# NUCLEAR POWER PLANT SYSTEM SOURCEBOOK

# BEAVER VALLEY 2

50-412

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# NUCLEAR POWER PLANT SYSTEM SOURCEBOOK

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50-412

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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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# BEAVER VALLEY 2
# RECORD OF REVISIONS

| REVISION | ISSUE | COMMENTS |
|---|---|---|
| 0 | 08/90 | Original report |
| | | |

# BEAVER VALLEY 2 SOURCEBOOK

This sourcebook contains summary information on the Beaver Valley 2 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 Beaver Valley 2 nuclear power plant is listed below:

| | |
|---|---|
| - Docket number | 50-412 |
| - Operator | Duquesne Light Company |
| - Location | Shippingport, PA |
| - Commercial operation date | 11/87 |
| - Reactor type | PWR |
| - NSSS vendor | Westinghouse |
| - Number of loops | 3 |
| - Power (MWt/MWe) | 2660/836 |
| - Architect-engineer | Stone & Webster Engineering Corporation |
| - Containment type | Subatmospheric, reinforced concrete cylinder with steel liner |

## 2. IDENTIFICATION OF SIMILAR NUCLEAR POWER PLANTS

Beaver Valley 2 utilizes a Westinghouse PWR three-loop nuclear steam supply system (NSSS). Other three-loop Westinghouse plants in the United States include:

- Beaver Valley 1
- Farley 1 and 2
- North Anna 1 and 2
- Robinson 2
- San Onofre 1
- Shearon Harris 1
- Summer
- Surry 1 and 2
- Turkey Point 3 and 4

Beaver Valley 2 is similar to most other three-loop Westinghouse plants in that it has three centrifugal charging pumps that also serve as the high-head safety injection pumps. Beaver Valley 2 also has the same number and type of auxiliary feedwater pumps as the other three-loop plants. Beaver Valley 2 has a subatmospheric containment that is comparable to the containment designs for Beaver Valley 1, North Anna 1 and 2, and Surry 1 and 2. Other Westinghouse three-loop plants have large, dry containments.

## 3. SYSTEM INFORMATION

This section contains descriptions of selected systems at Beaver Valley 2 in terms of general function, operation, system success criteria, major components, and support system requirements. A summary of major systems at Beaver Valley 2 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 Beaver Valley 2 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 |
| - Auxiliary Feedwater (AFW) and Secondary Steam Re[illegible] (SSR) Systems | Same | 3.2 | 10.4.9 |
| - Emergency Core Cooling Systems (ECCS) | Same | | |
| - High-Pressure Injection & Recirculation | High Head Safety Injection/ Charging System | 3.3 | 6.3, 9.3.4 |
| - Low-pressure Injection & Recirculation | Low Head Safety Injection/ System | 3.3 | 5.4.7 |
| - Decay Heat Removal (DHR) System (Residual Heat Removal (RHR) System) | Residual Heat Removal (RHR) System | X | 5.4.7 |
| - Main Steam and Power Conversion Systems | Main Steam Supply System<br>Condensate and Feedwater Systems,<br>Circulating Water System | X | 10.3<br>10.4.7<br>10.4.5 |
| - Other Heat Removal Systems | None identified | - | - |
| **Reactor Coolant Inventory Control Systems** | | | |
| - Chemical and Volume Control System (CVCS) (Charging System) | Same | 3.9 | 9.3.4 |
| - ECCS | See ECCS, above | - | - |

Table 3-1. Summary of Beaver Valley 2 Systems Covered in this Report (Continued)

| Generic System Name | Plant-Specific System Name | Report Section | FSAR Section Reference |
|---|---|---|---|
| **Containment Systems** | | | |
| - Containment | Same | X | 6.2.1 |
| - Containment Heat Removal Systems | | | |
| - Containment Spray Systems | Quench Spray System<br>Recirculation Spray System | 3.4<br>3.4 | 6.2.2.2.1<br>6.2.2.2.2 |
| - Containment Fan Cooler System | See Containment Ventilation System, below | - | - |
| - Containment Normal Ventilation Systems | Containment Ventilation System, including Atmosphere Recirculation and Atmosphere Filtration Subsystems | 3.4 | 9.4.7 |
| - Combustible Gas Control Systems | Same | X | 6.2.5 |
| **Reactor and Reactivity Control Systems** | | | |
| - Reactor Core | Same | X | 4 |
| - Control Rod System | Control Rod Drive System | X | 3.9N.4, 4.6 |
| - Boration Systems | See CVCS, above | - | - |
| **Instrumentation & Control (I&C) Systems** | | | |
| - Reactor Protection System (RPS) | Reactor Trip System | 3.5 | 7.2 |
| - Engineered Safety Feature Actuation System (ESFAS) | Same | 3.5 | 7.3 |
| - Remote Shutdown System | Emergency Shutdown Panel, Auxiliary Shutdown Panel | 3.5 | 7.4.1.3 |

Table 3-1. Summary of Beaver Valley 2 Systems Covered in this Report (Continued)

| Generic System Name | Plant-Specific System Name | Report Section | FSAR Section Reference |
|---|---|---|---|
| - Other I&C Systems | Various systems | X | 7.6 |
| **Support Systems** | | | |
| - Class 1E Electric Power System | Same | 3.6 | 8.1.5, 8.3 |
| - Non-Class 1E Electric Power System | Same | 3.6 | 8.1, 8.2 |
| - Diesel Generator Auxiliary Systems | Same | 3.6 | 9.5.4 thru 9.5.8 |
| - Component Cooling Water (CCW) System | Primary Component Cooling Cooling Water System | 3.8 | 9.2.2 |
| - Service Water System (SWS) | Same | 3.7 | 9.2.1 |
| - Other Cooling Water Systems | Standby Service Water System Turbine Plant Component Water System | X | 9.2.1, 9.[illegible].7 |
| - Fire Protection Systems | Same | X | 9.5.1 |
| - Room Heating, Ventilating, and Air-Conditioning (HVAC) Systems | Same | X | 9.4.1 thru 9.4.16 |
| - Instrument and Service Air Systems | Compressed Air Systems | X | 9.3.1 |
| - Refueling and Spent Fuel Systems | Spent Fuel Pool Cooling and Cleanup System, Light Load Handling System | X | 9.1.3, 9.1.4 |
| - Radioactive Waste Systems | Radioactive Waste Management Systems | X | 11 |
| - Radiation Protection Systems | Same | X | 12 |

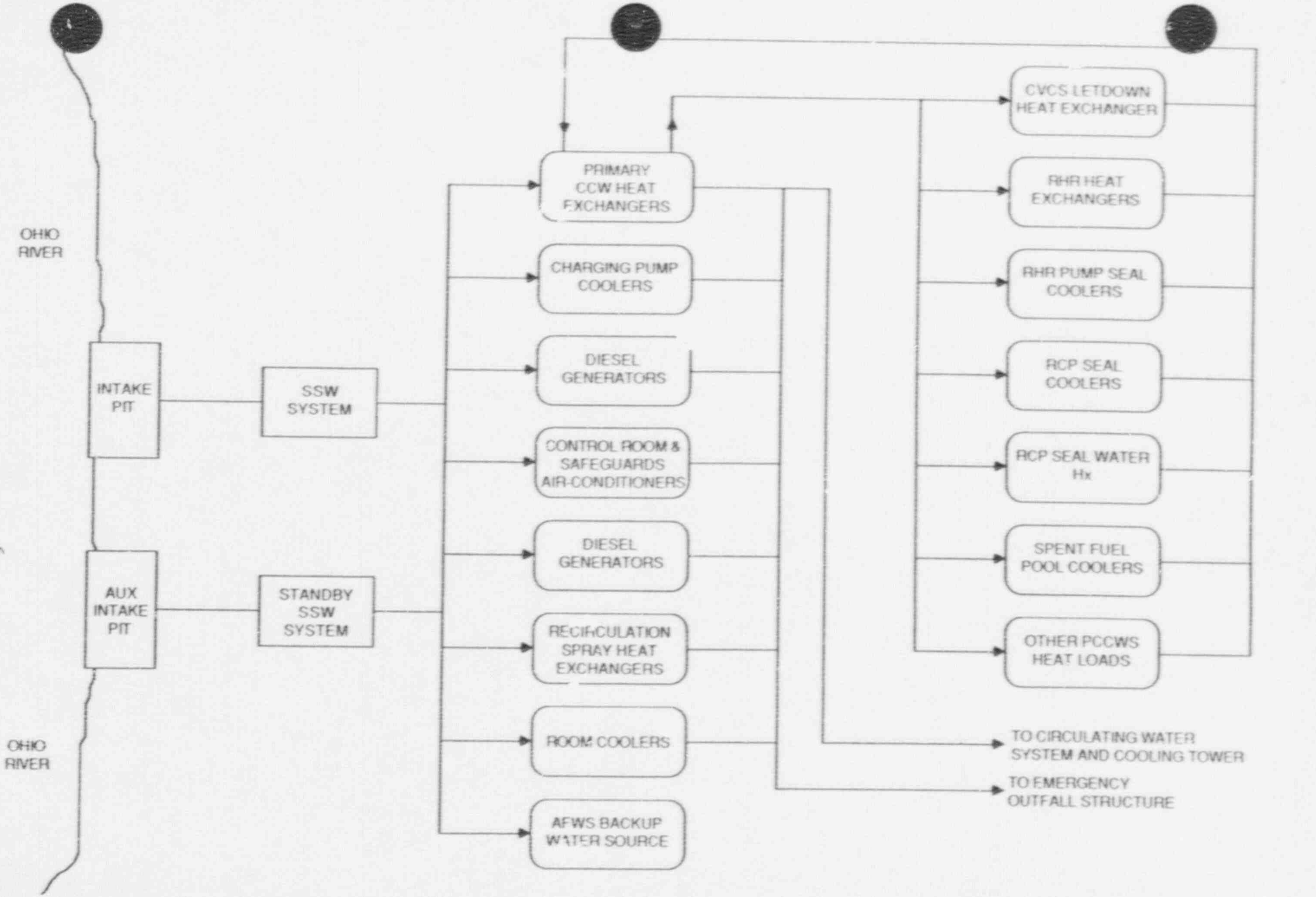



**Figure 3-1. Cooling Water Systems Functional Diagram for Beaver Valley 2**

## 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) three parallel reactor coolant loops, (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 3-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 three 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 three power-operated relief valves (each in series with a motor-operated block valve) and three safety valves on the pressurizer. 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.

### 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.

### 3.1.5 Component Information

A. RCS
1. Total system volume, including pressurizer: 9370 $ft^3$
2. Normal operating pressure: 2235 psig

B. Pressurizer
1. Internal volume: 1400 $ft^3$

C. Reactor Coolant Pumps (3)
1. Rated flow: 88,500 gpm @ 280 ft. head (121 psid) (each)
2. Type: Vertical, single-stage, centrifugal

D. Pressurizer Power-Operated Relief Valves (3)
1. Set pressure: 2335 psig
2. Relief capacity: 210,000 lb/hr (each)

E. Pressurizer Safety Valves (3)
1. Set pressure: 2485 psig
2. Relief capacity: 345,000 lb/hr (each)

F. Steam Generators (3)
1. Type: Vertical shell and U-tube
2. Model: Westinghouse model 51

### 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 charging system (see Section 3.9) supplies seal water to cool the reactor coolant pump shaft seals and to maintain a controlled in leakage 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 primary component cooling water system (PCCWS, see Section 3.8), cools the reactor coolant to an acceptable level before it enters the pump bearing and seal area (Ref. 1).

### 3.1.7 Section 3.1 References

1. Beaver Valley 2 FSAR, Section 5.4.1.2.2.

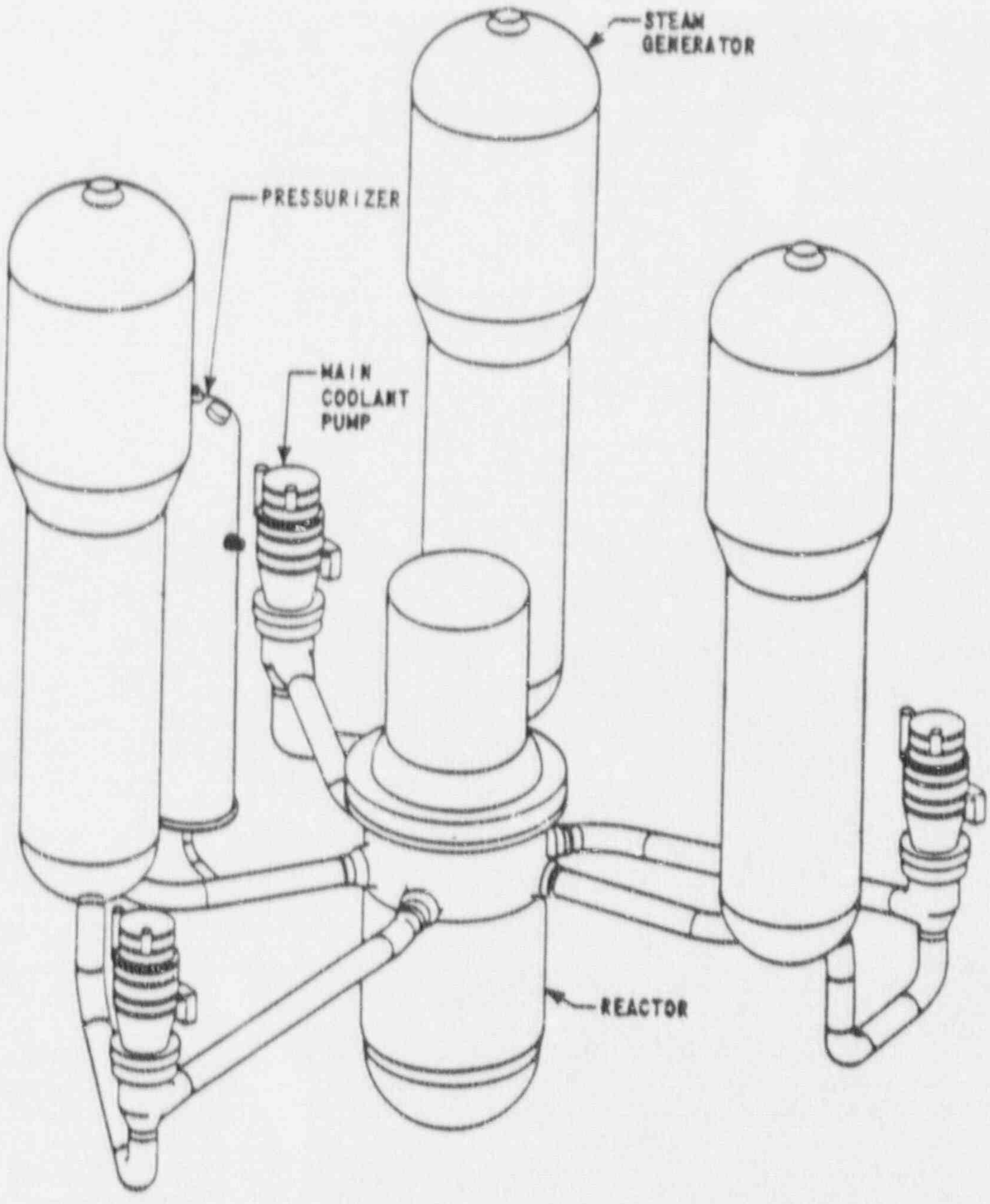



Figure 3.1-1. Isometric View of a 3-Loop Westinghouse RCS

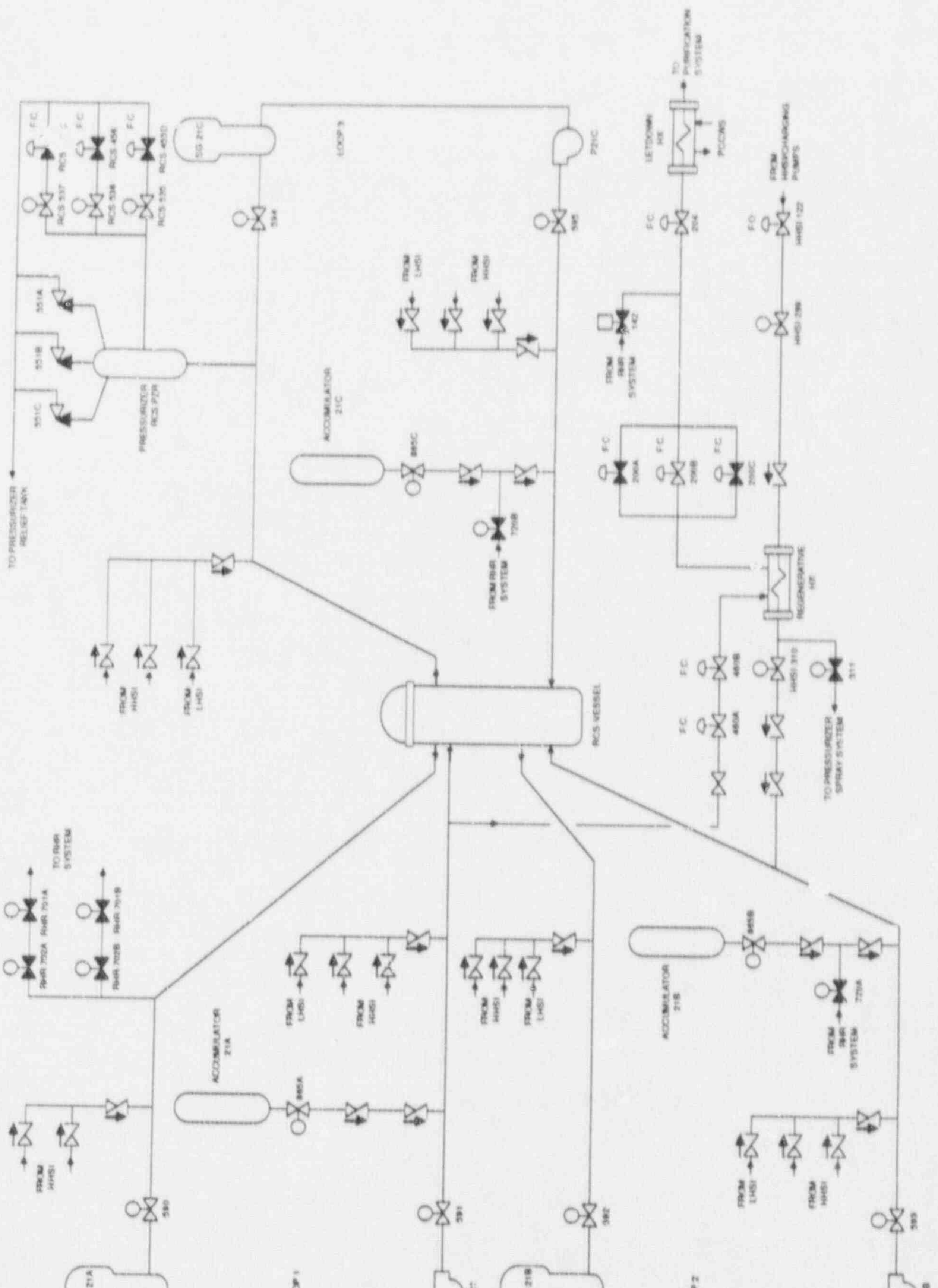



Figure 3.1-2. Beaver Valley 2 Reactor Coolant System

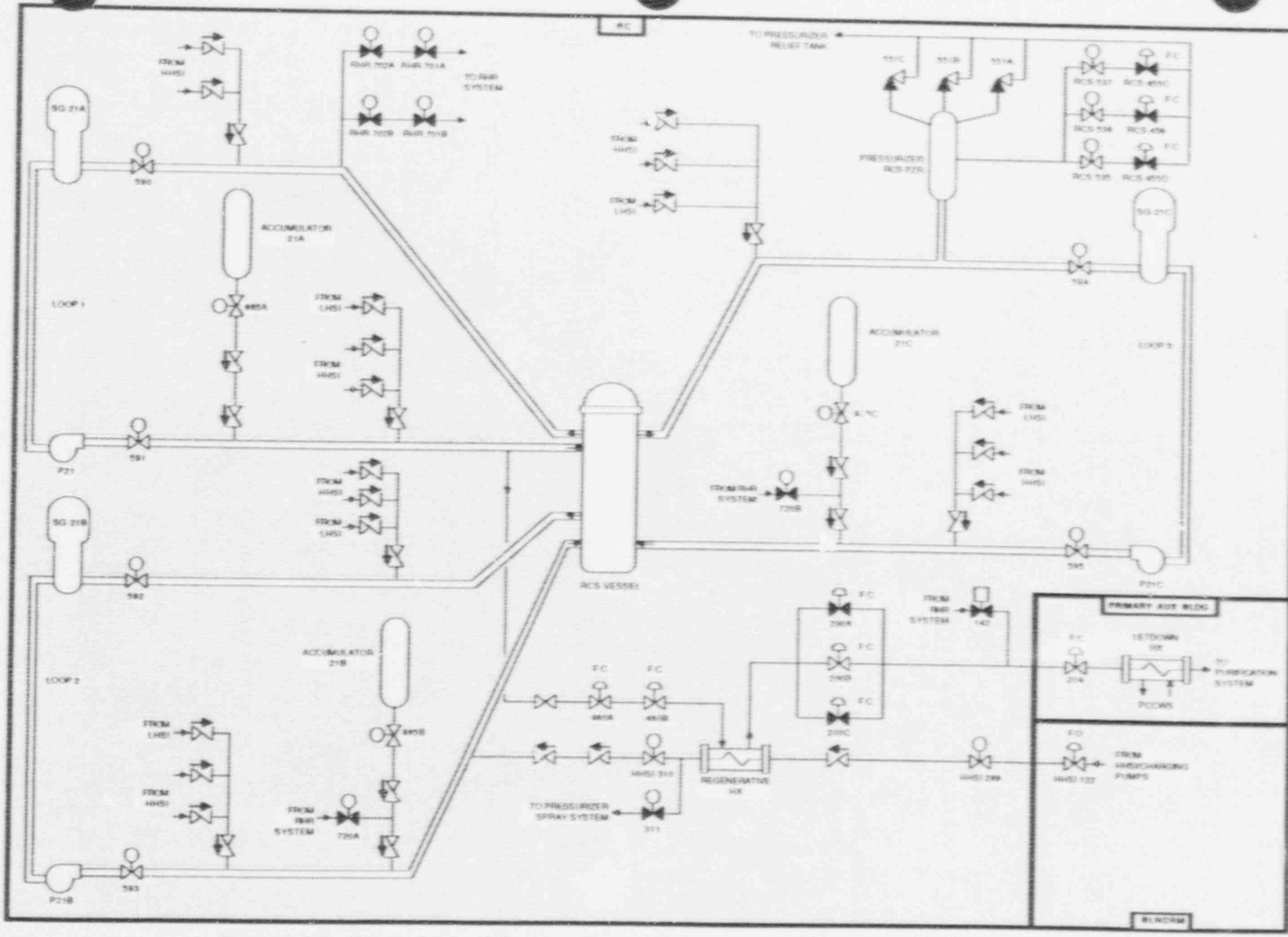



Figure 3.1-3. Beaver Valley 2 Reactor Coolant System Showing Component Locations

Table 3.1-1. Beaver Valley 2 Reactor Coolant System Data Summary for Selected Components

| COMPONENT ID | COMP. TYPE | LOCATION | POWER SOURCE | VOLT. E | POWER SOURCE LOCATION | EMERG. LOAD GRP. |
|---|---|---|---|---|---|---|
| RCS-455C | NV | RC | EP-BS-22 | 125 | ESWGRME | DC/2 |
| RCS-455D | NV | RC | EP-BS-21 | 125 | ESWGRMW | DC/1 |
| RCS-456 | NV | RC | EP-BS-21 | 125 | ESWGRMW | DC/1 |
| RCS-535 | MOV | RC | EP-MCC-E6 | 480 | 735ERCB | AC/B |
| RCS-536 | MOV | RC | EP-MCC-E5 | 480 | 735WRCB | AC/A |
| RCS-537 | MOV | RC | EP-MCC-E5 | 480 | 735WRCB | AC/A |
| RCS-PZR | HTR | RC | EP-BS-2N | 480 | ESWGRMW | AC/A |
| RCS-PZR | HTR | RC | EP-BS-2P | 480 | ESWGRME | AC/B |
| RCS-VESSEL | RV | RC | | | | |
| RHR-701A | MOV | RC | EP-MCC-E5 | 480 | 735WRCB | AC/A |
| RHR-701B | MOV | RC | EP-MCC-E5 | 480 | 735WRCB | AC/A |
| RHR-701B | MOV | RC | EP-MCC-E6 | 480 | 735ERCB | AC/B |
| RHR-702A | MOV | RC | EP-MCC-E5 | 480 | 735WRCB | AC/A |
| RHR-702A | MOV | RC | EP-MCC-E6 | 480 | 735ERCB | AC/B |
| RHR-702B | MOV | RC | EP-MCC-E6 | 480 | 735ERCB | 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.

### 3.2.2 System Definition

The AFWS consists of two motor-driven pumps and one steam turbine-driven pump that draw a suction on the primary plant demineralized water storage tank (PPDWST) and supply feedwater to all three steam generators. The turbine drive for the turbine-driven pump is supplied with steam from each of the steam generators. The AFWS also includes the associated piping and valves necessary to connect the PPDWST to pump suctions and pump discharges to the steam generators. All AFWS pumps can be aligned to take a suction on the service water system which serves as a secondary source for the AFWS.

The SSRS consists of five safety valves and one hydraulically operated atmospheric dump valve on each of the three main steam lines.

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. The motor-driven pumps are started on either a safety injection signal, a low-low level in two out of three steam generators, trip of the main feedwater pumps, failure of the turbine-driven AFWS pump, or a loss of offsite power. The turbine-driven pump will start on either a low-low level in any steam generator or an undervoltage on the reactor coolant pumps bus. The AFWS can also be started or shutdown remote-manually from the main control board or from the emergency shutdown panel.

The flow rate to each steam generator can be controlled remote manually from the main control board or emergency shutdown panel by modulating the appropriate flow control valve in the supply line. Downstream of the control valves, check valves are provided to prevent the loss of auxiliary feedwater in the event of an auxiliary feedwater header rupture. The turbine-driven pump is capable of supplying 700 gpm to the steam generators, and the two motor-driven pumps each have a design capacity of 375 gpm.

The PPDWST is the primary water source for the AFWS system and is reserved strictly for AFWS usage. The PPDWST inventory is sufficient to maintain the plant in a hot standby condition for nine hours following a reactor trip (Ref. 1). It is necessary to open manual valves in the auxiliary feedwater pump room in order to align the AFWS pumps to the backup water source, service water system header "B".

Steam for the AFWS turbine-driven pump is supplied from each of the three steam lines, upstream of the main steam isolation valves. The turbine steam supply valves are DC-powered. The steam supply valves are normally closed and receive a signal to open at the same time that the turbine pump actuation signal is initiated.

### 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:

- The turbine-driven pump or both motor-driven pumps can provide adequate flow to the steam generators.
- The PPDWST or the service water system is an adequate source of water for the AFWS pumps.
- Makeup to at least two steam generators provides adequate decay heat removal from the RCS.

### 3.2.5 Component Information

A. Mc or-driver AFWS pumps 23A, 23B
  1. Rated flow: 375 gpm @ 2760 ft. head (1197 psid)
  2. Rated capacity: 50%
  3. Type: Horizontal centrifugal

B. Turbine-driven AFWS pump 22
  1. Rated flow: 700 gpm @ 2760 ft. head (1197 psid)
  2. Rated capacity: 100%
  3. Type: Horizontal centrifugal

C. Primary Plant Demineralized Water Storage Tank
  1. Capacity: 140,000 gallons
  2. Reserved for AFWS use: 127,500 gallons

D. Atmospheric Dump Valves (3, 1 per line)
  1. Set pressure: Modulates to maintain a steamline pressure as determined from the main control room.
  2. Relief capacity: 26,200 lb/hr (each) @ 100 psia<br>890,000 lb/hr (each) @ 1,100 psia

### 3.2.6 Support Systems and Interfaces

A. Control Signals
  1. Automatic
     The AFWS motor-driven pumps are automatically actuated on either a safety injection signal, a low-low level in two out of three steam generators, trip of the main feedwater pumps, failure of the turbine-driven AFWS pump, or a loss of offsite power. The AFWS turbine-driven pump is automatically actuated on either a low-low level in any steam generator or an undervoltage on the reactor coolant pumps bus.
  2. Remote manual
     The AFWS can be operated from the main control board and from the emergency shutdown panel.

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

2. The turbine-driven pump is supplied with steam from the main steam lines of any of the three steam generators upstream of the main steam line isolation valves. The power and controls for the steam supply valves are supplied from the Class 1E DC system.

C. Other
1. Lubrication and cooling are assumed to be provided locally for the AFWS pumps.
2. AFWS pump room cooling is provided by the Safeguards Area Ventilation System which removes heat dissipated into the building from the equipment. This ventilation system consists of two identical systems: south safeguards area ventilation system and north safeguards area ventilation system. Each ventilation system consists of a room cooling unit with a fan and service water cooling coils. The fan is supplied from the Class 1E AC system.

