HADDAM NECK NUCLEAR POWER PLANT, WASTE DISPOSAL BUILDING
(Connecticut Yankee Nuclear Power Plant, Waste Disposal Building)
362 Injun Hollow Road
Haddam
Middlesex County
Connecticut

HAER CT-185-L
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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

REDUCED COPIES OF MEASURED DRAWINGS

FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
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HISTORIC AMERICAN ENGINEERING RECORD
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(Connecticut Yankee Nuclear Power Plant, Waste Disposal Building)

HAER No. CT-185-L

Location: ~~On Injun Hollow Road, approximately 2 miles southeast of intersection with Rock Landing Road, and 170 feet northeast of Connecticut River~~
362 Injun Hollow Road
Haddam
Middlesex County
Connecticut
U.S. Geological Survey Haddam & Deep River Quadrangles
UTM Coordinates 18.708713.4595168

Dates of Construction: 1964-1966 and 1973-1974

Engineers: Westinghouse Electric Company

Present Owners: Connecticut Yankee Atomic Power Company (CYAPCO)
362 Injun Hollow Road
Haddam Neck CT 06424-3022

Present Use: Demolished

Significance: The Haddam Neck Nuclear Power Plant was one of the earliest commercial-scale nuclear power stations in the United States, and was eligible for the National Register of Historic Places. The Waste Disposal Building contained the components which were used to process the radioactive liquid and gaseous waste generated by nuclear plant operation. Enhanced or enlarged facilities to process gaseous and liquid nuclear waste were completed in 1973-74, largely during the fourth refueling shutdown.

Project Information: CYAPCO ceased electrical generation at the Haddam Neck plant in 1996 and initiated decommissioning operations in 1998, subject to authority of the Nuclear Regulatory Commission (NRC). NRC authority brought the project under the purview of federal acts and regulation protecting significant cultural resources from adverse project effects.[1] This documentation was requested by the Connecticut State Historic Preservation Office to preclude the possibility of any adverse project effects.

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1 National Historic Preservation Act of 1966 (pL 89-655), the National Environmental Policy Act of 1969 (PL 91-190), the Archaeological and Historical Preservation Act (PL 93-291), Executive Order 11593, Procedures for the Protection of Historic and Cultural Properties (36 CFR Part 800).

Wastes generated at nuclear power plants - Liquid and Solid

Small quantities of radioactive wastes are produced during the operation of nuclear reactors. The wastes generated at nuclear power plants are low in activity and the contaminating radioactive isotopes have a low toxicity and generally, a short half-life.

The type and amount of wastes produced in a nuclear power plant depends on the design and type of reactor, operating conditions and fuel integrity. These radioactive wastes contain radioactive isotopes from structural, moderator, and coolant materials; corrosion products; and fission product contamination arising from the fuel.[1] The methods used for the treatment and conditioning of waste generated at the Haddam Neck nuclear power plant were effective and reliable.

Low and intermediate-level radioactive waste at the Haddam Neck plant was produced by contamination of various materials with the isotopes generated by fission and activation in the reactor or released from the fuel or cladding surfaces. These isotopes were primarily released and collected in the reactor coolant system and, to a lesser extent, in the spent fuel storage pool.

The main wastes arising during the operation of the plant are components which are removed during refueling or maintenance. In addition, operational wastes such as radioactive liquids, filters, and ion-exchange resins which are contaminated with fission products from circuits containing liquid coolant contributed to the liquid waste stream.

Volume reduction is effective for high volume waste that has low radiation activity. In order to reduce the quantities of waste for interim storage and to minimize disposal cost, a system was designed to reduce the volume of waste. This system included the waste disposal building and outside equipment such as external pumps, valves and tanks.

Liquid wastes and wet solid wastes

The volumes of liquid waste generated at pressurized-water reactors like Haddam Neck are significantly lower than those from boiling-water reactors. Active liquid wastes are generated by the cleanup of primary coolants, cleanup of the spent fuel storage pond, drains, wash water, and leakage waters. Decontamination operations at reactors also generate liquid wastes resulting from maintenance activities on plant piping and equipment.

Treatment and conditioning of liquid/solid waste

Liquid radioactive waste from nuclear power plants contains soluble and insoluble radioactive components and non-radioactive substances. The objective of waste treatment methods is to treat liquid waste to such an extent that the decontaminated bulk volume of aqueous waste can be either released to the environment or recycled. Concentrated waste is additionally conditioned, stored, and disposed of. Since nuclear power plants generate many categories of liquid waste, several processes are applied to treat radioactive waste. Each process has a specific effect on the radioactive content of the liquid.

The greatest volume reduction effect is achieved by evaporation. Evaporation is a proven method for the treatment of liquid radioactive waste. It provides both good decontamination and volume reduction. Water is removed in the vapor phase of the process leaving behind non-volatile components such as salts containing most radio isotopes. Evaporation is probably the best technique for wastes having relatively high salt content with a mixed chemical composition.

