HADDAM NECK NUCLEAR POWER PLANT, SERVICE BUILDING
(Connecticut Yankee Nuclear Power Plant, Service Building)
362 Injun Hollow Road
Haddam
Middlesex County
Connecticut

HAER CT-185-F
HAER CT-185-F

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

REDUCED COPIES OF MEASURED DRAWINGS

FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
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HISTORIC AMERICAN ENGINEERING RECORD

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HAER No. CT-185-F

Note: Documentation includes Service Boiler Room (HAER No. CT-185-Q) and Control Room.

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; renovated 1981-1984
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 Service Building complex housed many of the facilities supporting the power plant. The ground floor originally was devoted to receiving supplies, warehousing and a machine shop. Lockers and shower facilities were located at the north end of the building. After renovation locker and shower facilities were significantly expanded and facilities for disposal of contaminated protective clothing and monitoring of radiation were added. A boiler room that maintained many Auxiliary Steam System loads during repairs to that system or reactor shut-down periods was sited at the south end of the building. A third floor at elevation 59'-6" housed the control room and an observation room overlooking the turbine room.
Project Information:	CYAPCO ceased electrical generation at the Haddam Neck plant in 1996 and initiated decommissioning operations in 1997, 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. This documentation was requested by the Connecticut State Historic Preservation Office.

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General Building Description

The Service Building at elevation 21.5' was oriented on a northwest-southeast axis with the northwest end "called north" on plant drawings. The building was supported by a steel frame and concrete walls sheathed in Galbestos siding. This covering was composed of corrugated, zinc galvanized, heavy gage steel sheets coated on both sides with thin, asbestos felt-like layers. Framing was welded and bolted steel with columns forming two 20-foot, nine 25-foot and two 19 foot-wide bays. The building was structurally continuous with the Turbine Building and Control Room. The structure was 43 feet wide. Roof height over the one story southeast section that housed a warehouse and maintenance shop was 20 feet and covered an area of 7718.5 square feet. Adjacent to the warehouse and machine shop to the northwest was a multi-level area containing locker rooms, showers, offices, records storage and health physics facilities. A mezzanine, 62 feet by 103 feet, housed Switchgear Room A. The operating floor at elevation 59.5 feet housed the control room, a process computer room and an observation corridor overlooking the turbine room. The building was part of the original plant built between 1964 and 1966. Concrete seismic protection, a new roof and raised floors in the control room and chemistry lab were added in the renovation of 1981-1984. Sketch drawings showing the plans and elevations of the Service Building are shown in Figures 2 through 5.

Service Boiler Room

The Service Boiler Room was built at the south end of the Turbine Building's Auxiliary Bay, adjacent to the warehouse section of the Service Building. The single story, 24.3-foot-high, 40.2-by-44.8-foot structure had steel-braced, 8-inch-thick concrete block walls, insulated Galbestos siding on the lone exposed exterior facade, and a flat metal roof pitched towards the Auxiliary Bay for drainage. Two 13-foot-high, 12-foot-wide roll-up garage doors on the south side, fronted by concrete ramps, allowed for equipment installation, and a 3-foot-wide man door at the northwest corner provided access to the Auxiliary Bay. Around 1981, vehicle access to the Service Boiler Room was blocked by construction of a maintenance office. The roof was breached by an exhaust fan, and by a welded steel metal stack used to vent gases from the room's two boilers. From a 6.8-foot-square metal hood, the 2.8-foot-square stack rose approximately 18 feet, made a right-angle bend to run approximately 12 feet over the roof of the Auxiliary Bay, and joined an approximately 60-foot-high, 4-foot-diameter vertical pipe stack attached to the side of the Turbine Building.

The facility was technically part of the Auxiliary Steam System in the Turbine Building. When the Nuclear Steam Supply System was producing steam, the 6-inch Auxiliary steam line off the 36-inch header provided reduced- and low-pressure steam for various equipment and for steam heaters around the plant. During shutdowns of the reactors or during repairs to the Auxiliary Steam System, these loads were maintained from the Service Boiler Room.[1]

The heating loads at 100 psi included heat exchangers and ventilation heaters in the Turbine Building, Reactor Containment and its cable vaults. Also the Service Building, the Primary Auxiliary Building, the New and Spent Fuel Building, the Ion Exchange Area, and the Administration Building. Electrically-heated tanks included the Primary Water Storage Tank and the Primary Recycle Water Storage Tank. In addition to heating loads, the Service Boiler Room also backed up Auxiliary Steam System processing steam loads in Waste Disposal Building and the RadWaste Reduction Facility.[2] There were two other Auxiliary Steam System loads in the Turbine Building necessary for efficient running of the plant which were not supplied by the Service Boiler Room: the gland seal and exhaust systems of the turbines and generator, and the Priming Air Ejectors of the Condensate & Feed water System.[3] Either of the cylindrical, oil-fired fire-tube boilers in the Service Boiler Room could take 100% of the loads assigned to this facility, producing 25,000 lbs per hour of steam at 115 psig. The Cleaver-Brooks series 100 model boilers were "package" designs which could be hauled to the site largely complete on lowboy trailers.[4] were produced by each one. Feed water was treated to prevent harmful deposits on the tubes in a chemical addition tank which supplied the boiler feed pumps. A Fuel Oil Storage and Transfer System fed No. 2 fuel oil was fed into each burner. Fuel and combustion air was mixed in an atomizer and ignited by a propane pilot light. Hot gases from the burners flowed through tubes surrounded by water giving up heat through the tube walls and boiling the water. Baffles in the tube area forced the gases to make three more passes before exiting the boiler. Steam was collected in a space between the top of the water and the shell of the boiler and routed into a steam header connecting both boilers to the system. Non-return valves prevented one boiler from feeding steam into the other. The boilers had the usual suit of ASME code safety valves, gauge glasses, and fittings. An undocumented breeching combined the gases and directed them to the stack through the roof of the building.

The boilers were equipped with an automatic starting and control system. Unless an operator manually started the boilers, they would start and stop based on sensors on the steam header. If pressure in the header dropped because of high demand, the boilers came on. If the minimum firing rate exceeded the needs of the loads downstream the burner would be shut off. The system prevented startup if the pilot light failed or the water level dropped below a set point.

Condensed water from the various steam loads was sent to the main condensers in the Turbine Building when the main steam header was in service. When the reactor was down and the service boilers were operating, the condensed water went back to a condensate receiver tank in the Service Boiler Room which fed the boilers when they were supplying the load. Water was removed from the boilers to clear out sludge and impurities from the surface of the water space (top blow), and the bottom of the boiler tank (bottom blow) was discharged to a blow-off tank and then to the discharge canal.[5] The service boilers were not expected to come on line during the run cycle of the plant. They were normally laid up full

of water (wet lay-up) to exclude air for corrosion prevention and all control circuits were de-energized. Prior to a planned outage, the boilers had to be completely drained and then re-filled to the proper water level to ensure mixing of anti-corrosion chemicals.[6] The system was then energized and valves lined up for boiler service to the header.