### 3.2.7 Section 3.2 References

1. Beaver Valley 2 Final Safety Analysis Report, Section 10.4.9.1.

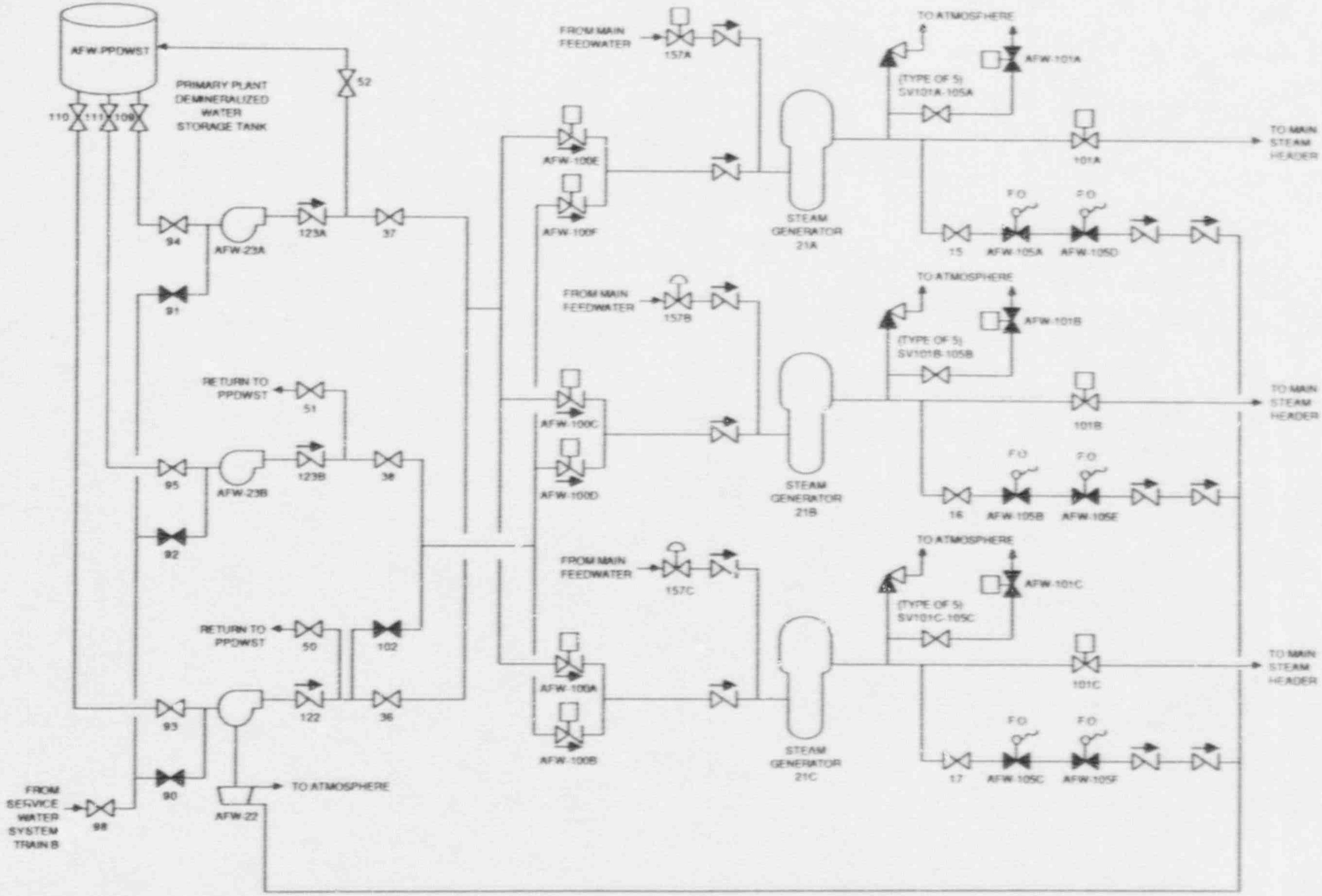



**Figure 3.2-1. Beaver Valley 2 Auxiliary Feedwater and Secondary Steam Relief Systems**

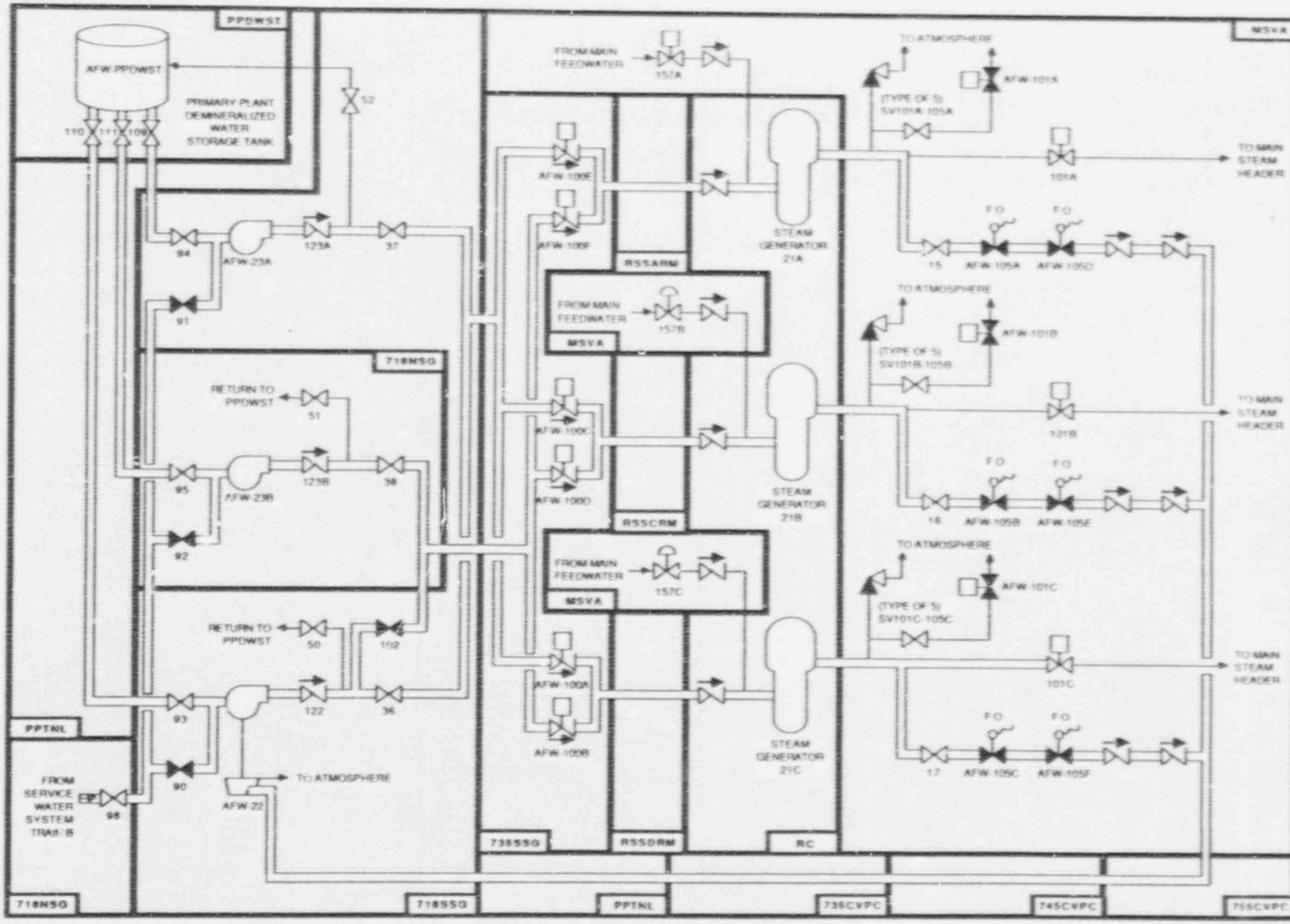


Figure 3.2-2. Beaver Valley 2 Auxiliary Feedwater and Secondary Steam Relief Systems Showing Component Locations

Table 3.2-1. Beaver Valley 2 Auxiliary Feedwater System Data Summary for Selected Components

| COMPONENT ID | COMP. TYPE | LOCATION | POWER SOURCE | VOLTAGE | POWER SOURCE LOCATION | EMERG. LOAD GRP. |
|---|---|---|---|---|---|---|
| AFW-100A | HV | 735SSG | EP-MCC-E13 | 480 | 735WRCB | AC/A |
| AFW-100B | HV | 735SSG | EP-MCC-E14 | 480 | 735ERCB | AC/B |
| AFW-100C | HV | 735SSG | EP-MCC-E13 | 480 | 735WRCB | AC/A |
| AFW-100D | HV | 735SSG | EP-MCC-E14 | 480 | 735ERCB | AC/B |
| AFW-100E | HV | 735SSG | EP-MCC-E13 | 480 | 735WRCB | AC/A |
| AFW-100F | HV | 735SSG | EP-MCC-E14 | 480 | 735ERCB | AC/B |
| AFW-105A | SOV | MSVA | EP-BS-21 | 125 | ESWGRMW | DC/1 |
| AFW-105B | SOV | MSVA | EP-BS-22 | 125 | ESWGRME | DC/2 |
| AFW-105C | SOV | MSVA | EP-BS-21 | 125 | ESWGRMW | DC/1 |
| AFW-105D | SOV | MSVA | EP-BS-22 | 125 | ESWGRME | DC/2 |
| AFW-105E | SOV | MSVA | EP-BS-21 | 125 | ESWGRMW | DC/1 |
| AFW-105F | SOV | MSVA | EP-BS-22 | 125 | ESWGRME | DC/2 |
| AFW-22 | TDP | 718SSG | | | | |
| AFW-23A | MDP | 718SSG | EP-BS-2AE | 4160 | ESWGRMW | AC/A |
| AFW-23B | MDP | 718NSG | EP-BS-2DF | 4160 | ESWGRME | AC/B |
| AFW-PPDWST | TK | PPDWST | | | | |
| SG-21A | SG | RC | | | | |
| SG-21B | SG | RC | | | | |
| SG-21C | SG | RC | | | | |

## 3.3 EMERGENCY CORE COOLING SYSTEM (ECCS)

### 3.3.1 System Function

The ECCS 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 system (see Section 3.4). A separate residual heat removal (RHR) system (not part of the low-head ECCS subsystem) provides for shutdown cooling of the RCS.

### 3.3.2 System Definition

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

- Safety Injection Accumulators
- High Head Safety Injection (HHSI)/Charging System
- Low Head Safety Injection (LHSI) System

The safety injection accumulators are pressure vessels, partially filled with borated water and pressurized with nitrogen gas, that discharge their contents into the RCS should RCS pressure fall below the accumulator pressure. One accumulator is attached to each of the three cold legs of the RCS. The high-head safety injection system utilizes the three centrifugal charging pumps of the charging system (CVCS) and feeds a common header which injects directly into the RCS cold legs and hot legs. There are no separate high-head injection pumps. It should be noted that the third charging pump (HHSI-P21C) is an installed spare. The low-head safety injection system consists of two motor-driven pumps which deliver water to the three RCS cold legs and to two RCS hot legs. The Refueling Water Storage Tank (RWST) is the water source for the high and low head safety injection systems

The recirculation spray pumps, part of the containment heat removal system, provide containment spray during the injection phase and also provide for ECCS recirculation during the recirculation phase. Two of four recirculation spray trains (trains C and D) are automatically realigned to the LHSI when the RWST reaches a predetermined low level setpoint. In the recirculation mode, these two recirculation spray pumps provide water directly to the RCS via the LHSI system, as well as to the suction of the HHSI/charging pumps for high-pressure recirculation. The recirculation spray system is discussed in Section 3.4.

Simplified drawings of the low-head safety injection system are shown in Figures 3.3-1 to 3.3-3. The high-head safety injection system is shown in Figures 3.3-4 to 3.3-6. Interfaces between the accumulators, the ECCS, and the RCS are shown in Section 3.1. A summary of data on selected ECCS components is presented in Table 3.3-1. Operation of the centrifugal charging pumps in the normal charging role is discussed in Section 3.9.

### 3.3.3 System Operation

During normal operation, the ECCS is in standby. The ECCS pumps are automatically actuated by a Safety Injection Signal which is generated on any of the following conditions:

- Low pressurizer pressure
- Low steam line pressure in one line
- High containment pressure
- Manual actuation from the main control board

The accumulators constitute a passive injection system, discharging their contents automatically when RCS pressure drops below the tank pressure. Sufficient borated water is supplied in the three tanks to rapidly fill the volume outside of the core barrel below the nozzles, the bottom plenum, and a portion of the core with the contents of one tank assumed to be lost through the break. During injection, the LHSI and HHSI/Charging pumps take suction on the RWST and deliver borated water to the RCS. The relative importance of the HHSI/Charging pumps is increased for small breaks when the RCS is still at high pressure, while the LHSI pumps are important in responding to large breaks.

Transfer from injection to cold leg recirculation is initiated automatically when the RWST reaches a predetermined low level setpoint. Only limited operator actions, such as opening or closing specific valves, are required to complete the transfer. In the recirculation mode the LHSI pumps are stopped, and two of the four recirculation spray pumps are aligned to deliver water from the containment sump to the RCS via the LHSI system (i.e., for low pressure recirculation) or to the suction of the HHSI/charging pumps (i.e., for high-pressure recirculation). Decay heat is transferred to the ultimate heat sink (service water system) via heat exchangers in the recirculation spray system. Later, the recirculation spray pumps are realigned manually to hot leg recirculation for long-term cooling.

### 3.3.4 System Success Criteria

LOCA mitigation requires that both the emergency coolant injection and emergency coolant recirculation (ECR) functions be accomplished. The ECI success criteria for a large LOCA are the following (Ref. 1):

- 2 of 3 safety injection accumulators provide makeup as RCS pressure drops below tank pressure, and
- 1 of 3 high-head safety injection/charging pumps takes a suction on the RWST and delivers water to the RCS, and
- 1 of 2 low-head safety injection pumps takes a suction on the RWST and delivers water to the RCS

If the large LOCA ECI success criteria are met, then the following large LOCA ECR success criteria will apply (Ref. 1):

- the successful establishment of at least one pumping path from the containment sump to an RSS pump to the RCS.

For small LOCAs that do not result in RCS depressurization below the LHSI pump shutoff head, the HHSI/charging pumps are required. The ECI success criteria for a small LOCA are the following:

- 1 of 3 high-head safety injection/charging pumps takes a suction on the RWST and delivers water to the RCS.

If the small LOCA ECI success criteria are met, then the following small LOCA ECR success criteria will apply:

- The successful establishment of at least one tandem pumping path from the containment sump to an RSS pump to one HHSI/charging pump to the RCS.

The RCS can be depressurized by the following means if the LHSI pumps are to provide makeup following a small LOCA:

- RCS cooldown (i.e., using the AFWS, see Section 3.2)
- Opening the power-operated relief valves on the pressurizer (three PORVs are available, see Section 3.1)

### 3.3.5 Component Information

A. Low-Head Safety Injection pumps P21A, P21B
   1. Rated flow: 3000 gpm @ 225 ft. head (97.6 psid)
   2. Rated capacity: 100%
   3. Type: horizontal centrifugal

B. High-Head Safety Injection/Charging Pumps P21A, P21B, P21C
   1. Rated flow: 150 gpm @ 5800 ft. head (2515 psid)
   2. Rated capacity: 100%
   3. Type: vertical centrifugal

C. Accumulators (3)
   1. Total accumulator volume: 1450 $ft^3$
   2. Nominal water volume: 925 $ft^3$
   3. Nominal operating pressure: 640 psig
   4. Nominal boron concentration: 1900 ppm

D. Refueling Water Storage Tank
   1. Capacity: 850,000 gallons
   2. Design pressure: atmospheric
   3. Nominal boron concentration: 2000 ppm

### 3.3.6 Support Systems and Interfaces

A. Control signals
   1. Automatic
      a. The ECCS subsystems are automatically actuated on any of the following safety injection signals:
         - Low pressurizer pressure
         - Low steam line pressure in one line
         - High containment pressure
         - Manual actuation from the main control board

      b. The SIS initiates the following actions:
         - reactor trip
         - starts the diesel generators
         - starts the HHSI/charging and LHSI pumps
         - opens the RWST to HHSI/charging pump isolation valves
         - opens the HHSI/charging pump to RCS cold legs isolation valves
         - closes the normal charging line isolation valves

c. The RWST is provided with level alarms to indicate that the useable volume of the RWST has been exhausted. Four transmitters (four channels) are provided to automatically actuate the ECCS and containment spray system switchover from injection mode to recirculation mode.

2. Remote manual
A safety injection signal can be initiated by remote-manual means from the main control board in the control room. The transition from the injection phase to the recirculation phase of ECCS operation requires limited remote manual actions.

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. Cooling for the HHSI/charging pumps is provided by the Service Water System (see Section 3.7).
2. Cooling for the LHSI pumps is assumed to be provided locally.
3. Pump lubrication is assumed to be provided locally
4. LHSI pump room cooling is provided by the Safeguards Area Ventilation System. See Section 3.2 for details.
5. HHSI pump room cooling is provided by the Auxiliary Building Ventilation System. Normally-operating portions of this system are not required to operate during accident conditions.

### 3.3.7 Section 3.3 References

1. Beaver Valley 2 Final Safety Analysis Report, Section 6.3.2.

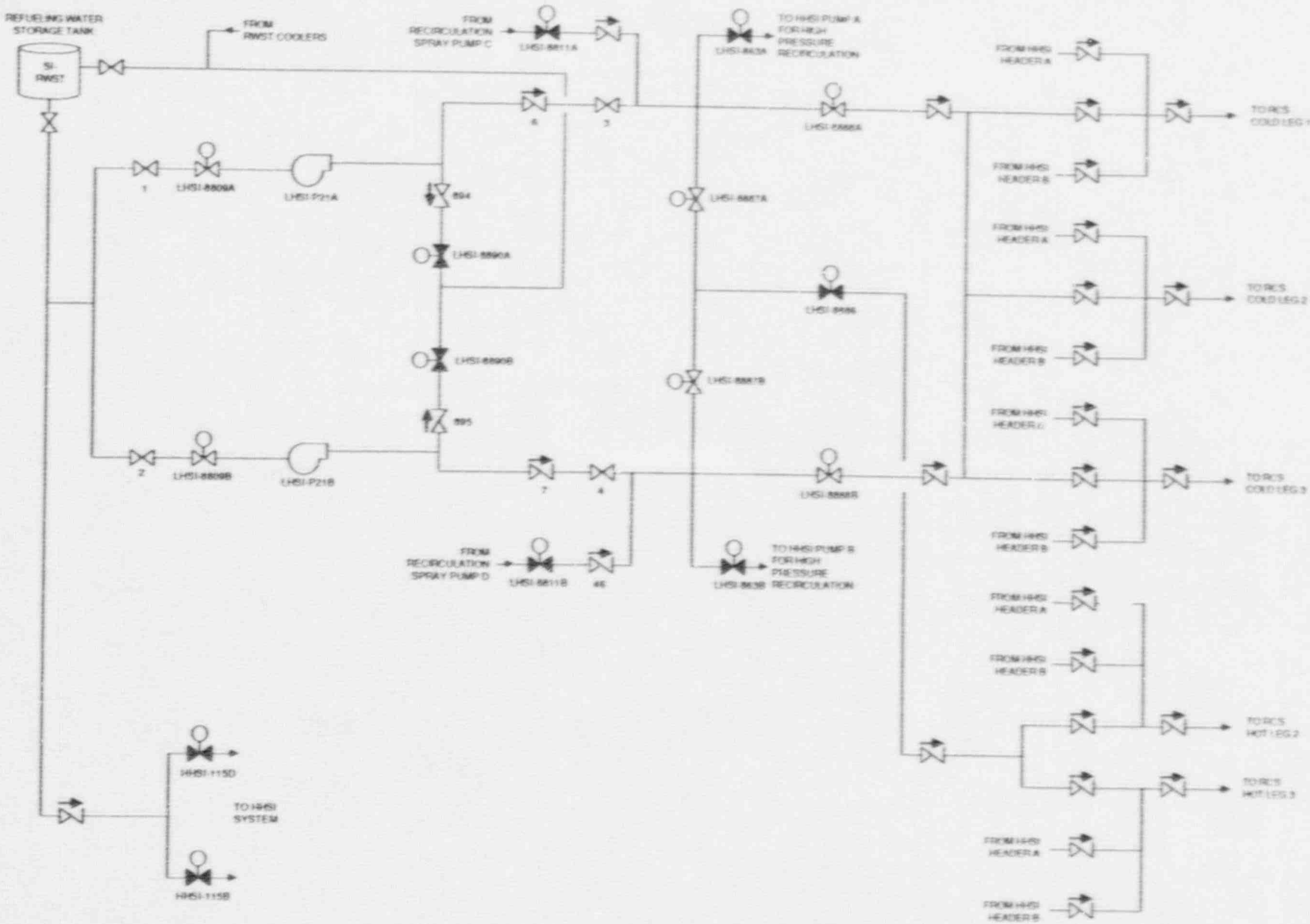



Figure 3.3-1. Beaver Valley 2 Low Head Safety Injection System

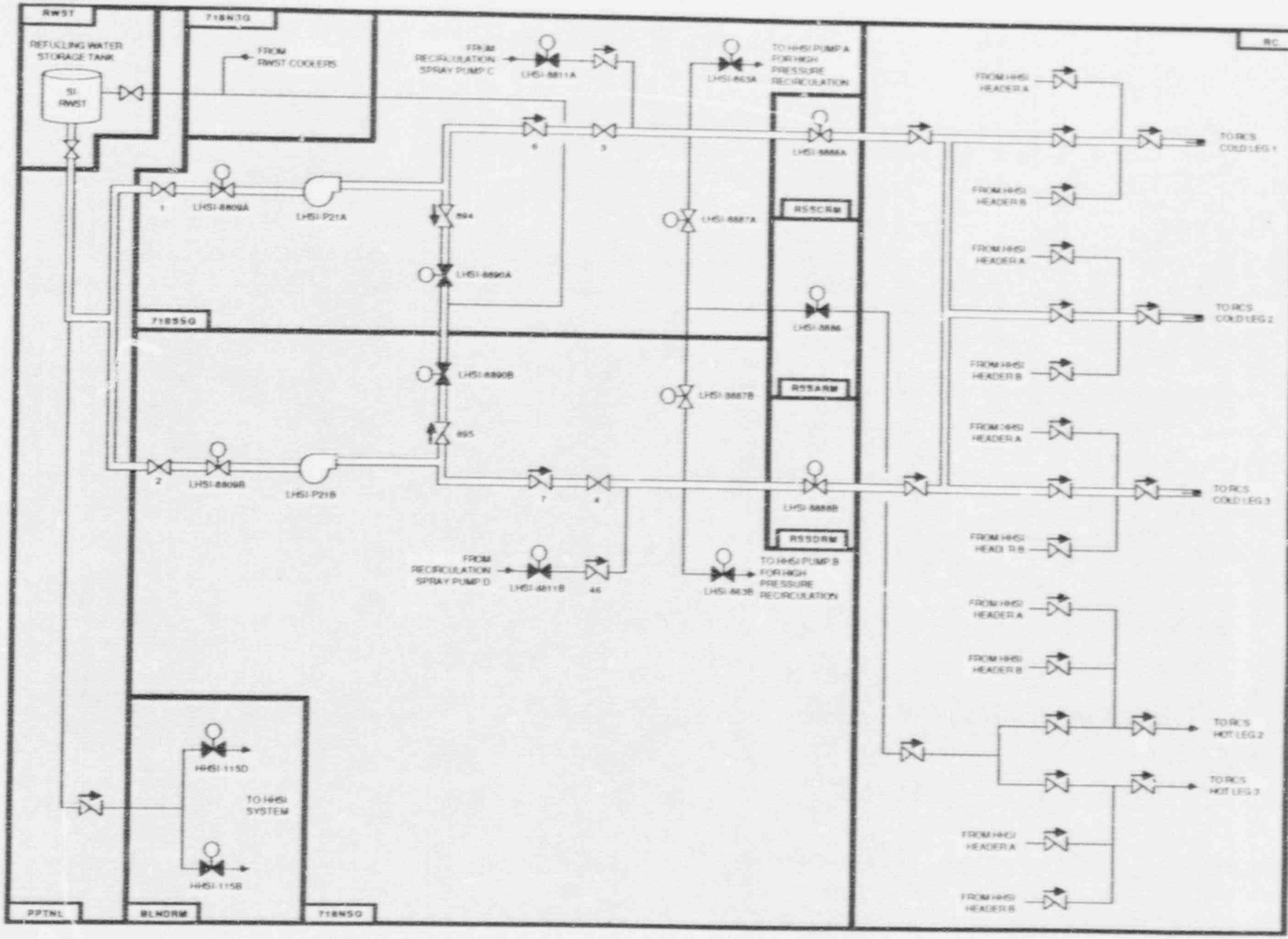



Figure 3.3-2. Beaver Valley 2 Low Head Safety Injection System (ECCS Injection Mode) Showing Component Locations

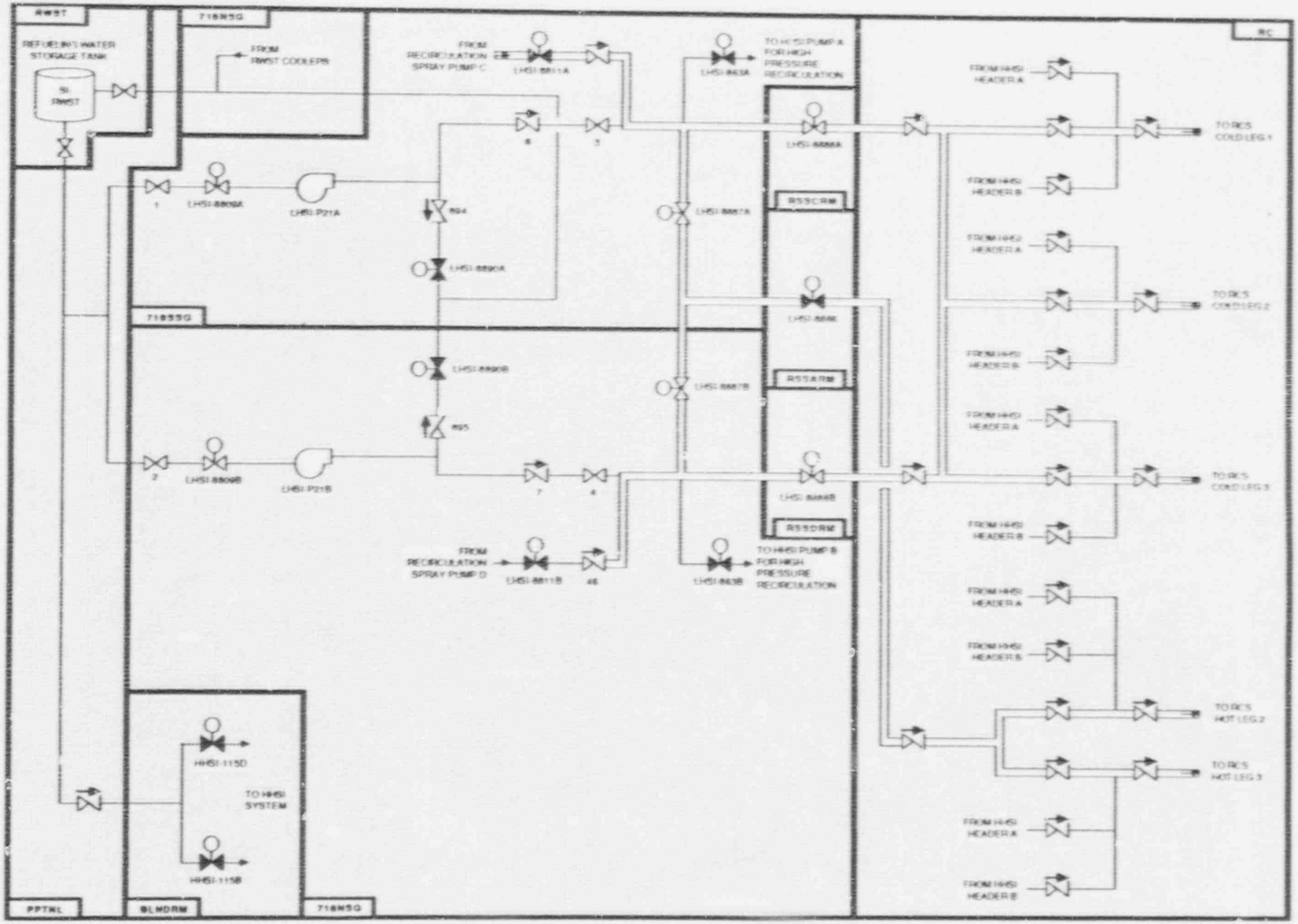



Figure 3.3-3. Beaver Valley 2 Low Head Safety Injection System (ECCS Recirculation Mode) Showing Component Locations

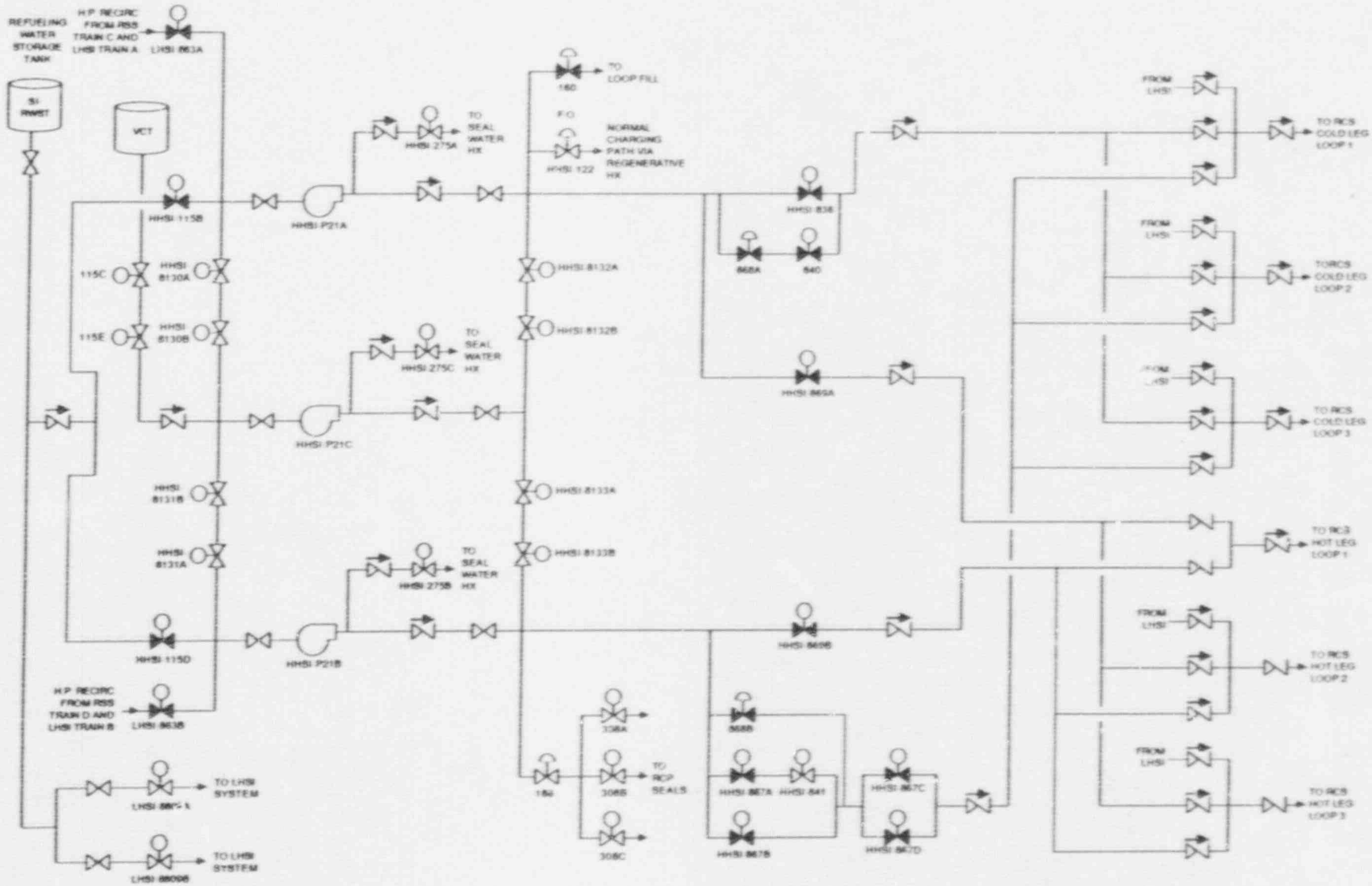



Figure 3.3-4. Beaver Valley 2 High Head Safety Injection (Charging) System

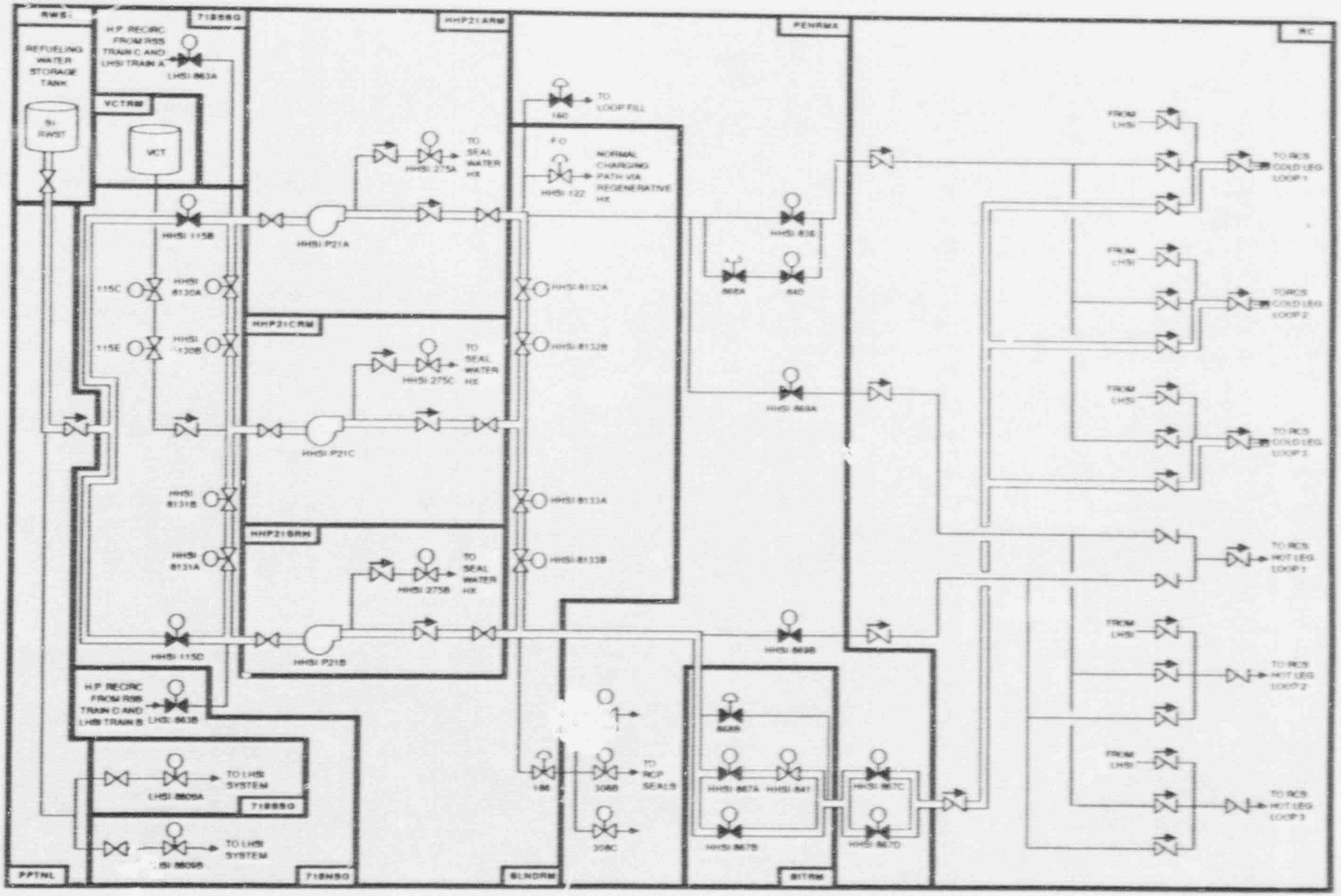



Figure 3.3-5. Beaver Valley 2 High Head Safety Injection (Charging) System (ECCS Injection Mode) Showing Component Locations

