HADDAM NECK NUCLEAR POWER PLANT, PRIMARY AUXILIARY BUILDING
(Connecticut Yankee Nuclear Power Plant, Primary Auxiliary Building)
362 Injun Hollow Road
Haddam
Middlesex County
Connecticut

HAER CT-185-G
HAER CT-185-G

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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HAER No. CT-185-G

Location:	362 Injun Hollow Road, Haddam, Middlesex County, Connecticut U.S. Geological Survey Haddam & Deep River Quadrangles UTM Coordinates 18.708748.4595057
Dates of Construction:	1964-1966
Engineers:	Stone & Webster Engineering Corporation
Present Owners:	Connecticut Yankee Atomic Power Company (CYAPCO) 362 Injun Hollow Road Haddam Neck CT 06424-3022
Present Use:	Decommissioned and demolished, with some foundations filled in place
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 Primary Auxiliary Building housed many of the reactor auxiliary systems and much of the equipment for the boron recovery and waste disposal systems.
Project Information:	CYAPCO ceased electrical generation at the Haddam Neck plant in 1996 and initiated decommissioning operations in 1997, subject to Nuclear Regulatory Commission (NRC) authority which brought the project under the purview of federal acts and regulation protecting significant cultural resources from adverse project effects.[a] This documentation was requested by the Connecticut State Historic Preservation Office to preclude the possibility of any adverse project effects.

[a] 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).

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Summary Building Description

The Primary Auxiliary Building (PAB) was a complex, essentially two-story structure with a deep basement section at the northeast end, located immediately north of Reactor Containment in Connecticut Yankee's orientation system[b]. Approximately 70 by 150 feet in plan, the PAB extended 32 feet above the main plant grade elevation of 21.5 feet,[c] and had two main floor levels at elevations 21.5 and 35.5. Rooms on the first level had elevations varying from 15.5 to 25. From the upper floor level down, the PAB was built with 1-to-2-foot-thick reinforced concrete walls and floors, which along with partial below-grade construction provided shielding for boron recovery, waste disposal, and other reactor auxiliary systems. At elevation 13.5, 6-foot-high pipe galleries ran the full length of the approximate longitudinal axis, with laterals connecting to PAB equipment. The galleries were covered with removable concrete slabs to allow for pipeline servicing, with the slabs forming the floor of a central first-floor corridor. At the pipe gallery elevation, three 6.5-foot-high pipe trenches totaling approximately 45 feet in width ran from Reactor Containment into the called southeast corner of the PAB. A Seal Water Filter Cubicle adjacent to one of these trenches contained filters which reduced particulate impurities in the high-pressure seal injection system forcing water into the reactor coolant pump seals in Reactor Containment as part of the Chemical and Volume Control System (CVCS). Pipes in two of the trenches from Reactor Containment ran to equipment in the lowest section of the PAB, a 70-by-34.5-foot complex of rooms with a floor elevation of -19 including the Residual Heat Removal Pit and equipment for the waste gas, liquid waste, service water, and chemical and volume control systems. [1]

Immediately above the pipe trenches from Reactor Containment, the first PAB level included rooms for the sampling and the steam generator blowdown systems at elevations 22 and 25 on the south side of the building, and for pumps on both sides used for the Primary Water System and for the Chemical and Volume Control System. Further west on the first level beyond the pipe trenches from Reactor Containment, the south side of the PAB had safety injection pumps used in the Emergency Core Cooling System at elevation 15.5, and an area for storage of metal drums. On the north side were two pump rooms used for the Chemical and Volume Control or Emergency Core Cooling systems, a multi-level complex housing most Boron Recovery System components, and Component Cooling Water System heat exchangers and cooling pumps at the northwest corner of the PAB. The Boron Recovery System components, described below, were in two adjacent rooms: a two-level space dominated by the Boric Acid

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[b] The PAB was longitudinally oriented northeast-southwest. The Connecticut Yankee "called north" direction, which paralleled the Connecticut River, was to the northwest. Thus the long side of the PAB closest to Reactor Containment was called the south side. See Figure 1, and drawing HAER No. CT-185, Sheet 4 of 7.