Control Room

The control room of the Connecticut Yankee plant was located at the north end of the service building. Approximately 90 feet x 102 feet[7], it was a actually a multi room facility. The largest area contained the main control board and auxiliary control boards. Other rooms were the computer room, observation room with windows overlooking the turbine room, work control center, a room for control alarm stations, mechanical equipment room, office, kitchen and toilets. The control room was maintained at a set temperature and ventilation was automatically shut down if containment pressure rose so operators could stay on duty during a LOCA.[8] An elevator and stairs were located outside the control room at the northeast corner of the building. Originally the plant operators utilized remote control technologies originally developed at the beginning of the 20th century to start up, run, monitor and shut down the plant from a central location via the control boards. During the 1980s complete updates to the Reactor Protection, Nuclear Instrumentation, Flux Monitoring and Post-accident sampling modernized the Control Room and installed solid state controls equal to those found in the most recently built plants. The Main Control Board (MCB) was about 45' wide in a 3 sided polygonal arc. The board was divided into sections (panels) A-J for clarity and to smooth the operation of multiple plant systems. Controls for all the plant equipment were on sloping consoles worked by operators from a standing position. Equipment was activated by push buttons, hand levers, or for safety from accidental activation, spring loaded pull knobs and other undocumented control interfaces. Above the consoles were vertical panels on which were mounted analog moving needle type dial meters, chart recorders and annunciators. The vertical surfaces met the suspended ceiling and behind the boards were racks and drawers of relays which signaled plant equipment, sent back signals indicating the actions taken and indicated status.

Major systems controlled from the MCB were Reactivity Control, Primary Systems, Reactor Coolant System and pressurizer, Containment auxiliaries, Control Rod Chemical and Volume Control System (CVCS), Emergency Core Cooling System (ECCS), Main Steam, Feed water, Condensate, Main Turbine, Main Generator, 115 KV, and 345 KV electrical distribution. A radiation monitoring system connected the main board with "channels" to various liquid, gas, and air counters and detectors around the plant.[9]

Opposite the left side of main board were the Auxiliary Control Boards that had their own annunciator panels which operated the Emergency Diesel Generators, Post Accident Monitoring and Sampling and the Low Pressure Dump. As originally configured, there was a small communications desk in front of the main board.

Annunciation

Along the top of the board were rows of backlit and labeled information boxes called annunciators which signaled the operators by illumination and alarm that a particular piece of equipment or function needed attention. Relays tied sensors in the specific location to each annunciator. Push button stations separated for plant primary side and secondary side had 3 buttons for Acknowledge, Reset, and Test. If an alarm condition occurred the lights would flash and an audible alarm went off. The operators had to acknowledge the indication to silence the alarm and stop the flashing lights. When the alarm condition was cleared, the lights would flash again until the operators reset the circuits. A contemporary photograph of the control room taken during initial plant testing shows annunciators lit with red and white lights. As the Plant information book describes indication as steady or flashing without reference to color, that may indicate an undocumented change in mode sometime during the life of the plant.[10]

For two major components: the reactor and the turbine, the annunciators operated differently. Designated "First Out", they monitored only the conditions that would cause the those units to trip out and ignored secondary alarm conditions which would result from transient changes in the sensors brought on by such major components shutting down. This allowed operators to see what conditions caused the alarm as opposed to those that resulted from it.[11] Typical wording on the First Out panels were "Turbine Trip, Loss of Reactor Coolant Flow, and Pressurizer Hi Press." Tests were done every 8 hours or once per shift. Electric power for the annunciators and the relay trains originating at the board was supplied from two 125v DC busses. They were considered highly reliable since were supplied by the backup battery banks.[12]

Integrated Process Computer

As originally designed, the control room used analog indicators and protocols. All indications were provided by moving needle dial type meters, chart recorders and colored or flashing labeled annunciators actuated by multiple sensors around the plant via trains of switching relays. The room may have been devoid of CRT screens except for those connected to observation TV cameras. Safety instrumentation was solid state. In the event of a series of malfunctions, the operators would be tasked with sorting out the causes and taking appropriate action. A 1965 article in Electrical World describing the plant discussed the inclusion of an 8K data logger computer which was to relieve operators of routine data collection, monitor reactor power, and alarm out of limit conditions.[13] The system as installed in the Computer Room was an IBM System 1800 with 8,192 words of core memory and 512,000 words of disc storage.[14] 600 analog and digital inputs could be scanned periodically while 110 digital inputs could be scanned several times a second. Alarm monitoring function was only supplementary to the annunciators. The incore neutron

detectors inputs could be mapped to provide fairly sophisticated data for core analysis. Output for the operators was largely via printouts from typewriters and a paper tape unit. There were 2 "digital displays" of undocumented type. The system had no capability to control components and operators relied on The Reactor Control[a] and Protection System which provided a high degree of automatic control through multiple sensors, control units, and an averaging unit which showed percent of power output on recorders at the main board.[15]

In September of 1982 a specification for a plant computer system was issued.[16] This was the result of investigations by the NRC into the causes of the Three Mile Island (TMI) accident [17] and from recommendations from the Westinghouse Owners Group, and owners groups formed around the other manufactures reactor systems.[18] Specifically the system was to address the problem of operator error resulting from multiple alarms going off during an emergency.[19] Further justification came from a task force report on Safety Parameter Display System (SPDS) in April of 1983 and another specification in 1986. In 1985 a PDCR was issued for the "replacement of the process computer" which was completed at the end of 1987.[20] Since the original IBM system was not referred to as the process computer, it is undocumented if the PDCR referred to an earlier intermediate system.

The apparent late inclusion of a state of the art system for managing data (but not control of major components) may indicate that Westinghouse was conservative in their approach to running nuclear plants and well behind England. In the U.S. 1965 Duke Power installed a primitive control computer in their fossil fuel Marshall Steam Station. The system admitted steam to the turbines, synchronized the generator and monitored alarms. The 8,000 word core, 80,000 word drum memory system displayed information to the operators by flashing photographic slides on a glass screen with different status messages.[21] In 1968, the Oldbury Nuclear Power Station in England may have been the first to have a computerized alarm system that displayed the plant status on CRTs.[22] It utilized a 1040 computer with 4096 word core and 2 8000 word drums. The system had a complex "alarm tree" design in which the alarms were sorted and highlighted or hidden in ways that would enable operators to control fast moving accidents and subsequent conditions. The plant was still run by operators at a large control board which had backup analog annunciators for shutting down the plant. At the slightly later English Hinkley Point B station, the system was used for a number of control functions. Each of the reactor/turbine units was controlled from a desk with a CRT with overall supervision from another CRT desk. There were two CPU's for

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[a] . Westinghouse documents refer to the main part of the automatic system that controlled the reactor as the Reactor Control System. (Spurgin 1970: 599.) CYAPCO documents don't use that terminology, instead referring to the Reactor Protection System, perhaps to avoid confusion with the Reactor Cooling System (RCS).

redundancy with 36,000 16 bit word cores each and 800,000 16 bit word storage drums. The reactor/turbine units could not be started without the computers on line and shutdown was required if the systems failed. There were wall mounted analog displays as backup. In previous stations the computer was still an adjunct to traditional control technologies; at Hinkley Point B the roles were reversed.[23] At the time that Connecticut Yankee went on line, Combustion Engineering designed plants utilized Westinghouse Prodoc 250 computer systems with 3,000,000 8-bit bytes and a working memory of up to 65,000 16-bit words. The system was used for data logging and processing, alarming, nuclear and steam plant calculations, processing of incore signals, fuel burnup, and Xenon transients. No reactor control functions or automatic safety shutdown function were incorporated.[24] A 1970 Westinghouse description of their system of nuclear plant control still described the three channel type Reactor Control System as used at Connecticut Yankee.[25] In explaining why computer control would be a future development, the author noted that while some plants had installed computers, there were risks. Specifically that a controlling computer could cause the Reactor Control System to fail at a critical juncture or that a system protection computer would increase risks by bringing together many functions that could be more readily trouble shot as separate entities. The standard of single failure criterion (component redundancy as proposed by the Institution of Electrical and Electronics Engineers) would thus require 2 computers with attending complexity.[26] In conclusion the article noted that changes in regulatory requirements and public influence on control and protection systems delayed and increased the cost of nuclear plant construction.