Liquid Waste System [2]

The Liquid Waste System is designed to collect, hold, process and dispose of all potentially radioactive aerated liquid generated. Steam generator blowdown condensate was also processed in this system. The building's location is shown in Figure 1.

The Liquid Waste System collects all liquid waste in two aerated drain tanks, "A" and "B". These tanks are pumped to the aerated waste holdup tank. The holdup tank would be sampled to determine which batch treatment method should be utilized prior to disposal. Any combination of the following process methods may be used:

Filtration for the removal of particulate matter
Ion exchange for the removal of dissolved impurities
Dilution for the reduction of activity levels
Evaporation for the concentration of isotopes and dissolved solids
Solidification for the disposal of high activity effluent

A simplified diagram of the Liquid Waste System is provided in Figure 2. As shown on this diagram, all aerated liquid waste is collected in the two aerated drain tanks. An aerated drain tank strainers in the Waste Disposal Building received contaminated aerated drains from the floor, equipment drain tanks and the containment drain header.

The second drain tank received contaminated condensate from the Steam Generator Blowdown System in the event of a steam generator tube leak or rupture, the drain flow from the Chemical Volume Control System chemical addition tank, and served as a backup receiver for the liquid from the aerated liquid strainers.

The liquid collected in the aerated drain tanks was normally pumped to the aerated drain holdup tank. The liquid in this tank was sampled to determine further processing requirements. If the liquid had a high activity or a high boron concentration, it might be processed by the liquid waste evaporator before flowing through the polishing demineralizer and evaporator filter prior to going into the Waste Test Tanks.

If the boron concentration and activity of the liquid is low, the evaporator is bypassed, and the water is either pumped directly through the polishing demineralizer and evaporator filter to the waste test tanks or through the Chemical Nuclear processing station then through the polishing demineralizer and evaporator filter to the waste test tanks. The liquid collected in the waste test tanks would then be sampled prior to disposal.
If the liquid meets the chemistry specs for discharge to the environment, it is pumped through the service water discharge header to the river. If the liquid does not meet the chemistry requirements, it may be recirculated through the polishing demineralizer and evaporator filter, or pumped back to the aerated drain holdup tanks for reprocessing.

Aerated Drains

The aerated drain tanks were 2500 gallon storage tanks approximately 17 feet high and 5 feet in diameter. These tanks, which are located as shown Figure 1, are vented to the Primary Auxiliary Building ventilation system. A manway is located near the bottom of the tank for inspection and cleaning. The "A" aerated drain tank pump must be manually started and stopped to control level in the tank. The "B" aerated drain tank pump automatically starts if tank level exceeds 2100 gallons, and stops the when tank level falls below 750 gallons.

The "A" Aerated Drain Tank receives flow from the following sources:

1. Waste Disposal Building floor and equipment drain sumps

2. Contaminated drains header
   a. Spent Resin container dewatering pump
   b. Ion exchanger pit sump pump
   c. Ion exchanger drains
   d. Liquid Waste System demineralizer drains
   e. Boric acid tank drain and overflow
   f. Reactor containment sump
   g. Miscellaneous drains

3. Aerated liquid strainers
   a. PAB floor drains
   b. PAB trench drain

c. Spent Fuel Building sump
d. RHR pit sump
e. Primary sample sink
f. Main Stack drain

4. Liquid Waste System sample lines

The 'B' Aerated Drains Tank receives flow from the following sources:

a. Steam Generator Blowdown System
b. CVCS chemical addition tank drain
c. Aerated liquid strainers overflow (the liquid strainers are normally aligned to "A" ADT)

The liquid collected in the aerated drain tanks is normally pumped to the aerated drain holdup tank. Aerated drain tank pump "A" normally took a suction on the "A" aerated drain tank, and discharged through the aerated drains filter, aerated drains demineralizer and to the aerated drain holdup tank.

The "B" ADT pump pulled suction on the "B" ADT, and discharged directly to the aerated drain holdup tank.

Many alternate flowpaths may be used. Infrequently used, but possible, other flowpaths include:

Taking a suction on the "A" aerated drain tank with the "B" aerated drain tank pump, or vice versa.
Pumping the "B" aerated drain tank directly to the service water discharge
Pumping the "A" aerated drain tank directly to the waste test tanks
Recirculating the aerated drain tanks
Bypassing the aerated drains demineralizer or filter

Aerated Drain Holdup Tank

The aerated drain holdup tank receives liquid from the aerated drain tanks. This tank provides holdup capability for isotopic decay, storage and operational flexibility of the waste evaporator. The aerated drain holdup tank is 99,280 gallon storage tank, which is located in the reactor containment yard. This tank is 26 feet, 4 inches tall and 24 feet in diameter. The tank is enclosed in a diked area, which is capable of containing the liquid from this tank in the event of a tank rupture.

