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

HAER CT-185-O
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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

REDUCED COPIES OF MEASURED DRAWINGS

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
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Washington, DC 20240-0001

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HAER No. CT-185-O

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:	1987-1989
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 Switchgear Building provided enhanced electrical facilities for operation of the important plant, low-voltage safety devices, and equipment and instrumentation circuits.
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.* This documentation was requested by the Connecticut State Historic Preservation Office to preclude the possibility of any adverse project effects.

* 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 of Original Switchgear Facilities

As originally constructed, the Connecticut Yankee plant included a Switchgear Room in the Service Building (HAER No. CT-185-F) that transformed, controlled and routed the three separate electrical systems that ran event-critical plant equipment: 125 V DC, Vital Power, and Semi-vital Power. Components for that purpose were circuit breakers, step-down transformers, motor control centers (MCC), battery chargers and battery banks providing low-voltage DC, and inverters to make low voltage AC current. The electrical systems operated the turbine-generator emergency auxiliaries, motor-operated switches, valves, annunciators, solenoid-powered valves, and emergency lighting. The Switchgear Room also had flywheel motor-generator sets to power the Control Rod Drive System along with their associated isolation and scram breakers.

Switchgear Building Design and Location[a]

In 1987, construction of a separate Switchgear Building was begun to enhance some of the Switchgear Room functions.[1] The new, substantially constructed facility was built to satisfy NRC Appendix R concerns (fire protection) that developed after a fire at a nuclear plant at Brown's Ferry. In summary, the building provided isolated redundant power supplies for essential emergency shutdown equipment. This remote shutdown facility was designated as Panel 909. Located approximately 16 feet from the northwest corner of the Primary Auxiliary Building (HAER No. CT-185-G), the Switchgear Building included a second switchgear room, designated Switchgear B; the original Switchgear Room was re-designated Switchgear A. Both rooms were at the same elevation to facilitate pedestrian connection via a passageway described below. The pile-supported, reinforced-concrete, 34-by-64-foot Switchgear Building rose 37.5 feet above ground level at elevation 21.5, had 2-foot thick walls and floors, and was divided into six interior bays by 2-by-4.5-foot concrete columns. Three floor levels included a basement laundry at elevation 13.5, a relatively open floor at elevation 27.5 with air-handling equipment for the lower two levels and a 480 V power distribution panel, and the switchgear room (Switchgear B) at elevation 41.5 with air-handling equipment for that floor. The roof had two 10-foot-high, 10-foot square reinforced-concrete penthouses covering HVAC openings in the roof, and condensing units for cooling of all building levels. The second level had four walls defining six interior spaces, and a central longitudinal hallway aligned with a metal roll-up door for truck-based equipment delivery at the northwest end of the building. The hallway ceiling in the corridor adjacent to the door had a hatch with removable concrete covers, through which

[a] Parenthetical references to Drawings are to large-format reproductions of original drawings; endnotes refer to Section A in Sources of Information/Bibliography. Elevations are in feet above mean sea level; the principal plant ground level was at 21.5 feet.

equipment could be lifted to the switchgear room by a 5-ton hoist mounted on a 12-inch I-beam hung from the switchgear room ceiling.[2]

A fully-enclosed, elevated steel-framed metal-sided passageway, approximately 12 feet high and 7-18 feet wide, extended over 50 feet between Switchgear B and Switchgear A and passed over the original Diesel Generator Building. At ground level, a similarly-constructed lower passageway, approximately 18 feet wide and 9 feet high, ran approximately 20 feet to connect the Service Building to the Switchgear Building basement via a ramp. Two exterior metal stairways provided ground-level access to the upper levels of the Switchgear Building, with the stair to Switchgear B leading to a door in the upper passageway (Figure 2; Drawings HAER Nos. CT-185-O-1 through CT-185-O-3).

