UNITED STATES NUCLEAR REGULATORY COMMISSION

NUCLEAR POWER PLANT SYSTEM SOURCEBOOK

HADDAM NECK

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NUCLEAR POWER PLANT SYSTEM SOURCEBOOK

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CAUTION

The information in this report has been developed over an extended period of time based on a site visit, the Final Safety Analysis Report, system and layout drawings, and other published information. To the best of our knowledge, it accurately reflects the plant configuration at the time the information was obtained, however, the information in this document has not been independently verified by the licensee or the NRC.

NOTICE

This sourcebook will be periodically updated with new and/or replacement pages as appropriate to incorporate additional information on this reactor plant. Technical errors in this report should be brought to the attention of the following:

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Corrections and other recommended changes should be submitted in the form of marked up copies of the affected text, tables or figures. Supporting documentation should be included if possible.

HADDAM NECK
RECORD OF REVISIONS

REVISION	ISSUE	COMMENTS
0	10/90	Original report

HADDAM NECK SYSTEM SOURCEBOOK

This sourcebook contains summary information on the Haddam Neck nuclear power plant. Summary data on this plant are presented in Section 1, and similar nuclear power plants are identified in Section 2. Information on selected reactor plant systems is presented in Section 3, and the site and building layout is illustrated in Section 4. A bibliography of reports that describe features of this plant or site is presented in Section 5. Symbols used in the system and layout drawings are defined in Appendix A. Terms used in data tables are defined in Appendix B.

1. SUMMARY DATA ON PLANT

Basic information on the Haddam Neck nuclear power plant is listed below:

- Docket number	50-213
- Operator	Connecticut Yankee Atomic Power Co.
- Location	Haddam, Connecticut
- Commercial operation date	1/68
- Reactor type	PWR
- NSSS vendor	Westinghouse
- Number of loops	4
- Power (MWt/MWe)	1825/569
- Architect-engineer	Stone & Webster
- Containment type	Reinforced concrete cylinder with steel liner

2. IDENTIFICATION OF SIMILAR NUCLEAR POWER PLANTS

Haddam Neck utilizes a Westinghouse PWR four-loop nuclear steam supply system (NSSS) in a large, dry containment. Other four-loop Westinghouse plants in the United States include:

- Braidwood 1 and 2
- Byron 1 and 2
- Callaway
- Catawba 1 and 2
- Comanche Peak 1 and 2
- Donald C. Cook 1 and 2 (ice condenser containment)
- Diablo Canyon 1 and 2
- Indian Point 2 and 3
- McGuire 1 and 2 (ice condenser containment)
- Millstone 3 (subatmospheric containment)
- Salem 1 and 2
- Seabrook 1
- Sequoyah 1 and 2 (ice condenser containment)
- South Texas 1 and 2
- Trojan
- Vogtle 1 and 2
- Watts Bar 1 and 2
- Wolf Creek
- Yankee Rowe
- Zion 1 and 2

Important points of comparison with other four-loop Westinghouse plants are listed below:

A. Haddam Neck has a smaller reactor core and vessel than all other four-loop Westinghouse PWRs except Yankee-Rowe. The Haddam Neck core consists of 157 fuel assemblies in a 154 inch vessel. Most other Westinghouse four-loop plants have 193 fuel assembly cores in a 173 inch vessel.

B. The Haddam Neck reactor coolant system has main loop isolation valves. This feature is not found in most U.S. commercial PWRs.

C. A separate low-pressure RCS overpressure protection system is used during shutdown cooling at Haddam Neck. These overpressure protection valves are installed in parallel with the pressurizer power-operated relief valves (PORVs) and are normally isolated by a block valve when the plant is at high pressure.

D. The Haddam Neck emergency core cooling system (ECCS) is unlike the ECCS found in most other Westinghouse PWR plants in the following respects:

- There are no safety injection (SI) accumulators. A separate low-pressure injection (LPI) system at Haddam Neck performs the function of the SI accumulators in later Westinghouse PWRs.
- The combined discharge of the LPI system and the residual heat removal (RHR) system enters the reactor coolant system via core deluge injection paths into the vessel head. Low pressure ECCS subsystems in later model Westinghouse plants inject into the RCS loops.
- The high pressure ECCS subsystems (high-pressure safety injection system and the charging system) inject only into the cold legs. There is no hot leg injection capability.
- The LPI and RHR systems can be aligned to perform the containment spray injection function. Only the RHR system can be aligned for containment spray recirculation from the containment sump. There is no separate containment spray system.

E. The Haddam Neck auxiliary feedwater system (AFWS) is unlike most other PWR AFWS in that it consists of two steam turbine-driven pumps. A motor-driven non-Class 1E startup feedwater pump interfaces with the AFWS, and is used for plant startup and shutdown.

3. SYSTEM INFORMATION

This section contains descriptions of selected systems at Haddam Neck in terms of general function, operation, system success criteria, major components, and support system requirements. A summary of major systems at Haddam Neck is presented in Table 3-1. In the "Report Section" column of this table, a section reference (i.e., 3.1, 3.2, etc.) is provided for all systems that are described in this report. An entry of "X" in this column means that the system is not described in this report. In the "FSAR Section Reference" column, a cross-reference is provided to the section of the Final Safety Analysis Report where additional information on each system can be found. Other sources of information on this plant are identified in the bibliography in Section 5.

Several cooling water systems are identified in Table 3-1. The functional relationships that exist among cooling water systems required for safe shutdown are shown in Figure 3-1. Details on the individual cooling water systems are provided in the report sections identified in Table 3-1.

Table 3-1. Summary of Haddam Neck Systems Covered in this Report

Generic System Name	Plant-Specific System Name	Report Section	FSAR Section Reference
Reactor Heat Removal Systems			
- Reactor Coolant System (RCS)	Same	3.1	5.1
- Auxiliary Feedwater (AFW) and Secondary Steam Relief (SSR) Systems	Same	3.2	8.1, 8.3
- Emergency Core Cooling Systems (ECCS)	Same	-	-
- High-Pressure Injection & Recirculation	Safety Injection System	3.3	5.2.7
- Low-pressure Injection & Recirculation	Low Pressure Injection System	3.3	5.2.7
- Decay Heat Removal (DHR) System (Residual Heat Removal (RHR) System)	Residual Heat Removal System	X	5.2.3.3
- Main Steam and Power Conversion Systems	Steam Systems,	X	8.1
	Turbine Generator,	X	8.2
	Condensate and Feedwater System,	X	8.3
	Condenser	X	8.4
- Other Heat Removal Systems	None identified	X	X

Table 3-1. Summary of Haddam Neck Systems Covered in this Report (Continued)

Generic System Name	Plant-Specific System Name	Report Section	FSAR Section Reference
Reactor Coolant Inventory Control Systems			
- Chemical and Volume Control System (CVCS) (Charging System)	Same	3.4	5.2.1
- ECCS	See ECCS, above	-	-
Containment Systems			
- Containment	Same	X	3.1 to 3.5
- Containment Heat Removal Systems		-	-
- Containment Spray System	Same	3.7	3.6.4
- Containment Fan Cooler System	Containment Air Recirculation System (CARC)	3.7	3.6.2
- Containment Normal Ventilation Systems	See CARC, above, also	-	-
	Purge System	X	3.6.5
- Combustible Gas Control Systems	None identified	X	X
- Containment Atmosphere Cleanup System	Filtration System (part of CARC)	3.7	3.6.3
Reactor and Reactivity Control Systems			
- Reactor Core	Same	X	4.1 to 4.3
- Control Rod System	Same	X	4.1.8, 4.2.2, 7.6
- Boration Systems	See CVCS, above	-	-

Table 3-1. Summary of Haddam Neck Systems Covered in this Report (Continued)

Generic System Name	Plant-Specific System Name	Report Section	FSAR Section Reference
Instrumentation & Control (I&C) Systems			
- Reactor Protection System (RPS)	Reactor Trip System (RTS)	3.5	7.2
- Engineered Safety Feature Actuation System (ESFAS)	Protection System	3.5	7.2
- Remote Shutdown System	Various local controls	3.5	X
- Other I&C Systems	Nuclear Instrumentation System,	X	7.3
	Radiation Monitoring System,	X	7.4
	In-core Instrumentation,	X	7.5
	Rod Drive Control,	X	7.6
	Plant Information System Computer	X	7.7
Support Systems			
- Class 1E Electric Power System	Same	3.6	9.4, 9.5, 9.6
- Non-Class 1E Electric Power System	Same	3.6	9.2, 9.3, 9.4, 9.6, 9.7
- Diesel Generator Auxiliary Systems	Same	3.6	9.5
- Component Cooling Water (CCW) System	Auxiliary Cooling Water System (ACWS)	3.8	5.2.3.2
- Service Water System (SWS)	Same	3.9	8.9
- Other Cooling Water Systems	Circulating Water System	X	8.5
- Fire Protection Systems	Same	X	8.11.3

Table 3-1. Summary of Haddam Neck Systems Covered in this Report (Continued)

Generic System Name	Plant-Specific System Name	Report Section	FSAR Section Reference
Support Systems (Continued)			
- Room Heating, Ventilating, and Air-Conditioning (HVAC) Systems	Building Service Systems	X	8.11.1, 8.11.2
- Instrument and Service Air Systems	Compressed Air System	X	8.10
- Refueling and Spent Fuel Systems	Fuel Handling and Storage Facilities	X	5.2.9
	Spent Fuel Pit Cooling System	X	5.2.3.4
- Radioactive Waste Systems	Same	X	5.3
- Radiation Protection Systems	Shielding	X	6.1, 6.2, 7.4
	See Radiation Monitoring System, above	-	-

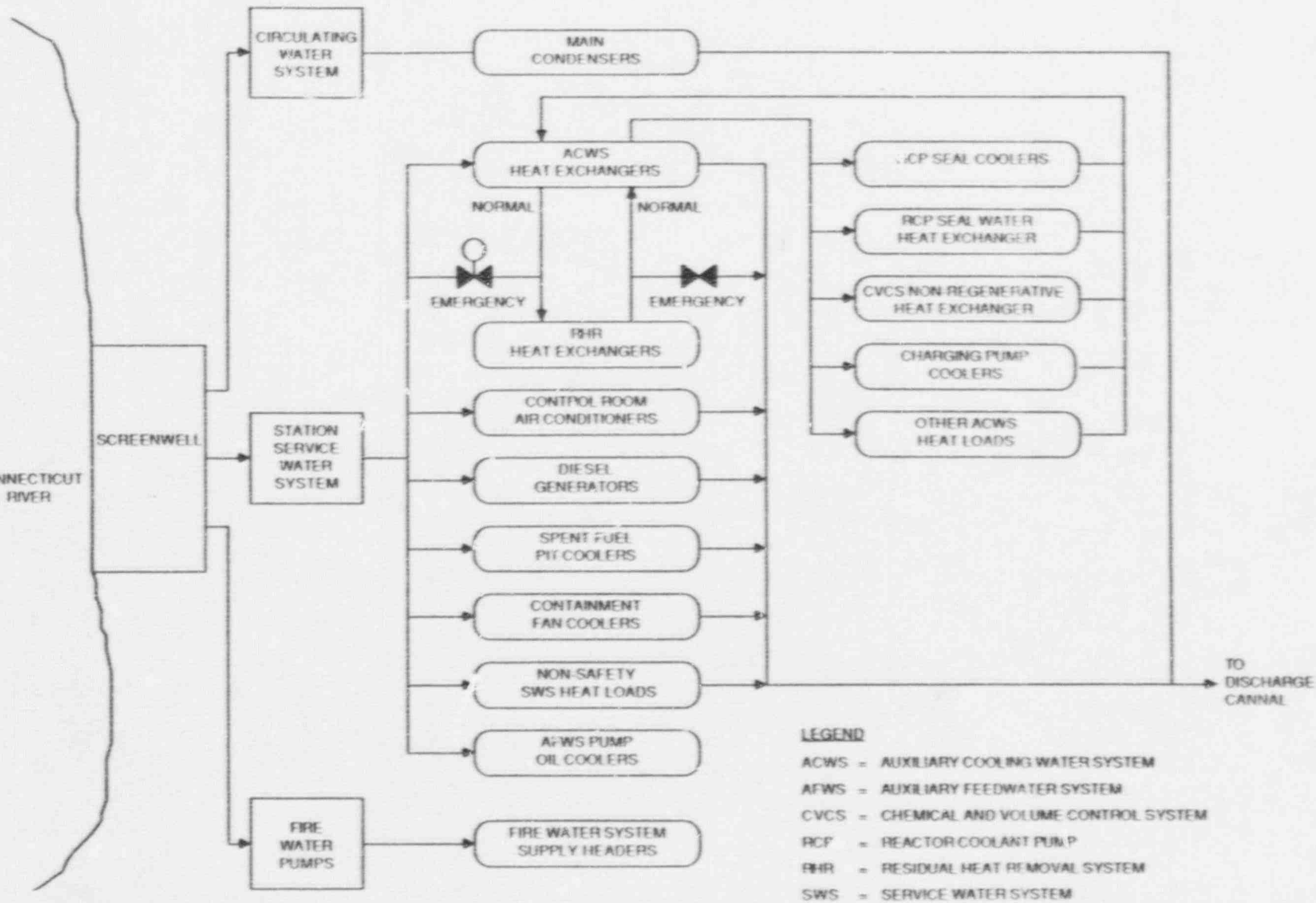


Figure 3-1. Cooling Water Systems Functional Diagram for Haddam Neck

3.1 REACTOR COOLANT SYSTEM (RCS)

3.1.1 System Function

The RCS transfers heat from the reactor core to the secondary coolant system via the steam generators. The RCS pressure boundary also establishes a boundary against the uncontrolled release of radioactive material from the reactor core and primary coolant.

3.1.2 System Definition

The RCS includes: (a) the reactor vessel, (b) four parallel reactor coolant loops with isolation valves, (c) reactor coolant pumps, (d) the primary side of the steam generators, (e) a pressurizer, and (f) connected piping out to a suitable isolation valve boundary. An isometric drawing of a four-loop Westinghouse RCS is shown in Figure 3.1-1. Simplified diagrams of the RCS and important system interfaces are shown in Figures 3.1-2 and 3.1-3. A summary of data on selected RCS components is presented in Table 3.1-1.

3.1.3 System Operation

During power operation, circulation in the RCS is maintained by one reactor coolant pump in each of the four reactor coolant loops. RCS pressure is maintained within a prescribed band by the combined action of pressurizer heaters and pressurizer spray. RCS coolant inventory is measured by pressurizer water level which is maintained within a prescribed band by the chemical and volume control system (CVCS).

At power, core heat is transferred to secondary coolant (feedwater) in the steam generators. The heat transfer path to the ultimate heat sink is completed by the main steam and power conversion system and the circulating water system.

Following a transient or small LOCA (if RCS inventory is maintained), reactor core heat is still transferred to secondary coolant in the steam generators. Flow in the RCS is maintained by the reactor coolant pumps or by natural circulation. The heat transfer path to the ultimate heat sink can be established by using the secondary steam relief system to vent main steam to atmosphere when the power conversion and circulating water systems are not available. If reactor core heat removal by this alternate path is not adequate, the RCS pressure will increase and a heat balance will be established in the RCS by venting steam or reactor coolant to the quench tank through the pressurizer relief valves. There are two power-operated relief valves (each in series with a motor-operated block valve) and three safety valves on the pressurizer. Additionally, two trains of low temperature, over pressure motor-operated relief valves exist for RCS overpressure protection during shutdown cooling with the RHR system. There are two valves per train, which are prevented from opening at temperatures greater than 350°F. A continued inability to establish adequate heat transfer to the steam generators will result in a LOCA-like condition (i.e., continuing loss of reactor coolant through the pressurizer relief valves). Repeated cycling of these relief valves has resulted in valve failure (i.e., relief valve stuck open).

Following a large LOCA, reactor core heat is dumped to the containment as reactor coolant and ECCS makeup water spills from the break. For a short period, the containment can act as a heat sink; however, the containment cooling systems must operate in order to complete a heat transfer path to the ultimate heat sink.

Each RCS loop may be isolated by shutting the respective loop stop valves (RCS-512, 501, 513, 524, 526, 537, 538, and 546). Cooldown of an isolated loop can be accomplished by opening the associated loop cross-tie valve (RCS-510, 515, 528, or 577). Loop heatup occurs from RCP operation with limited heat transfer via the steam generator.

3.1.4 System Success Criteria

The RCS "success" criteria can be represented in terms of LOCA and transient mitigation, as follows:

- An unmitigatable LOCA is not initiated.
- If a mitigatable LOCA is initiated, then LOCA mitigating systems are successful.
- If a transient is initiated, then either:
  - RCS integrity is maintained and transient mitigating systems are successful, or
  - RCS integrity is not maintained, leading to a LOCA-like condition (i.e., stuck-open safety or relief valve, reactor coolant pump seal failure), and LOCA mitigating systems are successful.

It appears that Haddam Neck is capable of bleed-and-feed cooling for mitigating certain small LOCAs. This entails opening both pressurizer PORVs to depressurize the RCS to the point that makeup can be provided by one of two high pressure safety injection pumps.

3.1.5 Component Information

A. RCS
1. Total system volume, including pressurizer: 8,782 ft^3
2. Normal operating pressure: 2000 psig

B. Pressurizer
1. Water volume, full power: 650 ft^3
2. Total volume: 1,300 ft^3

C. Reactor Coolant Pumps (4)
1. Rated flow: 67,200 gpm @ 21[illegible] ft. head (92.8 psig)
2. Type: Vertical, single-stage, centrifugal

D. Power-Operated Relief Valves (2)
1. Type: Nozzle with balancing bellows
2. Relief capacity: 210,000 lb/hr (each) @ 2170 psig

E. Safety Valves (3)
1. Set pressures: 2485 psig, 2535 psig, and 2585 psig
2. Relief capacity: 240,000 lb/hr (each)

F. Steam Generators (4)
1. Type: Vertical shell and U-tube
2. Model: Westinghouse Model 27

3.1.6 Support Systems and Interfaces

A. Motive Power
   1. The reactor coolant pumps are supplied from Non-Class 1E switchgear.
   2. The pressurizer heaters are Class 1E AC loads that can be supplied from the standby diesel generators as described in Section 3.6.

B. Reactor Coolant Pump Seal Injection Water System
   The chemical and volume control system supplies seal water to cool the reactor coolant pump shaft seals and to maintain a controlled inleakage of seal water into the RCS. Loss of seal water flow may result in RCS leakage through the pump shaft seals which will resemble a small LOCA. If loss of seal injection flow should occur, the thermal barrier heat exchanger, which is cooled by the auxiliary component cooling water system (ACWS, see Section 3.8), cools the reactor coolant to an acceptable level before it enters the pump bearing and the shaft seal area (Ref. 1).

3.1.7 Section 3.1 References

1. Haddam Neck FSAR, Section 5.1.

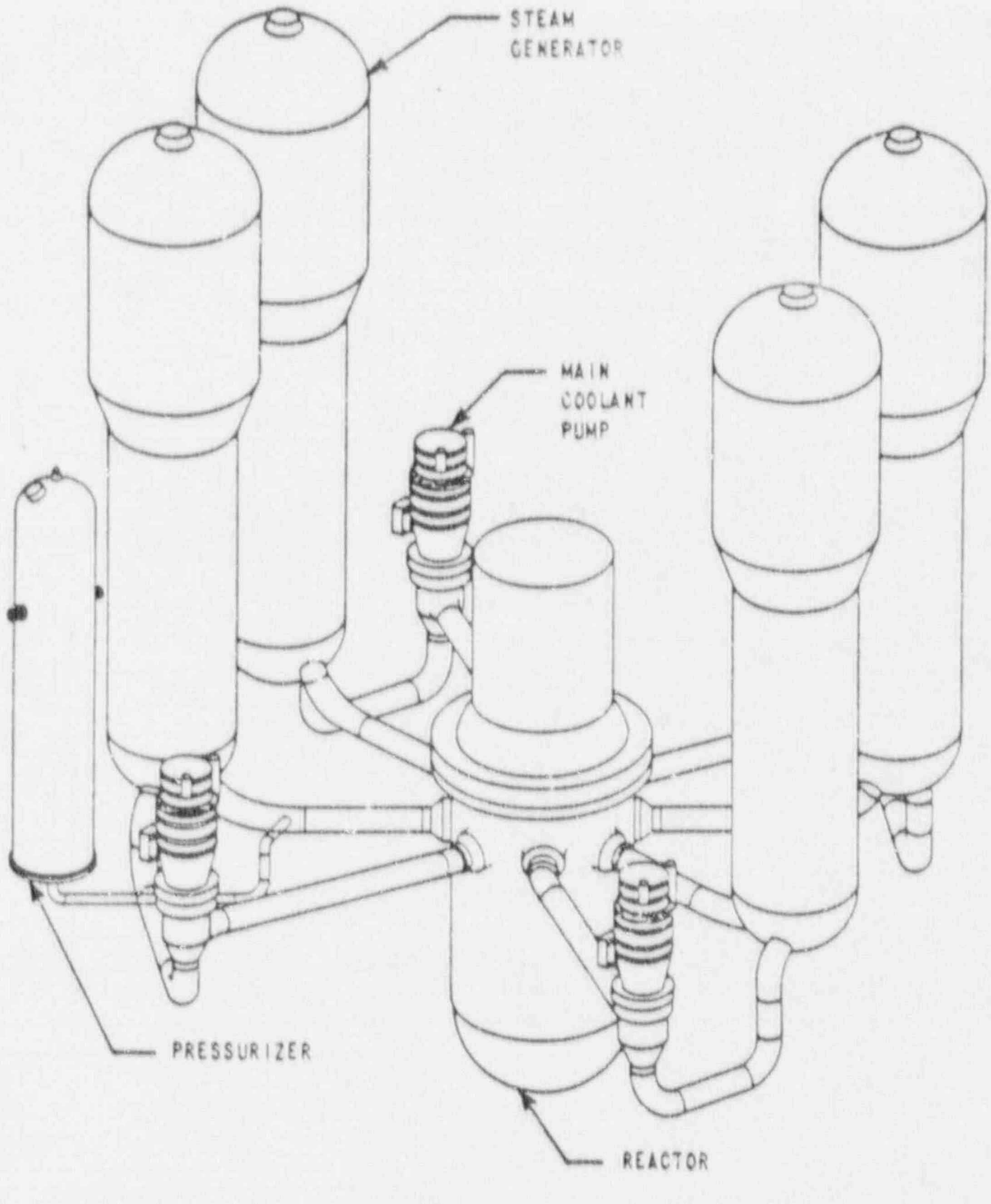


Figure 3.1-1. Isometric View of a 4-Loop Westinghouse RCS.

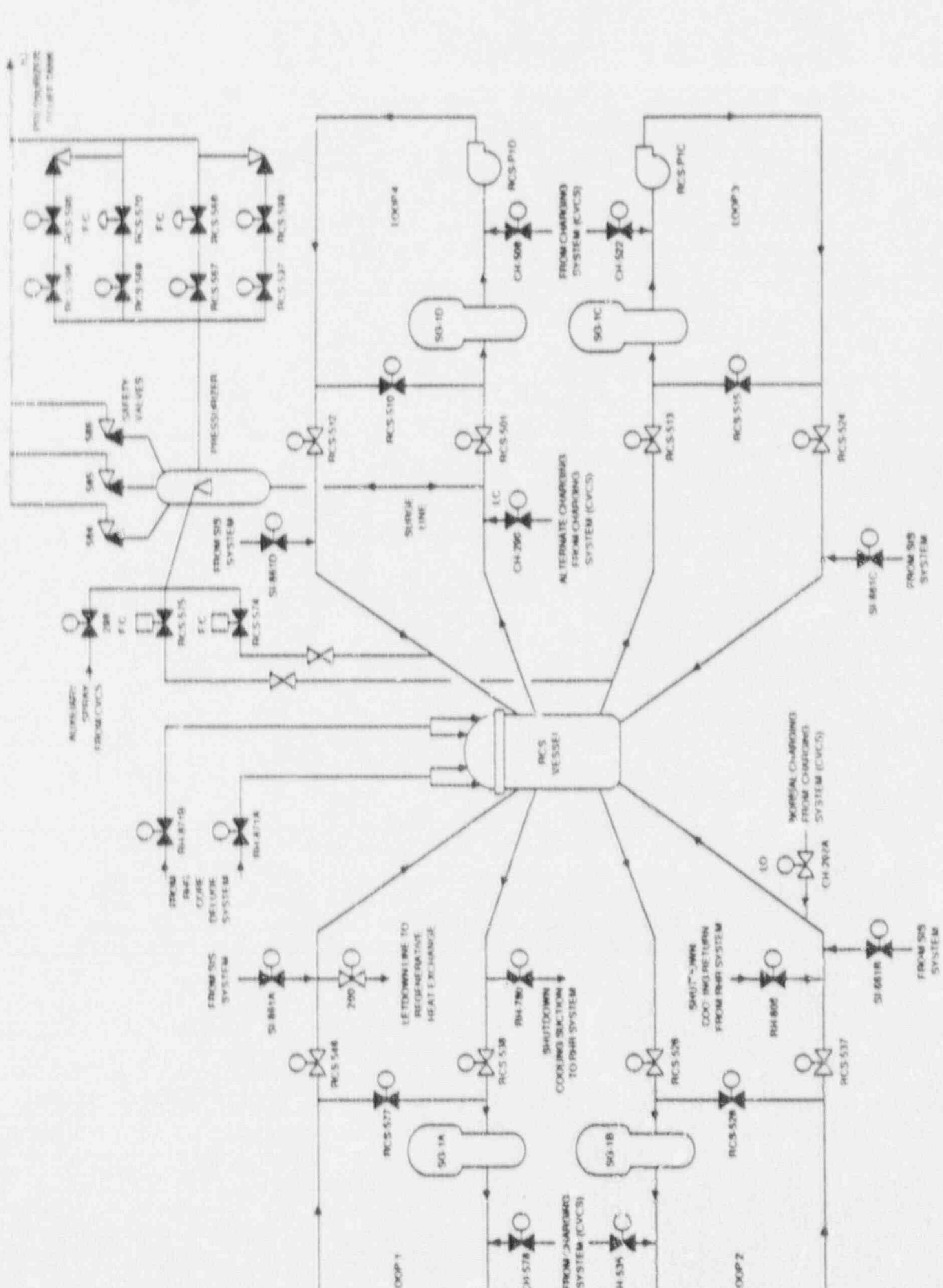


Figure 3.1-2. Haddam Neck Reactor Coolant System

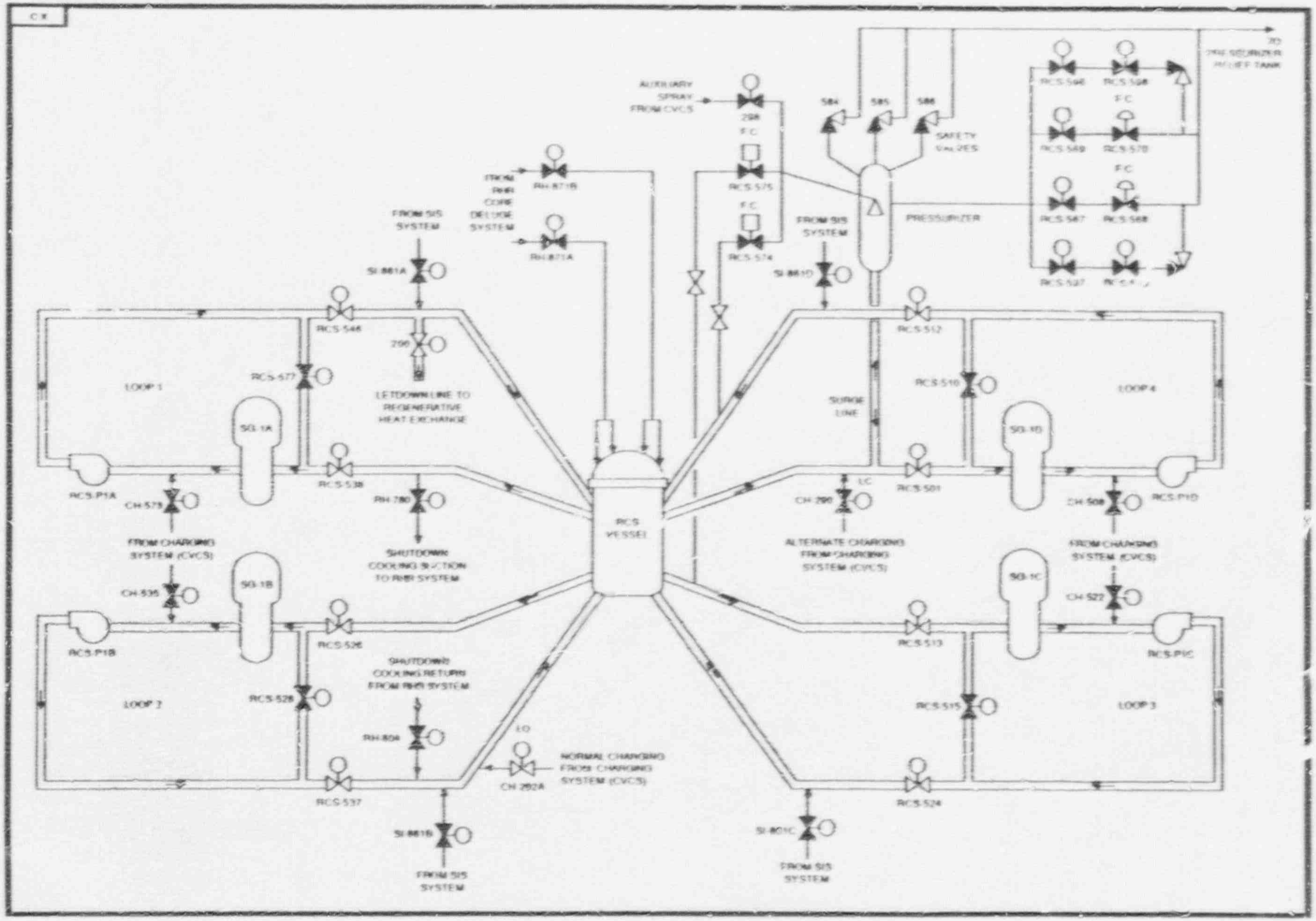


Figure 3.1-3. Haddam Neck Reactor Coolant System Showing Component Locations

Table 3.1-1. Haddam Neck Reactor Coolant System Data Summary for Selected Components

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
CH-200	MOV	CX	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
RCS-567	MOV	CX	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
RCS-568	NV	CX	EP-MCC7-1	480	CBLVLT	AC/B
RCS-569	MOV	CX	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
RCS-570	NV	CX	EP-MCC7-1	480	CBLVLT	AC/B

3.2 AUXILIARY FEEDWATER SYSTEM (AFWS) AND SECONDARY STEAM RELIEF SYSTEM (SSRS)

3.2.1 System Function

The AFWS provides a source of feedwater to the steam generators to remove heat from the reactor coolant system (RCS) when: (a) the main feedwater system is not available, and (b) RCS pressure is too high to permit heat removal by the residual heat removal (RHR) system. The Secondary Steam Relief System (SSRS) provides a steam vent path from the steam generators to the atmosphere, thereby completing the heat transfer path to an ultimate heat sink when the main steam and power conversion systems are not available. Together, the AFWS and SSRS constitute an open-loop fluid system that provides for heat transfer from the RCS following transients and small-break LOCAs (Refs. 1,2).

3.2.2 System Definition

The AFWS is composed of two pump trains which serve the four steam generators via two redundant injection paths. Each pump train consists of a turbine-driven pump that supplies 100% of the required auxiliary feedwater flow to each steam generator. Each turbine-driven pump is supplied with steam from a common header, which is in turn supplied by all four steam generators. A check valve in each steam generator supply line assures that failure of any steam generator will not interrupt steam supply to the turbine-driven pumps.

A non-Class 1E motor-driven startup feedwater pump is provided for plant startup and shutdown. Water supply for the pumps is taken from the demineralized water storage tank (DWST).

The SSRS consists of four safety valves on each of the four main steam lines, and one common atmospheric dump valve (decay heat release header safety valve) connected to the common steam header which supplies steam to the turbine-driven pumps.

Simplified drawings of the AFWS and the SSRS are shown in Figures 3.2-1 and 3.2-2. A summary of data on selected AFWS components is presented in Table 3.2-1.

3.2.3 System Operation

During normal operation the AFWS is in standby. There is no automatic initiation capability for the AFWS; rather the AFWS must be started locally or remote-manually from the control room.

Coolant is supplied to the pumps from the demineralized water storage tank (DWST), with the primary water storage tank (PWST) available as a secondary source of water. Additionally, a third source of water supply to the AFW pumps is the recycle water storage tank.

The normal flow path to the steam generators is through valve AFW-35. Alternate flow paths to the steam generators can be established by opening pneumatic isolation/flow control valves 1301-1a through 1301-4a.

The pneumatic isolation/flow control valves in the branch lines to each steam generator can be controlled locally or remote-manually from the control room to modulate the auxiliary feedwater flow and maintain the required steam generator water level. They can be manually closed to isolate the flow to a faulted steam generator and thus minimize coolant loss.

In the event of a loss of instrument air, the turbine-driven pumps would start due to the fail-open feature of the steam inlet valves and deliver feedwater to the steam-generators through the main bypass control valves (valves 1031-xA) which also fail-open on loss of air.

3.2.4 System Success Criteria

For the decay heat removal function to be successful, both the AFWS and the SSRS must operate successfully. The AFWS success criteria are the following:

- Makeup to any one of four steam generators provides adequate decay heat removal from the Reactor Coolant System (Ref. 3).
- Either of the turbine-driven pumps can provide adequate flow.
- Both the DWST and PWST are needed to provide a long-term source of water for the AFWS pumps (i.e., to support eight hours of system operation).
- Main feedwater isolation is accomplished.

3.2.5 Component Information

A. Turbine-driven AFWS Pumps 1A, 1B
   1. Rated flow: 450 gpm @ unknown head
   2. Rated capacity: 100%
   3. Type: Horizontal, centrifugal, multistage

B. Demineralized Water Storage Tank
   1. Capacity: 50,000 gallons (min.)

C. Primary Water Storage Tank
   1. Capacity: 80,000 gallons (min)

D. Safety Valves (16 total, 4 per line)
   1. Set pressure: 984 to 1034 psig
   2. Total relief capacity (all 16 valves): 9,504,000 lb/hr

E. Decay Heat Release Header Safety Valve
   1. Capacity: 120,000 lb/hr @ 900 psig

3.2.6 Support Systems and Interfaces

A. Control Signals
   The AFWS has no automatic initiation capability and relies on manual initiation from the control room, or locally.