The evaporator feed pumps pulls a common suction on the aerated drain holdup tank. These pumps may be used to recirculate the fluid contained in the aerated drain holdup tank, or to pump the tank contents to the waste evaporator, Chemical Nuclear Mobile Demineralizer, or to the waste test tanks.

One evaporator feed pump is run to recirculate the contents of the aerated drain holdup tank through the recirculator orifice prior to sampling. A sample connection, which is provided on discharge of the evaporator feed pumps, is located outside of the diked area in the RCA yard for easy access.

Once the desired method for processing has been determined, the evaporator feed pumps are used to transfer liquid into the waste evaporator, the Chemical Nuclear mobile demineralizer unit, or to the Waste Test Tanks through the evaporator bypass valve. Minimum flow for the evaporator feed pumps when pumping to the evaporator or waste test tanks is provided through a flow orifice and isolation valve.

Waste Liquid Evaporator

Feed to the waste evaporator flows from the evaporator feed pumps through the feed/distillate heat exchanger where it is preheated by the warm condensate flowing from the distillate tank. The feed then flows through a feed control valve, and into the suction of the re-boiler pump. The re-boiler pump circulates the evaporator bottoms and the incoming feed through the re-boiler tubes, where the fluid is heated to approximately 262°F by steam passing through the re-boiler shell. After passing through the re-boiler, the fluid passes through a flow-restricting orifice and enters the evaporator flash chamber. The orifice in this line is provided to maintain enough backpressure on the re-boiler to prevent boiling, which could cause impurities to plate out on the re-boiler tubes.

As the fluid enters the evaporator flash chamber, a small amount (approximately 1%) is flashed to steam and flows upward to the tower section of the evaporator. The remaining fluid is collected in the bottom of the flash chamber where it will be once again recirculated by the re-boiler pump.

The steam entering the tower section of the evaporator passes through five separation plates where impurities are scrubbed by reflux flow from the distillate pump. The steam then passes through the overhead condenser where it is condensed by the flow of cool service water flowing through the condenser tubes. Condensate from the overhead condenser is drained to the distillate tank, while any non-condensable gasses are vented through a thermostatic trap to the primary auxiliary building ventilation system.

The condensate collected in the distillate tank is pumped by evaporator distillate pump through the feed/distillate heat exchanger to the distillate cooler where it is further cooled by component cooling water.

From the distillate cooler, the evaporator effluent is directed to the waste test tanks through the polishing demineralizer and evaporator filter. After the bottoms of the evaporator have reached a predetermined volumetric run, the bottoms are then concentrated by boiling off excess liquid. The evaporator is stopped. The concentrated bottoms are pumped to the mobile solidification station for solidification.

The bottoms pump develops suction on the evaporator bottoms and discharges through the evaporator bottoms cooler to the drumming station. The flow of component cooling through the bottoms cooler is modulated as necessary to maintain effluent temperature at less than 170°F.

A preheater in the component cooling line to the cooler was provided to maintain effluent temperature at greater than 150°F. This was necessary to prevent solidification of the boron contained in the evaporator bottoms due to low temperature. During evaporator pump out with the bottoms pump, a small amount of recirculation flow is provided. This maintained an even temperatures within the shell of the evaporator and allowed better level control.

Evaporator Bypass

Fluid from the aerated drain hold up tank can bypass the waste liquid evaporator and be processed by two different means.

1. The first flowpath bypassed the evaporator by tapping off the supply line to the evaporator upstream of the feed/distillate heat exchanger. This line then taped back into the system ownstream of the waste evaporator distillate cooler.

2. The second flow path incorporates the use of the Chemi-Nuclear processing unit. This unit is owned and operated by Chemi-Nuclear a corporation that specializes in long term storage of low-level nuclear waste. The transportable unit is skid-mounted and it consists of a control station, booster pump, filters and demineralizers.

Flow was directed to the station by bypassing the evaporator. Flexible hose was used to construct the piping run. The liquid supply to the unit tapped off the waste liquid system at the feed/distillate heat exchanger. The processed fluid returned to the waste liquid system downstream of the distillate cooler and distillate tank level control valve. Flow then followed its normal path to the Waste Test Tanks. When utilizing the processor a Chem Nuclear Technician is responsible for its operation.

The primary side operator was responsible for running a waste liquid transfer pump and for verifying proper tank levels and the amount of liquid processed.

Waste Test Tanks

The waste test tanks are 16,000 gallon storage tanks which are located in the reactor containment yard. Each tank is 14 feet high and 14 feet in diameter. These tanks are vented to the primary auxiliary ventilation system.

Fluid entering the waste test tanks from the evaporator, or directly from the aerated drain holdup tank, first passes through the polishing ion exchanger and evaporator filter. Incoming fluid may be directed to either A or B waste test tank.

The waste test tanks pumps, which could pull a suction on either waste test tank may:

Recirculate the waste test tanks.
Discharge the contents of waste test tanks to the river.
Further process the liquid collected in the waste test tanks by recirculating it through the polishing ion exchanger and evaporator filter.

