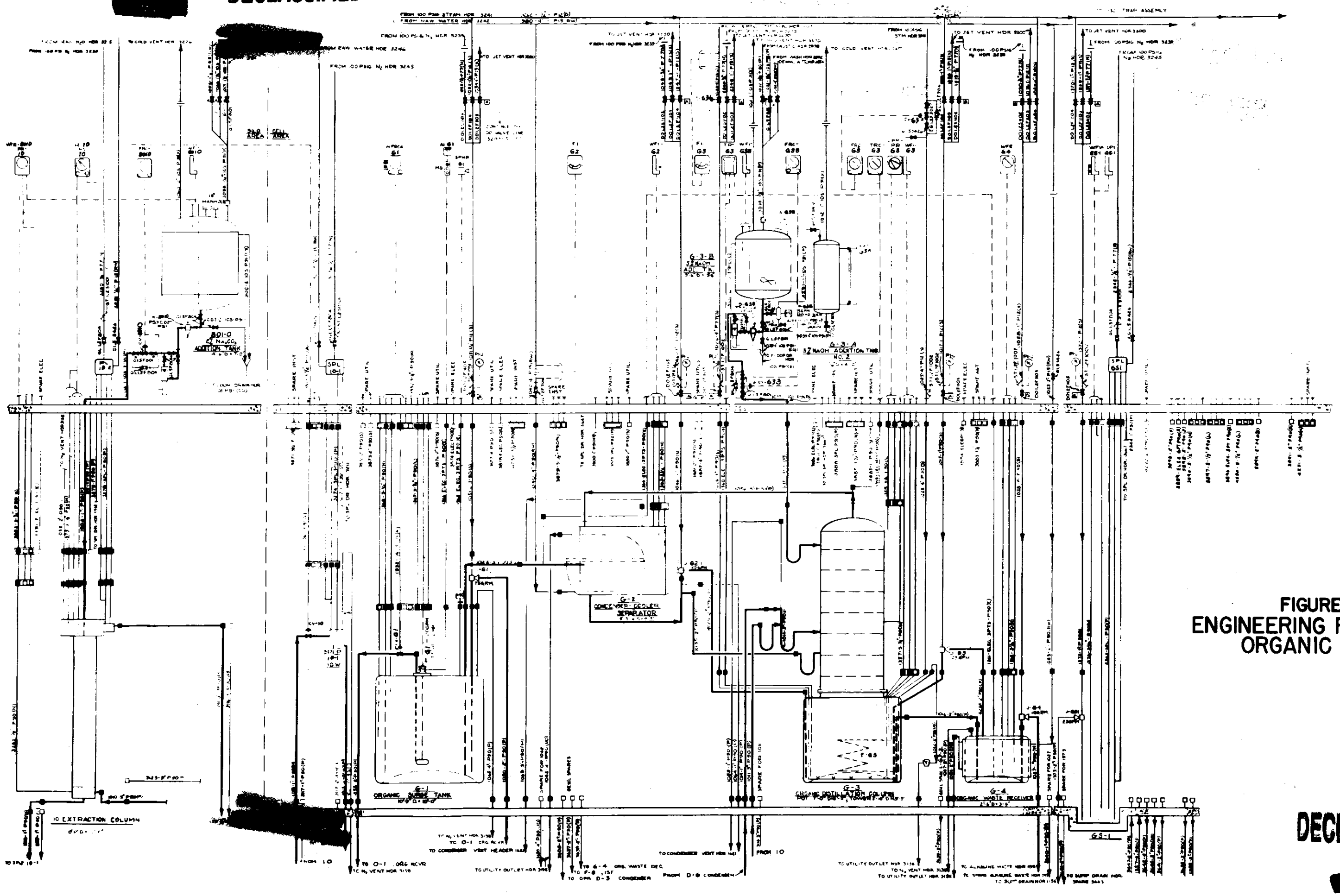

FIGURE XII-16
ENGINEERING FLOW DIAGRAM
ORGANIC RECOVERY

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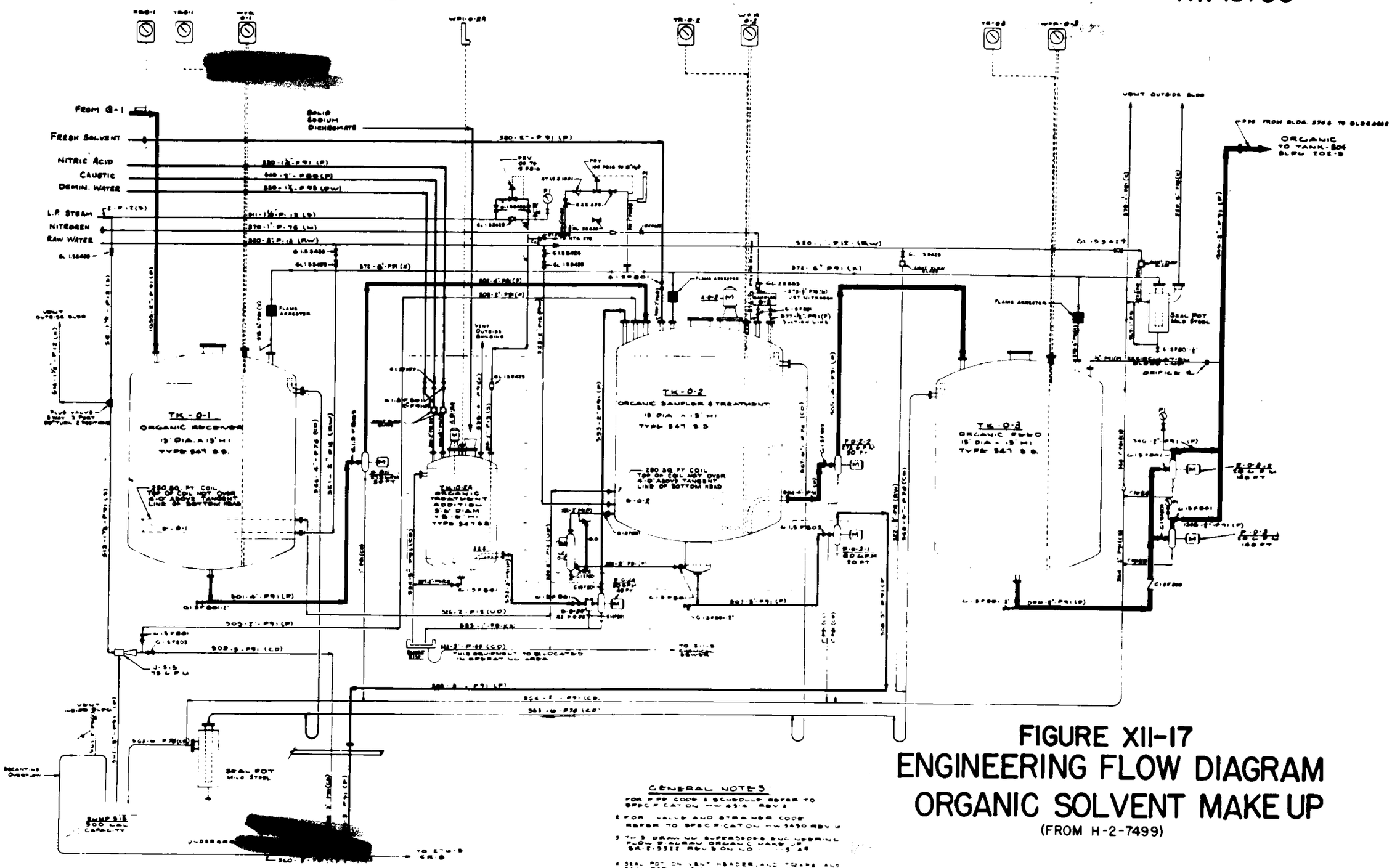

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GENERAL NOTES

FOR P.P.E. CODE & SCHEDULE REFER TO SPECIFICATION HW-43314 REV. 1

2 FOR VALVE AND STRAINER CODE REFER TO SPECIFICATION HW-3450 REV. 3

3 THIS DRAWING SUPERSEDES AND VERIFIES FLOW DIAGRAM ORGANIC MAKE UP SK-2-5337 REV. 8 ON FILE

4 SEAL POT ON VENT HEADER AND TANKS AND SEAL POT ON VENTOOL TRAILER TO BE DESIGNED FOR MAXIMUM OPERATING WATER PRESSURE OF THE SYSTEM

5 THE DRAINING DIRECTION [illegible] PROCESS AREA [illegible] SOLVENT [illegible] WATER PHASE [illegible] SEAL.

FIGURE XII-17
ENGINEERING FLOW DIAGRAM
ORGANIC SOLVENT MAKE UP
(FROM H-2-7499)

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FIGURE XII-18
ENGINEERING FLOW DIAGRAM
WASTE TREATMENT
(FROM H-2-75113)

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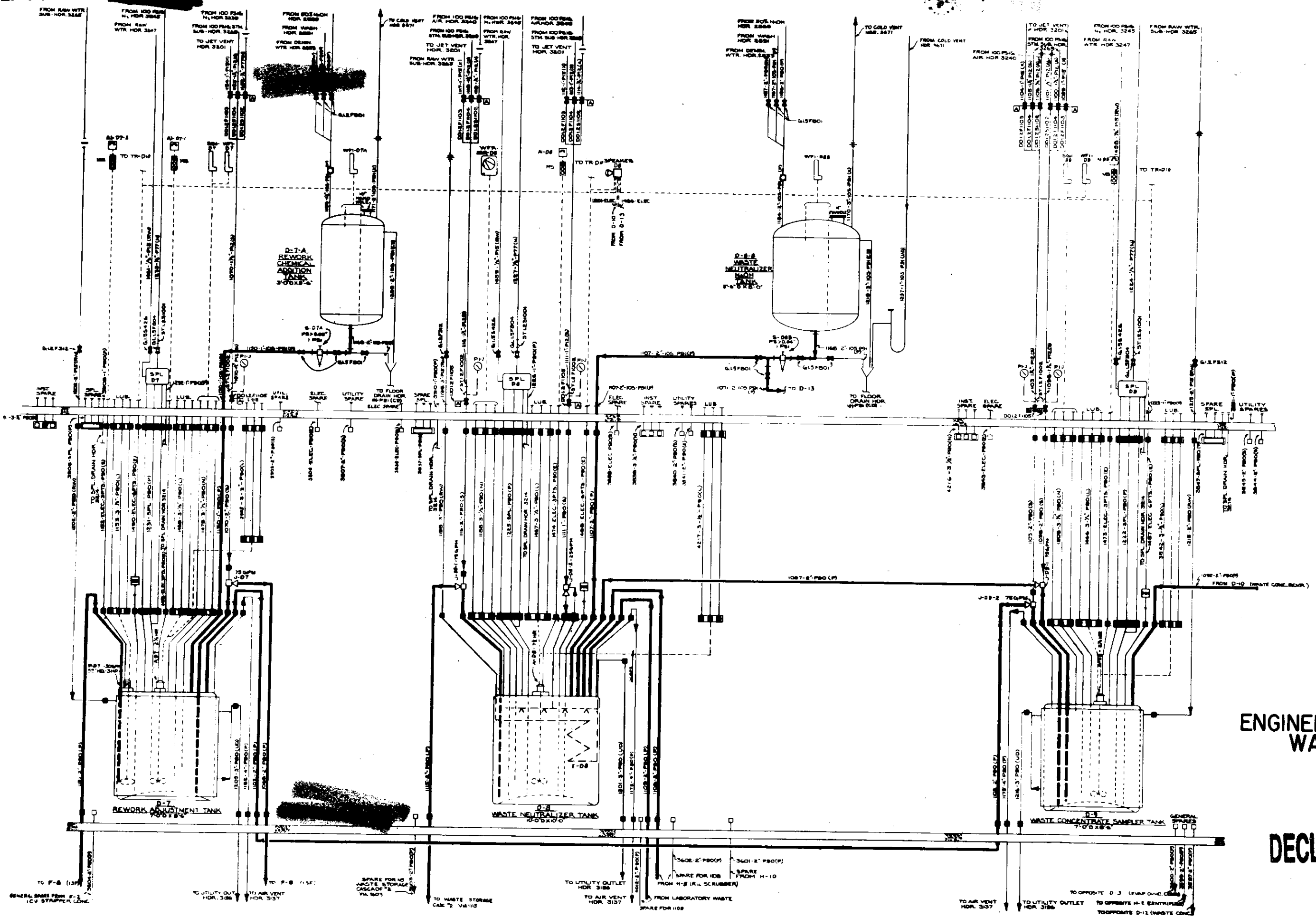

GENERAL NOTES

1. FOR PIPE [illegible] REFER TO SPEC. [illegible] REV. [illegible]
2. FOR VALVE & STRAINER CODES REFER TO SPEC. HW-3450, REV 8
3. ALL PIPES TO BE [illegible] SCHEDULE [illegible] UNLESS OTHERWISE NOTED

FIGURE XII-19
ENGINEERING FLOW DIAGRAM
WASTE TREATMENT
(FROM H-2-7514)

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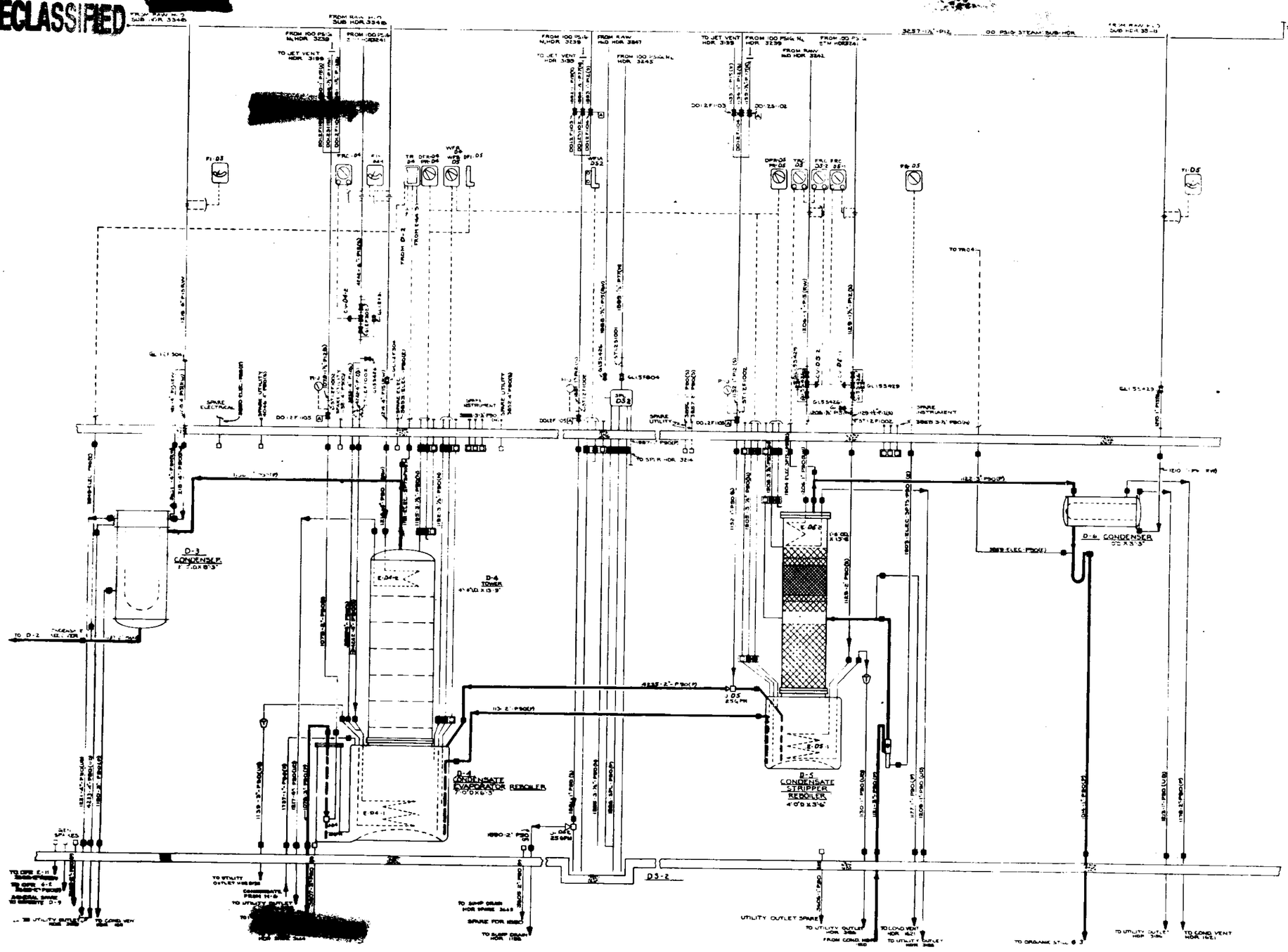

GENERAL NOTES

1. FOR PIPE CODES REFER TO SPECIFICATION HW-4346, REV. 1
2. FOR VALVE & STRAINER CODES REFER TO SPECIFICATION HW-8480, REV. 6
3. ALL PIPES TO BE SCHEDULE 40 UNLESS OTHERWISE NOTED

FIGURE XII-20
ENGINEERING FLOW DIAGRAM
WASTE TREATMENT
(FROM H-2-75145)

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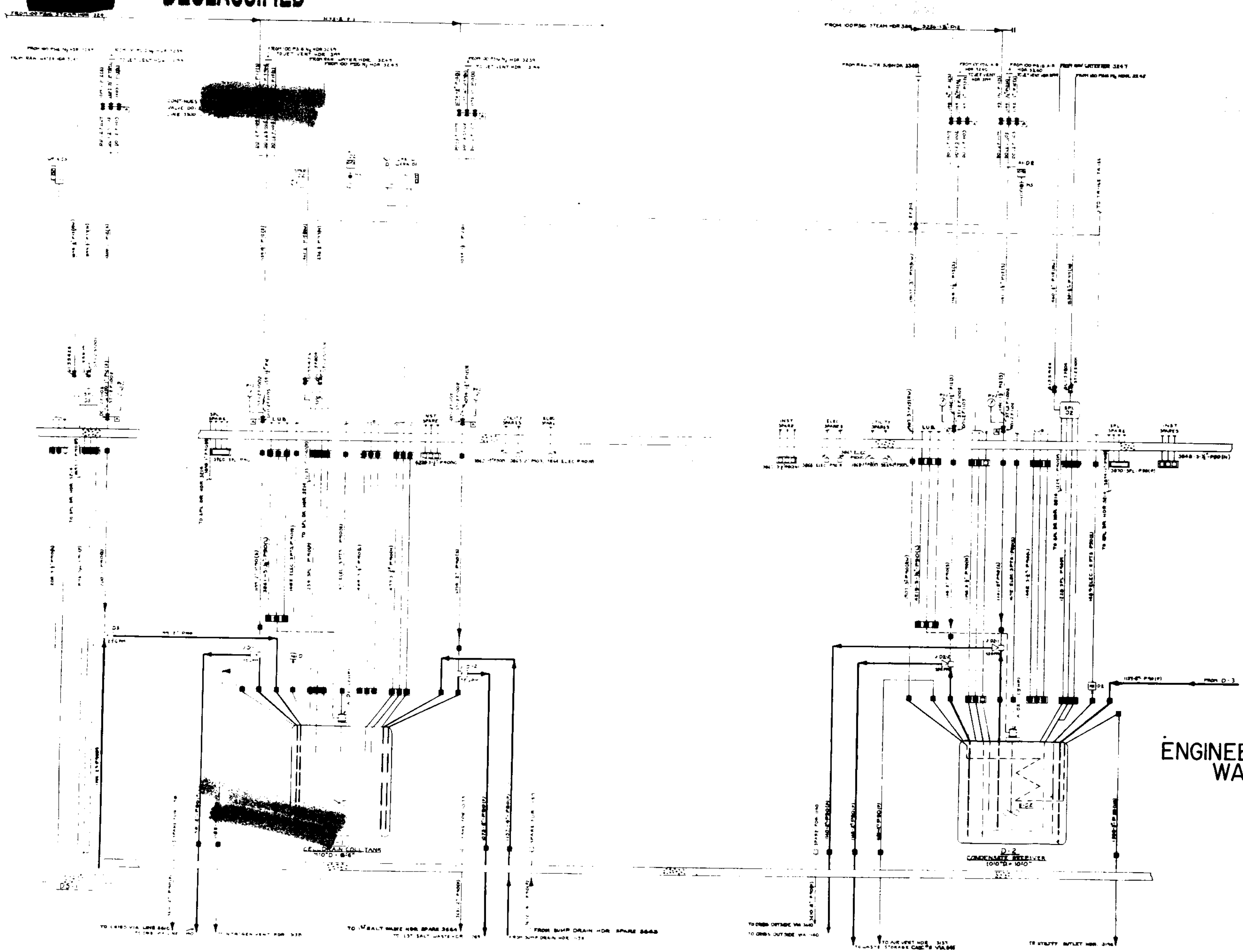

FIGURE XII-21
ENGINEERING FLOW DIAGRAM
WASTE TREATMENT
(FROM H-2-7516)

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PART III: PLANT AND EQUIPMENT, continued

CHAPTER XIII. TANKS

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CHAPTER XIII. TANKS

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A. VESSEL CLASSIFICATIONS AND MATERIAL(1)

1. Class I Vessels

All vessels designed to contain radioactive solutions are designated as Class I. All Class I vessels are located in the canyon process area, the silo area, and the Product Removal Room (PR Cage). The Class I vessels are divided as follows:

1.1 Standard vessels

In order to reduce the number of types of vessels required, the process working volumes are grouped into a relatively few standard volumes. Within a group, the tanks are standardized in size and all details; i.e., they are completely interchangeable.

1.2 Special vessels

Special vessels are those for which process considerations require a vessel that will not fit in the standard-vessel category. Solvent-extraction columns (described in Chapter XIV), concentrators and condensers (described in Chapter XV), and dissolvers (described at a subsequent point in this chapter) are examples of special vessels. Special vessels are designed to make use of standard vessel components (shells, heads, and associated equipment) wherever possible.

1.3 Materials

All Class I vessels are constructed of Type 347 stainless steel (or an equivalent in the 300 series stabilized toward intergranular corrosion by virtue of a Cb-Ta additive or extra low carbon content (ELC)) with the exception of those operating at elevated temperatures which are constructed of Type 309-S-Cb. Reference is made to Chapter XII for a basis of selection for materials of construction.

2. Class II Vessels

All stainless steel vessels designed to contain non-radioactive solutions are designated as Class II. All Class II vessels are constructed of Type 347 stainless steel (or the equivalent); they are designed according to normal chemical plant practices. Class II vessels are grouped in standard sizes, and standard head layout and tank supports are provided within the group wherever possible.

3. Class III Vessels

All carbon steel vessels designed to contain non-radioactive solutions are designated as Class III. They are designed according to normal chemical plant practices with standardized sizes, head layout, and supports. All vessels constructed of materials other than stainless steel or carbon steel are designated as Class III Special.

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4. General Design Bases

Design instructions and specifications for all process vessels are listed in references (2) through (8). In general the codes called for in the specifications are American Standards Association standards, American Society of Testing Materials specifications, and American Society of Mechanical Engineers codes. These bases have been used to guide the design of the process vessels.

B. "HOT" TANKS (CLASS I)

1. Design Basis

1.1 Canyon-area tanks

1.11 General

There are two chief design criteria for canyon area tanks: (a) satisfactory fulfillment of process requirements and, (b) satisfactory fulfillment of remote handling requirements. An important subsidiary design basis is the standardization of vessels and auxiliaries into as few general types as possible. Special vessels (those that do not fall into any standard grouping) are designed to include as much of the standard vessel design and to use as much standard associated equipment as is practicable.

Canyon area tanks consist of three basic parts: bottom head, shell, and top head. The minimum thickness of all parts is 1/4 inch; special tanks (such as the Dissolvers, described in Subsection 3) may be of heavier construction.

1.12 Bottom head

The bottom heads for all canyon tanks are fabricated in a reverse-dished shape with an inside corner radius to allow dip legs spaced around the tank periphery to reach the low points of the tank. The bottom head is fabricated from a single piece of stainless steel stock.

1.13 Shell

The shell of the tanks is of sufficient thickness (but not less than 1/4 inch) to support the maximum expected pipe and equipment load on the vessels. Jackets for standard vessels are welded to the shell. They are designed for utilization of 15 lb./sq.in. ga. steam for heating service and 40 lb./sq.in.ga. water for cooling. One or two expansion joints are provided in the jacket (See Figures XIII-1 and XIII-2) to compensate for differential expansion between the tank shell and the jacket. The jacket inlet and outlet nozzles are not part of the nozzle pattern of the top head.