B. Motive Power
   1. The turbine-driven AFWS pumps are supplied with steam from a common steam header supplied from all four main steam lines.
   2. Electrical power for valve AFW-35 is provided by 480 VAC MCC 7-1.

C. Other
   1. Lube oil cooling for the turbine-driven AFWS pumps is provided by the service water system (see Section 3.9).
   2. Systems for AFWS pump room cooling have not been identified.

3.2.7 Section 3.2 References

1. Haddam Neck Final Safety Analysis Report, Section 8.3.
2. NUREG-0611, "Generic Evaluation of Feedwater Transients and Small Break Loss of Coolant Accidents in Westinghouse-Designed Operating Plants," Appendix X.7, "Haddam Neck Auxiliary Feedwater System", USNRC, January 1980.
3. "Connecticut Yankee Probabilistic Safety Study", Section 4.2.1.9, Northeast Utilities Services Company, February 1986.

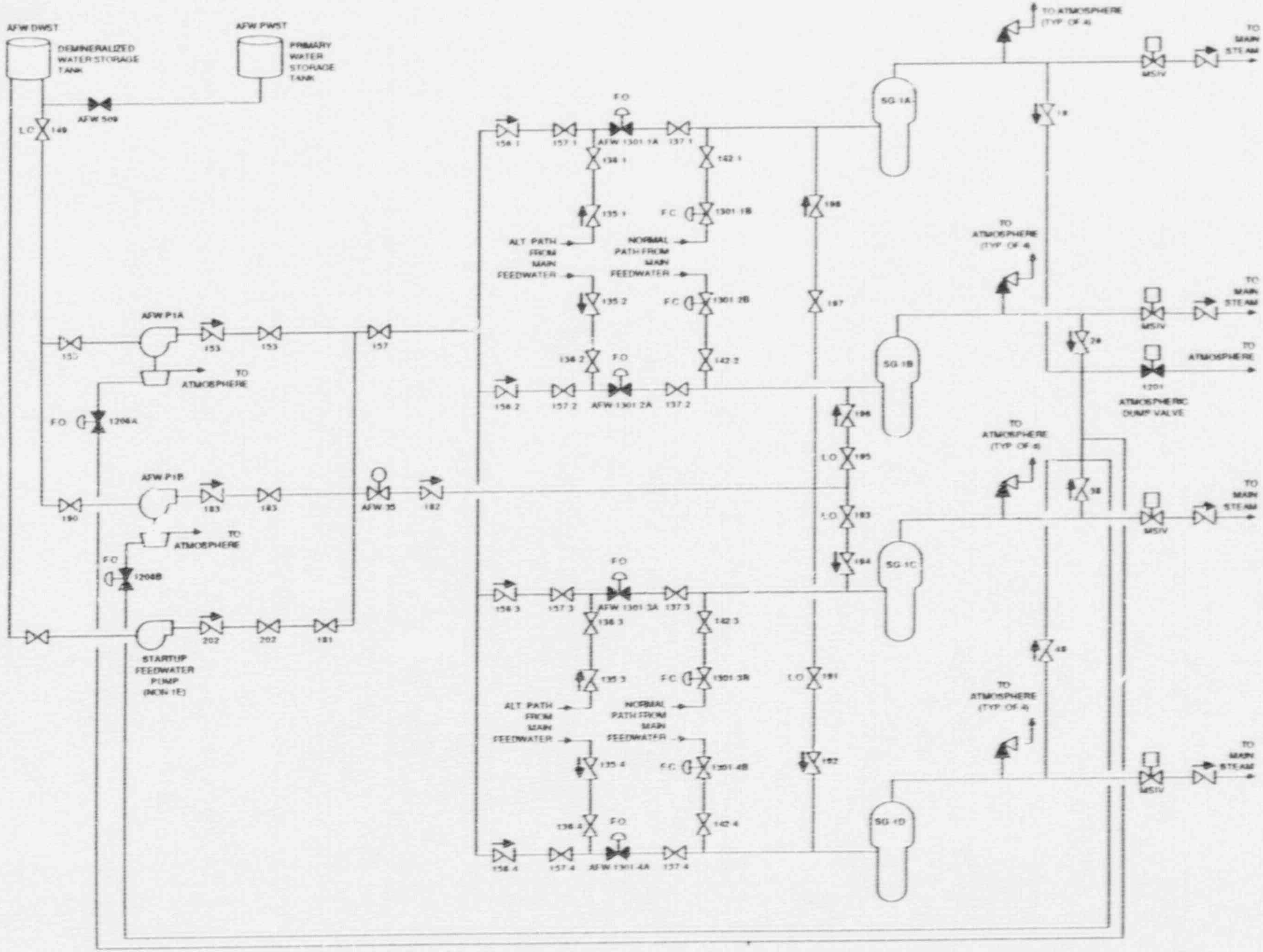


Figure 3.2-1. Haddam Neck Auxiliary Feedwater System (AFW)

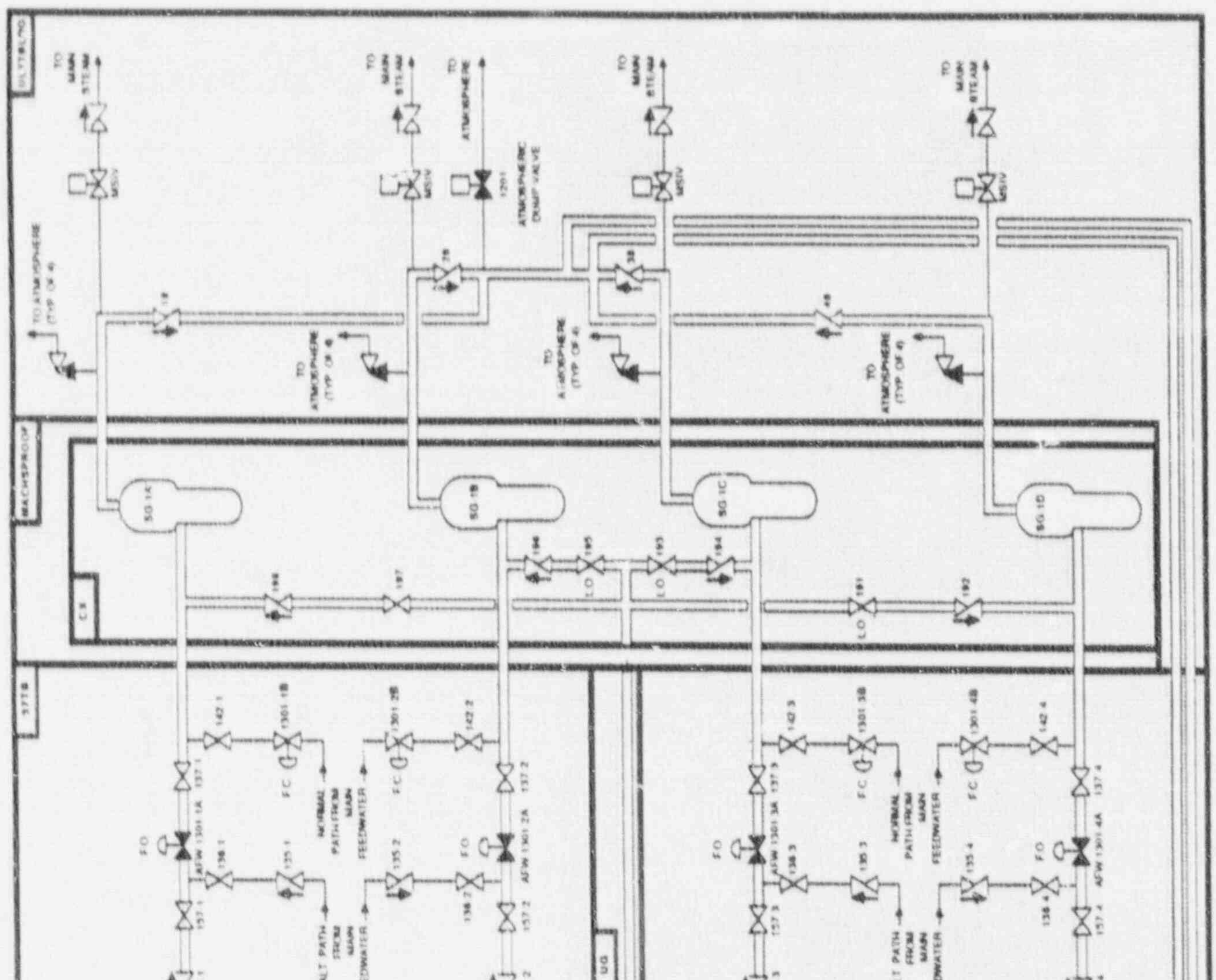


Figure 3.2-2. Haddam Neck Auxiliary Feedwater System (AFW) Showing Component Locations

Table 3.2-1. Haddam Neck Auxiliary Feedwater System Data Summary for Selected Components

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
AFW-1301-1A THRU-1301-4A	NV	37TB				
AFW-35	MOV	21TTBLDG	EP-MCC7-1	480	CBLVLT	AC/B
AFW-509	XV	DWST				
AFW-DWST	TK	DWST				
AFW-P1A	TDP	21TTBLDG				
AFW-P1B	TDP	21TTBLDG				
AFW-PWST	TK	PWST				

3.3 EMERGENCY CORE COOLING SYSTEM (ECCS)

3.3.1 System Function

The ECCS, or Safety Injection System (SIS), is an integrated set of subsystems that perform emergency coolant injection and recirculation functions to maintain reactor core coolant inventory and adequate decay heat removal following a LOCA. The coolant injection function is performed during a relatively short-term period after LOCA initiation, followed by realignment to a recirculation mode of operation to maintain long-term, post-LOCA core cooling. Heat from the reactor core is transferred to the containment. The heat transfer path to the ultimate heat sink is completed by the containment heat removal systems (see Section 3.7). Additionally, the ECCS supplies negative reactivity during an uncontrolled plant cooldown (Ref. 1).

3.3.2 System Definition

The emergency coolant injection (ECI) function is performed by the following subsystems:

- Charging System (CVCS, see Section 3.4)
- High Pressure Safety Injection (SI) System
- Low Pressure Safety Injection (LPI) System
- Residual Heat Removal (RHR) System

The charging system's two centrifugal charging pumps deliver borated water to the four cold legs of the RCS. The high pressure safety injection (SI) system consists of two motor-driven pump trains that deliver water to a common injection header. The header directs flow to the four cold legs of the RCS via injection paths independent from the charging system injection paths. The low pressure safety injection (LPI) system consists of two pump trains that deliver water directly to the RCS vessel in the event of a large LOCA. The RHR system consists of two motor-driven pumps that deliver water directly to the RCS vessel. During the recirculation phase, the RHR pumps can also deliver water to the suction of the charging pumps for operation in the high-pressure recirculation mode. The RHR pumps and heat exchangers also perform the shutdown cooling function. The Refueling Water Storage Tank (RWST) is the water source for the ECCS pumps during the injection phase. During recirculation, the RHR pumps take a suction on the containment sump and inject directly into the RCS vessel via the core deluge system at low pressure, or provide flow to the suction of the centrifugal charging pumps to establish a high pressure recirculation flow path.

Simplified drawings of the high pressure safety injection system are shown in Figures 3.3-1 and 3.3-2. The LPI and RHR systems are shown in Figures 3.3-3 to 3.3-6. The charging system (CVCS) is discussed in Section 3.4. A summary of data on selected ECCS components is presented in Table 3.3-1.

3.3.3 System Operation

During normal operation, the ECCS is in standby. The ECCS pumps are automatically actuated by a Safety Injection Signal.

The low pressure injection (LPI) system injects borated water from the RWST directly to the RCS vessel in the event of a large LOCA. This system is used in lieu of safety injection accumulator tanks, which are used on later Westinghouse plants. The LPI system is designed to deliver full flow to the RCS vessel within five seconds of actuation. In addition, the LPI system provides flow to the containment spray header as discussed in Section 3.7. During the injection phase, the charging, and high pressure safety injection pumps take suction on the RWST and deliver borated water to the four RCS cold legs via separate injection paths. The LPI and RHR pumps take suction on the RWST and deliver borated water directly to the RCS vessel via the core deluge system during injection mode. The relative importance of the charging and safety injection pumps is increased for small breaks when the RCS is still at high pressure, while the LPI and RHR pumps are more important in responding to large breaks.

When the RWST reaches a low-low level alarm setpoint, the recirculation phase is initiated. The RHR pumps are re-aligned to take a suction on the containment sump and deliver water through the RHR heat exchangers directly to the RCS vessel at low pressure (<400 psig) or to the suction of the charging pumps if the RCS pressure is greater than 400 psig.

3.3.4 System Success Criteria

LOCA mitigation requires both the emergency coolant injection (ECI) and emergency coolant recirculation (ECR) functions. The success criteria for the ECCS is defined in the Haddam Neck Probabilistic Safety Study (Ref. 2).

For large LOCAs, one of two LPI pumps and one of two open core deluge valves (valves RH-871A or RH-871B) provides the required flow. Alternatively, one of two RHR pumps may provide the required flow through the core deluge system (also using one of two valves). For smaller LOCAs at higher pressure, one of two high-pressure injection pumps or or one of two centrifugal charging pumps provides the required flow to the three unfaulted RCS loops.

The RWST is required for system success during the injection phase. The containment sump, one of two RHR pumps, and one of two RHR heat exchangers removing heat via the ACWS or SWS are required for system success during the low pressure recirculation phase. High pressure recirculation requires the successful establishment of at least one tandem pumping path from the containment sump to an RHR pump, to an RHR heat exchanger, to either an SI or centrifugal charging pump, and finally to the RCS.

For small LOCAs that do not result in RCS depressurization below the safety injection pump shutoff head, the charging pumps are required unless the RCS is depressurized below the safety injection pumps shutoff head (i.e., <1500 psig). Options for depressurizing the RCS may include:

- RCS cooldown (i.e., using auxiliary feedwater system, see Section 3.2)
- Opening power-operated relief valves on the pressurizer two of two (see Section 3.1)

3.3.5 Component Information

A. Centrifugal charging pumps 1A, 1B
   1. Rated flow: 360 gpm @ 5293 ft. head (2300 psig)
   2. Shutoff head: 5488 ft. head (2375 psig)
   3. Type: Horizontal, multi-stage, centrifugal

B. Safety Injection pumps 1A, 1B
   1. Rated flow: 1750 gpm @ 2250 ft. head (974 psig)
   2. Maximum flow: 2750 gpm @ 500 ft. head (216 psig)
   3. Shutoff head: 3466 ft. head (1500 psig)
   4. Type: Horizontal, multistage, centrifugal

C. Residual Heat Removal pumps 1A, 1B
   1. Rated flow: 2200 gpm @ 300 ft. head (130 psig)
   2. Shutoff head: 925 ft. head (400 psig)
   3. Type: Vertical, single-stage, centrifugal

D. Low Pressure Injection Pumps 1A, 1B
   1. Rated flow: 5500 gpm @ 590 ft head (255 psig)
   2. Shutoff head: 809 ft head (350 psig)
   3. Type: Horizontal, single stage centrifugal

E. Refueling Water Storage Tank
   1. Capacity: 250,000 gallons
   2. Minimum volume: 150,000 gallons
   3. Operating pressure: Atmospheric

F. RHR Heat Exchangers (2)
   1. Type: Vertical shell and U-tube
   2. Design duty: Not determined

3.3.6 Support Systems and Interfaces

A. Control Signals
   1. Automatic
      a. The ECCS subsystems are automatically started by a Safety Injection Actuation Signal (SIAS) based on any of the following conditions:
         - Low pressurizer pressure
         - High containment pressure
         - High differential pressure between any two steam lines outside of containment
         - High steam flow in two of four lines in coincidence with either low T_{avg} or low steam line pressure
         - Manual actuation

      b. The SIAS automatically initiates the following actions:
         - reactor trip
         - starts the diesel generators
         - starts the centrifugal charging, safety injection, LPI, and RHR pumps
         - opens the charging pump RWST suction valves

      c. Switchover from the injection/mode to recirculation is initiated on two-out-of-four RWST low level signals in conjunction with a SIAS. This causes the suction valves from the containment sump to open and the RWST isolation valves to close.

   2. Remote manual
      A safety injection signal can be initiated by remote manual means from the control room. ECCS operation can be initiated by remote manual means.

B. Motive Power
   All ECCS motor-driven pumps and motor-operated valves are Class 1E AC loads that can be supplied from the standby diesel generators as described in Section 3.6.

C. Other
1. SI, LPI, and RHR pumps are air-cooled and dependent on room ventilation. There are no other external auxiliaries for these pumps.
2. Cooling for the charging pump lube oil coolers is provided by the auxiliary cooling water system (ACWS, see Section 3.8).
3. The ACWS provides cooling water to the RHR heat exchangers during normal plant shutdown. However, during emergency shutdown conditions, valves 760A and B and 764A and B are manually closed and cooling water to the RHR heat exchangers is provided directly by the service water system (SWS, see Section 3.9).
4. Systems for ECCS pump room ventilation have not been identified.

3.3.7 Section 3.3 References

1. Haddam Neck Final Safety Analysis Report, Section 5.2.7.
2. "Connecticut Yankee Probabilistic Safety Study", Sections 4.2.12 thru 4.2.15, Northeast Utilities Service Company, February 1986.

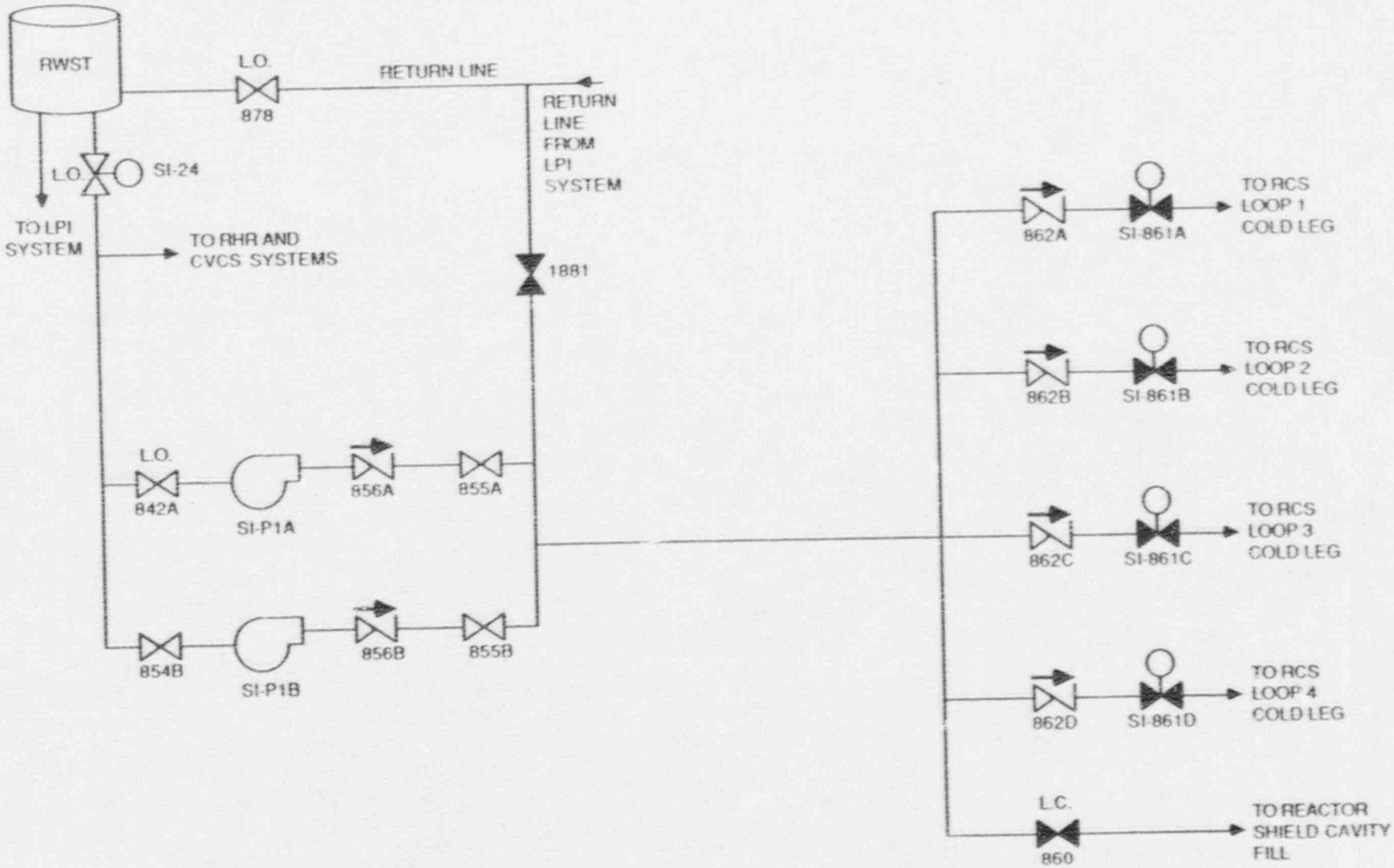


Figure 3.3-1. Haddam Neck High Pressure Safety Injection (SI) System

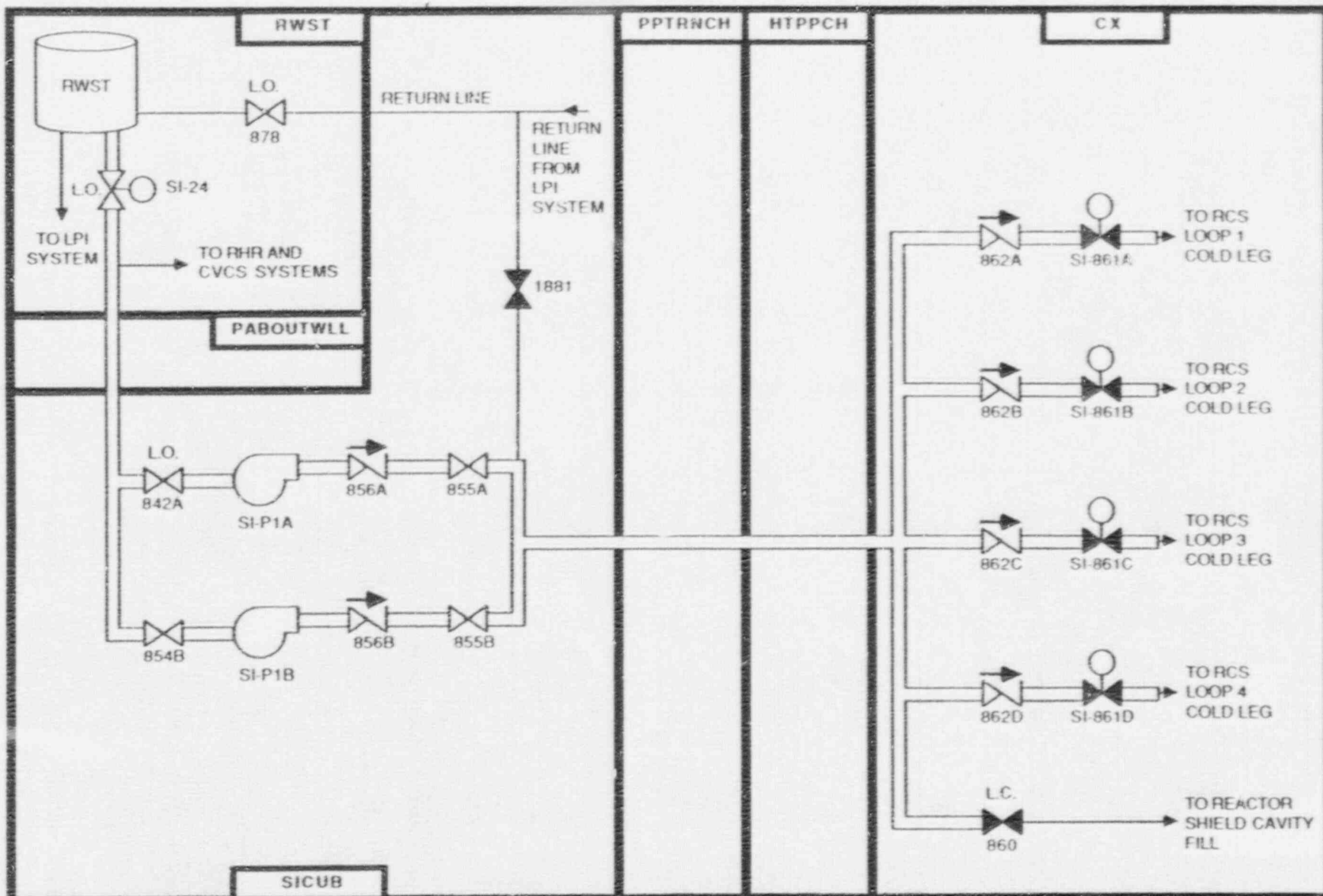


Figure 3.3-2. Haddam Neck High Pressure Safety Injection (SI) System Showing Component Locations

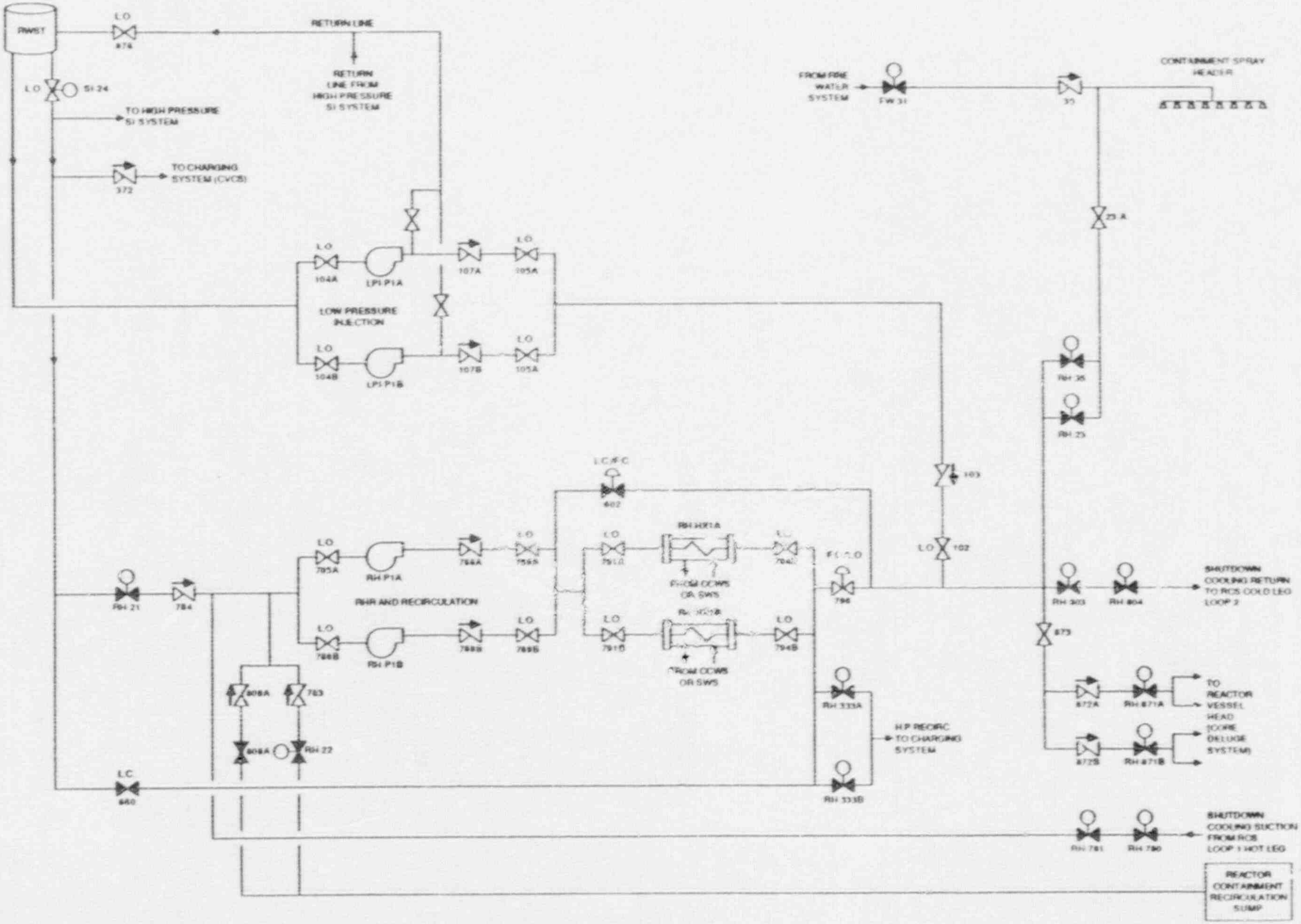


Figure 3.3-3. Haddam Neck Low-Pressure Safety Injection (LPI) and Residual Heat Removal (RHR) Systems

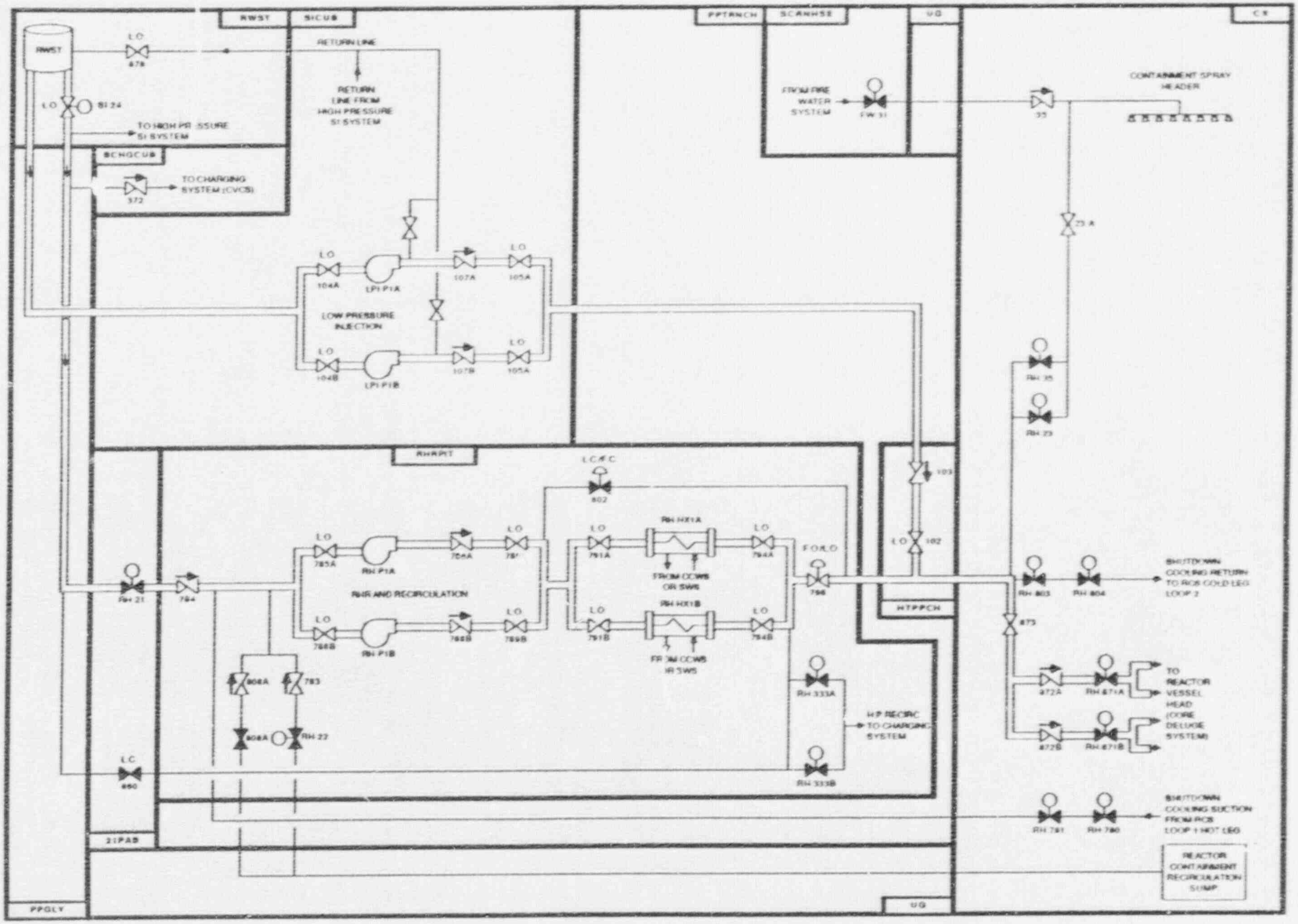


Figure 3.3-4. Haddam Neck Low-Pressure Safety Injection (LPI) and Residual Heat Removal (RHR) Systems (ECCS Low Pressure Injection Mode) Showing Component Locations

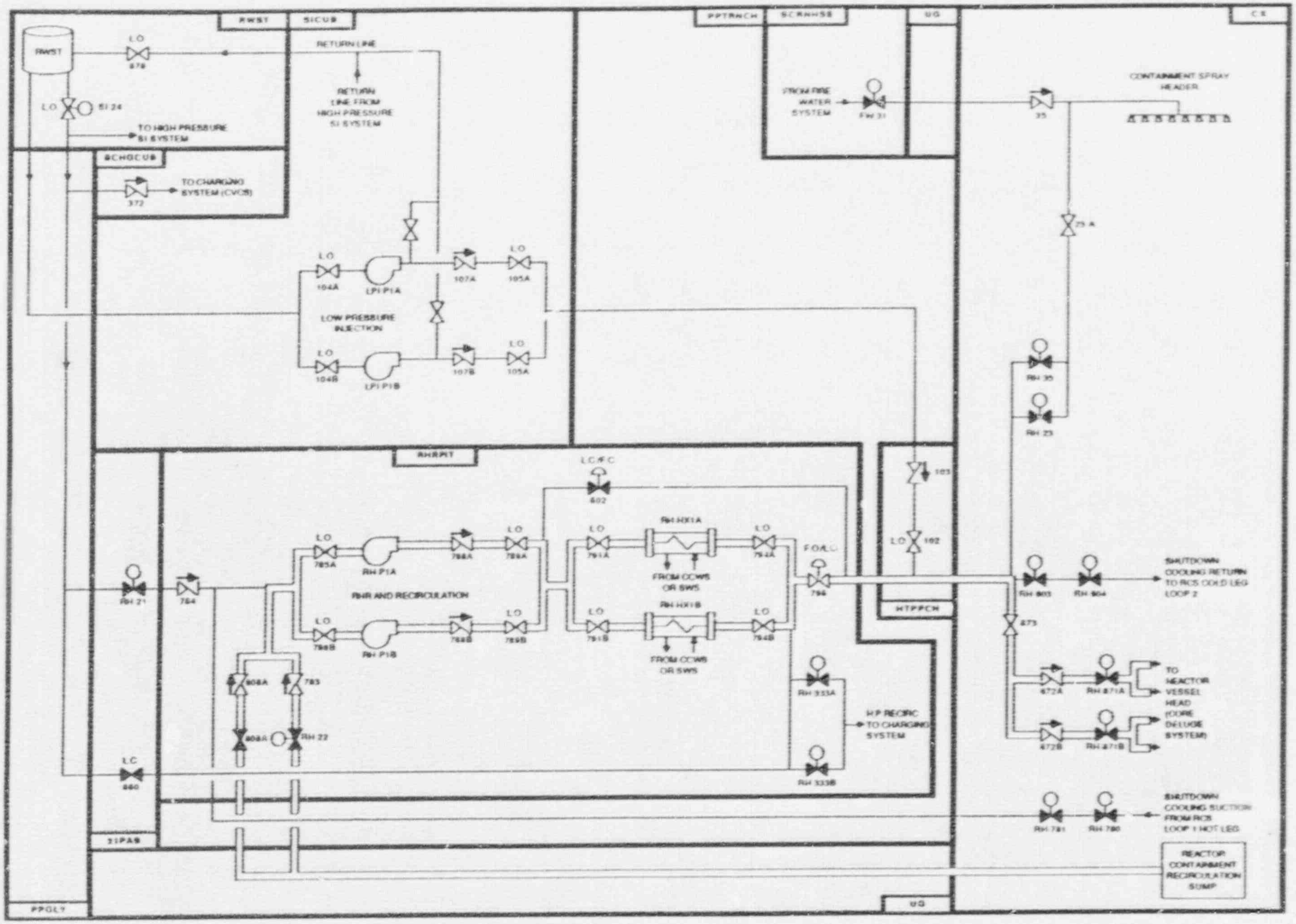


Figure 3.3-5. Haddam Neck Low-Pressure Safety Injection (LPI) and Residual Heat Removal (RHR) Systems (ECCS Low Pressure Recirculation Mode) Showing Component Locations