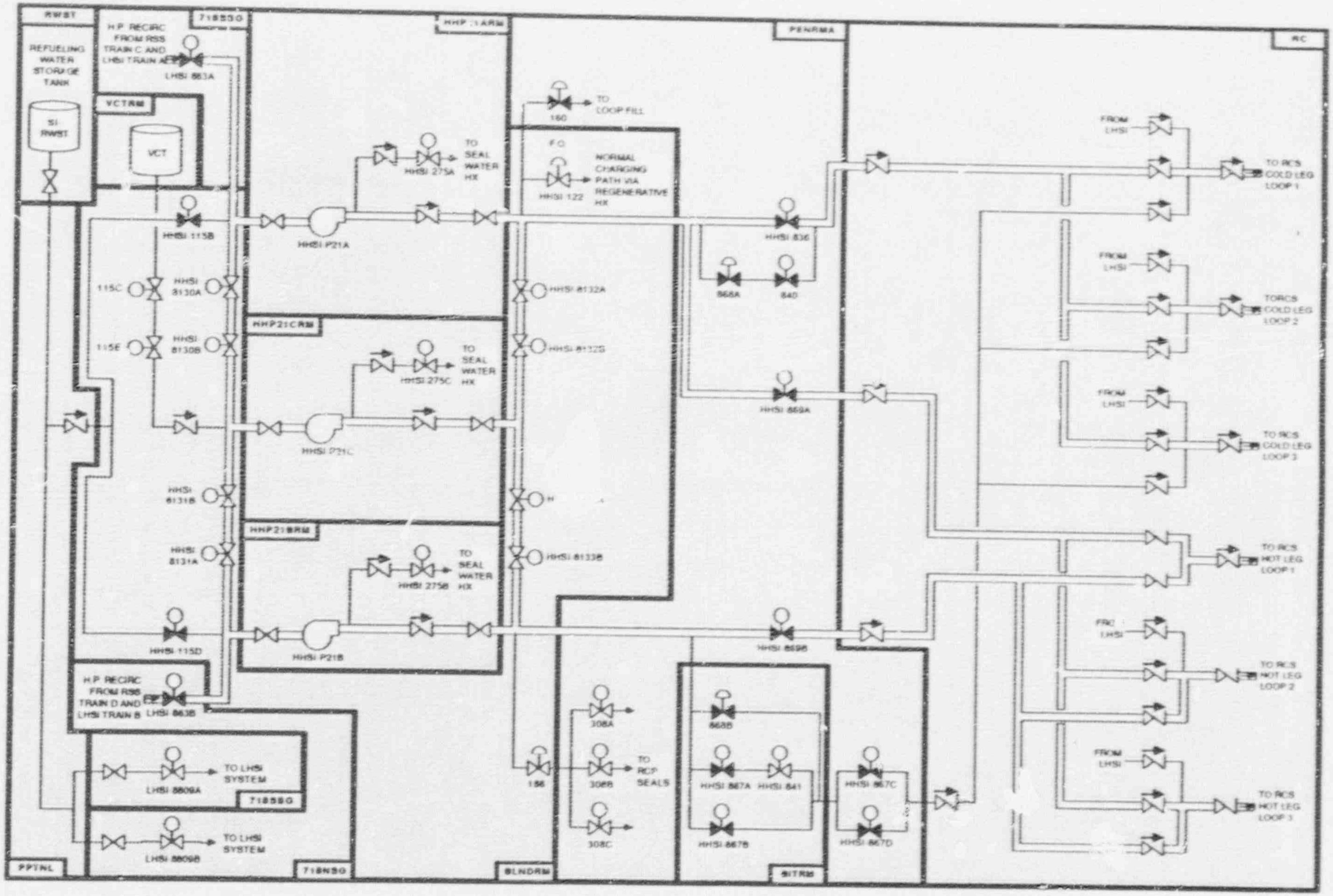



Figure 3.3-6. Beaver Valley 2 High Pressure Safety Injection (Charging) System (ECCS High Pressure Recirculation Mode) Showing Component Locations

## Table 3.3-1. Beaver Valley 2 Emergency Core Cooling System Data Summary for Selected Components

| COMPONENT ID | COMP. TYPE | LOCATION | POWER SOURCE | VOLTAGE | POWER SOURCE LOCATION | EMERG. LOAD GRP. |
|---|---|---|---|---|---|---|
| HHSI-115B | MOV | BLNDRM | EP-MCC-E3 | | 755PAB | AC/A |
| HHSI-115B | MOV | BLNDRM | EP-MCC-E3 | 480 | 755PAB | AC/A |
| HHSI-115D | MOV | BLNDRM | EP-MCC-E4 | 480 | 755PAB | AC/B |
| HHSI-115D | MOV | BLNDRM | EP-MCC-E4 | 480 | 755PAB | AC/B |
| HHSI-122 | AOV | BLNDRM | | | | |
| HHSI-259 | MOV | RC | EP-MCC-E5 | 480 | 735WRCB | AC/A |
| HHSI-275A | MOV | HHP21ARM | EP-MCC-E3 | 480 | 755PAB | AC/A |
| HHSI-275B | MOV | HHP21BRM | EP-MCC-E3 | 480 | 755PAB | AC/A |
| HHSI-275C | MOV | HHP21CRM | EP-MCC-[illegible] | 480 | 755PAB | AC/A |
| HHSI-310 | MOV | RC | EP-MCC-E6 | 480 | 735ER[illegible] | AC/B |
| HHSI-8130A | MOV | BLNDRM | EP-MCC-E3 | 480 | 755PAB | AC/A |
| HHSI-8130B | MOV | BLNDRM | EP-MCC-E4 | 480 | 755PAB | AC/B |
| HHSI-8131B | MOV | BLNDRM | EP-MCC-E4 | 480 | 755PAB | AC/B |
| HHSI-8132A | MOV | BLNDRM | EP-MCC-E3 | 480 | 755PAB | AC/A |
| HHSI-8132B | MOV | BLNDRM | EP-MCC-E4 | 480 | 755PAB | AC/B |
| HHSI-8133A | MOV | BLNDRM | EP-MCC-E3 | 480 | 755PAB | AC/A |
| HHSI-8133B | MOV | BLNDRM | EP-MCC-E4 | 480 | 755PAB | AC/B |
| HHSI-813A | MOV | BLNDRM | EP-MCC-E3 | 480 | 755PAB | AC/A |
| HHSI-836 | MOV | PENRMA | EP-MCC-E5 | 480 | 735WRCB | AC/A |
| HHSI-841 | MOV | BITRM | EP-MCC-E4 | 480 | 755PAB | AC/B |
| HHSI-867A | MOV | BITRM | EP-MCC-E3 | 480 | 755PAB | AC/A |
| HHSI-867B | MOV | BITRM | EP-MCC-E4 | 480 | 755PAB | AC/B |
| HHSI-867C | MOV | PENRMA | EP-MCC-E5 | 480 | 735WRCB | AC/A |
| HHSI-867D | MOV | PENRMA | EP-MCC-E6 | 480 | 735ERCB | AC/B |
| HHSI-869A | MOV | PENRMA | EP-MCC-E5 | 480 | 735WRCB | AC/A |
| HHSI-869B | MOV | PENRMA | EP-MCC-E6 | 480 | 735ERCB | AC/B |
| HHSI-P21A | MDP | HHP21ARM | EP-BS-2AE | 4160 | ESWGRMW | AC/A |
| HHSI-P21B | MDP | HHP21BRM | EP-BS-2DF | 4160 | ESWGRME | AC/B |

Table 3.3-1. Beaver Valley 2 Emergency Core Cooling System Data Summary for Selected Components (Continued)

| COMPONENT ID | COMP. TYPE | LOCATION | POWER SOURCE | VOLTAGE | POWER SOURCE LOCATION | EMERG. LOAD GRP. |
|---|---|---|---|---|---|---|
| HHSI-P21C | MDP | HHP21CRM | EP-BS-2AE | 4160 | ESWGRMW | AC/A |
| HHSI-P21C | MDP | HHP21CRM | EP-BS-2DF | 4160 | ESWGRME | AC/A |
| LHSI-863A | MOV | 718SSG | EP-MCC-E11 | 480 | 735SSG | AC/A |
| LHSI-863A | MOV | 718SSG | EP-MCC-E11 | 480 | 735SSG | AC/A |
| LHSI-863B | MOV | 718NSG | EP-MCC-E12 | 480 | 735NSG | AC/B |
| LHSI-863B | MOV | 718NSG | EP-MCC-E12 | 480 | 735NSG | AC/B |
| LHSI-8811A | MOV | 718SSG | EP-MCC-E11 | 480 | 735SSG | AC/A |
| LHSI-8811B | MOV | 718NSG | EP-MCC-E12 | 480 | 735NSG | AC/B |
| LHSI 887B | MOV | 718NSG | [illegible]-MCC-E12 | 480 | 73[illegible]NSG | AC/B |
| LHSI-8887A | MOV | 718SSG | [illegible]MCC-E11 | 480 | 735SSG | AC/A |
| SI-RWST | TK | RWST | | | | |

## 3.4 CONTAINMENT COOLING SYSTEMS

### 3.4.1 System Function

The Containment Ventilation System provides for normal containment cooling. The Containment Heat Removal System (CHRS), which is also called the containment depressurization system, is an integrated set of subsystems that provide the functions of containment heat removal and containment pressure control following a loss of coolant accident. In conjunction with the ECCS, the CHRS completes the post-LOCA heat transfer path from the reactor core to the ultimate heat sink.

### 3.4.2 System Definition

The Containment Ventilation System consists of two separate subsystems:

- Containment Atmosphere Recirculation System
- Containment Atmosphere Filtration System

The atmosphere recirculation system is a non-safety system consisting of three fan cooler units and distribution ductwork that provides for containment temperature control during normal conditions and following a loss of offsite power. The atmosphere filtration subsystem performs an air cleanup function.

The CHRS consists of two separate subsystems:

- Quench Spray System (QSS)
- Recirculation Spray System (RSS)

The QSS consists of two parallel redundant trains, each consisting of one horizontal centrifugal pump which draws suction from the Refueling Water Storage Tank (RWST). The two trains connect the two common 360 degree spray headers inside the containment. The RSS consists of two 360-degree spray headers and four pumps and heat exchangers. The two redundant recirculation spray pumps, that are connected to the same spray ring headers, are supplied with emergency power from separate emergency diesel generators. The four RSS pumps take suction from a common containment sump.

Simplified drawings of the Quench Spray System are shown in Figures 3.4-1 and 3.4-2, and simplified drawings of the Recirculation Spray System are shown in Figures 3.4-3 to 3.4-5. The interface between the RSS heat exchangers and the service water system (SWS) is shown on the SWS drawings in Section 3.7. A summary of data on selected containment cooling components is presented in Table 3.4-1.

### 3.4.3 System Operation

During normal operation, containment cooling is provided by the fan cooler units in the containment atmosphere recirculation system which is a subsystem of the containment ventilation system. The containment atmosphere recirculation system maintains containment air temperature less than 105°F during normal operations and less than 135°F following a loss of offsite power.

The QSS and RSS are in standby during normal operation. The QSS pumps are activated after receipt of a containment isolation phase B (CIB) signal and are effective approximately 90 seconds after a design basis LOCA. Each QSS pump operating alone is capable of supplying approximately 3,000 gpm of spray to the QSS headers. Quench spray operation is terminated when RWST level drops to a prescribed low level setpoint.

The RSS pumps are automatically started approximately ten minutes after receipt of a CIB signal and the spray becomes effective approximately twelve minutes after the CIB signal. When the water in the RWST has reached a predetermined extreme low level, two of the four RSS trains (trains C and D) are automatically switched from the spray recirculation mode to the ECCS cold leg recirculation mode, as discussed in Section 3.3. The remaining two RSS trains continue performing their recirculation spray function. In all RSS trains the recirculation water flows through recirculation coolers, where it is cooled by service water.

The QSS, together with the RSS, are capable of reducing the containment pressure to subatmospheric in less than 60 minutes following a loss of coolant accident, thus terminating all outleakage from the containment to the environment under any combination of credible events.

### 3.4.4 System Success Criteria

Two of three containment air recirculation units are required to maintain containment temperature less than 105°F during normal operation (Ref. 1).

The success criteria for the post-accident containment heat removal function is not clearly defined in the Beaver Valley 2 FSAR (Ref. 2). It appears that this function can be accomplished by the combined operation of one train of quench spray and one recirculation spray pump drawing a suction on the containment sump and recirculating water through its respective heat exchanger and then to the spray ring header. The success criteria for emergency coolant recirculation (ECR) is described in Section 3.3.

### 3.4.5 Component Information

A. Containment Air Recirculation Unit (3)
   1. Rated flow: 150,000 cfm/fan
   2. Rated capacity: 50% (based on normal containment heat loads)

B. Recirculation Spray System Pumps P21A, P21B, P21C, P21D
   1. Rated flow: 3500 gpm @ 266 ft. head (115 psid)
   2. Rated capacity: 100%
   3. Type: vertical centrifugal

C. Quench Spray System Pumps P21A, P21B
   1. Rated flow: 3000 gpm @ 300 ft. head (130 psid)
   2. Rated capacity: 100%
   3. Type: horizontal centrifugal

D. Recirculation Heat Exchangers (4)
   1. Design duty: 1.43 x $10^6$ Btu/hr (each)
   2. Type: shell and tube

E. Refueling Water Storage Tank
   1. Capacity: 850,000 gallons
   2. Pressure: atmospheric
   3. Nominal boron concentration: 2000 ppm

### 3.4.6 Support Systems and Interfaces

A. Control Signals
   1. Automatic
      a. The containment air recirculation units are automatically tripped by a safety injection (SI) signal.
      b. The QSS pumps are automatically actuated by a Hi-3 containment pressure signal (containment isolation phase B, CIB).

c. The RSS pumps are automatically actuated approximately ten minutes after a CIB signal.
d. An RWST low water level signal automatically terminates QSS operation and realigns two of four RSS pumps to perform the ECCS cold leg recirculation function.

2. Remote manual
The QSS and RSS can be actuated by remote manual means from the main control board in the control room.

B. Motive Power
1. The containment air recirculation units are supplied from the Class 1E buses.
2. The QSS and RSS 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. Redundant loads are supplied from separate load groups.

C. Cooling Water
1. The containment recirculation units are cooled by the chilled water system during normal operation. These units also can be cooled by the Service Water System (see Section 3.7).
2. The RSS heat exchangers are cooled by the Service Water System (see Section 3.7).

D. Other
1. Lubrication and pump cooling are assumed to be provided locally for the QSS and RSS pumps.
2. QSS and RSS pump room cooling is provided by the Safeguards Area Ventilation System.

### 3.4.7 Section 3.4 References

1. Beaver Valley 2 Final Safety Analysis Report, Section 9.4.7.1.3.
2. Beaver Valley 2 Final Safety Analysis Report, Section 6.2.2.2.

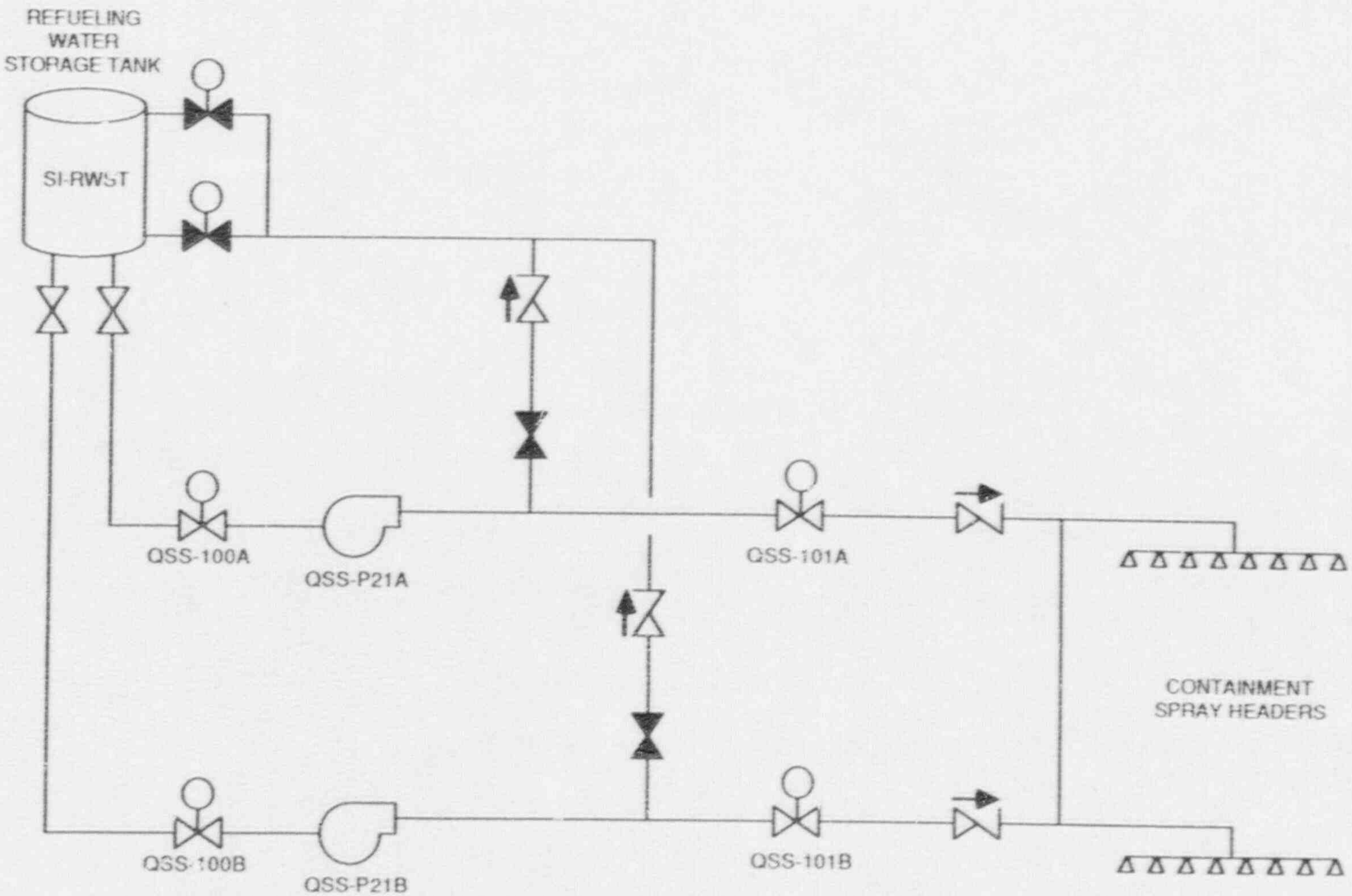



**Figure 3.4-1. Beaver Valley 2 Quench Spray System**

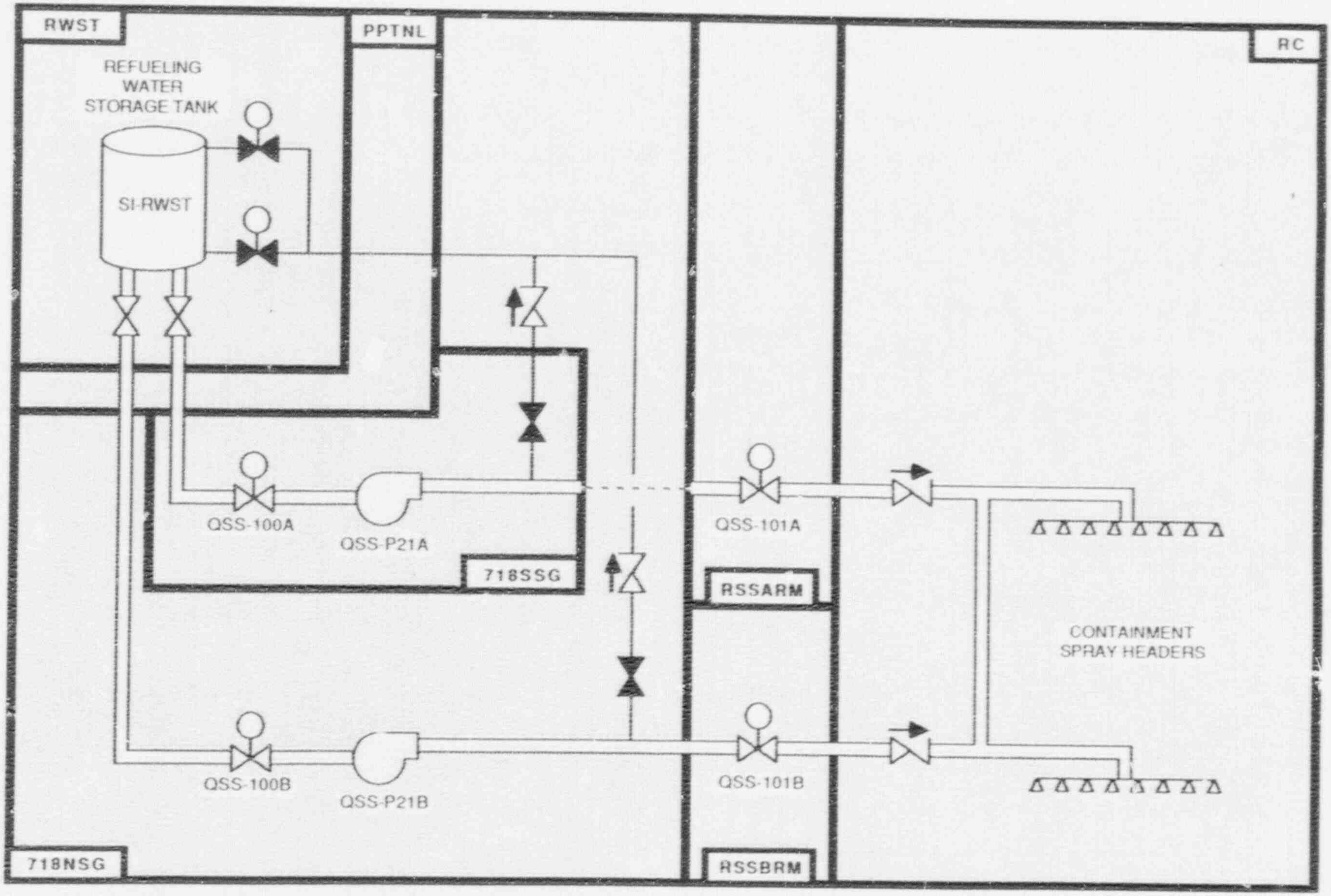



Figure 3.4-2. Beaver Valley 2 Quench Spray System Showing Component Locations

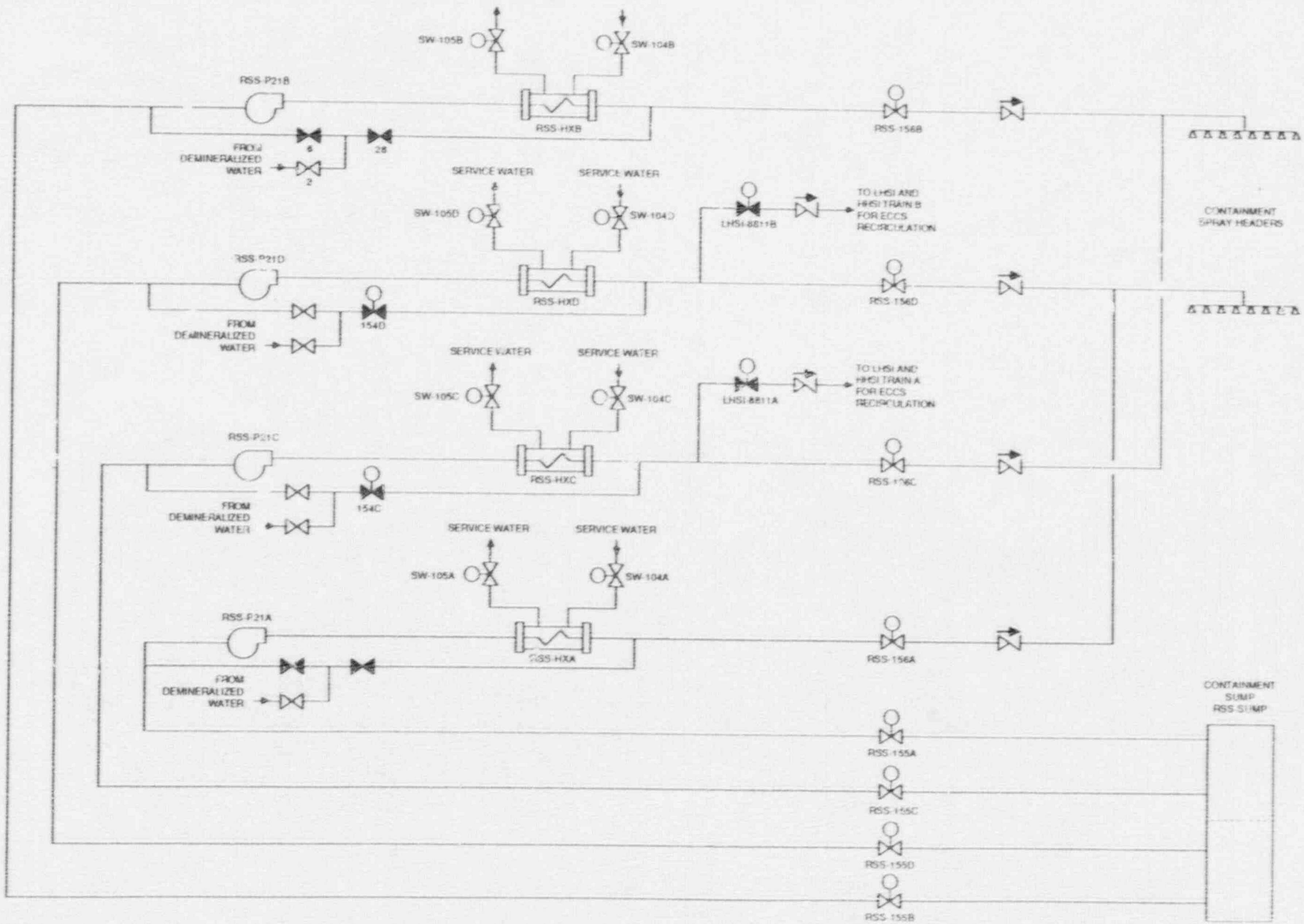



**Figure 3.4-3. Beaver Valley 2 Recirculation Spray System**

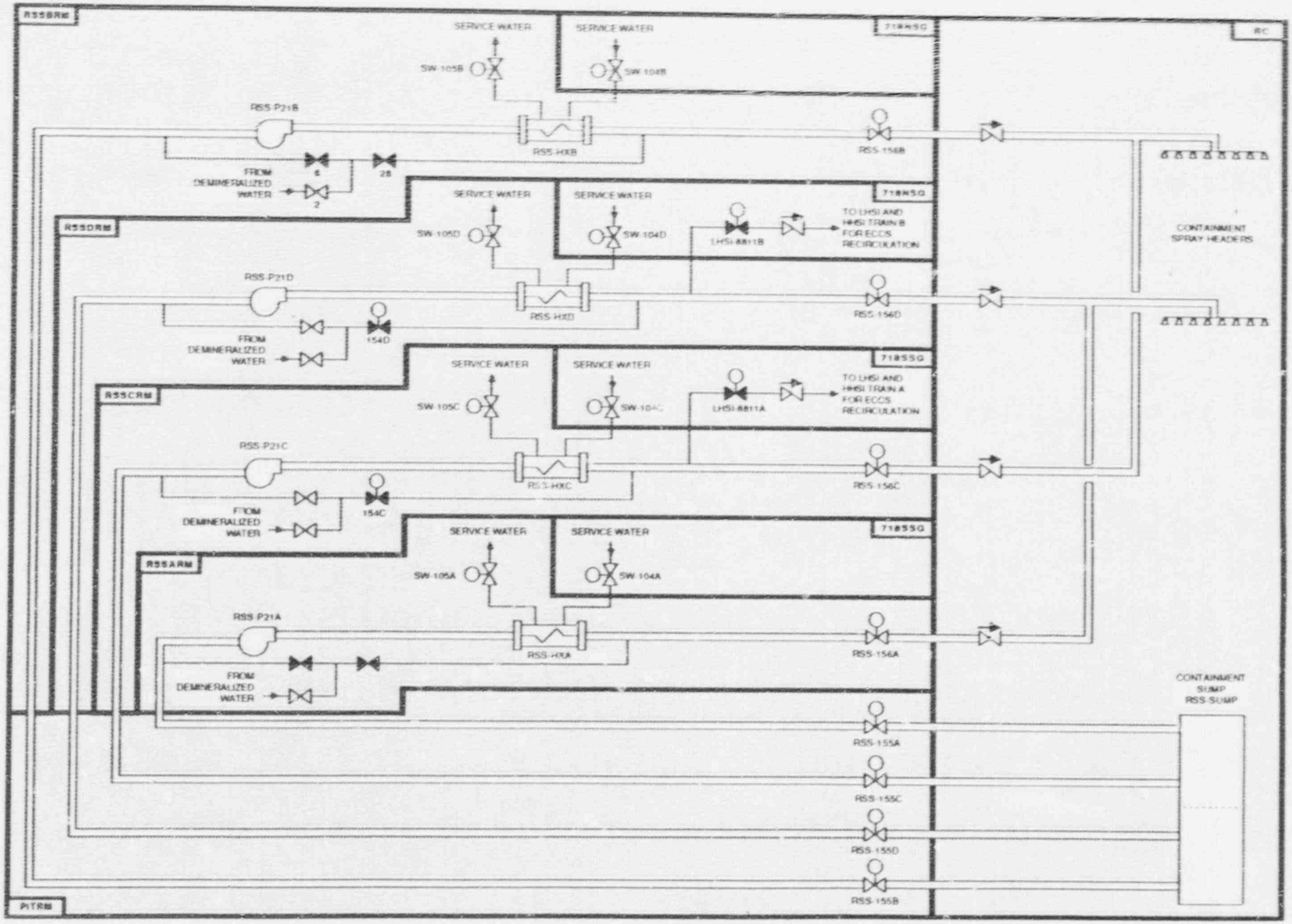



**Figure 3.4-4. Beaver Valley 2 Recirculation Spray System (Initial Spray Recirculation Mode) Showing Component Locations**

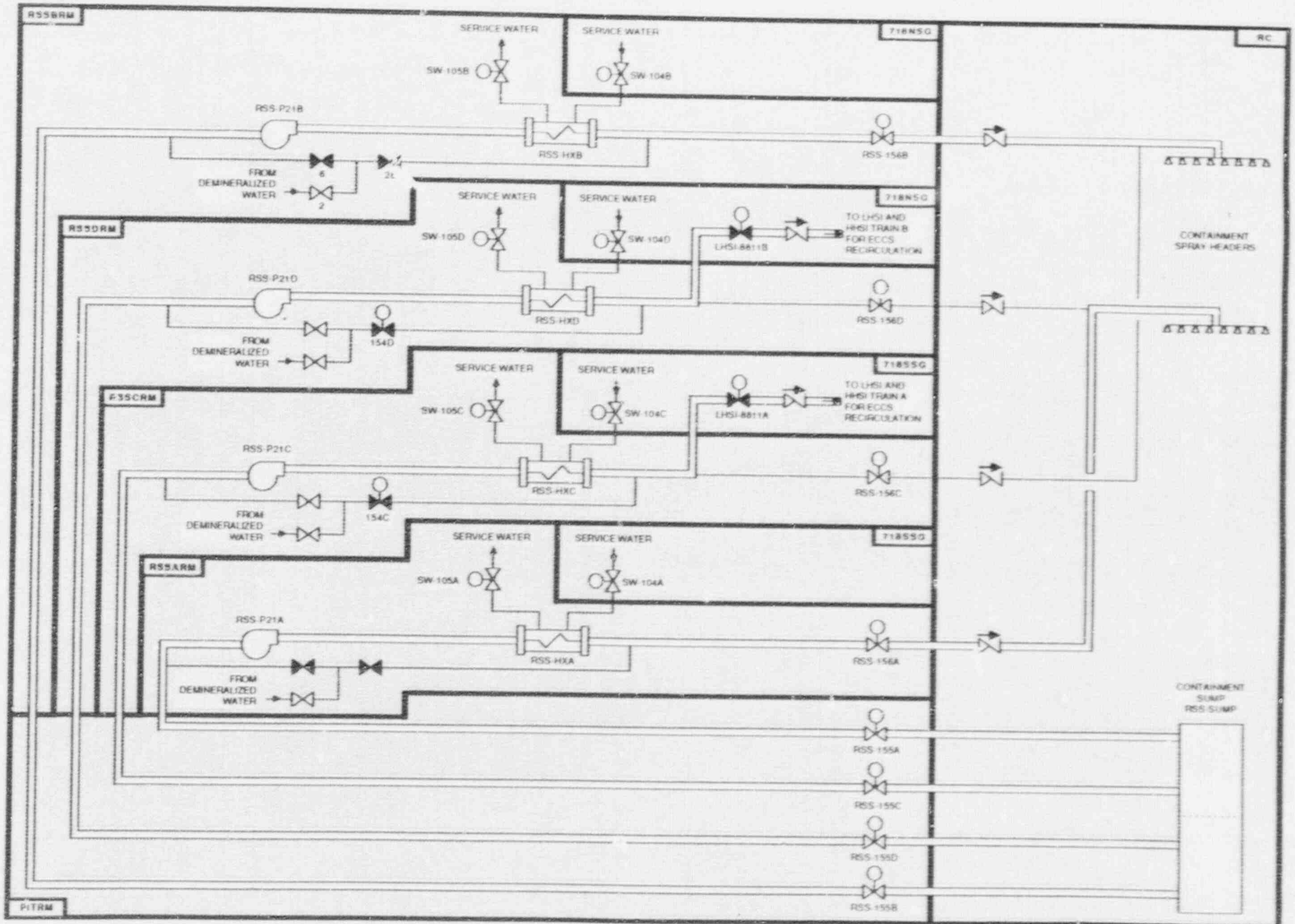



Figure 3.4-5. Beaver Valley 2 Recirculation Spray System (Spray and ECCS Recirculation Mode) Showing Component Locations

Table 3.4-1. Beaver Valley 2 Containment Heat Removal System Data Summary for Selected Components

| COMPONENT ID | COMP. TYPE | LOCATION | POWER SOURCE | VOLTAGE | POWER SOURCE LOCATION | EMERG. LOAD GRP. |
|---|---|---|---|---|---|---|
| QSS-100A | MOV | 718SSG | EP-MCC-E11 | 480 | 735SSG | AC/A |
| QSS-100B | MOV | 718NSG | EP-MCC-E12 | 480 | 735NSG | AC/B |
| QSS-101A | MOV | RSSARM | EP-MCC-E11 | 480 | 735SSG | AC/A |
| QSS-101B | MOV | RSSBRM | EP-MCC-E12 | 480 | 735NSG | AC/B |
| QSS-P21A | MDP | 718SSG | EP-BS-2AE | 4160 | ESWGRMW | AC/A |
| QSS-P21B | MDP | 718NSG | EP-BS-2DF | 4160 | ESWGRME | AC/B |
| RSS-155A | MOV | PITRM | EP-MCC-E11 | 480 | 735SSG | AC/A |
| RSS-155B | MOV | PITRM | EP-MCC-E12 | 480 | 735NSG | AC/B |
| RSS-155C | MOV | PITRM | EP-MC-E11 | 480 | 735SSG | AC/A |
| RSS-155D | MOV | PITRM | EP-MCC-E12 | 480 | 735NSG | AC/B |
| RSS-156A | MOV | RSSARM | EP-MCC-E11 | 480 | 735SSG | AC/A |
| RSS-156B | MOV | RSSBRM | EP-MCC-E12 | 480 | 735NSG | AC/B |
| RSS-156C | MOV | RSSCRM | EP-MCC-E11 | 480 | 735SSG | AC/A |
| RSS-156D | MOV | RSSDRM | EP-MCC-E12 | 480 | 735NSG | AC/B |
| RSS-HXA | HX | RSSARM | | | | |
| RSS-HXB | HX | RSSBRM | | | | |
| RSS-HXC | HX | RSSCRM | | | | |
| RSS-HXD | HX | RSSDRM | | | | |
| RSS-P21A | MDP | RSSARM | EP-BS-2AE | 4160 | ESWGRMW | AC/A |
| RSS-P21B | MDP | RSSBRM | EP-BS-2DF | 4160 | ESWGRME | AC/B |
| RSS-P21C | MDP | RSSCRM | EP-BS-2AE | 4160 | ESWGRMW | AC/A |
| RSS-P21D | MDP | RSSDRM | EP-BS-2DF | 4160 | ESWGRME | AC/B |
| RSS-SUMP | TK | RC | | | | |

## 3.5 INSTRUMENTATION AND CONTROL (I & C) SYSTEMS

### 3.5.1 System Function

The instrumentation and control systems consist of the Reactor Trip System (RTS), also known as the Reactor Protection System (RPS), the Engineered Safety Features Actuation System (ESFAS), and systems for the display of plant information to the operators. The RTS and the ESFAS monitor the reactor plant and alert the operator to take corrective action before specified limits are exceeded. The RTS will initiate an automatic reactor trip (scram) to rapidly shutdown the reactor when plant conditions exceed one or more specified limits. The ESFAS 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.