1.14 Top head

The top head of canyon tanks is designed for sufficient rigidity to support the maximum load of pipe and equipment without appreciable de-

flection. Larger tanks are provided with externally located head stiffeners to aid in meeting the deflection requirement. (See Figures XIII-1 and XIII-3. Nozzles for the entrance of lines into a tank are located near the periphery of the top head. They extend approximately 1 inch below the head and are welded to the head on both sides. Tank nozzles and connectors are designed so that a dip leg smaller in diameter than the nozzle may be inserted into the tank through the nozzle. Manholes on canyon tanks are large-diameter nozzles for accomodating such auxiliary equipment as pumps, agitators, or columns. The manhole flange supports the auxiliary equipment; the auxiliary has a mating flange for bolting to the manhole flange. "Captive" stud bolts are provided on the manhole flange and the "free" nuts are tightened down on the assembly with the impact wrench. As an aid in remotely aligning mating equipment pieces, all are equipped with two dowel pins and companion holes. The pins are located in the lowermost piece being positioned; the companion holes in the upper. The two dowels are of different lengths so that the longer can be used as a pivot to align the shorter with its hole. Gaskets for nozzles and manholes are made of Gasket Grade Teflon (or molded asbestos for steam supply lines); gaskets are designed to be retained by the removable assembly.

If a vessel is provided with a coil it is designed to be an integral part of the tank, i.e., the inlet and outlet nozzles are part of the vessel head nozzle pattern and are welded to the head. Coils are designed for the utilization of 100 lb./sq.in.ga. steam. They are constructed with as few welds as possible and with adequate reinforcement at joints to prevent failure from expansion.

1.15 Lifting bails

All vessels and removable auxiliaries are provided with lifting bails that will permit handling by standard crane lifting yokes. The bails are designed so that there will be no interference between other parts of the vessels and the lifting yokes. The bails are structurally strong enough to lift the empty vessel and attached auxiliaries and are located so that the vessel will be balanced when lifted.

1.16 Supports

Supports for all "hot" canyon tanks consist of 3-legged "Y's" of structural beams anchored to the floor by several bolts at the end of each leg. The "Y" supports compensate for floor irregularity and slope and have been adjusted to within 1/32 inch of the horizontal datum plane. Support pads welded to the bottom head of the vessels rest on the support beams and are maintained in position by aligning companion holes in the pads with two dowels in the "Y" supports. The vessels are secured by impacting "free" nuts on "captive" studs in the support beams.

1.17 Tolerances

Close tolerances are required for certain vessel dimensions. By maintaining close vertical tolerances on wall nozzles, vessel supports, and overall vessel dimensions, the major part of the overall cell tolerance is available for vertical variations in the pipe jumpers. Close

dimensional tolerances (nozzle face located within 1/16 inch of its nominal position in the horizontal plane and with 1/32 inch in the vertical plane) assure the correct fit of prefabricated pipe jumpers.

1.18 Finishes

Special finishes are generally not required for the exterior of canyon tanks.(2) The interiors of these vessels have a Standard No. 1 mill finish and are substantially free from hammer marks and weld spatter. Non-stainless steel parts are coated with a protective and chemical-resistant paint, Amercoat 23.(8)

1.19 Draining and flushing

All canyon tanks are drainable and flushable by means of the removal or addition of solution through lines extending through the heads of the vessels. No vessel has any outlet at or near the bottom head. There are no liquid retention pockets on the external or internal surfaces of any vessel.

1.2 Product Removal Room tanks

1.21 General

"Hot" tanks located in the Product Removal Room (PR-Cage) differ from those located in the canyon area in that PR-Cage equipment is maintained by direct contact methods and is operated from controls located outside the lucite cage. This is made possible here by the virtual absence of penetrating (gamma) radiation, the non-penetrating alpha rays of plutonium being the only radiation present in significant quantities. Except for the remote operation and maintenance requirement, the PR-Cage vessels generally meet the same Class I specifications as the canyon area tanks, discussed under 1.1, above.

PR-Cage vessels, floor, and stainless steel structural members are all finished to a 2-D or 3-B finish (ASTM-167). Valves, jets, etc., however, have no special finish, but all equipment is free of sharp edges, weld spatter, etc.

The Plutonium Concentrator, E-17, and Pre-Concentrator, E-16, are described in Chapter XV. The Plutonium Transfer Trap, briefly described below, is representative of other vessels in the PR-Cage.

1.22 Plutonium Transfer Trap

The Plutonium Transfer Trap, E-21, is a 2-1/2 ft. diameter by 3-1/2 ft. high jacketed vessel with eleven nozzles spaced around the periphery of the head of the tank and one nozzle in the center of the head. As distinguished from canyon tanks, the top head is of slightly convex shape. The tank is supported simply by stainless steel bearing plates beneath each of three 2-inch by 2-inch stainless steel angle irons welded to the side of the tank near the bottom. The bottom head of the tank has a reverse-dished shape. All transfers into or out of the vessel are effected through the nozzles on the top head.

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2. Standard Canyon Area Tanks

2.1 External features

The design criteria for canyon area tanks as discussed in Subsection B1, above, are illustrated by two representative standard canyon tanks, the IAF Make-Up Tank, H-1, and the 2A Feed Tank, E-5. Sketches of these vessels are presented in Figures XIII-1 and XIII-2, respectively. It may be seen that primary design (vessel shape, methods of support, jacket design, top head design, etc.) is approximately the same. The only basic differences between the two vessels is in size and in the number of auxiliaries. The IAF Make-Up Tank (7-ft. diam. by 8-1/2 ft. high) has a jacket with two expansion joints whereas the jacket on the smaller 2A Feed Tank (3-1/2 ft. diam. by 4-1/4 ft. high) requires only a single expansion joint. Inlet and outlet connectors for the jacket are maintained at the same level as all other connectors on either vessel and are supported above the jacket and close to the circumference of the top head.

Replaceable containers for exhaust lubricant from the pump and agitator auxiliaries are mounted in a framework attached to the outside of all tanks having such auxiliaries.

The methods of supporting pumps and agitators (on heavily flanged manholes) is made apparent by Figures XIII-1 and XIII-2. Figure XIII-2 shows the dowel-pin arrangement for positioning any auxiliary piece of equipment on a manhole. The spare manhole for the 2A Feed Tank is provided for conformity with the IBP Receiver, E-6, in the interest of standardization.

Nozzle functions are listed on Figures XIII-1 and XIII-2.

On large tanks, such as the IAF Make-Up Tank, which have an agitator or a column mounted on the center of the top head, stiffening of the head against the extra weight is provided as shown in Figure XIII-1.

2.2 Internal features

The standard design discussed in Subsection B1 also applies to the internal features of the IAF Make-Up Tank, H-1, and the 2A Feed Tank, E-5. Both have the reverse-dished bottom head with inside corner radius such that jet or pump suction can draw solution from the low point of the vessel. Pumps are located near the outer edge of either tank for this reason. It should be noted that both pumps and agitators will pass through their manhole openings without being tipped or cocked.

3. Special Canyon Area Tanks, Dissolvers

3.1 External features

The three identical Dissolvers, A-2, B-2, C-2, are special tanks, i.e., they are interchangeable with no other canyon vessels. The Dissolvers are illustrated in Figure XIII-3. Each vessel is sturdily constructed of 5/8-inch 309-S-Cb stainless steel to withstand the severe

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mechanical shock and corrosion conditions present during use. Each Dissolver is 7 ft. in diameter by 7 ft. 7 in. high. The bottom of the vessel is reinforced with 3/4-in. stainless steel plate (as illustrated) to withstand the impact of falling slugs. The maximum working liquid level is 4 ft. 2 in.

A 2-ft. 10-in. diameter opening through which uranium is charged is provided in the top head. The charging opening is covered with a heavy, gasketed, stainless steel lid resting on a grooved, machined surface but not fastened in place. The Dissolver Column (2 ft. diam. by 12 ft. high) is mounted on a manhole located in the center of the top head. The Dissolver Column is positioned on the manhole by dowels and secured in place by impacting "free" nuts on "captive" studs integral with the manhole flange. Thus ready removal of the Dissolver Column can be accomplished without disturbing the Dissolver. The lower portion of the Dissolver Column contains 4 ft. of 1-1/2 in. Duriron Raschig-ring packing. A 5-ft. long reflux condenser (six concentric coils of 1-in. schedule 40 pipe on 1-3/4 in. pitch) is located above the packing. Five connector nozzles serve the Dissolver Column and are located on the column head. Twelve connector nozzles serve the Dissolver proper. Figure XIII-3 shows the location and lists the function of each nozzle.

3.2 Internal features

A chute beneath the charging opening in the top head directs the slugs into a 4-ft. 6-in. diameter crib of stainless steel staves which protects the coil during charging operations. The three concentric-ring coil (5-turns high on 3-1/4 in. pitch) is located between the crib and the wall of the Dissolver and can be supplied with either water or steam. The air and steam sparger ring, placed at the bottom of the vessel below the coil, is made of 2-in. schedule 40 pipe. Holes 1/8 in. in diameter and spaced 2-in. apart are drilled in the sparger ring in such a way as to impart a swirling motion to the vessel contents during sparging. A 1/4-in. diameter hole is located on the bottom of the ring opposite the inlet.

A pair of tipping hooks and a set of centering guides (illustrated in Figure XIII-3) are centered inside the charging opening. Figure XIII-4 illustrates the charging operation. The slug bucket is lowered onto the tipping hooks and guided into position by the centering guides. As the bucket is lowered further, the lower lugs on the bucket engage the hooks causing the bucket to tip forward and dump the slugs into the Dissolver.

The bottom of the Dissolver has a reverse-dished shape; thus the dip tubes extend into the low points of the vessel.

C. "COLD" TANKS

1. Design Basis

"Cold" tank design follows normal chemical plant practices. Sizes, head layouts, and supports are standardized wherever possible. The wall thickness of these vessels is 1/4-in. minimum. Flanged or dished heads are employed wherever tank use permits. (Scale tanks, for example, have

flat, sloping bottom heads.) All spun or pressed heads have been stress relieved prior to welding onto the vessel. However, with the exception of caustic-containing vessels, the vessels themselves have not been heat treated for corrosion resistance. All Class II vessels have been pickled after the completion of welding and heat treatment, but neither Class II nor Class III vessels have been subjected to X-ray or Zyglo tests as Class I vessels have been.(5)

2. Process Tanks -- Classes II and III

2.1 External features

The external features of Class II and III process vessels are illustrated by Figures XIII-5 and XIII-6, Ferrous Sulphamate Preparation Tank, 504, and 2AS Make-Up Tank, 409, respectively. Features common to Class II or III process vessels, irrespective of size, are bottom outlets, tank overflow outlets, side outlets for coils, if used, and top-head vent outlets. The vessels are all of a cylindrical shape with a height (or length) to diameter ratio ranging from 1 to 2.9. All of the tanks with the exception of scale tanks have dished heads (or ends in the case of horizontal tanks). The bottom heads of scale tanks are flat.

2.2 Internal features

Class II and III process tanks are generally similar internally. Those with coils are represented by Figure XIII-5; those without by Figure XIII-6. Scale tanks, although similar in other respects, have a flat, sloping bottom with the bottom outlet at the side of the vessel at its low point. The Oxidizer Scale Tank, H-4-C, has a dished bottom and is an exception.

2.3 Aqueous make-up tanks

A listing of Class II and III aqueous make-up tanks (not included in the Engineering Flow Diagrams of Chapter XII) is presented below:

Tank Number	Class	Name	Diameter Ft.	Height (or Length) Ft.
201	II	ICX, 2EX, 3EX Make-Up	10	10
202	II	ANN Adjustment	8	10
406	II	2DS, 3DS Make-Up	8	10
601	II	ANN Solution	5-1/2	16
602	III Special	Demin. Water Head Supply	5-1/2	16
603	II	60% HNO_3 Supply	5-1/2	12
604	III	50% NaOH Supply	5-1/2	12
401	II	IAS Make-Up	6-1/2	8
508	III	40% NaOH Make-Up	5-1/2	8
509	II	26% $NaNO_3$ Make-Up	5-1/2	8
501	II	2% Na_2CO_3 Make-Up	5-1/2	8
505	II	Wash Solution Make-Up	5-1/2	8
402	II	ISS Make-Up	4-1/2	7
407	II	IBX Make-Up	4-1/2	7

Tank Number	Class	Name	Diameter, Ft.	Height (or Length), Ft.
408	II	2BX, 3BX Make-Up	4-1/2	7
409	II	2AS Make-Up	4-1/2	7
410	II	3AS Make-Up	4-1/2	7
506	II	50% $Na_2Cr_2O_7$ Make-Up	4	6
503	II	Ferrous Sulf. Adj. and Supply	4	6
504	II	Ferrous Sulfamate Preparation	4	6
507	III	25% NaOH Make-Up	4	6
405	II	30% $Fe(NH_2SO_3)_2$ Head Tank	3	3-1/2
404	III	50% NaOH Head Tank	1-1/2	4
403	II	60% HNO_3 Head Tank	1-1/2	4

Reference is made to the Engineer's Flow Sketch on aqueous make-up presented in Chapter VIIIfor auxiliaries and instrumentation on the vessels listed above.

3. Storage Tanks -- Classes II and III

Storage tanks are Class II vessels if constructed of stainless steel, Class III if constructed of carbon steel, or Class III Special if constructed of any other material. The storage tanks located outside the Processing Building (202-S) are in the Chemical Tank Farm (211-S), the Solvent Facilities Building (276-S), and the Decontaminated UNH Storage Facility (203-S). With the exception of the Decontaminated UNH Storage Tanks, SU-151 and SU-152, the vessels are designed and constructed in accordance with normal chemical plant practice.

The Organic Storage Tanks, SO-141 and 142, are 11-1/2 ft. diameter by 28-ft. long, buried, horizontal mild steel tanks of about 21,500 gal. capacity each; they are shown in Figure XIII-7. Storage tanks for aluminum nitrate solution, nitric acid, 50% sodium hydroxide, and demineralized water are provided in the Chemical Tank Farm. Three Aluminum Nitrate Storage Tanks, SS-111, SS-112, and SS-113, are 35-ft. diameter by 23-ft. high Tygon-lined mild steel vessels of 149,000 gal. capacity each; a fourth, SS-114, is a 9-ft. diameter by 9-ft. high stainless steel vessel holding 4300 gal. Two Nitric Acid Storage Tanks, SA-122 and SA-123, are each 20 ft. diameter by 20 ft. high and have a capacity of 41,000 gal. The third Nitric Acid Storage Tank, SA-121, is a 15,000 gal. capacity tank 12 ft. diameter by 19 ft. high, and the fourth Nitric Acid Unloading Tank, SA-124 is 9 ft. diameter by 9 ft. high and holds 4300 gal. All acid tanks are constructed of stainless steel. Two Caustic Storage Tanks, SQ-101 and SQ-102, are 30 ft. diameter by 20 ft. high. They are made of mild steel, and each holds 99,000 gal. The Demineralized Water Storage Tank, SW-131, is constructed of aluminum and holds 15,000 gal. It is 12 ft. diameter by 19 ft. high.

The Decontaminated UNH Storage Tanks, SU-151 and SU-152, are 9-1/2 ft. diameter by 10 ft. high and are constructed of Type 347 stainless steel.

Each vessel has a capacity of about 4,800 gal. Both have sloping bottom heads with an outlet at the low point of each tank. The vessels are interconnected through the bottom outlets. They are provided with a row of nozzles around the periphery of the top head, and normal transfers into or out of the vessels are accomplished through these nozzles.

Underground Waste Tanks store radioactive waste from the process. The vessels are described in Chapter XI.

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REFERENCES

(1) Seckendorff, Mechan[redacted] Instruction Letter No. 1, Section I -- 202-S Ves[redacted]d to 2-28-50).

(2) HW-3791 Surface Roughness Specification, Rev. 1.

(3) HW-4309 General Instrument Specification, Rev. 3. 11-17-50.

(4) HW-4310 Testing of Instrument Equipment and Installation.

(5) HW-4311 General Specification for Material Procurement and Shop Fabrication of Vessels, Rev. 2. 12-25-50.

(6) HW-4313 Erection Specification for the Assembly, Testing, and Installation of Canyon Equipment and Piping. 7-13-50.

(7) HW-4314 Process, Utility and Sewer Piping, Rev. 1. 2-6-50.

(8) HW-4315 Protective Coatings for Cell Walls and Cell Equipment, Rev. 1. 5-4-50.

(9) HW-4586 General Specifications for Material Procurement and Erection of Storage Tanks for the 211-S Building and Organic Solvent Treatment Tanks for the 276-S Building, Rev. 2. 10-13-50.

(10) HW-4651 Furnishing, Applying, and Testing Tank Linings for Salt Storage Tanks, Rev. 1. 12-12-50.

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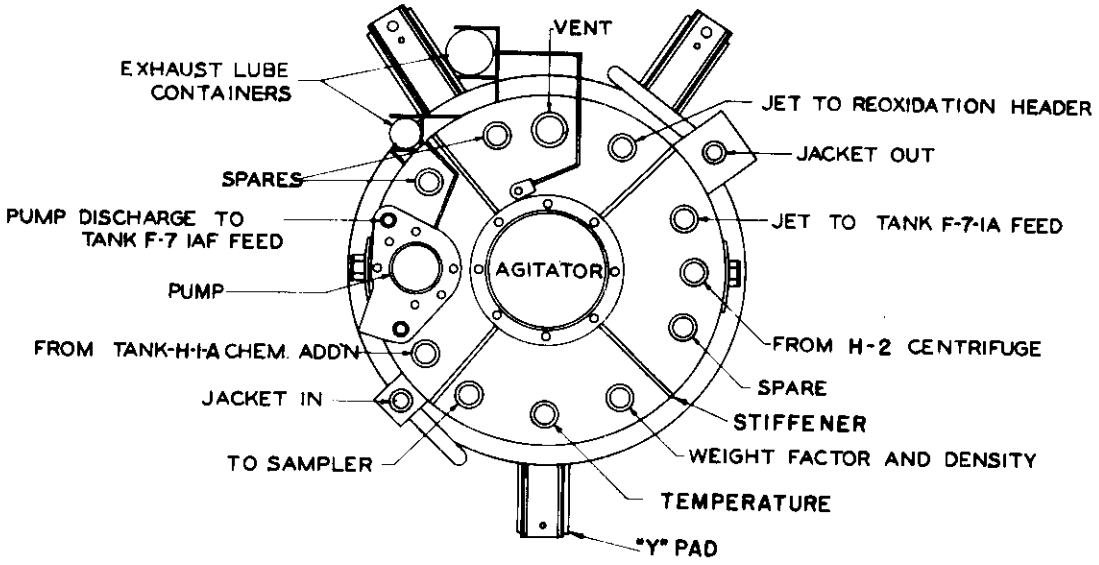
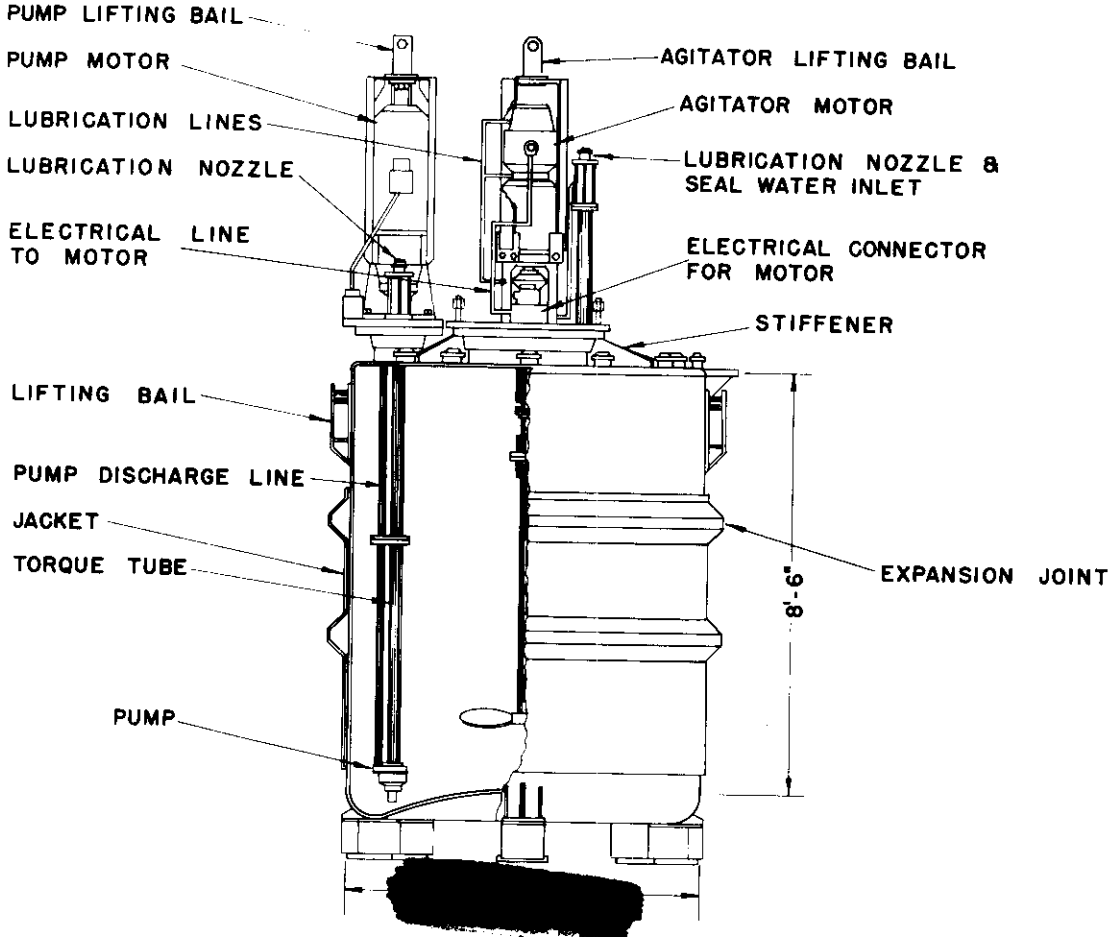
FIGURE XIII-1
1AF MAKE-UP TANK, H-1