[c] All elevations are in feet relative to mean sea level.

Mix Tank, including CVC boric acid equipment, with full or partial floors at elevations 21.5 and 36.5; and a three-level space for evaporators and pumps with floors at elevations 15.5, 25.5, and 36.5. Control boards for boron recovery and waste disposal systems, and for PAB equipment motor control centers, were located along the central corridor on the first level. From the longitudinal center of the corridor, a branch hallway ran north to the adjacent Waste Disposal Building (HAER No. CT-185-L), above an apparently unused pipe trench designed for the un-built second Connecticut Yankee unit.[2]

Above the first floor, concrete shielding was limited to the Volume Control Tank (VCT) used for chemical volume control and emergency core cooling, and to Boron Recovery System evaporators and condenser. The remainder of the second story had steel-framed, insulated Galbestos walls, and enclosed PAB ventilation equipment, Reactor Containment ventilation and purge fans, the exhaust fan and filter for the New and Spent Fuel Building (HAER No. CT-185-J), the Component Cooling Water Surge Tank, and Service Water System filters, Steam Generator Blowdown condensers, the Chemical Addition Tank for the Chemical Volume Control System, and storage areas for cement and boric acid. The steel-framed, metal-decked roof supported vent fans, was penetrated by a number of vent stacks, and supported vent ductwork structures.[3]

Ceiling-mounted monorails and hoists were used on both main PAB levels to handle equipment, move shielding blocks, and transport bags of boric acid or cement and drums of waste. On the first level, these systems had 2- and 5-ton capacities and were powered with electric motors. The upper-level monorail and hoist, serving only the Boric Acid Tank, had a 1-ton capacity and used hand-operated chains for hoisting. Liquid from the building floor drains in potentially contaminated areas flowed to the Aerated Drains tanks of the Aerated Liquid Waste System in the lowest section of the PAB. Water from floor drains in clean areas flowed to the yard storm sewer.[4]

As described in HAER No. CT-185, Connecticut Yankee operated with a large number of engineering safety systems, most of which included components in multiple structures to protect against accidents or system failures in the Reactor Containment Building. Some of these systems involved alternative functions of equipment used in normal operations. The Containment Sump, Containment Air Recirculation and Containment Spray systems had significant components within Containment, and are described below.

Primary Water System[4]

The Primary Water System (PWS) was a storage and distribution system serving principally to supply low-oxygen-content water to the Boric Acid Blender for automatic or manual make-up to the Reactor Coolant System, as part of the Chemical and Volume Control System. The

PWS also supplied high-purity water to various plant systems for filling, venting, flushing or special testing. The Primary Auxiliary Building housed the PWS pumps and most of the equipment receiving purified water.

The well water used in the PWS was purified in the Water Supply and Treatment System located in the Turbine Building auxiliary bay (HAER No. CT-185-C), and piped to two 150,000-gallon storage tanks located east of the New and Spent Fuel Building and the Radwaste Reduction Facility (HAER Nos. CT-185-J and CT-185-N), each heated to prevent freezing.[d] The Primary Water Storage Tank and the Recycle Primary Water Storage Tank were each associated with two centrifugal 200-gpm transfer pumps, run by 50-hp motors, in the Primary Water pump room at the east end of the PAB first floor. The PWS sat idle until needed, and supplied water via numerous valve line-ups from the transfer pumps. Normal service involved one tank and one pump, with the selected pump set for automatic start on a signal from the CVCS to supply the Boric Acid Blender, located immediately north of the Boric Acid Mix Tank on the north side of the PAB firsts floor. The selected pump could also be started manually to supply other equipment. In addition to the Boric Acid Blender and Boric Acid Mix Tank, other CVCS components supplied with primary water in the PAB included the Purification Pump in the northeast corner of the first floor and the Volume Control Tank Chemical Addition Tank on the second floor. In the Residual Heat Recovery Pit, the PWS supplied a flush connection for the Waste Liquids Strainers in the Liquid Waste System, and seals and hose connections for the Primary Drains Tank pumps in the Waste Gas System. Primary water could also feed the Sampling System heat exchangers and sample sink in the sample rooms at the northeast corner of the first floor, the seal of the Liquid Waste System's Waste Test Tank Pump at the east end of the first floor, and undocumented initial fill components of the Boron Recovery System.