### 3.5.2 System Definition

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

A summary of data on selected I & C system components is presented in Table 3.5-1.

### 3.5.3 System Operation

A. RTS

The RTS has two to four redundant input instrument channels for each sensed parameter. Two reactor trip breakers are actuated by two separate RTS logic matrices. The reactor trip breakers interrupt power to the control rod drive power supply. Bypass breakers are provided to permit testing of the trip breakers. Certain reactor trip channels are automatically bypassed at power levels where they are not required for safety. The following conditions result in reactor trip:

- High neutron flux (power range)
- Intermediate range high neutron flux
- Source range high neutron flux
- High neutron flux rate (power range)
- Negative neutron flux rate (power range)
- Overtemperature delta T
- Overpower delta T
- Low pressurizer pressure
- High pressurizer pressure
- High pressurizer water level
- Low reactor coolant flow
- Reactor coolant pump breakers open
- Reactor coolant pump undervoltage
- Reactor coolant pump underfrequency
- Safety injection signal
- Turbine trip

- Low feedwater flow
- Low-low steam generator water level
- Manual

B. ESFAS
The ESFAS consists of two distinct 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 channels and perform the logic needed to actuate the appropriate engineered safety features (ESF) equipment. The following functions are actuated by the ESFAS:

- Safety injection system actuation
- Containment isolation Phase A and Phase B
- Automatic transfer of ECCS injection to recirculation
- Service water system actuation
- Auxiliary feedwater system actuation
- Emergency diesel generators start
- Containment quench spray and recirculation spray actuation
- Main steam line isolation
- Feedwater isolation
- Control room ventilation isolation

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

C. Remote Shutdown
If temporary evacuation of the control room is required, the operator can establish and maintain the plant in a safe shutdown condition independent of the control room from the emergency shutdown panel (ESP). The prime intent of the ESP is to enable the operators to achieve and maintain a hot standby condition. The transfer is initiated manually by transfer pushbuttons and switches provided on the ESP. Transfer separates all control from the control room. Reset (override) is accomplished by hand reset transfer relays at the local relay panel. In the event of an exposure fire, the switching capability of the auxiliary shutdown panel (ASP) provides a means of alternate shutdown capability. The ASP will control train A of the Class 1E systems necessary for safe shutdown.

The emergency shutdown panel (ESP) contains controls and/or indicators for equipment in the following systems required for safe shutdown:

- Reactor Coolant System
- Main Steam System
- Auxiliary Feedwater System
- Residual Heat Removal System
- High Head Safety Injection/Charging System
- Service Water System
- Electric Power System

The auxiliary shutdown panel (ASP) contains controls and/or indicators for train A equipment in the following systems required for safe shutdown:

- Reactor Coolant System
- Main Steam System
- Residual Heat Removal System
- High Head Safety Injection/Charging System
- Service Water System
- Electric Power System

### 3.5.4 System Success Criteria

A. RTS

The RTS 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 RTS. A reactor scram is implemented by the reactor trip breakers which must open in response to a scram signal. There are two series breakers in the power path to the scram rods. One of two circuit breakers must open to cause a scram. Each reactor trip breaker has an associated bypass breaker to permit testing of the trip breakers. Details of the scram system for Beaver Valley 2 have not been determined.

B. ESFAS

In general, the loss of inst[illegible]t power to the sensors, instruments, or logic devices places that channel in the trip mode. Details of the ESFAS for Beaver Valley 2 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 RTS or an ESFAS 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 auxiliary control panel or a motor control center). 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).

B. Other

1. Cooling for the main control room, computer room, and HVAC equipment room is provided by the Control Room Air-Conditioning Subsystem.
2. Cooling for the cable tunnel, instrumentation and relay room, cable spreading room, MCC room, and communications room is provided by the Control Building Air-Conditioning Subsystem.

### 3.5.6 Section 3.5 References

1. Beaver Valley 2 Final Safety Analysis Report, Section 7.

## 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.

### 3.6.2 System Definition

The Class 1E system is divided into two redundant trains per unit (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 Unit 2 receive power from two 4160 VAC buses, designated 2AE (train A) and 2DF (train B). The emergency source of power for these buses are two diesel generators; diesel generator 2-1 feeds bus 2AE, and diesel generator 2-2 feeds bus 2DF. Each 4160 VAC bus feeds one emergency 480 VAC substation through transformers, and the 480 VAC substations in turn supply power to various motor control centers.

The 125 VDC system provides power for control and instrumentation and other loads. There are four 125 VDC systems (designated 2-1, 2-2, 2-3, and 2-4), each consisting of a dedicated battery, distribution switchboard, and a charger or rectifier.

Four independent Class 1E 120 VAC vital instrument power supplies are provided to supply the four channels of the protection systems and reactor control systems. Each vital instrument power supply consists of an inverter, transformer, and a vital panel.

Simplified one-line diagrams of the station electric power system are shown in Figures 3.6-1 and 3.6-2. The 4160 and 480 VAC systems are shown in Figures 3.6-3 and 3.6-4, and 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. 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 normal 4160 VAC buses 2A and 2D which in turn receive power from the main generator through the two station service transformers, 2C and 2D. 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.

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 rated for approximately 2 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. 1, Section 8.3.2.1.3).

Each 120 VAC instrumentation bus receives power from an inverter which normally is supplied from its associated 125 VDC battery (through its 125 VDC Bus) or a 480 VAC MCC through a rectifier. If the inverter is taken out of service, the 120 VAC bus can be supplied via its respective 480/120 volt regulating transformer.

Redundant safeguards equipment such as motor-driven pumps and motor-operated valves are supplied by different VAC buses. 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 2AE. Load group AC/B contains components powered either directly or indirectly by 4160 VAC bus 2DF. Components receiving DC power are assigned to load groups DC/1 or DC/2, 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 cross-ties that may 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
- Power to the battery chargers is restored before the batteries are exhausted

### 3.6.5 Component Information

A. Standby diesel generators 2-1, 2-2
   1. Rated load: 4238 kW (continuous duty)
   2. Rated voltage: 4160 VAC
   3. Manufacturer: Colt Industries

B. Batteries 2-1, 2-2, 2-3, 2-4
   1. Rated voltage: 125 VDC
   2. Rated capacity: approximately 2 hours with design loads

### 3.6.6 Support Systems and Interfaces

A. Control Signals
   1. Automatic
      The standby diesel generators are automatically started on loss of voltage on 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, emergency shutdown panel, and the auxiliary shutdown panel (DG 2-1 only).

B. Diesel Generator Auxiliary Systems
   1. Emergency Diesel Generator Cooling Water System
      Each diesel generator can be cooled by the service water system (see Section 3.7).
   2. Diesel Starting System
      Each diesel generator is equipped with an independent starting air system.
   3. Diesel Fuel Oil Transfer and Storage System
      A "day tank" supplies the short-term fuel needs of each diesel, each with a capacity of 1100 gallons. Each day tank can be replenished from a separate 58,000 gallon fuel oil storage tank embedded in concrete and located below the diesel generator building.
   4. Diesel Lubrication System
      Each diesel generator has an independent oil lubrication system.
   5. 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.

C. Emergency Switchgear and Battery Room Ventilation Systems
These systems maintain acceptable environmental conditions in the switchgear and battery rooms, respectively, and may be needed for long-term operation of the electric power systems. Each system consists of two 100-percent capacity fans which draw power from the Class 1E AC system.

### 3.6.7 Section 3.6 References

1. Beaver Valley 2 Final Safety Analysis Report.

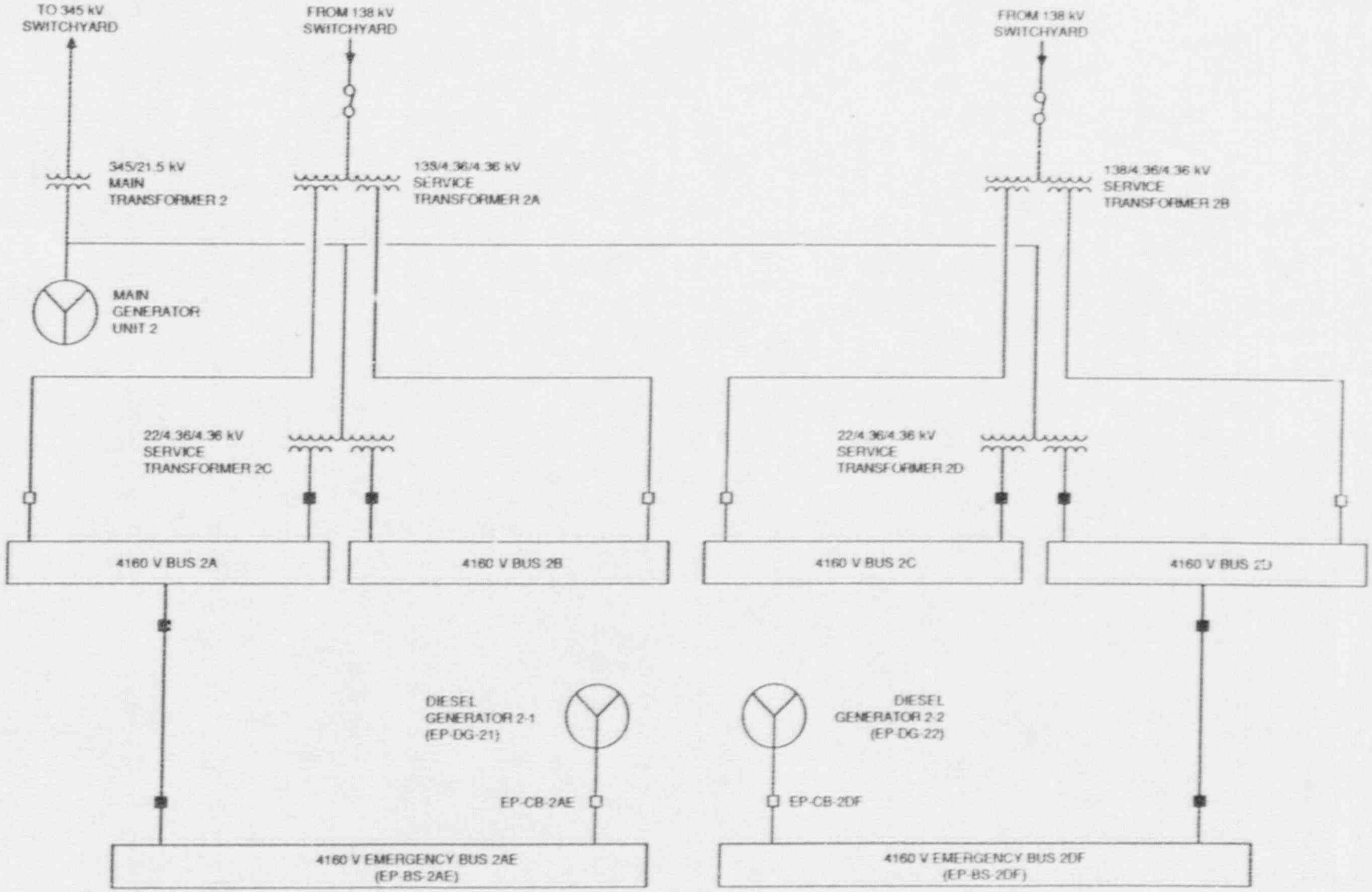
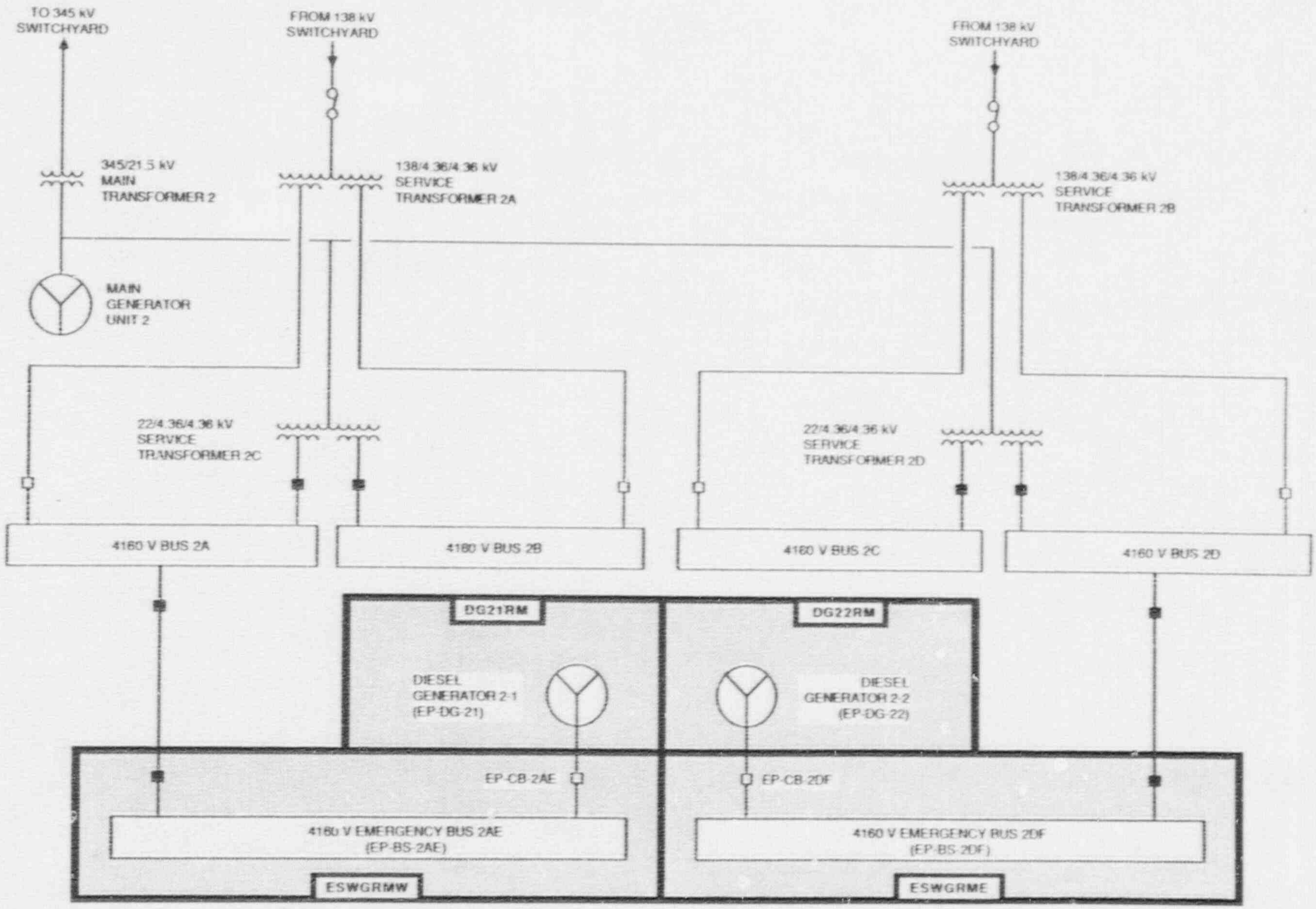



**Figure 3.6-1. Beaver Valley 2 Station Electric Power System**




NOTE: LINES MAY NOT REPRESENT TRUE CABLE ROUTING BETWEEN ROOMS

**Figure 3.6-2. Beaver Valley 2 Station Electric Power System Showing Component Locations**

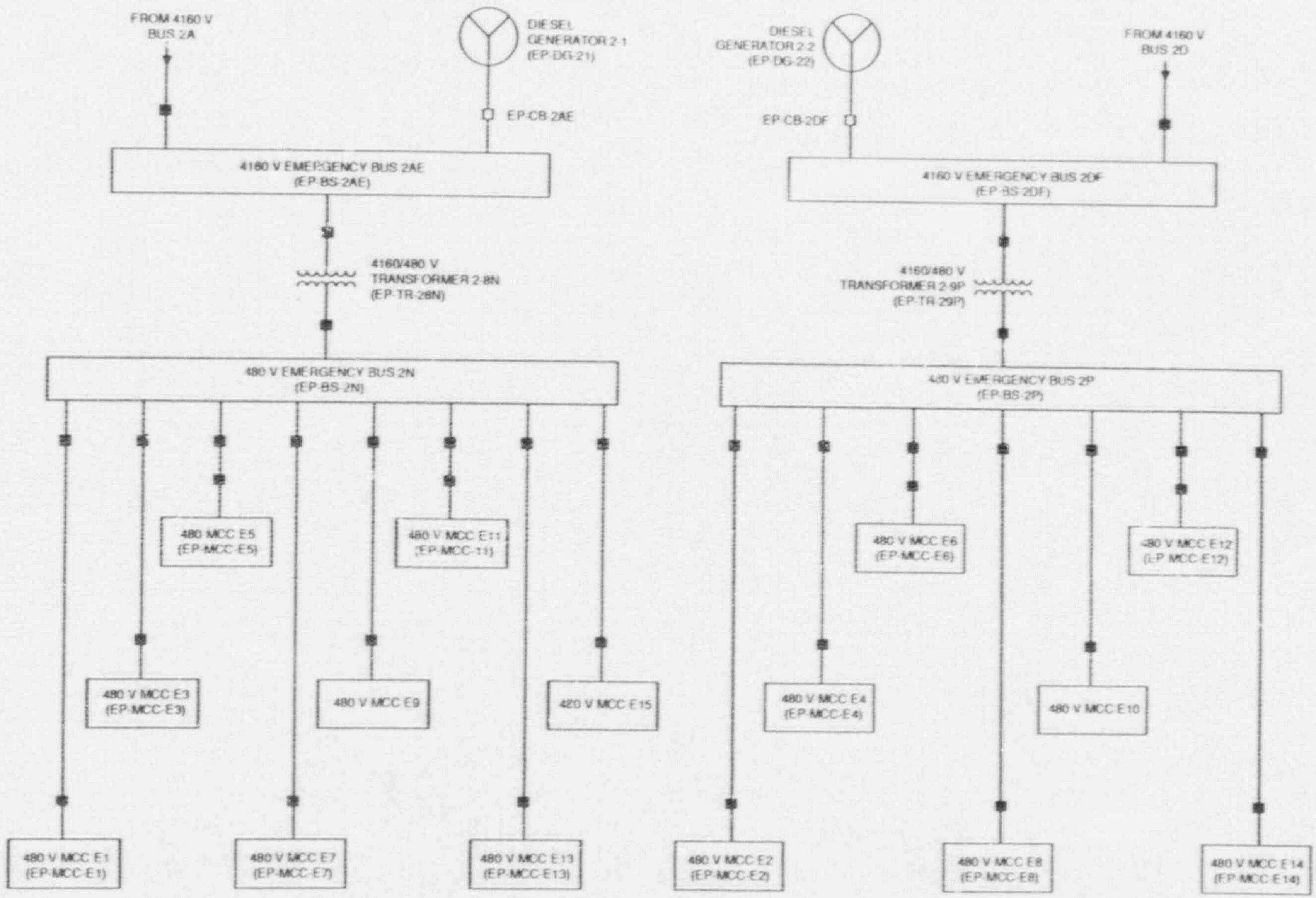



Figure 3.6-3. Beaver Valley 2 4160 and 480 VAC Electric Power Systems

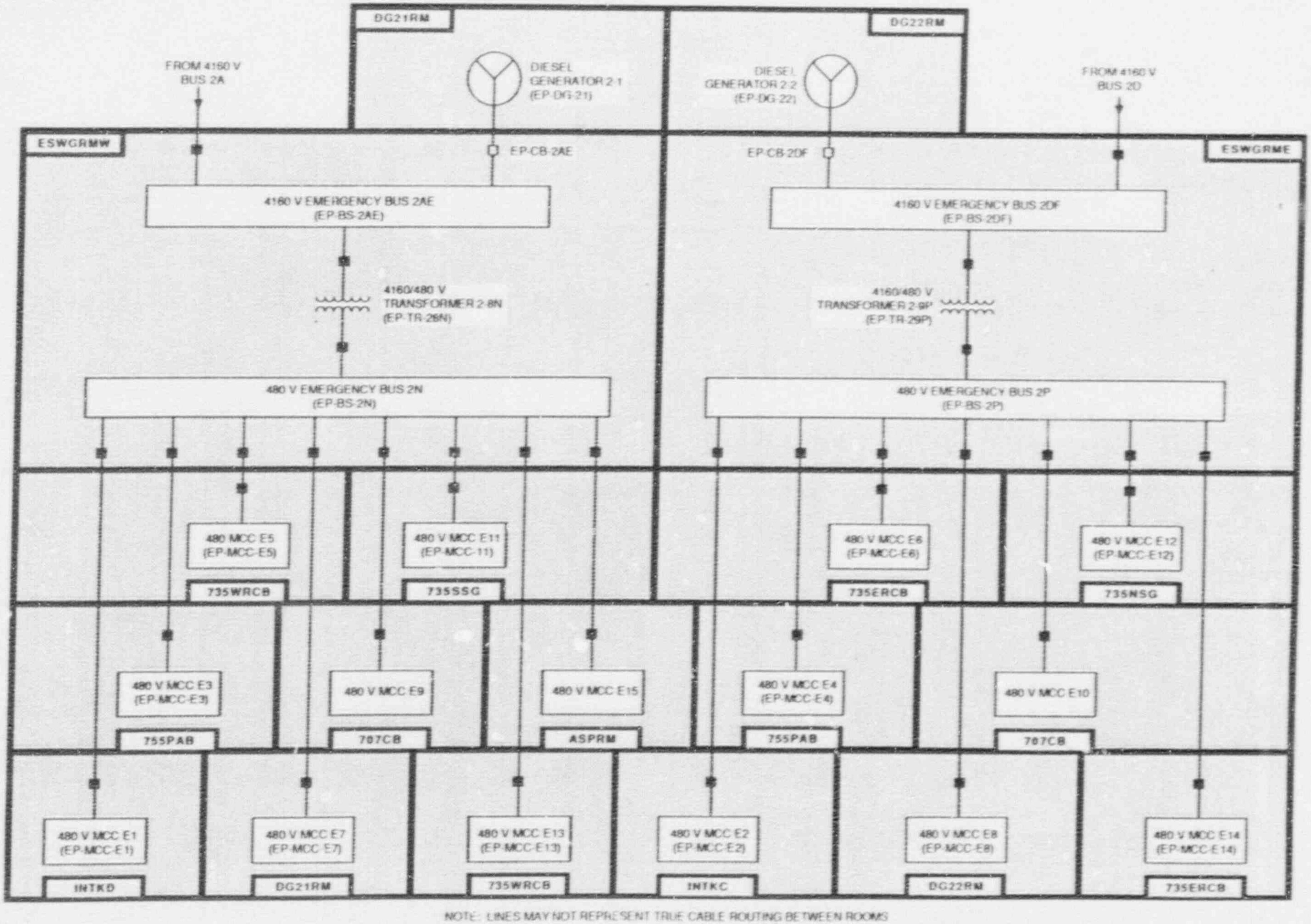



**Figure 3.6-4. Beaver Valley 2 4160 and 480 VAC Electric Power Systems Showing Component Locations**

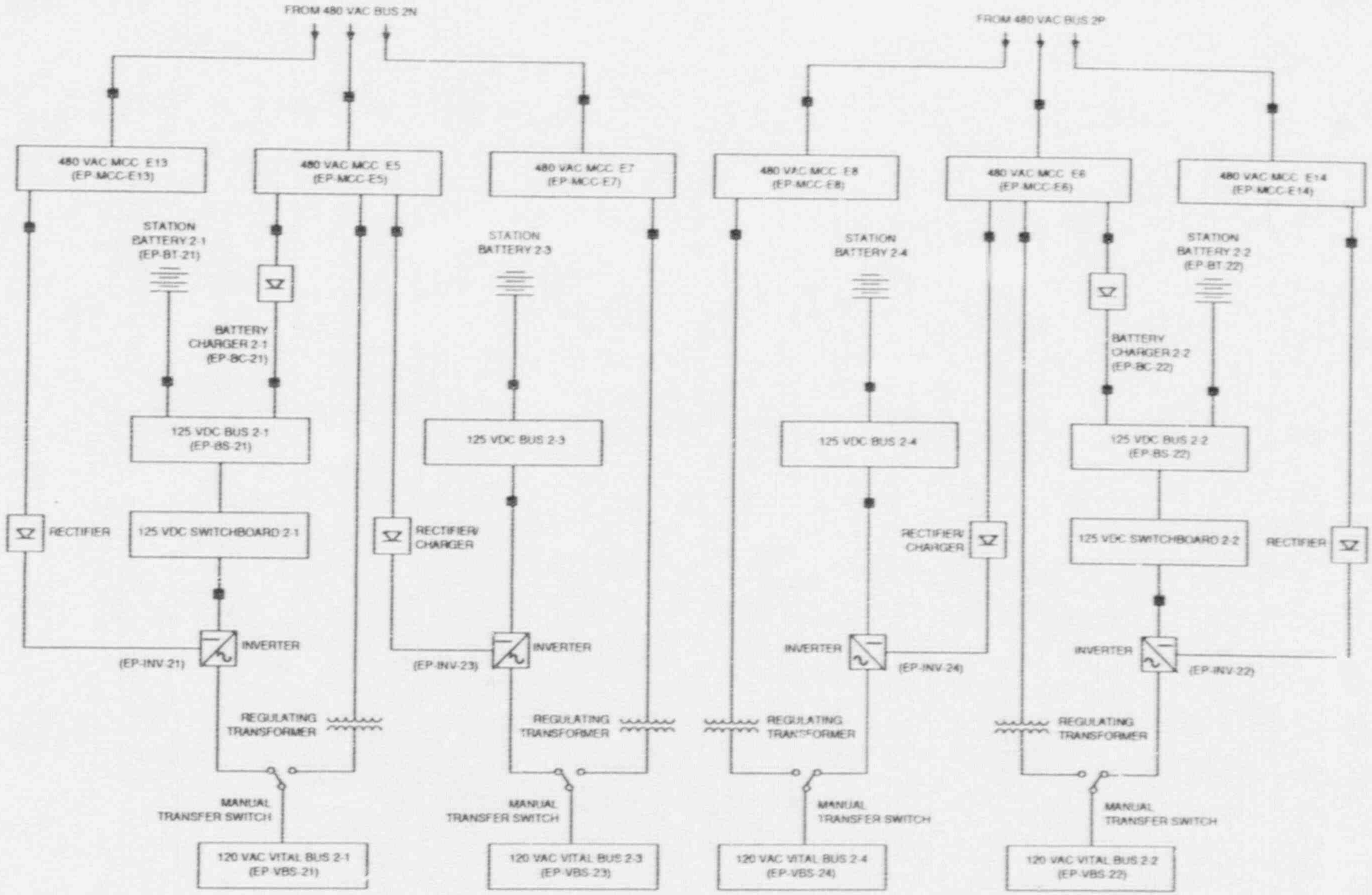
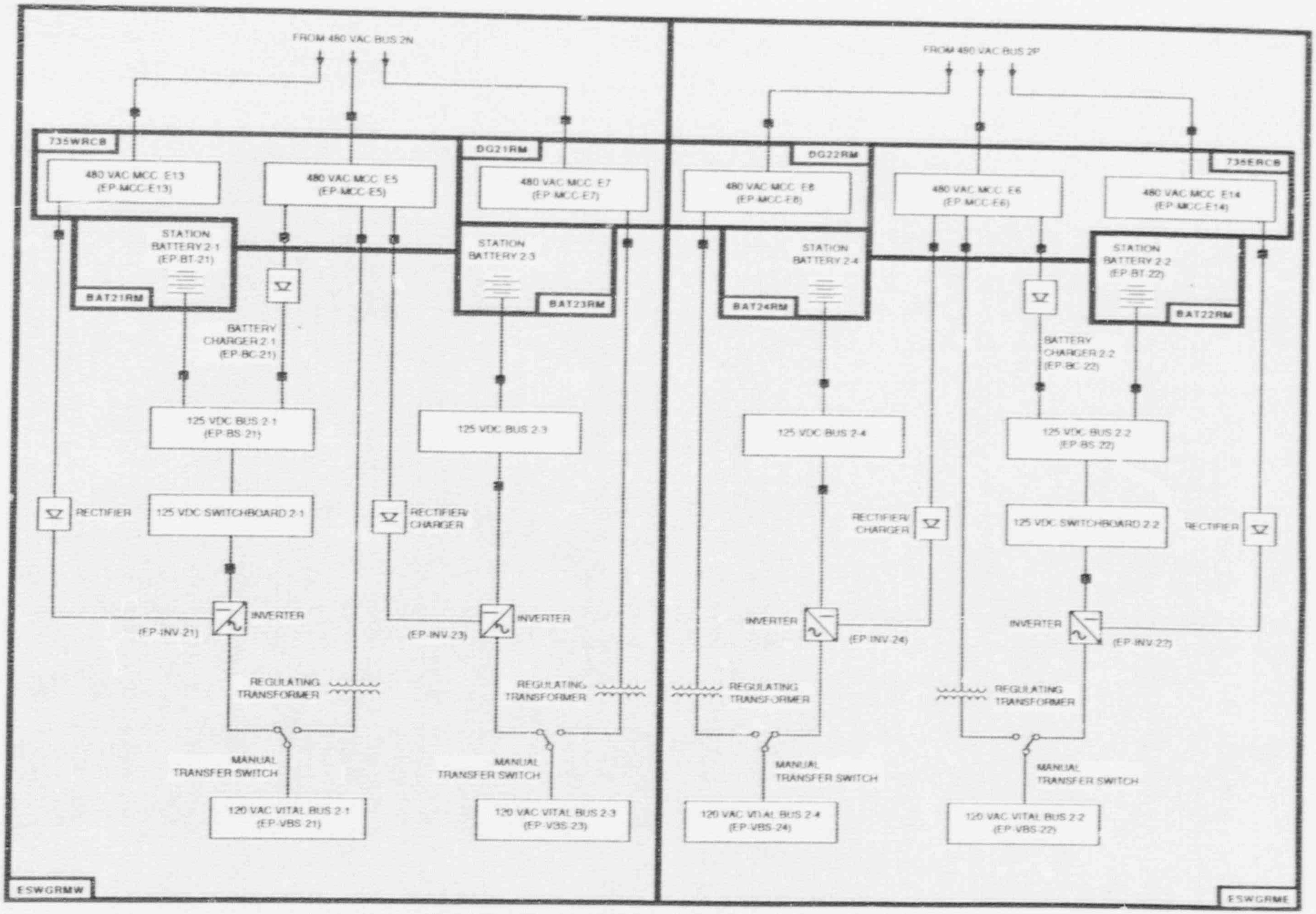