The Connecticut Yankee Integrated Computer System (ICS) which most plant documents call the Process Computer, utilized multiple color CRT displays/keyboards and redundant host CPUs to monitor plant operation.[27] The undocumented model of IBM[28] computer in the process computer room had 2 CPU's for 99% availability, synchronized with a time of day clock The dynamic data base was stored on high speed bulk memory data storage solid state devices with random access cores. A static database was stored on bulk data storage discs. Archival storage was on 2 magnetic tape drives. A new console was installed in place of the earlier communications desk to mount the control operators' terminal, alarm terminal and printer.[29] The Aydin Controls model 5215 color/graphic Alarm Terminal showed the newest alarm on top of the screen with up to 200 older alarms pushed down.[30] Additional CRTs were provided for the shift supervisor, reactor engineer and technical support personnel. A Technical Support Center (TSC) terminal was located in the Emergency Operations Building. Any of those screens could display the alarm status.[31] The Alarm, Trend, Reactor Operator, Reactor Engineers and TSC printers were specified to be either high speed or low speed and to be quiet enough to not require sound proof enclosures. A 1995 PDCR[32] described an upgrade to the Modcomp Plant Process Computer (Modcomp Computer System , Inc[33]). It is unclear whether the Modcomp Computer had earlier replaced the above described system.

Reflecting Westinghouse' reliance on their RCS which was perfected at the Yankee Rowe station[34], the main role of monitoring Critical Safety Functions (CSF) was still was provided by the Main Control Board through Emergency Operating Procedures (EOP). The computers' Safety Parameter Display System (SPDS) role was to aid the personnel in managing the plant via improved man-machine interface, alarm processing, increased data scan rates, better data logging, trending, and storage of historical information. One lesson from TMI was that the EOPs were to oriented to the sequences of events. They couldn't really handle multiple failure events while forcing operators to diagnose problems before choosing the correct EOP. Operators needed a system that was independent of the initiating causes to restore and maintain the plant after an accident. Reflecting the concern that the SPDS system would interfere with the Reactor Control/Protection System, inputs were passed through a signal validation process.[35] Signals were validated and given a "quality tag" after a pass/fail process. The seven critical safety functions covered by the new system were Subcriticality, Core Cooling, Heat Sink, RCS Integrity, Containment Integrity, Reactor Coolant Inventory and continuous radiation monitoring. The primary displays for the 7 functions were the Critical Safety Function Status Boxes which were tied in to status trees formulated from the Emergency Response Guidelines.[36] SPDS displays on the terminals were given 8 different colors i.e. Green = alarm status-normal or Red = Alarm Status - Immediate Operator Action Required.[37] The SPDS was not considered to be a safety grade system in spite of its 99% availability.

A field data acquisition subsystem to the Process Computer fed the CPU's with data from digital or analog sensors around the plant.[38] For example, the Rod Position Indication System sent AC analog signals to a converter behind the switchboards which sent a DC signal to the computer, while the rod Group Position Indication System sent digital signals to the computer.[39] If they indicated that the rods were out of step the computer actuated an alarm. However, the there were procedures to check the positions without the computer operating.[40] Incoming signals were isolated before being fed the ICS to prevent spurious interference with the SPDS.

Switchgear room.

Directly under the control room was a switchgear room that transformed, controlled and routed the three separate electrical systems that ran event critical equipment in the plant. Components for that purpose were circuit breakers, step down transformers, motor control centers, and the battery banks that provided low voltage DC and AC current that operated turbine generator emergency auxiliaries, motor operated switches, annunciators, solenoid powered valves, vital bus inverters and the emergency lighting. Power came into the Switchgear room from the 4160V AC station service transformers and was switched by air circuit breakers powered by 125 V DC motors.[41] This type of breaker originated in 19th century power stations for preventing damage from overloads and other anomalies in

relatively low voltages and currents. The arc produced when the current carrying copper conductors were separated was quenched by carbon contacts. Manual tripping and closing was powered by the DC system so control was independent from the 115kv supply to the plant. Each breaker was mounted in wheeled drawout sections (also known as truck boards) for ease of maintenance. Current was then stepped down to 480 V AC in four non-flammable Inerteen type oil insulated transformers. Two undocumented type transformers made a further reduction to 120/208 for station lighting. The main distribution system for the 480V service were Motor Control Centers (MCC) with separate bus sections and 15,000 amp circuit interrupting rating. All the wire in the 480 system was copper with 600 V insulation installed in trays, conduits or in-floor ducts. Also located in the room were the 2 flywheel motor generators that powered the Control Rod Drive System along with the isolation breakers and the reactor trip (scram) breakers mounted in cubicles.[42]

125V DC System.

Safe shutdown of the plant was required, even if all incoming 115kv power was interrupted and the diesel generators failed (station blackout).[43] Many of the components throughout the plant that worked on shutdown (valve, circuit breaker and relay control, motor operated disconnect switches, emergency lighting, emergency oil pumps, and Control room annunciators and horns) were designed to be controlled or powered from DC buses of the 125 V DC system in the switchgear room.[44] Power for the system originally came from 2 separate banks of 60 interconnected lead- acid battery cells with a capacity of 1800 amp hours mounted in earthquake resistant racks.[45] Both 20 foot long batteries were set along the east wall of the building. They were each supplied by a static (solid state) battery charger taking power from the 480V AC buses, stepping the voltage down by internal transformers and rectifying it to DC. During normal operation the battery chargers directly fed the DC buses while automatically maintaining a floating charge on the banks.

Vital Power System

Throughout the plant there were safety related low voltage devices that had to operate on alternating current. They were supplied by the very reliable 120V AC Vital Bus powered by the same batteries and chargers that powered the 125V DC system.[46] The DC was converted to AC by solid state inverters connected in pairs to each battery. They could operate independently and could shift load to each other.[47]

Semi-Vital Power System

The Semi-Vital 120V AC system was an additional source of regulated power for less important control and instrumentation circuits.[48] Loads included instrument detectors, control circuits, solenoid operated control valves and actuation relays. Power for the system

came from 2 different buses from the motor control center 5. Loss of the Semi-Vital would cause reactor trip due to the loss of the main feed water pumps. Many other important pumps would either loose power or require manual tripping.