Other possible flowpaths associated with waste test tanks include pumping the fluid in the waste test tanks back to the aerated drain holdup tank for reprocessing

Discharge Flow Paths

All radioactive liquid waste discharged from the Connecticut Yankee Plant flowed through a common radioactive discharge line to the service water discharge header.

The service water discharge empties into the main discharge canal which returned the water used by the Service Water and Circulating Water System to the river. This flowpath assured that any radioactive or chemical impurities that are released to the environment are well diluted before reaching the Connecticut River.

The common radioactive discharge line receives flow from:

The waste test tanks
Aerated drain tank header Recycle test tanks

Flow through the common discharge header is directed through either a high flow (50 gpm) orifice or a low flow (5 gpm) orifice, and the river effluent trip valve to the service water discharge header.

The flow orifices in this discharge line were provided to ensure that excessive flow rates will not be inadvertently achieved. The low flow orifice is used when the desired discharge rate is less than 5 gpm. The high flow orifice is used when the desired discharge rate is greater than 5 gpm. The river effluent trip valve is throttled as necessary to control the flow rate through the discharge header. This valve automatically triped if high radiation is detected in the service water discharge line, stopping further release of radioactivity to the environment.

Major Components

Aerated Drain Tank Pumps:
The aerated drain tank pumps are centrifugal pumps which each have a rated flow rate of 50 gpm at 25 psig. These pumps are located in the RHR pit, in the PAB.

Each pump was capable of pulling a suction on either aerated drain tank through the pump suction cross-connect line. This would only be done, however, if one of the aerated drain tank pumps were inoperable. Because each pump is interlocked with its respective aerated drain tank level transmitter, the cross-connect isolation valve is normally closed.

The aerated drain tank pumps are controlled from the Liquid Waste Panel in the Primary Auxiliary Building. Pump A is provided with a two position (ON-OFF) control switch. This pump was interlocked with the level in the A aerated drain tank, as follows:

The pump would trip if tank level falls below 600 gallons.
Pump B was provided with a three position (HAND-OFF-AUTO), control switch.
This pump was interlocked with/controlled by the level in the B aerated drain tank.
The pump would automatically start when tank level reaches 2100 gallons, if the control switch was in the AUTO position.
The pump would trip if tank level falls below 750 gallons, if the control switch is in either the AUTO or HAND position.

Aerated Drains Demineralizer

The aerated drains demineralizer was a mixed bed type demineralizer which is located in the ion exchanger area. This demineralizer was designed for a maximum flow rate of 160 gpm with a maximum pressure drop of 5 psid. The demineralizer was provided with inlet, outlet and bypass valves which allowed it to be bypassed during resin replacement.

Radioactive Liquid Release Permit

A Liquid Radioactive Release Permit must be utilized for all releases of radioactive liquids to the environment. This document ensured that all radioactive releases are performed in accordance with NRC regulations.

The release permit which was prepared by the Chemistry Department contained the following key information:

Radioactivity of liquid being released
Boron concentration of liquid to be released (limited to 2250 ppm)
Chromate concentration of liquid to be released (limited to 50 ppb)
Total number of gallons to be released
RM-18 (Service Water Rad Monitor) setpoint
RM-22 (Test Tank Discharge Rad Monitor) setpoint
Release rate
Required number of service water pump
Required number of circulating water pumps

System Interfaces

Service Water
Control Air
Radiation Monitoring
Component Cooling
Primary Ventilation

All controls for the Aerated Drain system were located on a control panel in the Primary Auxiliary Building – Lower Level.

SOLID WASTE MANAGEMENT SYSTEM

The function of the solid waste system is to receive, concentrate, solidify (as necessary) package, collect and store radioactive wastes that result from plant operation, maintenance and decommissioning activities.

Design Bases

The radioactive solid waste system is designed to:

(1) Package radioactive solid wastes for off-site shipment and disposal in accordance with the applicable Nuclear Regulatory Commission and Department of Transportation (DOT) regulations. DOT approved steel or high integrity liners and shipping containers are used for the packaging of dry solid wastes, solidified liquid waste, spent resins, and spent filter cartridges.

(2) Achieve system safety compliance requirements by the compartmentalization of equipment layout, shielding, accurate radiation and process monitoring, and remotely operated and highly reliable equipment.

(3) Contain selected equipment and storage capacities, which meet the station's solid waste processing requirements.

(4) Hold eleven 120-ft^3 liners in the Spent Resin Storage Facility (SRSF). The facility meets the minimum seismic criteria specified in Regulatory Guide 1.143.

(5) Hold Dry Activated Waste (DAW) in the Radwaste Reduction Facility (RRF). The capacity of the RRF is dependent upon:
a) The wastes generated, and
b) Waste volume reduction techniques employed.

(6) Collect and store dried spent filter cartridges and/or other similar dried radioactive waste in the on-site storage containers.