From the Primary Water System pumps, water was also supplied to Reactor Containment, the New and Spent Fuel Building, the Ion Exchange Area, and the Waste Disposal Building.

Boron Recovery System[5]

The Boron Recovery System classified, treated and disposed of potentially radioactive liquid, gaseous and solid materials and recovered boron from the liquid wastes for re-use in the

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[d] Connecticut Yankee Atomic Power Company/Stone & Webster Engineering Corp. 1963-1994 [drawings]. The Recycled Primary Water Storage Tank was added in 1973. Initially intended to store distillate effluent from the Boron Recovery System for return to the Reactor Coolant System, it was instead used as a backup to the Primary Water Storage Tank following a determination that the water would become radioactive if the tank was used as first planned; see Connecticut Yankee Atomic Power Company 1987-1993: Chapter 53, pages 5-6.

Reactor Coolant System. Most system components were located in the three-level PAB Boron Recovery Room, focused on two evaporators normally operated in series. All remote operations (start pumps, set controllers, monitor operation, etc.) were conducted from the control panel on the PAB ground floor just south of the Boron Recovery Room. The basic processes used in this system were natural decay of radioactive isotopes, ion exchange and filtration for removal of crud[e] and ionic isotopes, evaporation to reclaim boric acid or to concentrate radioactive constituents into small volumes of liquid wastes for solidification in concrete, baling to reduce the volume of compressible solid wastes, and dilution of low activity liquid and gaseous discharges.

Hydrogenated liquid waste, collected in the Primary Drains Collecting Tank as part of the Waste Gas System, was pumped under automatic level control to one of the two 75,000-gallon Boron Waste Storage Tanks (BWST), located in a concrete enclosure immediately east of the PAB. The BWSTs were originally protected against freezing by steam heat exchangers, later replaced with electric heat tracing. The boron concentration of the wastewater was approximately 2000 ppm. One BWST served to receive waste until the tank was 80% full, at which point the other tank was lined up to receive waste and the water in the nearly-full tank was placed on re-circulation, sampled by a chemical technician, and processed using the Boron Recovery System. Sampling allowed for calculation of the amount of water to be processed to get the boron concentration high enough (approximately 20,000-25,000 ppm) to be sent to the Boric Acid Mixing Tank (BAMT) for re-use. The Boron Recovery System was designed for automatic operational control, once all system control set points were established.

Using one of two Waste Liquid Transfer pumps, the wastewater to be processed was pumped from a BWST through the Waste Liquid Ion Exchanger and the Waste Liquid Transfer Filter (both located in the Ion Exchange Area - HAER No. CT-185-K). The Ion Exchanger resin removed fission products, and the exchanger and transfer filter also removed radioactive crud from the process water. The liquid flowed from the filter to the Distillate Feed Heat Exchanger in the lower level of Boron Recovery Room, and was there heated by effluent from the Reactor Containment system before entering the First Stage Evaporator.

The First Stage Evaporator Bottoms Pump pumped water from the evaporator to the First Stage Evaporator Boiler where it was heated by steam and returned to the First Stage Evaporator. Liquid in the First Stage Evaporator then flashed to steam, which was used as a

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[e] Crud is a colloquial acronym (from Chalk River Unidentified Deposits) for corrosion and wear products (rust particles, etc.) that become radioactive (i.e., activated) when exposed to radiation, based on the initial discovery of such material at the Chalk River Canadian nuclear plant (see a Worldwide Web definition at http://www.nrc.gov/reading-rm/basic-ref/glossary/crud.html).

heat source for the Second Stage Evaporator. The condensate formed in the First Stage Evaporator was fed to the Second Stage Evaporator, from which the Second Stage Evaporator Bottoms Pump pumped water to the Second Stage Evaporator Boiler. Steam from the first stage heated water in the Second Stage Evaporator Boiler. The water from this boiler flashed to steam in the Second Stage Evaporator. Both boilers were located in the lower level of the Boron Recovery Room.