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2A FEED TANK, E-5

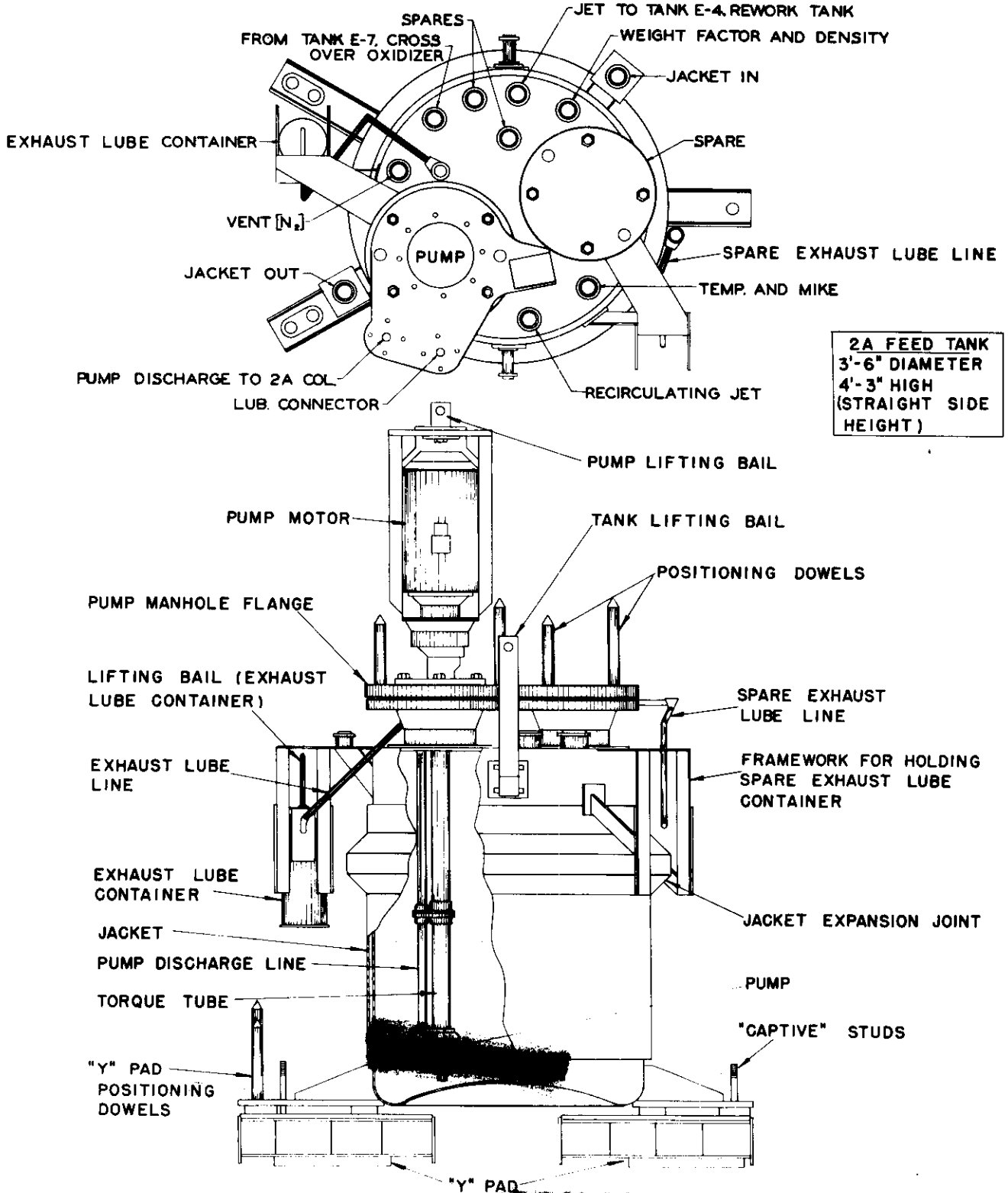

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FIGURE XIII-3

DISSOLVER, A-2, B-2, C-2

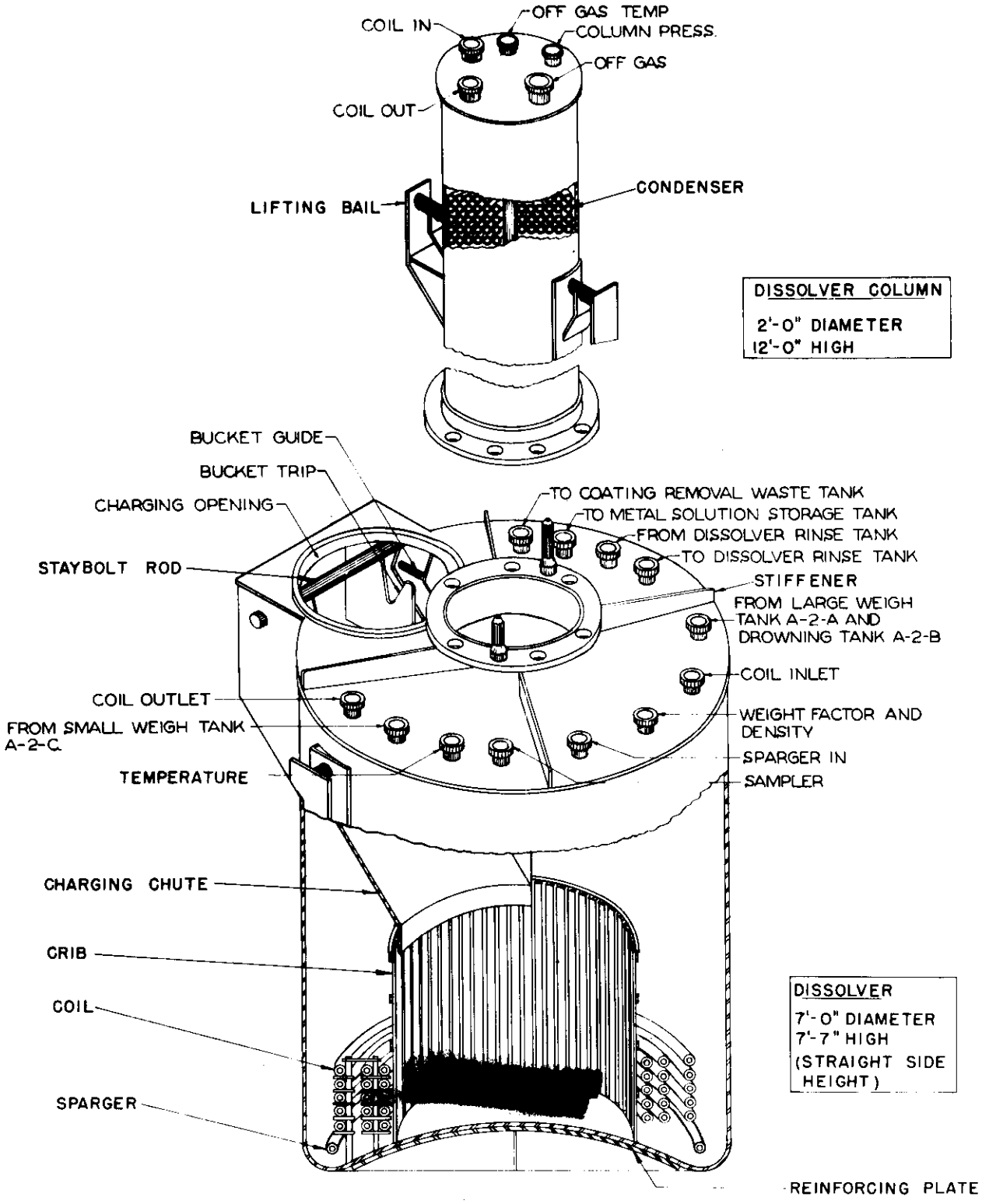

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FIGURE XIII-4

CHARGING THE DISSOLVER.

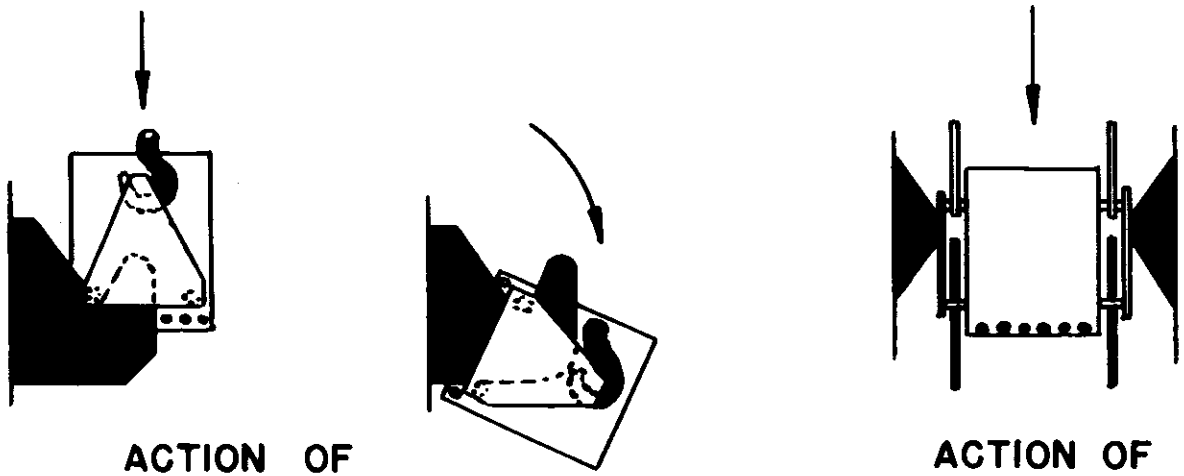

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FIGURE XIII-5

FERROUS SULFAMATE PREPARATION TANK, 504

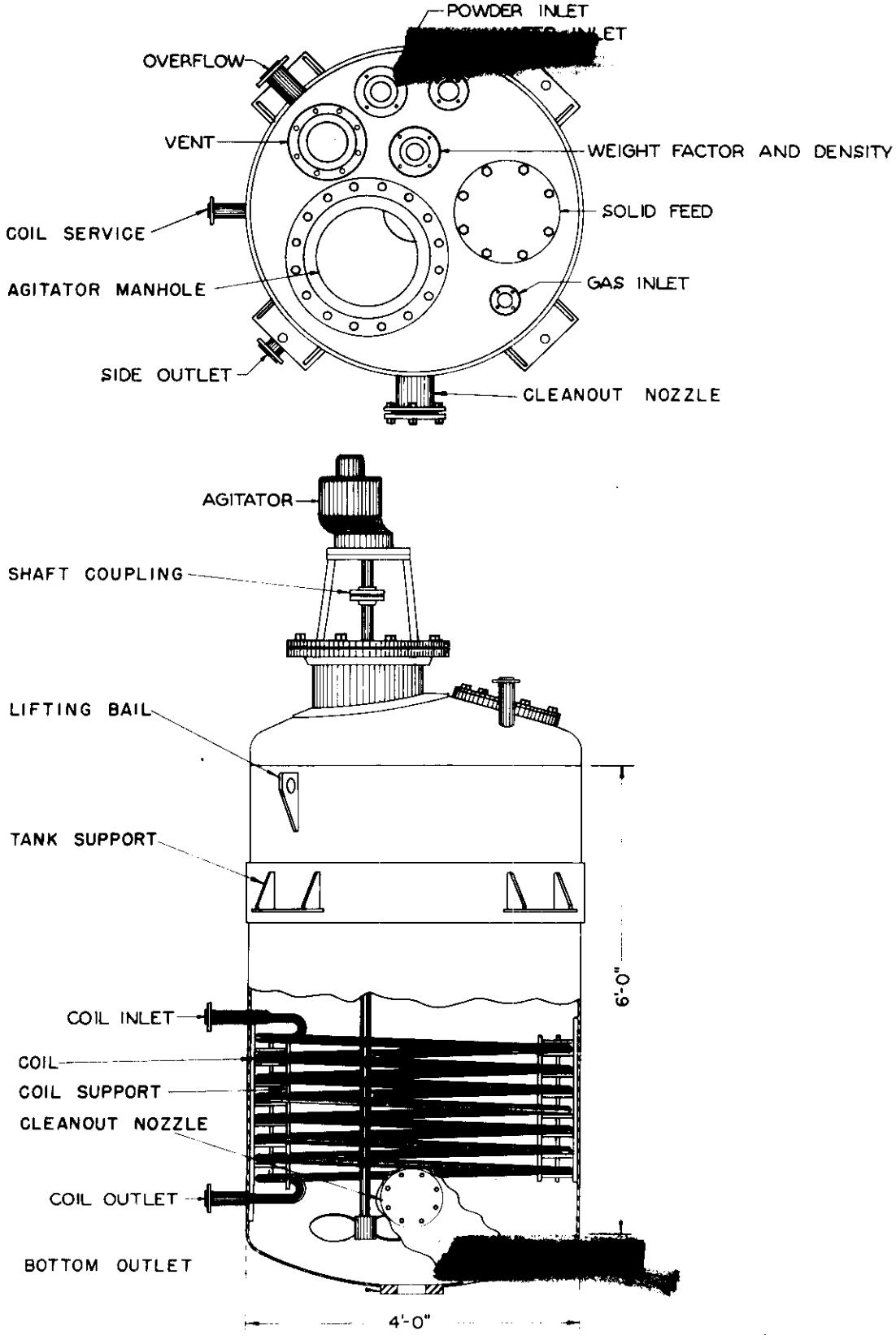

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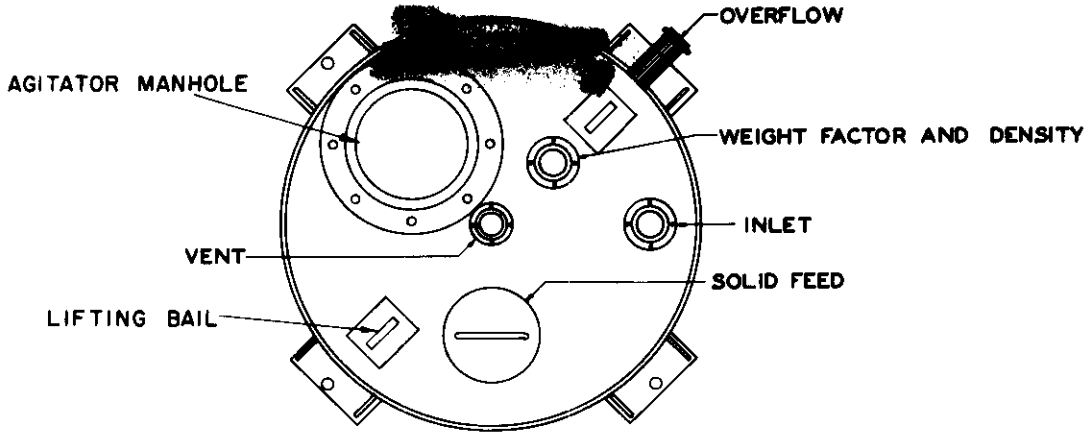
FIGURE XIII-6
2AS MAKE UP TANK, 409



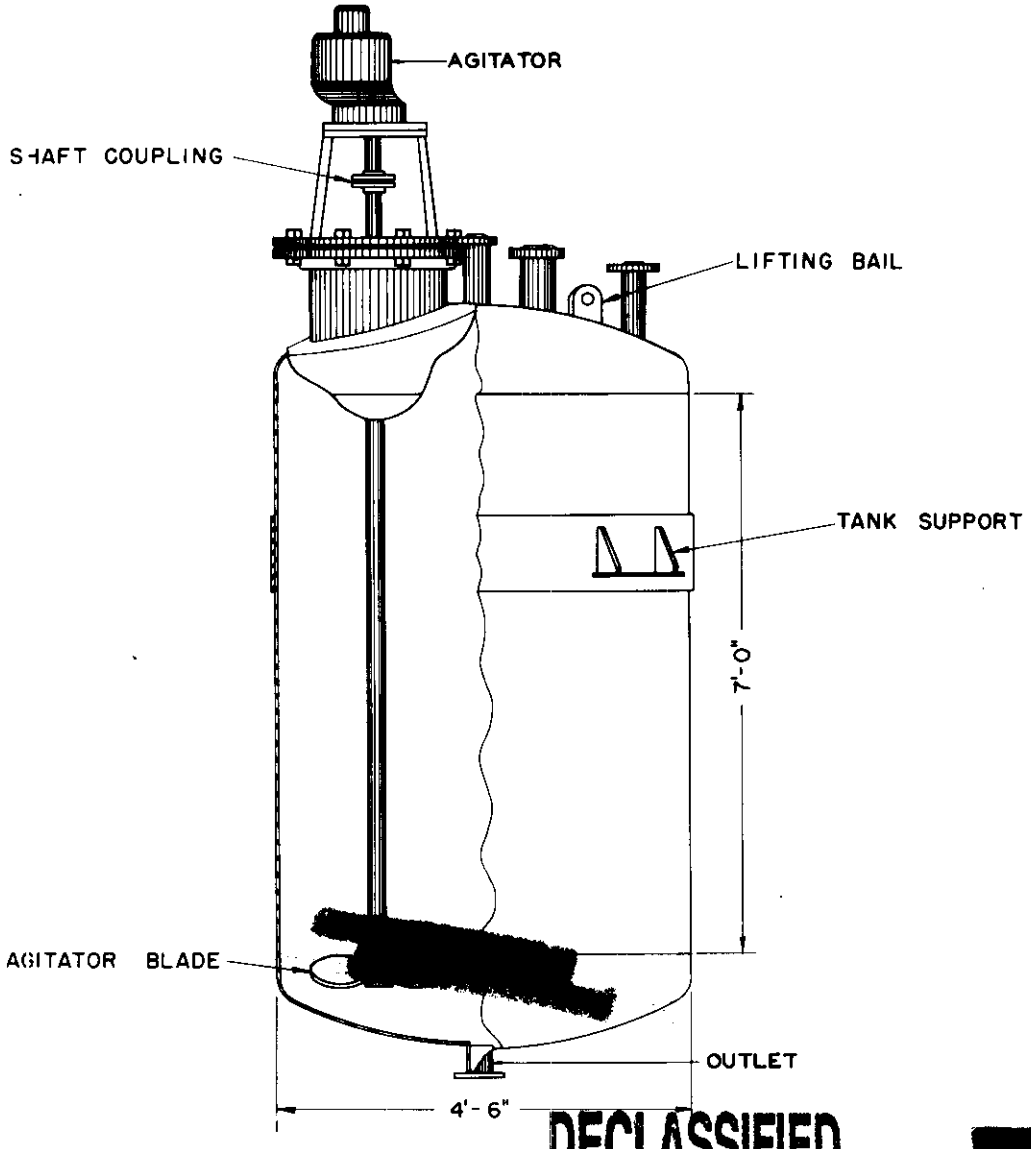


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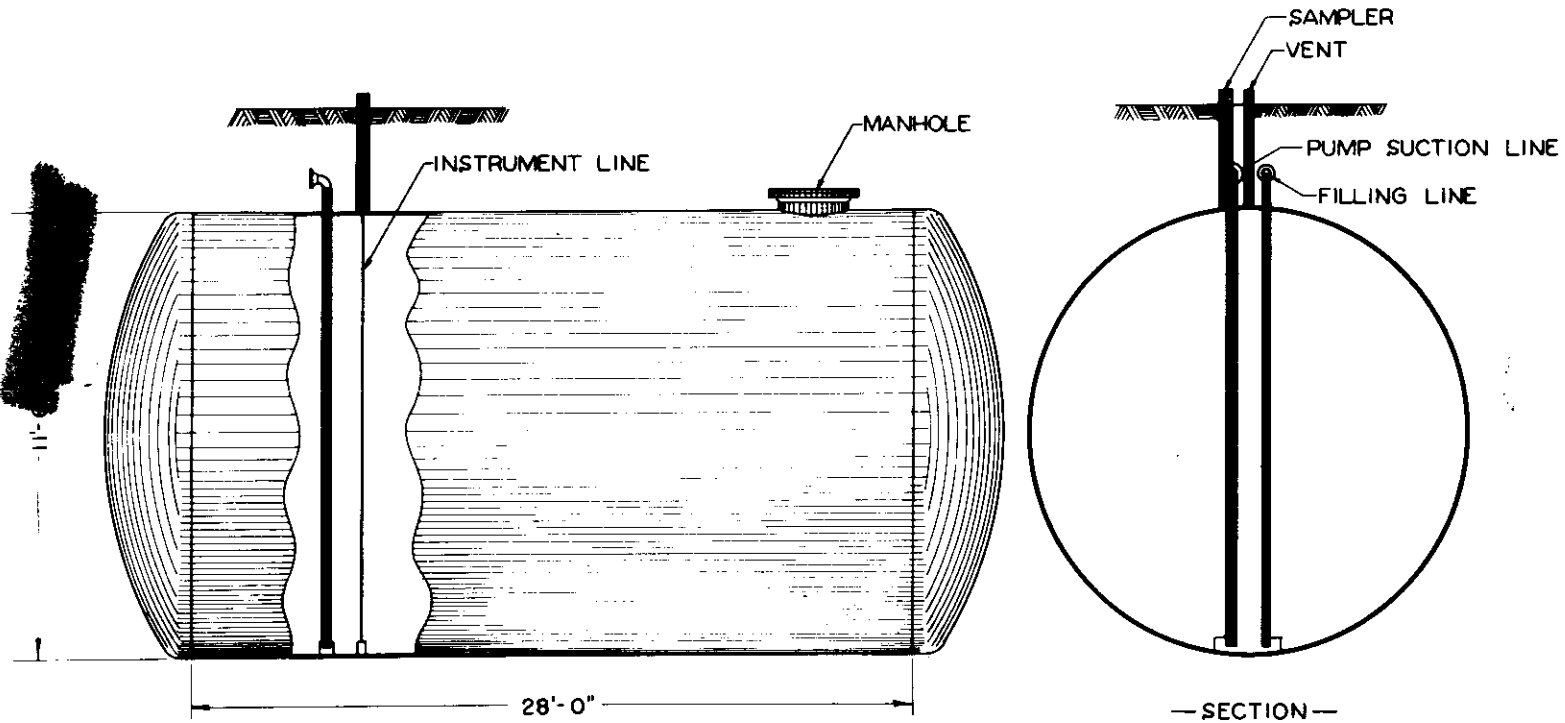
FIGURE XIII-7

ORGANIC STORAGE TANKS, SO-141 & 142



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PART III: PLANT AND EQUIPMENT, continued

CHAPTER XIV. SOLVENT-EXTRACTION COLUMNS

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CHAPTER XIV. SOLVENT-EXTRACTION COLUMNS

A. INTRODUCTION

The solvent-extraction columns are the "heart" of the Redox process and consequently a large portion of the engineering development work on the process was devoted to firming up specifications for their design. This development work included the operation of: (a) "hot" 1/2-inch to 2-inch-diameter columns packed with stainless steel Fenske helices and with 1/4-in. by 1/4-in. stainless-steel Raschig rings, at Argonne National Laboratory, (b) "hot" columns up to 3 inches in diameter packed with 1/4-in. by 3/8-in. stainless-steel Raschig rings, at Oak Ridge National Laboratory, and (c) "cold" columns up to 16 inches in diameter packed with stainless-steel Raschig rings up to 1-in. by 1-in., at Hanford Works.

Studies at the two national laboratories demonstrated the overall performance of the process (including decontamination) in packed columns of pilot-plant size. The effects on extraction performance of scaling the columns up to full plant size, including experimental demonstration of throughput capacity and rangeability for alternative column designs, were determined at Hanford Works by studies employing unirradiated uranium.

Early in the contactor development program, serious doubts existed as to the satisfactory performance of plant-size packed columns, and the use of mixer-settler type contactors was considered. However, acceptable performance of columns packed with stainless-steel Raschig rings was finally demonstrated, and firm design specifications were developed for all thirteen solvent-extraction columns in the Redox battery. Pertinent experimental data on which these specifications were based are presented and discussed in Chapter V. The purpose of the present chapter is to present the salient design specifications for the columns without discussing the background data behind these specifications or the performance expected from the columns (these considerations having been treated in Chapter V).

In addition to design specifications for all solvent-extraction columns (see Fig. XIV-1), detail drawings of the three prototype columns (IA, IB, and IC) are included as Figures XIV-2 through 7.

B. COLUMN DESIGN SPECIFICATIONS

Functions of each of the solvent-extraction columns are described in Chapters I and IV (and Chapter IX for the IO Column), and operation of the solvent-extraction battery is discussed in Chapter VI.

1. Design Capacity

1.1 Nominal design rate

The Redox Plant was designed for a maximum sustained production of 2.5 short tons of uranium or 630 grams of plutonium per day, whichever

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is limiting under the conditions of pile operation. In order to provide adequate flexibility (i.e., rangeability) for operating at less than maximum rates, 1.0 short ton of uranium per day was specified as the minimum sustained production rate.

To maintain the above sustained production rates with an allowance that the plant be shut down as much as 20 per cent of the time (i.e., assuming an 80 per cent operating-time efficiency), the above sustained production rates should be divided by 0.8 to arrive at the instantaneous production rates used for design, as follows:

	Sustained Capacity	Instantaneous Capacity
Uranium, short tons/day	2.5	3.1
Plutonium, grams/day	630	790

All of the solvent-extraction columns except IA and IS are sized for a maximum instantaneous production of at least 3.7 short tons of uranium per 24 hours. This includes the 3.1 tons per day listed above plus an additional capacity equivalent to approximately 0.5 short ton of uranium per day sustained rate (0.6 ton per day instantaneous rate) to handle the reworking of off-standard aqueous waste streams containing high concentrations of uranium or plutonium. Since the rework streams by-pass the IA Column and enter the solvent-extraction battery through the IS Column, the maximum instantaneous design rate of the IA Column is 3.1 short tons of uranium/day. The IS Column, packed with 1/2-in. rings, is capable of processing 0.3 to 1.6 tons/day (as a IA-type column) and will add an additional load equivalent to approximately 0.5 ton/day to all downstream columns when processing rework.

Although the plutonium-cycle columns (2A, 2B, 3A, 3B) do not process uranium, their maximum volume throughput rates, and hence their sizes, are fixed by the maximum uranium processing rate (3.7 short tons/day including the allowance for rework).

1.2 Processing rangeability

The solvent-extraction battery as a whole is capable of good performance over a range of instantaneous processing rates from approximately 1 to 3.1 short tons per day of pile discharge uranium, not counting 0.6 ton per day equivalent additional capacity for handling rework in all columns downstream from IA and IS. As indicated on Figure XIV-1, the range of good performance for some of the columns exceeds the above limits.

1.3 Operation at rates above nominal design

The volume throughput capacity of the solvent-extraction battery can be increased approximately 50 to 100 per cent above the nominal design rate by installing 3/4-in. or 1-in. Raschig rings in those columns scheduled to be packed with 1/2-in. Raschig rings. The performance characteristics and

processing capacities for these larger rings are discussed further in Chapter V.

Between the time this is written and plant start-up, a decision may be firmed up to increase the capacity of the Redox Plant above the nominal design rate by substituting 3/4-in. or 1-in. rings for 1/2-in. rings in those extraction columns which would otherwise limit capacity.

2. Detailed Column Specifications

Figure XIV-1 shows the detailed design specifications for all 13 Redox solvent-extraction columns. The columns are of all-welded construction, fabricated from Type 347 stainless steel, or equivalent. They range in overall height from 22 ft. (for IO) to 56 ft. (for IA, IS, 2A, and 3A), and in inside diameter from 3 in. (for 2B and 3B) to 12 in. (for IO).

2.1 The IA Column

Salient dimensions of the IA Column are given in the first line of the table on Figure XIV-1. The column is 55 ft. 10 in. in overall height (dimension H_1), not including nozzles or other external projections at either end. This overall height includes an enlarged top-end phase-disengaging section 5 ft. high by 13 in. I.D. (dimension D_2). The balance of the column is 6.5 in. I.D. (dimension D_1) composed of an upper packed (scrub) section 20 ft. high; an unpacked center feed zone 10 in. high; a lower packed (extraction) section 28 ft. high; and a bottom phase-disengaging section 2 ft. high, which contains a three-hole spider-type organic-feed distributor. For the IA Column, this three-hole spider is composed of three, 1/2-in. sched. 40 pipes equally spaced on a 4.3-in. diam. circle, with the pipes discharging the organic (IAX) inlet stream upward 3 in. (dimension h_2) below the bottom of the packing support.

The center feed (aqueous IAF) connection enters the unpacked middle section of the column as a single 1-in. pipe (size not shown) discharging upward at the centerline of the column 3 in. (dimension h_5) below the bottom of the packing support for the scrub section. As illustrated on the sketch, the top aqueous (IAS) feed enters the enlarged top section and discharges downward from a 1-in. pipe (size not shown) located at the centerline of the column 8 in. above the top of the packing hold-down grid. The centerline of the organic overflow connection is located 6 in. below the top of the column. Details of the packing supports and hold-down grids are given on Figure XIV-7.