7) Collect and store dry activated waste in Sea/Land type containers

System Description

The solid waste system receives and compacts radioactive dry solid wastes produced during operation, maintenance and decommissioning activities of the Haddam Nuclear Plant. The solid waste system is equipped to provide interim storage for the radioactive solid wastes prior to off-site shipment and disposal.

The types of wastes handled and processed by the solid waste system include the following:

(1) Demineralizer spent resins

(2) Expended cartridge filter elements

(3) Contaminated dry wastes consisting of air filters, miscellaneous paper, rags, etc., from contaminated areas; contaminated clothing; tools and equipment parts; and solid laboratory wastes.

The estimated volumes and the activities and isotopic contents of solid wastes are given in the Annual Radioactive Effluent and Waste Disposal Report.

Handling of Spent Resins

Spent resins from all the radioactive demineralizers and ion exchangers are slurried to the spent resin tank. Slurrying is accomplished by isolating the ion exchanger to be emptied, aligning it to the spent resin tank, and backflushing the exchanger with primary water. The spent resin sluice and flush water will be collected in the aerated drains. As a result of this categorization, handling of spent resins is controlled by plant procedures.

The spent resin that is collected in the spent resin tank will be sluiced on a batch basis to a shipping container. Spent resin remains in the shipping container while the flush water passes through a screen at the bottom of the container and is discharged to the spent resin tank via a portable dewatering pump.

When all spent resin has been transferred to the shipping container, the flushing flow is terminated and the water is pumped out of the shipping container by the shipping container dewatering pump. The spent resin-shipping container, which is a disposable liner or high integrity container, resides in the spent resin building in a process shield during filling.

The shipping container is made ready for storage and eventual shipping. It is stored in a cask or in the spent resin storage facility until it can be loaded onto the disposal contractor's truck. The spent resin activity is controlled by varying the length of time it remains in service in the ion exchange vessel prior to slurrying in order that the cask radiation levels meet Department of Transportation regulations.

Handling of Evaporator Bottoms

Concentrated evaporator bottoms from the aerated liquid waste are routed to a location between the Waste Disposal Building and the new tank farm for solidification by vendor supplied mobile solidification system. The waste line has recirculation sample capabilities, and a primary water connection. All waste lines have heat tracing. Although a number of solidification processes are available by licensed mobile solidification vendors, the evaporator bottoms are typically mixed with cement powder in 182 ft^3 steel liners. After suitable mixing to provide a homogeneous concrete mix and curing, the liners are transported to the yard storage area. Final disposal of the liners is done by a NRC licensed contractor.

Handling of Expended Filter Cartridges

Liquid filters from the spent fuel pool and the waste liquid system are removed from service when the pressure drop across the filters become excessive or the radiation level exceeds a prescribed maximum. The filter cartridges are removed from the filter housing with long-handled tools by personnel protected by a filter removal shield. The expended filter cartridges in their disposable basket are lifted into the filter removal shield and moved by the yard crane to a high integrity container.

Handling of Dry Solid Wastes

Contaminated materials are placed into a suitable transport package. The package is sealed and transported to a waste processor and/or disposal. Contaminated metallic materials and highly contaminated solid objects such as used reactor equipment are placed in packages for shipment and off-site disposal. Equipment too large to be handled in this way is first cut into small pieces before placement in the packages. Contaminated DAW may also be packaged and stored in Sea/Land containers prior to shipment off-site for processing and/or disposal.