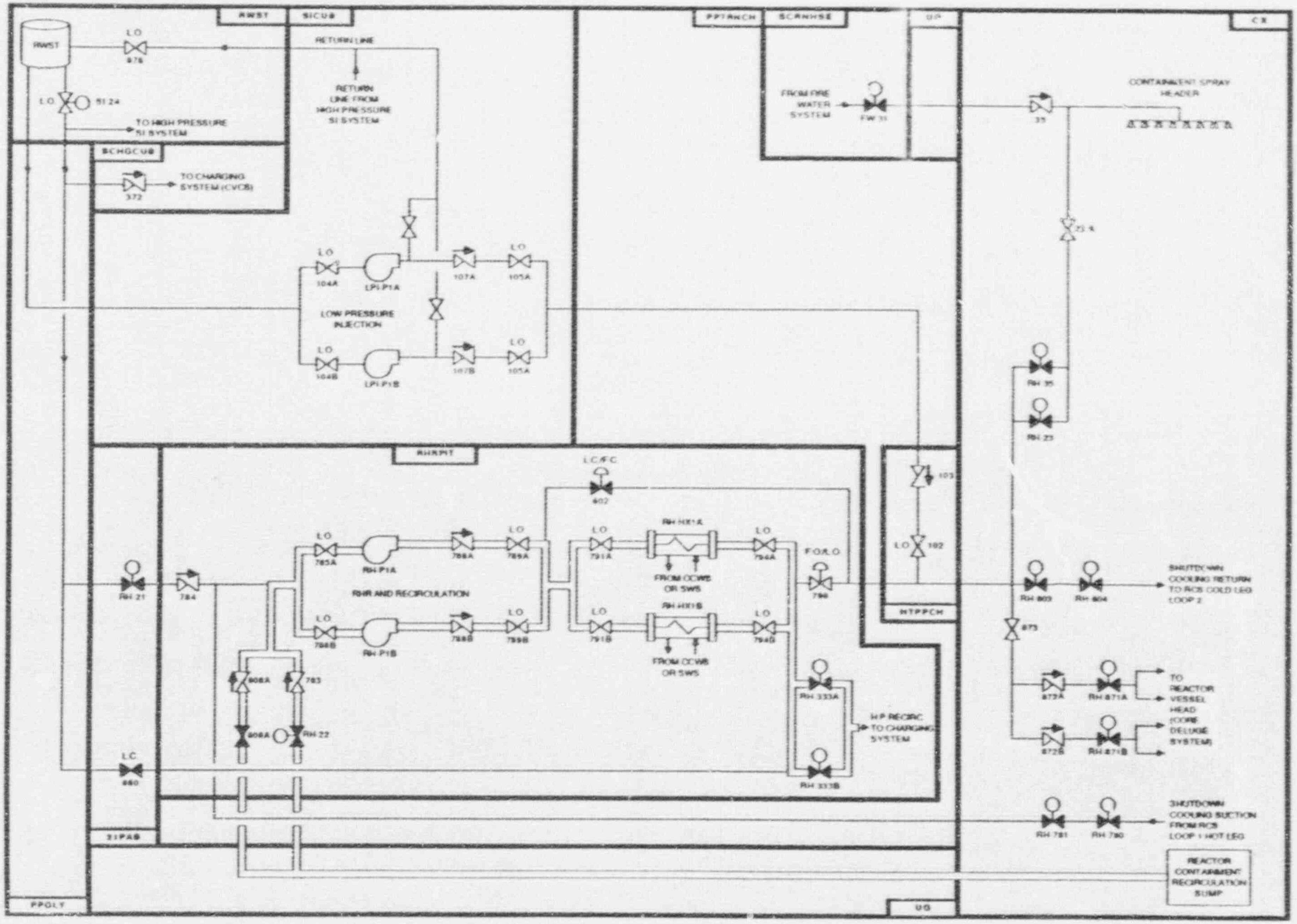


Figure 3.3-6. Haddam Neck Low-Pressure Safety Injection (LPI) and Residual Heat Removal (RHR) Systems (ECCS High Pressure Recirculation Mode) Showing Component Locations

Table 3.3-1. Haddam Neck Emergency Core Cooling System Data Summary for Selected Components

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
RH-21	MOV	21PAB	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
RH-780	MOV	CX	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
RH-781	MOV	CX	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
RH-803	MOV	CX	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
RH-804	MOV	CX	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
RH-871A, RH-871B	MOV	CX	EP-MCC7-1	480	CBLVLT	AC/B
RH-P1A	MDP	RHRPIT	EP-BUS 5	480	SWGRRM	AC/A
RH-P1B	MDP	RHRPIT	EP-BUS 6	480	SWGRRM	AC/B
SI-24	MOV	RWST	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
SI-861A THRU SI-861D	MOV	CX	EP-MCC7-1	480	CBLVLT	AC/B
SI-P1A	MDP	SICUB	EP-BUS 9	4160	DGRMB	AC/B
SI-P1B	MDP	SICUB	EP-BUS 8	4160	DGRMA	AC/A

3.4 CHEMICAL AND VOLUME CONTROL SYSTEM (CVCS)

3.4.1 System Function

The CVCS is responsible for maintaining the proper water inventory in the Reactor Coolant System, providing required seal water flow to the reactor coolant pump seals, and maintaining water purity and the proper concentration of neutron absorbing and corrosion inhibiting chemicals in the reactor coolant (Ref. 1). The centrifugal charging pumps also serve as part of the emergency core cooling system (ECCS, see Section 3.3) and provide injection flow to the RCS following a LOCA. The makeup function of the CVCS (charging system) is required to maintain the plant in an extended hot shutdown condition following a transient. An alternate method of providing cooling to the reactor coolant pumps is seals is available from the Auxiliary Cooling Water System (ACWS, see Section 3.8).

3.4.2 System Definition

The CVCS consists of several subsystems that perform the functions of maintaining RCS coolant inventory control, coolant chemistry and purity control, and reactivity control. The charging system consists of two centrifugal and one positive displacement charging pumps that, during normal operation, take a suction on the volume control tank (VCT) and return the purified reactor coolant to the RCS. The normal charging path is through the regenerative heat exchanger. The centrifugal charging pumps also perform a high pressure safety injection function, as described in Section 3.3. In this mode the charging pumps are aligned to take a suction on the refueling water storage tank (RWST) and inject directly into the four RCS cold legs.

Simplified drawings of the CVCS, focusing on the charging function, are shown in Figures 3.4-1 to 3.4-4. A summary of data on selected CVCS components is presented in Table 3.4-1.

3.4.3 System Operation

During normal operation, a side-stream of reactor coolant flows through the letdown line to the purification system and is returned to the RCS by a single normally-operating charging pump. Letdown flow from reactor coolant loop 1 cold leg passes through the shell side of the regenerative heat exchanger for an initial temperature reduction. The coolant then experiences a large pressure reduction as it passes through the letdown orifices and flow control valves. The cooled, low pressure water then undergoes a second temperature reduction in the tube side of the non-regenerative heat exchanger, followed by a second pressure reduction by the low pressure letdown valve. Flow is then directed through various filters and ion exchangers before being sprayed into the volume control tank where it is returned to the RCS by the charging pumps.

Normal charging flow is provided by one of the two centrifugal pumps. This charging flow splits into two paths. The bulk of the charging flow is pumped back to the RCS hot leg loop 1 through the regenerative heat exchanger. A portion of the charging flow is filtered and injected into the reactor coolant pump seals (nominally 4 gpm per pump). The positive displacement pump also is available to provide RCS makeup and water to the reactor coolant pump seals.

The centrifugal charging pumps serve as high-head safety injection pumps as part of the ECCS following a LOCA. Other than the centrifugal charging pumps and associated piping and valves, the balance of CVCS is not required to operate during a LOCA. In the event of a LOCA, charging pump suction is switched from the VCT to the RWST.

3.4.4 System Success Criteria

The following success criterion is given in the Haddam Neck PRA (Ref. 2) for CVCS makeup following a transient:

- 1 of 2 centrifugal charging pumps taking suction on the RWST is required for adequate post-transient makeup to the RCS.

The charging pump success criteria for small LOCA mitigation is one of two charging pumps taking suction on the RWST.

3.4.5 Component Information

A. Centrifugal charging pumps 1A, 1B
   1. Rated flow: 360 gpm @ 5293 ft. head (2300 psig)
   2. Shutoff head: 5488 ft. head (2375 psig)
   3. Type: Horizontal multi-stage centrifugal

B. Positive displacement charging pump 1C
   1. Rated flow: 30 gpm @ 2000 psig
   2. Shutoff head: 3750 psig
   3. Type: Positive displacement

C. Refueling Water Storage Tank
   1. Capacity: 250,00 gallons
   2. Minimum volume: 150,000 gallons
   3. Operating pressure: Atmospheric

D. Volume Control Tank
   1. Volume: 208 ft^3
   2. Design pressure: 75 psig

3.4.6 Support Systems and Interfaces

A. Control Signals
   1. Automatic
      a. During normal operation, CVCS letdown flow and RCS makeup flow are modulated by the pressurizer level control system.
      b. The charging pump suction is automatically aligned to the RWST if the level in the volume control tank drops to 10%.
      c. A safety injection signal automatically starts the standby centrifugal charging pump, isolates the letdown line, closes the normal charging path valves, causes pump suction to change from the VCT to the RWST and opens valve CH-344.

   2. Remote manual
      The charging pumps and associated motor-operated valves can be actuated by remote means from the control room.

B. Motive Power
   1. The centrifugal charging pumps and associated motor-operated valves are Class 1E AC loads that can be supplied from the standby diesel generators as described in Section 3.6.
   2. The positive displacement charging pump is a non-Class 1E load.

C. Other

1. Cooling water for the centrifugal charging pump lube oil coolers is provided by the auxiliary cooling water system (ACWS, see Section 3.8).
2. Charging pump lubrication is provided locally.
3. The positive displacement charging pump requires no external auxiliaries.
4. Charging pump room cooling systems have not been identified.

3.4.7 Section 3.4 References

1. Haddam Neck Final Safety Analysis Report, Section 5.2.1.
2. "Connecticut Yankee Probabilistic Safety Study", Section 4.2.10, Northeast Utilities Service Company, February 1986.

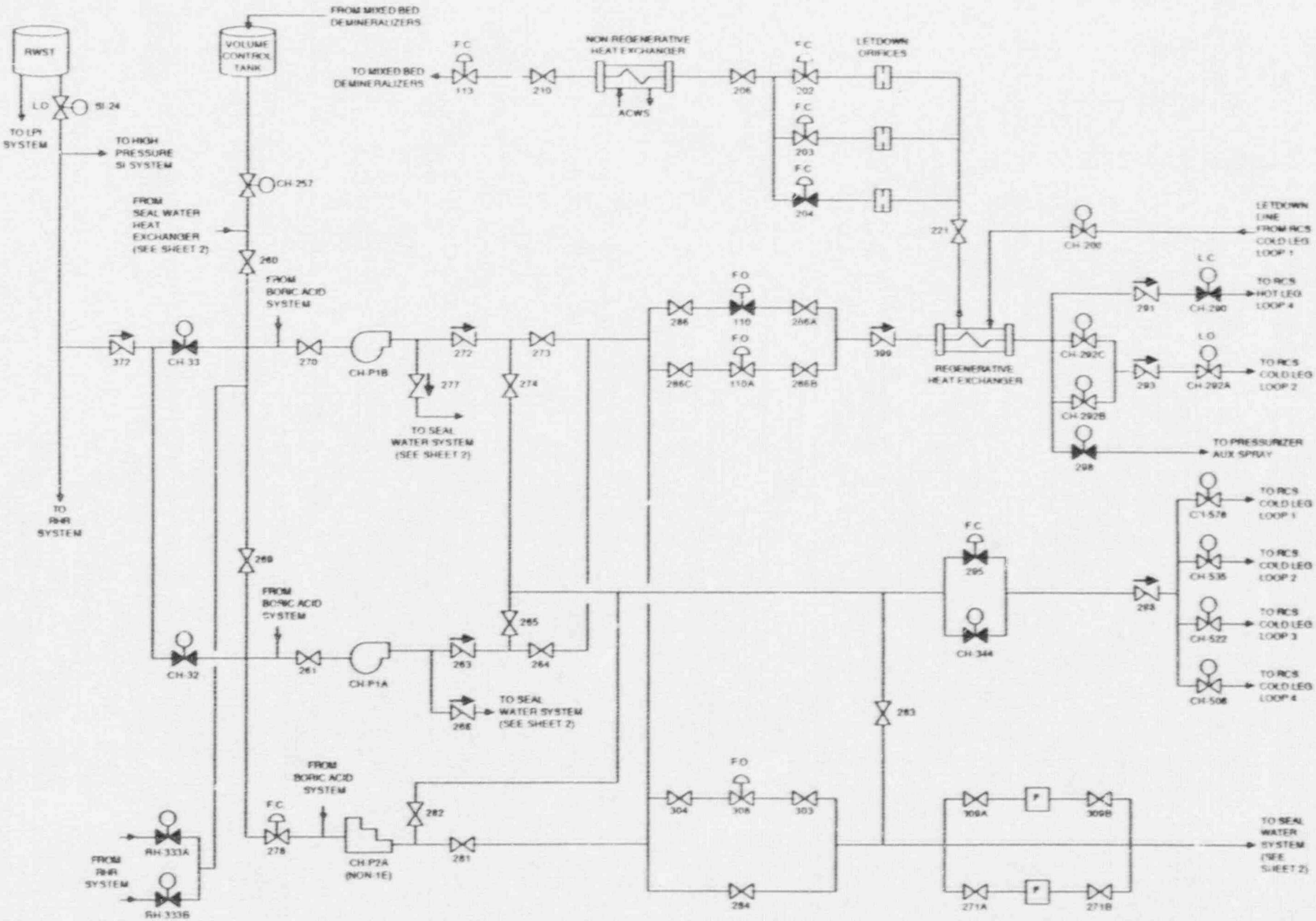


Figure 3.4-1. Haddam Neck Charging System (CVCS) (Sheet 1 of 2)

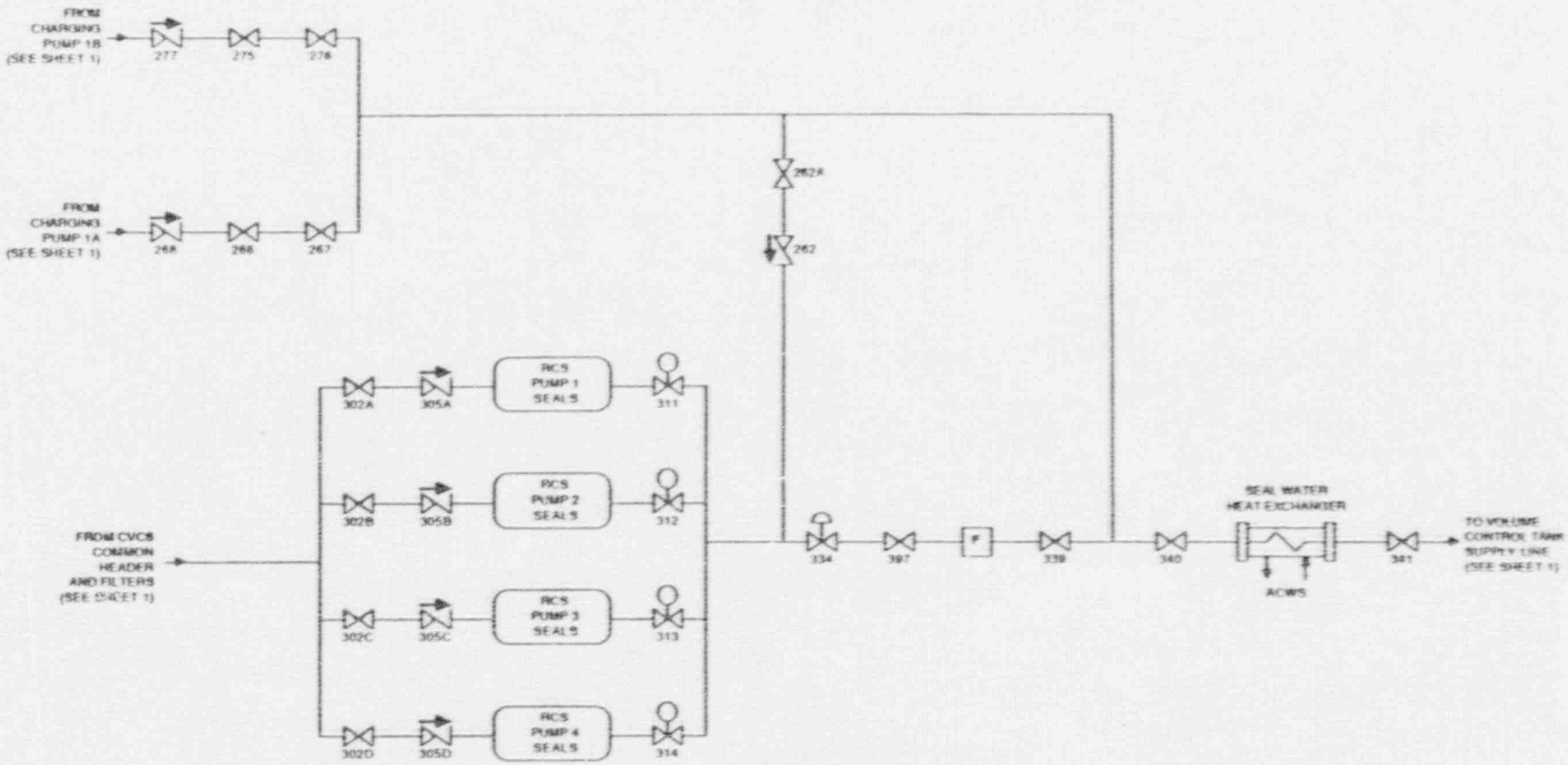


Figure. 3.4-1. Haddam Neck Charging System (CVCS) (Sheet 2 of 2)

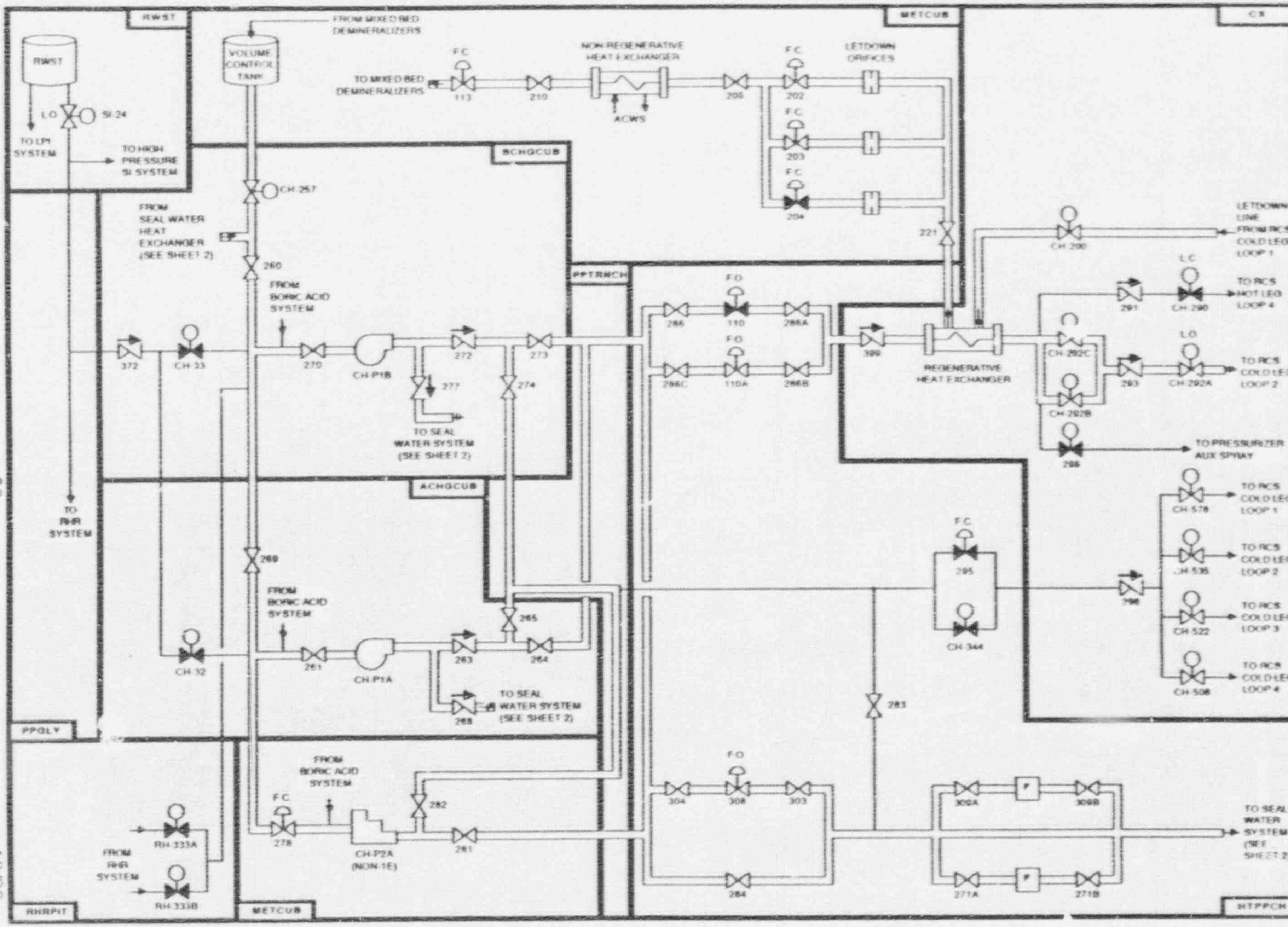


Figure 3.4-2. Haddam Neck Charging System (CVCS, Normal Charging Mode) Showing Component Locations (Sheet 1 of 2)

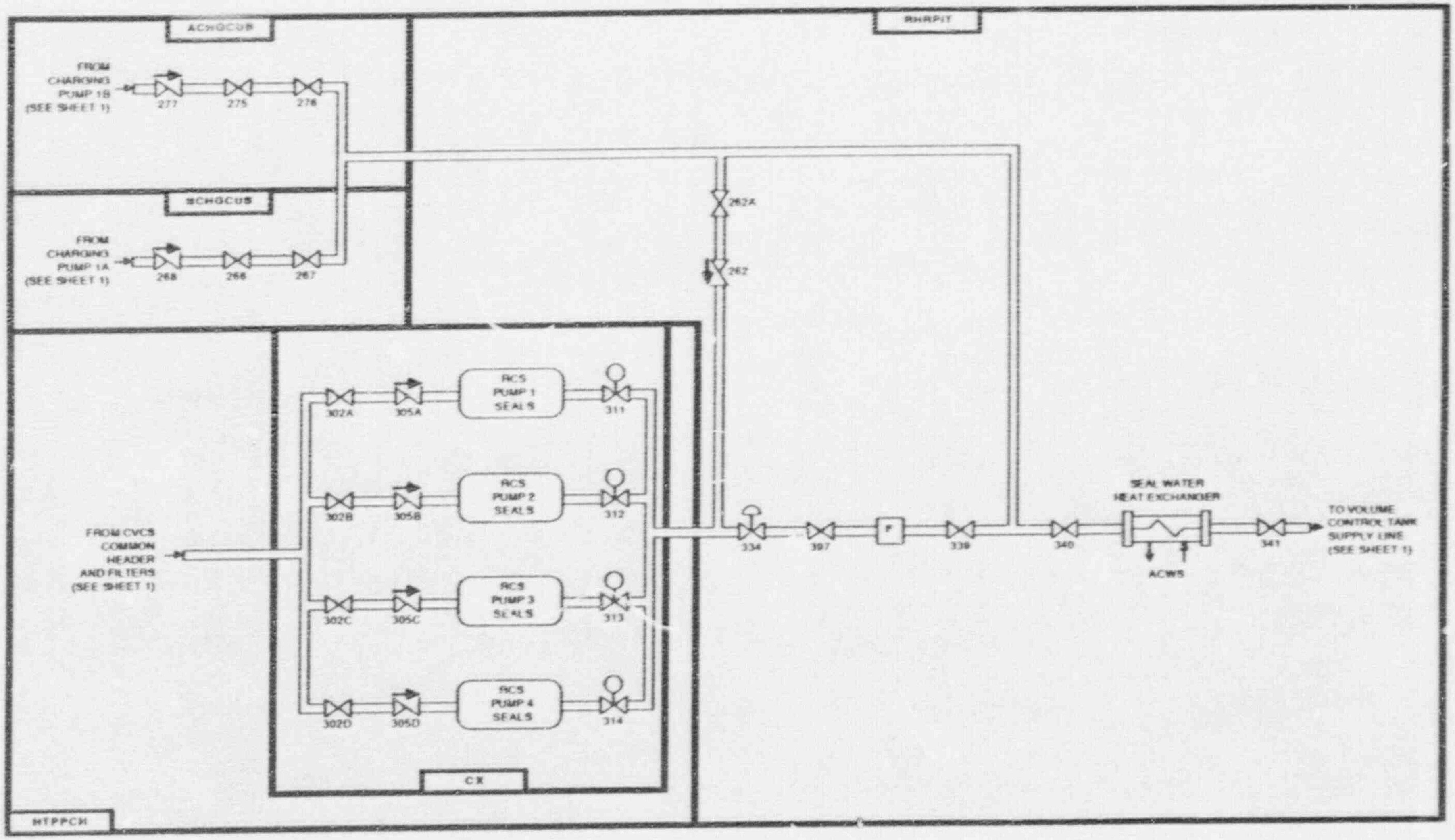


Figure. 3.4-2. Haddam Neck Charging System (CVCS, Normal Charging Mode) Showing Component Locations
(Sheet 2 of 2)

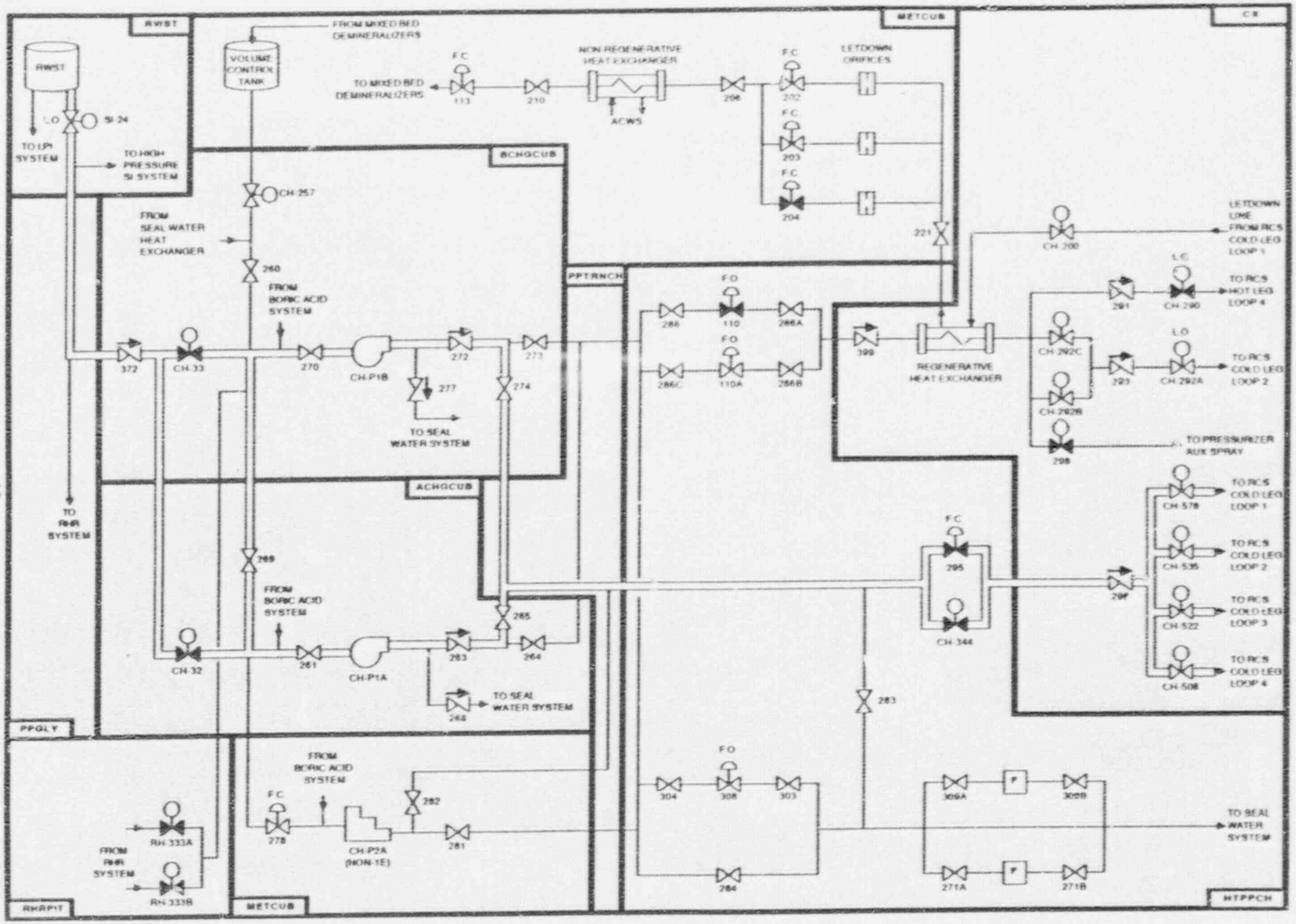


Figure 3.4-3. Haddam Neck Charging System (ECCS High Pressure Injection Mode) Showing Component Locations

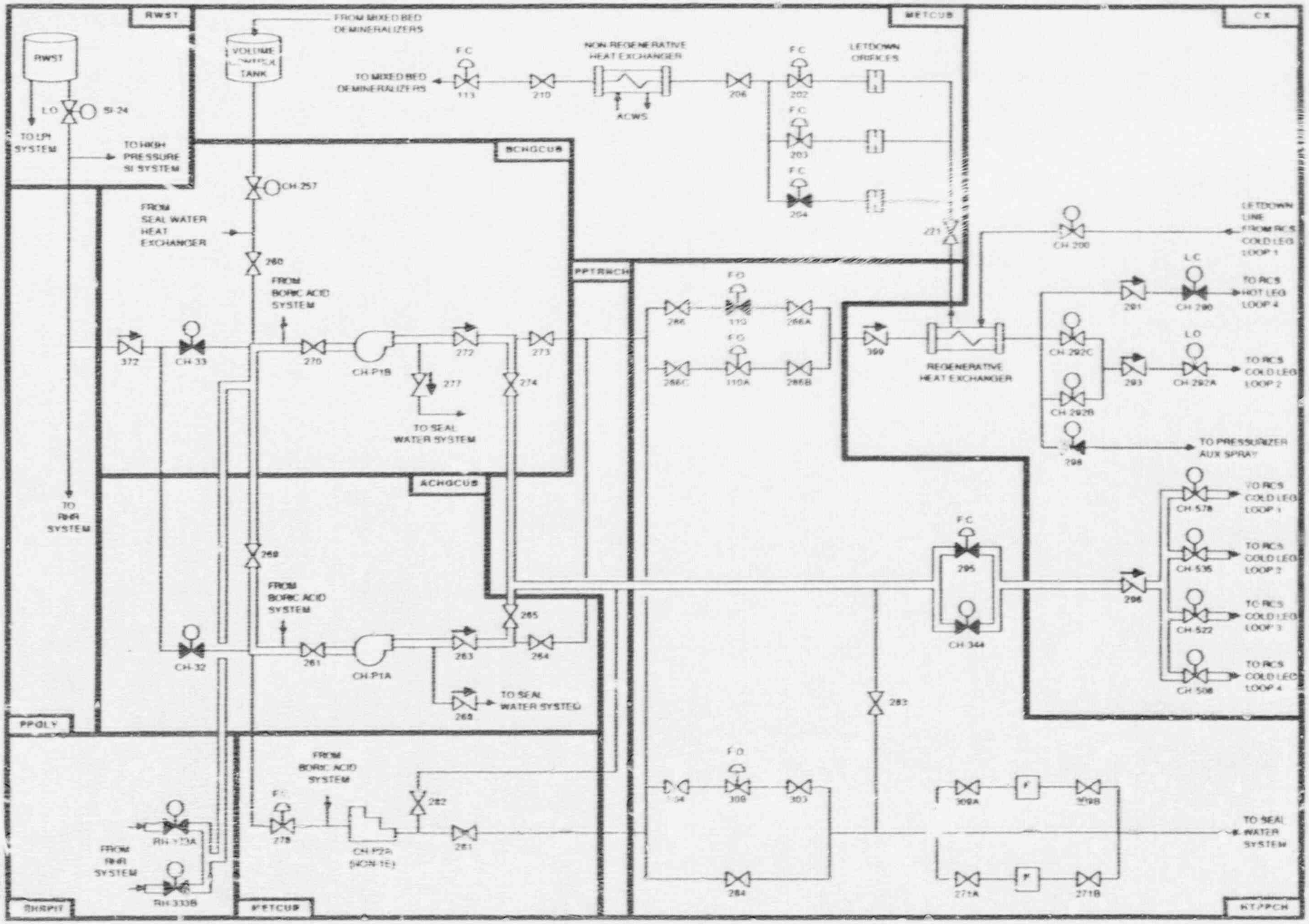


Figure 3.4-4. Haddam Neck Charging System (ECCS High Pressure Recirculation Mode) Showing Component Locations

Table 3.4-1. Haddam Neck Charging System (CVCS) Data Summary for Selected Components

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
CH-292B	MOV	CX	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
CH-292C	MOV	CX	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
CH-32	MOV	BCHGCUB	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
CH-33	MOV	ACHGCUB	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
CH-P1A	MDP	ACHGCUB	EP-BUS 9	4160	DGRMB	AC/B
CH-P1B	MDP	BCHGCUB	EP-BUS 8	4160	DGRMA	AC/A

3.5 INSTRUMENTATION AND CONTROL (I & C) SYSTEMS

3.5.1 System Function

The instrumentation and control systems consist of the Reactor Trip System (also known as the Reactor Protection System, RPS), the Engineered Safety Features (ESF) actuation systems, and systems for the display of plant information to the operators. The RPS and the ESF actuation systems monitor the reactor plant and alert the operator to take corrective action before specified limits are exceeded. The RPS will initiate an automatic reactor trip (scram) to rapidly shutdown the reactor when plant conditions exceed one or more specified limits. The ESF actuation systems will automatically actuate selected safety systems based on the specific limits or combinations of limits that are exceeded. A remote shutdown capability is provided to ensure that the reactor can be placed in a safe condition in the event that the main control room must be evacuated (Refs. 1,2).