On the upper Boron Recovery Room level, the steam from the second stage flowed through the Evaporator Overhead Condenser to become liquid or distillate which passed to the Distillate Accumulator.[f] One of two Distillate pumps on the middle level of the Boron Recovery Room moved the water through the Distillate Feed Heat Exchanger to one of two 16,000-gallon Recycle Test Tanks (RTT), located in a concrete enclosure outside the PAB immediately north of the Boron Waste Storage tanks. Water in the RTT was stored until released through the Service Water return header, or reprocessed through the Boron Recovery System. When the amount of water previously calculated for reprocessing had run through the system, steam was isolated from the First Stage Evaporator Boiler and a sample of the First Stage Evaporator was taken. If the boron concentration was correct, the First Stage Evaporator Bottoms Pump was used to pass the liquid to the Boron Drumming Pump for transfer to the BAMT. Before entering the BAMT, the liquid passed through the Boric Acid Recovery Cooler. Located on the lower level of the Boron Recovery Room, the cooler — a double-walled coil served by the Component Cooling Water System — prevented the solution from flashing to steam. If the liquid was not pumped to the BAMT, it could be pumped to the drumming room for drum storage and shipment off site. When pumping the bottoms of the First Stage Evaporator was complete, the liquid in the of the Second Stage Evaporator was pumped to the First Stage Evaporator, and the Second Stage Evaporator was refilled with demineralized water

Sampling Systems

Sampling systems provided liquid and gas samples for laboratory analysis to help control reactor coolant chemistry and radiochemistry. Analysis equipment and procedures evidently evolved during Connecticut Yankee operations, but the changes have not been documented in detail. Samples obtained from Reactor Containment were piped to heat exchangers for cooling in the radioactive valve room at the southeast corner of the PAB first floor, via a pipe trench from Reactor Containment, and were diverted to a ventilated, hooded sample sink in the

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[f] By c1990, the Evaporator Overhead Condenser was taken out of service, but documentation on how the condenser's function was replaced is not available (see Connecticut Yankee Atomic Power Company 1987-1993: Chapter 43, page 45).

adjacent sample and valve room to the west after purging as described below. Most Sampling System equipment was located in these PAB rooms. Drains from the sample sink went to one of the Waste Disposal System aerated drain tanks in the PAB Residual Heat Removal Pit. The radioactive valve room was continuously monitored by a plant area radiation monitor. A delay coil, capillary tube and several sample lines with associated valves were located in Reactor Containment. There were two general classes of sample: high temperature - high pressure samples taken from inside Reactor Containment as part of the Reactor Coolant (RCS), Steam Generator Blowdown, or Residual Heat Removal systems; and low temperature - low pressure samples taken from Reactor Containment, PAB equipment, or the Ion Exchange Area (HAER No. CT-185-K) as part of the Chemical and Volume Control, Reactor Coolant, Waste Liquid, and various auxiliary cooling systems.[6]

High Pressure - High Temperature Samples

These samples included one from each steam generator blowdown line, one from the pressurizer drain, a pressurizer steam space sample, a pressurizer liquid space sample, and a sample from the RCS loop 1 hot leg immediately upstream of the Residual Heat Removal intake line. Each sample line was controlled by a remotely-operated isolation valve is located just outside Reactor Containment.[7]