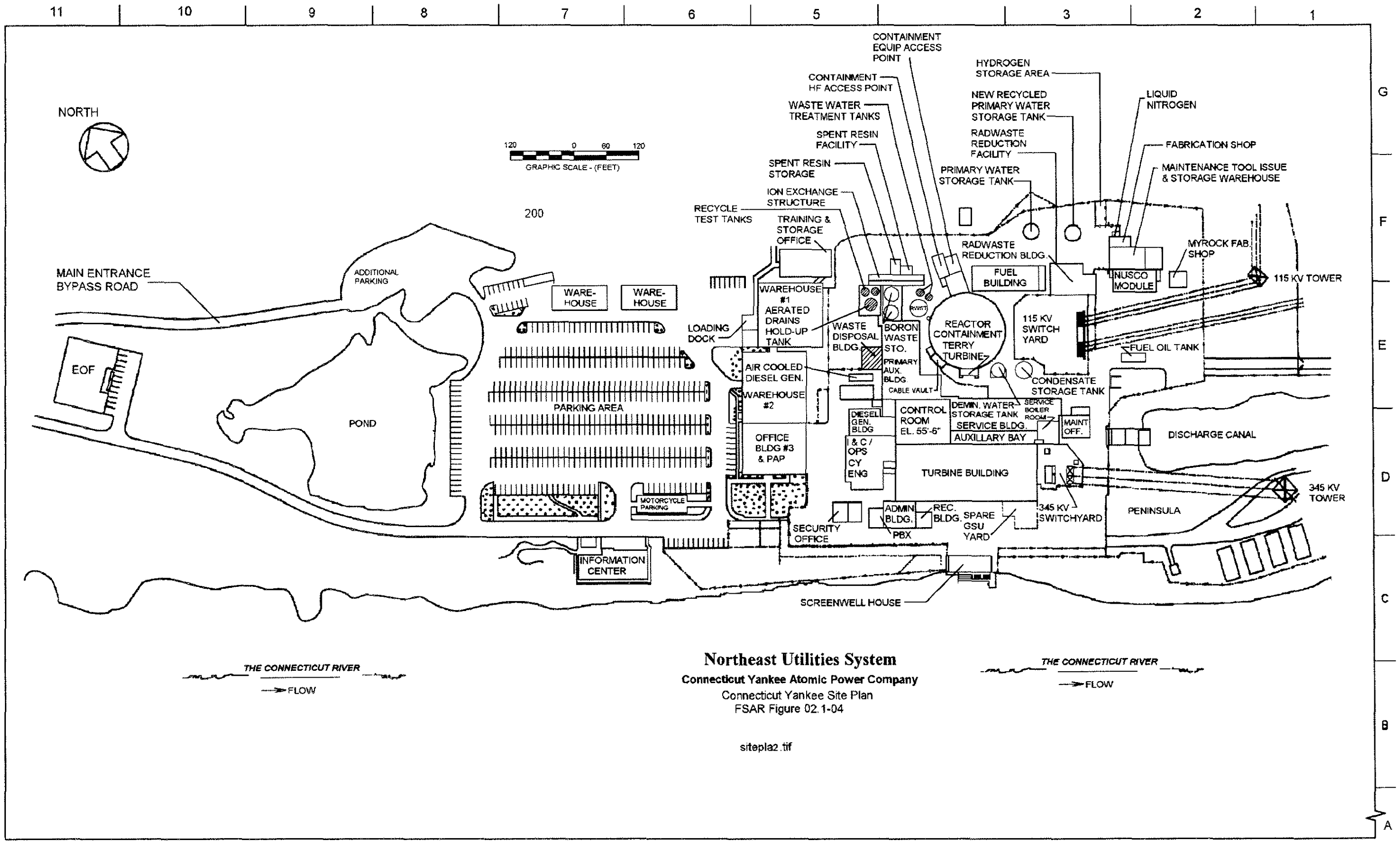

Figure 1 - Location Map - Waste Disposal Building

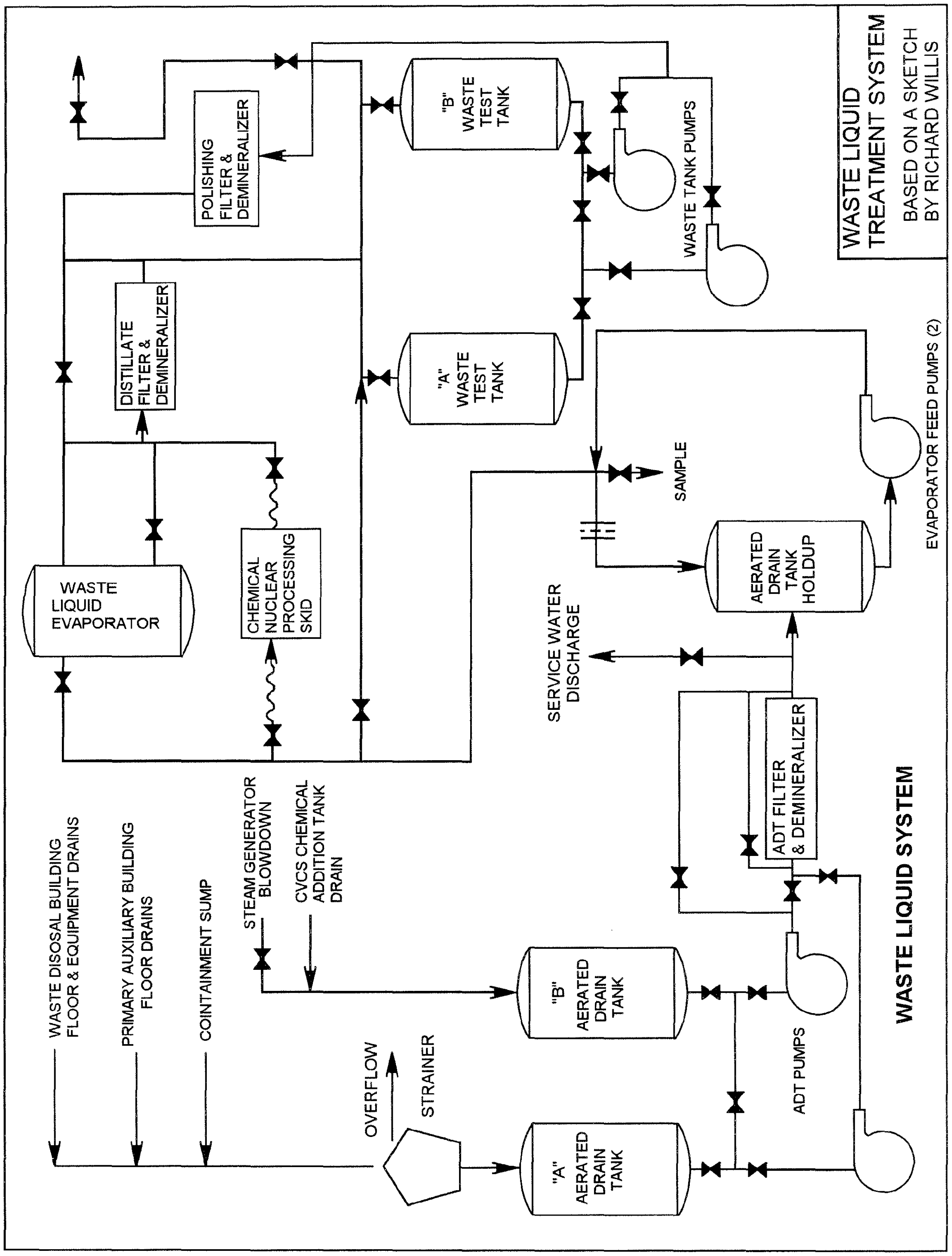

Figure 2 - Flow Chart of Liquid Waste Treatment at Haddam Neck Power Plant