The IA Column is provided with a pair of static-pressure taps spaced 4 ft. apart on the side of the extraction section. As indicated by dimension h_7, the top tap is 24 ft. 10 in. below the bottom of the top disengaging section (which places it 4 ft. down from the top of the extraction-section packing). There is no static-pressure tap at the bottom of the IA Column, as indicated by the absence of a dimension h_8 in the table.

Figure XIV-1 designates the originally specified 1/2-in. by 1/2-in stainless steel Raschig rings for the IA Column, resulting in a range of satisfactory operation of from 0.55 to 3.1 short tons of uranium processed

per 24 hours (these are instantaneous rates, and correspond to a range of flows from 300 to 1700 gal./(hr.)(sq.ft. of column cross-section), sum of both phases).

Although the diameters of the top disengaging sections vary for the different columns, as indicated by dimension D_2, all height dimensions of these top sections are the same for all 13 columns, and are indicated directly on the column sketch instead of in the table (Figure XIV-1).

2.2 Columns IS, 2D, 3D, 2A, and 3A

All of these columns have two separate packed sections (scrub section and extraction section) with a center aqueous-feed connection, as described above for the IA Column. They differ from the IA Column primarily in diameters and heights, as indicated by the table of dimensions on Figure XIV-1.

2.3 Columns IC, 2E, 3E, IO, 2B, and 3B

All of these stripping columns have only one packed section. They are similar to the IA Column, except that the unpacked section at the middle of the column and the center aqueous-feed connection are eliminated. Salient dimensions appear on Figure XIV-1.

2.4 The IB Column

The IB Column is fabricated with an upper packed section (plutonium extraction section) 9 in. in diameter by 15 ft. high, and a lower packed section (plutonium scrub section) 5 in. in diameter by 25 ft. high. The IBF hexone feed stream enters a 1-ft. high unpacked center feed section. Dimensions of this center feed section, which contains a 5-in. diam. hollow cone distributor, are given on an inset sketch on Figure XIV-1 (also see Figure XIV-7). Other salient dimensions of the IB Column appear on Figure XIV-1.

C. TYPICAL DETAIL DRAWINGS

Salient design details of all 13 Redox solvent-extraction columns are summarized on Figure XIV-1 and discussed in Section B, above. Additional construction details including shell thicknesses, external piping and supports, remote connectors, and internal column details are presented for the three prototype columns (IA, IB, and IC) on Figures XIV-2 through 7. For further mechanical details of these and other columns, see the Kellex drawings tabulated in reference (4).

1. The IA Column

Mechanical details of the IA Column are shown on Figures XIV-2 and 3. Detailed dimensions of the organic (IAX) feed distributor, the packing supports and hold-down grids, and the port-holes through which Raschig rings are inserted into the columns appear on Figure XIV-7.

An overall elevation drawing of the IA Column appears on the left side of Figure XIV-2, and is designated by a capital "A" on the enlarged top disengaging section. The overall height, 57 ft. 7-1/2 in., includes the 55-ft. 10-in. inside length (Figure XIV-1) plus external extensions at each end.

The functions of each of five remote-connector nozzles welded to a kick-plate at the top of the column, are indicated on the drawing. Three dip-legs of a "Redox Sampler" (Chapt. XVI) are inserted (through the second nozzle from the left) into the IAP sampler boot. The three dip tubes for the phase-interface controller are inserted through the third nozzle from the left.

The column is supported and accurately located in position in the silo by two trunnions welded on the side of the enlarged top section, and by two guide dowels at the bottom of the column.

The "reinforcing bands" around the column just below reference levels I-I and II-II contain port-holes through which the column packing is inserted, and which are welded shut after the column is packed. Dimensions of these reinforcing bands are shown on Figure XIV-7.

Four sets of fins extend radially from the column to protect external piping and supports when the column is moved. External piping is spiraled around the column, providing flexibility to relieve strains either set up during fabrication, or by temperature changes.

Additional construction details of the IA Column are shown by the plan view in the upper right-hand corner of Figure XIV-2 (designated by "B") and by the larger-scale elevation drawings (designated by "C", "D", "E", "F", and "G") on Figures XIV-2 and 3. Identical packing grates (Figure XIV-7) are used both for packing supports and for packing hold-down grids to keep the packing in place when the column is lowered on its side.

2. The IB Column

Drawings of the IB Column, which appear on Figures XIV-4 and 5, are arranged in a manner similar to those discussed above for the IA Column. External details of the two columns are generally similar.

Internal details of the IB Column appear on Figure XIV-7, including dimensions of the hollow-cone mixing device and IBF distributor.

3. The IC Column

Mechanical details and dimensions of the IC Column appear on Figures XIV-7 and 6.

REFERENCES [redacted]

(1) HW-14572 Redox Production Plant Solvent Extraction Column Design Specifications (Revised September 27, 1949). R. B. Richards. 9-29-49.

(2) HW-15663 Redox Plant Solvent-Extraction Columns. G. Sege, J. G. Bradley and F. W. Woodfield. 7-6-50.

(3) HDC-1635 Revised Specifications for 2nd. and 3rd. Pu Cycle Extraction Columns. R. B. Richards, R. E. Smith, J. M. Frame, D. E. Irons, and O. C. Schroeder. Hanford Works. 2-14-50.

(4) Kellex mechanical drawings of the Redox solvent-extraction columns are tabulated below:

Column	Equipment Piece No.	Drawing Nos.
IA	ET-117	H-2-8587, H-2-8588, H-2-8910
IS	ET-121	H-2-8813, H-2-8814, H-2-8906
IB	ET-118	H-2-8630, H-2-8816, H-2-8904
IC	ET-119	H-2-8786, H-2-8787, H-2-8905
2D and 3D	ET-126 & ET-131	H-2-8778, H-2-8779, H-2-8895
2E and 3E	ET-127 & ET-132	H-2-8782, H-2-8783, H-2-8912
2A and 3A	ET-142 & ET-145	H-2-8789, H-2-8790, H-2-8921
2B and 3B	ET-143 & ET-146	H-2-8801, H-2-8802, H-2-8907
IO	ET-154	H-2-8780, H-2-8781, H-2-8911

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Figure XIV-1

DIMENSION SPECIFICATIONS FOR REDOX PLANT SOLVENT EXTRACTION COLUMNS [a]

(This table is based on specifications transmitted to the Design and Construction Divisions in Documents HW-14572 and HDC-1635.)

[redacted]

Column	H_1	D_1	D_2	No. of Organic-Phase Distributor Holes	d_1, Organic-Phase Distributor-Hole Circle Diameter	d_2, Hole Diameter	h_1	h_2	h_3	h_4	h_5	h_6	Pressure Tap Location [b] h_7	Pressure Tap Location [b] h_8	Raschig Ring Size	Column Rangeability [c] Uranium Processed Per 24 Hours, Short Tons Min.	Uranium Processed Per 24 Hours, Short Tons Max.	Instantaneous Volume Velocity, (Sum of Both Phases), Gal./(Hr.)(Sq. Ft.) Min.	Instantaneous Volume Velocity, (Sum of Both Phases), Gal./(Hr.)(Sq. Ft.) Max.
IA	55'10"	6.5"	13"	3	4.3"	1/2" Sch. 40	21"	3"	28'	7"	3"	20'	24'10"		1/2" [d]	0.55	3.1 [d]	300	1700
IS	55'10"	5.0"	10"	3	3.3"	1/4" Sch. 40	21"	3"	28'	7"	3"	20'	24'10"		1/2"	0.3 [g]	1.6 [g]	300	1700
IB (Bot.)		5.0"		3	3.3"	3/8" Sch. 40	21"	3"	25'	4"		20'		41'5"	1/2"	1.1	5.0	400	1800
(Top)	48'0"	9.0"	18"									15'			1/2"	0.64	4.7	200	1500
IC	32'0"	10.0"	20"	3	6.6"	3/4" Sch. 40	21"	3"	$h_3 + h_6 = 25'$				13'		1"	0.95	7.9	300	2500
Second and Third Uranium Cycles																			
2D	50'10"	7.5"	15"	3	5.0"	1/2" Sch. 40	21"	3"	23'	7"	3"	20'	24'10"		1/2" [e]	0.74	4.1 [e]	300	1700
2E	37'0"	9.0"	18"	3	6.0"	3/4" Sch. 40	21"	3"	$h_3 + h_6 = 30'$				13'		1"	1.0	8.4	300	2500
3D	50'10"	7.5"	15"	3	5.0"	1/2" Sch. 40	21"	3"	23'	7"	3"	20'	24'10"		1/2" [e]	0.74	4.1 [e]	300	1700
3E	37'0"	9.0"	18"	3	6.0"	3/4" Sch. 40	21"	3"	$h_3 + h_6 = 30'$				13'		1"	1.0	8.4	300	2500
Solvent Treatment Column																			
IO	22'0"	12.0"	18"	7	8.0"	3/4" Sch. 40	21"	3"	$h_3 + h_6 = 15'$				15'6"		1"	(0.6) [f]	(5.0) [f]	300	2500
Second and Third Pu Cycles																Plutonium Production, g. Pu Per 24 Hours Min.	Plutonium Production, g. Pu Per 24 Hours Max.		
2A	55'10"	4.0"	8"	3	2.7"	1/8" Sch. 40	15"	3"	28'6"	7"	3"	20'	49'9"	1/2"		370	1400	350	1350
2B	31'6"	3.0"	6"	(One hole at column center-line)		3/8" Sch. 40	15"	3"	$h_3 + h_6 = 25'$				25'6"	1/2"		260	1380	250	1350
3A	55'10"	4.0"	8"	3	2.7"	1/8" Sch. 40	15"	3"	28'6"	7"	3"	20'	49'9"	1/2"		390	1490	350	1350
3B	31'6"	3.0"	6"	(One hole at column center-line)		3/8" Sch. 40	15"	3"	$h_3 + h_6 = 25'$				25'6"	1/2"		290	1540	250	1350

NOTES

(a) For definition of diameters and heights see sketch at right.

(b) Dimension h_7 is the distance from the bottom of the top disengaging section to the upper of a pair of differential-pressure taps, spaced 4 ft. apart. Differential-pressure taps, if provided, are located in the lower packed section of dual-purpose columns and in the packed section of uranium-stripping columns. Dimension h_8 is the distance from the bottom of the top disengaging section to a single static-pressure tap located, if provided, in the bottom disengaging section.

(c) Minimum and maximum volume velocities indicate for each solvent-extraction column the range of flows which column studies have indicated to be the zone of optimum mass-transfer performance. Based on compositions and flow ratios indicated for HW #4 Flowsheet (HW-19678) these ranges of flows have been converted to ranges of instantaneous uranium processing rates for the 1st cycle and the 2nd and 3rd uranium cycle columns of the diameters indicated above.

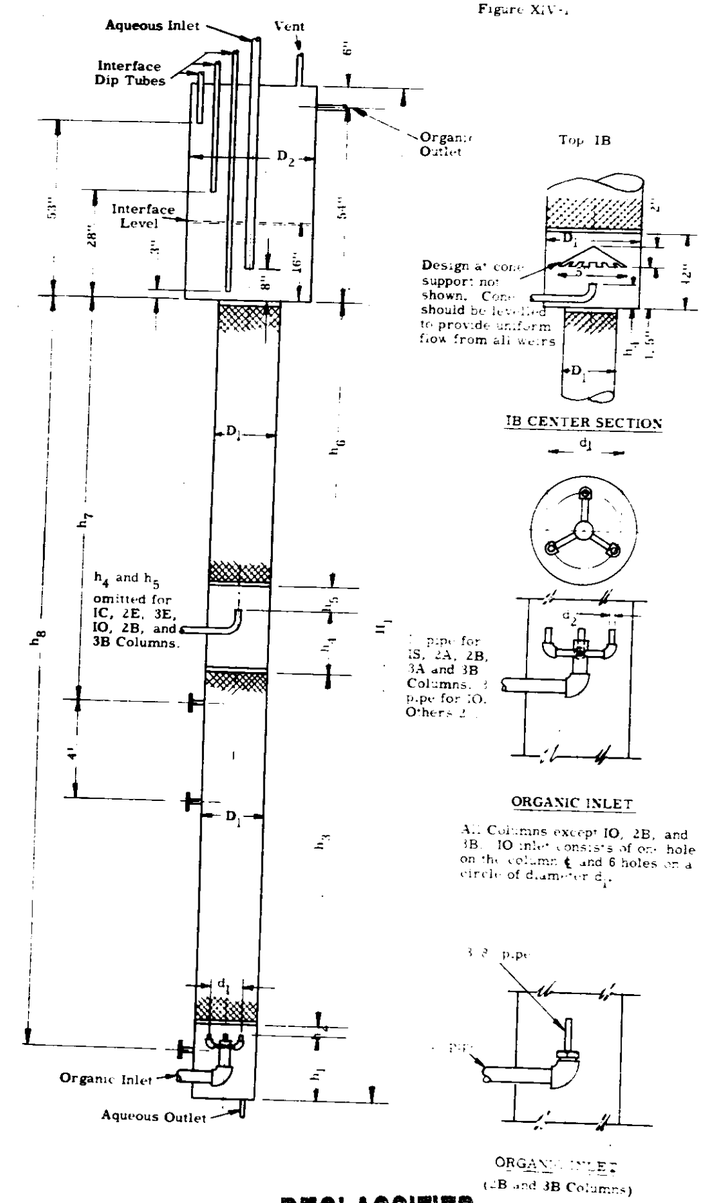
Minimum and maximum plutonium production rates indicated for the 2nd and 3rd plutonium cycle columns have been calculated for 400 g. Pu/short ton of U on the basis that the IS Column is not operating on rework material.

(d) Although cap[redacted] of satisfactory operation up to 3.1 tons/day (instantaneous rate), the best range for 1/2-in. packing is approximately 0.55 to 2.5 tons/day. [redacted] processing rates above 2.5 tons/day (instantaneous rate), 3/4-in. or 1-in. Raschig rings give better extraction performance (i. [redacted] of U and Pu) than 1/2-in. packing. See Chapter V for further discussion of performance using different sizes of packing.

(e) Although capable of satisfactory operation up to 4.1 tons/day (instantaneous rate), above 3.3 tons/day better extraction performance (i.e., lower waste losses of U) may be attained by substituting 3/4-in. or 1-in. Raschig rings for the 1/2-in. packing.

(f) The IO Column is capable of processing hexone from the entire solvent-extraction battery (12 columns) when the plant is processing uranium at the indicated rates. This corresponds to processing approximately 5,000 to 40,000 gal. of hexone/24 operating hours at HW #4 Flowsheet conditions.

(g) The rangeability of the IS Column is stated for operation as a IA Column



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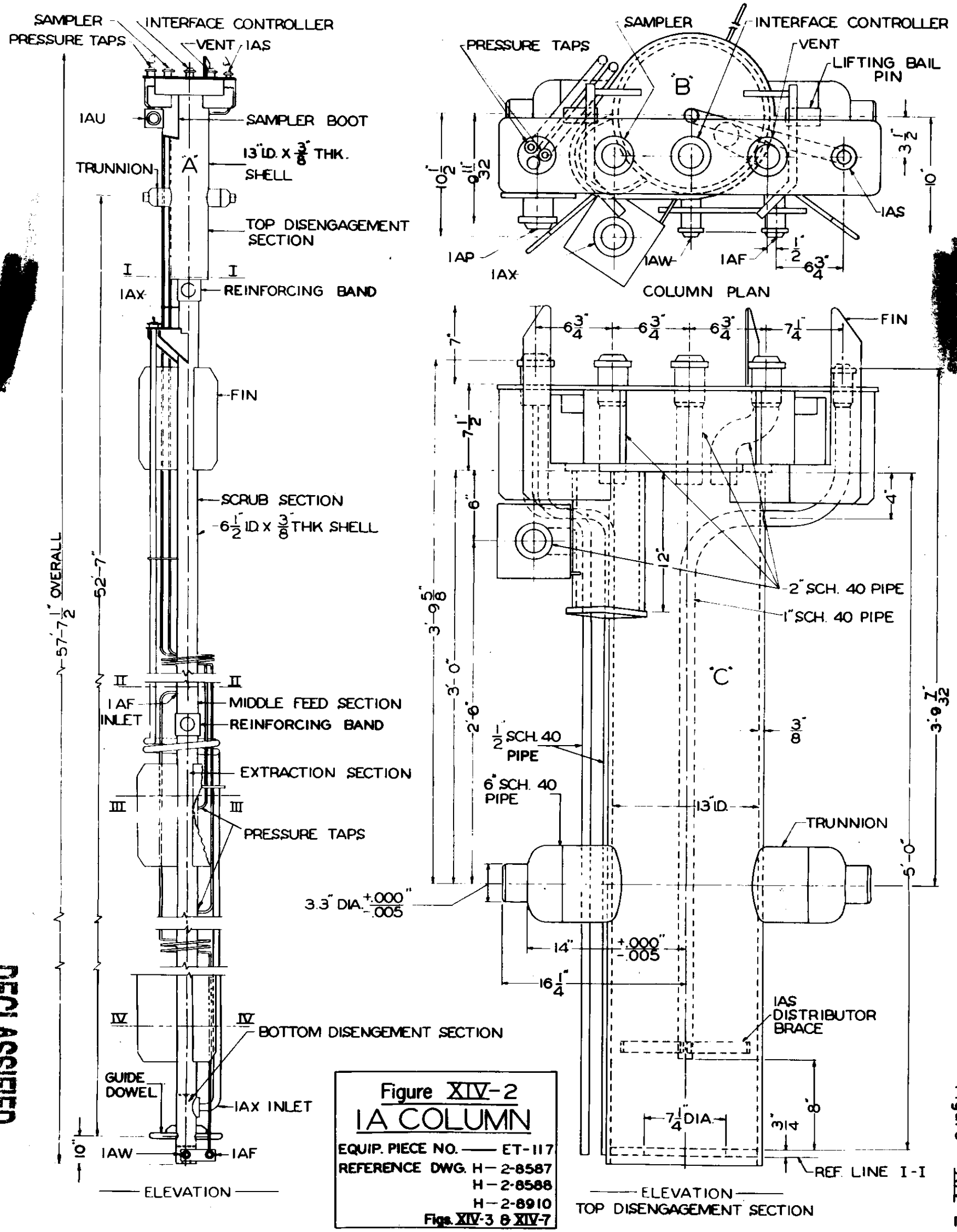

Figure XIV-2
IA COLUMN

EQUIP. PIECE NO. —— ET-117
REFERENCE DWG. H-2-8587
H-2-8588
H-2-8910
Figs. XIV-3 & XIV-7

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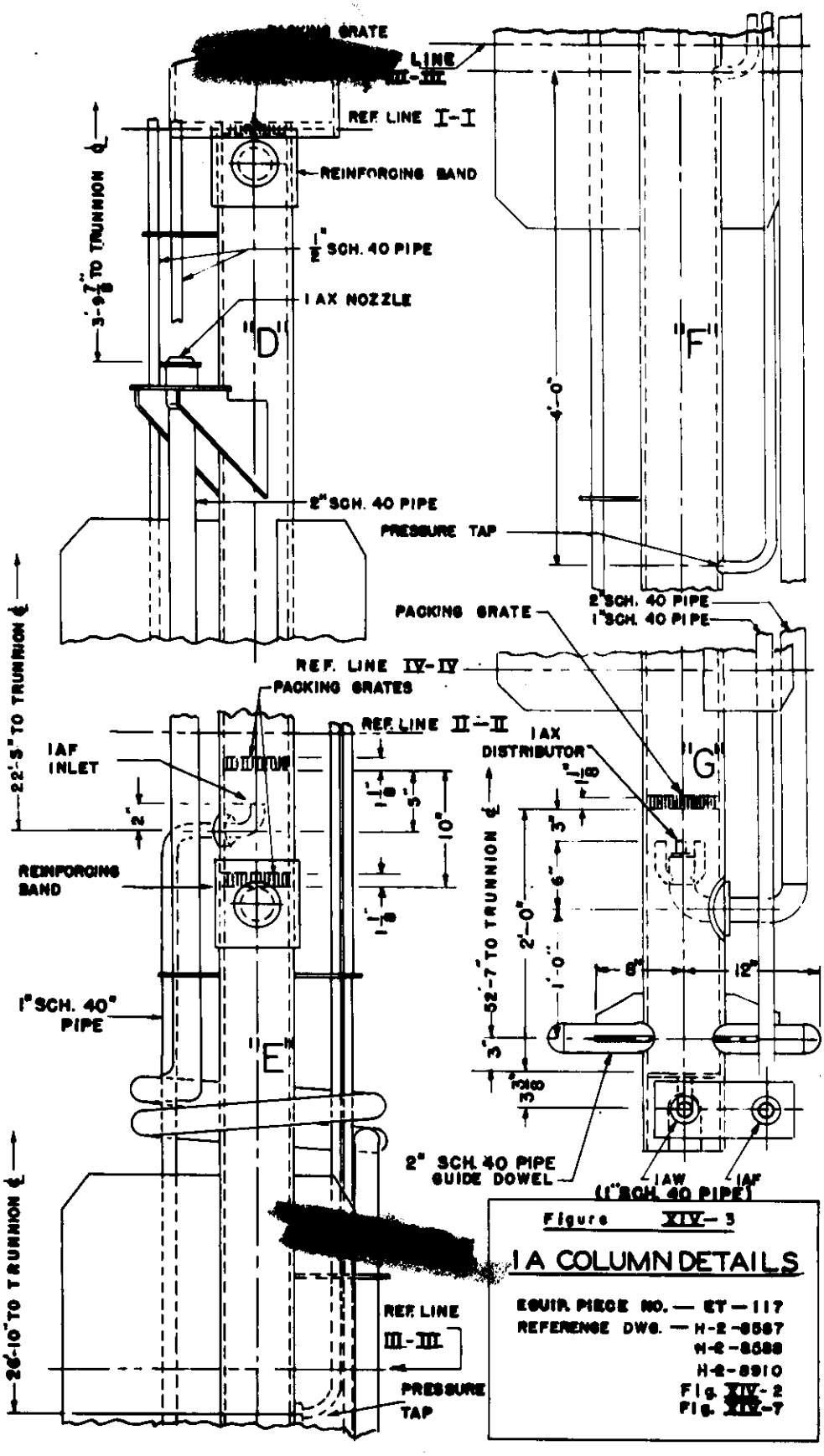

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Figure XIV-3

1 A COLUMN DETAILS

EQUIP. PIECE NO. — ET-117
REFERENCE DWG. — H-2-8587
H-2-8588
H-2-8910
Fig. XIV-2
Fig. XIV-7

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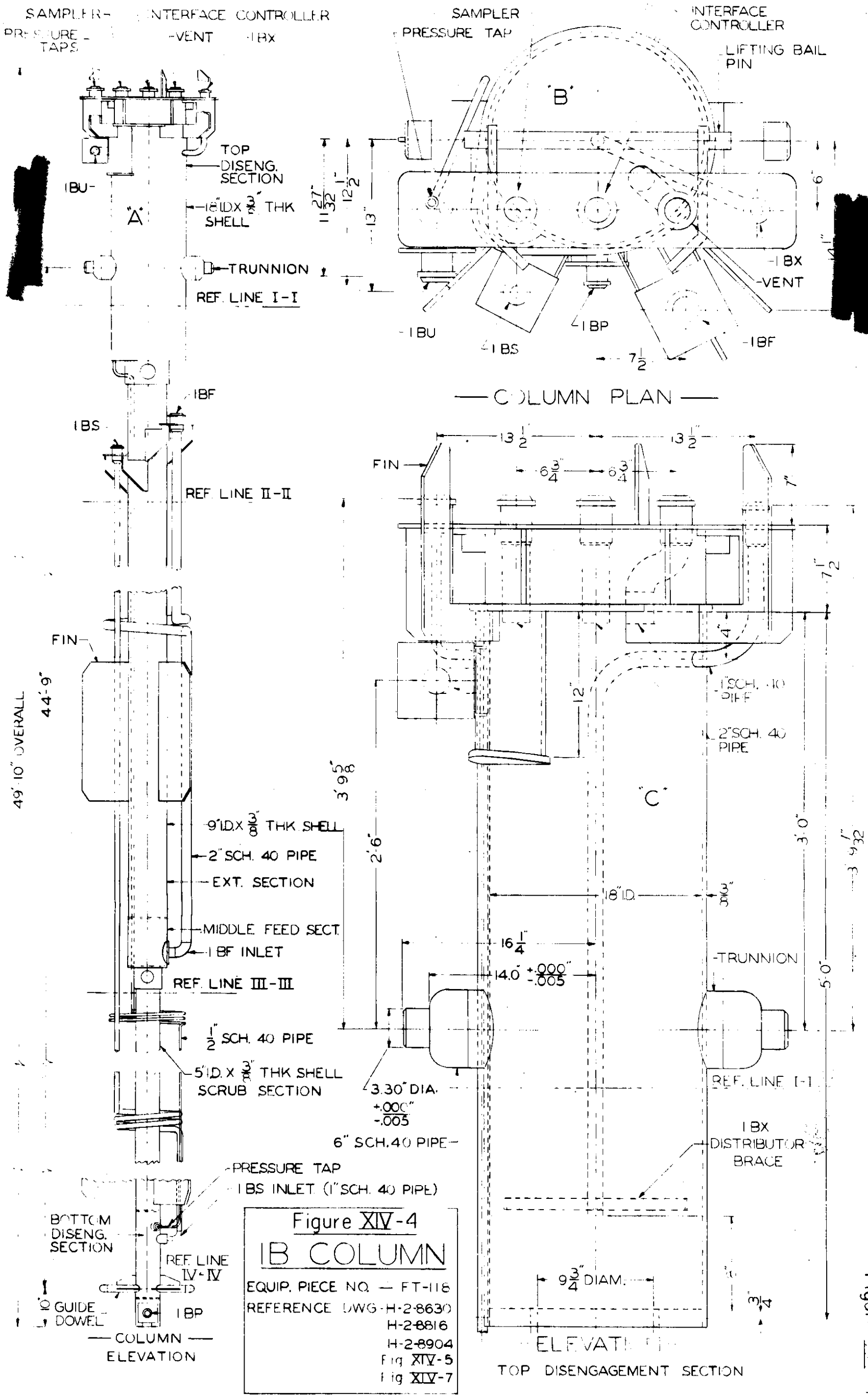