Functions and Equipment

Switchgear B provided enhanced electrical facilities for operation of the important equipment plant shut-down system, 125 V DC, low-voltage control and instrumentation safety devices (Vital Power System). The shut-down system included the 4160 volt AC and 480 volt AC power systems and less important instrumentation and control circuits (Semi-Vital System). During the construction of the Switchgear Building and the fit-out of Switchgear B, the original switchgear room was re-configured and updated to share the work of providing redundant control systems.

480 V AC power for equipment in Switchgear B came from two independent buses and was distributed by motor control centers to step-down transformers for the semi-vital system and to a static (solid state) battery charger for the vital and 125 V DC systems. The charger stepped voltage down with internal transformers and then rectified it to DC. It fed a lead-acid battery, split in two sections, designated Battery B. Part of the output was directly to DC devices and part to two inverters for low voltage AC service. It worked in concert with new lead-acid batteries and inverters in switchgear A which were designated A and C.[3] Each battery fed a bus (for example, B in Switchgear B) of the 125 V DC system and multiple buses of the Vital system. The two sets of battery chargers and batteries in Switchgear A and the single set in Switchgear B had a total of 200-300 amp capacity, directly supplying their respective buses during normal operation while maintaining the batteries fully charged. If the 480 V AC power to the chargers failed, the batteries took up the load.[4] The reasons for placing the A and B batteries in different rooms was for redundancy in the event of fire in accordance with CFR 50.48 and Appendix R to 10 CFR 50 since these batteries shared the most load. With maximum capacity of 1,200 amp hours, the system could power the required components for three hours if all off-site power was lost and the diesel generators failed to start.[5]

125 V DC System

Safe shutdown of the plant was required, even if all incoming 115kv power was interrupted and the diesel generators failed (station blackout).[6] 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 rooms.[7] Each battery/charger supplied its own bus in the 125 V DC system, and 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.[8] Loss of Battery B was not as critical except for disabling of the steam dump system. Bus C in Switchgear A could be cross connected to either A or B buses via a bus tie breakers. A fourth bus (BX) could be connected to the B bus. The technical specifications that governed operation of the plant had minimum operability requirements for the three charger/battery sets.

Battery Systems were a frequent source of trouble in nuclear power plants worldwide. Systems became overloaded with new equipment bringing down the run times.[9] Battery chargers sometimes failed. The battery plates cracked or altered in size from aging. The cases cracked and spilled electrolyte. If one battery lost all its fluid it could cause the loss of the entire bank, leaving the plant in an un-monitored condition since the critical gauging systems were run by DC for safety.[10] Even worse, if battery voltage dropped, control room indicators could then give erratic readings confusing the operators.[11] Remedies were increased surveillance and substitution of lead-acid batteries as was done at Connecticut Yankee.

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 120 V AC Vital Bus powered by the same batteries and chargers that powered the 125V DC system.[12] 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.[13] As reconstructed during Switchgear Building fit-out, the Vital system was fed by two inverters in Switchgear A each powered by battery A, and two inverters in Switchgear B from the single battery B there.[14] The A inverters (A, B) utilized silicon semi-conductor rectifiers (SCRs) 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 SCRs 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.[15] 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.[16] If there was a problem with the inverter

output or a battery failure, the C and D inverters could also receive back up AC current directly through a transfer switch from an MCC.[17] Most the vital buses were controlled from circuit breakers in the rear of the control room.

Semi-Vital Power System

The Semi-Vital 120V AC system was an additional source of regulated power for less important control and instrumentation circuits.[18] Loads included instrument detectors, control circuits, solenoid operated control valves and actuation relays. Power for the system originally came from two different buses from MCC 5 in Switchgear A. Loss of the Semi-Vital power 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. Soon after Switchgear Building completion, the system was re-configured to increase reliability of supply source. Since MCC 5 could be completely lost, MCC 12 was added as a backup source.[19] To power the semi-vital buses, the 480 volt supply was stepped down in the same type of "Sola" transformers that supplied the Vital bus from the inverters.