3.5.2 System Definition

The RPS includes sensor and transmitter units, logic units, and output trip relays that generate a reactor trip signal. The reactor trip signal opens the scram breakers, thus deenergizing the control rod magnetic latch mechanisms, allowing all control rod assemblies to drop into the core. The ESF actuation systems include independent sensor and transmitter units, logic units and relays that interface with the control circuits for the many different engineered safety features components that can be actuated by this system. Operator instrumentation display systems consist of display panels in the control room and local control stations that are powered by the 120 VAC electric power system (see Section 3.6).

3.5.3 System Operation

A. RPS

The RPS has three redundant input instrument channels for each sensed parameter. Two reactor trip circuit breakers are actuated by two separate RPS logic matrices. When either of the trip breakers opens, power is interrupted to the rod drive power supply, and the control and shutdown rods fall into the core. Certain reactor trip channels are automatically bypassed at power levels where they are not required for safety. The following conditions result in reactor trip:

- Operation of the 19kV or 345kV protective relays in the switchyard
- High neutron flux
- High neutron flux rate
- Negative neutron flux rate
- Overtemperature delta T
- Overpower delta T
- Low pressurizer pressure
- High pressurizer pressure
- High pressurizer water level
- Low reactor coolant flow
- Reactor coolant pump undervoltage
- Safety injection system actuation
- Turbine trip
- Low-low steam generator water level
- Excessive steam line flow
- Steam/feedwater flow mismatch
- Manual actuation

B. ESF Actuation Systems
The ESF actuation systems each consists of two discrete portions of circuitry: (1) an analog portion consisting of three to four redundant channels per parameter, and (2) a digital portion consisting of two redundant logic trains which receive inputs from the analog protection channels and perform the logic needed to actuate the ESF equipment, motor starters, and valve operators. The following vital functions are actuated:

- Safety injection system actuation
- Containment isolation
- Main steam line isolation
- Feedwater isolation
- Containment air recirculation system actuation
- Containment ventilation isolation
- Control room ventilation isolation

The actuation systems provide an actuation signal to each individual component in the required engineered safety features system.

C. Remote Shutdown
Equipment is provided in appropriate locations outside the control room to allow the plant to maintain a hot shutdown condition. Local controls are provided for the following systems, in addition to those controls in the main control room:

- Auxiliary Feedwater System
  Local controls and instrumentation exist for the turbine-driven AFW pumps.
- Diesel Generators
  Local control panels exist at each diesel generator, consisting of a local stop/start switch, DG circuit breaker control switch, and associated instrumentation necessary for operation of the diesel generator system.

In addition, a local control panel exists in the Primary Auxiliary Building (PAB). Details on the control capabilities of this panel have not been determined.

3.5.4 System Success Criteria

A. RPS
The RPS uses hindrance logic (normal = 1, trip = 0) in both the input and output logic. Therefore, a channel will be in a trip state when input signals are lost, when control power is lost, or when the channel is temporarily removed from service for testing or maintenance (i.e., the channel has a fail-safe failure mode). A reactor scram will occur upon loss of control power to the RPS. A reactor scram is implemented by the scram circuit breakers which must open in response to a scram signal. There are two series scram circuit breakers in the power path to the scram rods. In this case, one of two circuit breakers must open. Details of the scram system for Haddam Neck have not been determined.

B. ESF Systems
In general, the loss of instrument power to the sensors, instruments, or logic devices places that channel in the trip state. Details of the ESF actuation systems for Haddam Neck have not been determined.

C. Manually-Initiated Protective Actions
When reasonable time is available, certain protective actions may be performed manually by plant personnel. The control room operators are capable of operating individual components using normal control circuitry, or operating groups of components by manually tripping the RPS or an ESF subsystem. The control room operators also may send qualified persons into the plant to operate components locally or from some other remote control location (i.e., the Primary Auxiliary Building panel or the Switchgear Room). To make these judgments, data on key plant parameters must be available to the operators.

3.5.5 Support Systems and Interfaces

A. Control Power
Operator instrumentation displays are powered from the 120 VAC instrument buses (see Section 3.6).

3.5.6 Section 3.5 References

1. Haddam Neck Final Safety Analysis Report, Section 7 and 9.5.
2. "Connecticut Yankee Probabilistic Safety Study", Section 4.2.8, Northeast Utilities Service Company, February 1986.

3.6 ELECTRIC POWER SYSTEM

3.6.1 System Function

The electric power system supplies power to various equipment and systems needed for normal operation and/or response to accidents. The onsite Class 1E electric power system supports the operation of safety class systems and instrumentation needed to establish and maintain a safe shutdown plant condition following an accident, when the normal electric power sources are not available (Ref. 1).

3.6.2 System Definition

The Class 1E system is divided into two redundant trains (trains A and B), with either one of the trains capable of providing power to support systems needed to establish and maintain a safe shutdown condition. The engineered safety features for Haddam Neck receive power from two 4160 VAC buses, designated bus 8 (train A) and bus 9 (train B). The emergency source of power for these buses are two diesel generators; diesel generator 1A feeds bus 8, and diesel generator 1B feeds bus 9. Each 4160 VAC bus feeds another 4160 VAC emergency bus (bus 2 and bus 3). Each emergency 4160 VAC bus feeds an emergency 480 VAC load center through a transformer, and each emergency 480 VAC load center in turn supplies power to motor control centers supplying vital components.

The 125 VDC system provides power for control and instrumentation and other loads. There are two 125 VDC systems (identified A and B), each consisting of a dedicated battery, switchgear, battery charger, and 125 VDC distribution panels.

Four independent Class 1E 120 VAC vital instrument power supplies are provided to supply the channels of the reactor protection system, ESF actuation systems and reactor control systems. Each vital instrument power supply consists of an inverter, and a distribution panel. Simplified one-line diagrams of the 4160 VAC station electric power system are shown in Figures 3.6-1 and 3.6-2. The 480 VAC electric power system is shown in Figures 3.6-3 and 3.6-4. The 125 VDC and 120 VAC systems are shown in Figures 3.6-5 and 3.6-6. A summary of data on selected electric power system components is presented in Table 3.6-1 and selected loads and components supplied by the Class 1E electric power system are listed in Table 3.6-2.

3.6.3 System Operation

During normal operation, the Class 1E electric power system is supplied from the 115 kV switchyard through station auxiliary transformers 2 and 3. The emergency sources of AC power are the diesel generators. The transfer from the preferred power source to the diesel generators is accomplished automatically by opening the normal source circuit breakers and then reenergizing the Class 1E portion of the electric power system from the diesel generators.

Each 480 VAC motor control center is normally operated as two separate bus sections which are supplied from separate 480 VAC buses (with the exception of MCCs 9-1 and 10-1). A normally open manual cross-tie exists between bus sections. MCC 5-1 is operated as a single bus with its cross-tie normally closed, thereby insuring redundancy of emergency power supply from the diesel generators via an automatic bus transfer system.

Each 120 VAC instrumentation bus receives power from an inverter/rectifier, which normally is supplied from its associated 125 VDC battery (through its 125 VDC bus). If an inverter is taken out of service, the 120 VAC bus can be supplied by manual cross-ties to any of the other 120 VAC vital or semi-vital buses.

The DC power system normally is supplied through the battery chargers, with the batteries "floating" on the system, maintaining a full charge. Upon loss of AC power, the entire DC load draws from the batteries. The batteries are conservatively rated for approximately nine hours of operation without assistance from the battery chargers, based on the length of time they can supply the inverters following loss of AC power (Ref. 2, Section 4.2.1, with no credit for DC load shedding or the normally open manual cross-tie that exists between buses A and B).

Redundant safeguards equipment such as motor-driven pumps are supplied by different AC buses. Motor operated valves are supplied by a 480 VAC MCC, which in turn is supplied from Class 1E AC power trains. For the purpose of discussion, this equipment has been grouped into "load groups". Load group AC/A contains components powered either directly or indirectly from 4160 VAC bus 8. Load group AC/B contains components powered either directly or indirectly by 4160 VAC bus 9. Components receiving DC power are assigned to load groups DC/A or DC/B, based on the battery power source.

3.6.4 System Success Criteria

Basic system success criteria for mitigating transients and loss-of-coolant accidents are defined by front-line systems, which then create demands on support systems. Electric power system success criteria are defined as follows, without taking credit for normally open manual cross-ties that exist between independent load groups:

- Each Class 1E DC load group is supplied from its respective battery (also needed for diesel starting)
- Each Class 1E AC load group is isolated from the Non-Class 1E system and is supplied from its respective emergency power source (i.e., diesel generator)
- Power distribution paths to essential loads are intact

3.6.5 Component Information

A. Standby diesel generators 1A, 1B
   1. Rated load: 2850 kW
   2. Rated voltage: 4160 VAC
   3. Manufacturer: Unknown

B. Battery 1A
   1. Rated voltage: 125 VDC
   2. Rated capacity: 8 hours @ 120 amp
   3. Maximum capacity: 12 hours

C. Battery 1B
   1. Rated voltage: 125 VDC
   2. Rated capacity: 8 hours @ 105 amp
   3. Maximum capacity: 9 hours

D. Battery chargers 1A, 1B
   1. Rated output: 200 amps @ 130 volts DC
   2. Input: 480 volts AC

3.6.6 Support Systems and Interfaces

A. Control Signals
   1. Automatic
      The standby diesel generators are automatically started on loss of voltage to the respective 4160 VAC bus or receipt of a safety injection signal.
   2. Remote manual
      The diesel generators can be started, and many distribution circuit breakers can be operated, from the control room.

B. Diesel Generator Auxiliary Systems
1. Diesel Cooling Water System
Each diesel generator is cooled by the service water system (Section 3.9).
2. Diesel Generator Control System
The control system for each diesel generator is powered from the respective Class 1E 125 VDC system which is required for diesel startup and control.
3. Diesel Starting System
Each diesel generator is equipped with an independent starting air system capable of initiating 3 starts without outside power.
4. Diesel Fuel Oil Transfer and Storage System
A base-mounted fuel tank supplies the short-term fuel needs of each diesel (2 hours). Each base-mounted tank can be replenished from a dedicated 5,000 gallon fuel tank located underground adjacent to the diesel generator building. The fuel oil transfer pumps are powered from the 480 VAC Class 1E system.
5. Diesel Lubrication System
Each diesel generator has an independent oil lubrication system.
6. Diesel Room Ventilation System
This system consists of exhaust fans which maintain the environmental conditions in the diesel room within limits for which the diesel generator and switchgear have been qualified. This system may be needed for long-term operation of the diesel generator.
7. Combustion Air Intake and Exhaust System
Each diesel engine has an independent air intake and exhaust system.

C. Switchgear and Battery Room Ventilation Systems
These systems maintain acceptable environmental conditions in the switchgear and battery rooms, and may be needed for long-term operation of the electric power systems. Details of these systems have not been determined.

3.6.7 Section 3.6 References

1. Haddam Neck Final Safety Analysis Report, Section 9.
2. "Connecticut Yankee Probabilistic Safety Study", Sections 4.2.1 and 4.2.2, Northeast Utilities Service Company, February 1986.

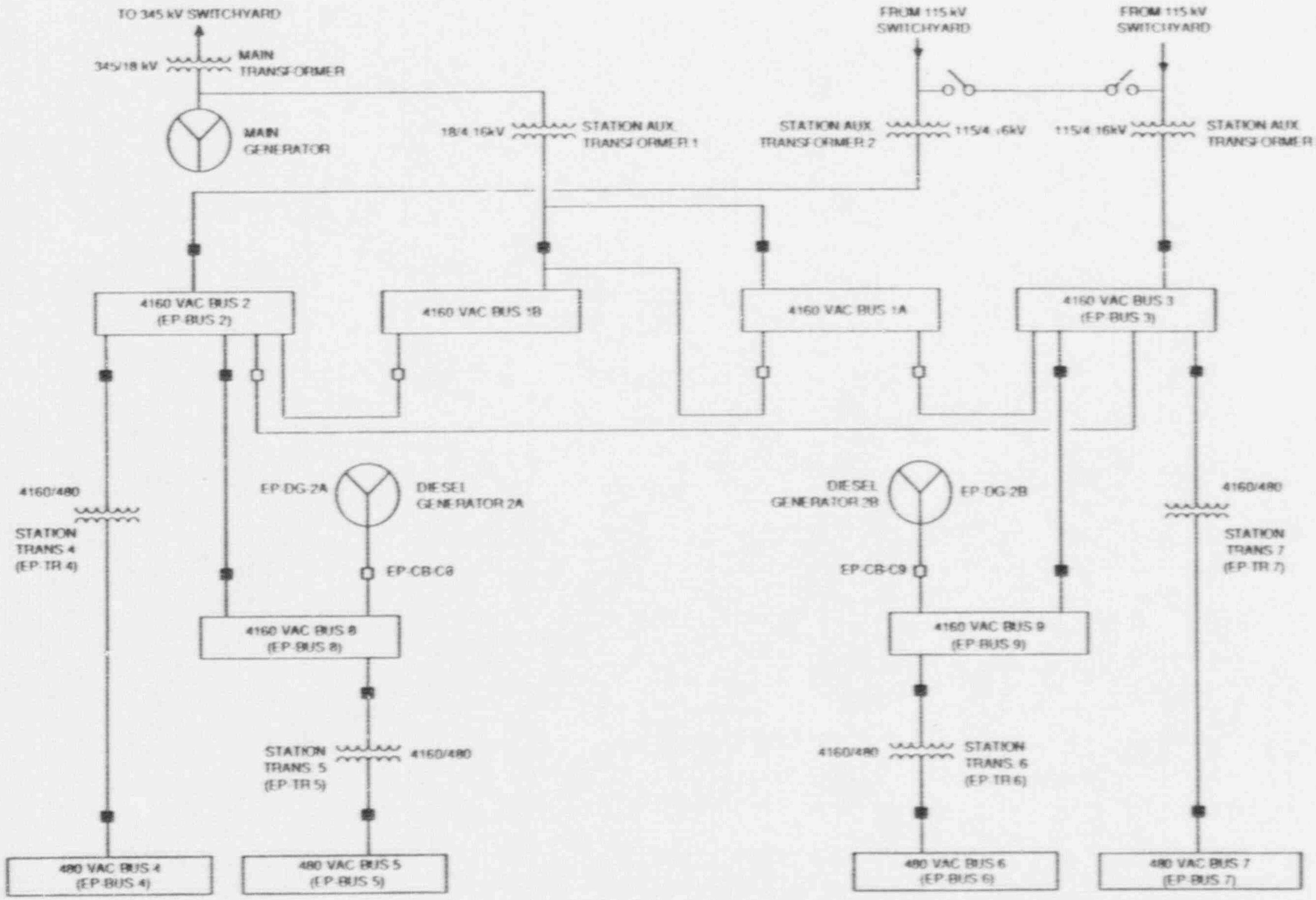
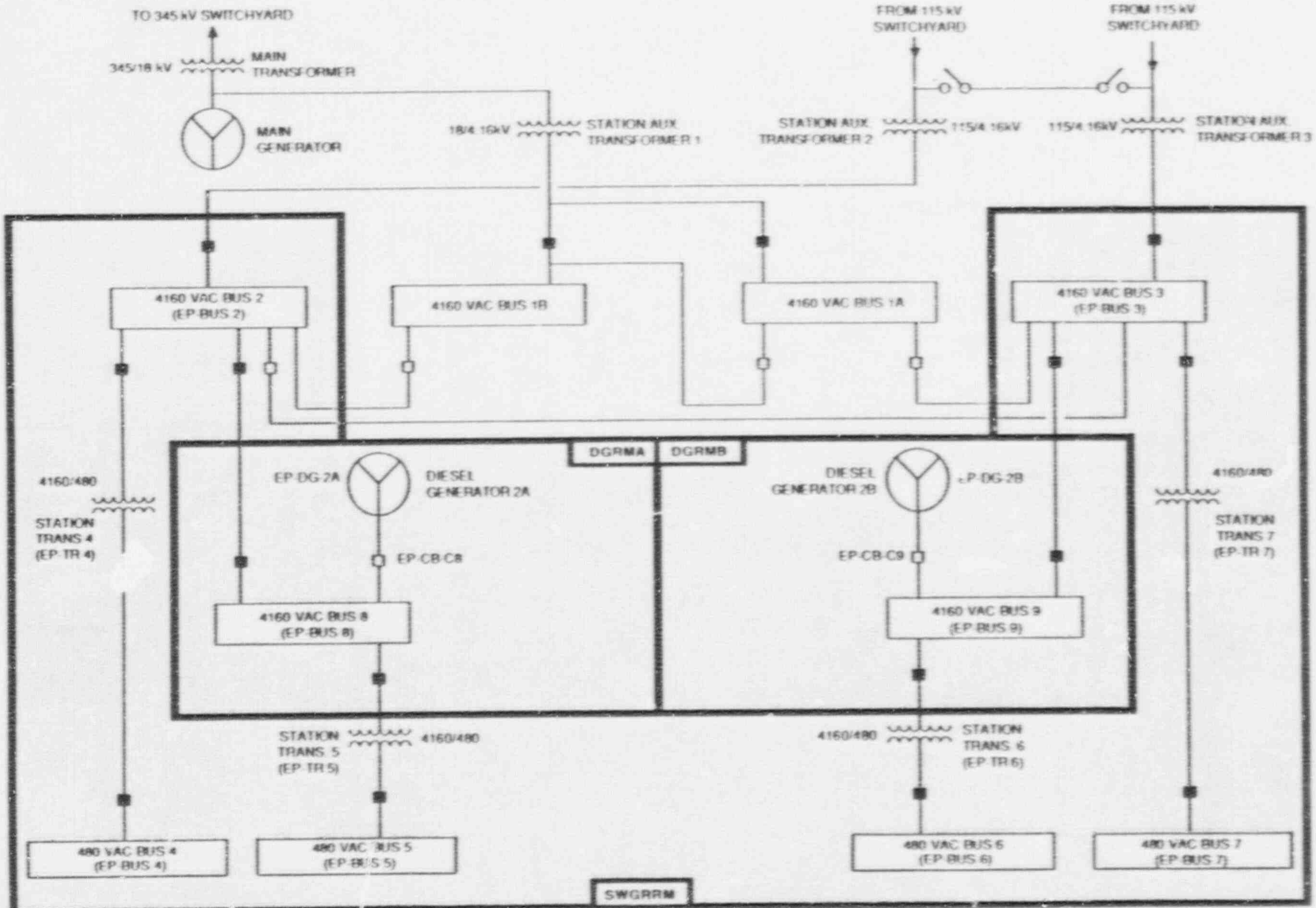


Figure 3.6-1. Haddam Neck 4160 VAC Electric Power System



Note: Lines may not represent true cabling between rooms

Figure 3.6-2. Haddam Neck 4160 VAC Electric Power System Showing Component Locations

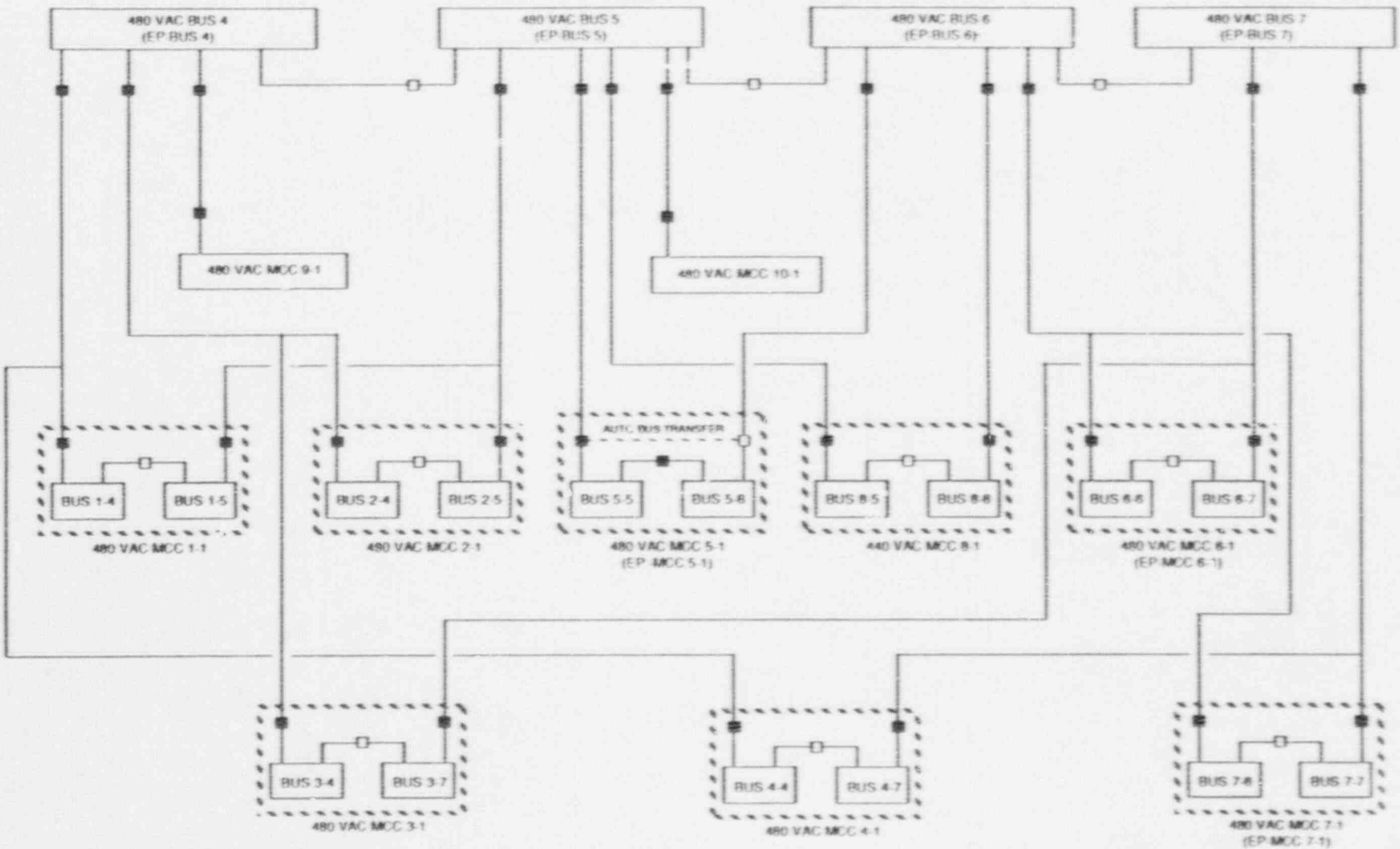
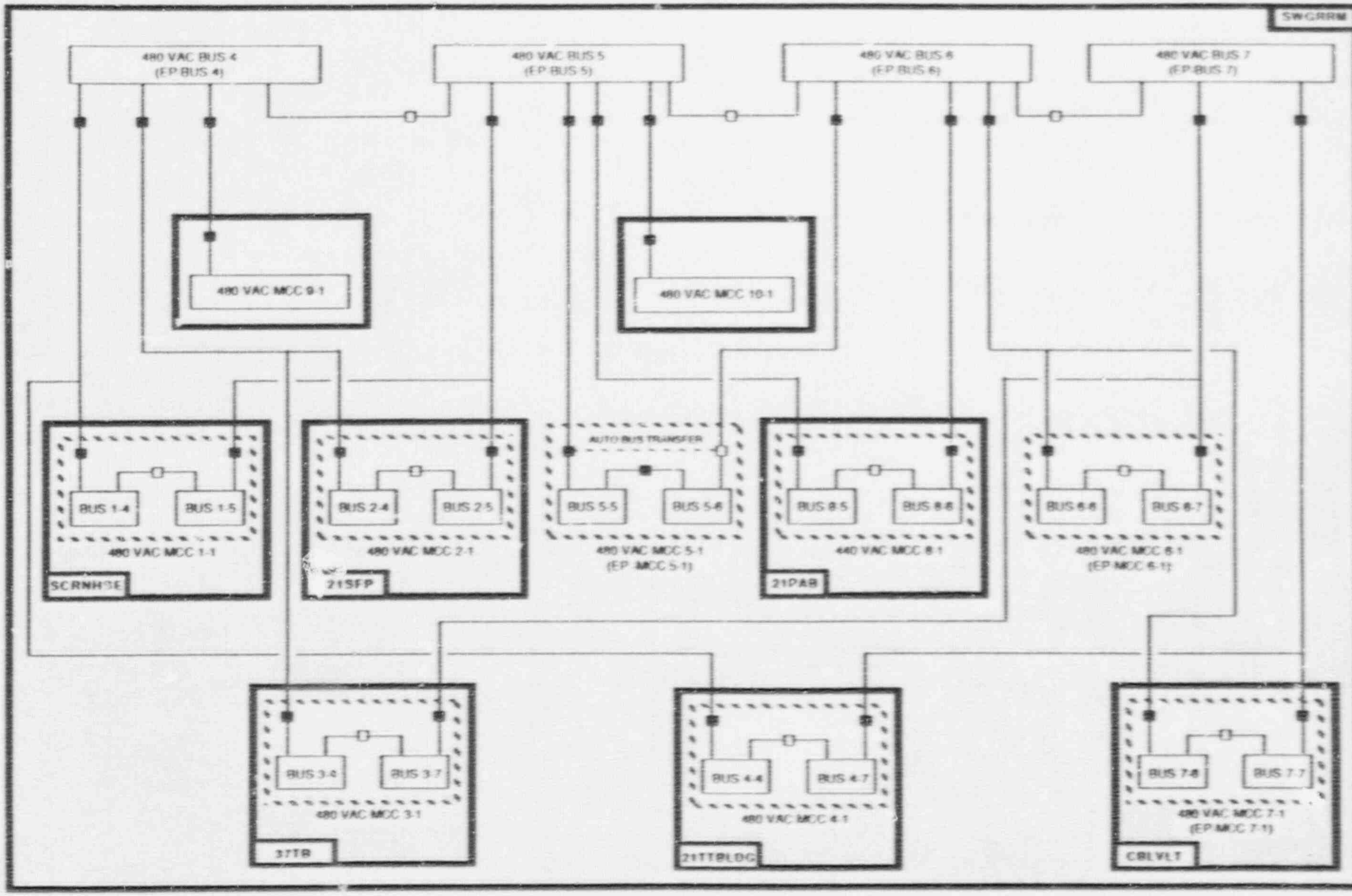


Figure 3.6-3. Haddam Neck 480 VAC Electric Power System



Note: Lines may not represent true cable routing between rooms.

Figure 3.6-4. Haddam Neck 480 VAC Electric Power System Showing Component Locations

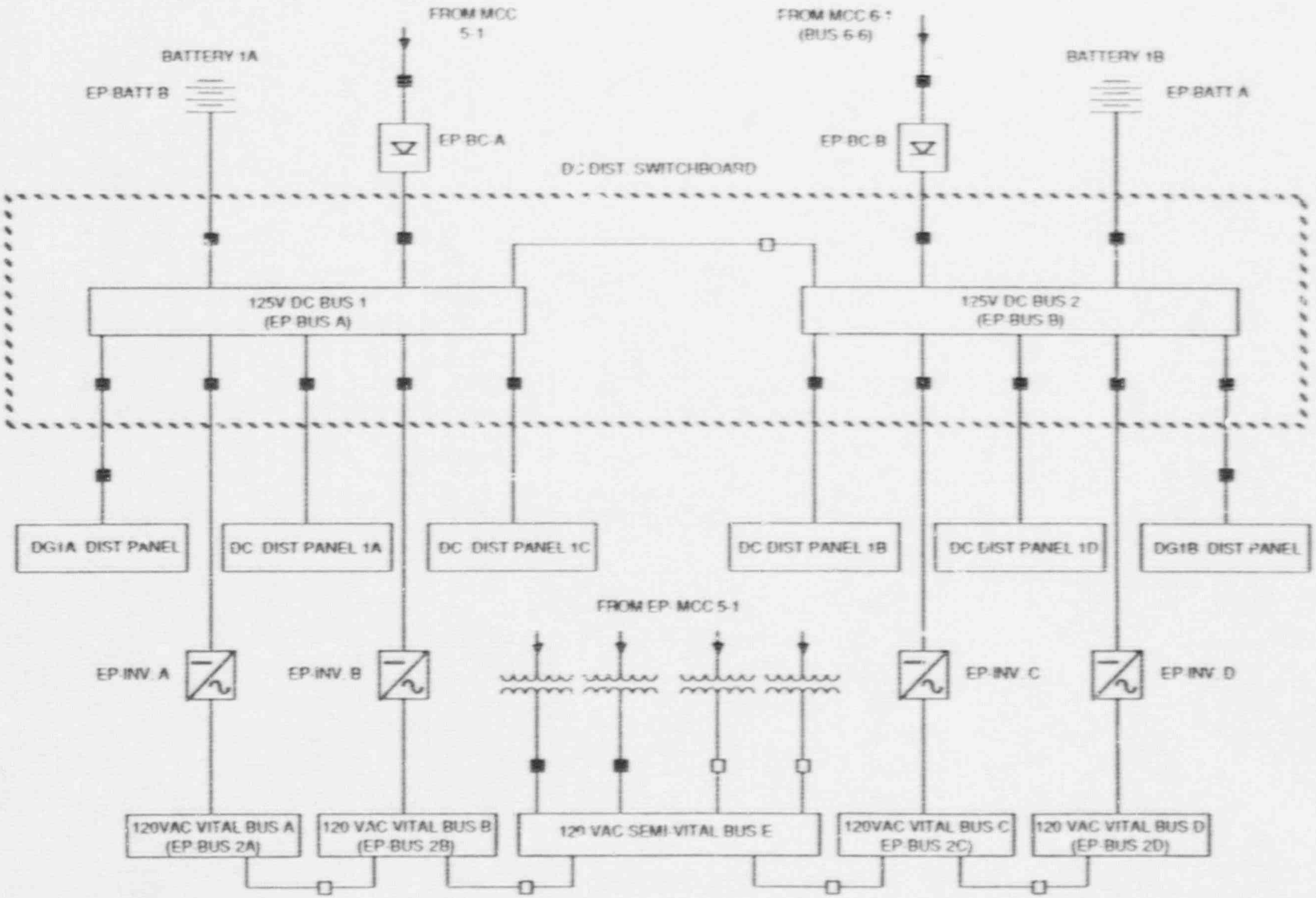
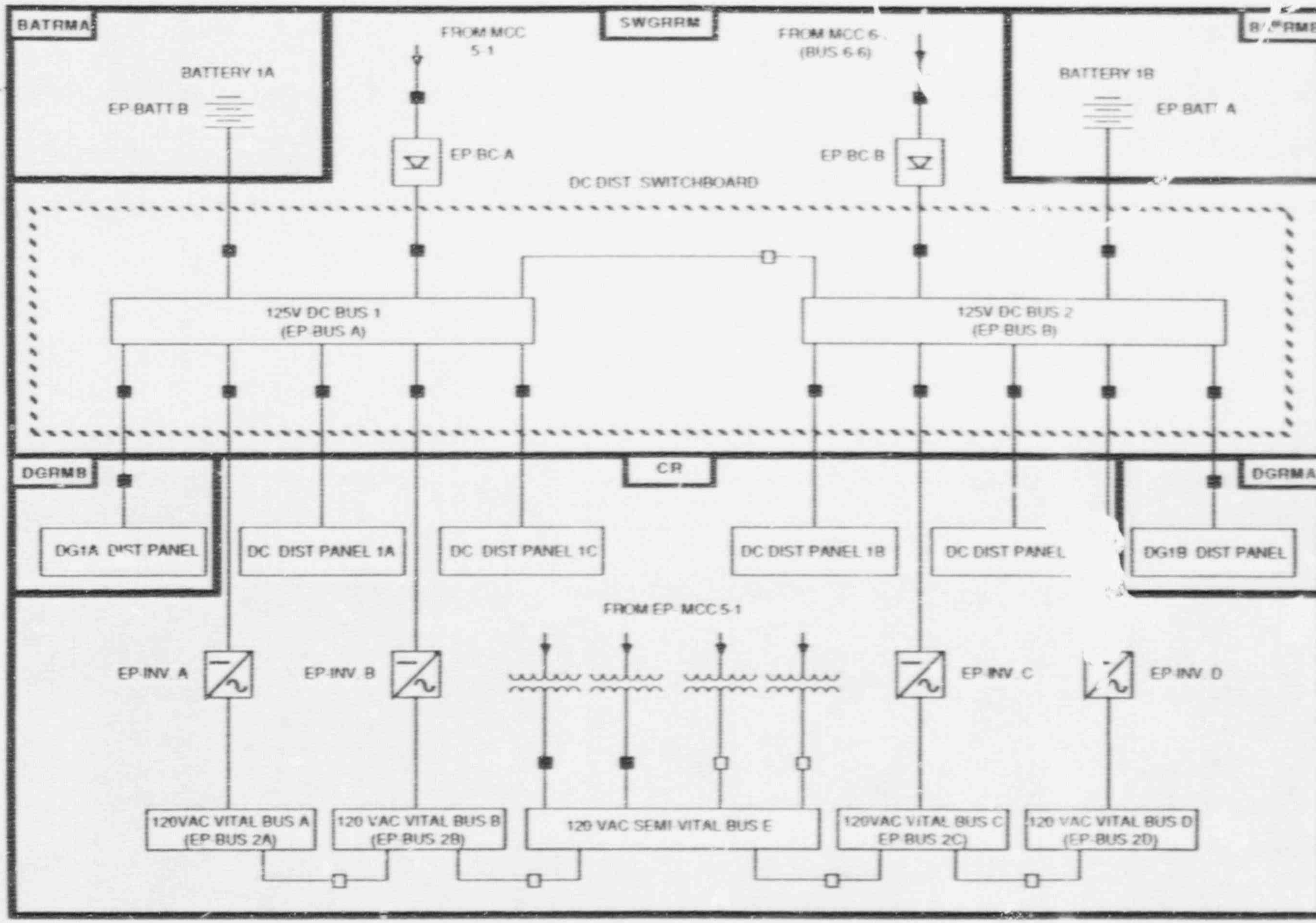