Figure XIV-4

1B COLUMN

EQUIP. PIECE NO. — FT-118

REFERENCE DWG-H-2-8630
H-2-8816
H-2-8904
Fig XIV-5
Fig XIV-7

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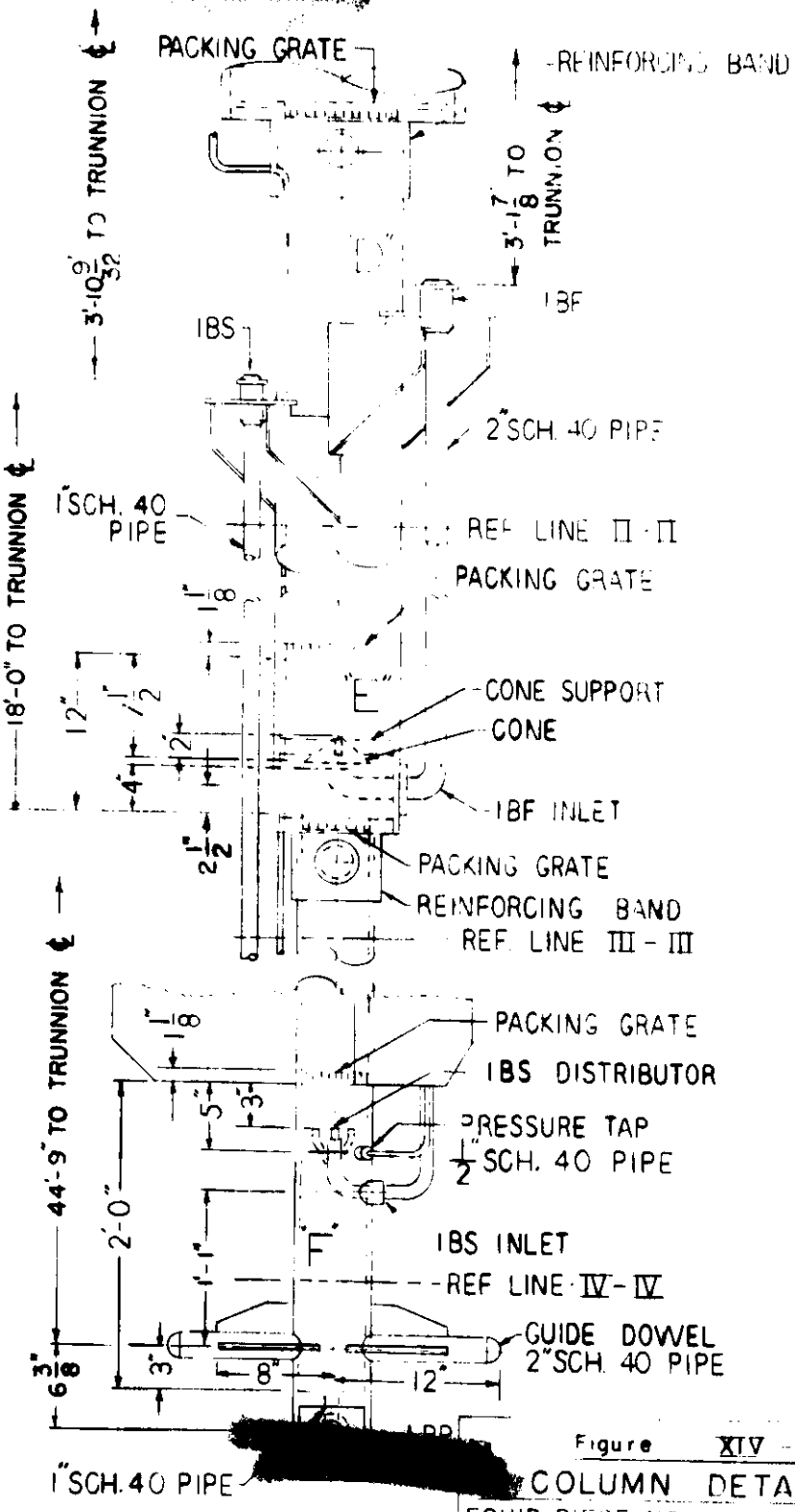

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Figure XIV - 5

COLUMN DETAILS

EQUIP. PIECE NO. — ET-118

REFERENCE DWG — H-2-8630
H-2-8816
H-2-8904
Fig. XIV-4
Fig. XIV-7

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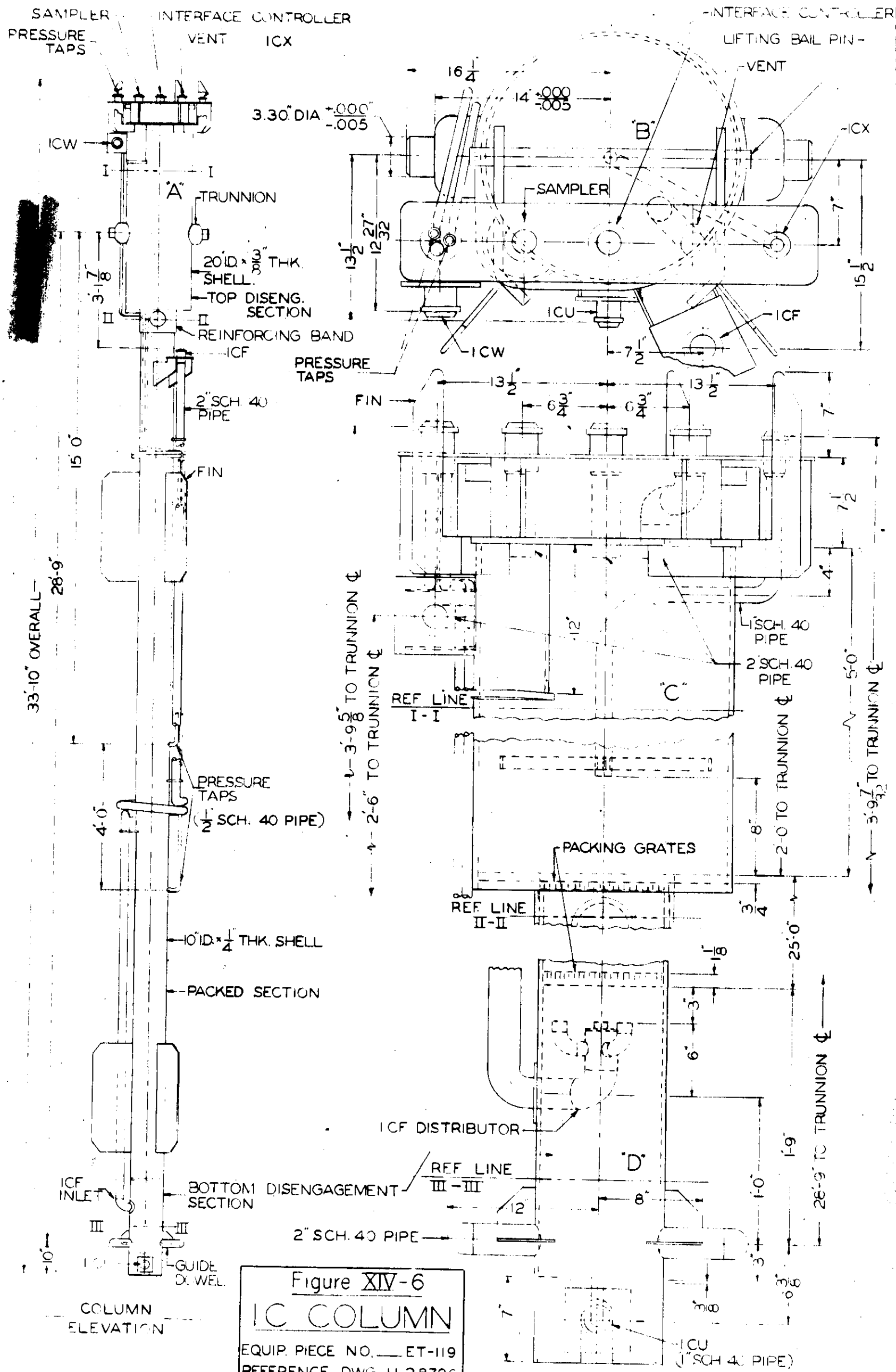

Figure XIV-6

IC COLUMN

EQUIP. PIECE NO. ET-119

REFERENCE DWG. H-2-8786
H-2-8787
H-2-8905
Fig. XIV-7

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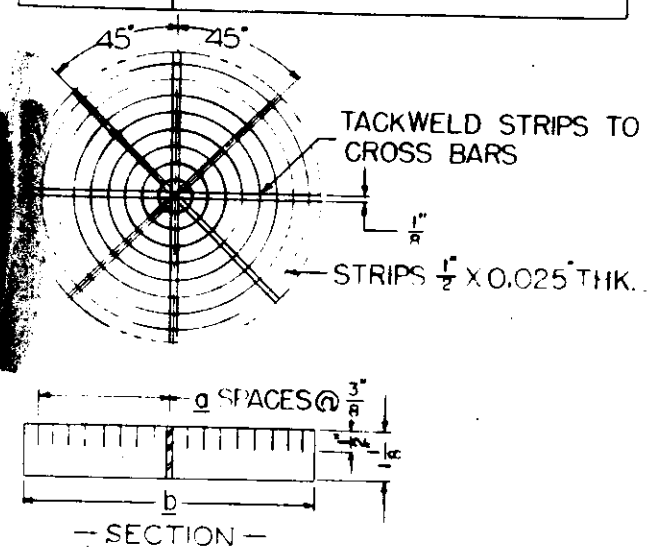
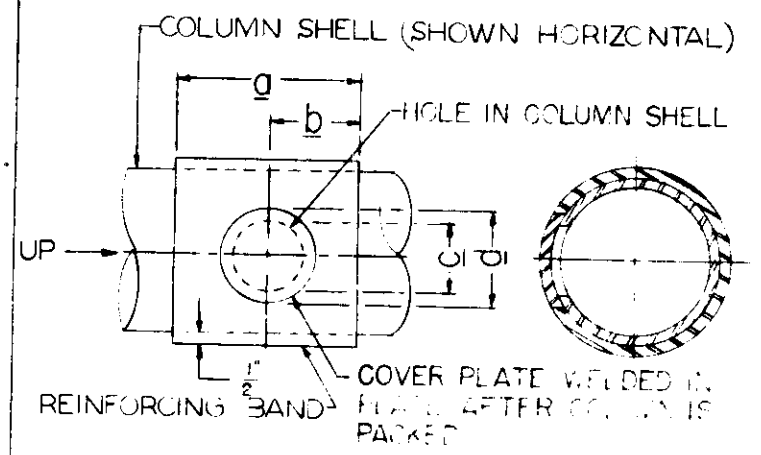
DIMENSION	COLUMN			
	1A	1B SECTION		1C
		EXTRACTION	SCRUB	
a	8	11	6	12
b	TO SUIT SHELL I.D.			

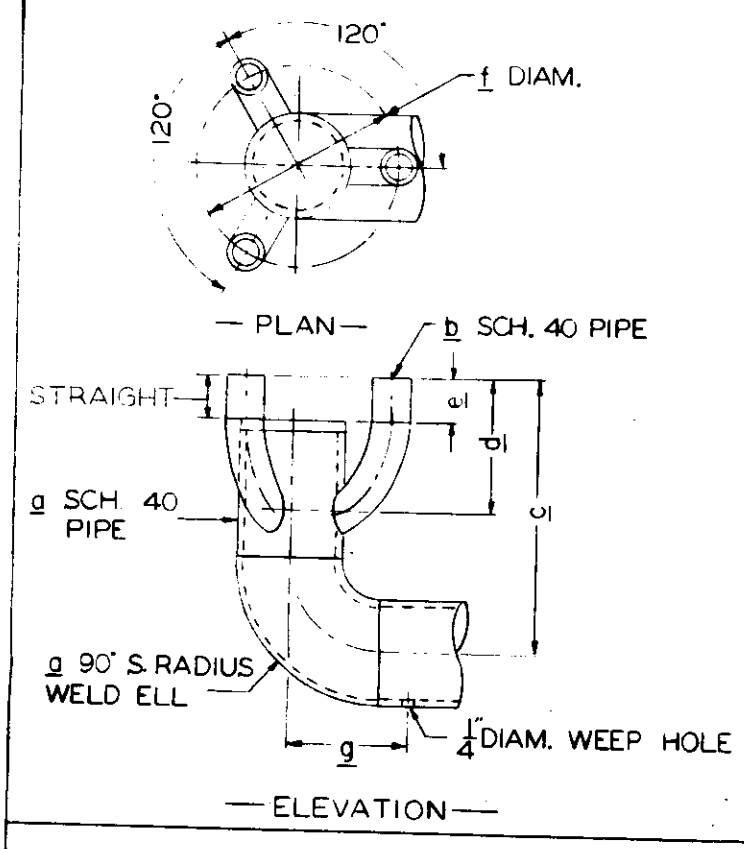


PACKING GRATE

DIMENSION	COLUMN			
	1A	1B (TOP)	1B (BOT)	1C
a	8"	7"	6"	8"
b	4"	3"	2 1/2"	3 1/2"
c	3"	3"	2"	4"
d	4"	4"	3"	5"

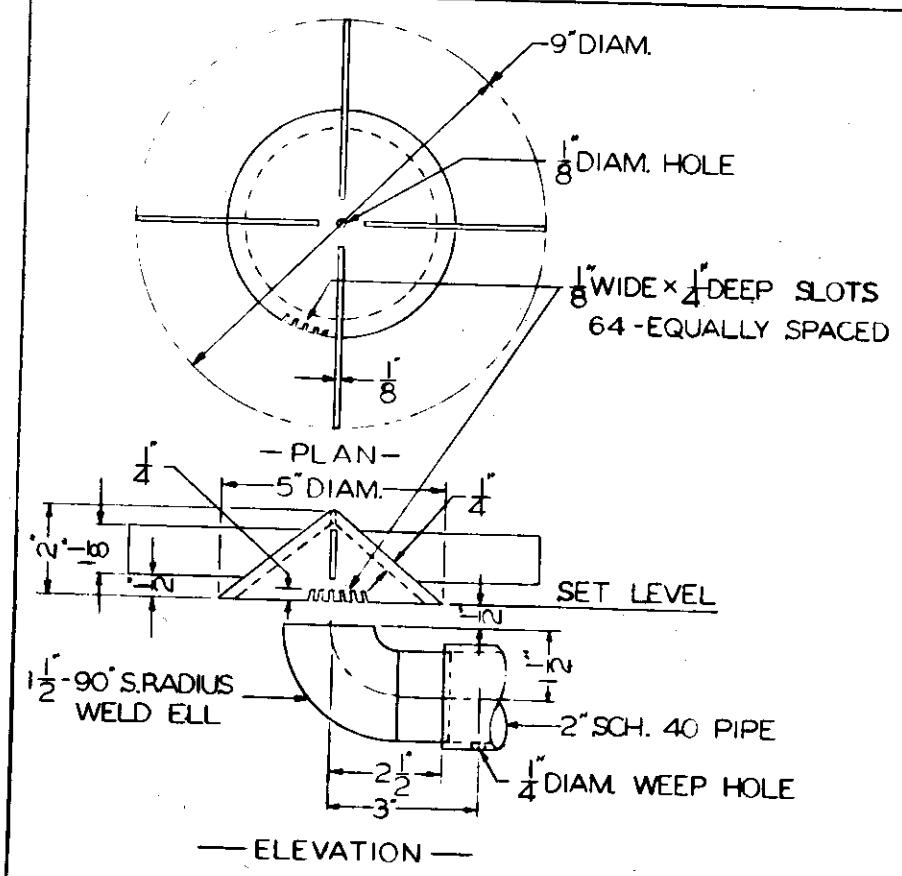


REINFORCING BAND



DIMENSION	COLUMN		
	1A	1B	1C
a	2"	1"	2"
b	1/2"	3/8"	3/4"
c	6"	5"	6"
d	3 1/4"	3 1/4"	2 1/4"
e	1"	1"	1/2"
f	4 5/16"	3 5/16"	6 11/16"
g	2 5/8"	1 3/4"	3 1/2"

BOTTOM ORGANIC FEED DISTRIBUTOR



1B COLUMN CONE AND 1BF DISTRIBUTOR

Figure XIV-7
COLUMN DETAILS

REFERENCE DWGS.

Figure XIV-3	H-2-8787
Figure XIV-5	H-2-8904
Figure XIV-6	H-2-8905
	H-2-8910

Fig XIV 7

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PART III: PLANT AND EQUIPMENT, continued

CHAPTER XV. GAS SCRUBBING, CONCENTRATION, AND DISTILLATION EQUIPMENT

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CHAPTER XV. GAS SCRUBBING, CONCENTRATION, AND DISTILLATION EQUIPMENT

A. INTRODUCTION

1. General

Gas scrubbing, concentration, and distillation equipment is used in the Redox Plant for a number of specific functions.

A gas scrubbing column has been provided to remove most of the ruthenium from the Oxidizer sparge gas. Provision has also been made to permit installation of scrubbers, to replace the Silver Reactors, for removal of iodine from the Dissolver off-gas.

Concentrators have been provided to permit concentration of the uranium-bearing aqueous effluent streams from each uranium extraction cycle, (1CU, 2EU, 3EU), the plutonium product stream (3BP), "hot" aqueous wastes, and the condensates from the other concentrators.

A stripping column has been provided for removal of hexone from the condensates.

A distillation column has been provided for treatment of the hexone.

All of the gas scrubbing, concentration, and distillation equipment listed above is described in this chapter. The Dissolvers and the Cross-Over Oxidizer, described in Chapter XIII, are also designed to effect some concentration.

The gas scrubbers are columns packed with Raschig rings.

The concentrators are of the pot-and-coil type, mounted with packed or plate columns for removal of entrained liquid from the vapor stream and, in some cases, to strip hexone from the feed solution.

The Hexone Still is a bubble-cap plate column mounted on a pot-and-coil reboiler.

The gas scrubbing, concentration, and distillation equipment falls in the category of Class I vessels (see Chapter XIII) subjected to high-temperature duty and is therefore constructed of Type 309 SCb stainless steel.

2. Supports

The concentrator pots each have three feet, which rest on dunnage or directly on the "Y" pads (described in Chapter XIII). These pads are located within 1/64 inch of their nominal position in the horizontal directions and within 1/32 inch of the datum plane in the vertical direction. The locating hole on the dunnage or tank is 1/16 inch larger than the

locating dowel on the pad making a total tolerance of ±3/64 inch in locating the dunnage or a tank resting directly on the pad. The dunnage is a support for the concentrators or condensers, consisting of two set pads (upper and lower) connected with cross-braced channel iron (carbon steel) in the case of the concentrators, and 20-inch sch. 40 pipe for the condensers. The plane of the upper pads is located to a tolerance of ±1/32 inch of the lower pads so that the feet of any vessel are located to ±1/16 inch of their nominal position in the vertical direction. The locating dowels on the upper pads are positioned to ±1/64 inch of their nominal position relative to the center of the locating holes on the bottom pads and the dowel to hole clearance is again 1/16 inch. The horizontal position of any vessel on dunnage, then is within 3/32 inch of its nominal location.

3. Deentrainment

The maximum allowable entrainment of liquid by the vapor effluent in the several equipment pieces dealt with here is approximately as follows:

Equipment	Maximum Allowable Entrainment, Lb.Liq./Lb.Vapor	Limiting Factor
Dissolvers, A-2, B-2, and C-2[a]	5×10^{-6}[b][c]	Radioactivity in stack gas
Dissolver Off-Gas Scrubbers, A-3, B-3, and C-3[c]	5×10^{-4}	Radioactivity in stack gas
Oxidizer, H-4[a]	2.5×10^{-6}[b][e]	Radioactivity in stack gas
Ruthenium Scrubber, H-5	1×10^{-5}	Radioactivity in stack gas
ICU Concentrator, F-2	1×10^{-3}	Loss of uranium
2EU Concentrator, F-5	1×10^{-3}	Loss of uranium
3EU Concentrator, E-10	1×10^{-3}	Loss of uranium
Cross-Over Oxidizer, E-7[a]	1×10^{-3}	Loss of plutonium
Plutonium Pre-Concentrator, E-16	1×10^{-3}	Loss of plutonium
Plutonium Concentrator, E-17	1×10^{-3}	Loss of plutonium
Waste Concentrator, D-12	3×10^{-4}[f]	Radioactivity in condensate

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Equipment	Maximum Allowable Entrainment, Lb.Liq./Lb.Vapor	Limiting Factor
Condensate Stripper, D-5	1×10^{-2}	Water in Hexone Still
Condensate Evaporator, D-4	4×10^{-4}(f)	Radioactivity in condensate
Hexone Still, G-3	1×10^{-2}(g)	Radioactivity in hexone

Notes: (a) These vessels are discussed in Chapter XIII.

(b) Based on air tolerance of 3×10^{-8} g.U/l., 3×10^{-14} g.Pu/l., and 10^{-12} beta curies/l.

(c) This is the overall entrainment of Dissolver solution allowed in the off-gas after deentrainment in the Dissolver column, Silver Reactor or Dissolver Off-Gas Scrubber, and Fiberglas filter. It is expected that a deentrainment factor of at least 10 will be obtained after the Dissolver column, so that the allowable entrainment from the Dissolver column itself may be as high as 5×10^{-5} lb.liq./lb.vapor or more.

(d) These vessels have been ordered, but will not be installed.

(e) This is the overall entrainment of Oxidizer solution allowed in the sparge gas after deentrainment in the Oxidizer column, Ruthenium Scrubber, and Fiberglas filter. It is expected that a deentrainment factor of at least 10 will be obtained after the Oxidizer column, so that the allowable entrainment from the Oxidizer column itself may be as high as 2.5×10^{-5} lb.liq./lb.vapor or more.

(f) Based on a cribbing tolerance of 5×10^{-7} g.Pu/l., 4×10^{-6} beta curies/l., and a uranium concentration that will give the same alpha counts/l. as the tolerable plutonium (0.05 g.U/l.).

(g) Based on a concentration of 10^{-7} gamma curies/l., which corresponds to 0.1 mr./hr. at the liquid surface, if the radiation is taken as 1 M.e.v.

Since the entrainment of liquid droplets from a boiling liquid surface may be as high as on the order of 10^{-3} or more lb.liq./lb. of vapor some deentrainment must be obtained in the columns.

The deentrainment effectiveness of a packed or plate column may be correlated with a factor F_I which is derived from the settling-velocity equation and is defined as follows:

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$$F_L = (\text{Vapor velocity, ft./sec.})\left(\frac{\text{Vapor density, lb./cu.ft.}}{\text{Sp.gr. of entrained liquid}}\right)^{1/2}$$

(The square-root term corrects all systems to a common vapor and liquid density basis, but does not correct for second-order variables such as liquid viscosity or surface tension, which may sometimes be important.) Generally, the deentrainment effectiveness improves as F_L decreases, while the column cross-sectional area — and hence cost — increases as F_L decreases. The optimum range of values of F_L for the packed and plate deentrainment column sections used in the Redox Plant is about 0.25 to 0.7 (vapor velocities 1 to 3.5 ft./sec. for water vapor of atmospheric pressure) with serious impairment of deentrainment effectiveness above an F_L value of approximately 1.0 (vapor velocity approximately 5 ft./sec. for steam). In packed-column experiments at Hanford Works and plate-column experiments at Brookhaven National Laboratory, with no reflux, the entrainment in the vapor effluent at F_L's in this optimum range was on the order of 10^{-6} to 10^{-5} lb. of liquid/lb. of vapor. The packed column in these experiments was a 5-in. diameter column with 2 ft. of 1/2-in. Raschig ring packing. The plate column was a 14-in. diameter column with 13 bubble-cap plates spaced 12 in. apart.

Deentrainment may sometimes be improved by the use of about 10 to 25% liquid reflux. However, the use of a reflux ratio which is too high at the prevailing F_L may actually impair deentrainment by causing the column to load or even flood. The reflux ratio which causes loading decreases with increasing F_L. It is estimated that the highest reflux ratio (L/V) that may be used in the Redox Plant without actually impairing deentrainment is about 60% at $F_L = 1$ and about 100% at $F_L = 0.25$.