Figure 3.6-5. Beaver Valley 2 125 VDC and 120 VAC Electric Power Systems




NOTE: LINES MAY NOT REPRESENT TRUE CABLE ROUTING BETWEEN ROOMS

Figure 3.6-6. Beaver Valley 2 125 VDC and 120 VAC Electric Power Systems Showing Component Locations

Table 3.6-1. Beaver Valley 2 Electric Power System Data Summary for Selected Components

| COMPONENT ID | COMP. TYPE | LOCATION | POWER SOURCE | VOLTAGE | POWER SOURCE LOCATION | EMERG. LOAD GRP. |
|---|---|---|---|---|---|---|
| EP-BC-21 | BC | ESWGRMW | EP-MCC-E5 | 480 | 735WRCB | DC/1 |
| EP-BC-22 | BC | ESWGRME | EP-MCC-E6 | 480 | 735ERCB | DC/2 |
| EP-BS-21 | BUS | ESWGRMW | EP-BC-21 | 125 | ESWGRMW | DC/1 |
| EP-BS-22 | BUS | ESWGRME | EP-BC-22 | 125 | ESWGRME | DC/2 |
| EP-BS-22 | BUS | ESWGRME | EP-BC-22 | 125 | ESWGRME | DC/2 |
| EP-BS-2AE | BUS | ESWGRMW | EP-DG-21 | 4160 | DG21RM | AC/A |
| EP-BS-2DF | BUS | ESWGRME | EP-DG-22 | 4160 | DG22RM | AC/B |
| EP-BS-2N | BUS | ESWGRMW | EP-TR-28N | 480 | ESWGRMW | AC/A |
| EP-BS-2P | BUS | ESWGRME | EP-TR-29P | 480 | ESWGRME | AC/B |
| EP-BT-21 | BATT | BAT21RM | | | | |
| EP-BT-22 | BATT | BAT22RM | | | | |
| EP-CB-2AE | CB | ESWGRMW | | | | |
| EP-CB-2DF | CB | ESWGRME | | | | |
| EP-DG-21 | DG | DG21RM | | | | AC/A |
| EP-DG-22 | DG | DG22RM | | | | |
| EP-MCC-E1 | MCC | INTKD | EP-BS-2N | 480 | ESWGRMW | AC/A |
| EP-MCC-E11 | MCC | 735SSG | EP-BS-2N | 480 | ESWGRMW | AC/A |
| EP-MCC-E12 | MCC | 735NSG | EP-BS-2P | 480 | ESWGRME | AC/B |
| EP-MCC-E13 | MCC | 735WRCB | EP-BS-2N | 480 | ESWGRMW | AC/A |
| EP-MCC-E14 | MCC | 735ERCB | EP-BS-2P | 480 | ESWGRME | AC/B |
| EP-MCC-E2 | MCC | INTKC | EP-BS-2P | 480 | ESWGRME | AC/B |
| EP-MCC-E3 | MCC | 755PAB | EP-BS-2N | 480 | ESWGRMW | AC/A |
| EP-MCC-E4 | MCC | 755PAB | EP-BS-2P | 480 | ESWGRME | AC/B |
| EP-MCC-E5 | MCC | 735WRCB | EP-BS-2N | 480 | ESWGRMW | AC/A |
| EP-MCC-E6 | MCC | 735ERCB | EP-BS-2P | 480 | ESWGRME | AC/B |
| EP-MCC-E7 | MCC | DG21RM | EP-BS-2N | 480 | ESWGRMW | AC/A |
| EP-MCC-E8 | MCC | DG22RM | EP-BS-2P | 480 | ESWGRME | AC/B |
| EP-TR-28N | TR | ESWGRMW | EP-BS-2AE | 4160 | ESWGRMW | AC/A |

Table 3.6-1. Beaver Valley 2 Electric Power System Data Summary for Selected Components (Continued)

| COMPONENT | | LOCATION | POWER SOURCE | VOLTAGE | POWER SOURCE LOCATION | EMERG. LOAD GRP. |
|---|---|---|---|---|---|---|
| EP-TR-29P | [illegible] | ESWGRME | EP-BS-2DF | 4160 | ESWGRME | AC/B |
| EP-VBS-21 | [illegible] | ESWGRMW | EP-INV-21 | 120 | ESWGRMW | AC/A |
| EP-VBS-22 | [illegible] | ESWGRME | EP-INV-22 | 120 | ESWGRME | AC/B |
| EP-VBS-23 | BUS | ESWGRMW | EP-INV-23 | 120 | ESWGRMW | AC/A |
| EP-VBS-24 | BUS | ESWGRME | EP-INV-24 | 120 | ESWGRME | AC/B |

## Table 3.6-2. Partial Listing of Electrical Sources and Loads at Beaver Valley 2

| POWER SOURCE | VOLTAGE | EMERG LOAD GRP | POWER SOURCE LOCATION | LOAD SYSTEM | LOAD COMPONENT ID | COMP TYPE | COMPONENT LOCATION |
|---|---|---|---|---|---|---|---|
| EP-BC-21 | 125 | DC/1 | ESWGRMW | EP | EP-BS-21 | BUS | ESWGRMW |
| EP-BC-22 | 125 | DC/2 | ESWGRME | EP | EP-BS-22 | BUS | ESWGRME |
| EP-BC-22 | 125 | DC/2 | ESWGRME | EP | EP-BS-22 | BUS | ESWGRME |
| EP-BS-21 | 125 | DC/1 | ESWGRMW | AFWS | AFW-105A | SOV | MSVA |
| EP-BS-21 | 125 | DC/1 | ESWGRMW | AFWS | AFW-105C | SOV | MSVA |
| EP-BS-21 | 125 | DC/1 | ESWGRMW | AFWS | AFW-105E | SOV | MSVA |
| EP-BS-21 | 125 | DC/1 | ESWGRMW | RCS | RCS-455D | NV | RC |
| EP-BS-21 | 125 | DC/1 | ESWGRMW | RCS | RCS-455 | NV | RC |
| EP-BS-22 | 125 | DC/2 | ESWGRME | AFWS | AFW-105B | SOV | MSVA |
| EP-BS-22 | 125 | DC/2 | ESWGRME | AFWS | AFW-105D | SOV | MSVA |
| EP-BS-22 | 125 | DC/2 | ESWGRME | AFWS | AFW-105F | SOV | MSVA |
| EP-BS-22 | 125 | DC/2 | ESWGRME | RCS | RCS-455C | NV | RC |
| EP-BS-2AE | 4160 | AC/A | ESWGRMW | AFWS | AFW-23A | MDP | 718SSG |
| EP-BS-2AE | 4160 | AC/A | ESWGRMW | CHRS | QSS-P21A | MDP | 718SSG |
| EP-BS-2AE | 4160 | AC/A | ESWGRMW | CHRS | RSS-P21A | MDP | RSSARM |
| EP-BS-2AE | 4160 | AC/A | ESWGRMW | CHRS | RSS-P21C | MDP | RSSCRM |
| EP-BS-2AE | 4160 | AC/A | ESWGRMW | ECCS | HHSI-P21A | MDP | HHP21ARM |
| EP-BS-2AE | 4160 | AC/A | ESWGRMW | ECCS | HHSI-P21C | MDP | HHP21CRM |
| EP-BS-2AE | 4160 | AC/A | ESWGRMW | EP | EP-TR-28N | TR | ESWGRMW |
| EP-BS-2AE | 4160 | AC/A | ESWGRMW | SWS | SW-P21A | MDP | INTKD |
| EP-BS-2AE | 4160 | AC/A | ESWGRMW | SWS | SW-P21C | MDP | INTKB |
| EP-BS-2DF | 4160 | AC/B | ESWGRME | AFWS | AFW-23B | MDP | 718NSG |
| EP-BS-2DF | 4160 | AC/B | ESWGRME | CHRS | QSS-[illegible]21B | MDP | 718NSG |
| EP-BS-2DF | 4160 | AC/B | ESWGRME | CHRS | RSS-P21B | MDP | RSSBRM |
| EP-BS-2DF | 4160 | AC/B | ESWGRME | CHRS | RSS-P21D | MDP | RSSDRM |
| EP-BS-2DF | 4160 | AC/B | ESWGRME | ECCS | HHSI-P21B | MDP | HHP21BRM |
| EP-BS-2DF | 4160 | AC/A | ESWGRME | ECCS | HHSI-P21C | MDP | HHP21CRM |
| EP-BS-2DF | 4160 | AC/B | ESWGRME | EP | EP-TR-29P | TR | ESWGRME |
| EP-BS-2DF | 4160 | AC/B | ESWGRME | SWS | SW-P21B | MDP | INTKC |
| EP-BS-2DF | 4160 | AC/B | ESWGRME | SWS | SW-P21C | MDP | INTKB |
| EP-BS-2N | 480 | AC/A | ESWGRMW | EP | EP-MCC-E1 | MCC | INTKD |

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

| POWER SOURCE | VOLTAGE | EMERG LOAD GRP | POWER SOURCE LOCATION | LOAD SYSTEM | LOAD COMPONENT ID | COMP TYPE | COMPONENT LOCATION |
|---|---|---|---|---|---|---|---|
| EP-BS-2N | 480 | AC/A | ESWGRMW | EP | EP-MCC-E11 | MCC | 735SSG |
| EP-BS-2N | 480 | AC/A | ESWGRMW | EP | EP-MCC-E13 | MCC | 735WRCB |
| EP-BS-2N | 480 | AC/A | ESWGRMW | EP | EP-MCC-E3 | MCC | 755PAB |
| EP-BS-2N | 480 | AC/A | ESWGRMW | EP | EP-MCC-E5 | MCC | 735WRCB |
| EP-BS-2N | 480 | AC/A | ESWGRMW | EP | EP-MCC-E7 | MCC | DG21RM |
| EP-BS-2N | 480 | AC/A | ESWGRMW | RCS | RCS-PZR | HTR | RC |
| EP-BS-2P | 480 | AC/B | ESWGRME | EP | EP-MCC-E12 | MCC | 735NSG |
| EP-BS-2P | 480 | AC/B | ESWGRME | EP | EP-MCC-E14 | MCC | 735ERCB |
| EP-BS-2P | 480 | AC/B | ESWGRME | EP | EP-MCC-E2 | MCC | INTKC |
| EP-BS-2P | 480 | AC/B | ESWGRME | EP | EP-MCC-E4 | MCC | 755PAB |
| EP-BS-2P | 480 | AC/B | ESWGRME | EP | EP-MCC-E6 | MCC | 735ERCB |
| EP-BS-2P | 480 | AC/B | ESWGRME | EP | EP-MCC-E8 | MCC | DG22RM |
| EP-BS-2P | 480 | AC/B | ESWGRME | RCS | RCS-PZR | HTR | RC |
| EP-DG-21 | 4160 | AC/A | DG21RM | EP | EP-BS-2AE | BUS | ESWGRMW |
| EP-DG-22 | 4160 | AC/B | DG22RM | EP | EP-BS-2DF | BUS | ESWGRME |
| EP-INV-21 | 120 | AC/A | ESWGRMW | EP | EP-VBS-21 | BUS | ESWGRMW |
| EP-INV-22 | 120 | AC/B | ESWGRME | EP | EP-VBS-22 | BUS | ESWGRME |
| EP-INV-23 | 120 | AC/A | ESWGRMW | EP | EP-VBS-23 | BUS | ESWGRMW |
| EP-INV-24 | 120 | AC/B | ESWGRME | EP | EP-VBS-24 | BUS | ESWGRME |
| EP-MC-E11 | 480 | AC/A | 735SSG | CHRS | RSS-155C | MOV | PITRM |
| EP-MCC-E1 | 480 | AC/A | INTKD | SWS | SW-102A | MOV | INTKD |
| EP-MCC-E1 | 480 | AC/A | INTKD | SWS | SW-102C1 | MOV | INTKB |
| EP-MCC-E1 | 480 | AC/A | INTKD | SWS | SW-102C1 | MOV | INTKB |
| EP-MCC-E11 | 480 | AC/A | 735SSG | CHRS | QSS-100A | MOV | 718SSG |
| EP-MCC-E11 | 480 | AC/A | 735SSG | CHRS | QSS-101A | MOV | RSSARM |
| EP-MCC-E11 | 430 | AC/A | 735SSG | CHRS | RSS-155A | MOV | PITRM |
| EP-MCC-E11 | 480 | AC/A | 735SSG | CHRS | RSS-156A | MOV | RSSARM |
| EP-MCC-E11 | 480 | AC/A | 735SSG | CHRS | RSS-156C | MOV | RSSCRM |
| EP-MCC-E11 | 480 | AC/A | 735SSG | ECCS | LHSI-863A | MOV | 718SSG |
| EP-MCC-E11 | 480 | AC/A | 735SSG | ECCS | LHSI-863A | MOV | 718SSG |
| EP-MCC-E11 | 480 | AC/A | 735SSG | ECCS | LHSI-8811A | MOV | 718SSG |

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

| POWER SOURCE | VOLTAGE | EMERG LOAD GRP | POWER SOURCE LOCATION | LOAD SYSTEM | LOAD COMPONENT ID | COMP TYPE | COMPONENT LOCATION |
|---|---|---|---|---|---|---|---|
| EP-MCC-E11 | 480 | AC/A | 735SSG | ECCS | LHSI-8887A | MOV | 718SSG |
| EP-MCC-E11 | 480 | AC/A | 735SSG | SWS | SW-104A | MOV | 718SSG |
| EP-MCC-E11 | 480 | AC/A | 735SSG | SWS | SW-104C | MOV | 718SSG |
| EP-MCC-E11 | 480 | AC/A | 735SSG | SWS | SW-105A | MOV | RSSARM |
| EP-MCC-E11 | 480 | AC/A | 735SSG | SWS | SW-105C | MOV | RSSCRM |
| EP-MCC-E12 | 480 | AC/B | 735NSG | CHRS | QSS-100B | MOV | 718NSG |
| EP-MCC-E12 | 480 | AC/B | 735NSG | CHRS | QSS-101B | MOV | RSSBRM |
| EP-MCC-E12 | 480 | AC/B | 735NSG | CHRS | RSS-155B | MOV | PITRM |
| EP-MCC-E12 | 480 | AC/B | 735NSG | CHRS | RSS-155D | MOV | PITRM |
| EP-MCC-E12 | 480 | AC/B | 735NSG | CHRS | RSS-156B | MOV | RSSBRM |
| EP-MCC-E12 | 480 | AC/B | 735NSG | CHRS | RSS-156D | MOV | RSSDRM |
| EP-MCC-E12 | 480 | AC/B | 735NSG | ECCS | LHSI-863B | MOV | 718NSG |
| EP-MCC-E12 | 480 | AC/B | 735NSG | ECCS | LHSI-863B | MOV | 718NSG |
| EP-MCC-E12 | 480 | AC/B | 735NSG | ECCS | LHSI-8811B | MOV | 718NSG |
| EP-MCC-E12 | 480 | AC/B | 735NSG | ECCS | LHSI-887B | MOV | 718NSG |
| EP-MCC-E12 | 480 | AC/B | 735NSG | SWS | SW-104B | MOV | 718NSG |
| EP-MCC-E12 | 480 | AC/B | 735NSG | SWS | SW-104D | MOV | 718SSG |
| EP-MCC-E12 | 480 | AC/B | 735NSG | SWS | SW-105B | MOV | RSSBRM |
| EP-MCC-E12 | 480 | AC/B | 735NSG | SWS | SW-105D | MOV | RSSDRM |
| EP-MCC-E13 | 480 | AC/A | 735WRCB | AFWS | AFW-100A | HV | 735SSG |
| EP-MCC-E13 | 480 | AC/A | 735WRCB | AFWS | AFW-100C | HV | 735SSG |
| EP-MCC-E13 | 480 | AC/A | 735WRCB | AFWS | AFW-100E | HV | 735SSG |
| EP-MCC-E14 | 480 | AC/B | 735ERCB | AFWS | AFW-100B | HV | 735SSG |
| EP-MCC-E14 | 480 | AC/B | 735ERCB | AFWS | AFW-100D | HV | 735SSG |
| EP-MCC-E14 | 480 | AC/B | 735ERCB | AFWS | AFW-100F | HV | 735SSG |
| EP-MCC-E2 | 480 | AC/B | INTKC | SWS | SW-102B | MOV | INTKC |
| EP-MCC-E2 | 480 | AC/B | INTKC | SWS | SW-102C2 | MOV | INTKB |
| EP-MCC-E2 | 480 | AC/B | INTKC | SWS | SW-102C2 | MOV | INTKB |
| EP-MCC-E3 | 480 | AC/A | 755PAB | ECCS | HHSI-115B | MOV | BLNDRM |
| EP-MCC-E3 | 480 | AC/A | 755PAB | ECCS | HHSI-115B | MOV | BLNDRM |
| EP-MCC-E3 | 480 | AC/A | 755PAB | ECCS | HHSI-275A | MOV | HHP21ARM |

## Table 3.6-2. Partial Listing of Electrical Sources and Loads at Beaver Valley 2 (Continued)

| POWER SOURCE | VOLTAGE | EMERG LOAD GRP | POWER SOURCE LOCATION | LOAD SYSTEM | LOAD COMPONENT ID | COMP TYPE | COMPONENT LOCATION |
|---|---|---|---|---|---|---|---|
| EP-MCC-E3 | 480 | AC/A | 755PAB | ECCS | HHSI-275B | MOV | HHP21BRM |
| EP-MCC-E3 | 480 | AC/A | 755PAB | ECCS | HHSI-275C | MOV | HHP21CRM |
| EP-MCC-E3 | 480 | AC/A | 755PAB | ECCS | HHSI-8130A | MOV | BLNDRM |
| EP-MCC-E3 | 480 | AC/A | 755PAB | ECCS | HHSI-8132A | MOV | BLNDRM |
| EP-MCC-E3 | 480 | AC/A | 755PAB | ECCS | HHSI-8133A | MOV | BLNDRM |
| EP-MCC-E3 | 480 | AC/A | 755PAB | ECCS | HHSI-613A | MOV | BLNDRM |
| EP-MCC-E3 | 480 | AC/A | 755PAB | ECCS | HHSI-867A | MOV | BITRM |
| EP-MCC-E3 | 480 | AC/A | 755PAB | SWS | SW-103A | MOV | VPITA |
| EP-MCC-E3 | 480 | AC/A | 755PAB | SWS | SW-103A | MOV | VPITA |
| EP-MCC-E3 | 480 | AC/A | 755PAB | SWS | SW-106A | MOV | VPITA |
| EP-MCC-E3 | 480 | AC/A | 755PAB | SWS | SW-107A | MOV | 710PAB |
| EP-MCC-E3 | 480 | AC/A | 755PAB | SWS | SW-107C | MOV | 710PAB |
| EP-MCC-E3 | 480 | AC/A | 755PAB | SWS | SW-116A | MOV | VPITA |
| EP-MCC-E3 | 480 | AC/A | 755PAB | SWS | SW-120A | MOV | VPITA |
| EP-MCC-E4 | 480 | AC/B | 755PAB | ECCS | HHSI-115D | MOV | BLNDRM |
| EP-MCC-E4 | 480 | AC/B | 755PAB | ECCS | HHSI-115D | MOV | BLNDRM |
| EP-MCC-E4 | 480 | AC/B | 755PAB | ECCS | HHSI-8130B | MOV | BLNDRM |
| EP-MCC-E4 | 480 | AC/B | 755PAB | ECCS | HHSI-8131B | MOV | BLNDRM |
| EP-MCC-E4 | 480 | AC/B | 755PAB | ECCS | HHSI-8132B | MOV | BLNDRM |
| EP-MCC-E4 | 480 | AC/B | 755PAB | ECCS | HHSI-8133B | MOV | BLNDRM |
| EP-MCC-E4 | 480 | AC/B | 755PAB | ECCS | HHSI-841 | MOV | BITRM |
| EP-MCC-E4 | 480 | AC/B | 755PAB | ECCS | HHSI-867B | MOV | BITRM |
| EP-MCC-E4 | 480 | AC/B | 755PAB | SWS | SW-103B | MOV | VPITB |
| EP-MCC-E4 | 480 | AC/B | 755PAB | SWS | SW-103B | MOV | VPITB |
| EP-MCC-E4 | 480 | AC/B | 755PAB | SWS | SW-106B | MOV | VPITB |
| EP-MCC-E4 | 480 | AC/B | 755PAB | SWS | SW-107B | MOV | 710PAB |
| EP-MCC-E4 | [illegible] | AC/B | 755PAB | SWS | SW-107D | MOV | 710PAB |
| EP-MCC-E4 | 480 | AC/B | 755PAB | SWS | SW-116B | MOV | VPITB |
| EP-MCC-E4 | 480 | AC/B | 755PAB | SWS | SW-120B | MOV | VPITB |
| EP-MCC-E5 | 480 | AC/A | 735WRCB | ECCS | HHSI-259 | MOV | RC |
| EP-MCC-E5 | 480 | AC/A | 735WRCB | ECCS | HHSI-836 | MOV | PENRMA |

## Table 3.6-2. Partial Listing of Electrical Sources and Loads at Beaver Valley 2 (Continued)

| POWER SOURCE | VOLTAGE | EMERG LOAD GRP | POWER SOURCE LOCATION | LOAD SYSTEM | LOAD COMPONENT ID | COMP TYPE | COMPONENT LOCATION |
|---|---|---|---|---|---|---|---|
| EP-MCC-E5 | 480 | AC/A | 735WRCB | ECCS | HHSI-867C | MOV | PENRMA |
| EP-MCC-E5 | 480 | AC/A | 735WRCB | ECCS | HHSI-869A | MOV | PENRMA |
| EP-MCC-E5 | 480 | DC/1 | 735WRCB | EP | EP-BC-21 | BC | ESWGRMW |
| EP-MCC-E5 | 480 | AC/A | 735WRCB | RCS | RCS-536 | MOV | RC |
| EP-MCC-E5 | 480 | AC/A | 735WRCB | RCS | RCS-537 | MOV | RC |
| EP-MCC-E5 | 480 | AC/A | 735WRCB | RCS | RHR-701A | MOV | RC |
| EP-MCC-E5 | 480 | AC/A | 735WRCB | RCS | RHR-701B | MOV | RC |
| EP-MCC-E5 | 480 | AC/A | 735WRCB | RCS | RHR-702A | MOV | RC |
| EP-MCC-E6 | 480 | AC/B | 735ERCB | ECCS | HHSI-310 | MOV | RC |
| EP-MCC-E6 | 480 | AC/B | 735ERCB | ECCS | HHSI-867D | MOV | PENRMA |
| EP-MCC-E6 | 480 | AC/B | 735ERCB | ECCS | HHSI-869B | MOV | PENRMA |
| EP-MCC-E6 | 480 | DC/2 | 735ERCB | EP | EP-BC-22 | BC | ESWGRME |
| EP-MCC-E6 | 480 | AC/B | 735ERCB | RCS | RCS-535 | MOV | RC |
| EP-MCC-E6 | 480 | AC/B | 735ERCB | RCS | RHR-701B | MOV | RC |
| EP-MCC-E6 | 480 | AC/B | 735ERCB | RCS | RHR-702A | MOV | RC |
| EP-MCC-E6 | 480 | AC/B | 735ERCB | RCS | RHR-702B | MOV | RC |
| EP-MCC-E7 | 480 | AC/A | DG21RM | SWS | SW-113A | MOV | DG21RM |
| EP-MCC-E8 | 480 | AC/B | DG22RM | SWS | SW-11[illegible] | MOV | DG22RM |
| EP-TR-28N | 480 | AC/A | ESWGRMW | EP | EP-BS-2N | BUS | ESWGRMW |
| EP-TR-29P | 480 | AC/B | ESWGRME | EP | EP-BS-2P | BUS | ESWGRME |

## 3.7 SERVICE WATER SYSTEM (SWS)

### 3.7.1 System Function

The SWS is a safety-related system that provides cooling water to remove heat from the power plant auxiliary systems during all modes of operation, including emergency shutdown. Equipment cooled by the SWS includes the diesel generators, HHSI/charging system pumps lube oil coolers, recirculation spray heat exchangers, primary component cooling water heat exchangers, and various air-conditioning and ventilation coolers and condensers. The SWS can also deliver water to the suction of the auxiliary feedwater pumps, thereby serving as a backup water source to the primary plant demineralized water storage tank.

### 3.7.2 System Definition

The SWS consists of the intake structure, pumps, valves, and distribution piping. These pumps take suction from the intake structure (located on the Ohio River) and furnish all operating service water requirements through two redundant headers. The standby SWS consists of two 100-percent capacity pumps which take suction on the auxiliary intake structure and discharge to a line connected to the redundant service water supply lines.

Simplified drawings of the SWS, focusing on emergency related loads, are shown in Figures 3.7-1 and 3.7-2. A summary of data on selected SWS components is presented in Table 3.7-1.

### 3.7.3 System Operation

During normal operation, service water requirements can be met by two SWS pumps taking suction on the intake structure. The pumps discharge into two 30-inch headers which have branches leading to the various equipment to be cooled. The service water is discharged to the main circulating water lines downstream of the main condenser and travels from there to the cooling tower. Service water is also discharged to the emergency outfall structure.

In the event of a design basis accident initiating a containment isolation phase B (CIB) signal, the SWS is designed to supply sufficient cooling water to safely shutdown the unit. As a minimum, cooling water would be supplied to a least two recirculation spray coolers, one charging pump lube oil cooler, one emergency diesel generator cooler, and various air conditioning units. Flow will be automatically diverted from the primary and secondary component cooling water heat exchangers to the four recirculation spray coolers. The motor-operated inlet valves to the emergency diesel generators are opened. During this mode of operation, each pump is considered to be a 100-percent capacity pump.

The standby service water pumps are located in the auxiliary intake structure and discharge to a 30-inch line connected to the redundant 30-inch service water supply lines. From the point of connection to the service water lines, the cooling water flows to the systems and equipment described above. The standby service water pumps are used only when the service water pumps cannot maintain adequate flow throughout the system.

### 3.7.4 System Success Criteria

Under emergency shutdown and accident conditions, system success can be achieved by one SWS pump or one standby SWS pump. The pump used should be of the same train as the essential equipment in need of cooling.

### 3.7.5 Component Information

A. Service Water System Pumps P21A, P21B, P21C
   1. Rated flow: 15,000 gpm @ 190 ft head (82 psid)
   2. Rated capacity: 100% (safe shutdown)
   3. Type: vertical turbine

B. Standby Service Water System Pumps 21A, 21B
   1. Rated flow: 15,000 gpm @ 200 ft head (87 psid)
   2. Rated capacity: 100%
   3. Type: vertical turbine

### 3.7.6 Support Systems and Interfaces

A. Control Signals
   1. Automatic
      a. The SWS pumps will be started automatically on a safety injection signal or a diesel loading sequence signal.
      b. The standby pumps will be started automatically on a low pressure signal in either SWS header, provided there is no loss of power signal present.
   2. Remote Manual
      The SWS pumps can be operated from the control room or the emergency shutdown panel.

B. Motive Power
   The motor-driven SWS and standby SWS 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, cooling, and sealing of the SWS pumps is normally provided by the Beaver Valley 1 filtered water system but can be provided locally.
   2. Lubrication, cooling, and sealing of the standby SWS pumps is provided locally.
   3. SWS pump cooling is provided by the Intake Structure Ventilation System which maintains an environment suitable for personnel access and equipment operation during both normal and accident conditions. There are three separate, independent, and redundant intake pump cubicles, each with its own ventilation system. Each ventilation system consists of a ventilation fan, and this ventilation fan is supplied power by the respective emergency bus supplying the associated service water pump.

### 3.7.7 Section 3.7 References

1. Beaver Valley 2 Final Safety Analysis Report.

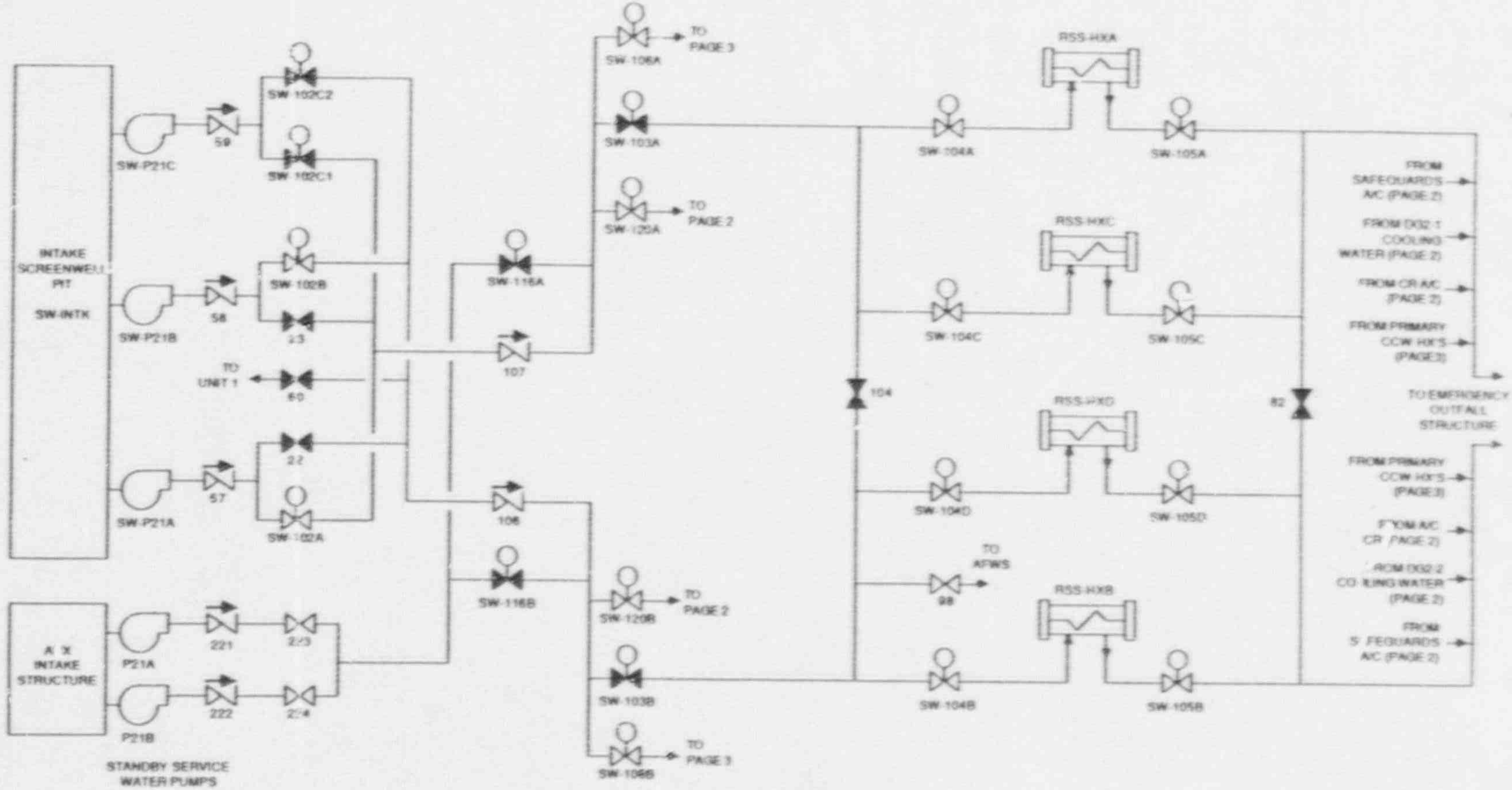



Figure 3.7-1. Beaver Valley 2 Service Water System (page 1 of 3)