Switchgear Building

On 3-7-87 PDCR #865 was issued to initiate construction of a new stand alone Switchgear Building containing a Switchgear room designated B was constructed to augment the old Switchgear room which became Switchgear A. The reasons for the change is undocumented. Completion of the structure in Sept. 1989 resulted in the following changes:

125 Volt DC

Equipment in the Switchgear Room of the new Switchgear Building included a lead-calcium battery designated Battery B split into 2 sections with a battery charger, and 2 inverters. At that time the batteries in the old Switchgear room were converted to lead-calcium type along with new inverters.[49] One battery (A) was located at the original site but enclosed in a room with a "seismic wall" built at the north end for undocumented reasons. Battery C was installed behind a wire fence at the south end of the room.[50] Each battery fed a bus (A, B, sub bus Bx and C) of the 125V DC system. 2 battery chargers in the A room and 1 in the B room had a total of 200 to 300 amp capacity and directly supplied their respective DC buses during normal operation while maintaining the batteries fully charged. As noted in UFSAR 1998, the original Inerteen oil transformers were replaced for undocumented reasons with 5 dry type (non-oil insulated) with fan forced or natural air cooling.[51] They were powered by the emergency bus for safety. If the 480V AC power the to chargers failed, the batteries took up the load.[52] Batteries A and B could be powered by the back up diesel generators.[53] Although each battery/charger supplied its own bus, the buses were not redundant. Loss of Bus A led to a reactor trip since instrumentation for the pressurizer levels and reactor power failed in the trip position on power loss. This scenario could also make it difficult to trip the main turbine.[54] Loss of Battery B was not as critical except for disabling of the steam dump system. Bus C could be cross connected to either A or B buses via a bus tie breakers. The reasons for placing the A and B batteries in different rooms may have been for redundancy in the event of fire since they shared the most load. With maximum capacity of 1,200 amp hours the system could power the required components for 3 hours if all off-site power was lost and both (circa 1990) diesel generators failed to start.[55] Regular loads on the DC system were the vital bus static inverters and control power for AC switchgear. Motor loads were the Emergency Turbine Bearing Oil Pumps, Emergency Air Side Seal Oil Pumps from bus C and motor drive disconnect switches from the other buses.[56]

Battery Systems in general were a source of trouble in American and Foreign plants including CY. Systems became overloaded with new equipment bringing down the run times.[57] Battery Chargers sometimes failed. The plates cracked or altered in size from aging. The cases cracked and spilled electrolite. If one battery lost all its fluid it could cause the loss of the entire bank, leaving the plant in an unanalized conditions since the critical monitoring systems were run by DC for safety.[58] Even worse, if battery voltage dropped, control room indicators could then give erratic readings confusing the operators.[59] Remedies were increased surveillance and substitution of lead-calcium batteries as was done at CY.

Vital

As reconstructed, the Vital system was fed by two inverters in Switchgear A each powered by battery A, and 2 inverters in Switchgear B from the single battery B there.[60] The A inverters (A, B) utilized silicon semi-conductor rectifiers (SCR) which rapidly switched current from the semi-vital bus on and off (60 times per second) creating a square wave AC current. The timing rate of the SCR's was controlled by a logic board with 120V AC input from the Semi-Vital Bus. "Sola" transformers capable of very close regulation then "rounded off" the corners of the wave form through induction creating a very close version of the normal AC sine wave.[61] The B Inverters (C, D) did not require the logic boards and the regulating "Sola" transformers to produce a closely regulated (+or- .5%) AC output.[62] As reconstructed, the Vital system was fed by 2 inverters in Switchgear A each powered by battery A, and 2 inverters in Switchgear B from the single battery B there.[63] The A inverters (A, B) utilized silicon semi-conductor rectifiers (SCR) which rapidly switched current from the semi-vital bus on and off (60 times per second) creating a square wave AC current. The timing rate of the SCR's was controlled by a logic board with 120V AC input from the Semi-Vital Bus. "Sola" transformers capable of very close regulation then "rounded off" the corners of the wave form through induction creating a very close version of the normal AC sine wave.[64] The B Inverters (C, D) did not require the logic boards and the regulating "Sola" transformers to produce a closely regulated (+or- .5%) AC output.[65] [b]

Semi-Vital

Due to its important role in maintaining backup for control devices PDCR 942 (not in file, date undocumented) called for a major configuration change to increase reliability of the systems' original source of supply. Since Motor Control Center (MCC) 5 could be completely lost, MCC-12 was added as a backup source.[66] Whether this change occurred during the reconfiguration with Switchgear B is undocumented. To power the semi-vital buses, the 480 volt supply was stepped down in the same type of "Sola" transformers that

[b]. Documentation of original equipment of vital bus equipment is sketchy; inverters and sola transformers in Switchgear A may be original equipment.

supplied the Vital bus from the inverters. The system was energized at all times but was switched off from all loads until needed.[67]

Uninterruptible Power Supply

The addition of modern computer equipment in the control room required a new AC supply system. An Uninterruptible Power Supply (UPS) came from a 3 phase 120/208 bus which could be supplied by DC to AC invertors, battery chargers, 60 cell lead-calcium battery, or 3 phase regulating transformer. Switching from the normal inverter supply to the transformer was by an automatic static transfer switch which utilized silicon rectifiers instead mechanical contacts for current switching. The lead-calcium batteries could power the inverter at full load for ½ hour without recharging. Most of this equipment was located in the UPS room abutting the Oil Storage Room towards the N.W. corner of the ground floor Turbine Building.[68] (HAER No. CT-185-C). While the MCC 6. supply bus for the UPS could be supplied by the Emergency Generators [69] the UPS loads were de-energized if both the battery and transformer supply was lost. The system was considered "highly desirable" for plant operation, but since the plant could operate with the computer down, operability requirements were not included in the Administrative Control Procedures.[70]