The F_L factors for the various deentrainment columns in the Redox Plant are as follows:

Design Flow Rates for Deentrainment Sections

Basis: 3-1/8 tons U per day instantaneous production rate.

Equipment	Vapor Velocity, Ft./Sec.	F_L[a]
Dissolvers, A-2, B-2, and C-2[b]	5.3	1.05
Dissolver Off-Gas Scrubbers[c]	0.6	0.14
Oxidizer, H-4[b]	4.7	0.97
Ruthenium Scrubber, H-5	2.0	0.37
ICU Concentrator, F-2	2.4	0.46[d]
2EU Concentrator, F-5	2.4	0.46[d]

Equipment	Vapor Velocity, Ft./Sec.	F_L(a)
3EU Concentrator, E-10	2.4	0.46(d)
Cross-Over Oxidizer, E-7(b)	1.8	0.33(d)
Plutonium Pre-Concentrator, E-16	2.8	0.53(d)
Plutonium Concentrator, E-17	3.7	0.70(d)
Waste Concentrator, D-12	2.4	0.45(d)
Condensate Stripper, D-5	0.7	0.14
Condensate Evaporator, D-4	3.4	0.64(d)
Hexone Still, G-3	2.2	0.61

Notes: (a) $F_L = (\text{Vapor velocity, ft./sec.})\left(\frac{\text{Vapor density, lb./cu.ft.}}{\text{Sp. gr. of entrained liq.}}\right)^{1/2}$

The significance of this term is discussed on foregoing pages.

(b) These vessels are discussed in Chapter XIII.

(c) These vessels are ordered, but will not be installed

(d) These values include 25% reflux (L/V = 0.25). To obtain F_L for 10% reflux the tabulated values are multiplied by 0.833, and to obtain F_L for no reflux they are multiplied by 0.75.

B. DISSOLVER OFF-GAS SCRUBBERS, A-3, B-3, AND C-3

The Dissolver Off-Gas Scrubbers were designed for scrubbing radioiodine, and also nitrogen dioxide, from the Dissolver off-gas by means of dilute caustic, as discussed in Chapter III. With iodine removal now accomplished by Silver Reactors (described in Chapter XVI), these scrubbers are not installed in the plant, but provisions exist for their possible later installation in place of the Silver Reactors if removal of nitrogen dioxide as well as of iodine should be required.

The Dissolver Off-Gas Scrubbers are 23-1/2 in. diameter columns, 20 ft. high (overall) packed with 1-in. stainless steel Raschig rings. For details, reference is made to Drawing H-2-7720.

C. RUTHENIUM SCRUBBER, H-5

The Ruthenium Scrubber was installed to remove most of the ruthenium from the wet Oxidizer sparge gas. This is accomplished in the lower (scrubbing) section by scrubbing with caustic liquor recirculated from the pot without make-up. A 1-ft. high deentrainment section is provided above the feed point to remove most of the entrained caustic from the gas stream. The gas leaving the scrubber is cooled and most of the water vapor is removed in a tubular condenser.

1. General Description

The Scrubber, H-5, is approximately 20 feet in overall height, the height of the pot being 3 feet, that of the column 17 feet. The pot is 5 feet in diameter. The column is 36 inches in diameter and is packed with 1-inch stainless steel Raschig rings. The Condenser, H-6, is 20 inches in diameter and 9 feet long, with 112 3/4-inch U tubes with a total heat transfer area of 315 square feet.

2. Construction Details

The construction details of the Ruthenium Scrubber are shown on Figure XV-1 and summarized in the table below. The table below also includes the more important construction details of the Ruthenium Scrubber Condenser, H-6, which is not shown on Figure XV-1. In general structural features, these condensers resemble the uranium concentrator condensers shown on Figure XV-3.

Ruthenium Scrubber Details

Item	Description or Dimension
Pot	
Outside diameter	5 ft.
Overall height	3 ft.
Heating provision	Coil, single helix
Heat transfer area	16 sq.ft.
Heat transfer duty	None
Column	
Inside diameter	35.5 in.
Overall height	17 ft.
Packing size and type	1-in. by 1-in. stainless steel Raschig rings with 3/32-in. wall thickness
Packed height	13 ft. (scrubbing) 1 ft. (deentrainment)
Reflux provision	None

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Item	Description or Dimension
Condenser	
Type	U-tube (horizontal)
Outside diameter	20 inches
Overall length	9 ft.
Number and diameter of tubes	112 U tubes, 3/4-in.
Heat transfer area	315 sq.ft.
Heat transfer duty	1.3×10^6 B.t.u./hr.

As shown on Figure XV-1, the scrubber pot is welded to the column. A 10-inch nozzle is provided for the submerged pump so that it can be removed or replaced remotely.

The column is made from 1/4-inch rolled and welded stainless steel sheet and is 36 inches O.D. by 17 feet long excluding the connectors. It is provided with lifting bails and the entire unit may be removed or replaced remotely. The packing support consists of 1/8-inch by 1-1/2 inch high parallel bars on 13/16-inch centers with notches 1/2 in. deep on 3/4-inch spacing to keep the packing from restricting the "free" cross-sectional area at the packing support. Two cross braces, 1/4 inch wide by 1-1/2 inches high, each 6 inches from the center, keep the support bars parallel. Hold-down grates identical with the packing supports are placed above each packed section. A liquid feed distributor above the stripping section consists of 36 distribution points of 1-inch sch. 40 pipe. Each pipe protrudes 2 inches above the distributor plate and has a slotted weir 2 inches high. At the design rate (30 gal./min.) the liquid should be about 1 inch deep. The annular vapor riser areas in this distributor plate are 36% of the total cross-sectional area of the column.

The condenser is of all-welded construction to the same standards as the uranium concentrator condensers shown in Figure XV-3. The heat transfer surface is of the U-tube type. Fifteen gas baffles 12 inches wide alternating right and left are provided to insure maximum cooling of the sparge gas.

D. URANIUM CONCENTRATORS, F-2, F-5, AND E-10

The uranium concentrators concentrate the 0.8 M UNH solutions from the uranium extraction cycles to 2.0 M for feeding to the next cycle or for storage. To prevent thermal decomposition of the dissolved hexone, which would result in some uranium precipitation, a hexone stripping column is placed on the concentrator pot. In this column the rising water vapor strips the dissolved hexone from the liquid feed before it enters the pot. Above the stripping section of the column there is a deentrainment section which removes most of the entrained UNH and fission products from the vapor stream.

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1. General Description

The three uranium concentrators (Figure XV-2) -- the ICU Concentrator, F-2, the 2EU Concentrator, F-5, and the 3EU Concentrator, E-10, -- including auxiliaries -- are of identical construction. They are approximately 18 feet in overall height, 5 ft. 4-1/8 in. for the pot and 12 ft. 10-3/8 in. for the column. The pots are 4-1/2 feet in diameter. The column is 22 inches in diameter and is packed with 1 in. stainless steel Raschig rings. The Condensers F-3, F-6, and E-9 (Figure XV-3), like the Cross-Over Oxidizer Condenser, E-8, are 16 inches in diameter and 7 feet 10 inches long with 50 3/4-inch U tubes comprising a heat transfer area of 123 square feet.

2. Construction Details

The construction details of the uranium concentrators are shown on Figure XV-2 and summarized in the table below. The construction details of the uranium concentrator condensers are also summarized in the table below and shown in Figure XV-3.

Uranium Concentrator Details

Item	Description or Dimension
Pot	
Outside diameter	4 ft. 6 in.
Overall height	5 ft. 4-1/8 in.
Heating provision	Coil, 4 concentric helices
Heat transfer area	82 sq.ft.
Heat transfer duty	1.2×10^6 B.t.u./hr.
Column	
Inside diameter	21-1/2 in.
Overall height	12 ft. 10-3/8 in.
Packing size and type	1 in. x 1 in. stainless steel Raschig rings with 3/32-in. wall thickness
Packed height	5 ft. (stripping) 4 ft. 4 in. (deentrainment)
Reflux provision	Coil, 3 concentric helices
Heat transfer area	24 sq.ft.
Heat transfer duty	2.4×10^5 B.t.u./hr.
Reflux flow rate	0.5 gal./min.
Condenser	
Type	U-tube (horizontal)
Outside diameter	16 inches
Overall length	7 ft. 10 in.
Number and diameter of tubes	50 3/4-in. U tubes
Heat transfer area	134 sq.ft.
Heat transfer duty	7.6×10^5 B.t.u./hr.

As shown on Figure XV-3, the concentrator pot is similar to the standard tanks described in Chapter XIII, except that a side overflow line (2 inch) is provided. This overflow line is connected to a calming pipe which dips to the bottom of the tank and is vented to the vapor space near the tank top.

The column is made from 1/4-inch rolled and welded stainless steel plate and is 22 inches O.D. by 12 feet 10-3/8 inches long excluding the connectors. It is provided with lifting bails and may be removed from or replaced on the pot remotely, or the entire unit may be removed or replaced remotely. The packing supports consist of 1/8-inch by 1-1/2 inch high parallel bars on 13/16-inch centers with notches 1/2 in. deep on 3/4-in. spacing to keep the packing from restricting the "free" cross-sectional area at the packing support. Two cross braces 1/4 in. by 1-1/2 in. high, each 3-1/2 in. from the center, are provided to keep the support bars parallel. Hold-down grates identical with the packing supports are placed above each section. A liquid feed distributor above the stripping section consists of 14 distribution points of 1-inch sch. 40 pipe. Each pipe protrudes 2 inches above the distributor plate and has a slotted weir 2 inches high. At the design rate (of 3-1/8 tons U/day, instantantaneous rate) the liquid should be about 1 inch deep. The annular and center vapor riser area of the feed distributor is 37% of the total cross-sectional area of the column. A reflux distributor consisting of 12 distribution points similar to those described above is provided above the deentrainment section. It has three vapor risers with a total cross section of 32% of the tower cross section. Each riser is equipped with a "rain hat" to prevent bypassing the distributor.

These three condensers and the Cross-Over Oxidizer Condenser, E-10, are identical and are of all-welded construction. The heat transfer surface is of the U-tube type. Two distribution baffles are provided to prevent short circuiting of the vapor from the inlet to the vent through the void in the center of the "U".

E. PLUTONIUM CONCENTRATORS, E-16 AND E-17

The plutonium concentrators concentrate the dilute 3BP solution (about 1.2 g. Pu/l.) for shipment in the PR can (about 10 g. Pu/l.) as discussed in Chapter VII. This concentration is performed in two steps, the second concentrator being smaller than the first. As in the case of the uranium concentrators a hexone stripping section is provided in the Plutonium Pre-Concentrator. Each vessel is equipped with a packed column to remove most of the entrained plutonium from the vapor. After the batch stripping operation is completed the stripping section acts as an additional deentrainment section.

1. General Description

The Plutonium Pre-Concentrator and Concentrator E-16 and E-17 are direct-maintained equipment and are therefore of somewhat simpler construction than other Class I vessels. The Pre-Concentrator, E-16, is shown in Figure XV-4 and the Concentrator, E-17, is shown in Figure XV-5.

The Plutonium Pre-Concentrator is about 14 feet high overall, 8-1/2 feet for the column, 5 feet for the pot, and the remainder for legs. The pot O.D. is 3 feet (including the jacket) and the column O.D. is 12-1/2 inches. The packing consists of 1-inch stainless steel Raschig rings. The Plutonium Pre-Concentrator Condenser, E-15 is of the U-tube type, with an 8-inch diameter by 5-foot 8-inch shell. The heat transfer area is 22 sq.ft.

The Plutonium Concentrator is also about 14 feet high, 6-1/2 feet for the column, 3-2/3 feet for the pot, and remainder for the legs. The pot O.D. is 21 inches (including the jacket) and the column O.D. is 6-1/2 inches. The packing is graded consisting principally of 1/2-inch stainless steel Raschig rings. The Plutonium Concentrator Condenser, E-18, consists of a single helix with 9.8 sq.ft. of heat transfer area in an 8-inch diameter by 4-foot 2-inch shell. The Transfer Trap Vacuum Jet Condenser, E-20, is identical with E-18.

2. Construction Details

2.1 Comparison of design features

The construction details of the plutonium concentrators are shown on Figure XV-4 and 5 and listed in the table below. The construction details of the plutonium concentrator condensers are based on the same design considerations as the uranium concentrator condensers shown in Figure XV-3. A comparative summary of the more important construction features of the Plutonium Pre-Concentrator and Concentrator and their condensers is presented in the table below.

Plutonium Pre-Concentrator and Concentrator Details

Item	Pre-Concentrator, E-16	Concentrator, E-17
Pot		
Outside diameter	3 ft.	21 in.
Overall height	5 ft.	4 ft.
Heating provision	Coil, 6-turn flat spiral, plus a jacket	Coil, 4-turn flat spiral, plus a jacket
Heat transfer area	9.4 + 8.1 sq.ft.	2.8 + 2.9 sq.ft.
Heat transfer duty	1.7×10^5 B.T.u./hr. (heating) 7.2×10^4 B.t.u./hr. (cooling)	7×10^4 B.t.u./hr. (heating) 1.3×10^4 B.t.u./hr. (cooling)
Column		
Inside diameter	12 in.	6 in.
Overall height	8 ft. 6 in.	6 ft. 7 in.
Packing size and type	1-in. by 1-in stainless steel Raschig rings with 3/32-in. wall thickness	Graded stainless steel Raschig rings(a)

Item	Pre-Concentrator, E-16	Concentrator, E-17
Packed height	4 ft. 9 in. (stripping) 1 ft. 9 in. (deentrainment)(b) 6 ft. 6 in. (total)(b)	4 ft. 8 in. (deentrainment
Reflux provision	Three 1/8-in. spray nozzles	9 cold fingers
Heat transfer area	---	2.4 sq.ft.
Heat transfer duty	---	2×10^4 B.t.u./hr.
Reflux flow rate	0 to 1 gal./min.	0.04 gal./min.
Condenser		
Type	U-tube (horizontal)	Single helix (horizontal)
Outside diameter	8 in.	8-in.
Overall length	5 ft. 8 in.	4 ft. 2 in.
Number and diameter of tubes	Twelve 3/4-in. O.D. tubes	One 1-in. sch. 40 pipe
Heat transfer area	22 sq.ft.	9.8 sq.ft.
Heat transfer duty	2×10^5 B.t.u./hr.	8×10^4 B.t.u./hr.

(a) The bottom 3 in. of this column are packed with 1-in. by 1-in. Raschig rings; the next 3 in. and the 3-in. layer at the top, with 3/4-in. by 3/4-in.; the remaining 3 ft. 11 in., with 1/2-in. by 1/2-in. The wall thickness of all these rings is 3/32 in.

(b) During evaporation the 4-ft. 9-in. stripping section functions as additional packed height for deentrainment.

2.2 Plutonium Pre-Concentrator, E-16

A drawing of the Plutonium Pre-Concentrator is presented as Figure XV-4. Its more important construction details are summarized in the table under 2.1, above. Some additional details are described below.

The column packing supports (see Fig. XV-4) consist of 1/8-in. by 1-in. parallel bars on 13/16-in. centers with 1/2-in. deep notches on 3/4-in. spacing to keep the packing from restricting the free cross-sectional area at the packing support. Hold-down grates identical with the packing supports are placed above each packed section. A liquid feed distributor above the stripping section consists of 4 distribution points of 1-inch sch. 40 pipe. Each pipe protrudes 2 inches above the distributor plate and has a slotted weir 2 inches high. The annular and center vapor-riser area is 40% of the total cross-sectional area of the column. Reflux, if used, is supplied through three 1/8-in. spray nozzles with 0.04-in. orifices.

2.3 Plutonium Concentrator, E-17

A drawing of the plutonium concentrator is presented as Figure XV-5. Its more important construction details are summarized under 2.1, above.

The partly concentrated solution from the Pre-Concentrator is drawn by vacuum into the Concentrator pot, since no further hexone stripping is required. The column is for deentrainment only, and thus has no intermediate liquid feed point.

Nine cold fingers are provided for generating reflux if desired. The cold fingers serve as a 9-point reflux distributor.

2.4 Condensers

The Plutonium Pre-Concentrator Condenser, E-15, is of all-welded construction and is of the U-tube type similar to the uranium concentrator condensers (Figure XV-3). It has twelve 3/4-inch O.D. tubes with a total heat transfer area of 22 sq.ft. One distribution baffle is provided to prevent short circuiting of the vapor from the inlet to the vent through the void in the center of the "U".

The Plutonium Concentrator and Transfer Trap Vacuum Jet Condensers, E-18 and E-20, are identical. They are of all-welded construction consisting of a single helix, 18-1/2 turns of 1-in. sch. 40 pipe, with a 6-in. helix diameter in an 8-inch shell (8-in. sch. 20 pipe). The heat transfer area is 9.8 sq.ft.

F. WASTE CONCENTRATOR, D-12

The Waste Concentrator removes excess water from the solvent-extraction battery wastes for storage volume economy, as discussed in Chapter X. Since this concentrated solution may be reprocessed in the event of high uranium or plutonium loss, the hexone is stripped out prior to concentration to avoid precipitation of these elements with the decomposition products of hexone. Therefore, a stripping section consisting of 6 bubble-cap plates has been provided. Above this, there is a packed section to remove most of the entrained fission products from the vapor stream.

1. General Description

The Waste Concentrator, D-12, is about 17 feet high overall, 12 feet for the column and 5 feet for the pot. The pot is 7 feet in diameter. The column is 50 inches in diameter and its upper (deentrainment) section is packed with 1-inch stainless steel Raschig rings. The lower (stripping) section contains 6 bubble-cap plates spaced 14 inches apart. The condenser, D-11, is 20 inches in diameter and 8 feet 2 inches long, and contains ninety-eight 3/4-inch U tubes with a total heat transfer area of 210 sq.ft.

2. Construction Details

The construction details of the Waste Concentrator, D-12, are shown on Figure XV-6 and summarized in the table below. The construction details of the Waste Concentrator Condenser, D-11, are also summarized

in the table. In general appearance and structure it resembles the uranium concentrator condensers shown on Figure XV-3.

Waste Concentrator Details

Item	Description or Dimension
Pot	
Outside diameter	7 ft.
Overall height	5 ft. 3 in.
Heating provision	Coil, 9 concentric helices
Heat transfer area	370 sq.ft.
Heat transfer duty	4.1×10^6 B.t.u./hr.
Column	
Inside diameter	49-1/4 in.
Overall height	12 ft.
Packing size and type	1-in. by 1-in. stainless steel Raschig rings with 3/32-in. wall thickness
Packed height	3.5 feet (deentrainment)
Number of bubble-cap plates	6 (stripping)
Number of bubble-caps per plate	108
Number and size of slots per cap	Twenty-four, 3/32-in. by 1-in.
Reflux provision	Six 1/8-in. spray nozzles
Reflux flow rate	0 to 2 gal./min.
Condenser	
Type	U tube (horizontal)
Outside diameter	20 in.
Overall length	8 ft. 2 in.
Number and diameter of tubes	Ninety-eight 3/4-in. U tubes
Heat transfer area	210 sq.ft.
Heat transfer duty	3.5×10^6 B.t.u./hr.

As shown on Figure XV-6 the concentrator pot is similar to the standard tanks described in Chapter XIII, except that a side overflow line (2 inch) is provided. This overflow line is connected to a calming pipe dipping to the bottom of the tank and vented to the vapor space near the tank top.

The column is made from 3/8-inch rolled and welded stainless steel plate and is 50 inches O.D. by 12 feet long excluding the connectors. It is provided with lifting bails and may be removed from or replaced on the pot remotely. It is also possible to remove or replace the entire unit remotely.

The deentrainment section packing support section consists of 1/8-inch by 1-1/2 inch high parallel bars on 13/16-inch centers with notches 1/2 inch deep on 3/4-inch spacing to keep the packing from restricting the free cross-sectional area at the packing support. Two cross braces 1/4 in. by 1-1/2 in high each 8 in. from the center are provided to keep the support bars parallel. A hold-down grate identical with the packing support is placed above the packing. The liquid feed is delivered to the top tray of the stripping section and the reflux or wash-down solution is delivered above the deentrainment section through a spray head consisting of six 1/8-in. nozzles with 0.04-in. orifices.

The stripping section consists of 6 trays formed from 1/2-inch stainless steel plate. The splash baffles and downcomer plates are of 12-gage stainless steel plate welded in place. The trays are level to ±1/16 inch. There are 108 vapor risers (2-inch diam., 10-gage) per plate, which provide a riser area 10.6% of the total column cross-sectional area. The slot area of the 108 bubble caps is 10.5% of the column cross-sectional area. One row of chevron baffles, consisting of 2-inch stainless steel angle iron on 13/16-inch centers is placed below each plate to reduce entrainment of liquid in the vapor stream.

The condenser is of all-welded construction similar to the uranium concentrator condensers, shown in Figure XV-3. The heat transfer surface is of the U-tube type. One distribution baffle is provided to prevent short circuiting of the vapor from the inlet to the vent through the void in the center of the "U".

G. CONDENSATE STRIPPER, D-5

The Condensate Stripper removes hexone from the combined condensate of all the concentration equipment described above, as discussed in Chapter X. This is done to preclude the possibility of a hexone vapor explosion or fire at the cribs and to recover as much hexone as possible (about 500 gal./day) for economic reasons. Although the pot itself would undoubtedly meet the cribbing specification of not over 50% saturation with hexone, a column with a stripping section was added to obtain 95% or better recovery. The vapor leaving the stripping section is expected to contain less than 10^{-6}% of the Dissolver solution fission products, uranium and plutonium, but, nevertheless, a deentrainment section was provided to minimize any contamination fed to the organic treatment column.

1. General Description

The Condensate Stripper, D-5, is about 16 feet high overall, 13 feet for the column and 3 feet for the pot. The pot is 4 feet in diameter. The column is 20 inches in diameter and is packed with 1-inch stainless steel Raschig rings. The Condenser, D-6, is 12 inches in diameter and 3 feet 3 inches long, and contains twenty-one 3/4-inch U tubes with a total heat transfer area of 20 sq.ft.

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2. Construction Details

The construction details of the Condensate Stripper, D-5, are shown on Figure XV-7 and summarized in the table below. The construction details of the Condensate Stripper Condenser, D-6, are also summarized in the table. In general appearance and structure it resembles the uranium concentrator condensers, shown on Figure XV-3.

Condensate Stripper Details

Item	Description or Dimension
Pot	
Outside diameter	4 ft.
Overall height	3 ft.
Heating provision	Coil, 5 concentric helices
Heat transfer area	49 sq.ft.
Heat transfer duty	7.6×10^5 B.t.u./hr.
Column	
Inside diameter	19.5 in.
Overall height	13 ft.
Packing size and type	1-in. by 1-in. stainless steel Raschig rings with 3/32-in. wall thickness
Packed height	5.5 ft. (stripping) 4 ft. (deentrainment)
Reflux provision	Coil, 2 concentric helices
Heat transfer area	10.8 sq.ft.
Heat transfer duty	9.6×10^4 B.t.u./hr.
Reflux flow rate	0.2 gal./min.
Condenser	
Type	U tube (horizontal)
Outside diameter	12 in.
Overall length	3 ft. 3 in.
Number and diameter of tubes	Twenty-one 3/4-in. U tubes
Heat transfer area	20 sq.ft.
Heat transfer duty	1.6×10^5 B.t.u./hr.

As shown on Figure XV-7 the concentrator pot is similar to the standard tanks described in Chapter XIII, except that a side overflow line (2 inch) is provided. This overflow line is connected to a calming pipe dipping to the bottom of the tank and vented to the vapor space near the tank top.

The column is made from 1/4-inch rolled and welded stainless steel plate and is 20 inches O.D. by 13 feet long excluding the connectors. It is provided with lifting bails and may be removed from or replaced on the

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pot remotely, or the entire unit may be removed or replaced remotely. The packing supports consist of 1/8-inch by 1-1/2 inch high parallel bars on 13/16-inch centers with notches 1/2 inch deep on 3/4-inch spacing to keep the packing from restricting the free cross-sectional area at the packing support. Two cross braces 1/4 inch by 1-1/2 inch high each 3-1/8 inches from the center are provided to keep the support bars parallel. Hold-down grates identical with the packing supports are placed above each section. A liquid feed distributor above the stripping section consists of 11 distribution points of 1-inch sch. 40 pipe. Each pipe protrudes 2 inches above the distributor plate and has a slotted weir 2 inches high. At the design rate (3-1/8 tons U/day instantaneous processing rate) the liquid level on the distributor tray should be about 1 inch deep. The annular and center vapor riser area of the distributor tray is 39% of the total cross-sectional area of the column. A reflux distributor consisting of 12 distribution points similar to those described above is provided above the deentrainment section. It has three vapor risers having a total cross section of 28% of the tower cross section. Each riser has a "rain hat" to prevent liquid from bypassing the distributor.

The condenser is of all-welded construction similar to the uranium concentrator condensers shown on Figure XV-3. The heat transfer surface is of the U-tube type. Two distribution baffles are provided to prevent short circuiting of the vapor from the inlet to the vent through the void in the center of the "U".