Figure 3.6-5. Haddam Neck 125 VDC and 120 VAC Electric Power Systems



Note: Lines may not represent true cable routing between rooms

Figure 3.6-6. Haddam Neck 125 VDC and 120 VAC Electric Power Systems Showing Component Locations

Table 3.6-1. Haddam Neck Electric Power System Data Summary for Selected Components

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
EP-BATT A	BATT	BATRMA				
EP-BATT-B	BATT	BATRMB				
EP-BC-1A	BC	SWGRRM	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
EP-BC-1B	BC	SWGRRM	EP-MCC6-1	480	SWGRRM	AC/B
EP-BUS 2	BS	SWGRRM	EP-BUS 8	4160	DGRMA	AC/A
EP-BUS 2A	BS	CR	EP-INV-A	120	CR	DC/A
EP-BUS 2B	BS	CR	EP-INV-B	120	CR	DC/A
EP-BUS 2C	BS	CR	EP-INV-C	120	CR	DC/B
EP-BUS 2D	BS	CR	EP-INV-D	120	CR	DC/B
EP-BUS 3	BS	SWGRRM	EP-BUS 9	4160	DGRMB	AC/B
EP-BUS 4	BS	SWGRRM	EP-TR-4	480	SWGRRM	AC/A
EP-BUS 5	BS	SWGRRM	EP-TR-5	480	SWGRRM	AC/A
EP-BUS 6	BS	SWGRRM	EP-TR-6	480	SWGRRM	AC/B
EP-BUS 7	BS	SWGRRM	EP-TR-7	480	SWGRRM	AC/B
EP-BUS 8	BS	DGRMA	EP-DG-2A	4160	DGRMA	AC/A
EP-BUS 9	BS	DGRMB	EP-DG-2B	4160	DGRMB	AC/B
EP-BUS A	BS	SWGRRM	EP-BATT A	125	BATRMA	DC/A

Table 3.6-1. Haddam Neck Electric Power System Data Summary for Selected Components (Continued)

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
EP-BUS B	BS	SWGRRM	EP-BATT B	125	BATRMB	DC/B
EP-CB-C8	CB	DGRMA	EP-BUS A	125	BATRMA	DC/A
EP-CB-C9	CB	DGRMB	EP-BUS-B	125	BATRMB	DC/B
EP-DG-2A	DG	DGRMA				
EP-DG-2B	DG	DGRMB				
EP-INV-A	INV	CR	EP-BUS A	125	BATRMA	DC/A
EP-INV-B	INV	CR	EP-BUS A	125	BATRMA	DC/A
EP-INV-C	INV	CR	EP-BUS B	125	BATRMB	DC/B
EP-INV-D	INV	CR	EP-BUS B	125	BATRMB	DC/B
EP-MCC5-1	MCC	SWGRRM	EP-BUS 5	480	SWGRRM	AC/A
EP-MCC5-1	MCC	SWGRRM	EP-BUS 6	480	SWGRRM	AC/B
EP-MCC6-1	MCC	SWGRRM	EP-BUS 6	480	S[illegible]M	AC/B
EP-TR 4	TR	SWGRRM	EP-BUS 2	4160	SWGRRM	AC/A
EP-TR 5	TR	SWGRRM	EP-BUS 8	4160	DGRMA	AC/A
EP-TR 6	TR	SWGRRM	EP-BUS 9	4160	DGRMB	AC/B
EP-TR 7	TR	SWGRRM	EP-BUS 3	4160	SWGRRM	AC/B

Table 3.6-2. Partial Listing of Electrical Sources and Loads at Haddam Neck

POWER SOURCE	VOLTAGE	EMERG LOAD GRP	POWER SOURCE LOCATION	LOAD SYSTEM	LOAD COMPONENT ID	COMP TYPE	COMPONENT LOCATION
EP-BATT A	125	DC/A	BATRMA	EP	EP-BUS A	BS	SWGRRM
EP-BATT B	125	DC/B	BATRMB	EP	EP-BUS B	BS	SWGRRM
EP-BUS 2	4160	AC/A	SWGRRM	EP	EP-TR 4	TR	SWGRRM
EP-BUS 3	4160	AC/B	SWGRRM	EP	EP-TR 7	TR	SWGRRM
EP-BUS 4	480	AC/A	SWGRRM	ACWS	ACS-P1A	MDP	21PAB
EP-BUS 4	480	AC/A	SWGRRM	SWS	SWS-P1A	MDP	SCRNHSE
EP-BUS 5	480	AC/A	SWGRRM	ECCS	RH-P1A	MDP	RHRPIT
EP-BUS 5	480	AC/A	SWGRRM	EP	EP-MCC5-1	MCC	SWGRRM
EP-BUS 5	480	AC/A	SWGRRM	SWS	SWS-P1B	MDP	SCRNHSE
EP-BUS 6	480	AC/B	SWGRRM	ACWS	ACS-P1B	MDP	21PAB
EP-BUS 6	480	AC/B	SWGRRM	ECCS	RH-P1B	MDP	RHRPIT
EP-BUS 6	480	AC/B	SWGRRM	EP	EP-MCC5-1	MCC	SWGRRM
EP-BUS 6	480	AC/B	SWGRRM	EP	EP-MCC6-1	MCC	SWGRRM
EP-BUS 6	480	AC/B	SWGRRM	SWS	SWS-P1C	MDP	SCRNHSE
EP-BUS 7	480	AC/B	SWGRRM	ACWS	ACS-P1C	MDP	21PAB
EP-BUS 7	480	AC/B	SWGRRM	SWS	SWS-P1D	MDP	SCRNHSE
EP-BUS 8	4160	AC/A	DGRMA	CVCS	CH-P1B	MDP	BCHGCUB
EP-BUS 8	4160	AC/A	DGRMA	ECCS	SI-P1B	MDP	SICUB
EP-BUS 8	4160	AC/A	DGRMA	EP	EP-BUS 2	BS	SWGRRM
EP-BUS 8	4160	AC/A	DGRMA	EP	EP-TR 5	TR	SWGRRM
EP-BUS 9	4160	AC/B	DGRMB	CVCS	CH-P1A	MDP	ACHGCUB
EP-BUS 9	4160	AC/B	DGRMB	ECCS	SI-P1A	MDP	SICUB
EP-BUS 9	4160	AC/B	DGRMB	EP	EP-BUS 3	B[illegible]	SWGRRM
EP-BUS 9	4160	AC/B	DGRMB	EP	EP-TR 6	TR	SWGRRM
EP-BUS A	125	DC/A	BATRMA	EP	EP-CB-C8	CB	DGRMA
EP-BUS A	125	DC/A	BATRMA	EP	EP-INV-A	INV	CR
EP-BUS A	125	DC/A	BATRMA	EP	EP-INV-B	INV	CR
EP-BUS B	125	DC/B	BATRMB	EP	EP-INV-C	INV	CR
EP-BUS B	125	DC/B	BATRMB	EP	EP-INV-D	INV	CR
EP-BUS-B	125	DC/B	BATRMB	EP	EP-CB-C9	CB	DGRMB
EP-DG-2A	4160	AC/A	DGRMA	EP	EP-BUS 8	BS	DGRMA

Table 3.6-2. Partial Listing of Electrical Sources and Loads at Haddam Neck (Continued)

POWER SOURCE	VOLTAGE	EMERG LOAD GRP	POWER SOURCE LOCATION	LOAD SYSTEM	LOAD COMPONENT ID	COMP TYPE	COMPONENT LOCATION
EP-DG-2B	4160	AC/B	DGRMB	EP	EP-BUS 9	BS	DGRMB
EP-INV-A	120	DC/A	CR	EP	EP-BUS 2A	BS	CR
EP-INV-B	120	DC/A	CR	EP	EP-BUS 2B	BS	CR
EP-INV-C	120	DC/B	CR	EP	EP-BUS 2C	BS	CR
EP-INV-D	120	DC/B	CR	EP	EP-BUS 2D	BS	CR
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	ACWS	SWS-3	MOV	21PAB
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	ACWS	SWS-4	MOV	21PAB
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	CVCS	CH-292B	MOV	CX
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	CVCS	CH-292C	MOV	CX
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	CVCS	CH-32	MOV	BCHGCUB
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	CVCS	CH-33	MOV	ACHGCUB
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	ECCS	RH-21	MOV	21PAB
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	ECCS	RH-780	MOV	CX
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	ECCS	RH-781	MOV	CX
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	ECCS	RH-803	MOV	CX
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	ECCS	RH-804	MOV	CX
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	ECCS	SI-24	MOV	RWST
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	EP	EP-BC-1A	BC	SWGRRM
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	RCS	CH-200	MOV	CX
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	RCS	RCS-567	MOV	CX
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	RCS	RCS-569	MOV	CX
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	SWS	SWS-1	MOV	21TTBLDG
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	SWS	SWS-2	MOV	21TTBLDG
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	SWS	SWS-5	MOV	21PAB
EP-MCC5-1	480	AC/A, AC/B	SWGRRM	SWS	SWS-6	MOV	21PAB
EP-MCC6-1	480	AC/B	SWGRRM	EP	EP-BC-1B	BC	SWGRRM
EP-MCC7-1	480	AC/B	CBLVLT	AFWS	AFW-35	MOV	21TTBLDG
EP-MCC7-1	480	AC/B	CBLVLT	ECCS	RH-871A, RH-871B	MOV	CX
EP-MCC7-1	480	AC/B	CBLVLT	ECCS	SI-861A THRU SI-861D	MOV	CX
EP-MCC7-1	480	AC/B	CBLVLT	RCS	RCS-568	NV	CX
EP-MCC7-1	480	AC/B	CBLVLT	RCS	RCS-570	NV	CX

Table 3.6-2. Partial Listing of Electrical Sources and Loads at Haddam Neck (Continued)

POWER SOURCE	VOLTAGE	EMERG LOAD GRP	POWER SOURCE LOCATION	LOAD SYSTEM	LOAD COMPONENT ID	COMP TYPE	COMPONENT LOCATION
EP-TR-4	480	AC/A	SWGRRM	EP	EP-BUS 4	BS	SWGRRM
EP-TR-5	480	AC/A	SWGRRM	EP	EP-BUS 5	BS	SWGRRM
EP-TR-6	480	AC/B	SWGRRM	EP	EP-BUS 6	BS	SWGRRM
EP-TR-7	480	AC/B	SWGRRM	EP	EP-BUS 7	BS	SWGRRM

3.7 CONTAINMENT HEAT REMOVAL SYSTEMS

3.7.1 System Function

The containment heat removal systems consist of an integrated set of subsystems that perform the functions of containment heat removal and containment pressure control following a loss of coolant accident (LOCA). In conjunction with the ECCS, the containment heat removal systems complete the post-LOCA heat transfer path from the reactor core to the ultimate heat sink.

3.7.2 System Definition

The containment heat removal systems consists of two separate subsystems:

- Containment Air Recirculation (CAR) System
- Containment Spray (CS) System

The Containment Air Recirculation System consists of four separate 50-percent fan air cooler units (ACUs) inside the containment which reject heat to the service water system (SWS). Each fan cooling unit consists of a fan, drive motor, cooling coils, duct distribution system, and instrumentation and controls. The containment air filtration system uses the air recirculation fans as a driving force. The filters are located in four separate banks connected to the inlet plenums of the four air recirculation fans. Each filter bank consists of a moisture separator, absolute type (HEPA) filter, and charcoal filters. A charcoal spray system protects the filter banks from overheating.

The Containment Spray System consists of a spray ring header, spray nozzles, valves, and connecting piping. There are no heat exchangers in the containment spray system (except for the RHR heat exchangers used when the RHR system provides containment spray flow). During the injection mode, flow to the containment spray system is delivered by the two low-pressure injection system (LPI) pumps with water supplied from the RWST. The fire water system is available as a backup. During recirculation mode, flow to the containment spray system is delivered by the two RHR pumps taking suction on the containment emergency sump.

The interface between the containment spray system and the LPI and RHR systems is shown in Figures 3.7-1 to 3.7-3. A summary of data on selected LPI and RHR system components is included in Section 3.3 (ECCS). The interface between the containment fan coolers and the service water system is shown on the SWS drawings in Section 3.9.

3.7.3 System Operation

The containment air recirculation system is an engineered safety feature (ESF) system that is in use during normal plant operation with three or four fans operating. System ESF operation is initiated automatically upon receipt of a safety injection signal which starts any unused fans. The containment air cooling units can be stopped and started from the control room. Cooling to the units is supplied from the service water system.

The containment spray system is normally in standby and is actuated by a signal initiated manually from the control room. Manual actuation includes starting the LPI pumps (if not already running) and opening either valve RH-23 or RH-35. The LPI pumps are used to provide flow during the injection phase. After the ECCS is realigned from injection to recirculation, the flow is remote-manually shifted from the LPI pumps to the RHR pumps. The containment spray system is to be actuated when containment pressures exceed 40 psig.

3.7.4 System Success Criteria

The success criteria for the containment heat removal function is either the containment spray system (requiring 2 of 2 LPI pumps or 2 of 2 RHR pumps if the core deluge valves are open) or 2 of 4 fan cooler units from the Containment Air Recirculation (CAR) System (requiring 1 of 4 service water pumps to complete the heat transfer path). If the core deluge valves are closed, the success criteria for the containment spray system is 1 of 2 LPI pumps or 1 of 2 RHR pumps (Refs. 1, 2).

3.7.5 Component Information

A. RHR Pumps 1A, 1B
   1. Rated Flow: 2200 gpm @ 300 ft head (130 psig)
   2. Shutoff Head: 925 ft head (400 psig)
   3. Type: Vertical, single stage, centrifugal

B. LPI Pumps 1A, 1B
   1. Rated Flow: 5500 gpm @ 590 ft head (255 psig)
   2. Shutoff Head: 809 ft head (350 psig)
   3. Type: Horizontal, single stage, centrifugal

C. Containment Fan Cooler Units (4)
   1. Flow Rate: 55,000 cfm @ 40 psig
   2. Max Flow Rate: 65,000 cfm
   3. Type: Centrifugal fan and transverse finned coils

D. Refueling Water Storage Tank
   1. Nominal volume: 250,000 gallons
   2. Minimum Volume: 150,00 gallons
   3. Operating pressure: Atmospheric

3.7.6 Support Systems and Interfaces

A. Control Signals
   1. Automatic
      An SI signal automatically starts all containment fan cooler units.

   2. Remote manual
      a. The CS system containment fan cooler units and associated valves can be actuated by remote-manual means from the control room.
      b. The containment fan cooler units can be controlled from the control room.

B. Motive Power
   The LPI and RHR pumps, containment fan cooler units, and related motor-operated valves are Class 1E AC loads that can be supplied from the standby diesel generators, as described in Section 3.6. Redundant loads are supplied from separate load groups.

C. Cooling Water
   The containment fan cooler units are cooled by the service water system (see Section 3.9).

3.7.7 Section 3.7 References

1. "Connecticut Yankee Probabilistic Safety Study", Sections 4.2.16 and 4.2.17, Northeast Utilities Service Company, February 1986.
2. Haddam Neck FSAR, Section 3.6.

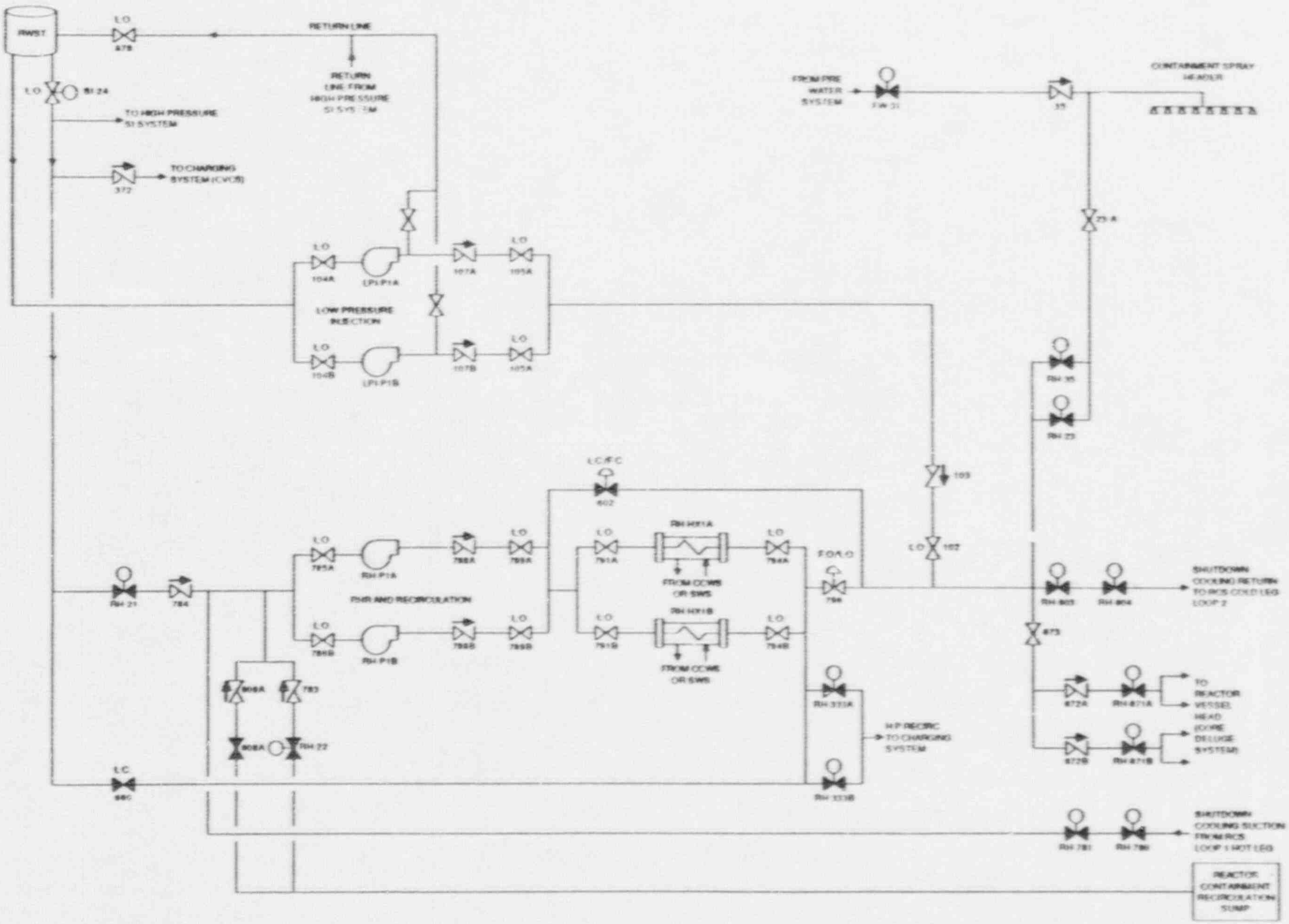


Figure 3.7-1. Haddam Neck Low-Pressure Safety Injection (LPI) and Residual Heat Removal (RHR) Systems

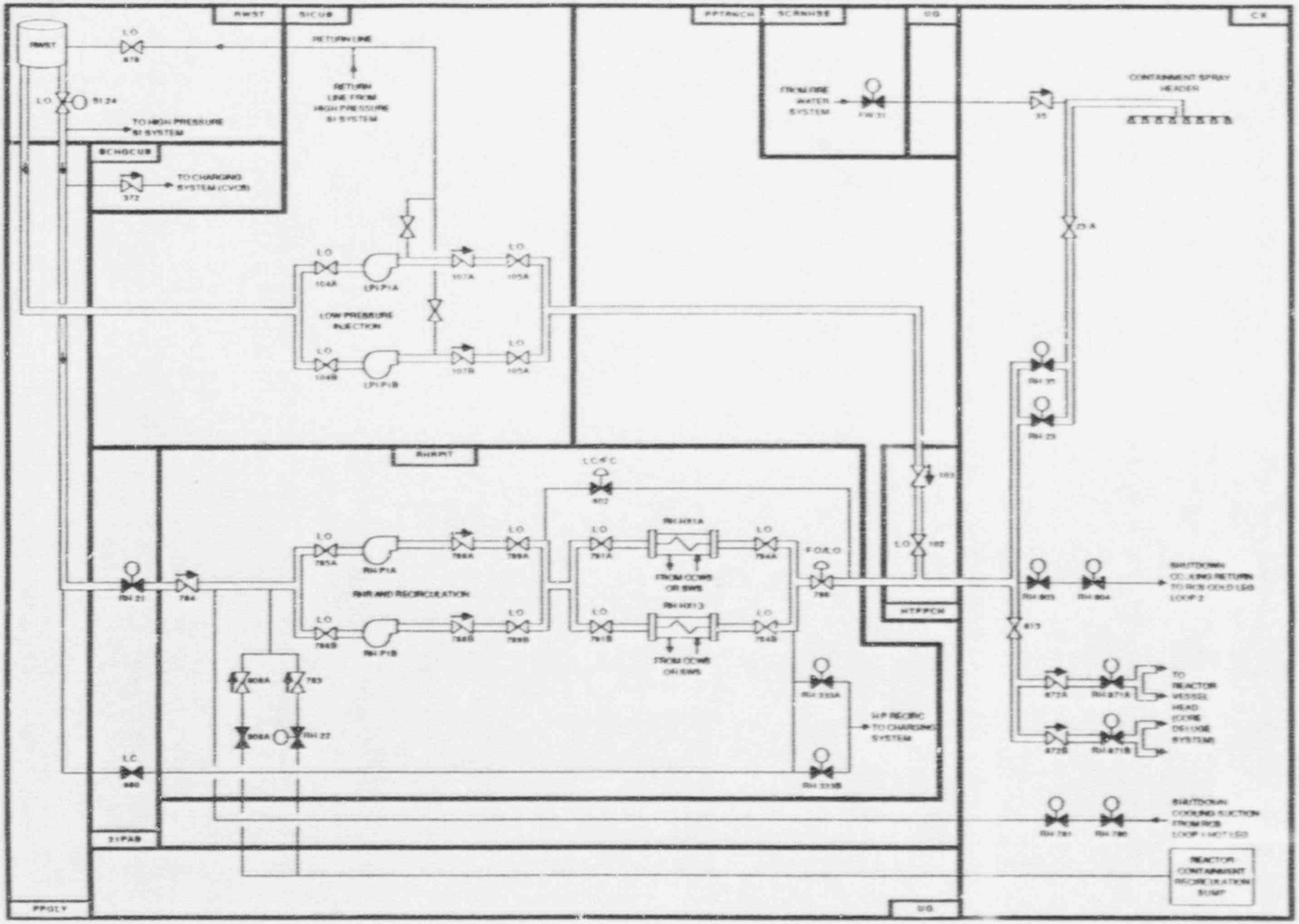


Figure 3.7-2. Haddam Neck Low-Pressure Safety Injection (LPI) and Residual Heat Removal (RHR) Systems (Containment Spray Injection Mode) Showing Component Locations

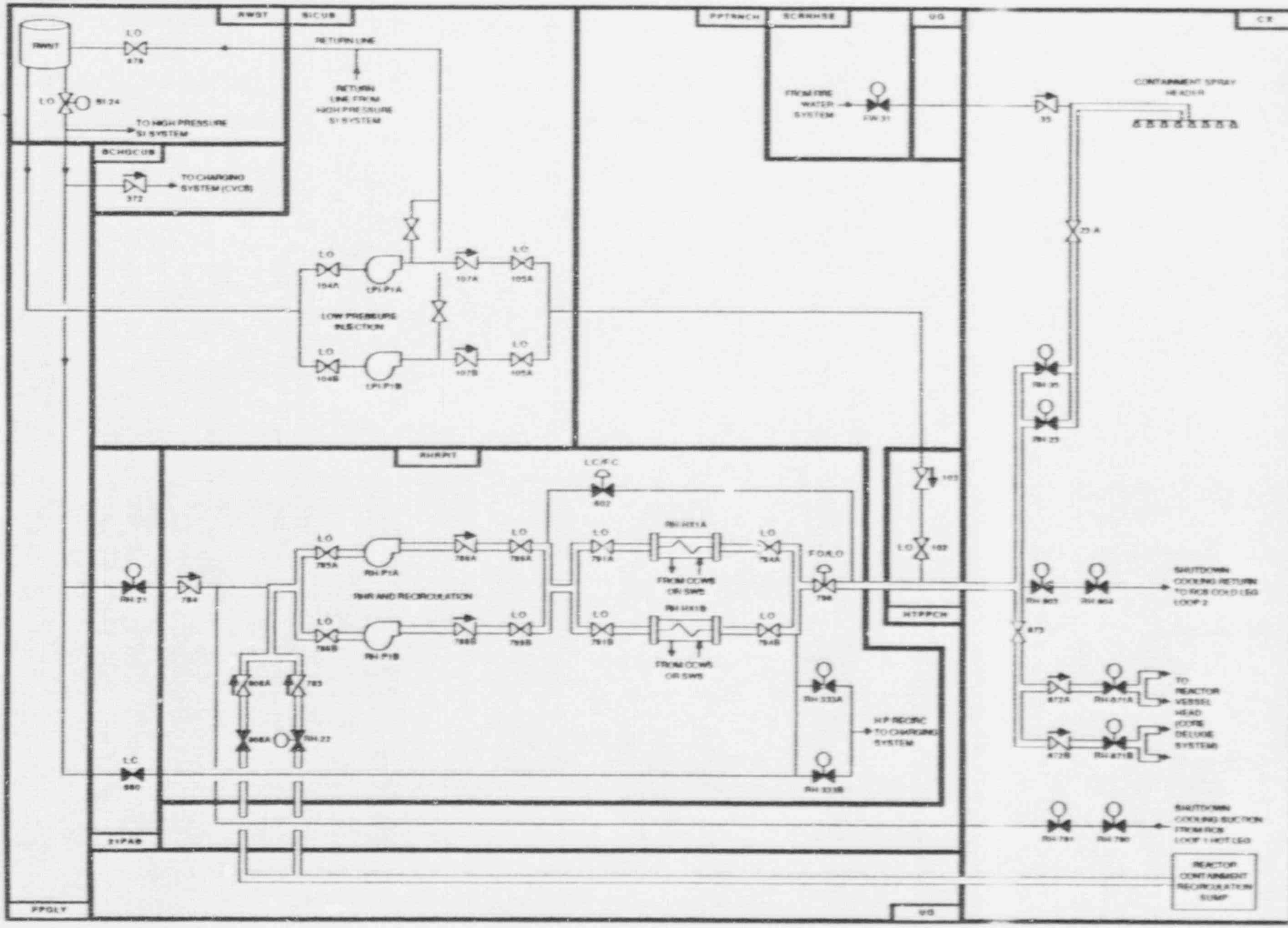


Figure 3.7-3. Haddam Neck Low-Pressure Safety Injection (LPI) and Residual Heat Removal (RHR) Systems (Containment Spray Recirculation Mode) Showing Component Locations

3.8 AUXILIARY COOLING WATER SYSTEM (ACWS)

3.8.1 System Function

The ACWS serves to remove heat from the reactor auxiliaries and RHR heat exchangers and to transfer heat to the Service Water System for rejection to the ultimate heat sink. The ACWS operates during all normal modes of operation and following accidents. The ACWS serves as an intermediate system between the RCS and SWS, thereby reducing the probability of leakage to the environment of potentially radioactive coolant. The ACWS also serves as a backup system to cool the reactor coolant pump seals (see Section 3.4).

3.8.2 System Definition

The auxiliary cooling water system (ACWS) is a closed-loop cooling water system consisting of three 100% capacity pumps, two 100% capacity heat exchangers, one ACS surge tank, and associated valves, piping, and instrumentation. The system is designed to supply cooling water to the following vital components:

- Reactor coolant pump thermal barriers and bearing oil coolers.
- Nonregenerative heat exchangers
- Seal water heat exchanger
- RHR heat exchangers (during plant cooldown)
- Charging pump lube-oil coolers
- RHR pump seal coolers (during plant cooldown)

Heat is transferred by the ACS heat exchangers to the service water system. Simplified drawings of the ACWS are shown in Figures 3.8-1 and 3.8-2. A summary of data on selected ACWS components is presented in Table 3.8-1.

3.8.3 System Operation

During normal operation two pumps and one heat exchanger are capable of serving all operating components. The standby pump and heat exchanger provides 100% backup during normal operation. All three pumps and both heat exchangers are used to remove residual and sensible heat during shutdown, however, only one pump and heat exchanger are required.

All three pumps supply a common header to the heat exchangers, which in turn supplies a common header serving all remaining components, so that any pump and heat exchanger combination can cool the components served by the system. In spite of the redundancy in pumps and heat exchangers, the ACWS is a single-train system.

The ACS heat exchangers transfer heat to the Service Water System. The ACS surge tank is connected to the suction side of the pumps, accommodating fluid expansion and contraction in the system and maintaining pump suction head requirements.

3.8.4 System Success Criteria

Following a LOCA, one ACS pump and one heat exchanger are capable of fulfilling system requirements (Refs. 1, 2). The Service Water System is required to remove heat from the ACWS (see Section 3.9).

3.8.5 Component Information

A. Auxiliary Cooling Water pumps 1A, 1B, 1C
   1. Rated flow: 2750 gpm @ 150 ft. head (65 psid)
   2. Rated capacity: 100%
   3. Type: Horizontal centrifugal

B. Auxiliary Cooling System heat exchangers 1A, 1B
   1. Design Temperature: 200°F
   2. Design Press: 150 psig
   3. Design Duty: Not determined
   4. Type: Shell and straight tube

C. Surge tank
   1. Total Volume: 2000 gallons
   2. Normal water volume: 1000 gallons

3.8.6 Support Systems and Interfaces

A. Control Signals
   1. Automatic
      a. The ACWS pumps are automatically actuated.
      b. ACWS lines into containment are automatically isolated following a LOCA by a Safety Injection (SI) system.

   2. Remote manual
      The ACWS can be operated from the control room.

B. Motive Power
   The motor-driven ACWS pumps and motor-operated valves are Class 1E loads that can be supplied from the standby diesel generators as described in Section 3.6.

C. Other
   1. Lubrication and cooling are assumed to be provided locally for the ACWS pumps.
   2. Systems providing ventilation for the ACWS pump room have not been determined

3.8.7 Section 3.8 References

1. Haddam Neck Final Safety Analysis Report, Section 5.2.3.2.
2. "Connecticut Yankee Probabilistic Safety Study", Section 4.2.5, Northeast Utilities Service Company, February 1986.