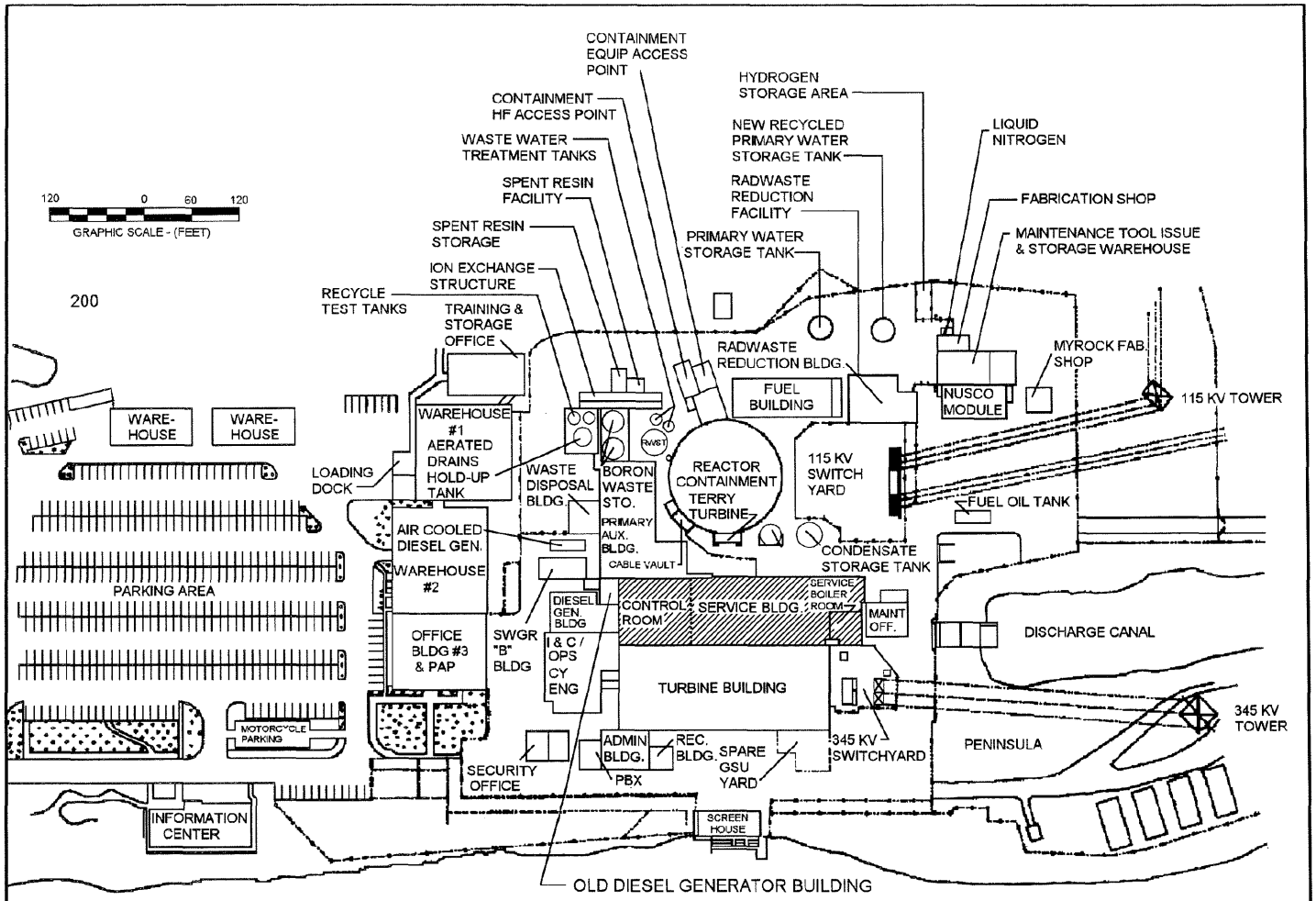


Figure 1 - LOCATION OF SERVICE BUILDING, CONTROL ROOM AND BOILER ROOM

HADDAM NECK NUCLEAR POWER PLANT

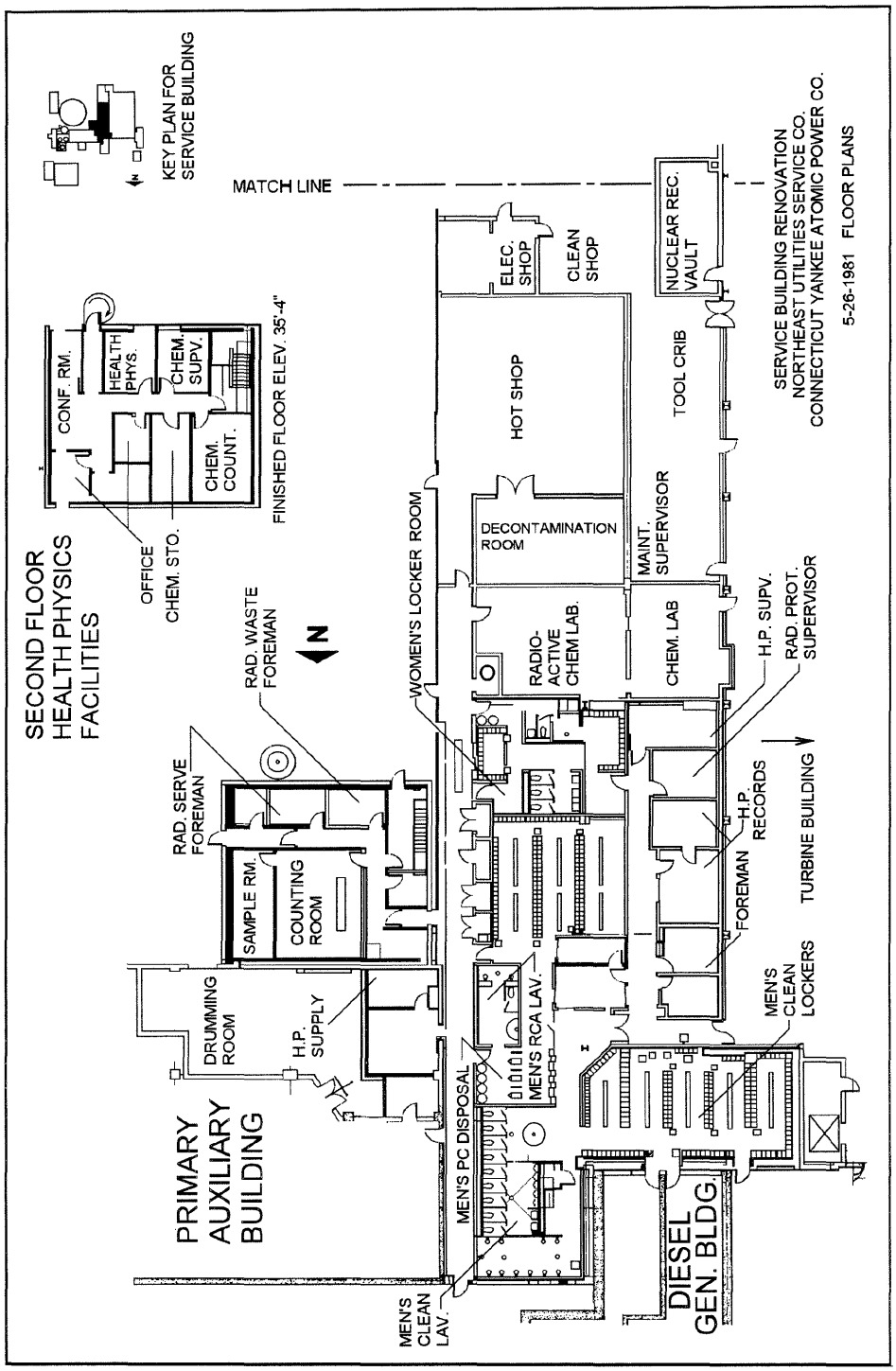


Figure 2 - FLOOR PLAN-SERVICE BUILDING-RENOVATED

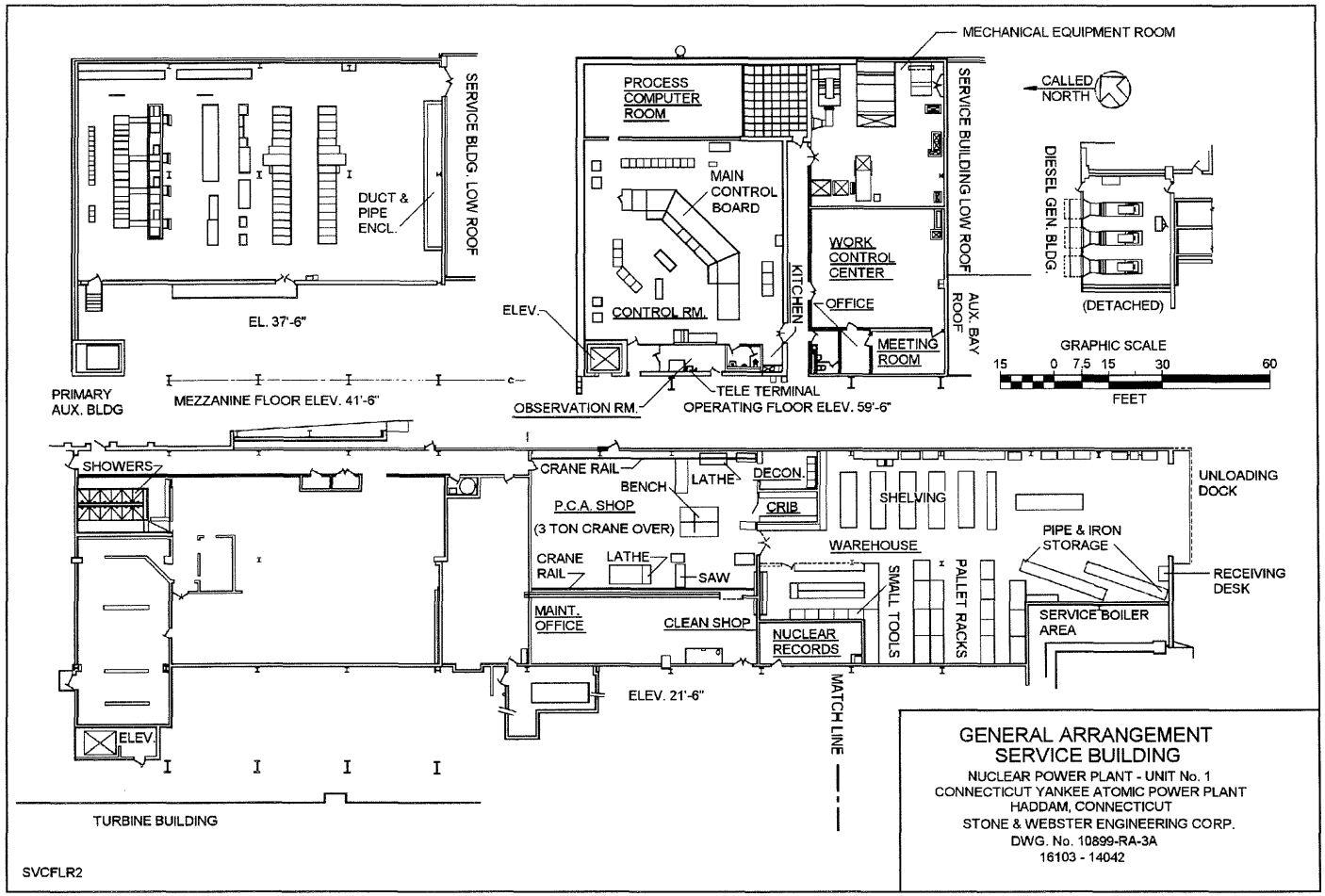