H. CONDENSATE EVAPORATOR, D-4

The Condensate Evaporator receives the (thermally) hot aqueous bottoms from the Condensate Stripper and the condensate from the Ruthenium Scrubber Condenser for redistillation to insure obtaining a cribbable condensate, as discussed in Chapter X. A six-plate deentrainment section is provided to remove most of the entrained fission products, uranium, and plutonium from the vapor stream.

1. General Description

The Condensate Evaporator, D-4, is about 20 feet high, 7 feet for the pot and 13 feet for the column. The pot is 7 feet in diameter and the column is 4-1/2 feet in diameter with 6 trays on 18-inch spacing. The Condenser, D-3, is 2 feet in diameter and 8-1/4 feet high, and contains 193 U tubes (3/4-in.) with a total heat transfer area of 515 sq.ft.

2. Construction Details

The construction details of the Condensate Evaporator, D-4, are shown on Figure XV-8 and are summarized in the table below. The construction details of the Condensate Evaporator Condenser, D-3, are also summarized below. In structure it is similar to the Uranium Concentrator Condenser shown on Figure XV-3 and it is somewhat similar in general appearance, except that it is mounted vertically.

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Condensate Evaporator Details

Item	Description or Dimension
Pot	
Outside diameter	7 ft.
Overall height	6 ft. 11-3/4 in.
Heating provision	Coil, 9 concentric helices
Heat transfer area	516 sq.ft.
Heat transfer duty	9.6×10^6 B.t.u./hr.
Column	
Inside diameter	4 ft. 5-1/4 in.
Overall height	13 ft. 1 in.
Number of bubble-cap plates	6
Number of bubble caps per plate	116 caps, 3-in. O.D.
Number and size of slots per cap	48 slots, 3/32 in. by 1-in.
Reflux provision	Coil, 7 concentric helices
Heat transfer area	255 sq.ft.
Heat transfer duty	2.3×10^6 B.t.u./hr.
Reflux flow rate	4.7 gal./min.
Condenser	
Type	U-tube (vertical)
Outside diameter	2 ft.
Overall length	8 ft. 3 in.
Number and diameter of tubes	193 tubes, 3/4-in.
Heat transfer area	515 sq.ft.
Heat transfer duty	7.6×10^6 B.t.u./hr.

As shown on Figure XV-8 the Evaporator pot is similar to the standard tanks described in Chapter XIII except that a 2-inch side inlet is provided as the normal feed inlet from the Condensate Stripper, D-5, and a 12-inch jet well, which permits placing a remotely removable jet at the bottom of the tank so that the boiling liquid may be jetted to the Waste Header Receiver, D-13.

The column is made from 3/8-inch rolled and welded stainless steel plate and is 4 feet 6 inches O.D. by 12 feet 10-3/8 inches high excluding the connectors. It is provided with lifting bails and may be removed from or replaced on the pot remotely, or the entire unit may be removed or replaced remotely. The trays are formed from 1/2-inch stainless steel plate and the splash baffles and downcomer plates are of 12-gage stainless steel plate welded in place. The trays are level to ± 1/16 inch. There are 116 vapor risers (2-inch, 10 gage) per plate which provide a riser area 12.1% of the total column cross-sectional area. The slot area is 24% of the column area. One row of chevron baffles consisting of 2-inch stainless steel angle iron on 13/16-inch centers is placed below each tray and two are placed below the reflux coil to reduce entrainment of liquid in the vapor stream.

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The condenser is of all-welded construction similar to the uranium concentrator condenser, shown in Figure XV-3, and is somewhat similar in general appearance except that it is mounted vertically. The heat transfer surface is of the U-tube type. Three distribution baffles are provided to prevent short circuiting of the vapor from the inlet to the vent through the void in the center of the "U".

I. HEXONE DISTILLATION COLUMN, G-3

The organic overflow from the IO Column and the overhead from the Condensate Stripper are fed to the Hexone Distillation Column for steam distillation from a caustic heel on the feed plate and below. The upper trays treat the vapor further with 5% NaOH as discussed in Chapter IX and also serve to remove essentially all of the entrained fission products, uranium, and plutonium from the vapor stream.

1. General Description

The Hexone Distillation Column, G-3, is about 19-1/2 feet high, 6-1/2 feet for the pot and 13 feet for the column. The pot is 7 feet in diameter. The column is 3 feet 10 inches in diameter and contains 7 trays on 18-inch spacing. The Condenser, G-2, is 3 feet 4 inches in diameter by 9 feet 5 inches long, and contains 322 tubes (3/4-inch diam., U-shaped) with a total heat transfer area of 840 sq.ft.

2. Construction Details

The construction details of the Hexone Distillation Column are shown on Figure XV-9 and are listed in the table below. The construction details of the Hexone Distillation Column Condenser are shown in Figure XV-10 and are also summarized below.

Hexone Distillation Column Details

Item	Description or Dimension
Pot	
Outside diameter	7 ft.
Overall height	6 ft. 6 in.
Heating provision	Coil, 9 concentric helices
Heat transfer area	317 sq.ft.
Heat transfer duty	4.1×10^6 B.t.u./hr.
Column	
Inside diameter	3 ft. 9-1/4 in.
Overall height	13 ft.
Number of bubble-cap plates	7 (4 treatment and 3 distillation)
Number of bubble caps per plate	86

Item	Description or Dimension
Number and size of slots per cap	48 slots, 3/32-in. by 1-in.
Reflux provision	1-in. pipe to top plate
Reflux flow rate	0.31 gal./min.
Condenser	
Type	U-tube (horizontal)
Outside diameter	3 ft. 4 in.
Overall length	7 ft. 5 in.
Number and diameter of tubes	322 tubes, 3/4-in.
Heat transfer area	840 sq.ft. (420 for subcooling and 420 for condensing)
Heat transfer duty	3.9×10^6 B.t.u./hr.

As shown on Figure XV-9 the Hexone Distillation Column pot is similar to the standard tanks described in Chapter XIII, except that a side overflow line (2 inch) is provided. This overflow line is connected to a calming pipe dipping to the bottom of the tank and vented to the vapor space near the tank top.

The column is made from 3/8-inch rolled and welded stainless steel plate and is 3 ft. 10 in. O.D. by 13 ft. high excluding the connectors. It is provided with lifting bails and may be removed from or replaced on the pot remotely, or the entire unit may be removed or replaced remotely. The trays are formed from 3/8-inch stainless steel plate and the splash baffles and downcomer plates are of 12-gage stainless steel plate welded in place. The trays are level to ±1/16 inch. There are 86 vapor risers per plate (2-inch diam., 12 gage) which provide a riser area 12.6% of the total column cross-sectional area. The slot area is 25% of the column area. One row of chevron baffles consisting of 2-inch stainless steel angle iron on 13/16-inch centers is placed below each tray and two above the top tray to reduce entrainment of liquid in the vapor stream.

The condenser is of all-welded construction with a heat transfer surface of the U-tube type. The lower (inlet) leg of the U is in the liquid phase to subcool the hexone while the upper leg is in the vapor space. A horizontal baffle is provided to cause the condensed liquid to travel the length of the subcooling coils. Two partial transverse baffles are provided to prevent short-circuiting of the vapor to the vent. The condenser is equipped with a side outlet for the condensed, cooled, and separated hexone, and a bottom outlet with a jackleg of proper height to withdraw the aqueous phase.

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Figure XV-1

RUTHENIUM SCRUBBER H-5

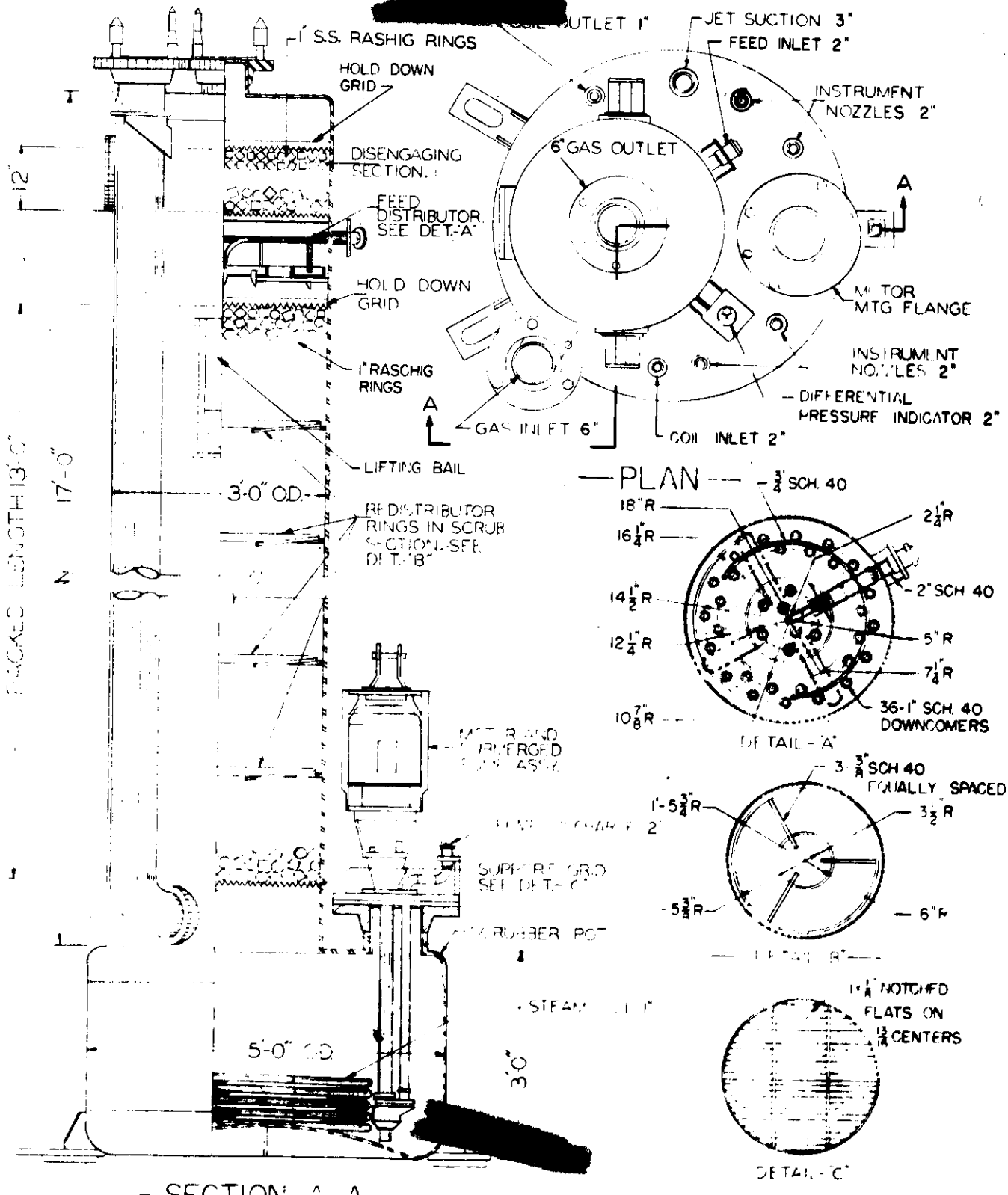

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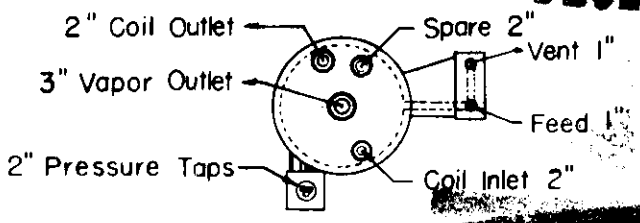
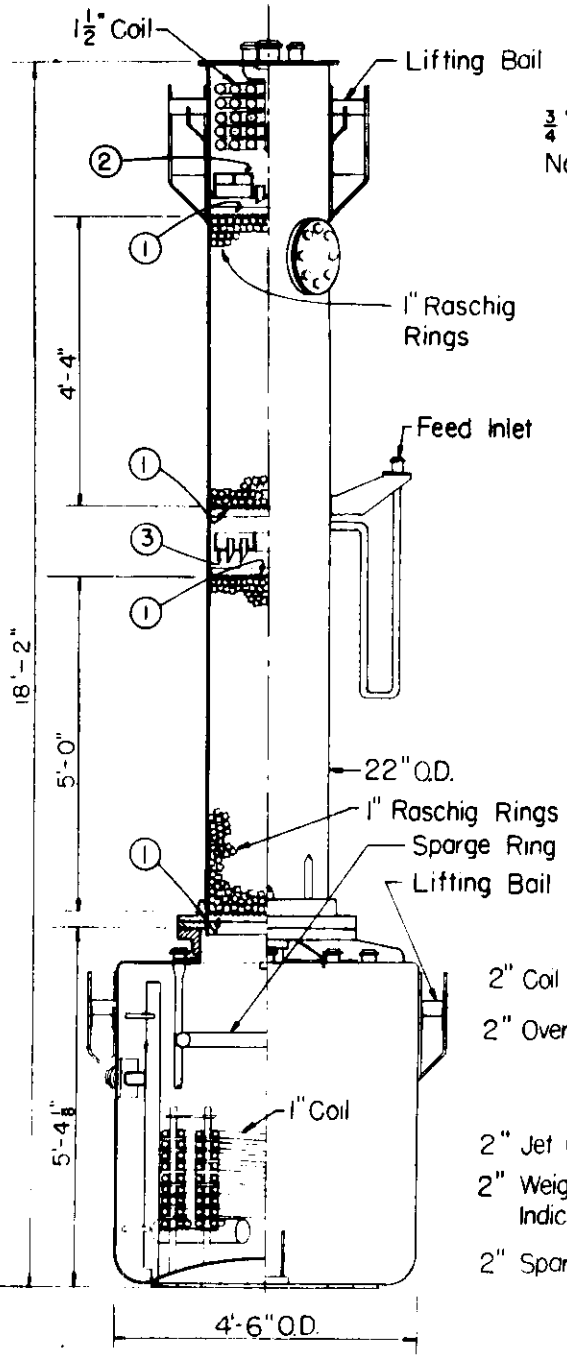
FIGURE XV-2

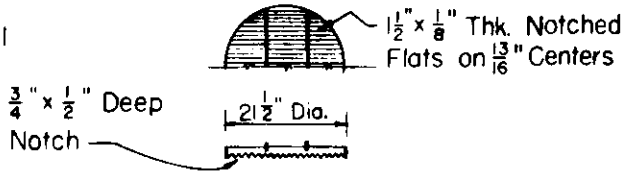
URANIUM CONCENTRATOR-

F-2, F-5, E-10

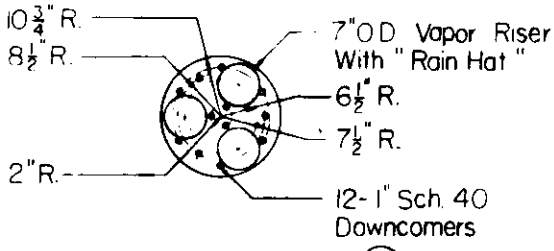


— TOWER CONNECTOR [redacted]

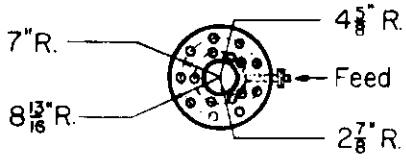




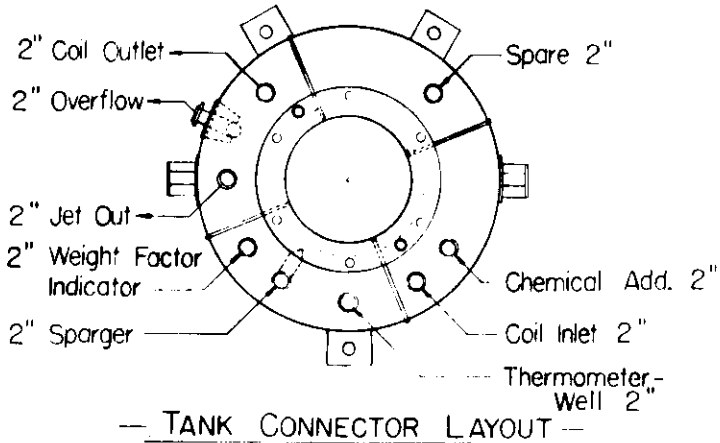
PACKING SUPPORT (1)



REFLUX DISTRIBUTOR (2)



FEED DISTRIBUTOR (3)



— TANK CONNECTOR LAYOUT —

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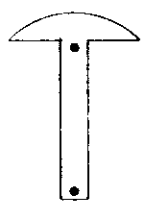
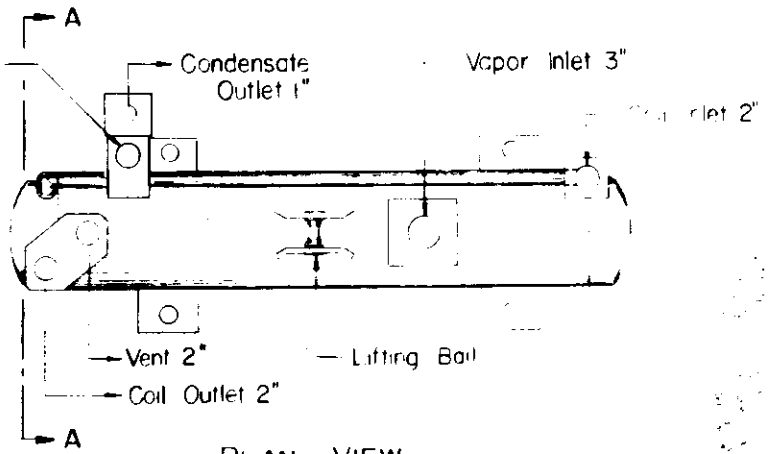
FIGURE XV-3

URANIUM CONCENTRATOR CONDENSERS - F-3, F-6, E-9

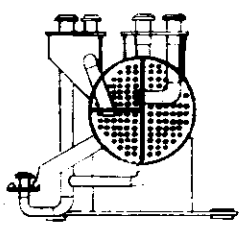


DETAIL

— DISTRIBUTION BAFFLE —



— PLAN VIEW —



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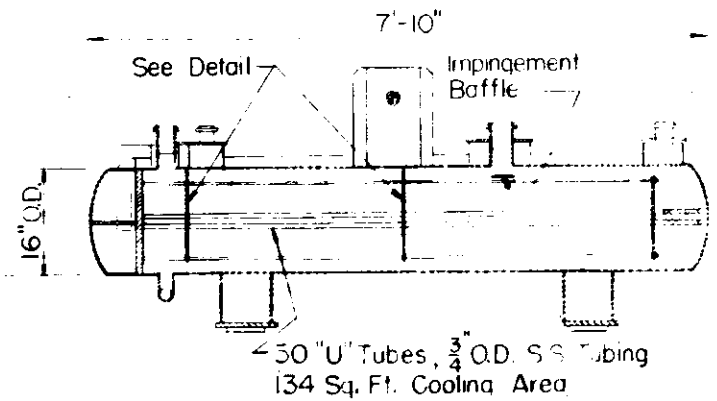

— SECTIONAL ELEVATION —

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FIGURE XV-4

PLUTONIUM PRECONCENTRATOR - E-16

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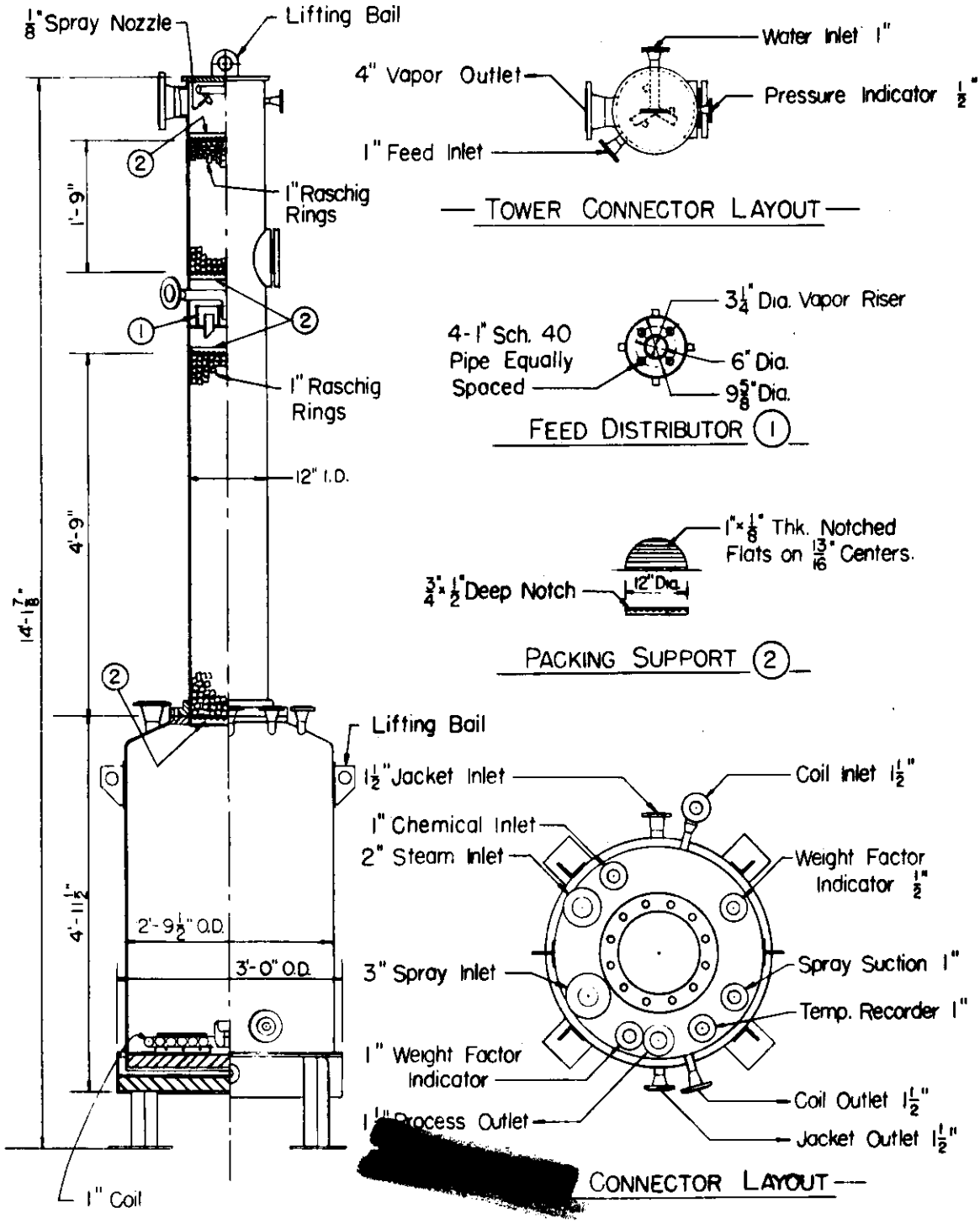

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H-2-8169

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Figure XV-5
PLUTONIUM CONCENTRATOR E-17