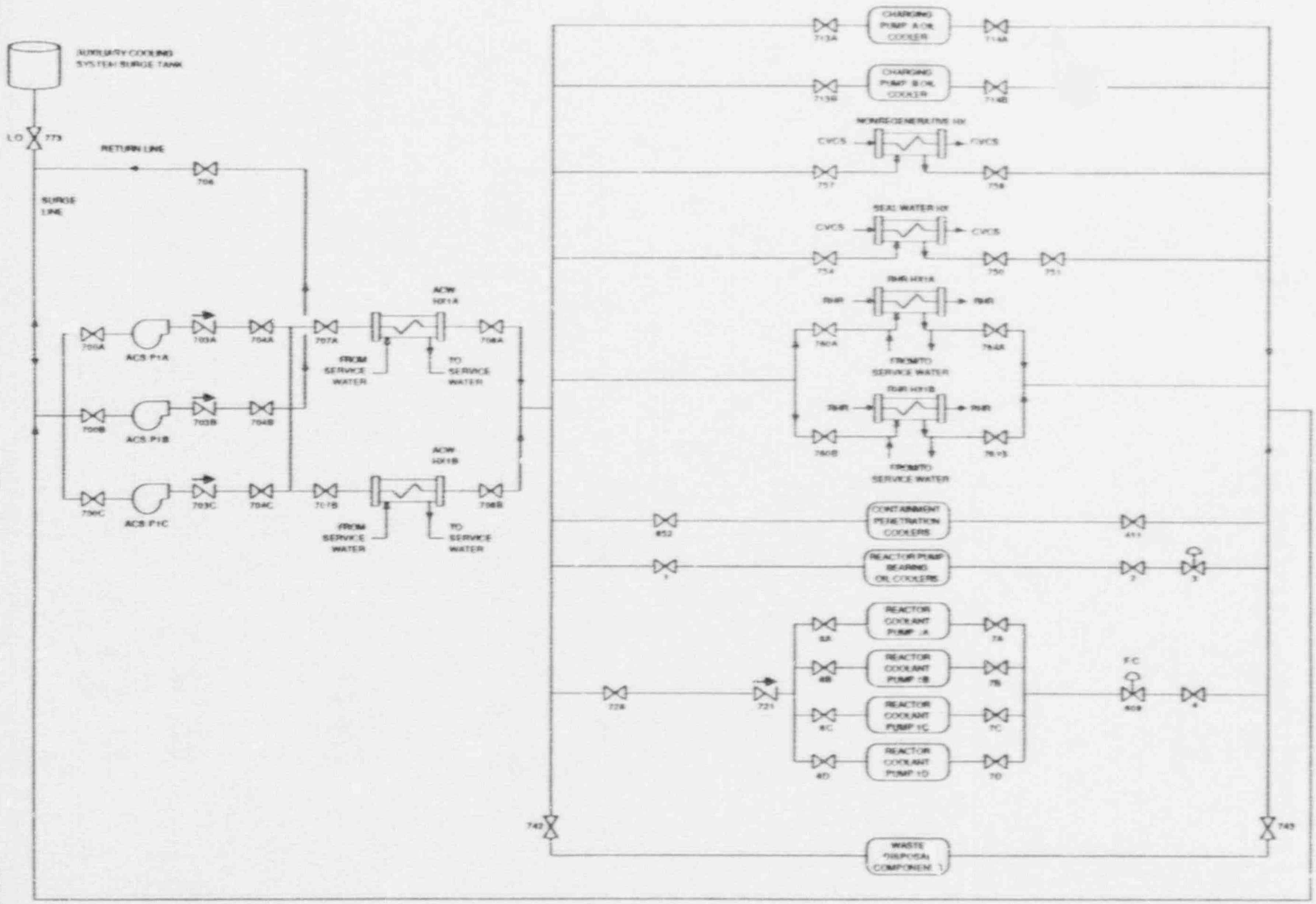
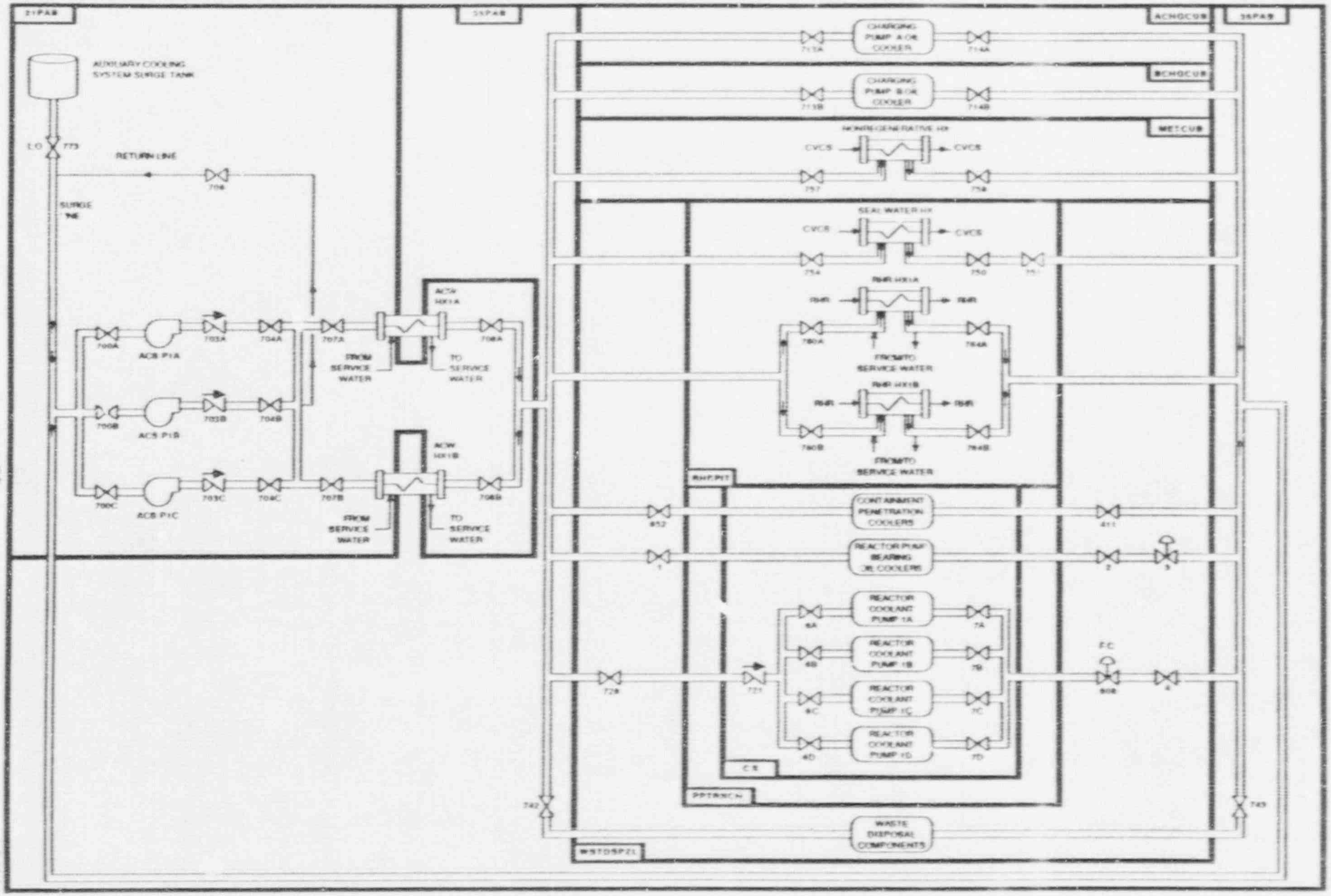


Figure 3.8-1. Haddam Neck Auxiliary Cooling Water System (ACWS)



Note: Piping interfaces with the ACWS heat exchangers exist in area 21P/ e ACWS heat exchangers are vertical U-tube units located in 21PAB and 35PAB.

Figure 3.8-2. Haddam Neck Auxiliary Cooli ; Water System (ACWS) Showing Component Locations

Table 3.8-1. Haddam Neck Auxiliary Cooling Water System Data Summary for Selected Components

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
ACS-HX1A, ACS-HX1B	HX	21PAB				
ACS-HX1A, ACS-HX1B	HX	35PAB				
ACS-P1A	MDP	21PAB	EP-BUS-4	480	SWGRRM	AC/A
ACS-P1B	MDP	21PAB	EP-BUS-6	480	SWGRRM	AC/B
ACS-P1C	MDP	21PAB	EP-BUS-7	480	SWGRRM	AC/B
SWS-3	MOV	21PAB	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
SWS-4	MOV	21PAB	EP-MCC5-1	480	SWGRRM	AC/A, AC/B

3.9 SERVICE WATER SYSTEM (SWS)

3.9.1 System Function

The SWS supplies all the equipment cooling water for the plant, including the emergency shutdown requirements. Equipment cooled by the SWS includes the diesel generators, the component cooling water heat exchangers, containment air cooler units, RHR heat exchangers (under emergency conditions), spent fuel pit cooler, and various air conditioning and ventilation coolers and condensers.

3.9.2 System Definition

The SWS is an open loop system. The system consists of four pumps that feed two separate main supply headers. The headers are cross-tied by manual valves 236 and 237 so that any combination of pumps can serve both headers during normal operating conditions. The pumps take a suction from the screenwell. Cooling water to the spent fuel pit cooler, containment air cooling units, and CCW heat exchangers can be provided by either header. Cooling water to the diesel generators can be provided by either header if the manual cross-tie between the service water loops is left in the normally open position.

Simplified drawings of the SWS are shown in Figures 3.9-1 and 3.9-2. A summary of data on selected SWS components is presented in Table 3.9-1.

3.9.3 System Operation

During normal operation, three SWS pumps are running, with the fourth pump in standby. The fourth pump will automatically start on a loss of header pressure.

The service water pumps are powered by 480 VAC buses 4, 5, 6 and 7. Each diesel generator is sized to accommodate two service water pumps in addition to the other engineered safeguards loads.

Under emergency shutdown and accident conditions non-safety loads serviced by the SWS can be isolated to reduce the load on the system by closing motor-operated valves SW-1 and SW-2.

3.9.4 System Success Criteria

Under emergency shutdown and accident conditions, system success can be achieved by one of four service water pumps if non-safety loads are isolated (motor-operated valves SW-1 and SW-2 close). If the non-safety loads are not isolated, two of four SWS pumps are required (Refs. 1,2).

3.9.5 Component Information

A. Service Water pumps 1A, 1B, 1C, 1D
   1. Rated flow: 6,000 gpm @ 150 ft head (65 psig)
   2. Rated capacity: 100% (safety loads only)
   3. Type: Vertical, two-stage, centrifugal

3.9.6 Support Systems and Interfaces

A. Control Signals
   1. Automatic
      During normal operation with three SWS pumps running, the fourth pump will be automatically started if pump discharge pressure decreases below a setpoint value.
   2. Remote Manual
      The SWS pumps can be operated from the control room.

B. Motive Power
The motor-driven SWS pumps and motor-operated valves are Class 1E loads that can be supplied from the standby diesel generators as described in Section 3.7.

C. Other
1. Lubrication is provided locally for the SWS pumps.
2. Cooling is assumed to be provided locally for the SWS pumps.
3. The SWS pump room has open windows and doors, with a roof exhaust ventilator.

3.9.7 Section 3.9 References

1. Haddam Neck Final Safety Analysis Report, Section 9.2.1.
2. "Connecticut Yankee Probabilistic Safety Study", Section 4.2.4, Northeast Utilities Service Company, February 1986.

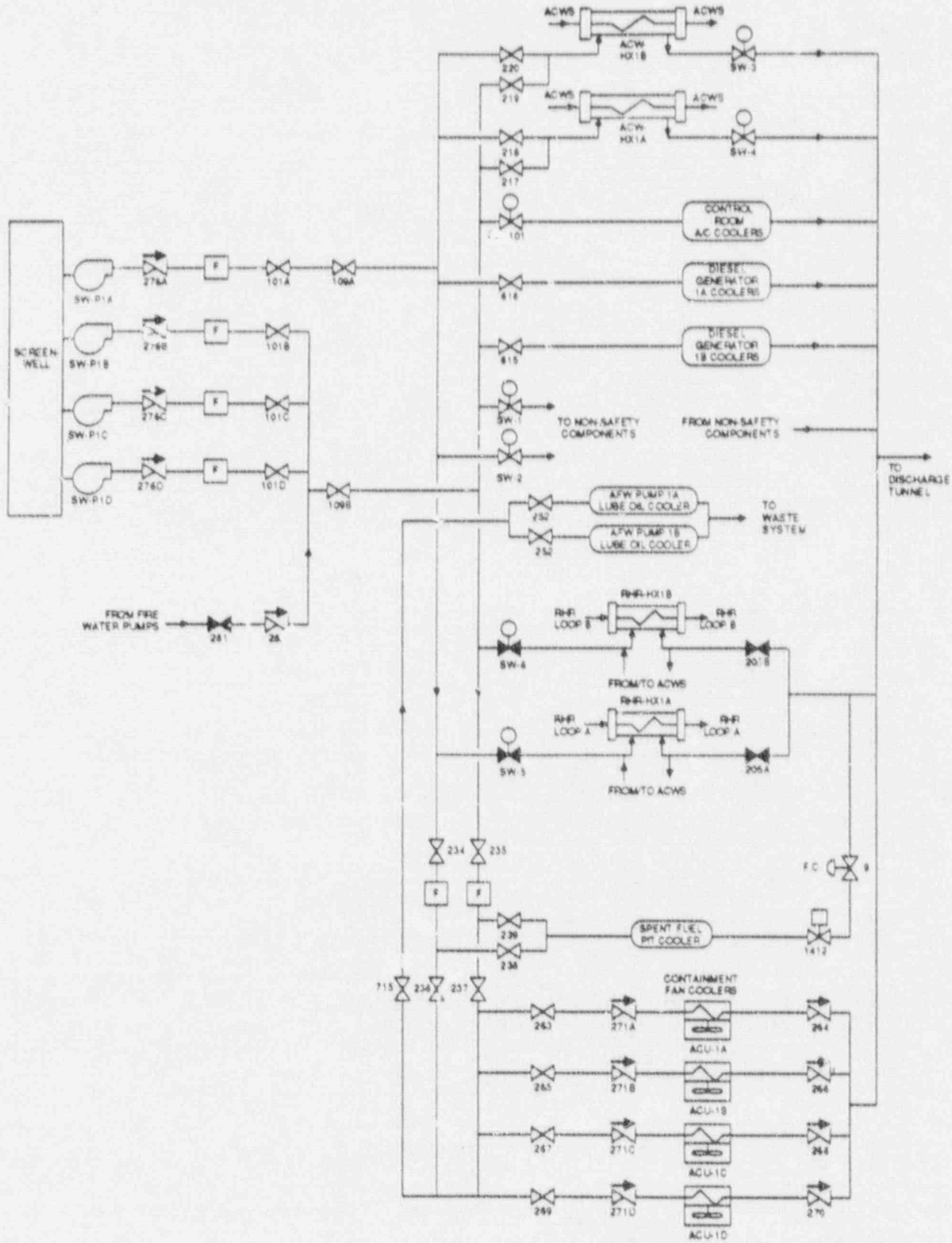


Figure 3.9-1. Haddam Neck Service Water System (SWS)

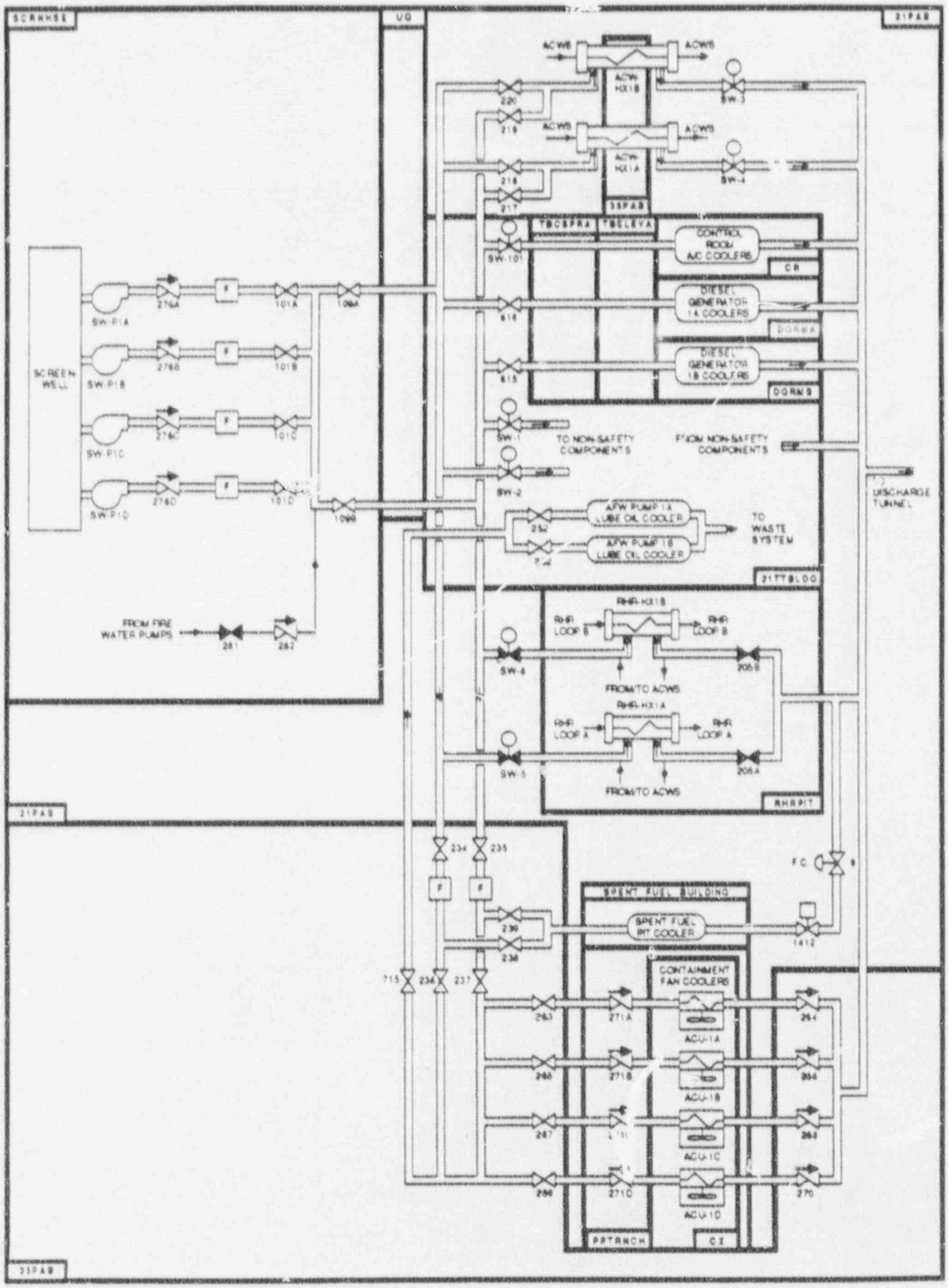


Figure 3.9-2. Haddam Neck Service Water System (SWS) Showing Component Locations

Table 3.9-1. Haddam Neck Service Water System Data Summary for Selected Components

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
SWS-1	MOV	21TTBLDG	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
SWS-2	MOV	21TTBLDG	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
SWS-5	MOV	21PAB	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
SWS-6	MOV	21PAB	EP-MCC5-1	480	SWGRRM	AC/A, AC/B
SWS-P1A	MDP	SCRNHSE	EP-BUS 4	480	SWGRRM	AC/A
SWS-P1B	MDP	SCRNHSE	EP-BUS 5	480	SWGRRM	AC/A
SWS-P1C	MDP	SCRNHSE	EP-BUS 6	480	SWGRRM	AC/B
SWS-P1D	MDP	SCRNHSE	EP-BUS 7	480	SWGRRM	AC/B

4. PLANT INFORMATION

4.1 SITE AND BUILDING SUMMARY

The Haddam Neck plant is located near the town of Haddam, Connecticut on the east bank of the Connecticut River. The site consists of 525 acres. Figure 4-1 (from Ref. 1) shows a general view of the site, while Figure 4-2 shows a simplified plot plan. The major structures include the Reactor Containment, the Turbine Building, the Primary Auxiliary Building, the Fuel Storage Building, and the Service/Machine Shop Building.

The Reactor Containment contains the RCS and portions of the AFWS, ECCS, CVCS, and RHR systems.

The Primary Auxiliary Building is located to the north of the containment and contains most of the engineered safety features components. Components of the ECCS, CVCS, CCWS, and RHR systems are located in the Primary Auxiliary Building.

The Service/Machine Shop Building is attached to the west side of the Primary Auxiliary Building and contains portions of the electric power and instrumentation and control systems.

The Turbine Building is attached to the west side of the Service Building and contains the power conversion system and portions of the AFWS. There is a piping facade, which runs from the west side of the reactor containment to the Terry Turbine Building over the machine shop roof. The facade contains a portion of the AFWS piping and the main feedwater and steam lines.

The Screenhouse is located at the east bank of the Connecticut River and contains the service water pumps, circulating water pumps, and fire water pumps.

4.2 FACILITY LAYOUT DRAWINGS

Figure 4-3 shows various section views of the Haddam Neck station. Figures 4-4 through 4-13 show simplified layout drawings for the major buildings at Haddam Neck. Major rooms, stairways, elevators and doorways are included, however some interior features are omitted for clarity in these simplified layout drawings. Labels printed in uppercase correspond to the location codes listed in Table 4-1 and used in the component data listings and system drawings in Section 3. Other lowercase labels are provided for information only. Symbols used in the layout drawings are defined in Appendix A.

A listing of components by location is presented in Table 4-2. Components included in Table 4-2 are those found in the system data tables in Section 3, therefore this table is only a partial listing of the components and equipment that are located in a particular room or area of the plant.

Section 4 References

1. Heddleson, F.A. "Design Data and Safety Features of Commercial Nuclear Power Plants", ORNL-NSIC-55, Vol. I, Oak Ridge National Laboratory December 1973.

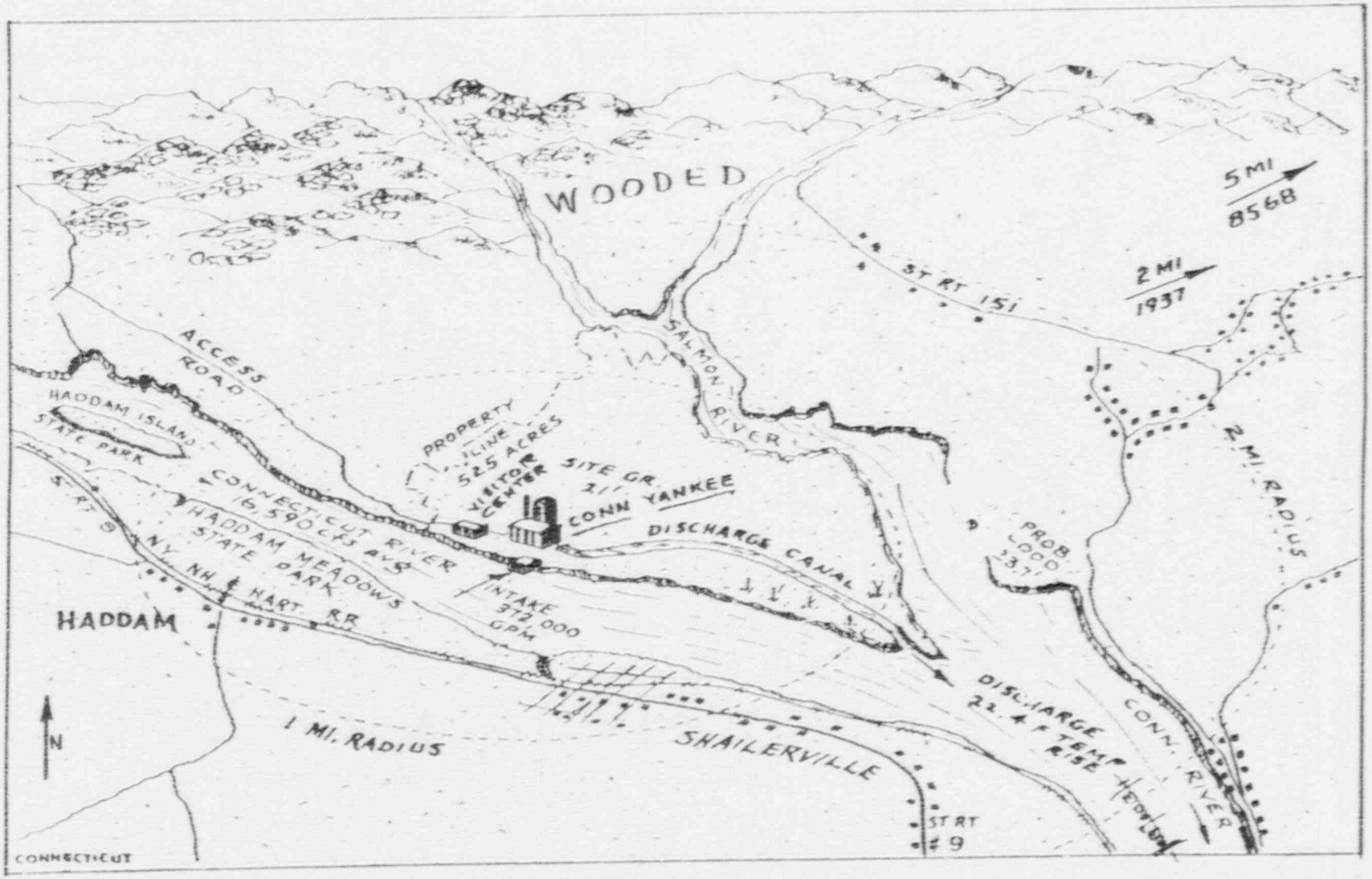


Figure 4-1. General View of Haddam Neck Site and Vicinity

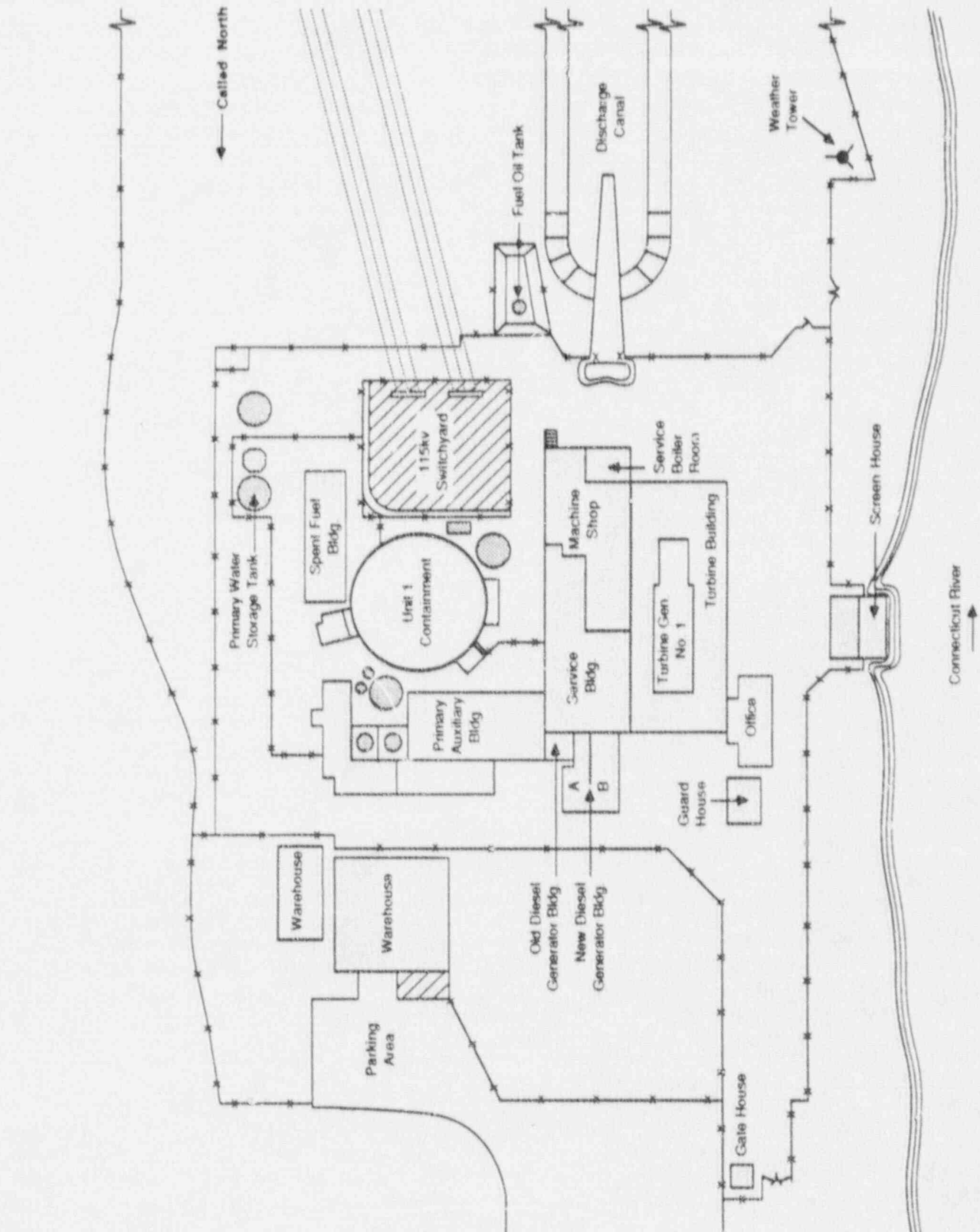
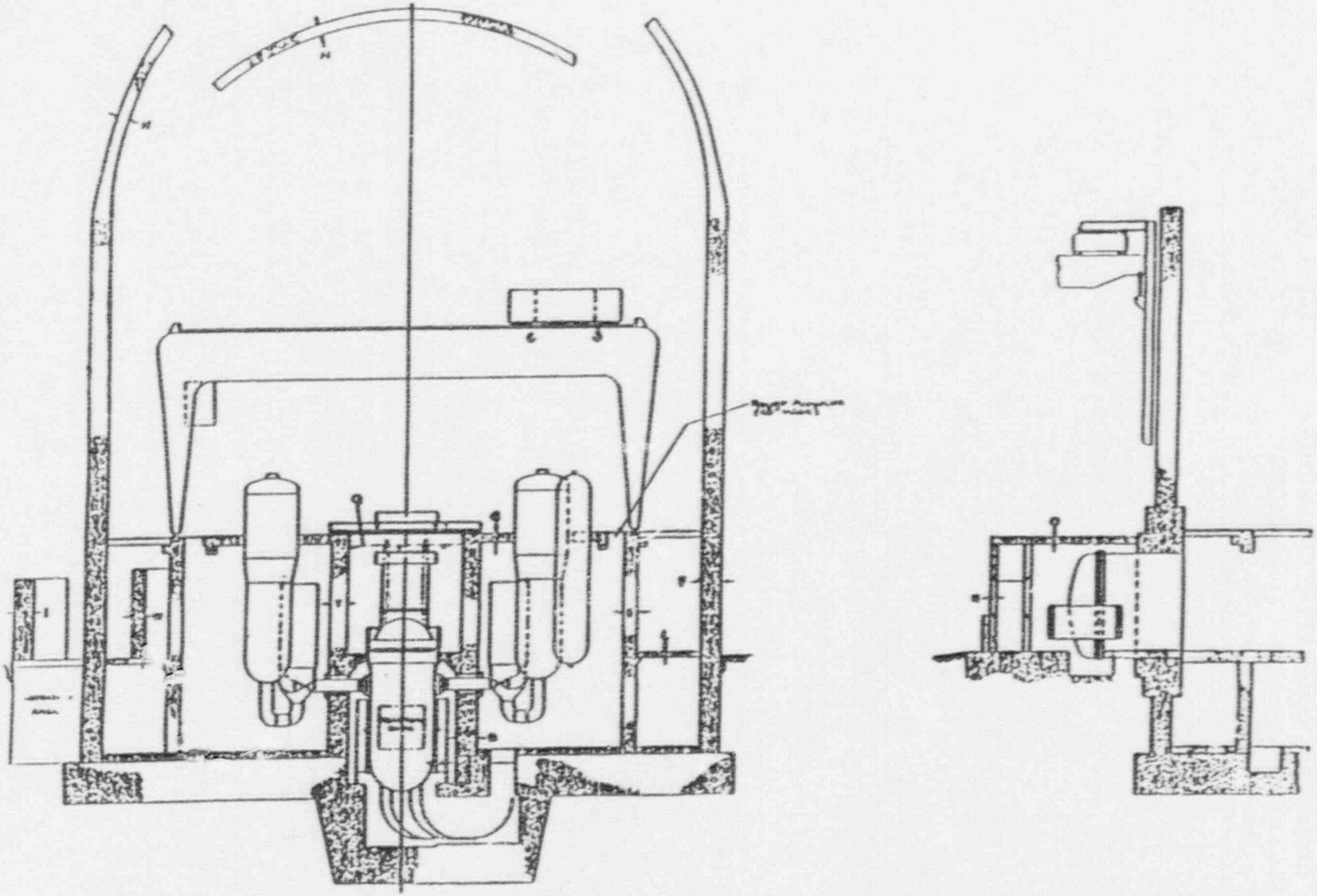


Figure 4-2. Haddam Neck Simplified Site Plan



Reactor Containment Looking East

Containment Equipment Hatch Looking South

Figure 4-3. Haddam Neck Reactor Containment (Sheet 1 of 3)

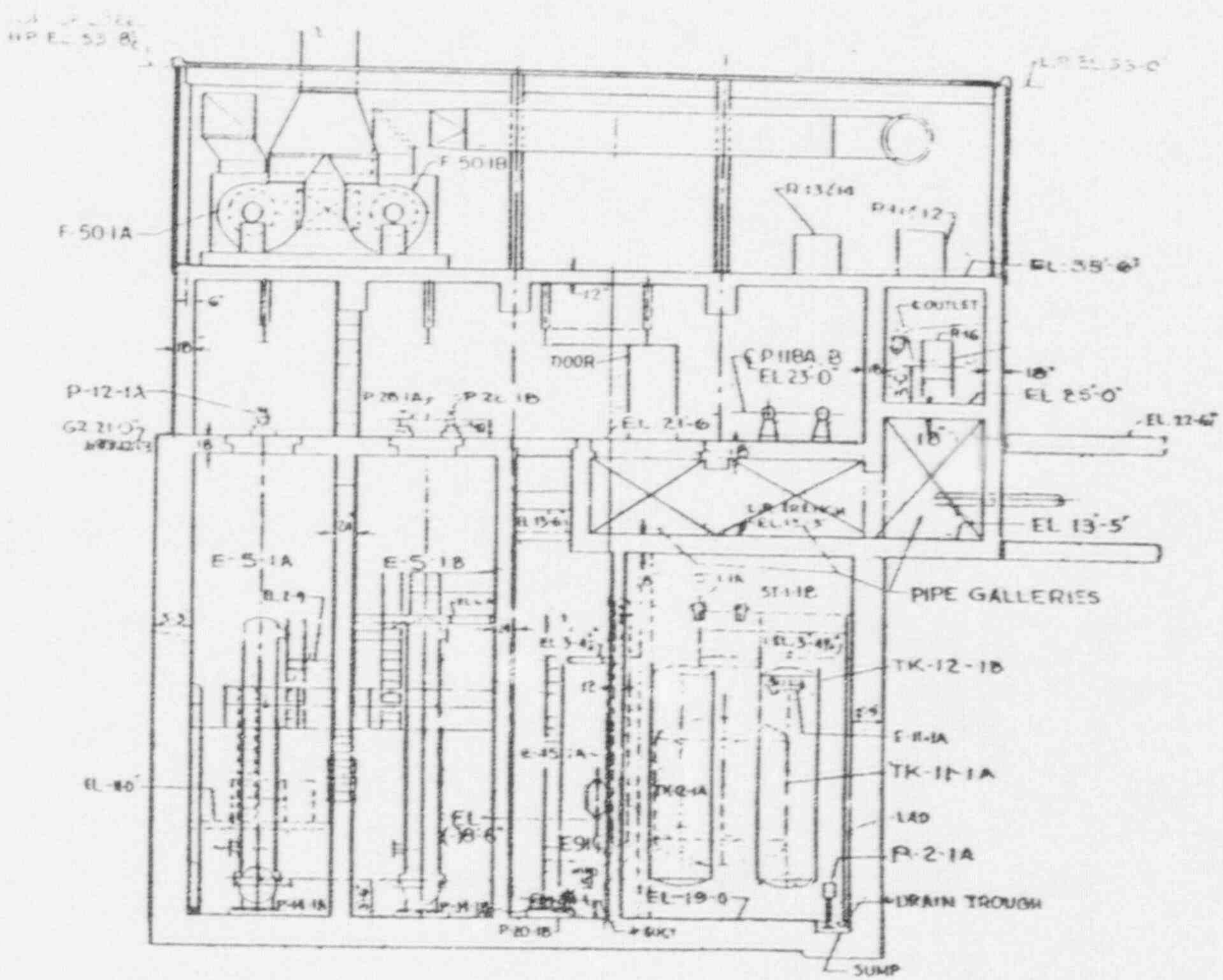


Figure 4-3. Haddam Neck Primary Auxiliary Building and RHR Pit, Looking North (Sheet 2 of 3)