Figure 3 - SERVICE BUILDING 1ST FLOOR WAREHOUSE, MACHINE SHOP AND OPERATING FLOOR CONTROL ROOM

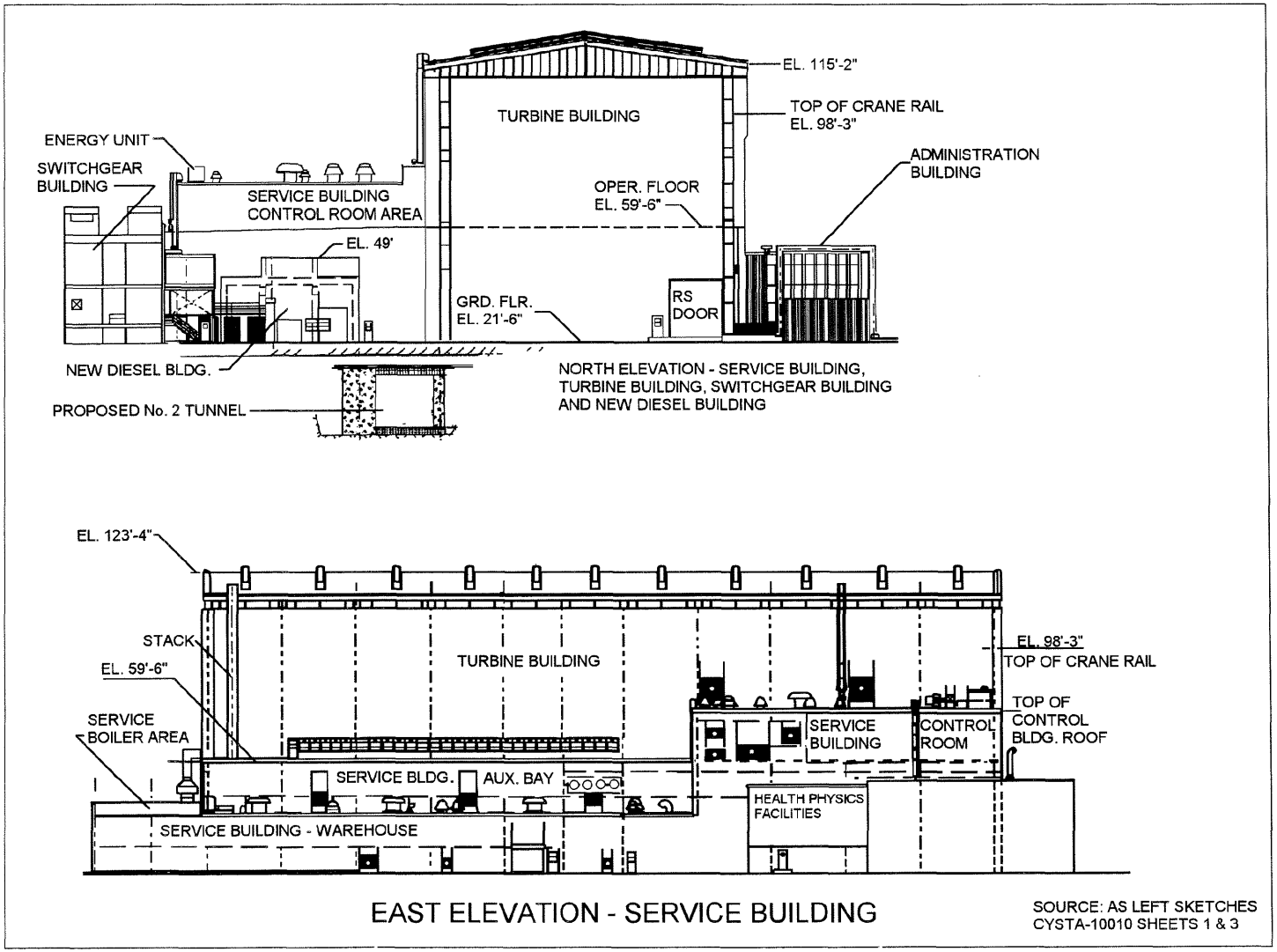


Figure 4 - ELEVATIONS OF SERVICE BUILDING

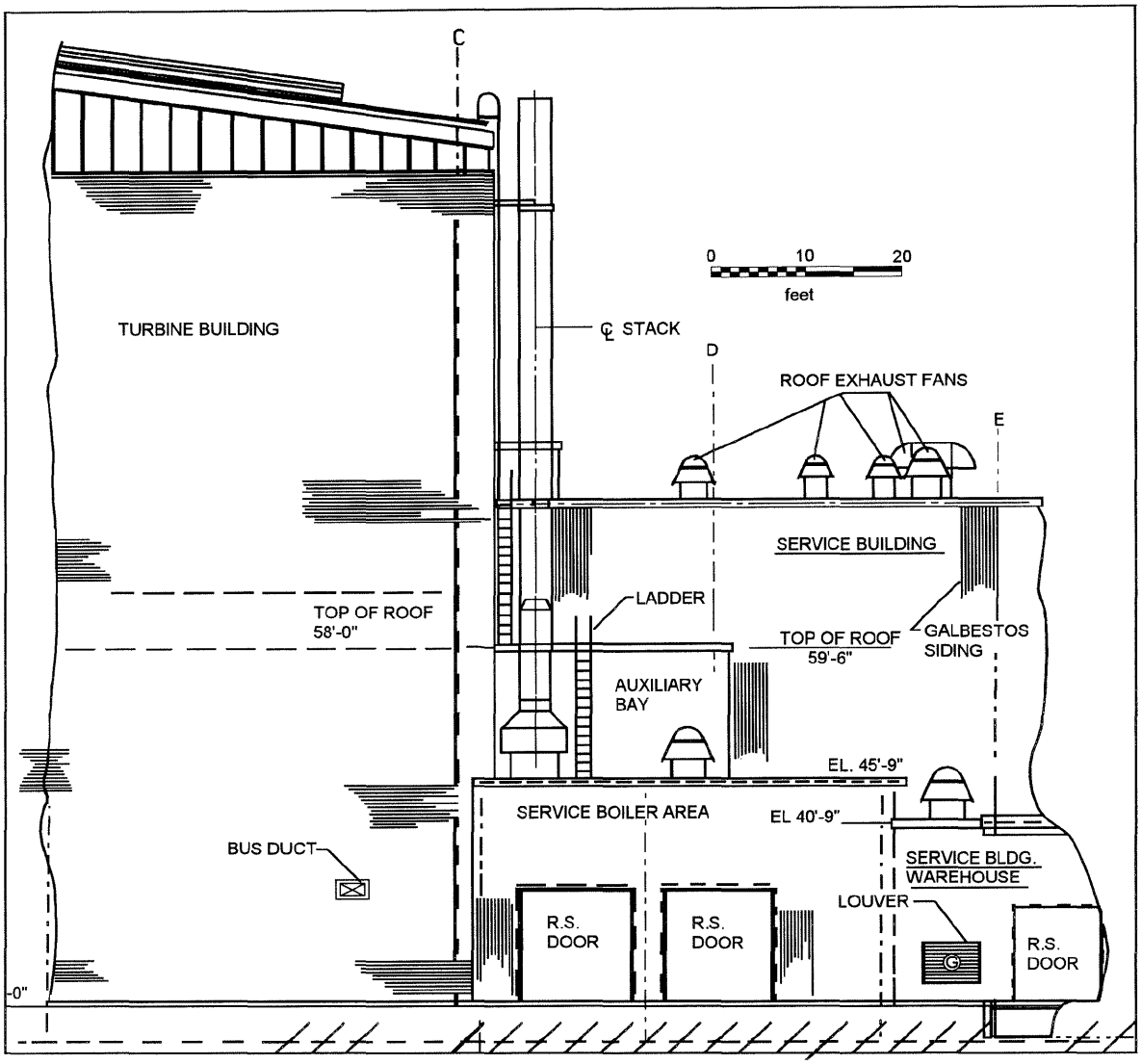
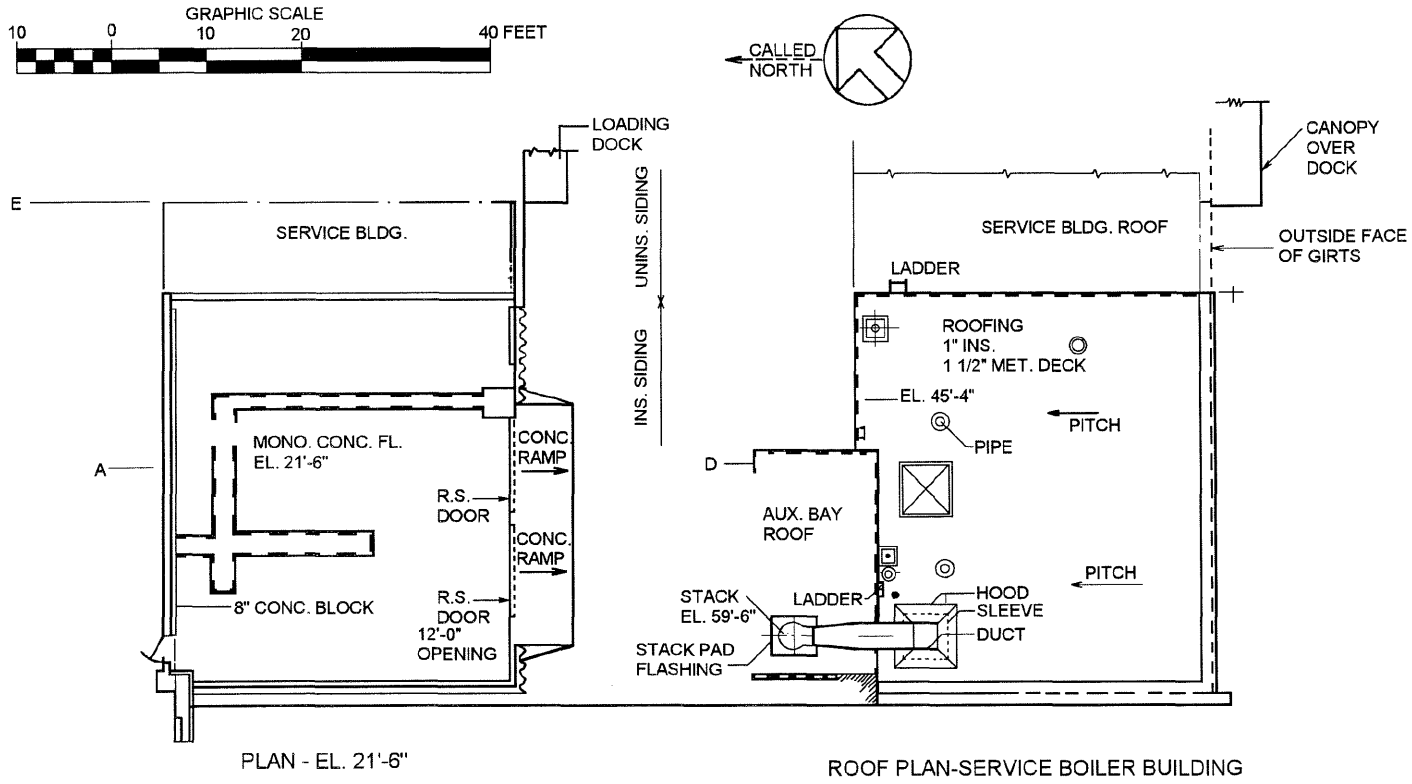


Figure 5 - PARTIAL VIEW OF ELEVATION OF SOUTH END OF SERVICE BUILDING, TURBINE BUILDING AND SERVICE BOILER AREA



SERVICE BOILER ROOM FLOOR AND ROOF PLANS

source: Connecticut Yankee Atomic Power Company/Stone & Webster Engineering Corp. 1964-1984 (drawings)