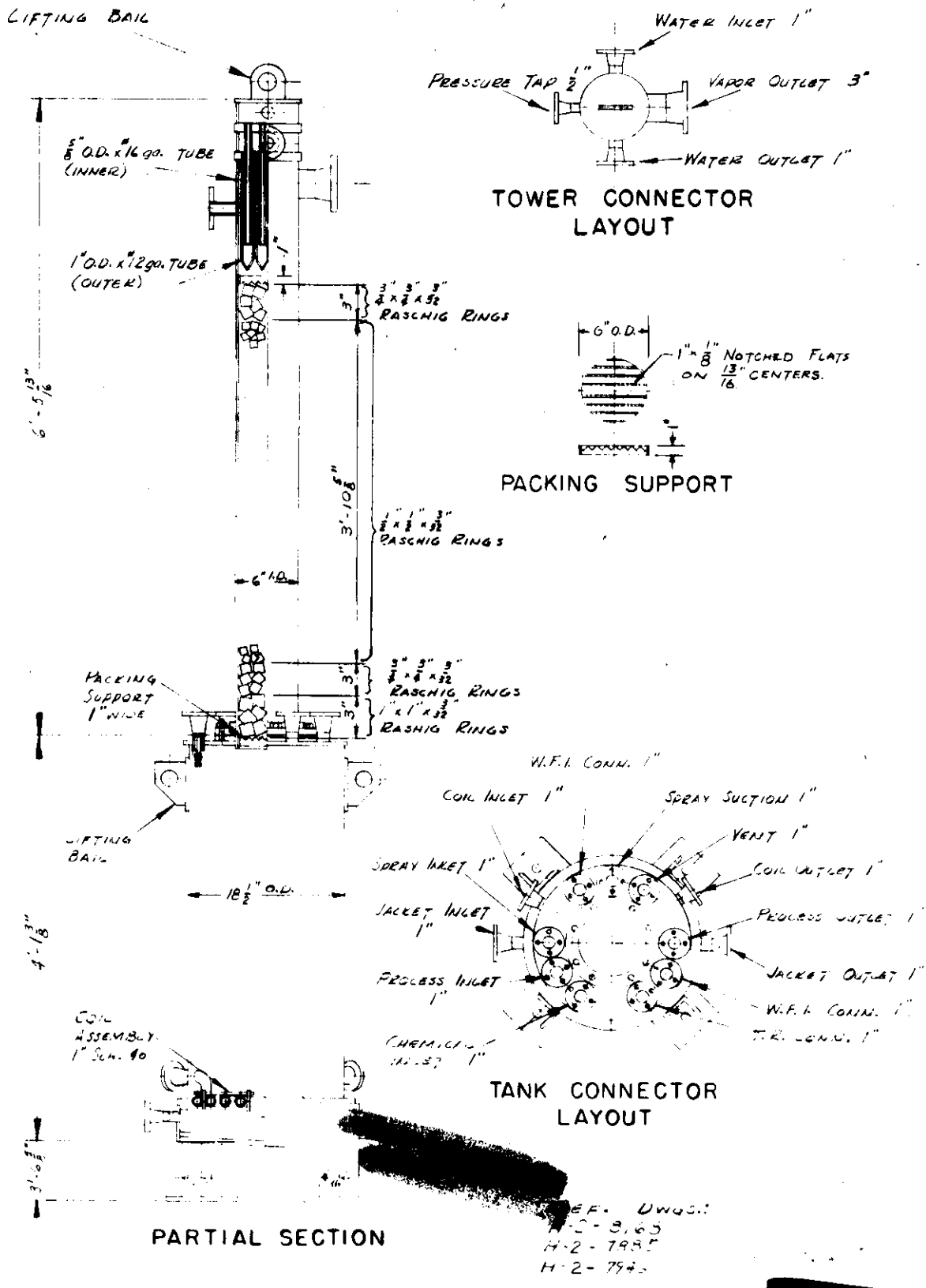

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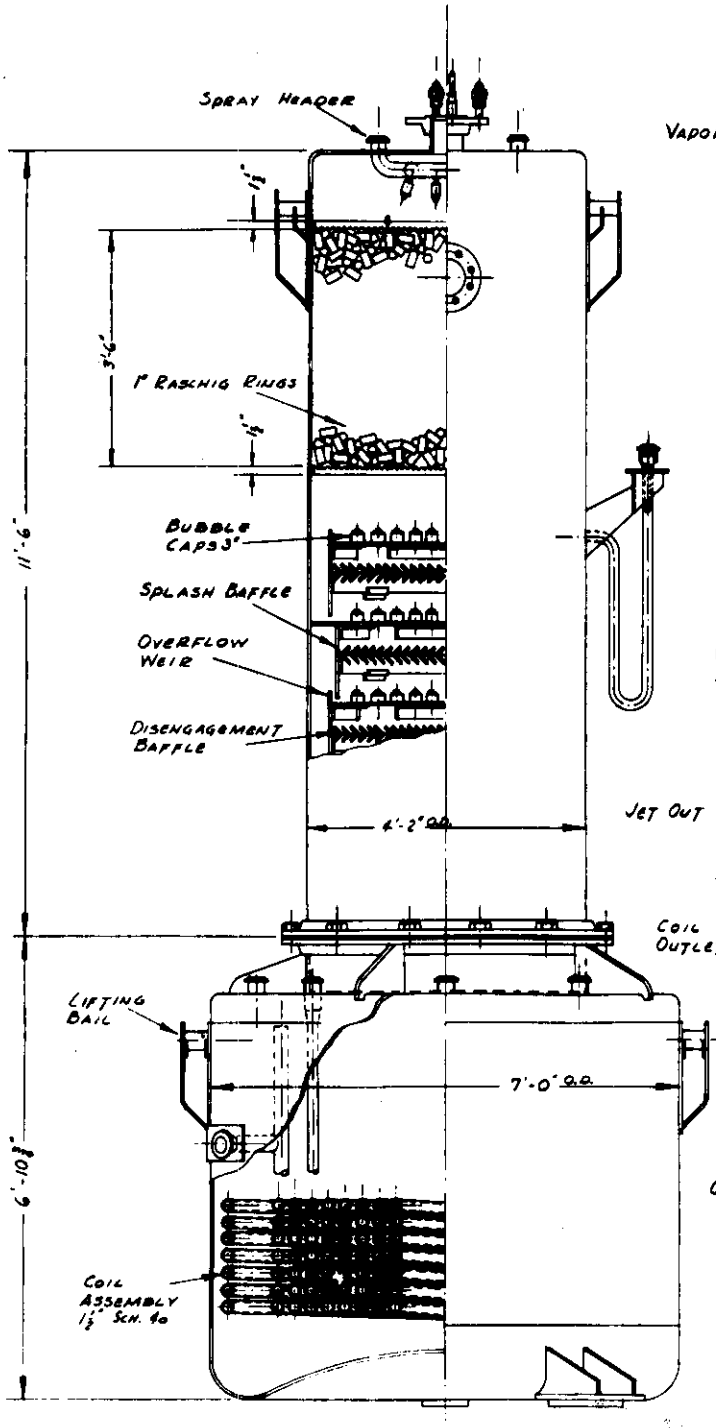
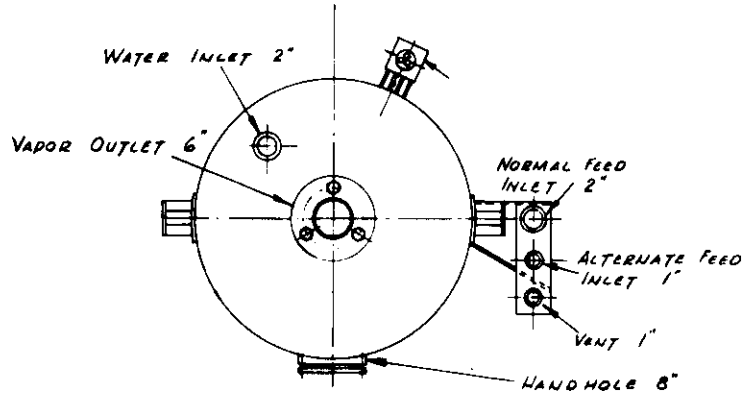
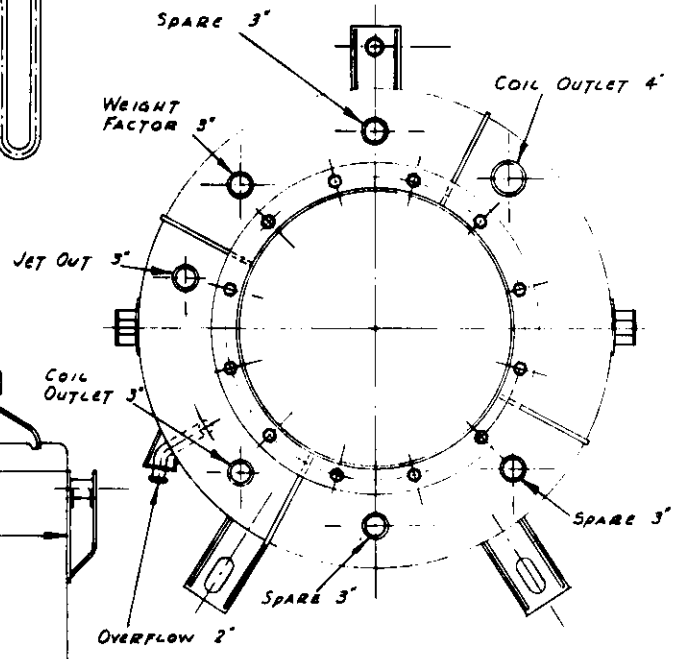
Figure XV-6
WASTE CONCENTRATOR D-12



PARTIAL SECTION



TOWER CONNECTOR LAYOUT



TANK CONNECTOR LAYOUT

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H-2-8301

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Figure XV-7
CONDENSATE STRIPPER D-5

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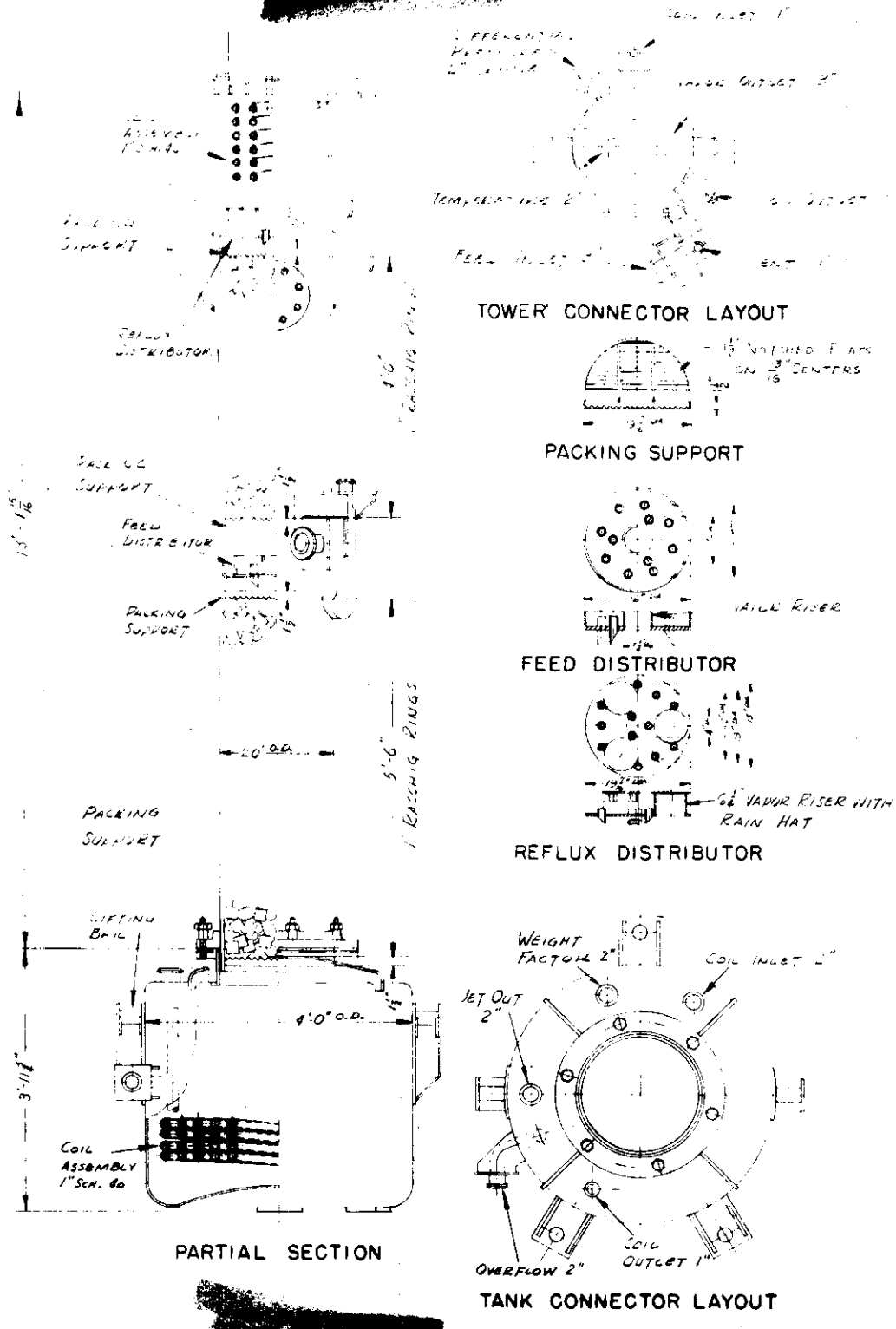

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REF. DWGS.:
H-2-8289
H-2-8325
H-2-7747

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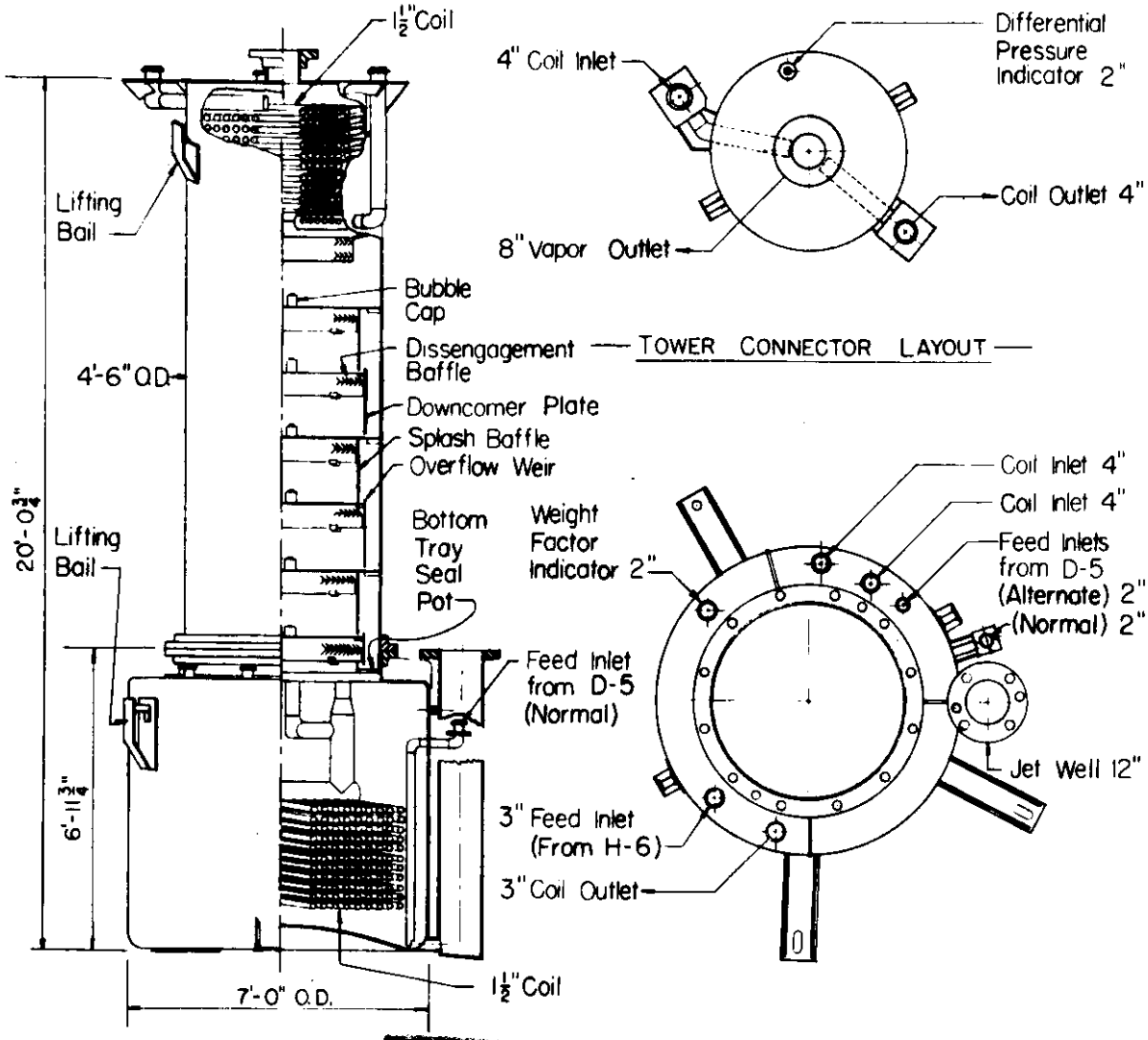
FIGURE XV-8

CONDENSATE EVAPORATOR-D-4



— SECTIONAL ELEVATION [redacted] TANK CONNECTOR LAYOUT —

REFERENCE DWGS: H-2-8385
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H-2-8435

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Figure XV-9
HEXONE DISTILLATION COLUMN-G-3

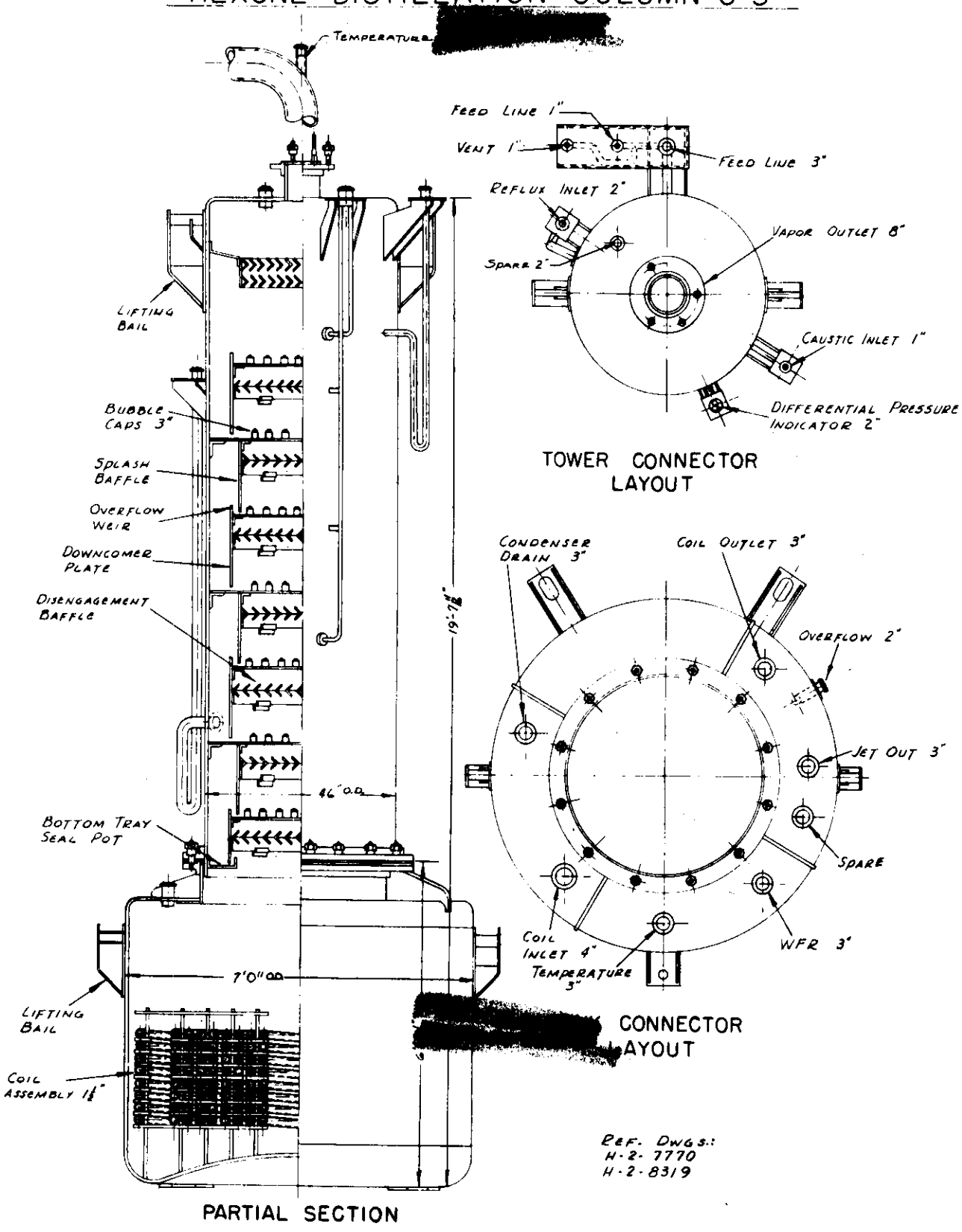

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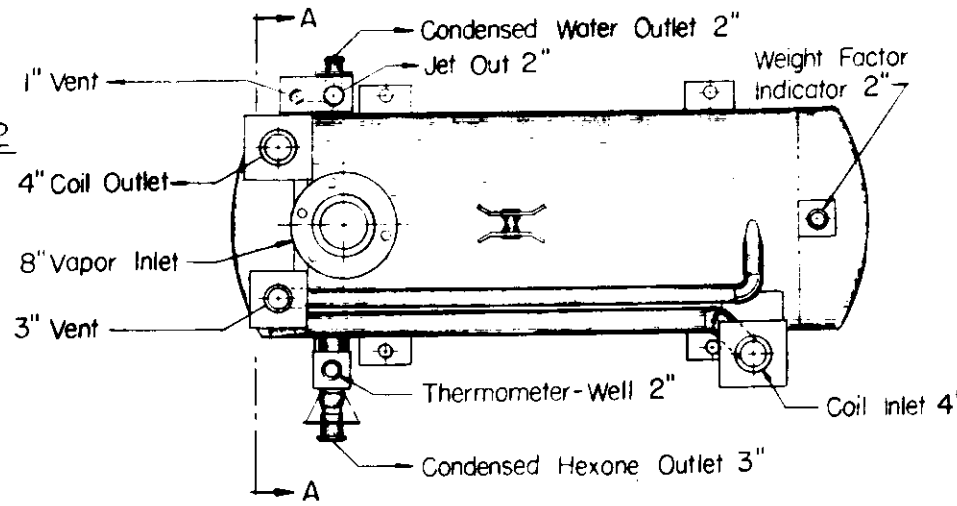
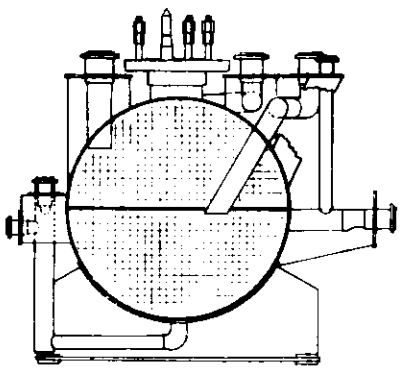
FIGURE XV-10

CONDENSER & PHASE SEPARATOR G-2
FOR THE
ORGANIC DISTILLATION COLUMN

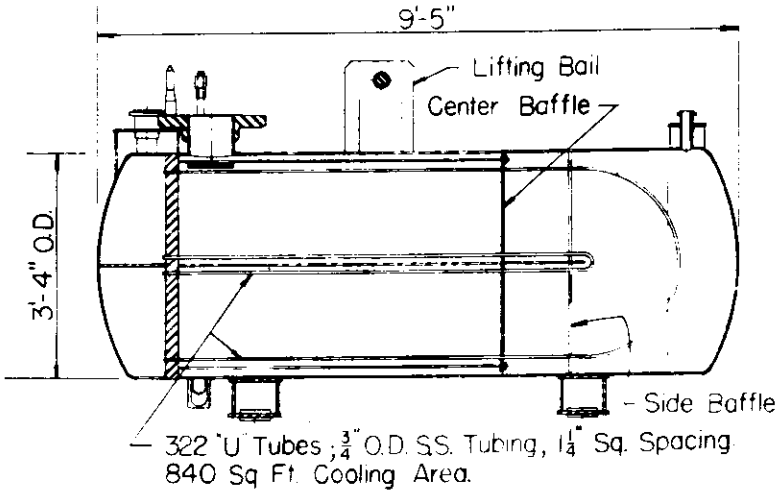
[redacted]ERENCE DWG. H-2-7745



— PLAN VIEW —



— SECTION A-A —



— SECTIONAL ELEVATION —

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FIG. XV-10

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PART III: PLANT EQUIPMENT, continued

CHAPTER XVI. OTHER PROCESS EQUIPMENT

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C. AGITATORS 1604

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E. PR CAN 1608

F. AUXILIARIES 1609

1. Gang Valves 1609

2. Samplers 1610

3. Strainers 1611

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REFERENCES 1614

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CHAPTER XVI. OTHER PROCESS EQUIPMENT

A. SLUG CARRYING CASKS

Irradiated, canned uranium slugs are transported to the 202-S Building in a perforated stainless steel bucket contained within a slug-carrying cask.(2) The casks are transported to the 202-S Building in special railway cars known as cask cars. Each cask car contains two water-filled vats which hold one slug-carrying cask in each vat. The bucket and cask are illustrated in Figure XVI-1 and are identical to the equipment described in Section C of the Hanford Works Technical Manual, HW-10475.

1. Weight and Capacity

The slug-carrying capacity and weight of the cask are as follows:

Weight of slugs (280 four-inch slugs)	1100 pounds
Weight of perforated bucket	275 pounds
Weight of cask(3)(5)	39600 pounds
Weight of cask lid(4)	4960 pounds
Total Weight	45935 pounds

2. Radiation Intensity and Shielding

The radiation intensity of a bucket of irradiated (418 Mw.-days/ton) slugs (removed from carrying cask) hanging in mid-air is 2.5 r./hr. at 50 ft. after "cooling" 72 days in the 200-N Area Metal Storage Basin, Building 212. When contained in a carrying cask, which has lead-filled stainless steel walls 12.5 in. thick, the radiation intensity directly outside the cask before "cooling" is on the order of 1 mr./hr.

3. Cooling Provision

The heat resulting from decay of the radioactive materials in the slugs must be removed from the cask to avoid the attainment of excessively high temperatures. The carrying cask is equipped with S-shaped tubes in the walls and lid to allow cooling water to circulate freely from the vats on the cask car to the slugs. The tubes are S-shaped to attenuate the radiation passing outward from the slugs.

4. Slug Removal

The cask car enters the 202-S Building through the railway tunnel. The cask lid which is stepped into the cask is unlocked by means of an impact wrench, lifted by means of the crane, and placed on the flat bed of the cask car. The bucket of slugs is then lifted from the cask with the crane, allowed to drain, carried to the Dissolver Cell and charged to the Dissolver.

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