Samples from the steam generator blowdown lines and the pressurizer drain entered a common header. All the high temperature - high pressure samples noted above appear to have been cooled in heat exchangers by component cooling water, to temperatures of under approximately 120° F. The steam generator blowdown samples were cooled in four heat exchangers (E-24-1, 2, 3 and 4) and the other high temperature - high pressure samples were evidently cooled in three other nearby "hot leg" heat exchangers (E-9-1, 2, and 3). The latter samples, after discharge from the heat exchangers, were manually throttled to 100 psi gage or less, and then purged to the Volume Control Tank or to the waste disposal system. After sufficient purging, smaller samples were diverted to the sample sink for collection. Most of the steam generator blowdown sample flow was directed via a common sample line through two steam generator blowdown radiation monitors (R-16A and R-16B) in the PAB radioactive valve room, and then into the Steam Generator Blowoff Tank in the adjacent sample and valve room. The radiation monitors provided remote indication on the Main Control Board in the Service Building (see HAER No. CT-185-F). The remaining steam generator blowdown sample flow passed through a second heat exchanger and individual steam generator chemistry monitoring panels before discharge to the floor drains. Each of the four steam generator chemistry monitoring panels, located in the PAB Primary Water pump room or in one of the two PAB sample rooms, provided continuous, local and remote indication of PH, raw conductivity, cation Conductivity, chloride concentration, and sodium concentration.[8]

In addition to the pressurizer samples noted above, a sample of pressurizer gas space was diverted to the sample sink for collection, after sufficient purging to the Volume Control Tank or Waste Disposal System.[9] Samples from Residual Heat Removal System lines, upstream of the system's pumps and downstream of its heat exchangers in the PAB Residual Heat Removal pit, were low-pressure samples with high temperatures. These samples were cooled in the hot leg sample heat exchangers, and the pressure was reduced by a manual throttle valve. After sufficient purging to the Volume Control Tank or Waste Disposal System, some of the flow is diverted to the sample sink for collection.[10]

Low Pressure - Low Temperature Samples

These samples, purged directly to the to the Volume Control Tank or Waste Disposal System prior to collection in the sample sink, included one each from the de-mineralizer inlet and outlet in the Ion Exchange Area, one taken downstream of the centrifugal charging pumps in the PAB charging pump room, a gas space sample from the Volume Control Tank, and a gas space sample from the pressurizer relief tank in Reactor Containment. The gas space samples were obtained by purging through a stainless-steel, 10-milliliter sample vessel to the PAB ventilation system, and then isolating the sample in the sample vessel which was removed for analysis. The sample vessel station was located in the well-ventilated sampling hood.[11]

In the Primary Auxiliary Building, the Residual Heat Removal pumps in the recirculation mode pulled water from the sump (but not the overflow) and sent the water to the Low Pressure Safety Injection Pumps, High Pressure Safety Injection and Charging pumps — components of the Emergency Core Cooling System (ECCS) — for addition to the coolant loops.

NOTES

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[1] Connecticut Yankee Atomic Power Company/Stone & Webster Engineering Corp. 1964-1993a, 1964-1993b, 1964-1985, 1964-1996 [drawings]; Connecticut Yankee Atomic Power Company 1966-1974: 5.4-1
2. Ibid.
3. Ibid.
4. This section compiled from Connecticut Yankee Atomic Power Company 1987-1993: Chapter 53.
5. This section compiled from Connecticut Yankee Atomic Power Company/Stone & Webster Engineering Corp. 1964-1993b, 1964-1996, [drawings]; Connecticut Yankee Atomic Power Company 1966-1974: 5.3; Connecticut Yankee Atomic Power Company 1987-1993: Chapter 44, page 15; Willis 2002.
6. Connecticut Yankee Atomic Power Company 1966-1974: 5.2.4, 8.1; Connecticut Yankee Atomic Power Company 1987-1993: Chapter 6, 10, and 30.
7. Connecticut Yankee Atomic Power Company 1966-1974: 5.2.4-1; Connecticut Yankee Atomic Power Company 1987-1993: Chapter 30, page 17.

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8. Connecticut Yankee Atomic Power Company/Stone & Webster Engineering Corp. 1964-1993b [drawings]; Connecticut Yankee Atomic Power Company 1966-1974: 5.2.4-1, 5.2.4-2; Connecticut Yankee Atomic Power Company 1987-1993: Chapter 30, pages 17-18.
9. Connecticut Yankee Atomic Power Company 1966-1974: 5.2.4-2.
10. Ibid.
11. Connecticut Yankee Atomic Power Company 1966-1974: 5.2.4.