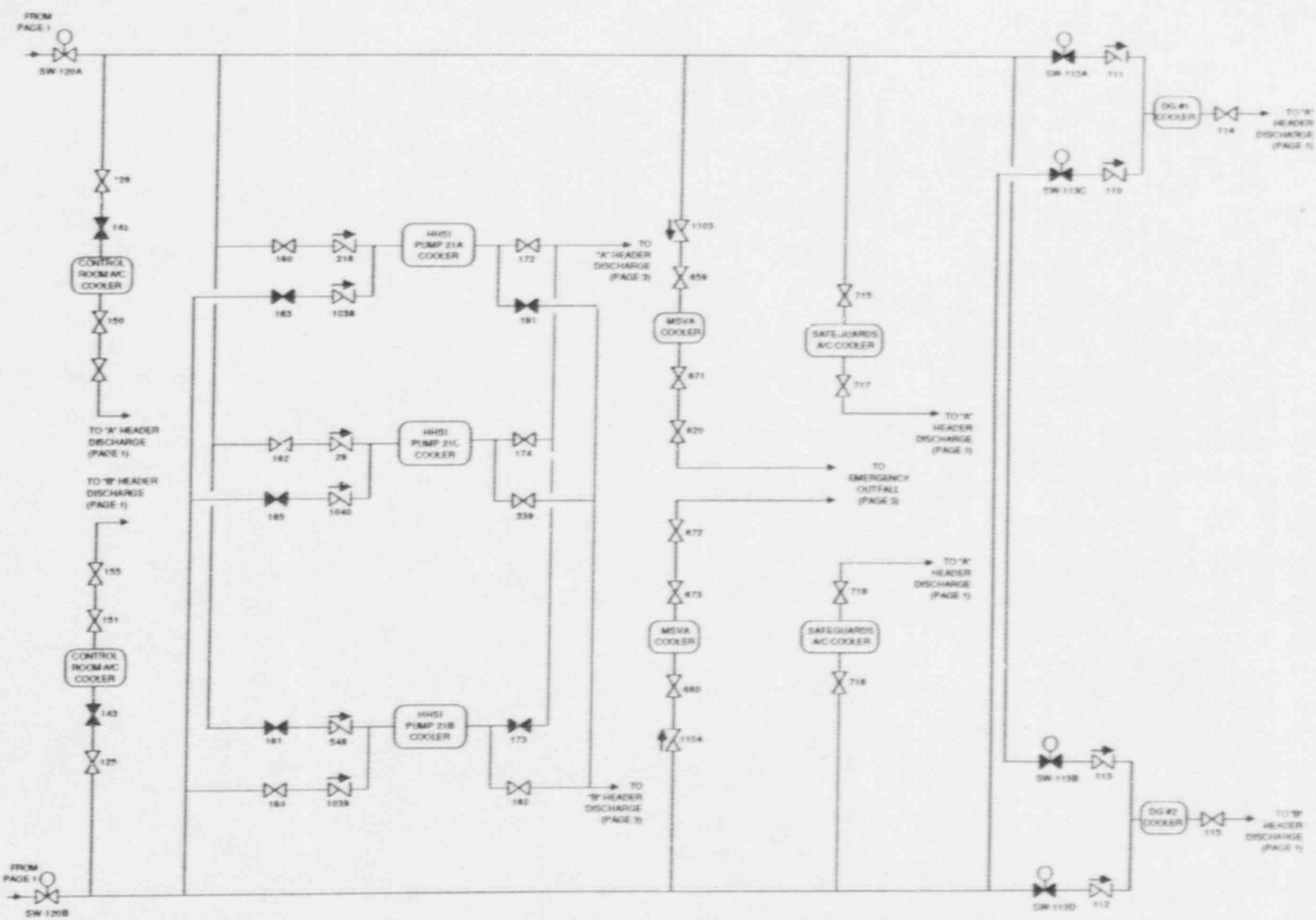



Figure 3.7-1. Beaver Valley 2 Service Water System (page 2 of 3)

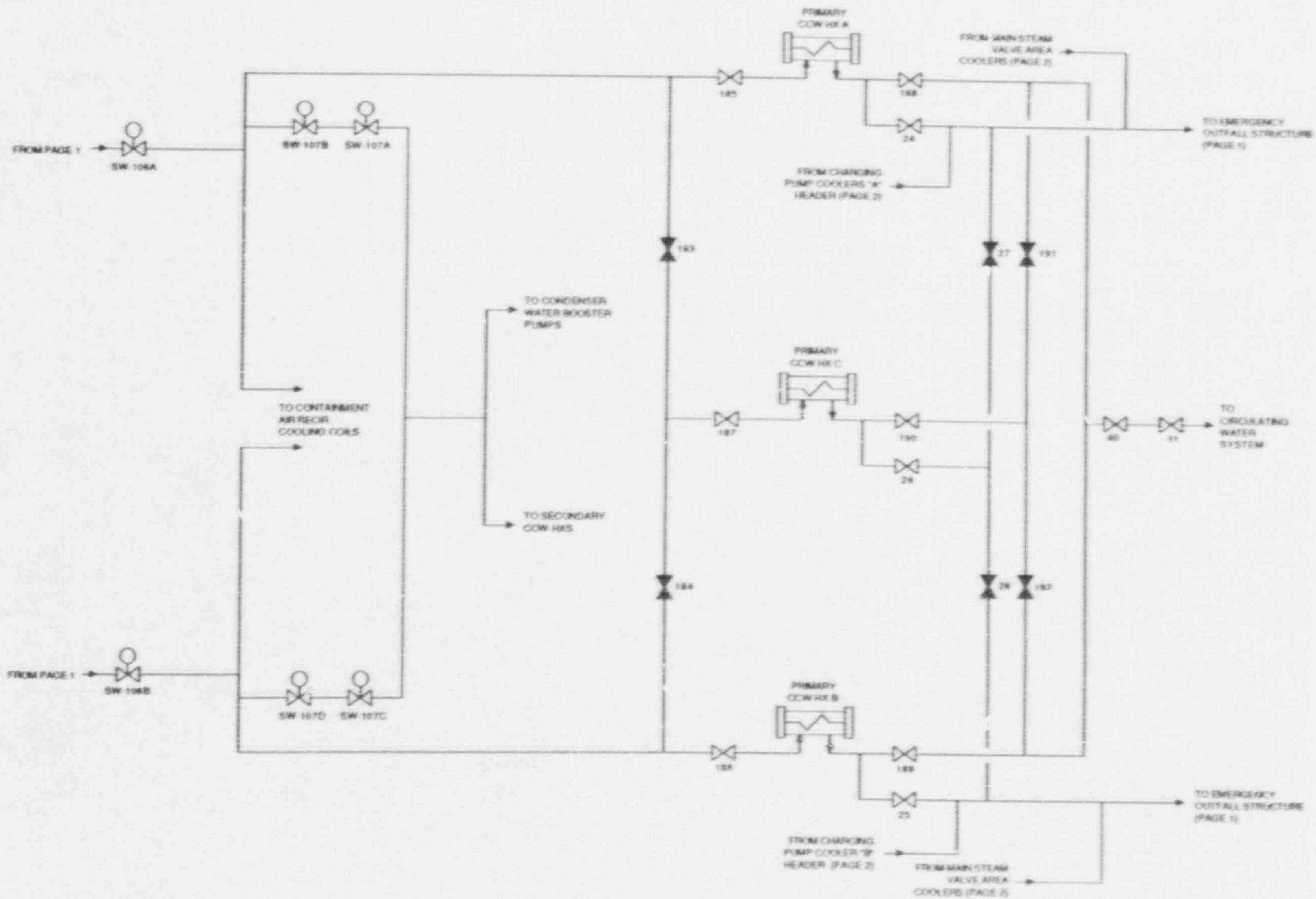



Figure 3.7-1. Beaver Valley 2 Service Water System (page 3 of 3)

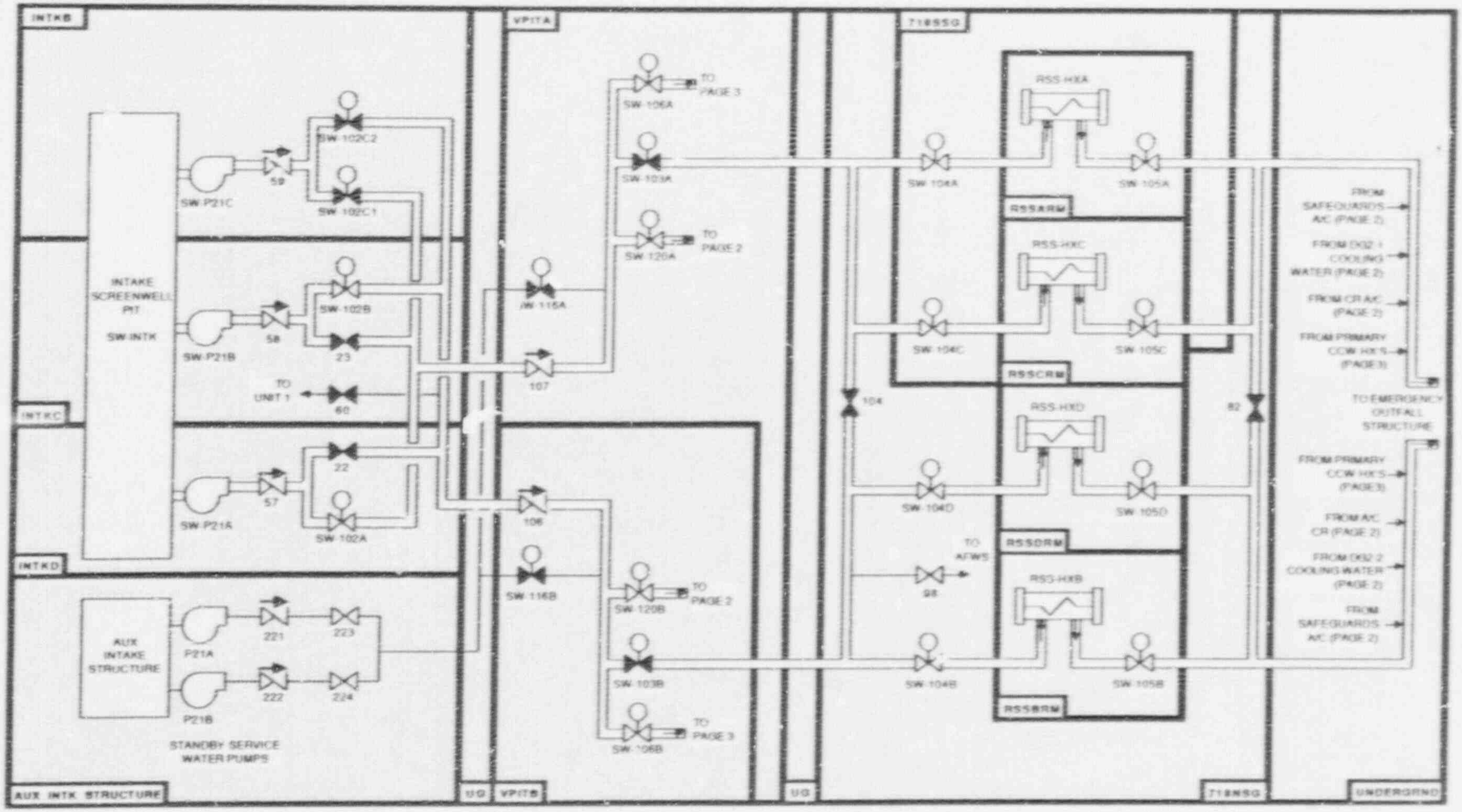



Figure 3.7-2. Beaver Valley 2 Service Water System Showing Component Locations (page 1 of 3)



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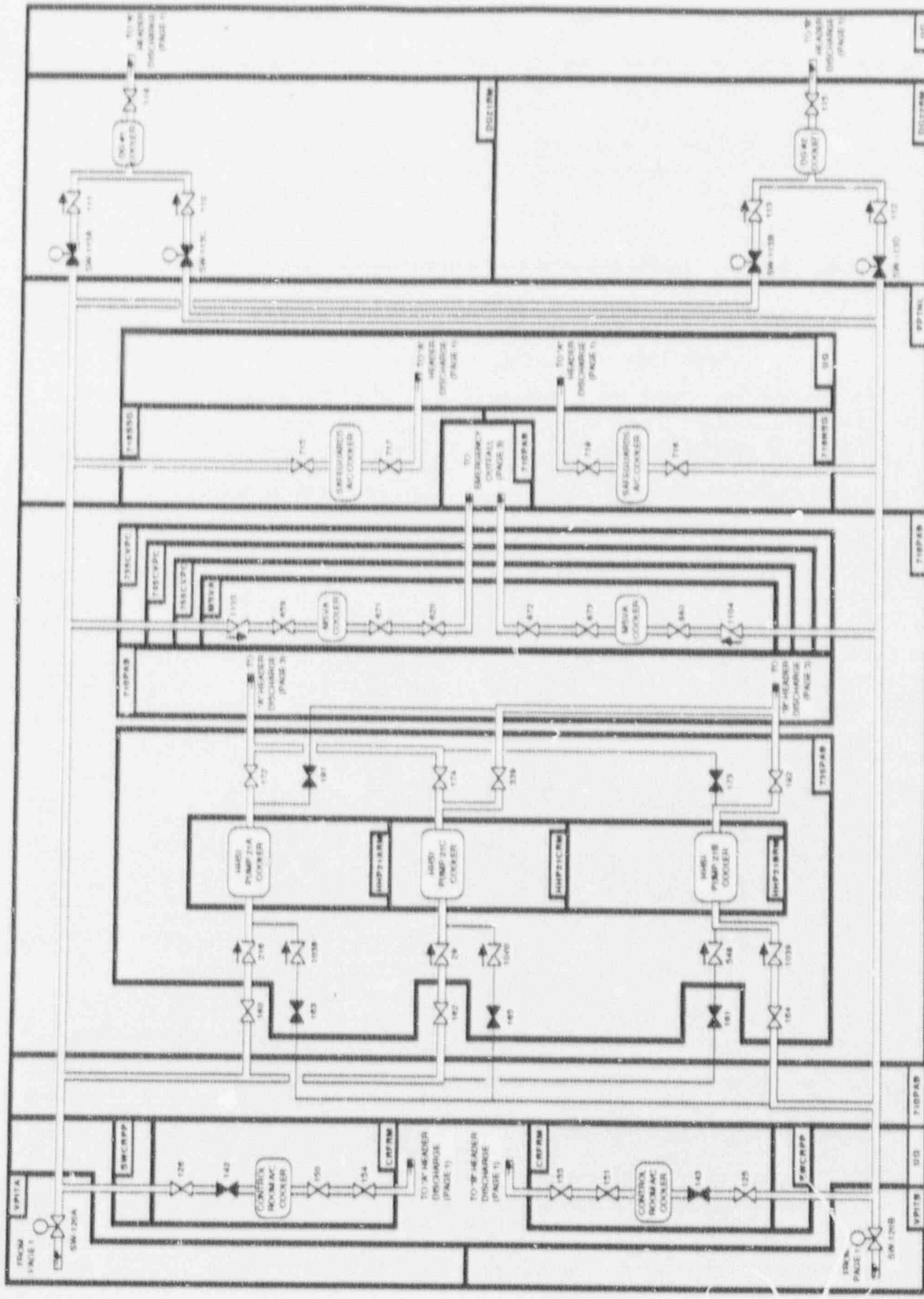


Figure 3.7-2. Beaver Valley 2 Service Water System Showing Component Locations (page 2 of 3)

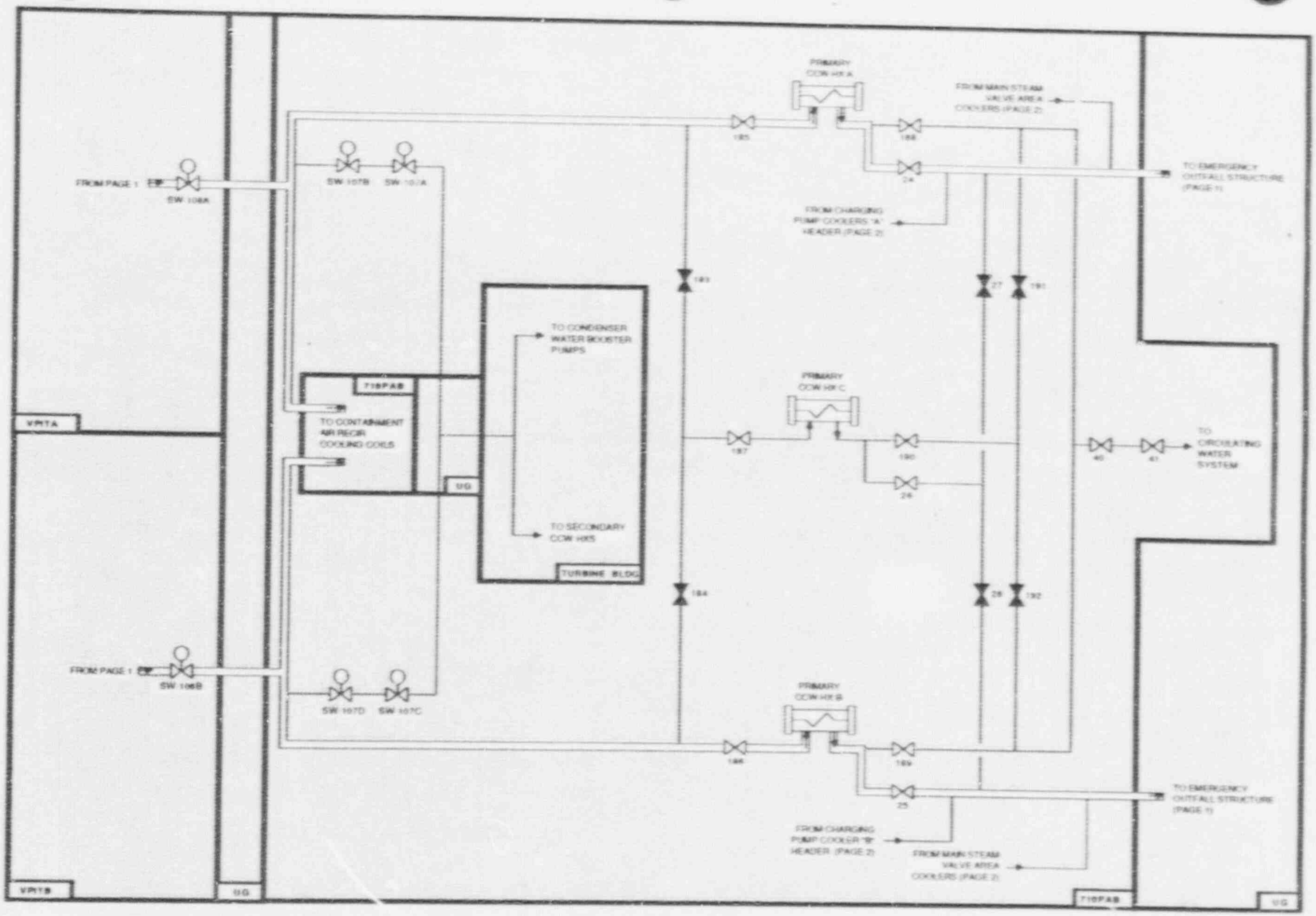



Figure 3.7-2. Beaver Valley 2 Service Water System Showing Component Locations (page 3 of 3)

Table 3.7-1. Beaver Valley 2 Service Water System Data Summary for Selected Components

| COMPONENT ID | COMP. TYPE | LOCATION | POWER SOURCE | VOLTAGE | POWER SOURCE LOCATION | EMERG. LOAD GRP. |
|---|---|---|---|---|---|---|
| SW-102A | MOV | INTKD | EP-MCC-E1 | 480 | INTKD | AC/A |
| SW-102B | MOV | INTKC | EP-MCC-E2 | 480 | INTKC | AC/B |
| SW-102C1 | MOV | INTKB | EP-MCC-E1 | 480 | INTKD | AC/A |
| SW-102C1 | MOV | INTKB | EP-MCC-E1 | 480 | INTKD | AC/A |
| SW-102C2 | MOV | INTKB | EP-MCC-E2 | 480 | INTKC | AC/B |
| SW-102C2 | MOV | INTKB | EP-MCC-E2 | 480 | INTKC | AC/B |
| SW-103A | MOV | VPITA | EP-MCC-E3 | 480 | 755PAB | AC/A |
| SW-103A | MOV | VPITA | EP-MCC-E3 | 480 | 755PAB | AC/A |
| SW-103B | MOV | VPITB | EP-MCC-E4 | 480 | 755PAB | AC/B |
| SW-103B | MOV | VPITB | EP-MCC-E4 | 480 | 755PAB | AC/B |
| SW-104A | MOV | 718SSG | EP-MCC-E11 | 480 | 735SSG | AC/A |
| SW-104B | MOV | 718NSG | EP-MCC-E12 | 480 | 735NSG | AC/B |
| SW-104C | MOV | 718SSG | EP-MCC-E11 | 480 | 735SSG | AC/A |
| SW-104D | MOV | 718SSG | EP-MCC-E12 | 480 | 735NSG | AC/B |
| SW-105A | MOV | RSSARM | EP-MCC-E11 | 480 | 735SSG | AC/A |
| SW-105B | MOV | RSSBRM | EP-MCC-E12 | 480 | 735NSG | AC/B |
| SW-105C | MOV | RSSCRM | EP-MCC-E11 | 480 | 735SSG | AC/A |
| SW-105D | MOV | RSSDRM | EP-MCC-E12 | 480 | 735NSG | AC/B |
| SW-106A | MOV | VPITA | EP-MCC-E3 | 480 | 755PAB | AC/A |
| SW-106B | MOV | VPITB | EP-MCC-E4 | 480 | 755PAB | AC/B |
| SW-107A | MOV | 710PAB | EP-MCC-E3 | 480 | 755PAB | AC/A |
| SW-107B | MOV | 710PAB | EP-MCC-E4 | 480 | 755PAB | AC/B |
| SW-107C | MOV | 710PAB | EP-MCC-E3 | 480 | 755PAB | AC/A |
| SW-107D | MOV | 710PAB | EP-MCC-E4 | 480 | 755PAB | AC/B |
| SW-113A | MOV | DG21RM | EP-MCC-E7 | 480 | DG21RM | AC/A |
| SW-113D | MOV | DG22RM | EP-MCC-E8 | 480 | DG22RM | AC/B |
| SW-116A | MOV | VPITA | EP-MCC-E3 | 480 | 755PAB | AC/A |
| SW-116B | MOV | VPITB | EP-MCC-E4 | 480 | 755PAB | AC/B |

Table 3.7-1. Beaver Valley 2 Service Water System Data Summary for Selected Components (Continued)

| COMPONENT ID | COMP. TYPE | LOCATION | POWER SOURCE | VOLTAGE | POWER SOURCE LOCATION | EMERG. LOAD GRP. |
|---|---|---|---|---|---|---|
| SW-120A | MOV | VPITA | EP-MCC-E3 | 480 | 755PAB | AC/A |
| SW-120B | MOV | VPITB | EP-MCC-E4 | 480 | 755PAB | AC/B |
| SW-INTK | TK | INTKD | | | | |
| SW-INTK | TK | INTKB | | | | |
| SW-INTK | TK | INTKC | | | | |
| SW-P21A | MDP | INTKD | EP-BS-2AE | 4160 | ESWGRMW | AC/A |
| SW-P21B | MDP | INTKC | EP-BS-2DF | 4160 | ESWGRME | AC/B |
| SW-P21C | MDP | INTKB | EP-BS-2AE | 4160 | ESWGRMW | AC/A |
| SW-P21C | MDP | INTKB | EP-BS-2DF | 4160 | ESWGRME | AC/B |

## 3.8 PRIMARY COMPONENT COOLING WATER SYSTEM

### 3.8.1 System Function

The primary component cooling water (CCW) system provides an intermediate cooling loop for removing heat from the reactor plant auxiliary systems and transferring it to the service water system (SWS). The primary CCW system provides cooling for the following components:

- Residual Heat Removal Heat Exchangers
- Residual Heat Removal Pump Seal Coolers
- Nonregenerative (Letdown) Heat Exchanger
- RCP Seal Water Heat Exchanger
- RCP Thermal Barrier Coolers
- Fuel Pool Heat Exchangers
- Degasifier Heat Exchangers
- Gaseous Waste Compressors
- Containment Instrument Air Compressors
- Containment Penetration Cooling Coils

Serving as an intermediate system between the RCS and SWS, the primary CCW system reduces the probability of leakage to the environment of potentially radioactive primary coolant.

### 3.8.2 System Definition

The primary CCW system is a closed loop cooling water system consisting of two 100-percent capacity trains (train A and train B). The system consists of three heat exchangers, three 100-percent capacity pumps, two CCW surge tanks, and associated piping, valves, and instrumentation. The A and B train CCW heat exchangers are cooled by the corresponding service water train, and the swing heat exchanger can be cooled by either service water train. Similarly, the A and B train CCW pumps are supplied power from the corresponding Class 1E AC train, and the swing pump can be supplied power from either Class 1E AC train. Simplified drawings of the primary CCW system are shown in Figures 3.8-1 and 3.8-2.

### 3.8.3 System Operation

During normal plant operation, two component cooling pumps and heat exchangers are utilized. However, cold shutdown can be achieved and maintained with one CCW train. The CCW pumps take suction from and discharge to common headers and circulate the component cooling water through the CCW heat exchangers. From the heat exchangers, coolant is discharged into a common header, through the components to be cooled, and then back to the pump suction header via two return headers. The heat transferred through the heat exchangers is rejected to the service water system.

Two surge tanks are connected to the pump suction header and function to ensure that the system is kept filled and pump suction head requirements are maintained.

### 3.8.4 System Success Criteria

Cold shutdown can be achieved and maintained with one CCW train utilizing one pump (Ref. 2.) The Service Water System is required to remove heat from the corresponding CCW heat exchanger (see Section 3.7).

### 3.8.5 Component Information

A. Primary Component Cooling Water pumps 21A, 21B, 21C
   1. Rated flow: 6000 gpm @ 200 ft. head (87 psid)
   2. Rated capacity: 100%
   3. Type: Horizontal centrifugal

B. Primary Component Cooling Water heat exchangers 21A, 21B, 21C
   1. Heat transferred: 33 x $10^6$ Btu/hr each
   2. Rate capacity: 100%
   3. Type: Shell-and-tube

C. Surge tanks (2)
   1. Total volume: 1650 gallons each
   2. Operating pressure: Atmospheric
   3. Type: Cylindrical, vertical

### 3.8.6 Support Systems and Interfaces

A Control Signals
   1. Automatic
      The non-nuclear safety (NNS) class portion of the primary CCW system is isolated automatically on a containment isolation Phase A (CIA) signal or low surge tank level.
   2. Remote manual
      All CCW pumps can be controlled from the main control room and the emergency shutdown panel (ESP). CCW pump P21A can be controlled from the auxiliary shutdown panel (ASP).

B. Motive Power
   The motor-driven CCW 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. Heat is transferred from the CCW heat exchangers to the service water system (see Section 3.7).
   2. Lubrication and cooling is assumed to be provided locally for the CCW pumps.
   3. CCW pump room cooling is provided by the Auxiliary Building Ventilation System.

### 3.8.7 Section 3.8 References


1. Beaver Valley 2 Final Safety Analysis Report, Section 9.2.2.1.
2. Fire Protection Safe Shutdown Report, Beaver Valley Power Station - Unit 2, Duquesne Light Company.

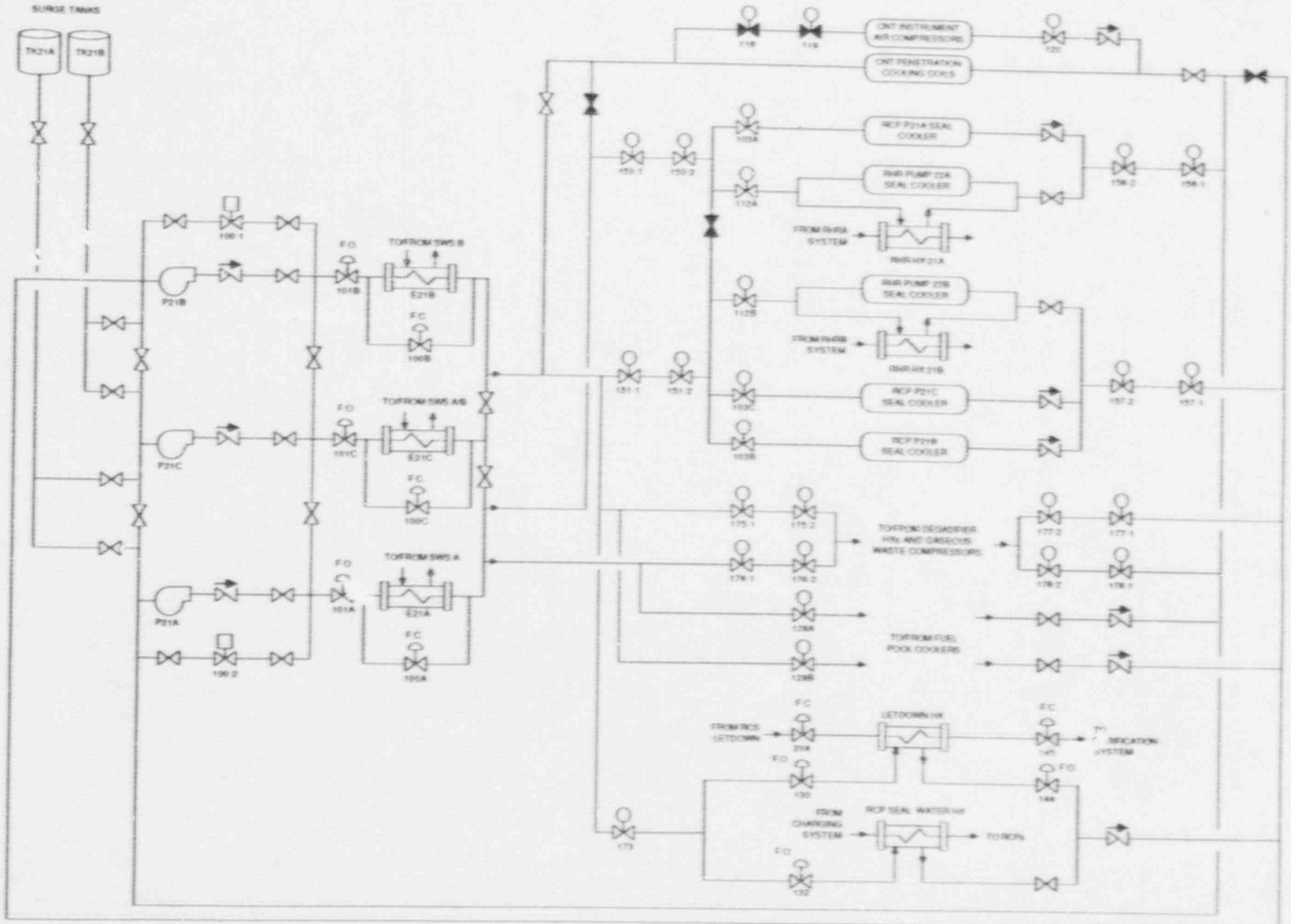



Figure 3.8-1. Beaver Valley 2 Primary Component Cooling Water System

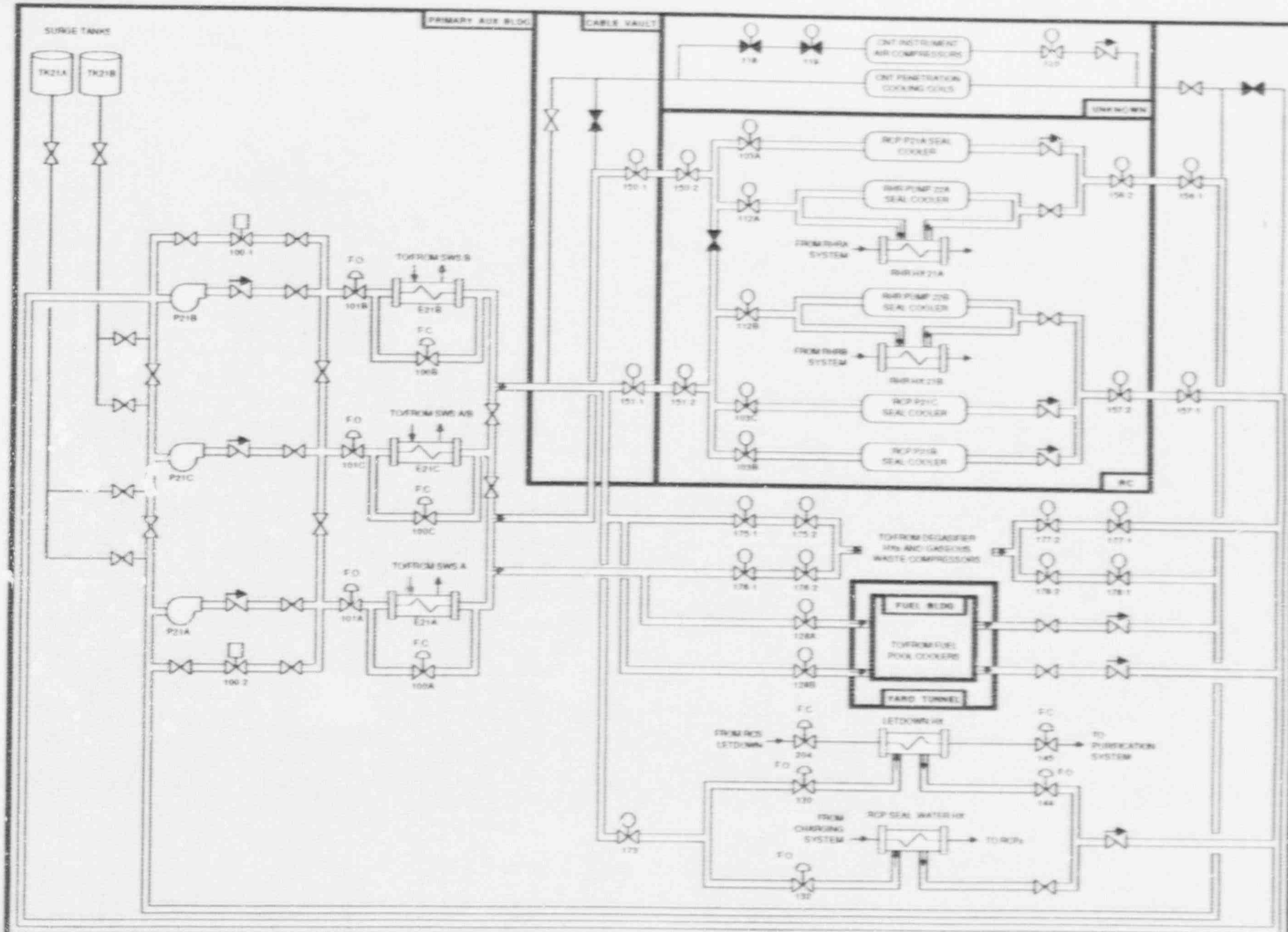



Figure 3.8-2. Beaver Valley 2 Primary Component Cooling Water System Showing Component Locations

## 3.9 CHEMICAL AND VOLUME CONTROL SYSTEM (CVCS)

### 3.9.1 System Function

The Chemical and Volume Control System (CVCS) is responsible for maintaining the proper water inventory in the Reactor Coolant System and maintaining water purity and the proper concentration of neutron absorbing and corrosion inhibiting chemicals in the reactor coolant. The CVCS is designed to provide the following services to the RCS:

- maintain programmed water level in the pressurizer, (i.e., maintain the required water inventory in the RCS).
- maintain seal water injection flow to the reactor coolant pumps.
- control of reactor coolant water chemistry conditions, activity level, soluble neutron absorber concentration, and makeup.
- supplying means for filling, draining, and pressure testing of the RCS.
- provide reactor coolant purification.
- provide safety grade boration and makeup during cold shutdown.
- provide a means to purify fresh or recycled boric acid

The normal makeup function of the CVCS is required to maintain the plant in a long-term hot shutdown condition following a transient. In addition, the centrifugal charging pumps serve as the high-head safety injection system as part of the ECCS.