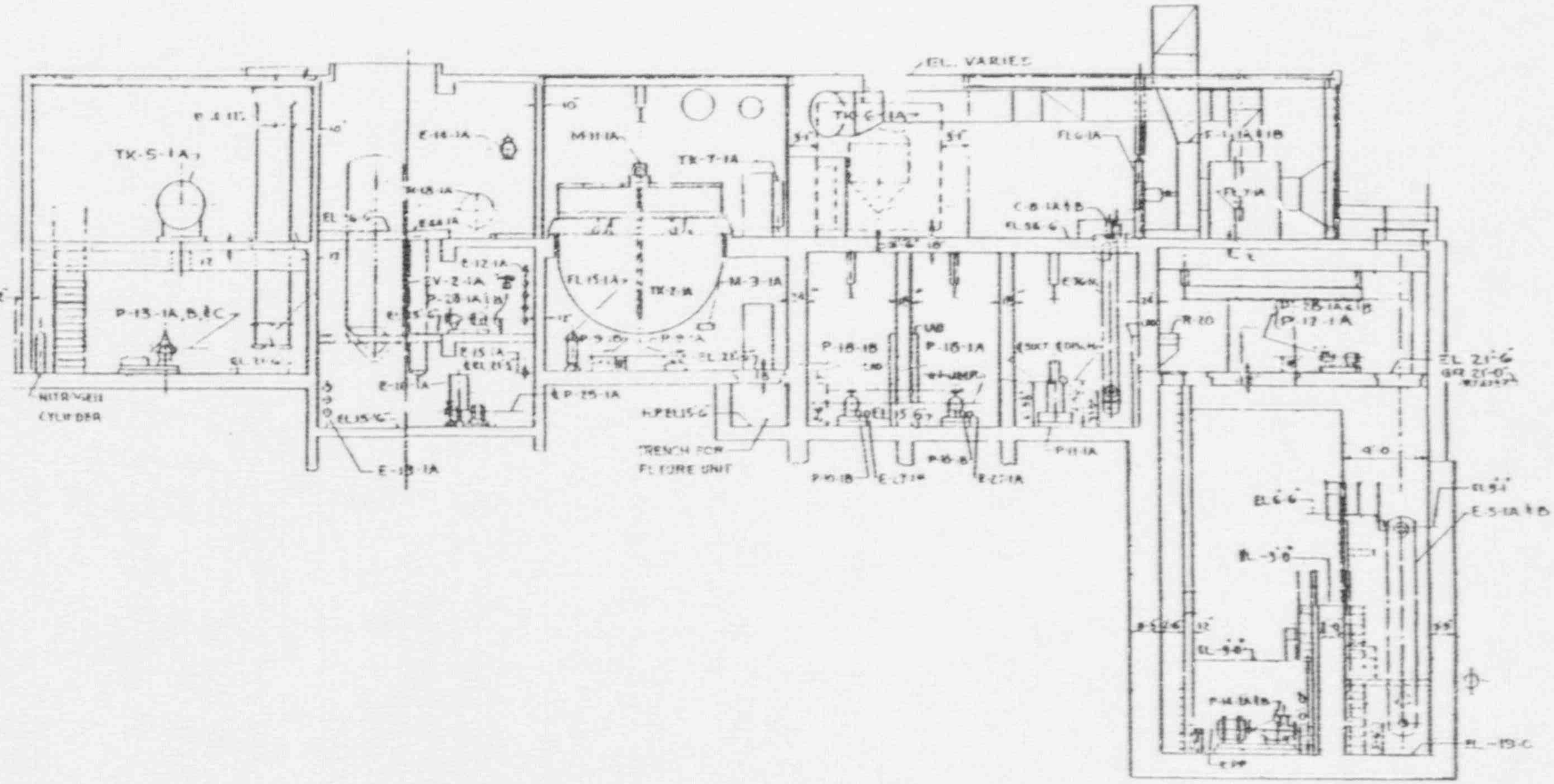


Figure 4-3. Haddam Neck RHR Pit, Looking East (Sheet 3 of 3)

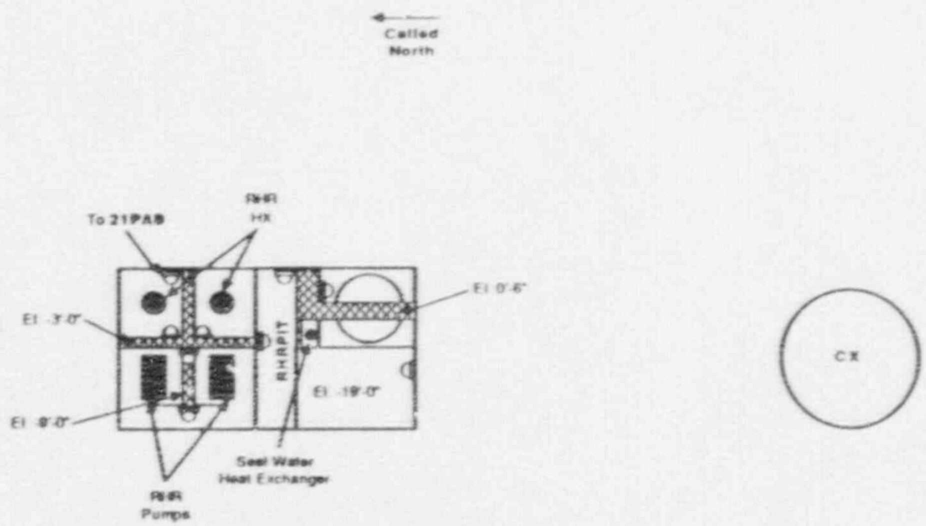


Figure 4-4. Haddam Neck RHR Pit, Elevation -19'-0"

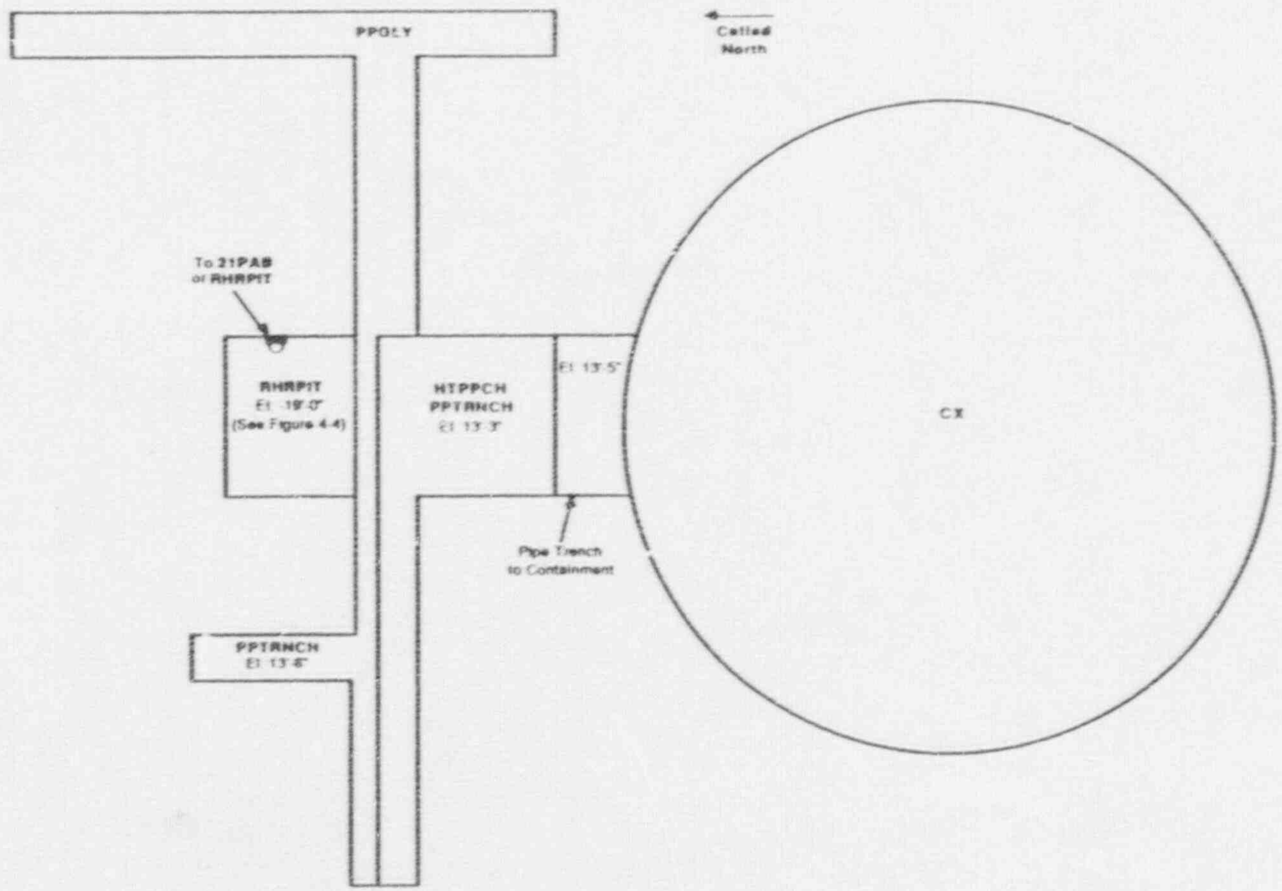


Figure 4-5. Haddam Neck Reactor Containment and Pipe Trenches, Elevation 13'-6"

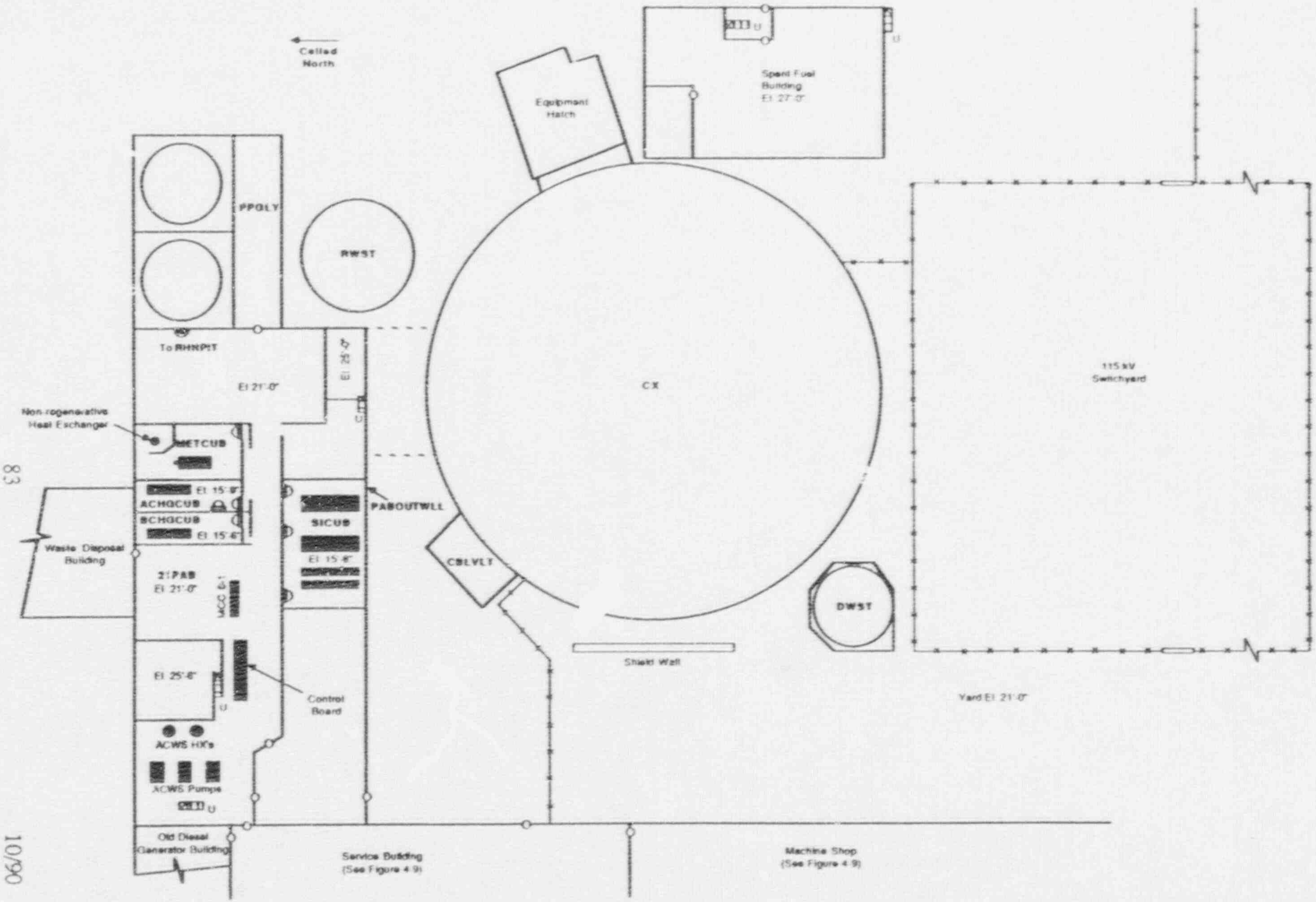


Figure 4-6. Haddam Neck Reactor Containment, Auxiliary Building, and Spent Fuel Building, Elevation 21'-6"

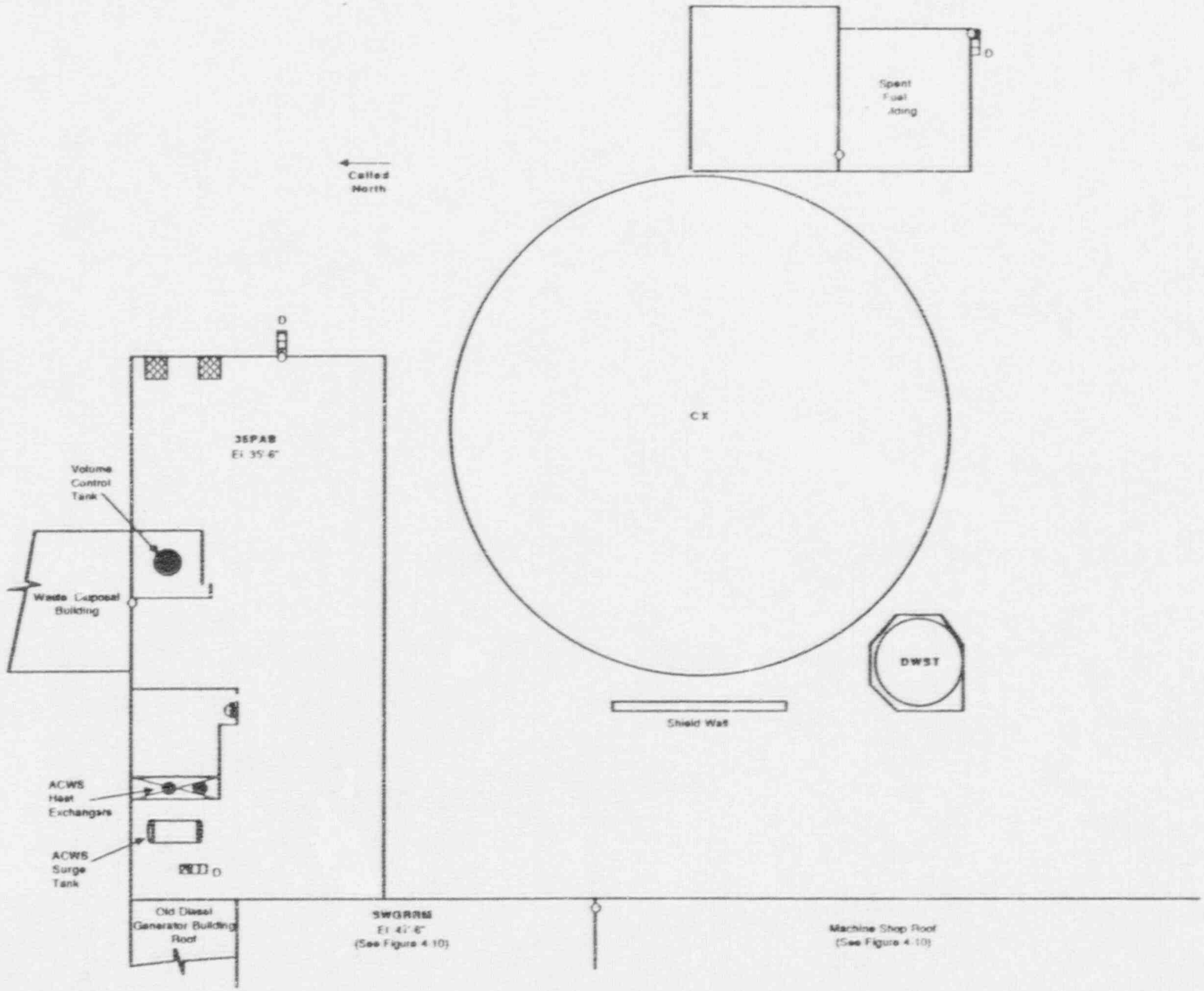


Figure 4-7. Haddam Neck Reactor Containment, Auxiliary Building, Elevation 35'-6" and Spent Fuel Building, Elevation 35'-0"

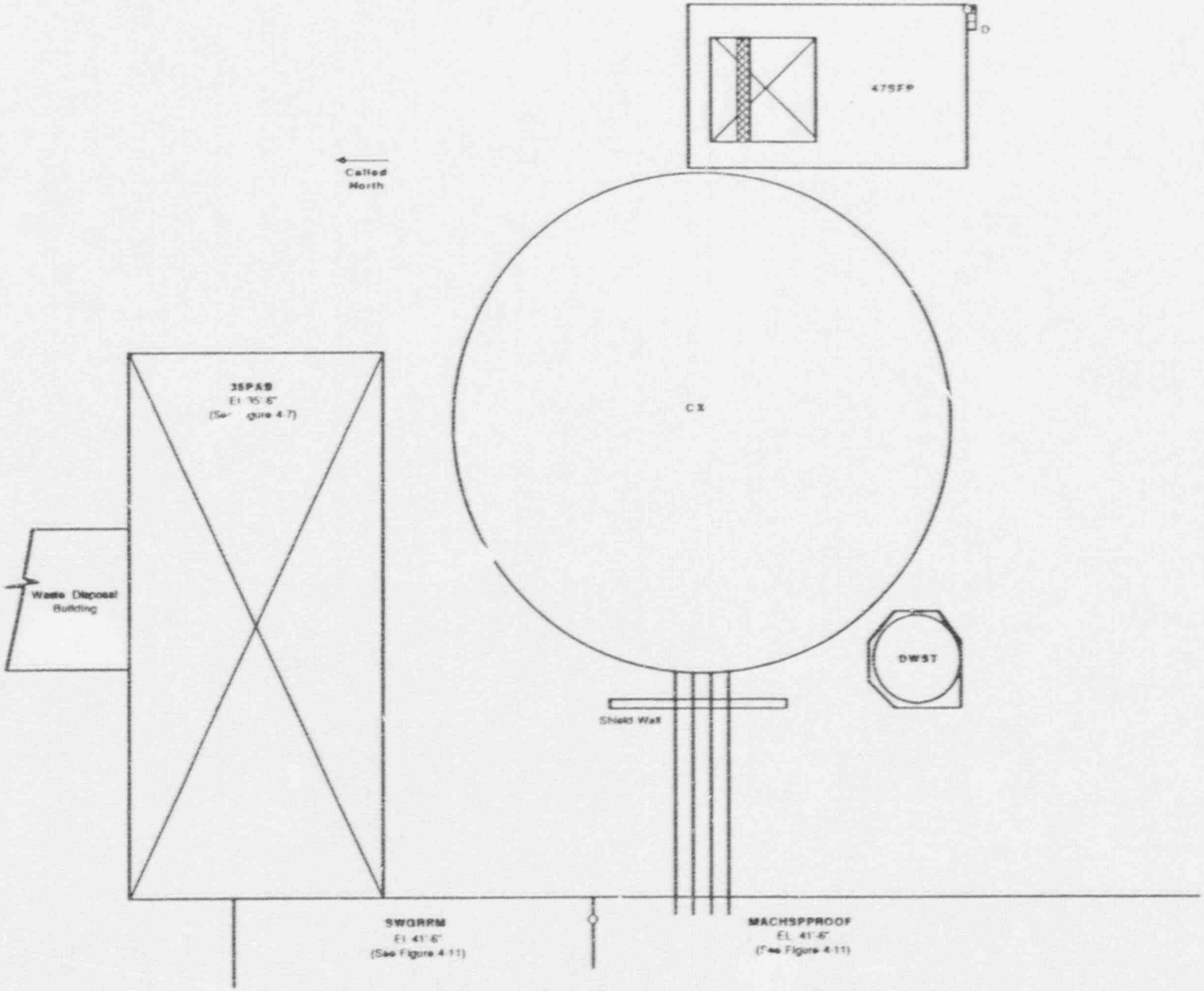


Figure 4-8. Haddam Neck Reactor Containment, Auxiliary Building, and Spent Fuel Building, Elevation 47'-0"

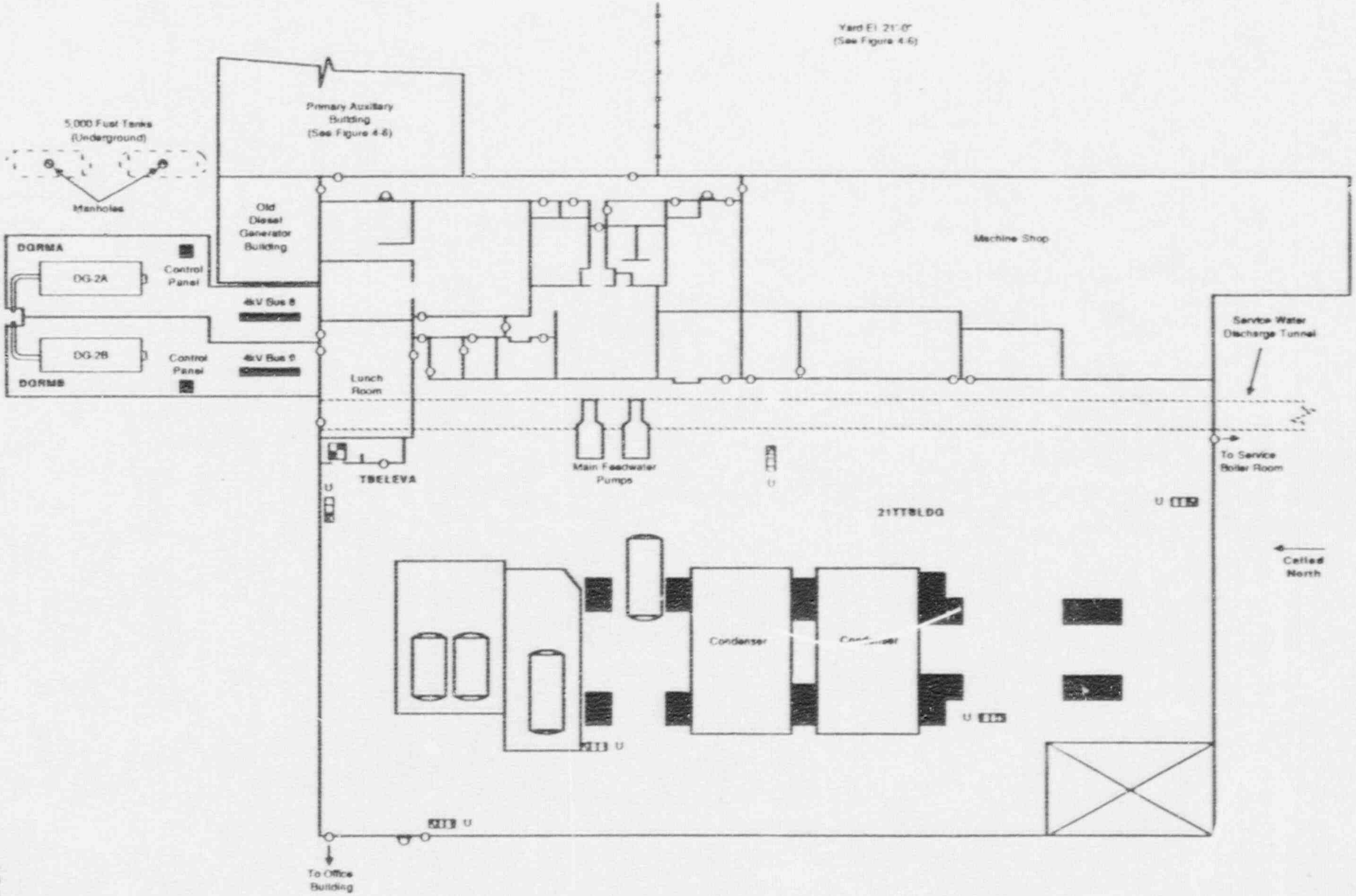


Figure 4-9. Haddam Neck Turbine Building, Service Building and Diesel Generator Building, Elevation 21'-6"

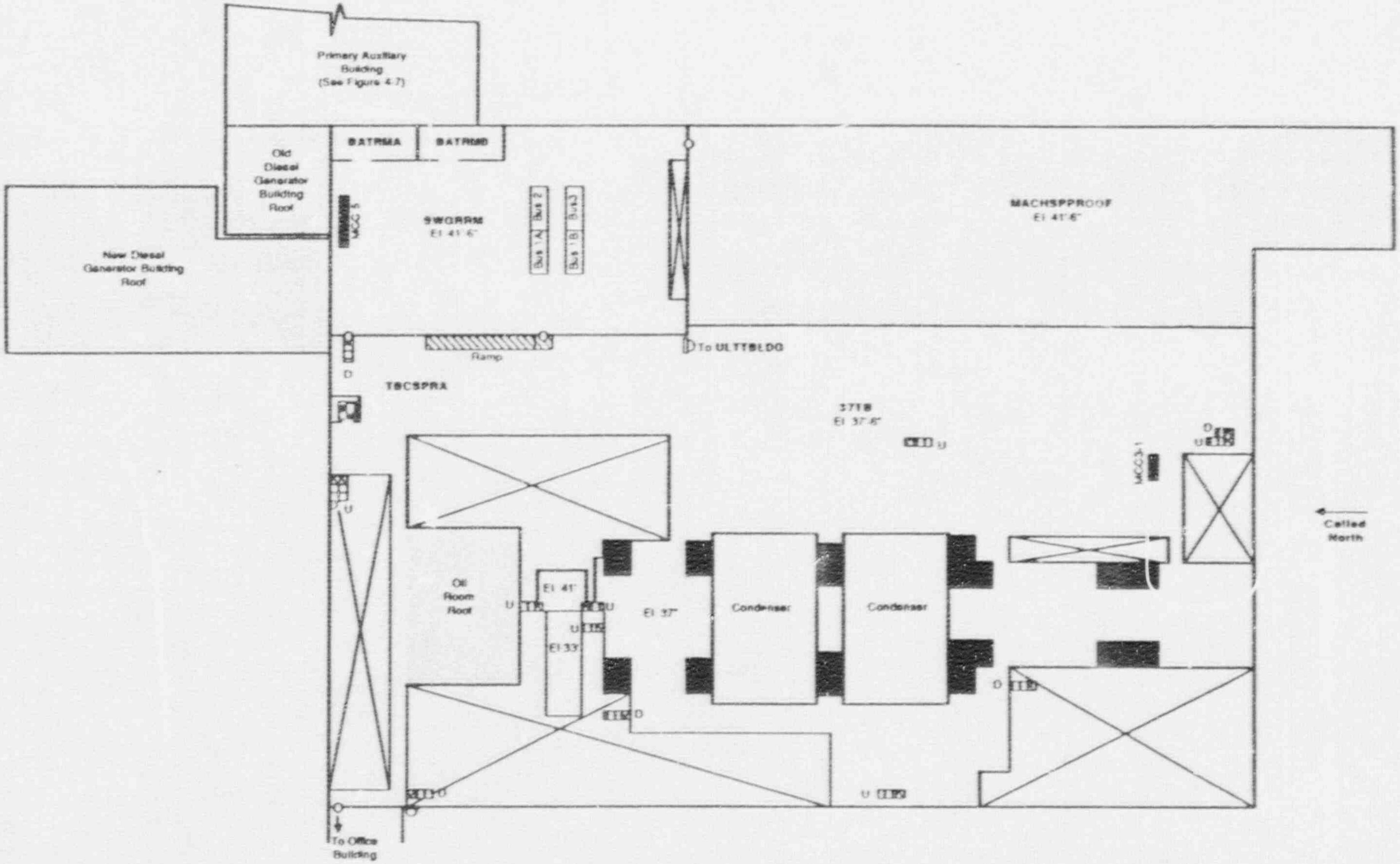


Figure 4-10. Haddam Neck Turbine Bui'ding, Switchgear Room, and Machine Shop Roof Elevation 37'-6"

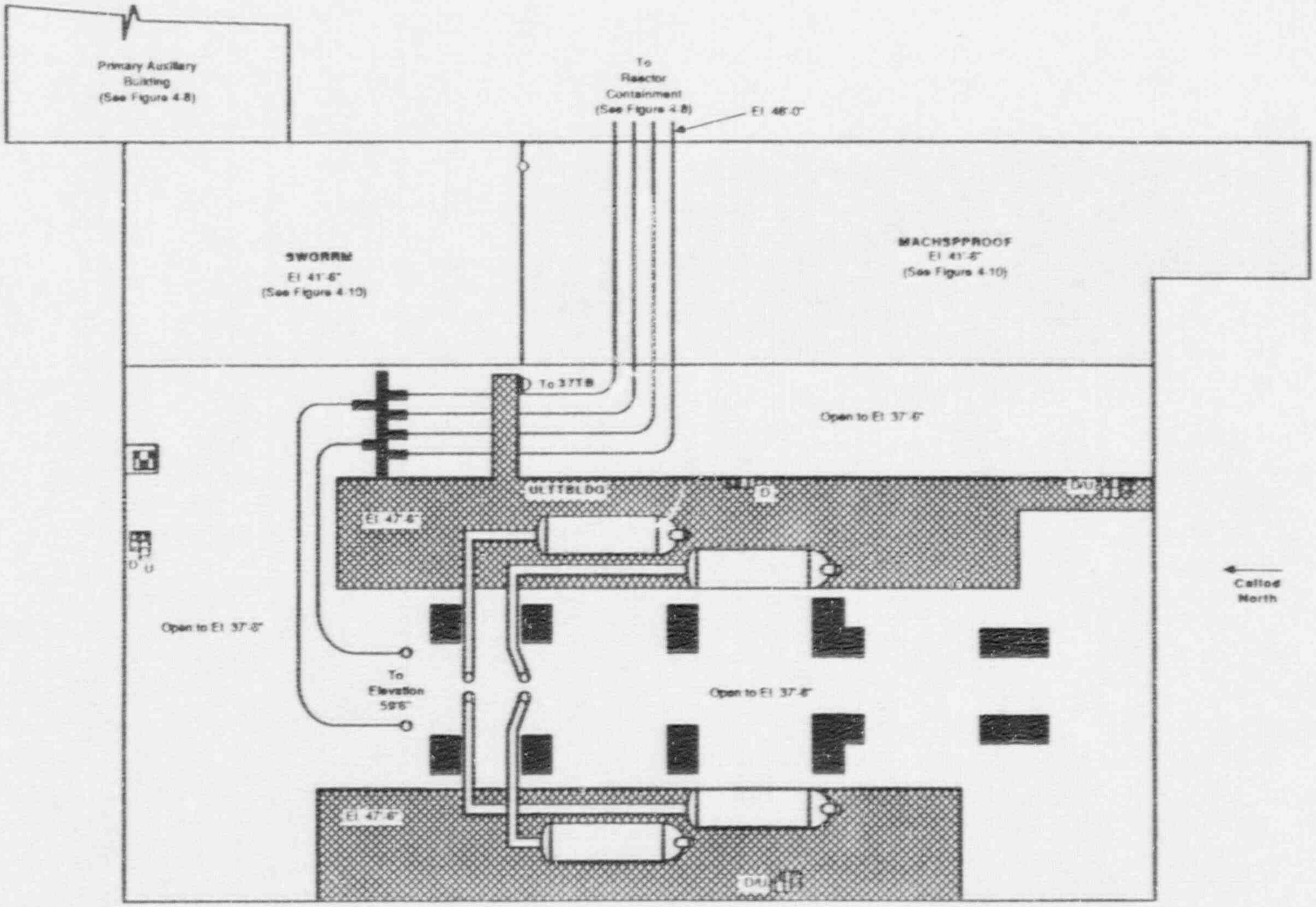


Figure 4-11. Haddam Neck Turbine Building, Switchgrear Room, and Machine Shop Roof Elevation 47'-6"

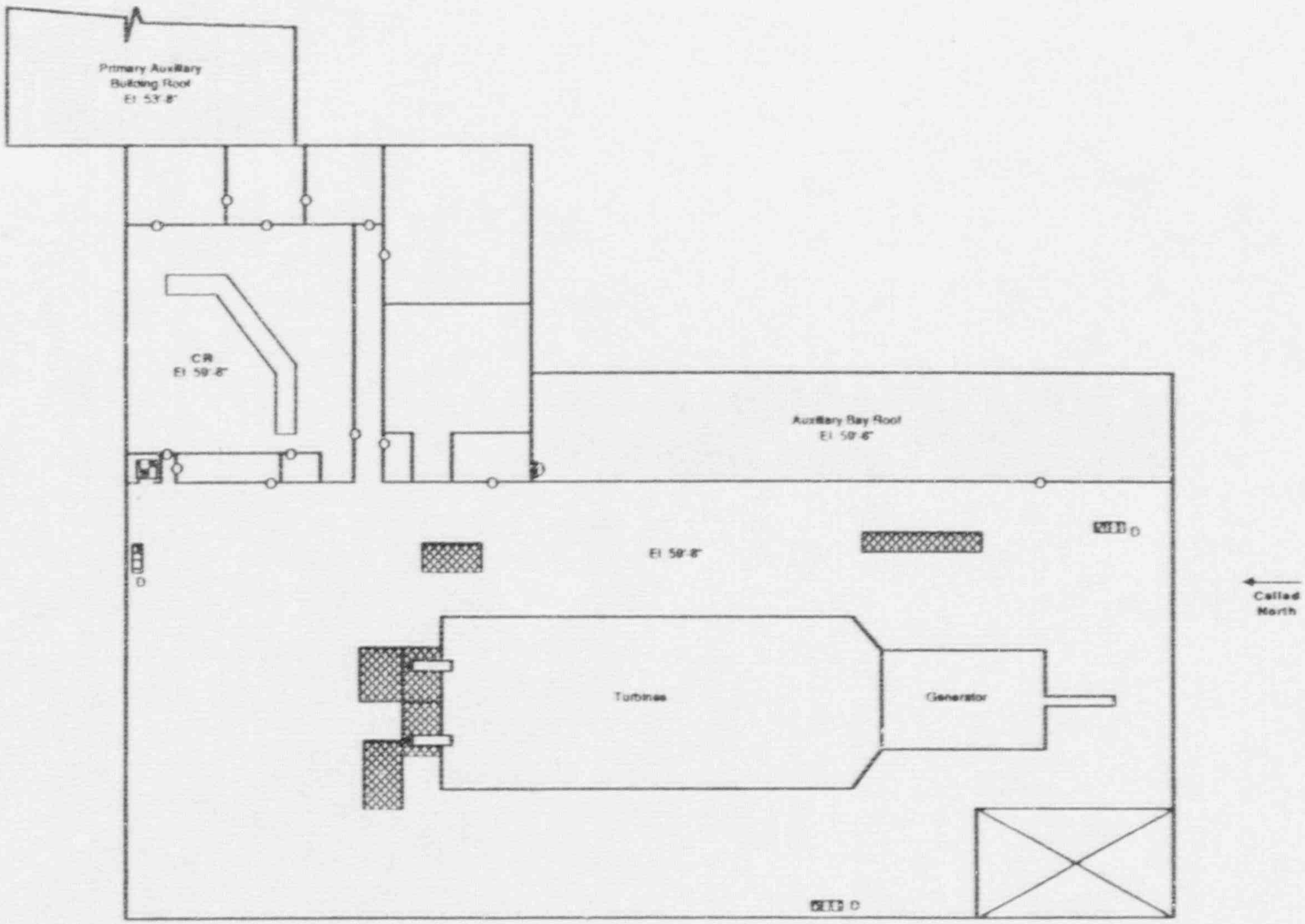


Figure 4-12. Haddam Neck Turbine Building and Control Room, Elevation 59'-6"