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HAER No. CT-185-G

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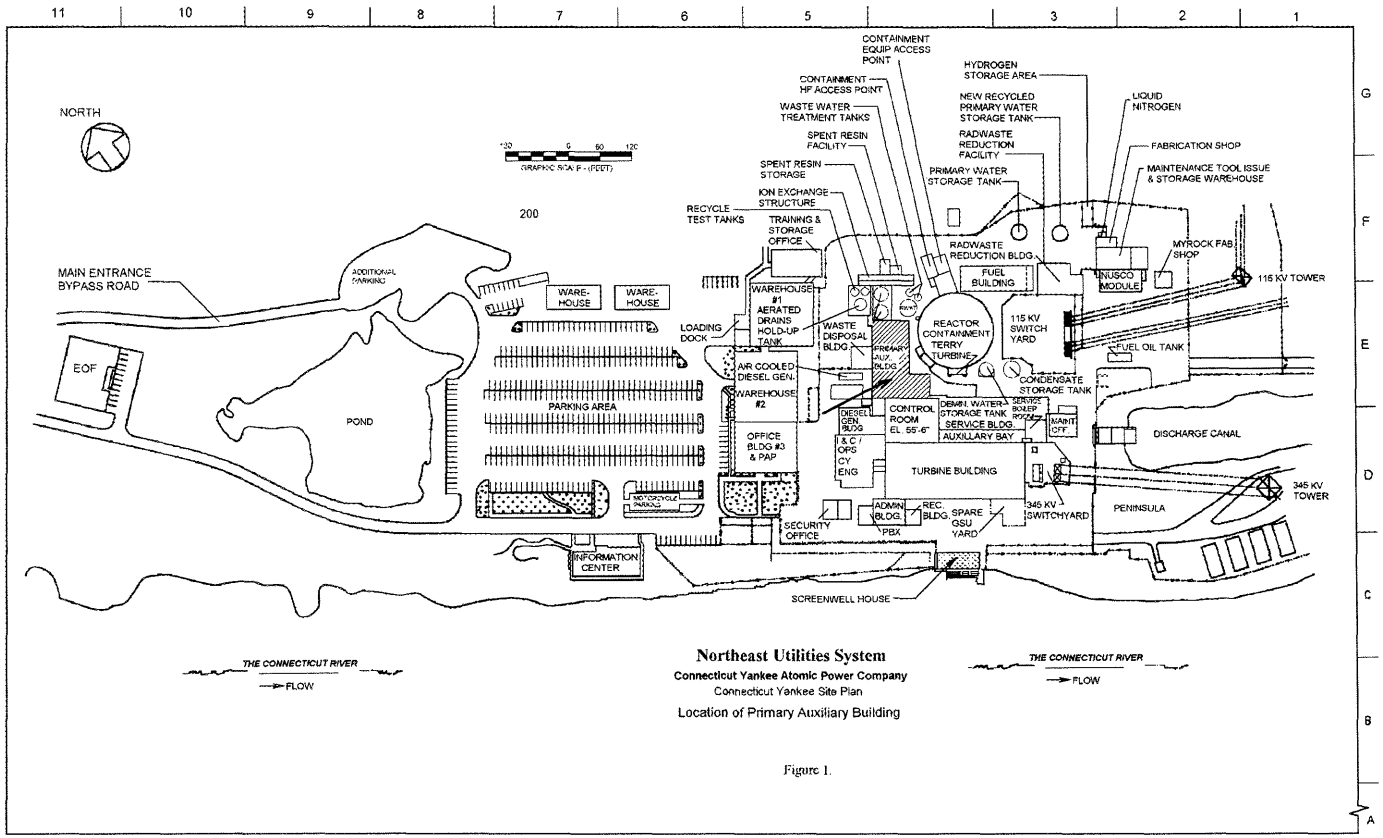

Figure 1.