### 3.9.2 System Definition

The CVCS consists of the following subsystems: the Charging, Letdown, and Seal Water System, the Reactor Coolant Purification and Chemistry Control System, the Reactor Makeup Control System, and the Boron Thermal Regeneration System. The CVCS includes the following:

- three centrifugal charging pumps
- a normal charging flow paths to the RCS
- two letdown flow paths from the RCS (normal and excess letdown paths)
- borated water sources for the charging pumps (boric acid tanks and refueling water storage tank)
- various demineralizers, filters, and other subsystems for maintaining reactor coolant purity, pH, and chemical concentration

Simplified drawings of the CVCS, focusing on the normal charging portion of the system, are shown in Figures 3.9-1 and 3.9-2. Simplified drawings of the charging system focusing on the ECCS operating modes are included in Section 3.3 along with summary data on selected charging system components.

### 3.9.3 System Operation

The charging and letdown functions of the CVCS are used to maintain proper RCS inventory during all modes of plant operation. The letdown flow (60 gpm nominal, 120 gpm max) from the reactor coolant system is cooled by the regenerative heat exchanger and the letdown heat exchanger, and pressure is reduced along the letdown flow path to the letdown filters and mixed-bed demineralizers. Boron concentration is adjusted before the letdown flow is directed to the Volume Control Tank (VCT). The charging pumps normally are aligned to take a suction on the VCT.

Normal charging flow is handled by one of the three centrifugal charging pumps. The bulk of the charging flow is returned to the RCS loop 2 cold leg through the tube side of the regenerative heat exchanger. The letdown flow in the shell side of the regenerative heat exchanger raises the charging flow to a temperature approaching the reactor coolant temperature. A flow path is also provided to the auxiliary pressurizer spray line. The remainder of the charging flow (about 24 gpm) is pumped to the reactor coolant pump seals.

Low water level in the VCT initiates makeup of a blend of boric acid and primary grade water. If the VCT level continues to decrease, a low-low level signal causes the suction of the charging pumps to be switched to the refueling water storage tank. The pumps also can be aligned to take a suction on the boric acid tanks.

### 3.9.4 System Success Criteria

In order to provide RCS makeup to maintain the plant in a long-term hot shutdown condition following a transient the success criteria are the following:

- One of three centrifugal charging pumps must operate.
- The RWST is assumed to be the only adequate long-term water source for extended hot shutdown (i.e., without requiring more extensive manual actions to resupply the VCT or align to the boric acid tanks).

### 3.9.5 Component Information

A. Charging/High-Head Safety Injection Pumps P21A, P21B, P21C
   1. Rated flow: 150 gpm @ 5800 ft head (2515 psid)
   2. Rated capacity: 100%
   3. Design pressure: 3100 psig

B. Boric Acid Transfer Pumps A, B
   1. Design flow: 75 gpm @ 235 ft head (102 psid)
   2. Design pressure: 150 psig

C. Volume Control Tank
   1. Volume: not determined
   2. Design pressure: not determined

D. Refueling Water Storage Tank
   1. Design volume: 850,000 gallons
   2. Design pressure: atmospheric
   3. Nominal boron concentration: 2000 ppm

E. Boric Acid Tanks A, B
   1. Volume: 12,500 gal each
   2. Design pressure: atmospheric

### 3.9.6 Support Systems and Interfaces

A. Control Signals
   1. Automatic
      a. Low level in the VCT initiates makeup of boric acid and primary-grade water.
      b. Low-low level in the VCT causes automatic transfer of the suction of the charging pumps to the RWST.

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

B. Motive Power

The centrifugal charging pumps and motor-operated valves associated with the ECCS function are Class 1E AC loads that can be supplied from the standby diesel generators as described in Section 3.6.

C. Other

1. Cooling for the charging/HHSI pumps is provided by the Service Water System (see Section 3.7).
2. Charging/HHSI pump room cooling is provided by the Auxiliary Building Ventilation System.

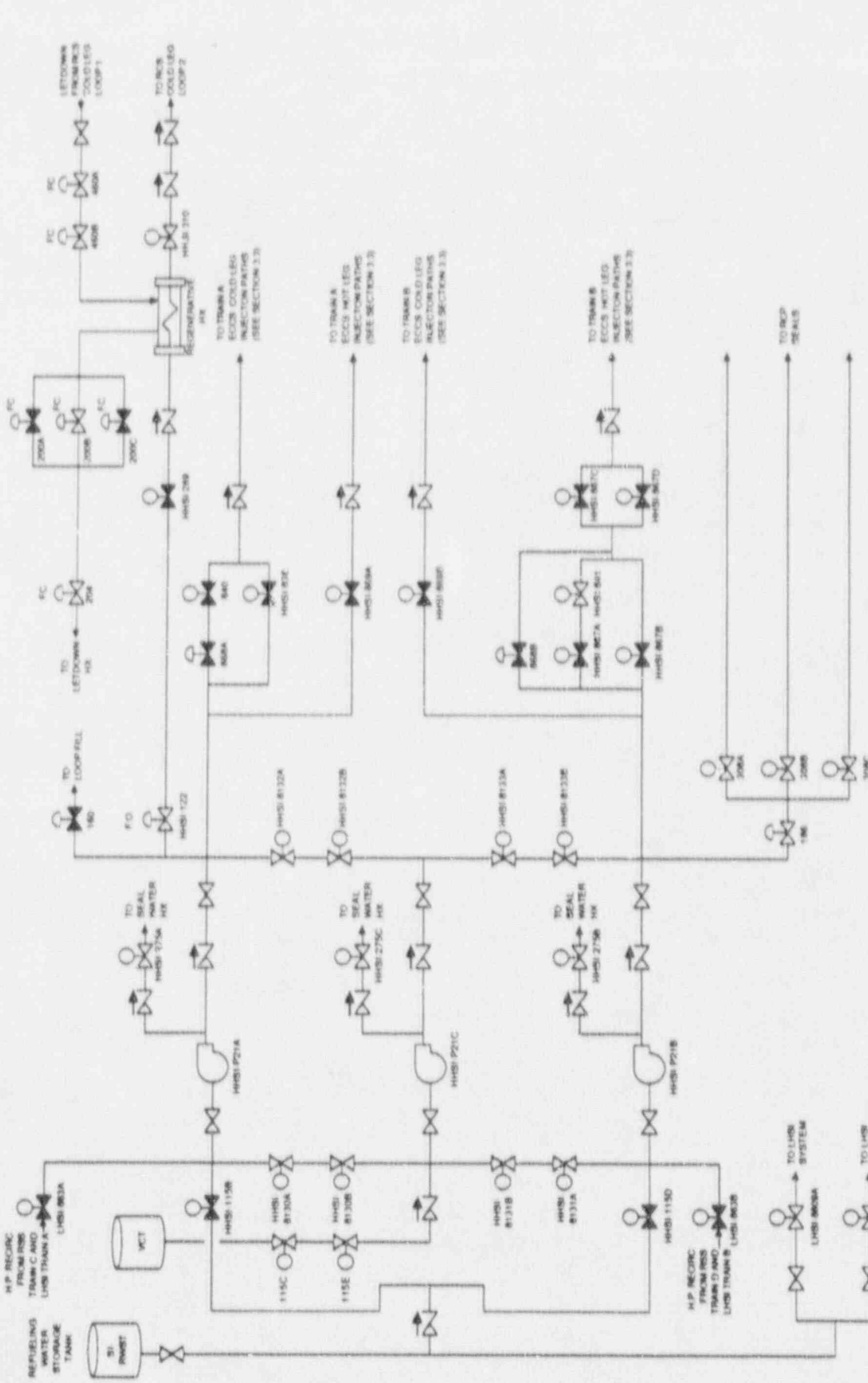


Figure 3.9-1. Beaver Valley 2 Charging System

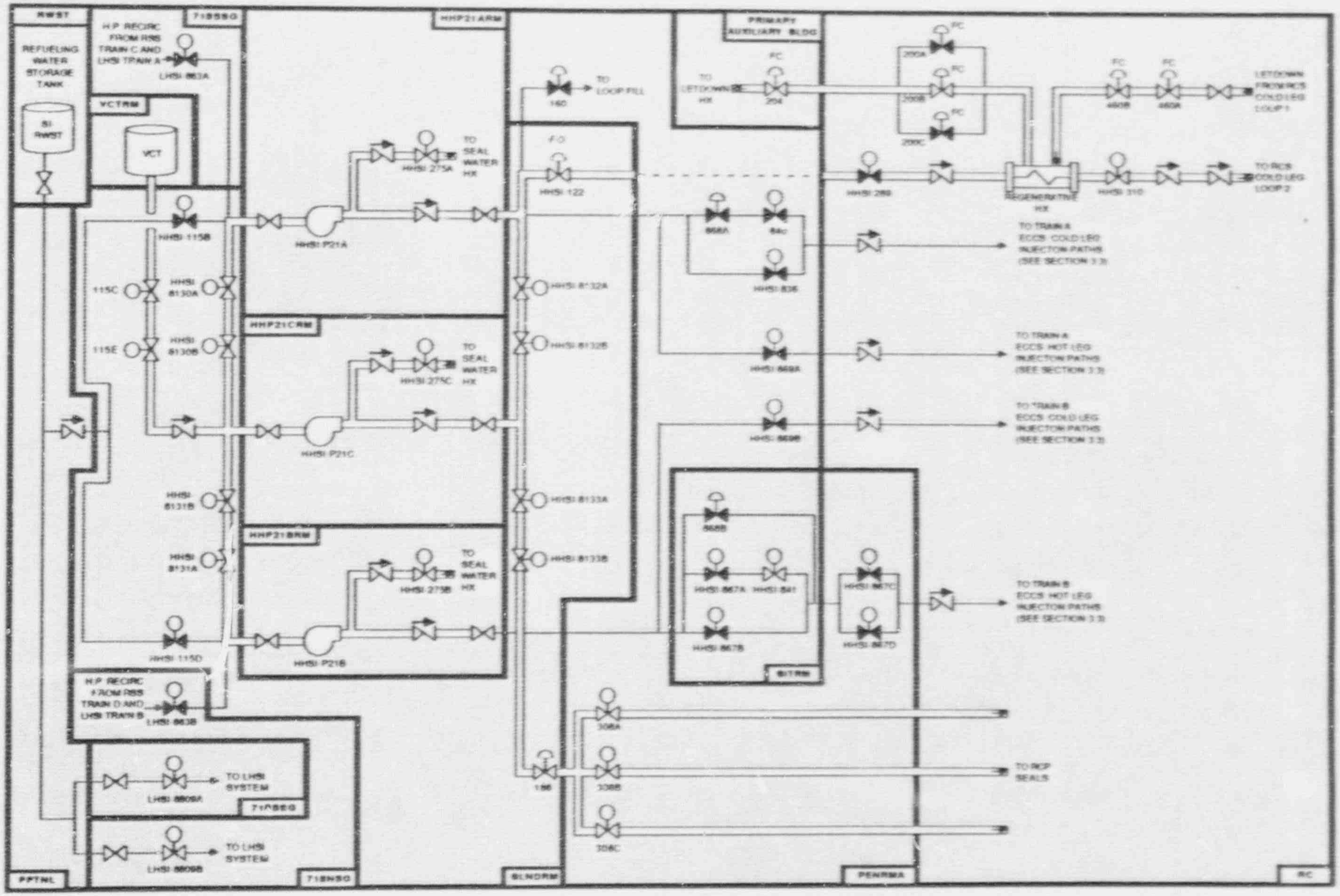



Figure 3.9-2. Beaver Valley 2 Charging System Showing Component Locations

# 4. PLANT INFORMATION

## 4.1 SITE AND BUILDING SUMMARY

The Beaver Valley Power Station (BVPS) is located in Shippingport Borough, Pennsylvania, on the south bank of the Ohio River. Containing approximately 501 acres, the BVPS site houses both BVPS Unit 1 (BVPS-1) and BVPS Unit 2 (BVPS-2), as well as the Shippingport Atomic Power Station (SAPS). The site is approximately 25 miles northwest of Pittsburg and 5 miles east of Liverpool, Ohio. Figure 4-1 (Ref. 1) shows a general view of the site, Figure 4-2 shows a perspective view of the site, and Figure 4-3 shows a simplified plot plan of the site.

The major building areas include the containment structure, safeguards area, auxiliary building, fuel and decontamination building, main steam and cable vault area, turbine building, condensate polishing building, cooling tower, refueling water storage tank (RWST) enclosure, primary plant demineralized water storage tank (PPDWST) enclosure, emergency outfall structure, cooling tower pump house, gaseous waste storage area, and control building. Except for the steel framed turbine building and cooling tower pump house, the structures are constructed predominantly of reinforced concrete. The subatmospheric containment is a steel-lined, reinforced concrete cylinder with a hemispherical dome and flat base. The cooling tower is a natural draft hyperbolic type with a reinforced concrete shell.

Structures housing safety-related equipment are the containment structure, safeguards area, main steam and cable vault, auxiliary building, fuel and decontamination building, control building, diesel generator building, service building, RWST enclosure, and PPDWST enclosure.

## 4.2 FACILITY LAYOUT DRAWINGS

Figures 4-4, 4-5, 4-6, and 4-14 show various section views of the Beaver Valley 2 station. Figures 4-7 through 4-13 and 4-15 show simplified layout drawings for Beaver Valley 2. Major rooms, stairways, elevators and doorways are included, however some interior features are omitted in these simplified layout drawings. Labels printed in uppercase correspond to the location codes listed in Table 4-1 and used in component data listings and system drawings in Section 3. Some additional labels are included for information and are printed in lowercase type.

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.

## 4.3 Section 4 References

1. Heddleson, F.A., "Design Data and Safety Features of Commercial Nuclear Power Plants," ORNL-NSIC-55, Volume III, Oak Ridge National Laboratory, April, 1974.

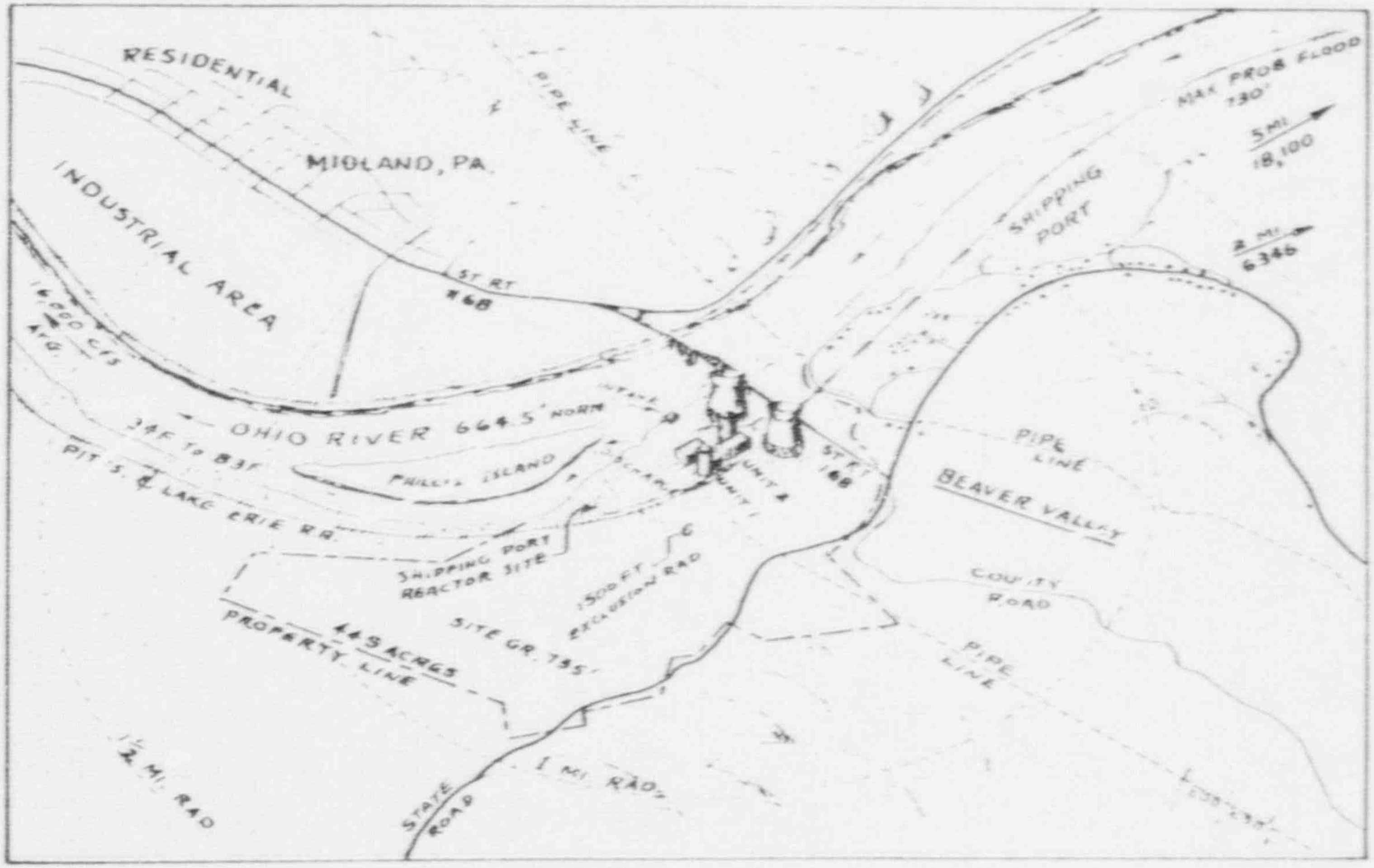



Figure 4-1. General View of the Beaver Valley Site and Vicinity

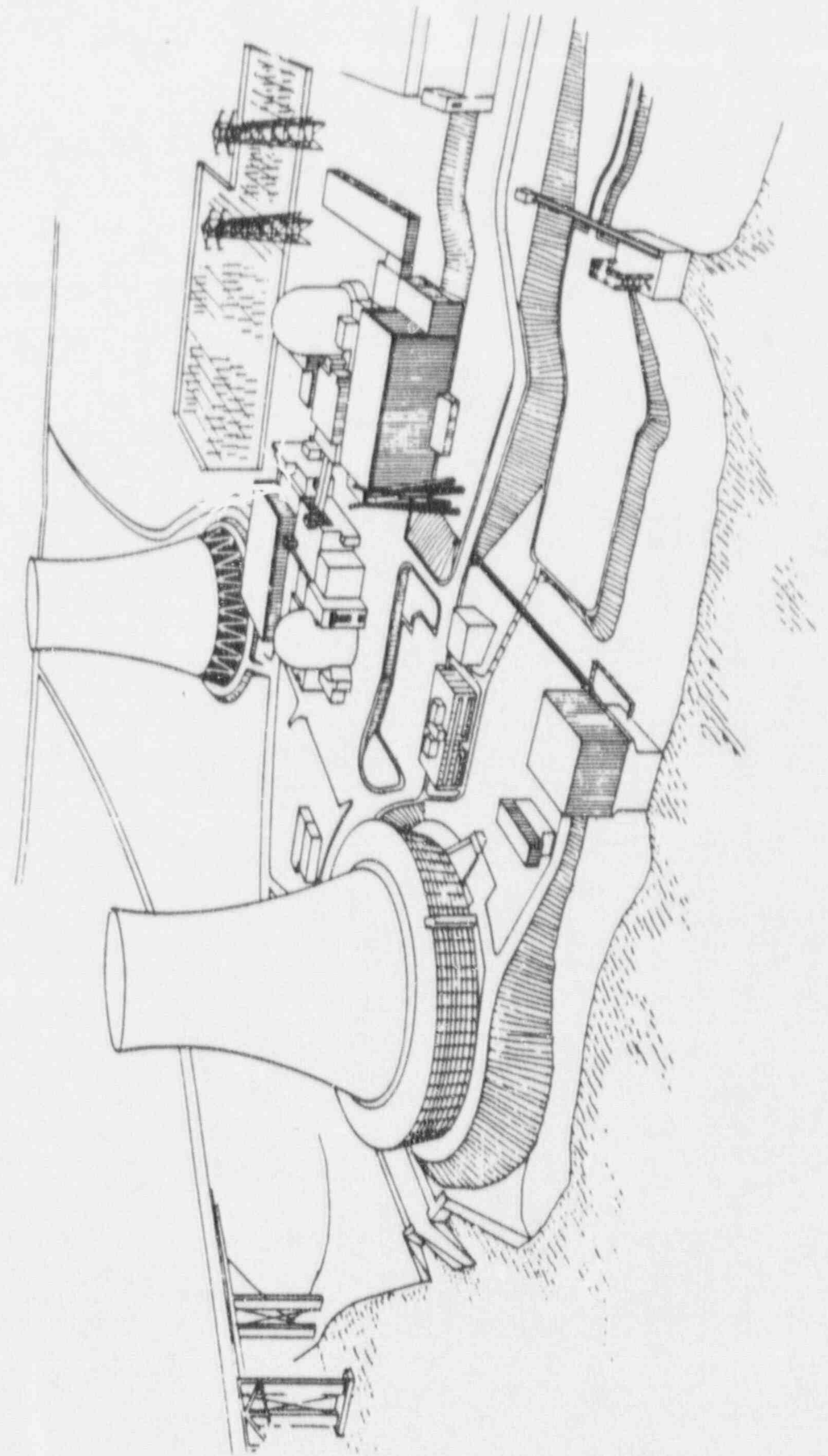


Figure 4-2. Perspective View of the Beaver Valley Site

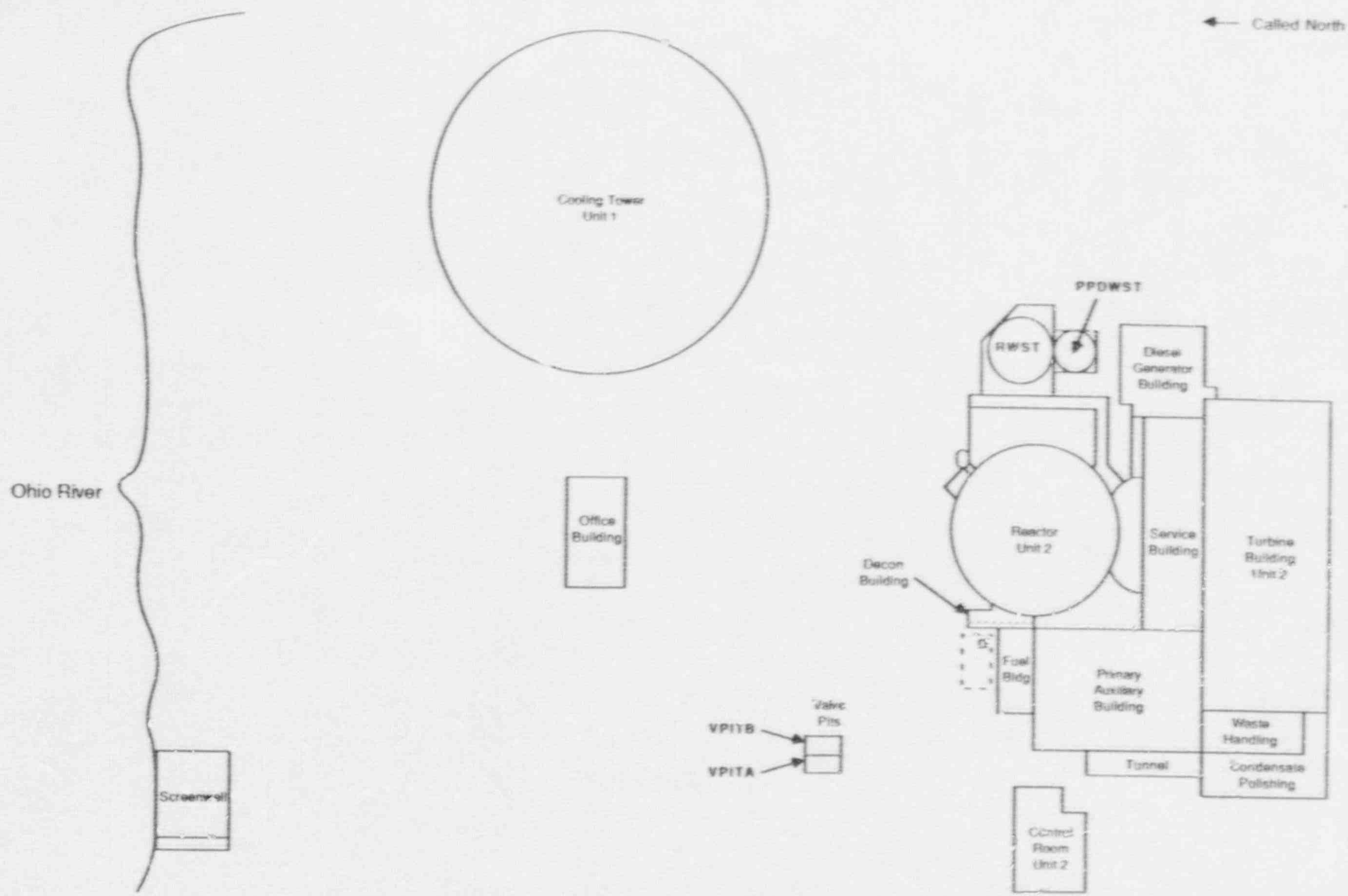



Figure 4-3. Site Plan for Beaver Valley 2

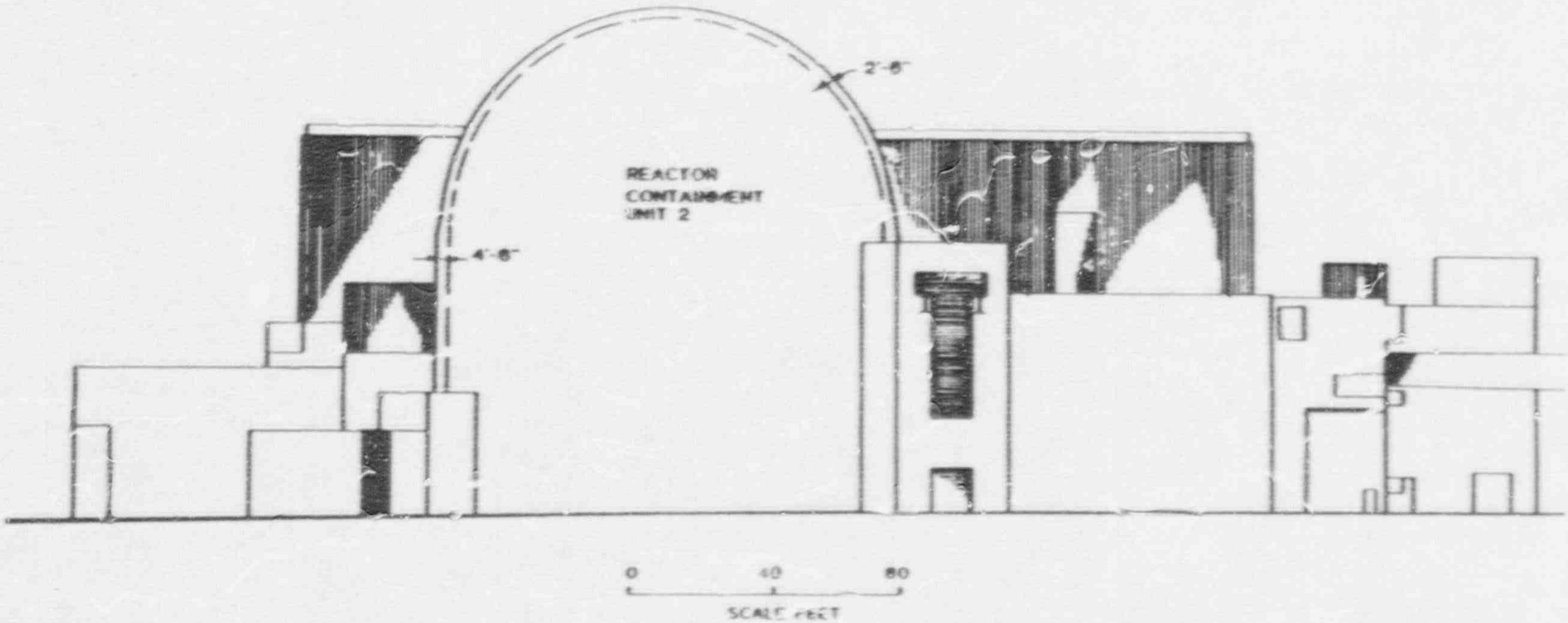



Figure 4-1. Section View of Beaver Valley 2 Looking South

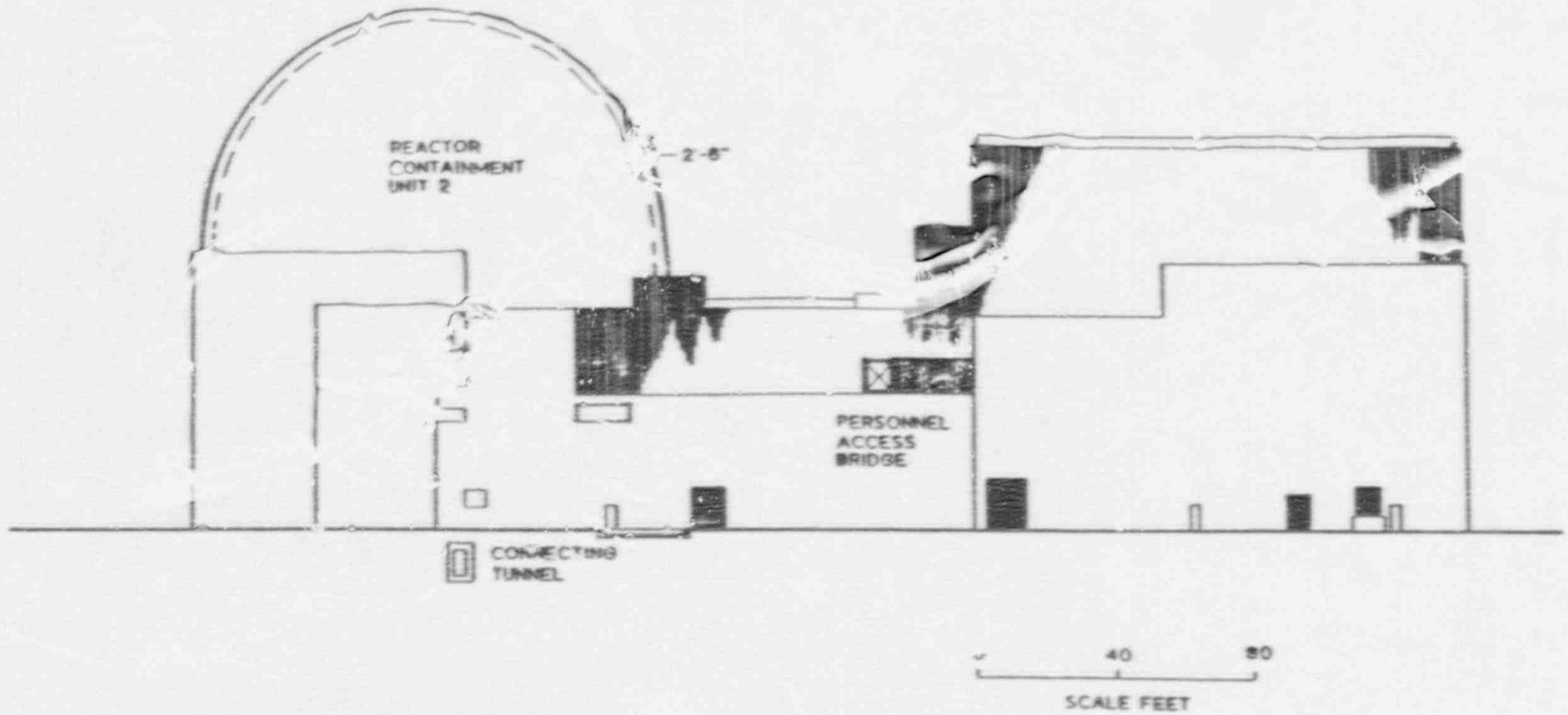



Figure 4-5. Section View of Beaver Valley 2 Looking West

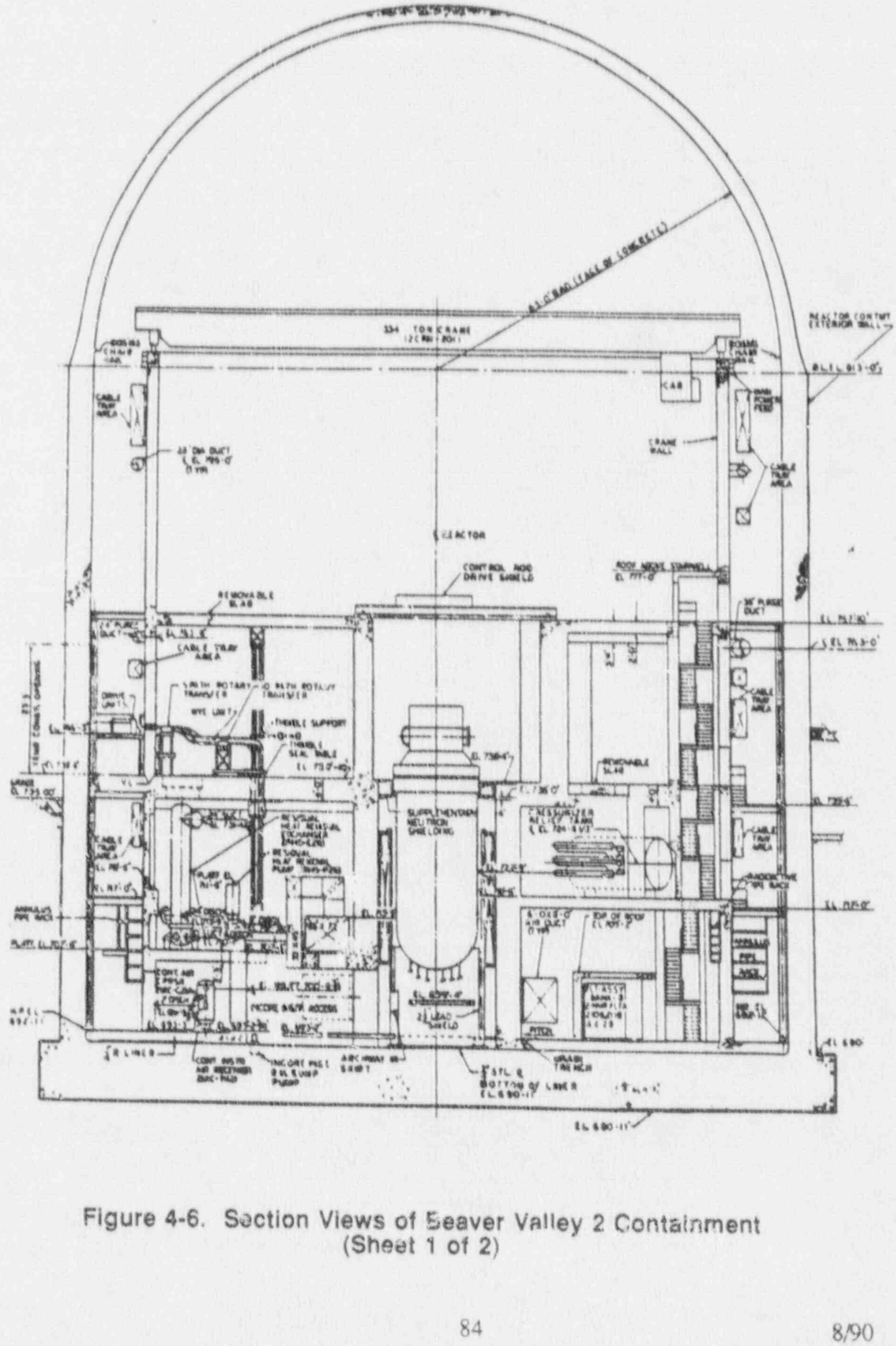


Figure 4-6. Section Views of Beaver Valley 2 Containment
(Sheet 1 of 2)