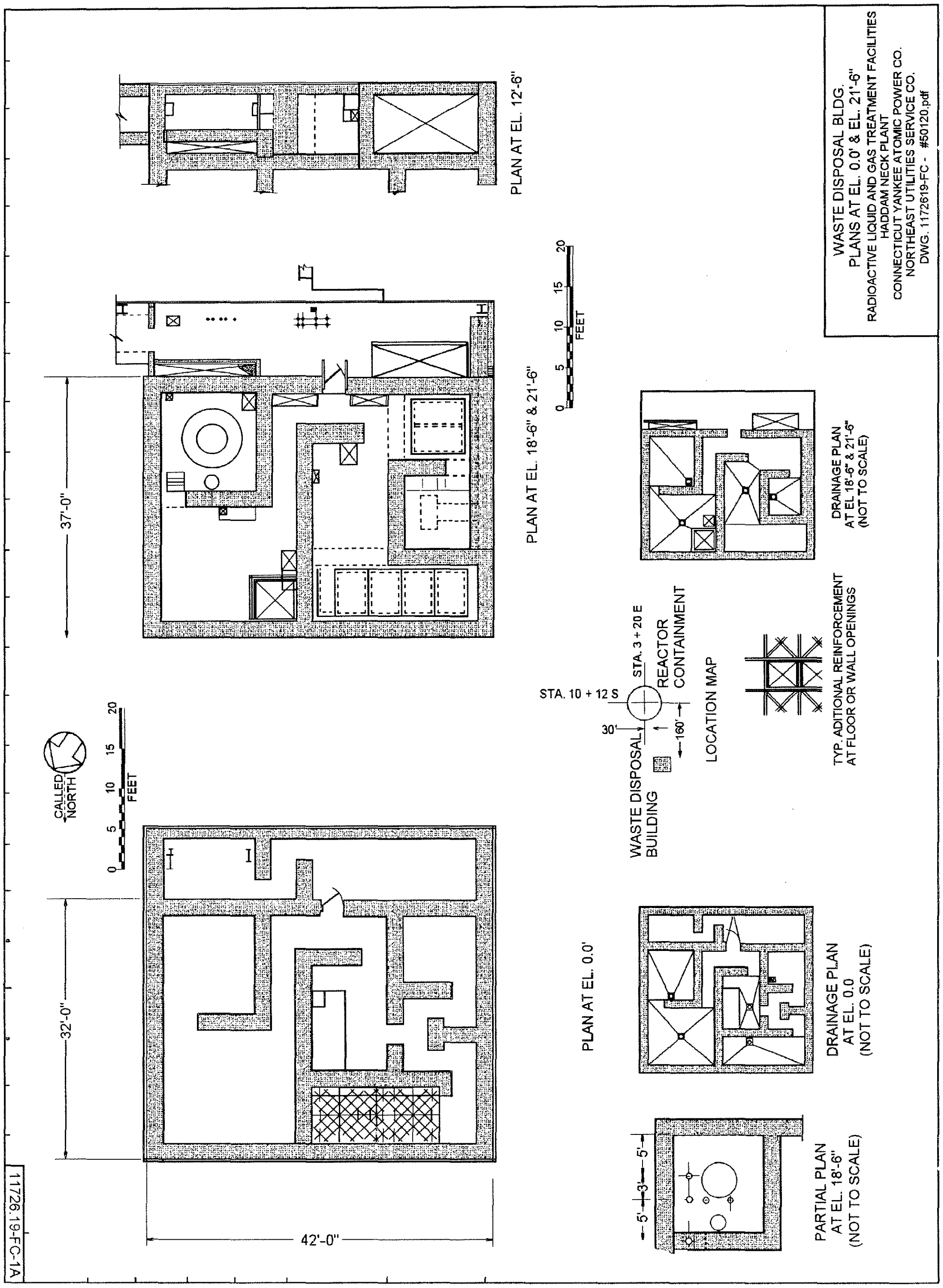

Figure 3 - Floor Plans - Liquid Waste Disposal Building

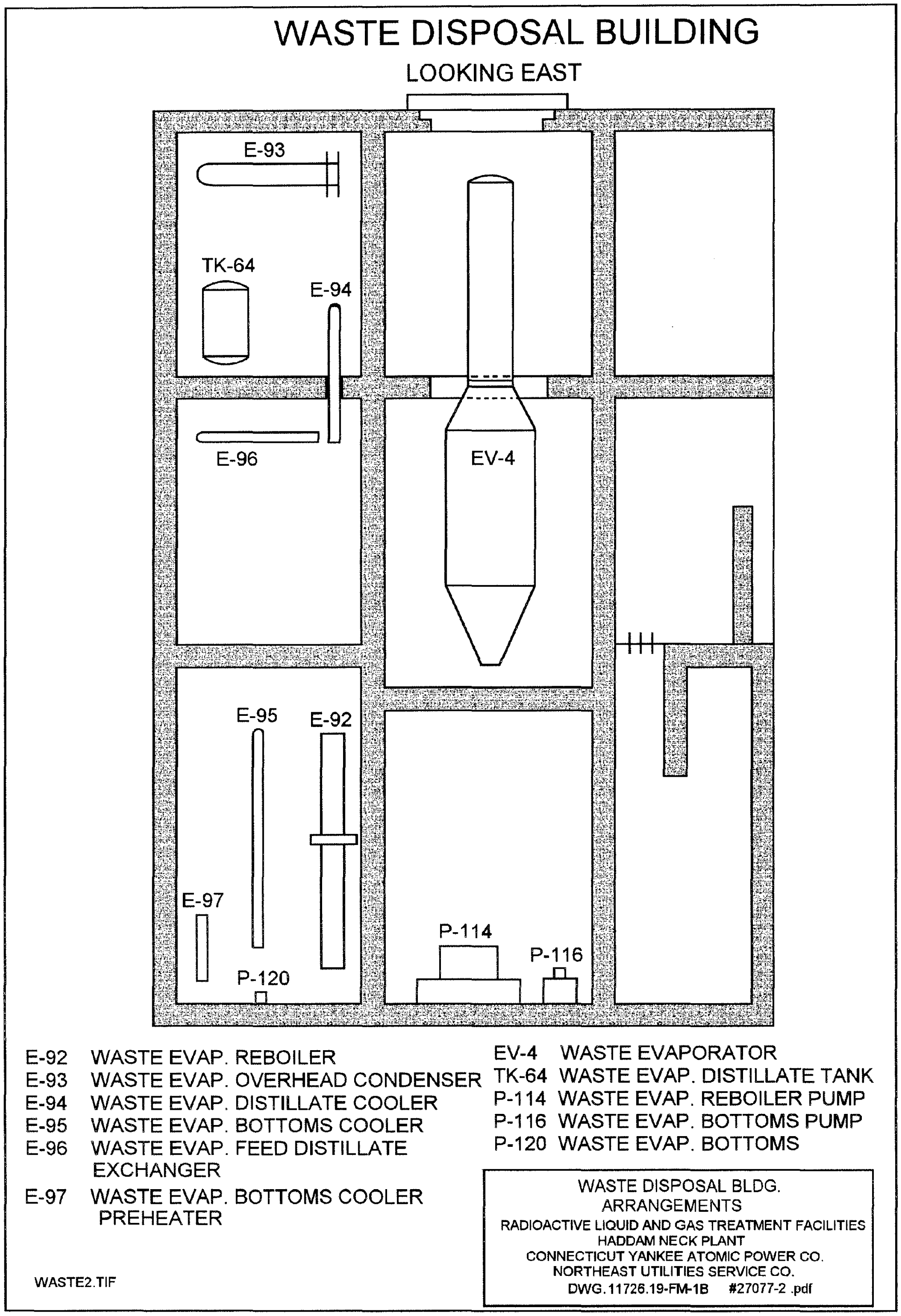

Figure 4 - Section of Waste Disposal Building

NOTES

[1] V.M. Efremenkov. Nuclear Fuel Cycle and Waste Management. IAEA BULLETIN (Vienna, Austria: International Atomic Energy Agency-April 1989), 37-42

[2] Richard Willis. Monographs on Haddam Neck Power Plant facilities (System Descriptions) 28 October 2009.