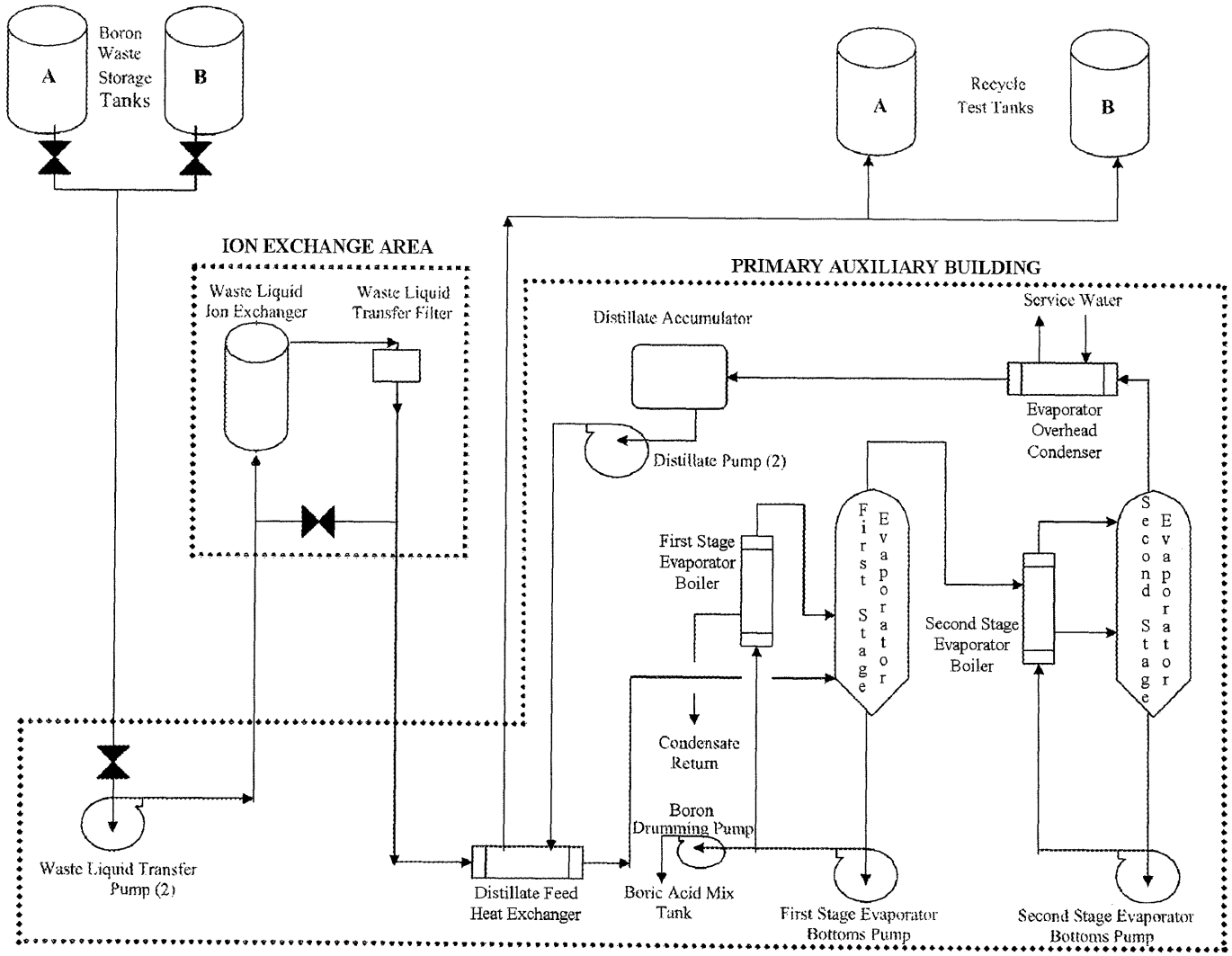

Figure 2. BORON RECOVERY SYSTEM FLOW PATH DIAGRAM
base image: Willis 2002