SOURCES OF INFORMATION/BIBLIOGRAPHY

A. Engineering Drawings

Drawings 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.

Bechtel Construction, Inc./Northeast Utilities Service Co./Connecticut Yankee Atomic Power Co.

1986-1994a Switchgear Building General Arrangement/Plan - El. 13'-6". No. 16103-27084 Sh. 1.

1986-1994b Switchgear Building General Arrangement/Plan - El. 27'-6". No. 16103-27084 Sh. 2.

1986-1994c Switchgear Building General Arrangement/Plan - El. 41'-6". No. 16103-27084 Sh. 3.

1986-1994d Switchgear Building General Arrangement/Roof - El. 58'-6" & 68'-6". No. 16103-27084 Sh. 4.

1986-1994e Switchgear Building General Arrangement/Sections A & B. No. 16103-27084 Sh. 5.

Northeast Utilities System for Connecticut Yankee Atomic Power Company

1987-1992a Switchgear Building Floor Plans at El. 13'-6" & El. 27'-6." No. 16103-14017 Sh. 1.

1987-1992b Switchgear Building Floor Plan at El. 41'-6" & Roof Plans. No. 16103-14017 Sh. 2.

1987-1992c Switchgear Building Elevations. No. 16103-14017 Sh. 3.

B. Bibliography

Connecticut Yankee Atomic Power Company and Northeast Utilities sources 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.

Connecticut Yankee Atomic Power Company (CYAPCO)

1966-1974 Facility Description & Safety Analysis(FDSA) Vol. 1. Topical Report No. NYO-3250-5. Haddam Neck Plant, Haddam, Connecticut.

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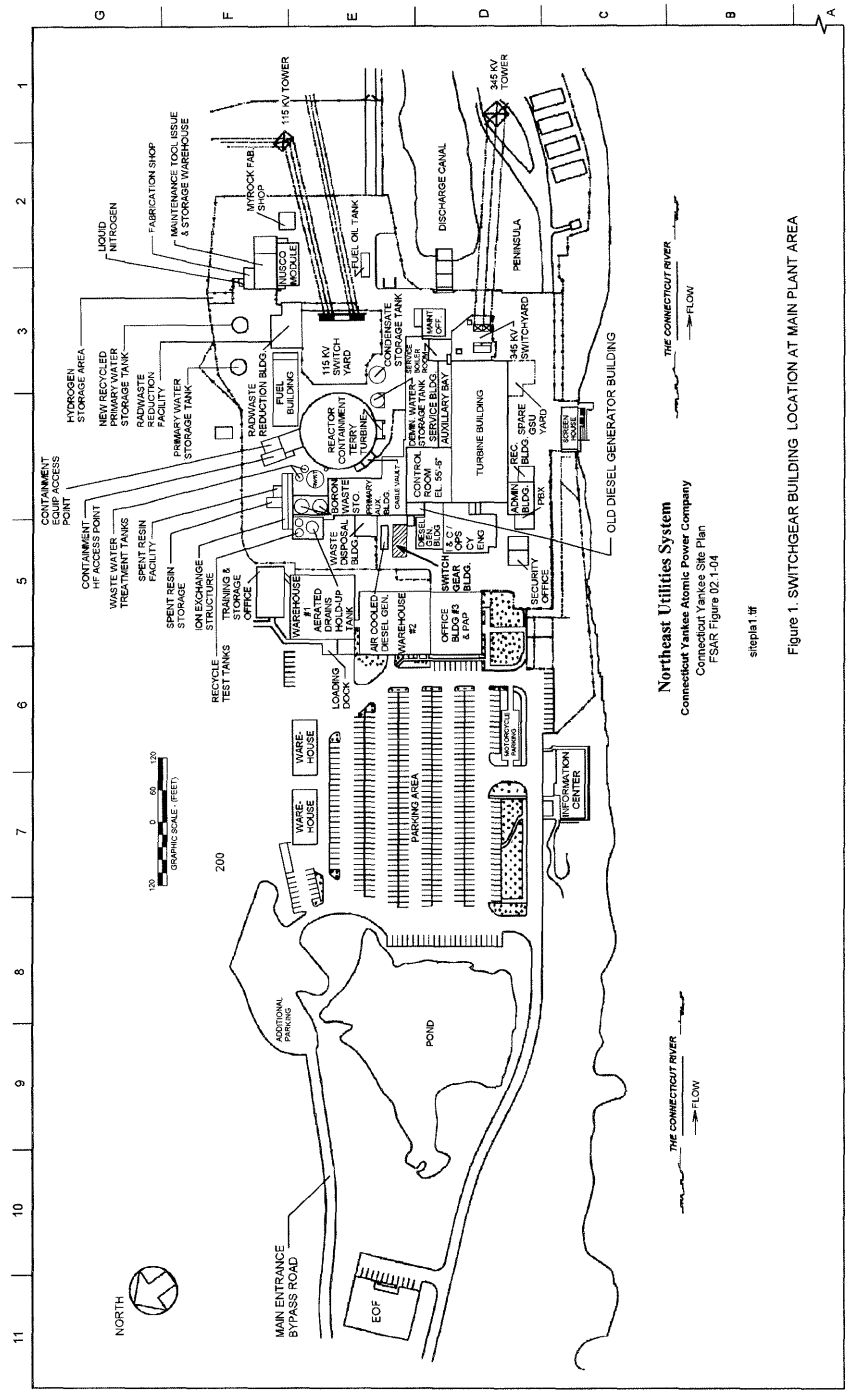