Figure 6 - FLOOR AND ROOF PLANS FOR SERVICE BOILER BUILDING

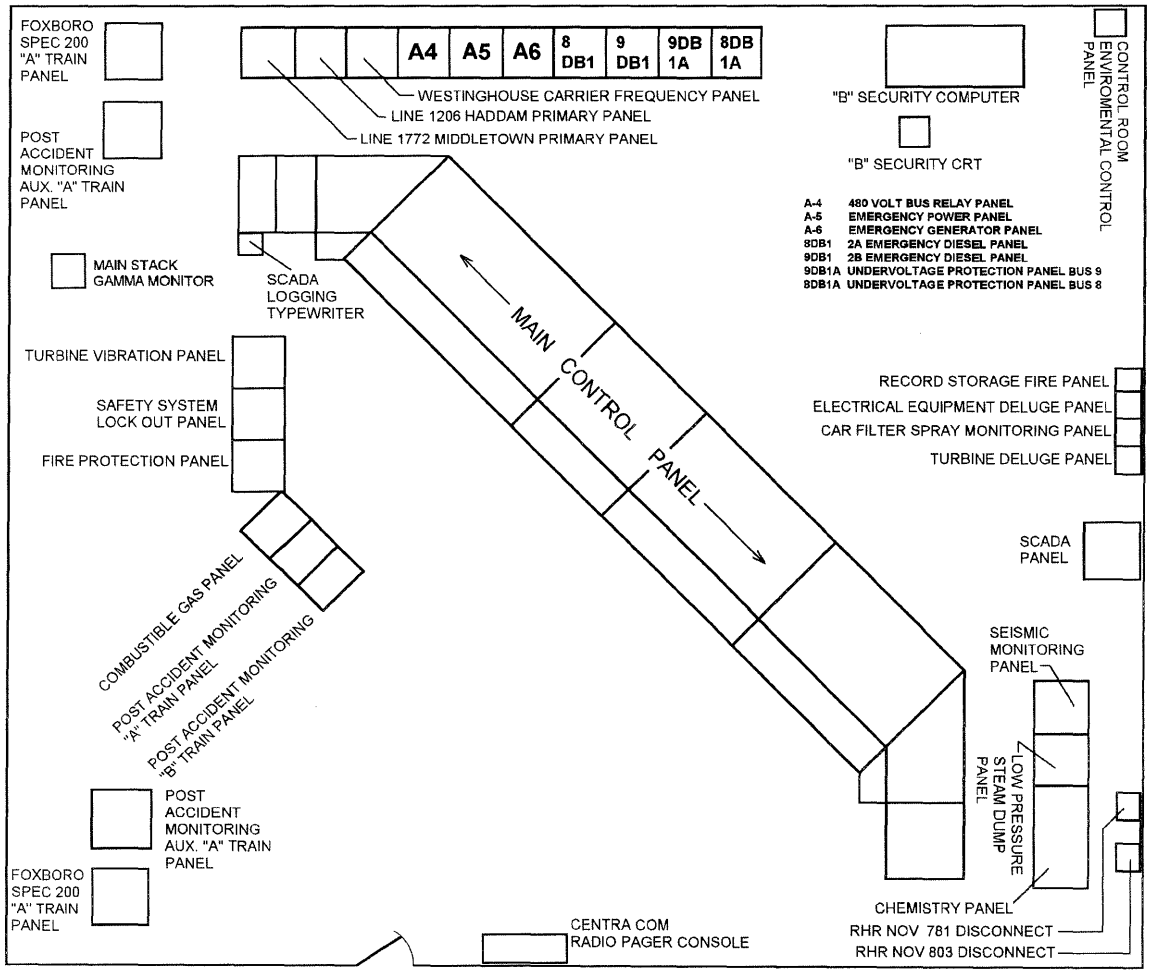


Figure 7 - FLOOR PLAN OF CONTROL ROOM IN SERVICE BUILDING

NOTES

[1] Connecticut Yankee Atomic Power Company 1987-1993: Chapter 59, page 1.

[2] Ibid: page 9.

[3] Ibid: page 7.

[4] Ibid: page 32.

[5] Ibid: page 12.

[6] Ibid

7. Drawing 16105-14042.

8. FDSA 7.1-1 1/67.

9. FDSA 7.4-1 10/70

10. PIB 1/14/88 9 of 17. Ch 87, Photo 1967-020.jpg.

11. Ibid 10 of 17.

12. FDSA 7.1-1 1/67

13. Vandenburgh, Woodman, and Yadon: 1965 p. 94.

14. FDSA 7.7-1 5/66

15. FDSA 7.3-1. 10/70

16. PIB Ch 84 p.111

17. PIB Ch 84, Appendix 9.1 p, 1

18. Ibid 1.

19. Ibid 2

20. PDCR 85-713. 5-9-85.

21. Lee: 1965 p.2

22. Patterson: 1968. p. 1858.

23. Makin: 1968 p. 663

24. Bevilacqua and Yuile: 1968. p. 198

25. Spurgin: 1970 p. 599.

26. Ibid: 603.

27. PIB ch 84. P.3

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28. PIB ch 71 p.33
29. Ibid 14.
30. Ibid: 84 p. 15
31. FDSA 9.6-1 10/70
32. PDCR 1542 5/3/95
33. PIB ch84 p. 108.
34. Obermesser 1960: 475.
35. PIB Ch. 84 appendix 9.1 p. 6.
36. Ibid 10.
37. Ibid 8.
38. PIB 84 p. 7.
39. PIB ch 79 p. 12.
40. PIB ch 79 p. 39.
41. FDSA 9.4-3
42. PIB ch. 78 p. 1.
43. PIB ch 69 p. 39
44. PIB ch 69 p. 1
45. FDSA 9.6-1 10/70, DRWG CT-185-F1
46. UFSAR 8.3-16 Jan 98.
47. FDSA 9.6-1 10/70
48. FDSA 9.4-5. 5/66

43. PIB ch 67 p. 2, UFSAR 8.3-18
50. DRWG CT-185-F4
51. UFSAR 8.3-3 Jan 198
52. Ibid: PIB ch 67 p.1.
53. UFSAR 8.3-1
54. Pib ch 69 p. 49.
55. UFSAR 8.3-19 1/98.
56. PIB ch 68 p. 3.
57. PIB ch. 69 p. 92
58. Ibid 69 p. 94.
59. Ibid p. 97

60. PIB Ch 67 p. 3.
61. Ibid: p.7
62. Ibid: 14.
63. PIB Ch 67 p. 3.
64. Ibid: p.7
65. Ibid: 14.
66. Ibid p.1.
67. PIB Ch 68 p. 10
68. PIB Ch 71, p.1
69. FDSA 9.4-4 10/70, UFSAR 1/98 8.3-18.
70. PIB ch 71 p. 18.

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1964b South Elevation. Turbine Building Area. Nuclear Power Plant - Unit No. 1. No. 16103-
14005. Reproduced as Drawing HAER No. CT-185-C-2.

1964a East Elevation. Turbine Building Area. Nuclear Power Plant - Unit No. 1. No. 16103-14044. Reproduced as Drawing HAER No. CT-185-C-3.

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B. Historic Views

A limited number of photographs and color slides showing HAER No. CT-185-C are archived as part of the Connecticut Yankee Atomic Power Company, Haddam Neck Plant Records Collection, Archives & Special Collections, Thomas J. Dodd Research Center, University of Connecticut Libraries.

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