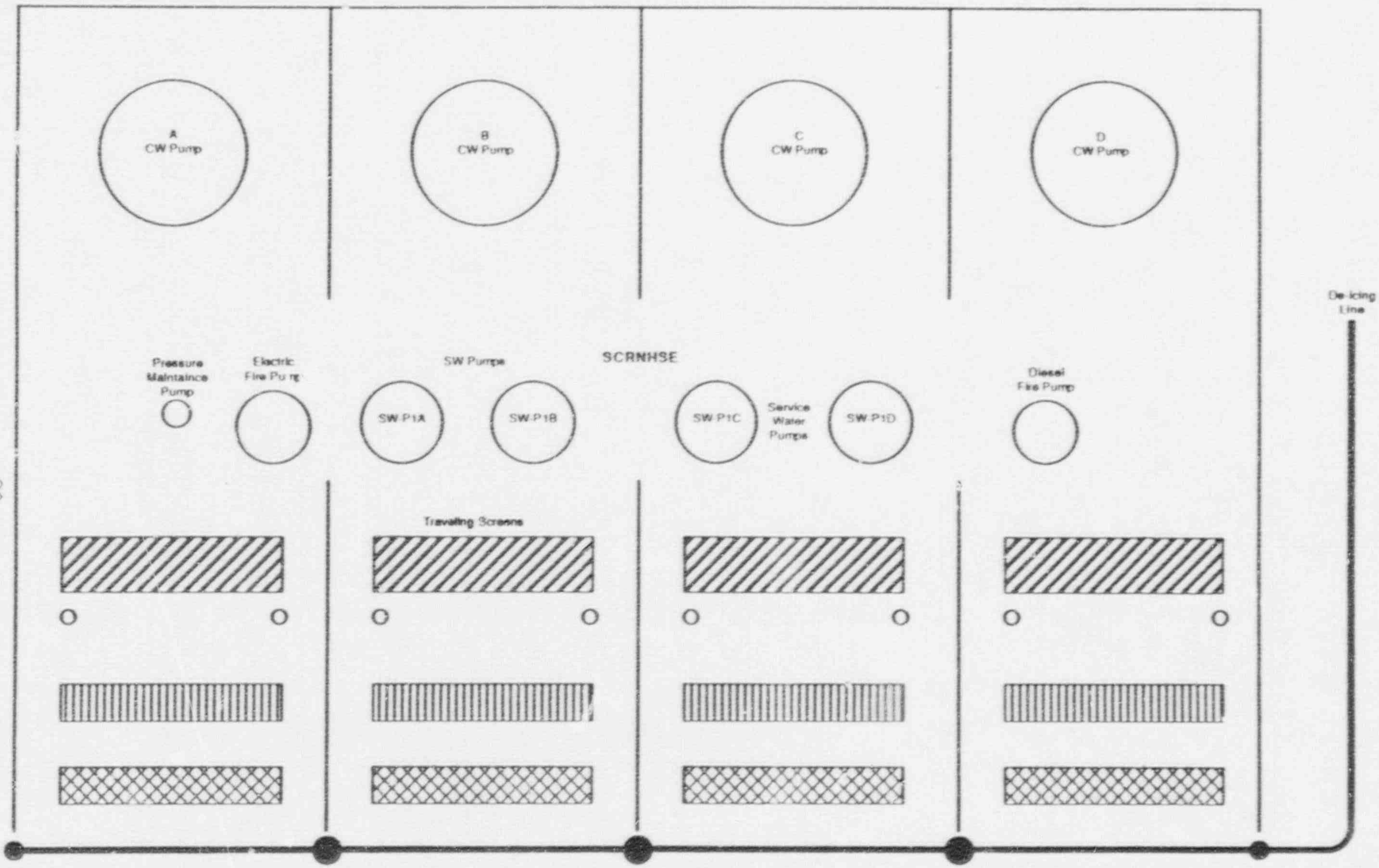


Figure 4-13. Haddam Neck Screenhouse

Table 4-1. Definition of Haddam Neck Building and Location Codes

	Codes	Descriptions
1.	ACHGCUB	Charging Pump A Cubicle located in the Primary Auxiliary Building at the 21' elevation.
2.	BATRMA	Battery Room A located in the switchgear room.
3.	BATRMB	Battery Room B located in the switchgear room.
4.	BCHGCUB	Charging Pump B cubicle located in the Primary Auxiliary Building at the 21' elevation.
5.	CBLVLT	Cable Vault located at the 21' elevation on the northwest side of the Reactor Containment
6.	CR	Control Room located in the Service Building at the 59' elevation.
7.	CX	Reactor Containment.
8.	DGRMA	New Diesel Generator Room 2A located east of the Service Building lunch room at the 21' elevation.
9.	DGRMB	New Diesel Generator Room B located east of the Service Building lunch room at the 21' elevation.
10.	DWST	Demineralized Water Storage Tank located southwest of the Reactor Containment.
11.	HTPPCH	Hot Pipe Chase adjacent to the cold pipe chase located underground at the 13'-5" elevation between the Primary Auxiliary Building and the Reactor Containment, and underneath the Primary Auxiliary Building.
12.	MACHSHPROOF	Machine Shop Roof located at the 41'-6" elevation.
13.	METCUB	Metering Pump Cubicle located in the Primary Auxiliary Building at the 21' elevation.
14.	PABOUTWLL	High Pressure Injection system suction piping running between the RWST and the 21' elevation of the Primary Auxiliary Building outside along the south wall of the Primary Auxiliary Building.
15.	PPGLY	Pipe Gallery located east of the Primary Auxiliary Building between the RWST and Boron injection tanks at the 13'-6" elevation.

Table 4-1. Definition of Haddam Neck Building and Location Codes (Continued)

Codes	Descriptions
16. PPTRNCH	Pipe Trench located underground at the 13'-5" elevation underneath the Primary Auxiliary Building and between the Primary Auxiliary Building and the Reactor Containment.
17. PWST	Primary Water Storage Tank located southeast of the Reactor Containment and Fuel Storage Building.
18. PWST-UNK	Primary Water Storage Tank piping areas running between the PWST and RWST.
19. RHRPIT	Residual Heat Removal Pit located in the Primary Auxiliary Building at the 19' elevation.
20. RWST	Refueling Water Storage Tank located adjacent to the east end of the Primary Auxiliary Building.
21. SCRNHSE	Screenhouse intake structure located at the east bank of the Connecticut River.
22. SICUB	High-Pressure Safety Injection Cubicle located in the 21' elevation of the Primary Auxiliary Building.
23. SWGRRM	Switchgear Room located at the 41' elevation of the Service Building.
24. TBCSPRA	Cable Spreading Area located inside the Terry Turbine Building at the the 37' elevation over the lunch room.
25. TBELEVA	SWS piping to the diesel generators running in the Terry Turbine Building at the 21' elevation by the elevator.
26. ULTTBLDG	Area inside the 47' elevation of the Terry Turbine Building where the main steam and feedwater piping runs from the west side of the Reactor Containment.
27. WSTDSPZL	Areas inside the waste disposal building where ACWS piping runs.
28. 21PAB	The 21' elevation of the Primary Auxiliary Building.
29. 21TTBLDG	The 21' elevation of the Terry Turbine Building.
30. 35PAB	The 35' elevation of the Primary Auxiliary Building.
31. 37TB	The 37' elevation of the Terry Turbine Building.
32. 47SFP	The Spent Fuel Pool located in the Fuel Storage Building at the 47' elevation.

Table 4-2. Partial Listing of Components by Location at Haddam Neck

LOCATION	SYSTEM	COMPONENT ID	COMP TYPE
21PAB	ACWS	ACS-HX1A, ACS-HX1B	HX
21PAB	ACWS	ACS-P1A	MDP
21PAB	ACWS	ACS-P1B	MDP
21PAB	ACWS	ACS-P1C	MDP
21PAB	ACWS	SWS-4	MOV
21PAB	ACWS	SWS-3	MOV
21PAB	ECCS	RH-21	MOV
21PAB	SWS	SWS-5	MOV
21PAB	SWS	SWS-6	MOV
21TTBLDG	AFWS	AFW-P1A	TDP
21TTBLDG	AFWS	AFW-P1B	TDP
21TTBLDG	AFWS	AFW-35	MOV
21TTBLDG	SWS	SWS-1	MOV
21TTBLDG	SWS	SWS-2	MOV
35PAB	ACWS	ACS-HX1A, ACS-HX1B	HX
37TB	AFWS	AFW-1301-1A THRU-1301-4A	NV
ACHGCUB	CVCS	CH-P1A	MDP
ACHGCUB	CVCS	CH-33	MOV
BATRMA	EP	EP-BATT A	BATT
BATRMB	EP	EP-BATT-B	BATT
BCHGCUB	CVCS	CH-P1B	MDP
BCHGCUB	CVCS	CH-32	MOV
CR	EP	EP-BUS 2A	BS
CR	EP	EP-BUS 2B	BS
CR	EP	EP-BUS 2C	BS
CR	EP	EP-BUS 2D	BS
CR	EP	EP-INV-A	INV
CR	EP	EP-INV-B	INV
CR	EP	EP-INV-C	INV
CR	EP	EP-INV-D	INV

Table 4-2. Partial Listing of Components by Location at Haddam Neck (Continued)

LOCATION	SYSTEM	COMPONENT ID	COMP TYPE
CX	CVCS	CH-292B	MOV
CX	CVCS	CH-292C	MOV
CX	ECCS	RH-871A, RH-871B	MOV
CX	ECCS	SI-861A THRU SI-861D	MOV
CX	ECCS	RH-781	MOV
CX	ECCS	RH-780	MOV
CX	ECCS	RH-803	MOV
CX	ECCS	RH-804	MOV
CX	RCS	CH-200	MOV
CX	RCS	RCS-569	MOV
CX	RCS	RCS-570	NV
CX	RCS	RCS-568	NV
CX	RCS	RCS-567	MOV
DGRMA	EP	EP-CB-C8	CB
DGRMA	EP	EP-DG-2A	DG
DGRMA	EP	EP-BUS 8	BS
DGRMB	EP	EP-CB-C9	CB
DGRMB	EP	EP-DG-2B	DG
DGRMB	EP	EP-BUS 9	BS
DWST	AFWS	AFW-DWST	TK
DWST	AFWS	AFW-509	XV
PWST	AFWS	AFW-PWST	TK
RHRPIT	ECCS	RH-HX1A, RH-HX1B	HX
RHRPIT	ECCS	RH-P1A	MDP
RHRPIT	ECCS	RH-P1B	MDP
RWST	ECCS	SI-24	MOV
SCRNHSE	SWS	SWS-P1A	MDP
SCRNHSE	SWS	SWS-P1B	MDP
SCRNHSE	SWS	SWS-P1C	MDP
SCRNHSE	SWS	SWS-P1D	MDP

Table 4-2. Partial Listing of Components by Location at Haddam Neck (Continued)

LOCATION	SYSTEM	COMPONENT ID	COMP TYPE
SICUB	ECCS	SI-P1A	MDP
SICUB	ECCS	SI-P1B	MDP
SWGRRM	EP	EP-BC-1A	BC
SWGRRM	EP	EP-BC-1B	BC
SWGRRM	EP	EP-BUS 2	BS
SWGRRM	EP	EP-BUS 3	BS
SWGRRM	EP	EP-BUS A	BS
SWGRRM	EP	EP-BUS B	BS
SWGRRM	EP	EP-BUS 4	BS
SWGRRM	EP	EP-BUS 5	BS
SWGRRM	EP	EP-BUS 6	BS
SWGRRM	EP	EP-BUS 7	BS
SWGRRM	EP	EP-TR 4	TR
SWGRRM	EP	EP-TR 5	TR
SWGRRM	EP	EP-TR 6	TR
SWGRRM	EP	EP-TR 7	TR
SWGRRM	EP	EP-MCC5-1	MCC
SWGRRM	EP	EP-MCC6-1	MCC
SWGRRM	EP	EP-MCC5-1	MCC

5. BIBLIOGRAPHY FOR HADDAM NECK

1. NUREG-0611, "Generic Evaluation of Feedwater Transients and Small Break Loss of Coolant Accidents in Westinghouse-Designed Operating Plants," Appendix X.7, "Haddam Neck Auxiliary Feedwater System", USNRC, January 1980.

2. NUREG-0826, "Integrated Plant Safety Assessment Report, Systematic Evaluation Program - Haddam Neck Plant," USNRC Division of Licensing, June 1983.

3. NUREG-1185, Volumes 1 and 2 (Draft), "Integrated Safety Assessment Report," USNRC Division of Reactor Projects, July 1987.

4. EPRI NP-3488, "Fuel Failures in the Connecticut Yankee Reactor (Haddam Neck), Addendum to NP-2119," Northwest Utilities Service Company, May 1984.

5. NUSCO-149, "Connecticut Yankee Probabilistic Safety Study," Northeast Utilities. February 1986.

APPENDIX A
DEFINITION OF SYMBOLS USED IN THE SYSTEM AND LAYOUT DRAWINGS

A1. SYSTEM DRAWINGS

A1.1 Fluid System Drawings

The simplified system drawings are accurate representations of the major flow paths in a system and the important interfaces with other fluid systems. As a general rule, small fluid lines that are not essential to the basic operation of the system are not shown in these drawings. Lines of this type include instrumentation lines, vent lines, drain lines, and other lines that are less than 1/3 the diameter of the connecting major flow path. There usually are two versions of each fluid system drawing; a simplified system drawing, and a comparable drawing showing component locations. The drawing conventions used in the fluid system drawings are the following:

- Flow generally is left to right.
  - Water sources are located on the left and water "users" (i.e., heat loads) or discharge paths are located on the right.
  - One exception is the return flow path in closed loop systems which is right to left.
  - Another exception is the Reactor Coolant System (RCS) drawing which is "vessel-centered", with the primary loops on both sides of the vessel.
  - Horizontal lines always dominate and break vertical lines.

- Component symbols used in the fluid system drawings are defined in Figure A-1.
  - Most valve and pump symbols are designed to allow the reader to distinguish among similar components based on their support system requirements (i.e., electric power for a motor or solenoid, steam to drive a turbine, pneumatic or hydraulic source for valve operation, etc.)
  - Valve symbols allow the reader to distinguish among valves that allow flow in either direction, check (non-return) valves, and valves that perform an overpressure protection function. No attempt has been made to define the specific type of valve (i.e., as a globe, gate, butterfly, or other specific type of valve).
  - Pump symbols distinguish between centrifugal and positive displacement pumps and between types of pump drives (i.e., motor, turbine, or engine).

- Locations are identified in terms of plant location codes defined in Section 4 of this Sourcebook.
  - Location is indicated by shaded "zones" that are not intended to represent the actual room geometry.
  - Locations of discrete components represent the actual physical location of the component.
  - Piping locations between discrete components represent the plant areas through which the piping passes (i.e. including pipe tunnels and underground pipe runs).
  - Component locations that are not known are indicated by placing the components in an unshaded (white) zone.
  - The primary flow path in the system is highlighted (i.e., bold white line) in the location version of the fluid system drawings.

A1.2 Electrical System Drawings

The electric power system drawings focus on the Class 1E portions of the plant's electric power system. Separate drawings are provided for the AC and DC portions of the Class 1E system. There often are two versions of each electrical system drawing; a simplified system drawing, and a comparable drawing showing component locations. The drawing conventions used in the electrical system drawings are the following:

- Flow generally is top to bottom
  - In the AC power drawings, the interface with the switchyard and/or offsite grid is shown at the top of the drawing.
  - In the DC power drawings, the batteries and the interface with the AC power system are shown at the top of the drawing.
  - Vertical lines dominate and break horizontal lines.

- Component symbols used in the electrical system drawings are defined in Figure A-2.

- Locations are identified in terms of plant location codes defined in Section 4 of this Sourcebook.
  - Locations are indicated by shaded "zones" that are not intended to represent the actual room geometry.
  - Locations of discrete components represent the actual physical location of the component.
  - The electrical connections (i.e., cable runs) between discrete components, as shown on the electrical system drawings, DO NOT represent the actual cable routing in the plant.
  - Component locations that are not known are indicated by placing the discrete components in an unshaded (white) zone.

A2. SITE AND LAYOUT DRAWINGS

A2.1 Site Drawings

A general view of each reactor site and vicinity is presented along with a simplified site plan showing the arrangement of the major buildings, tanks, and other features of the site. The general view of the reactor site is obtained from ORNL-NSIC-55 (Ref. 1). The site drawings are approximately to scale, but should not be used to estimate distances on the site. As-built scale drawings should be consulted for this purpose.

Labels printed in bold uppercase correspond to the location codes defined in Section 4 and used in the component data listings and system drawings in Section 3. Some additional labels are included for information and are printed in lowercase type.

A2.2 Layout Drawings

Simplified building layout drawings are developed for the portions of the plant that contain components and systems that are described in Section 3 of this Sourcebook. Generally, the following buildings are included: reactor building, auxiliary building, fuel building, diesel building, and the intake structure or pumphouse. Layout drawings generally are not developed for other buildings.

Symbols used in the simplified layout drawings are defined in Figure A-3. Major rooms, stairways, elevators, and doorways are shown in the simplified layout drawings however, many interior walls have been omitted for clarity. The building layout drawings, are approximately to scale, should not be used to estimate room size or distances. As-built scale drawings for should be consulted his purpose.

Labels printed in uppercase bolded also correspond to the location codes defined in Section 4 and used in the component data listings and system drawings in Section 3. Some additional labels are included for information and are printed in lowercase type.

A3. APPENDIX A REFERENCES

1. Heddleson, F.A., "Design Data and Safety Features of Commercial Nuclear Power Plants.", ORNL-NSIC-55, Volumes 1 to 4, Oak Ridge National Laboratory, Nuclear Safety Information Center, December 1973 (Vol.1), January 1972 (Vol. 2), April 1974 (Vol. 3), and March 1975 (Vol. 4)

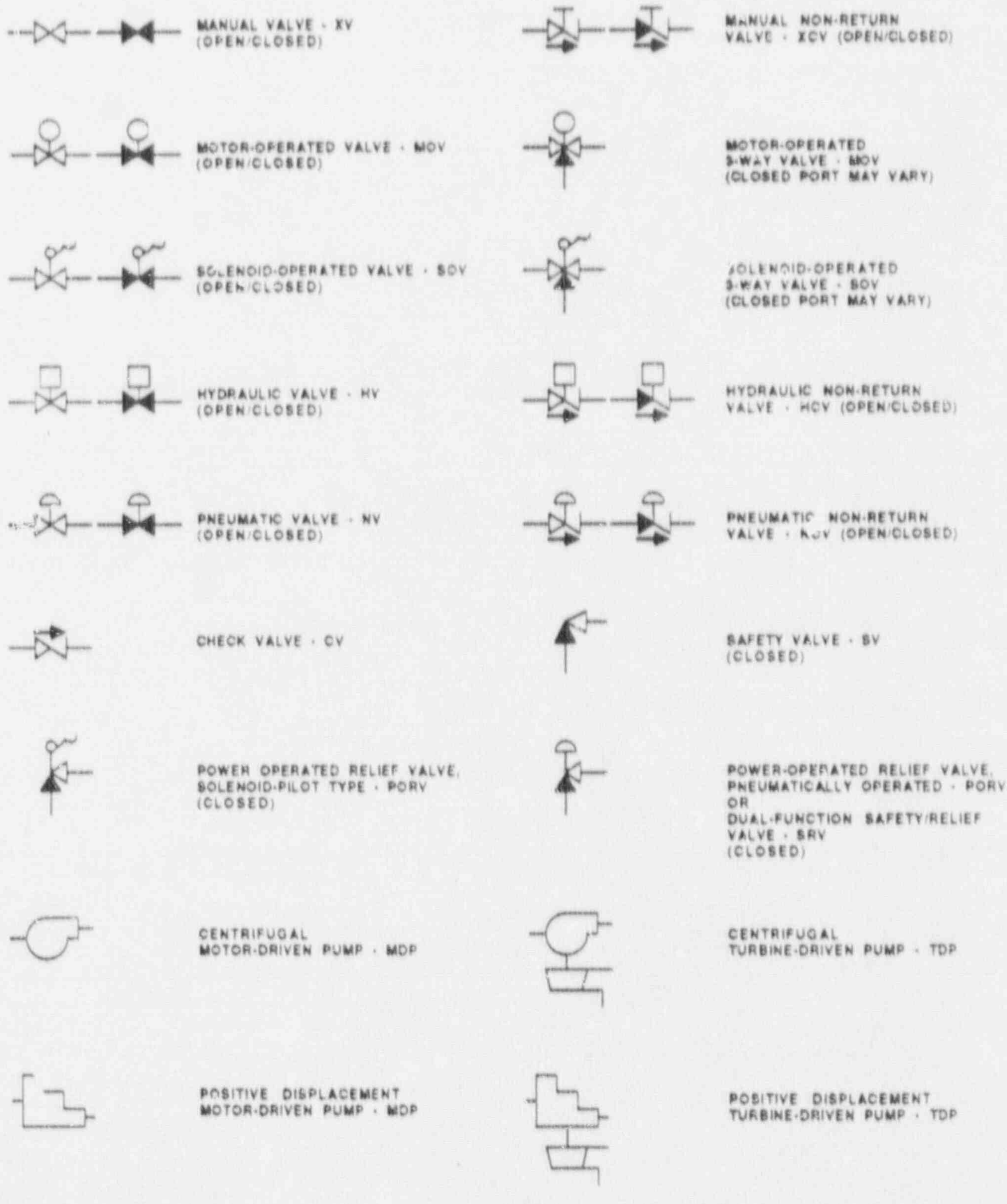


Figure A-1. Key To Symbols In Fluid System Drawings

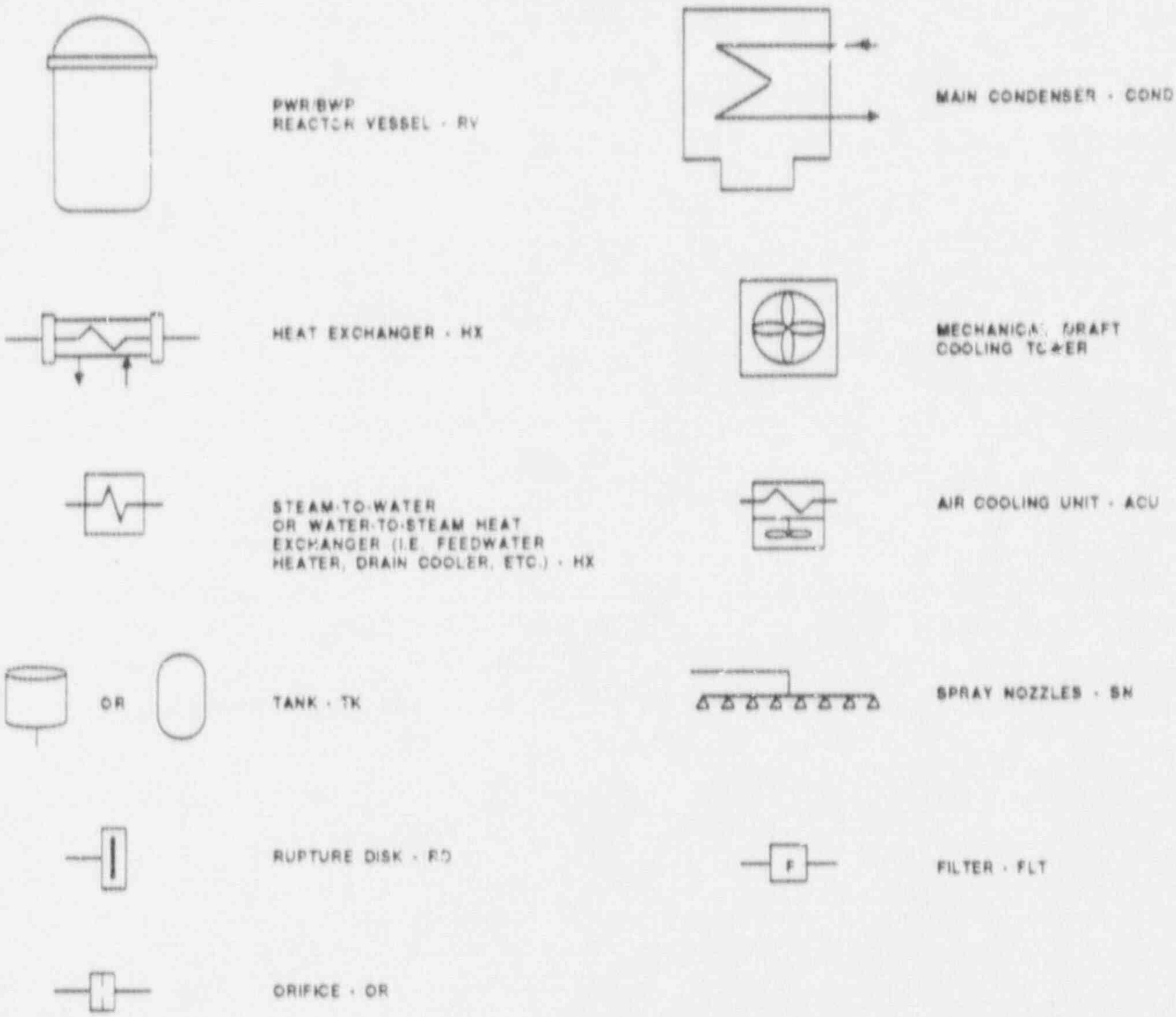


Figure A-1. Key To Symbols in Fluid System Drawings (Continued)

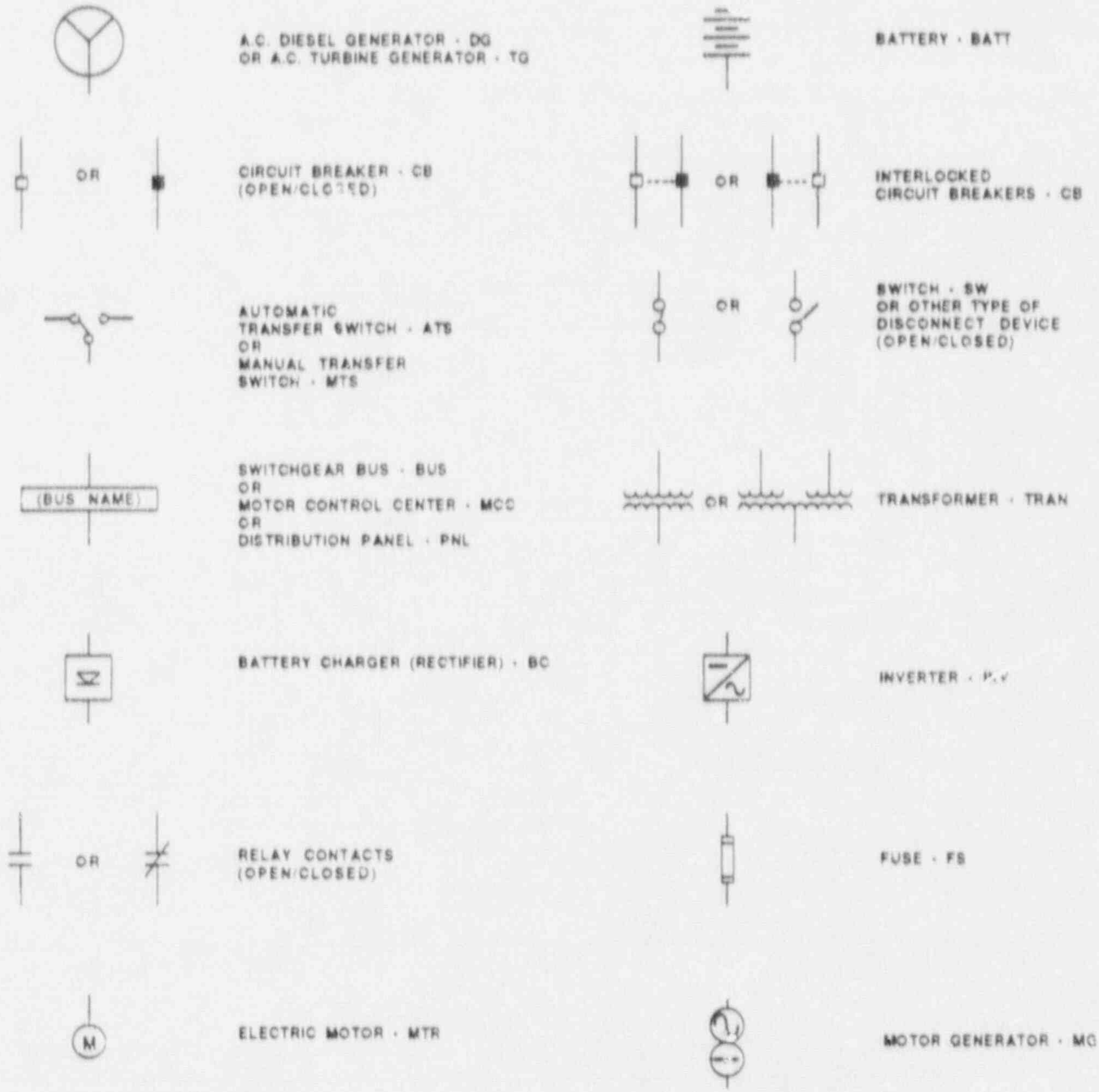


Figure A-2. Key To Symbols In Electrical System Drawings

Figure A-3. Key To Symbols In Facility Layout Drawings

APPENDIX B
DEFINITION OF TERMS USED IN THE DATA TABLES

Terms appearing in the data tables in Sections 3 and 4 of this Sourcebook are defined as follows:

SYSTEM (also LOAD SYSTEM) - All components associated with a particular system description in the Sourcebook have the same system code in the data base. System codes used in this Sourcebook are the following:

Code	Definition
RCS	Reactor Coolant System
AFWS	Auxiliary Feedwater System
ECCS	Emergency Core Cooling System (including HPI, LPI, RHR, and Containment Spray)
CVCS	Charging System
EP	Electric Power System
ACWS	Auxiliary Cooling Water System
SWS	Service Water System

COMPONENT ID (also LOAD COMPONENT ID) - The component identification (ID) code in a data table matches the component ID that appears in the corresponding system drawing. The component ID generally begins with a system preface followed by a component number. The system preface is not necessarily the same as the system code described above. For component IDs, the system preface corresponds to what the plant calls the component (e.g. HPI, RHR). An example is HPI-730, denoting valve number 730 in the high pressure injection system, which is part of the ECCS. The component number is a contraction of the component number appearing in the plant piping and instrumentation drawings (P&IDs) and electrical one-line system drawings.

LOCATION (also COMPONENT LOCATION and POWER SOURCE LOCATION) - Refer to the location codes defined in Section 4.

COMPONENT TYPE (COMP TYPE) - Refer to Table B-1 for a list of component type codes.

POWER SOURCE - The component ID of the power source is listed in this field (see COMPONENT ID, above). In this data base, a "power source" for a particular component (i.e. a load or a distribution component) is the next higher electrical distribution or generating component in a distribution system. A single component may have more than one power source (i.e. a DC bus powered from a battery and a battery charger).

POWER SOURCE VOLTAGE (also VOLTAGE) - The voltage "seen" by a load of a power source is entered in this field. The downstream (output) voltage of a transformer, inverter, or battery charger is used.

EMERGENCY LOAD GROUP (EMERG LOAD GROUP) - AC and DC load groups (or electrical divisions) are defined as appropriate to the plant. Generally, AC load groups are identified as AC/A, AC/B, etc. The emergency load group for a third-of-a-kind load (i.e. a "swing" load) that can be powered from either of two AC load groups would be identified as AC/AB. DC load group follows similar naming conventions.

TABLE B-1. COMPONENT TYPE CODES

COMPONENT	COMP TYPE
VALVES:	
Motor-operated valve	MOV
Pneumatic (air-operated) valve	NV or AOV
Hydraulic valve	HV
Solenoid-operated valve	SOV
Manual valve	XV
Check valve	CV
Pneumatic non-return valve	NCV
Hydraulic non-return valve	HCV
Safety valve	SV
Dual function safety/relief valve	SRV
Power-operated relief valve (pneumatic or solenoid-operated)	PORV
PUMPS:	
Motor-driven pump (centrifugal or PD)	MDP
Turbine-driven pump (centrifugal of PD)	TDP
Diesel-driven pump (centrifugal of PD)	DDP
OTHER FLUID SYSTEM COMPONENTS:	
Reactor vessel	RV
Steam generator (U-tube or once-through)	SG
Heat exchanger (water-to-water HX, or water-to-air HX)	HX
Cooling tower	CT
Tank	TANK or TK
Sump	SUMP
Rupture disk	RD
Orifice	ORIF
Filter or strainer	FLT
Spray nozzle	SN
Heaters (i.e. pressurizer heaters)	HTR
VENTILATION SYSTEM COMPONENTS:	
Fan (motor-driven, any type)	FAN
Air cooling unit (air-to-water HX, usually including a fan)	ACU or FCU
Condensing (air-conditioning) unit	COND
EMERGENCY POWER SOURCES:	
Diesel generator	DG
Gas turbine generator	GT
Battery	BATT

TABLE B-1. COMPONENT TYPE CODES (Continued)

COMPONENT	COMP TYPE
ELECTRIC POWER DISTRIBUTION EQUIPMENT:	
Bus or switchgear	BUS
Motor control center	MCC
Distribution panel or cabinet	PNL or CAB
Transformer	TRAN or XFMR
Battery charger (rectifier)	BC or RECT
Inverter	INV
Uninterruptible power supply (a unit that may include battery, battery charger, and inverter)	UPS
Motor generator	MG
Circuit breaker	CB
Switch	SW
Automatic transfer switch	ATS
Manual transfer switch	MTS