Figure 1 - LOCATION OF SWITCHGEAR BUILDING

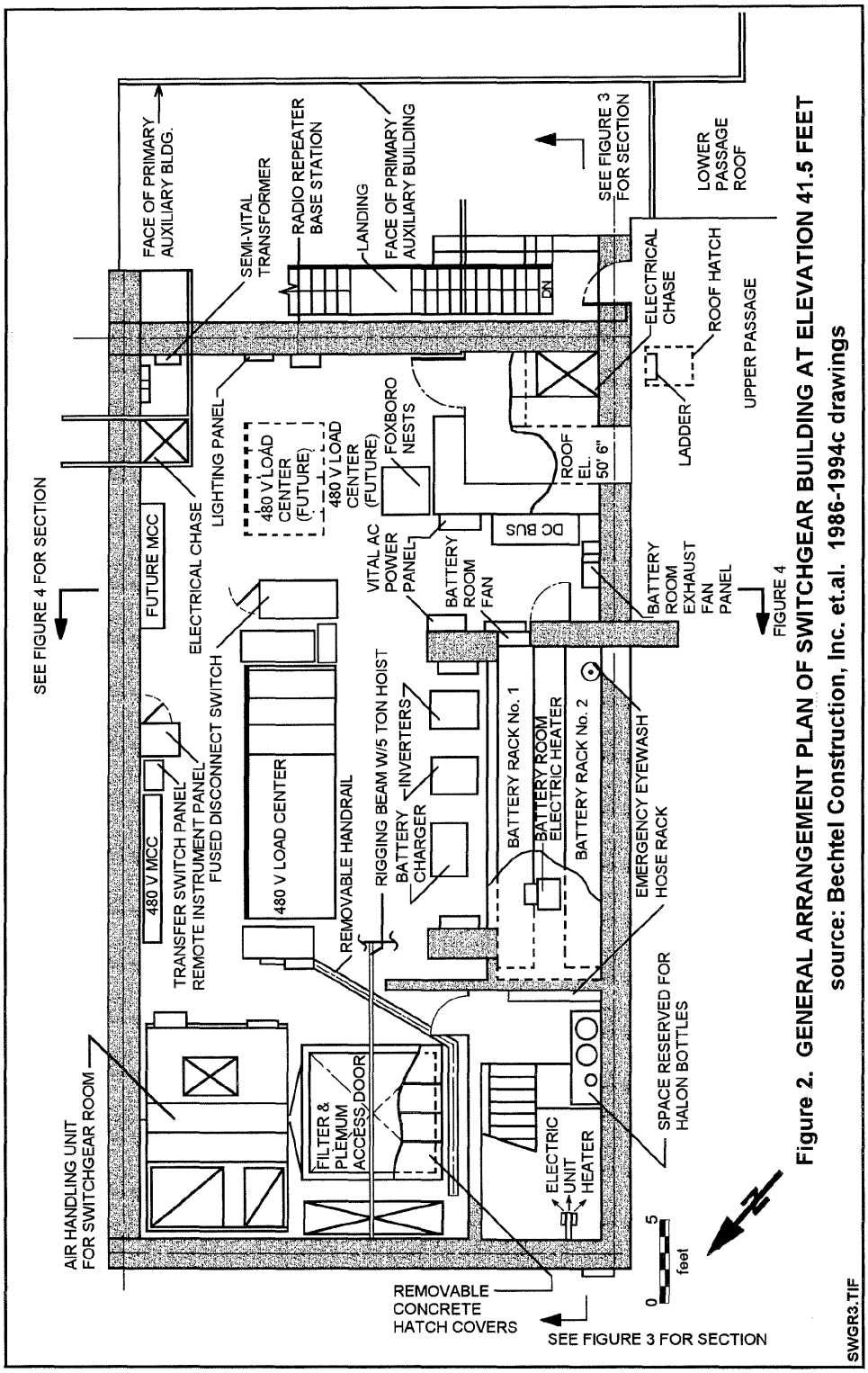

Figure 2. GENERAL ARRANGEMENT PLAN OF SWITCHGEAR BUILDING AT ELEVATION 41.5 FEET
source: Bechtel Construction, Inc. et.al. 1986-1994c drawings

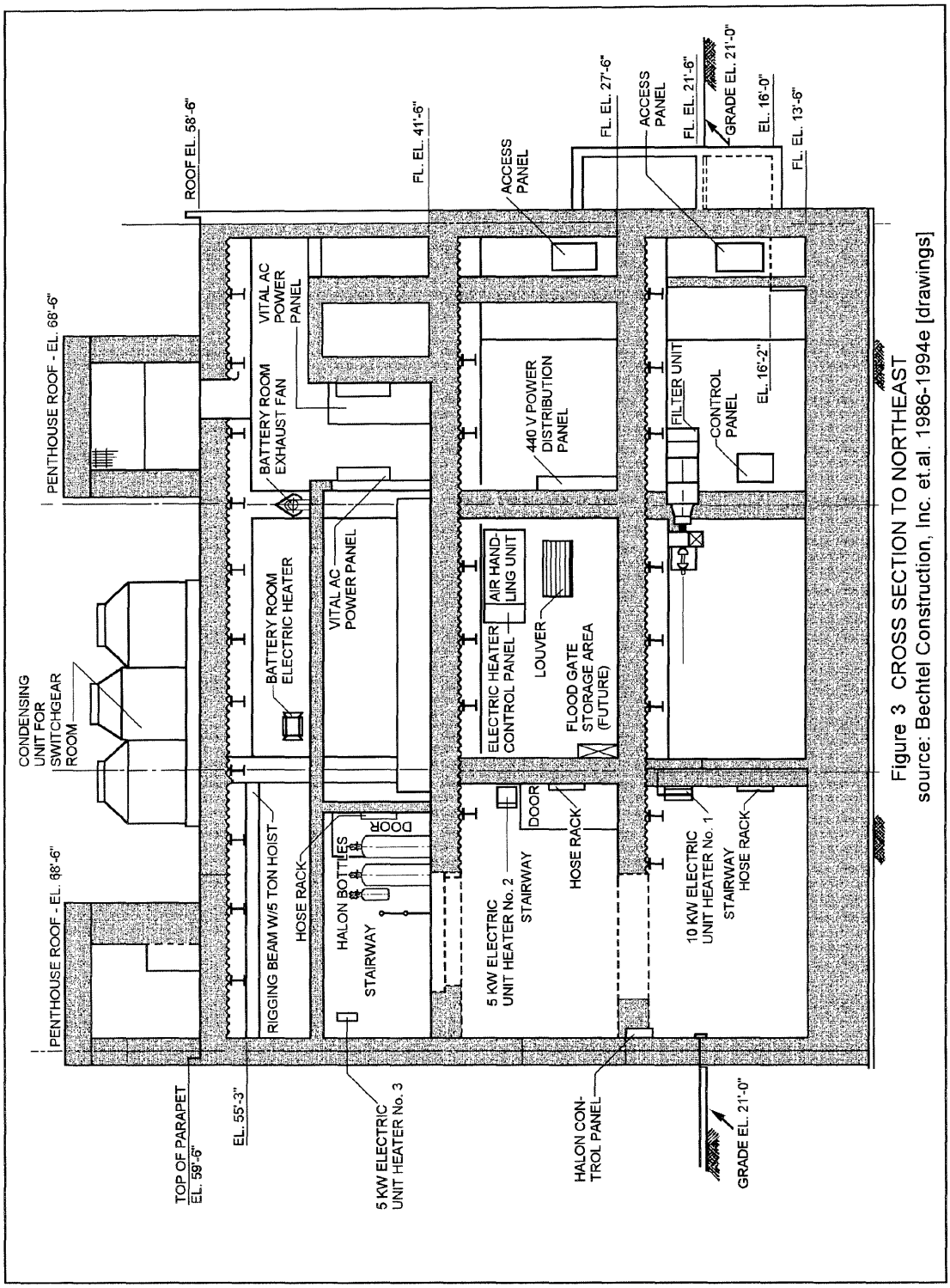

Figure 3 CROSS SECTION TO NORTHEAST
source: Bechtel Construction, Inc. et.al. 1986-1994e [drawings]

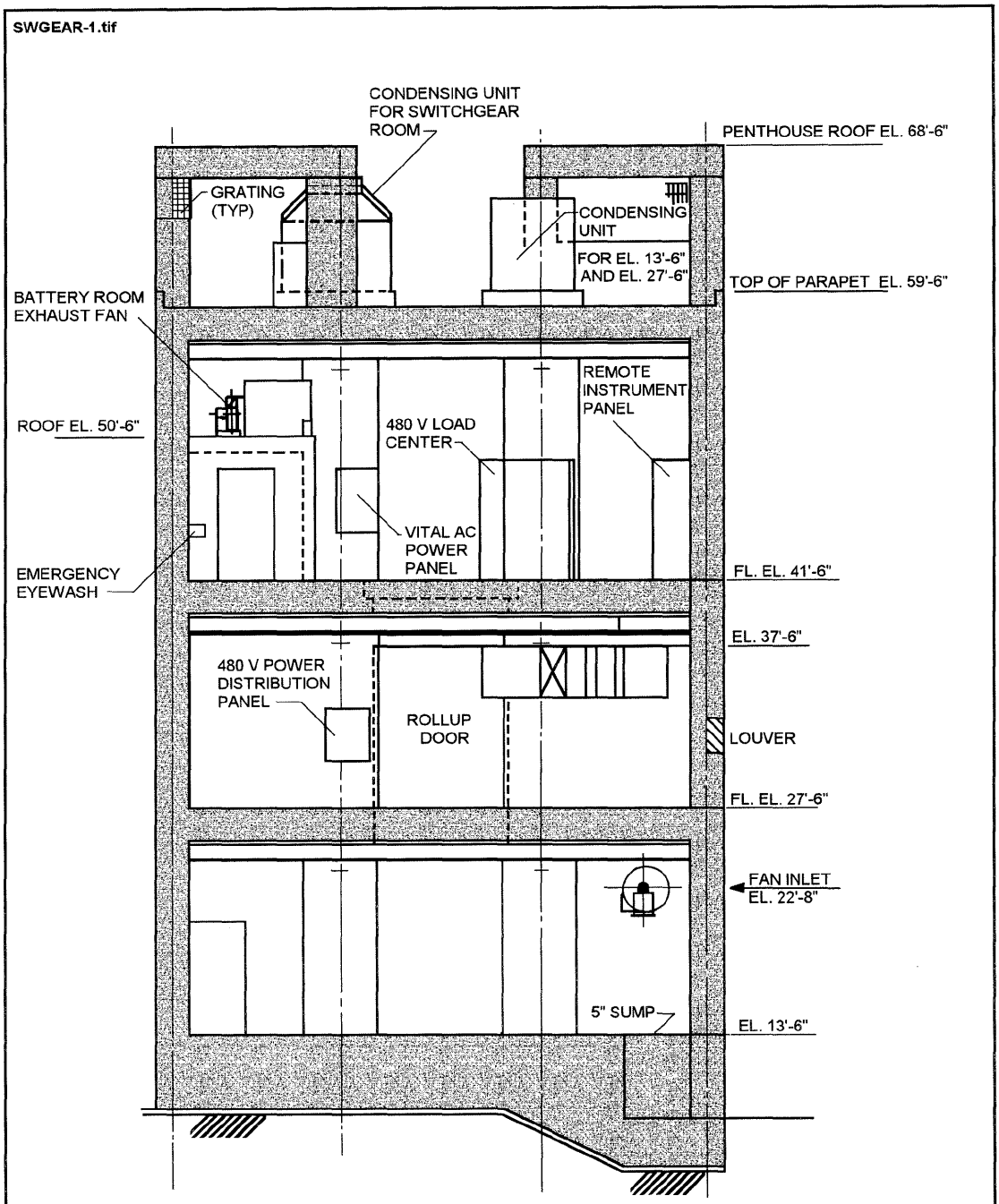

Figure 4. SECTION OF SWITCHGEAR HOUSE TO NORTHWEST
source: Bechtel Construction, Inc. 1986-1994e [drawings]

NOTES

[1] Connecticut Yankee Atomic Power Company 1967-1997: PDCR 865.

[2] Bechtel Construction, Inc. et al. 1986-1994a-d [drawings].

[3] . Connecticut Yankee Atomic Power Company 1987-1993: ch 67 p. 2; Connecticut Yankee Atomic Power Company 1998: 8.3-18

[4] Connecticut Yankee Atomic Power Company 1987-1993: ch 67 p.1.

[5] Connecticut Yankee Atomic Power Company 1998: 8.3-19 1/98.

[6] Connecticut Yankee Atomic Power Company 1987-1993: ch 69 p. 39.

[7] Connecticut Yankee Atomic Power Company 1987-1993: ch 69 p. 1.

[8] Connecticut Yankee Atomic Power Company1987-1993: ch 69m p. 49.

[9] Connecticut Yankee Atomic Power Company 1987-1993: ch 69, p. 92

[10] Ibid: p. 94.

[11] Ibid: p. 97.

[12] Connecticut Yankee Atomic Power Company 1998: 8.3-16 Jan 98.

[13] Connecticut Yankee Atomic Power Company 1966-1974: 9.6-1 10/70

[14] Connecticut Yankee Atomic Power Company 1987-1993: Ch 67, p. 3.

[15] Ibid: p. 7.

[16] Ibid: p. 14.

[17] Ibid: p. 20.

[19] Yankee Atomic Power Company 1966-1974: 9.4-5. 5/66

[19] Connecticut Yankee Atomic Power Company 1987-1993: ch 67, p.1; Connecticut Yankee Atomic Power Company 1967-1997: PDCR 942.