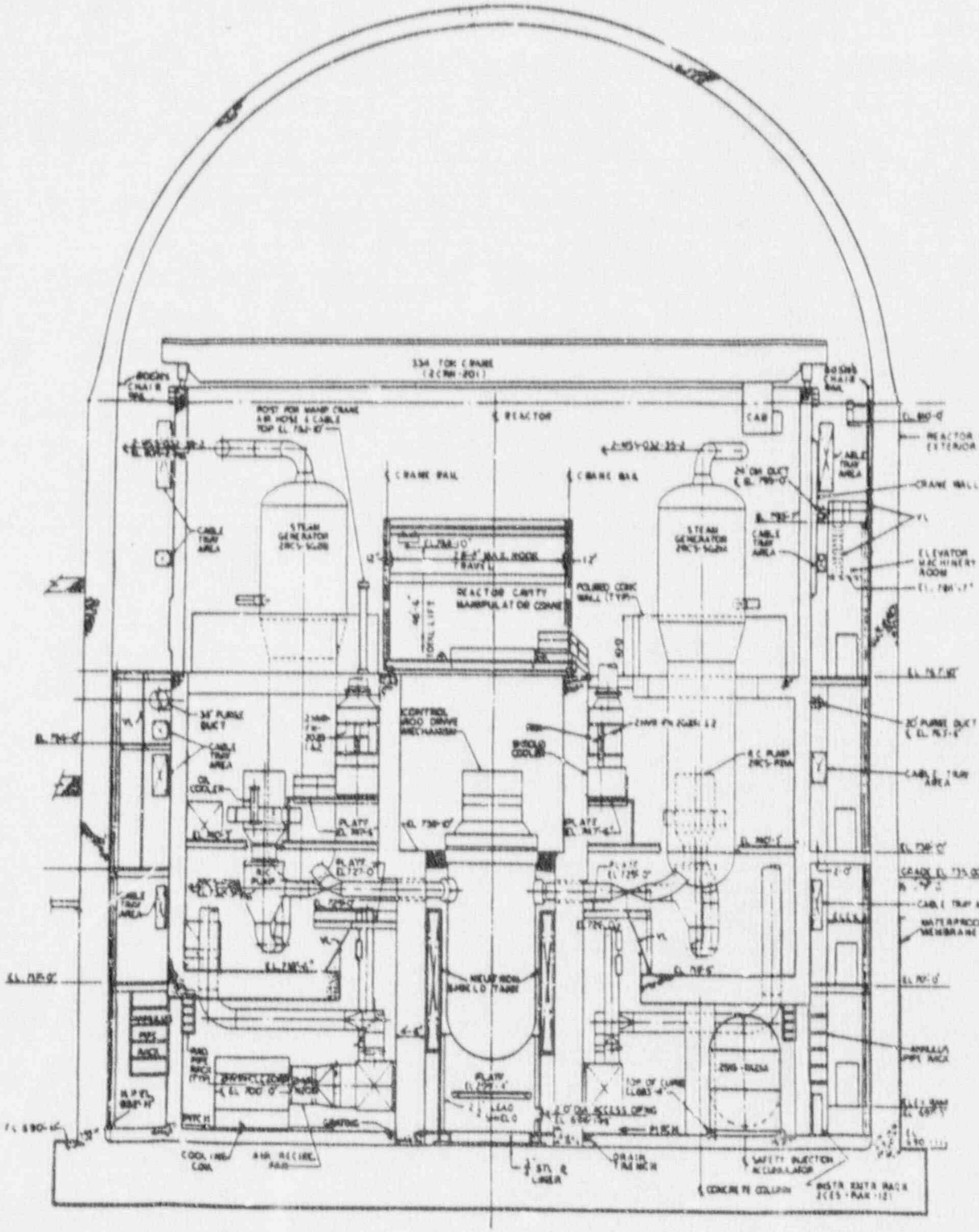



Figure 4-6. Section Views of Beaver Valley 2 Containment
(Sheet 2 of 2)

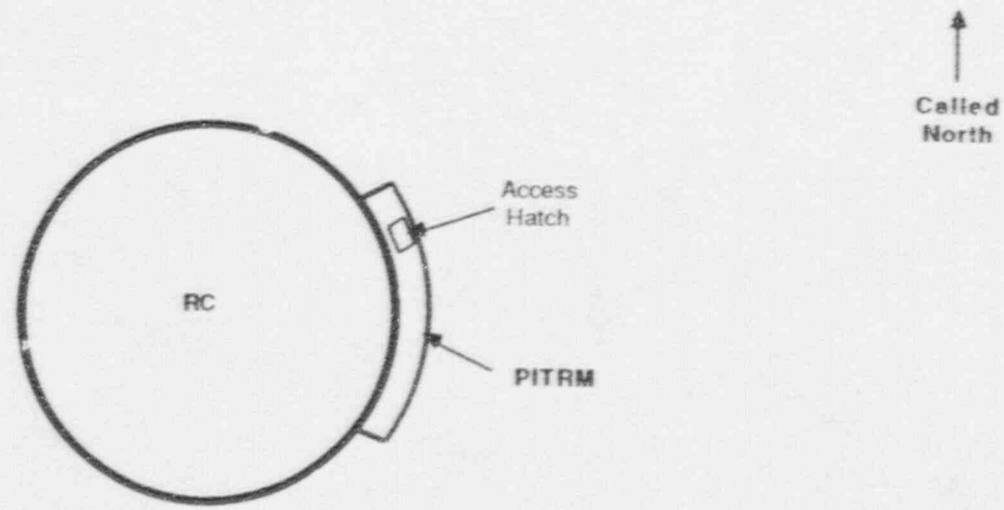



Figure 4-7. Beaver Valley 2 Reactor Containment and Safeguards Building (Elevation 692')

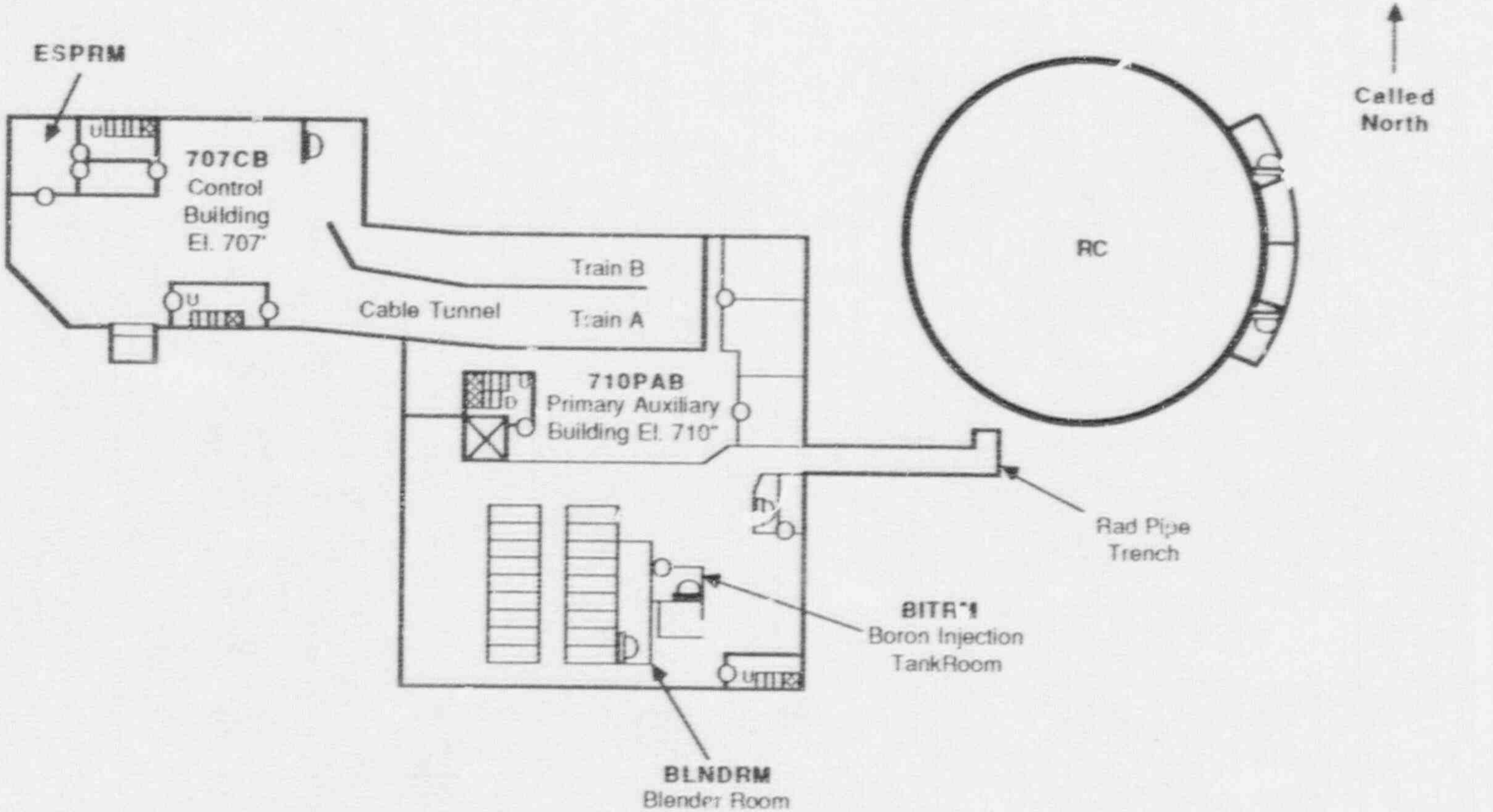



Figure 4-8. Beaver Valley 2 Reactor Containment, Control Building, Primary Auxiliary Building, and Safeguards Building (Elevation 710'6")

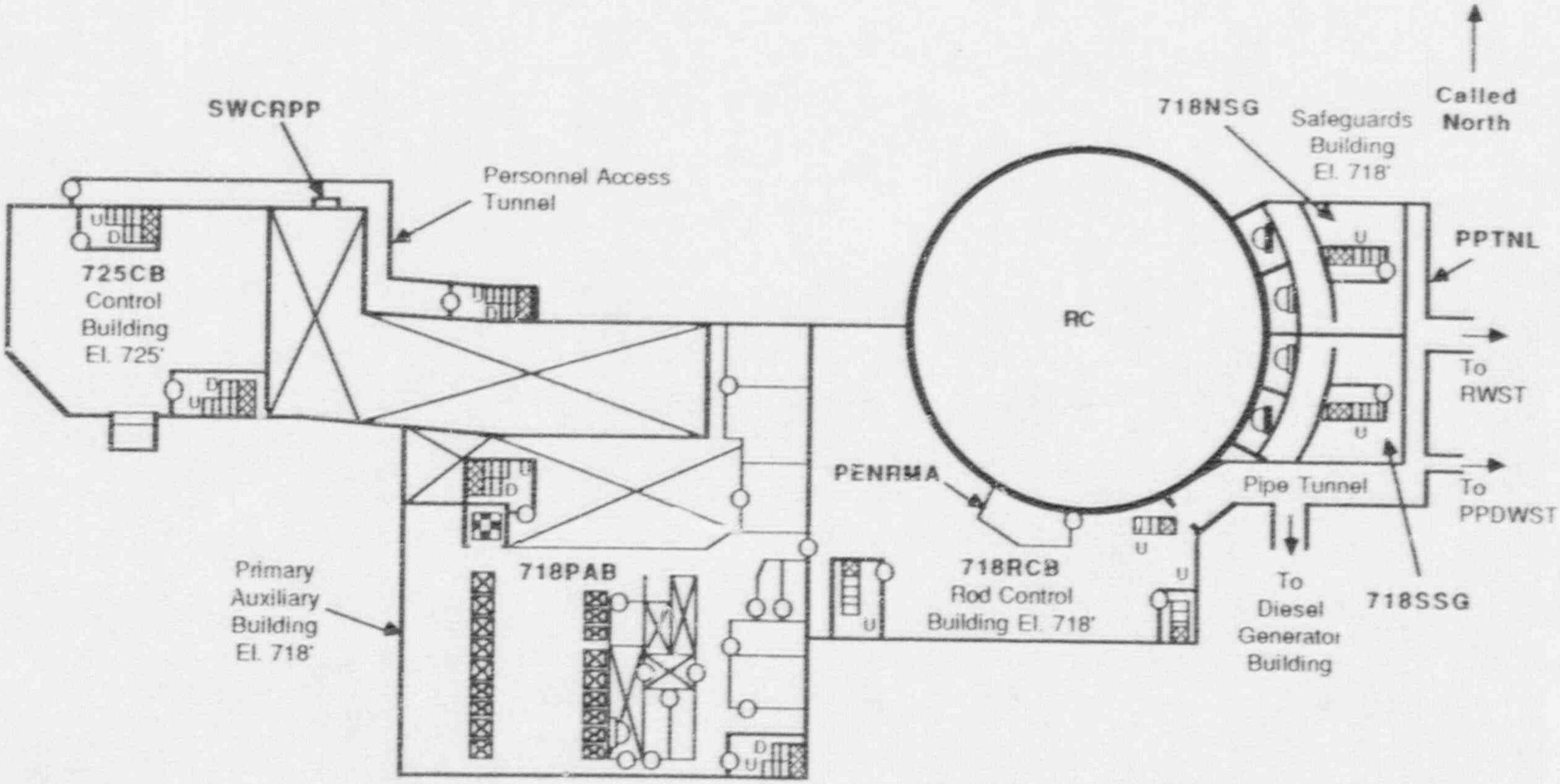



Figure 4-9. Beaver Valley 2 Reactor Containment, Control Building, Primary Auxiliary Building, Safeguards Building, and Rod Control Building (Elevation 718'6")

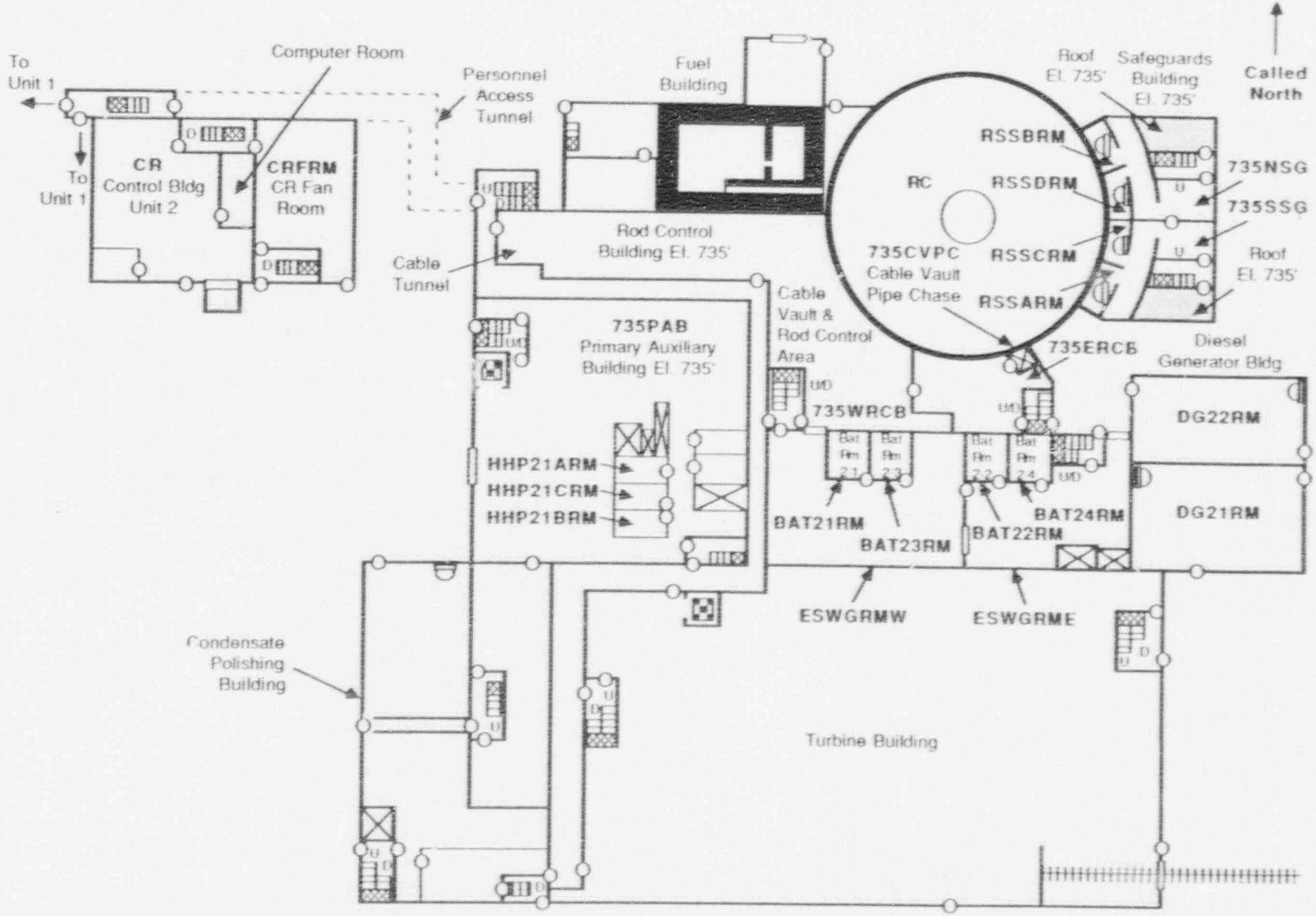



Figure 4-10. Beaver Valley 2 Reactor Containment, Control Building, Primary Auxiliary Building, Diesel Generator Building, Safeguards Building, Rod Control Building, Fuel Building, and Turbine Building (Elevation 735'6')

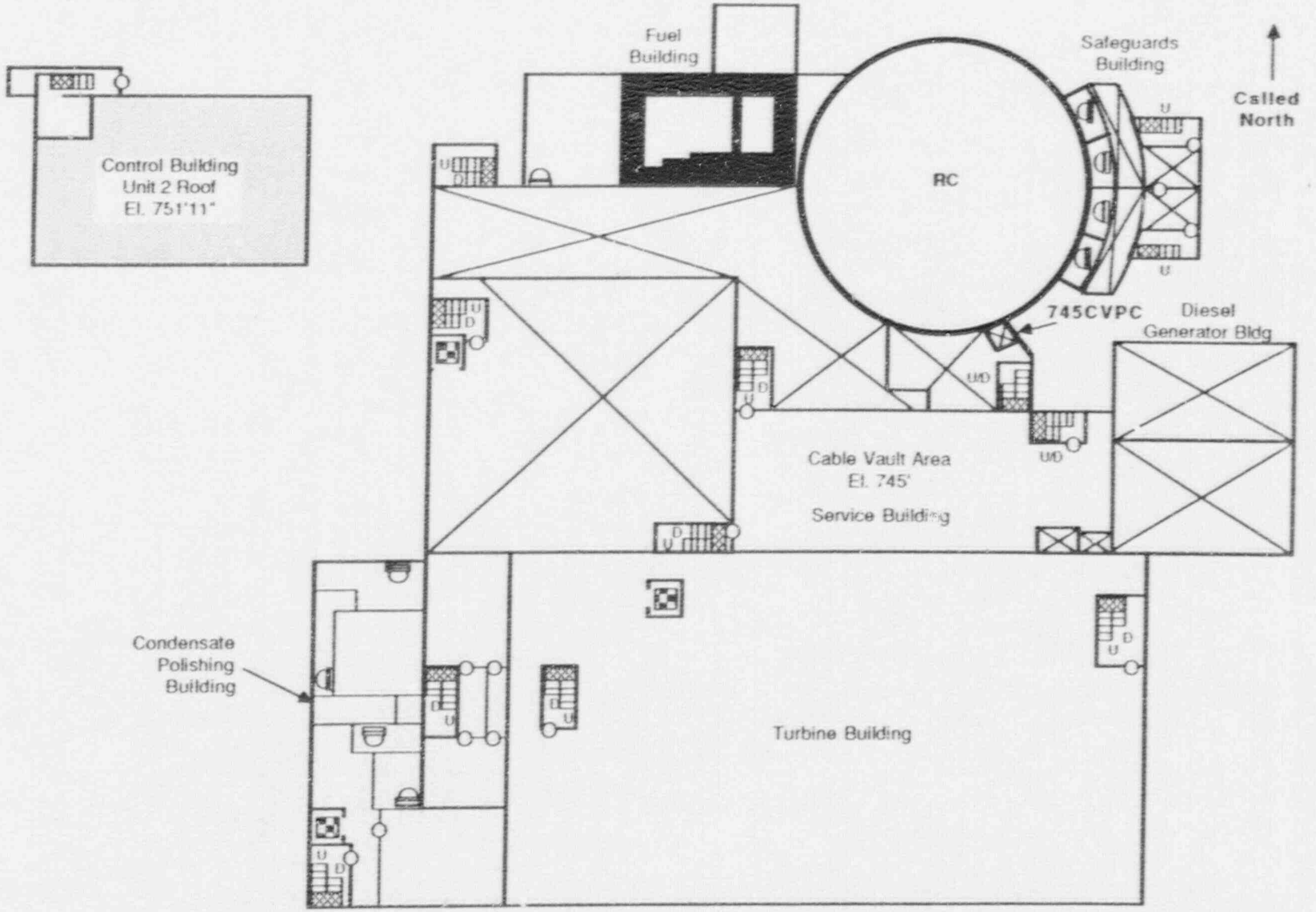



Figure 4-11. Beaver Valley 2 Reactor Containment, Control Building, Primary Auxiliary Building, Diesel Generator Building, Safequards Building, Rod Control Building, Fuel Building, and Turbine Building (Elevation 745'6")

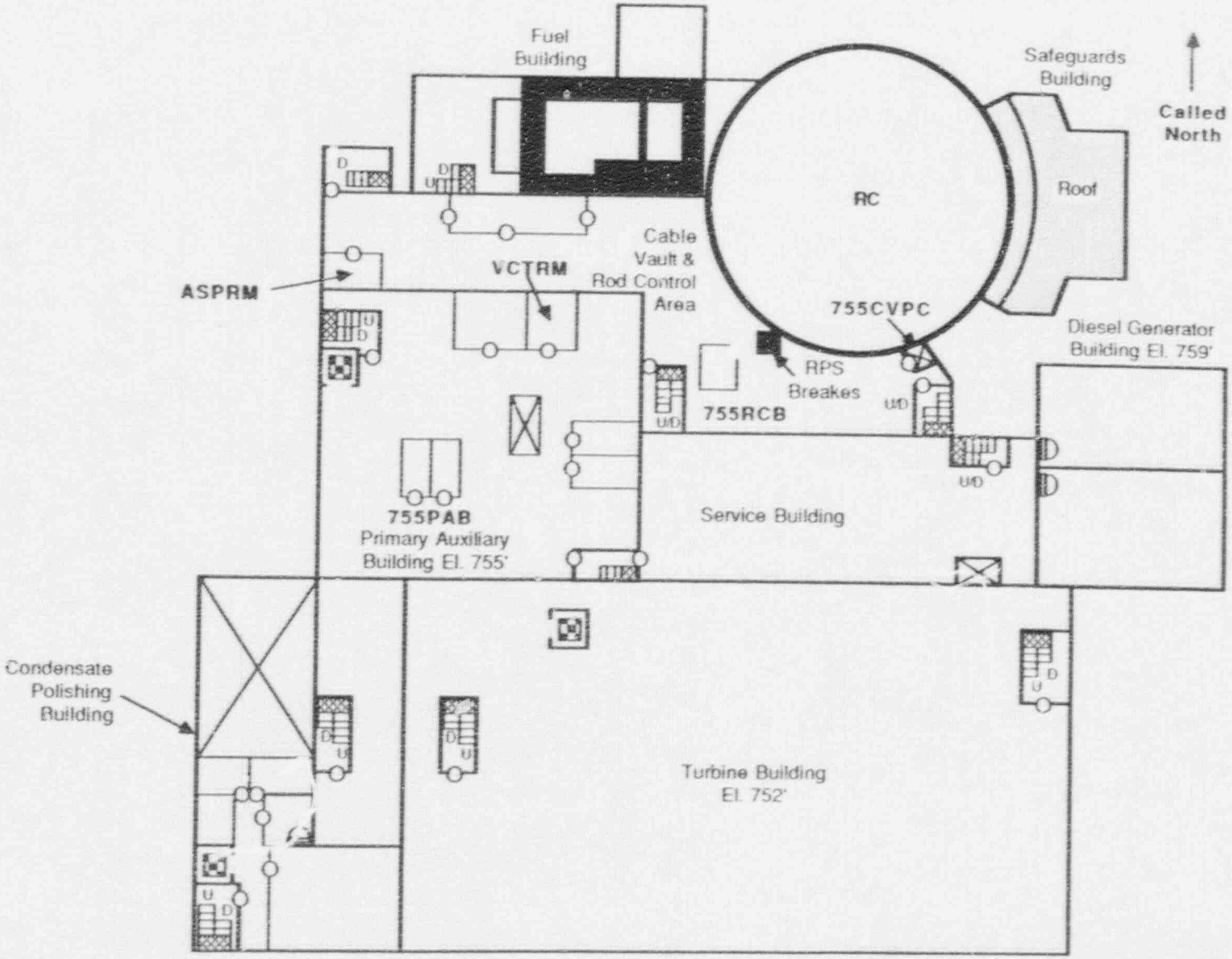
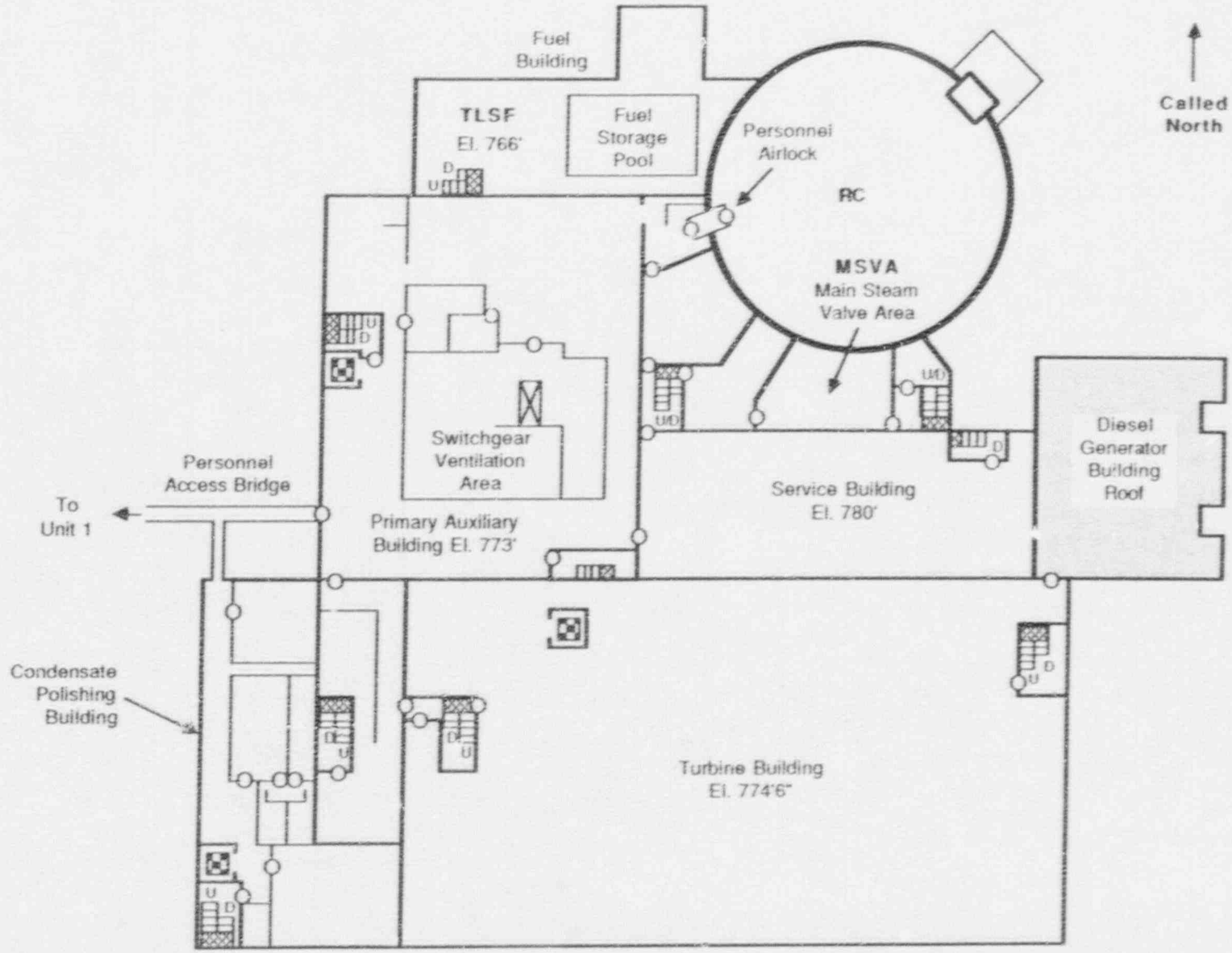



**Figure 4-12. Beaver Valley 2 Reactor Containment, Primary Auxiliary Building, Diesel Generator Building, Safeguards Building, Rod Control Building, Fuel Building, and Turbine Building (Elevation 755'6")**

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8/90

**Figure 4-13. Beaver Valley 2 Reactor Containment, Primary Auxiliary Building, Rod Control Building, Fuel Building, and Turbine Building (Elevation 774'6")**

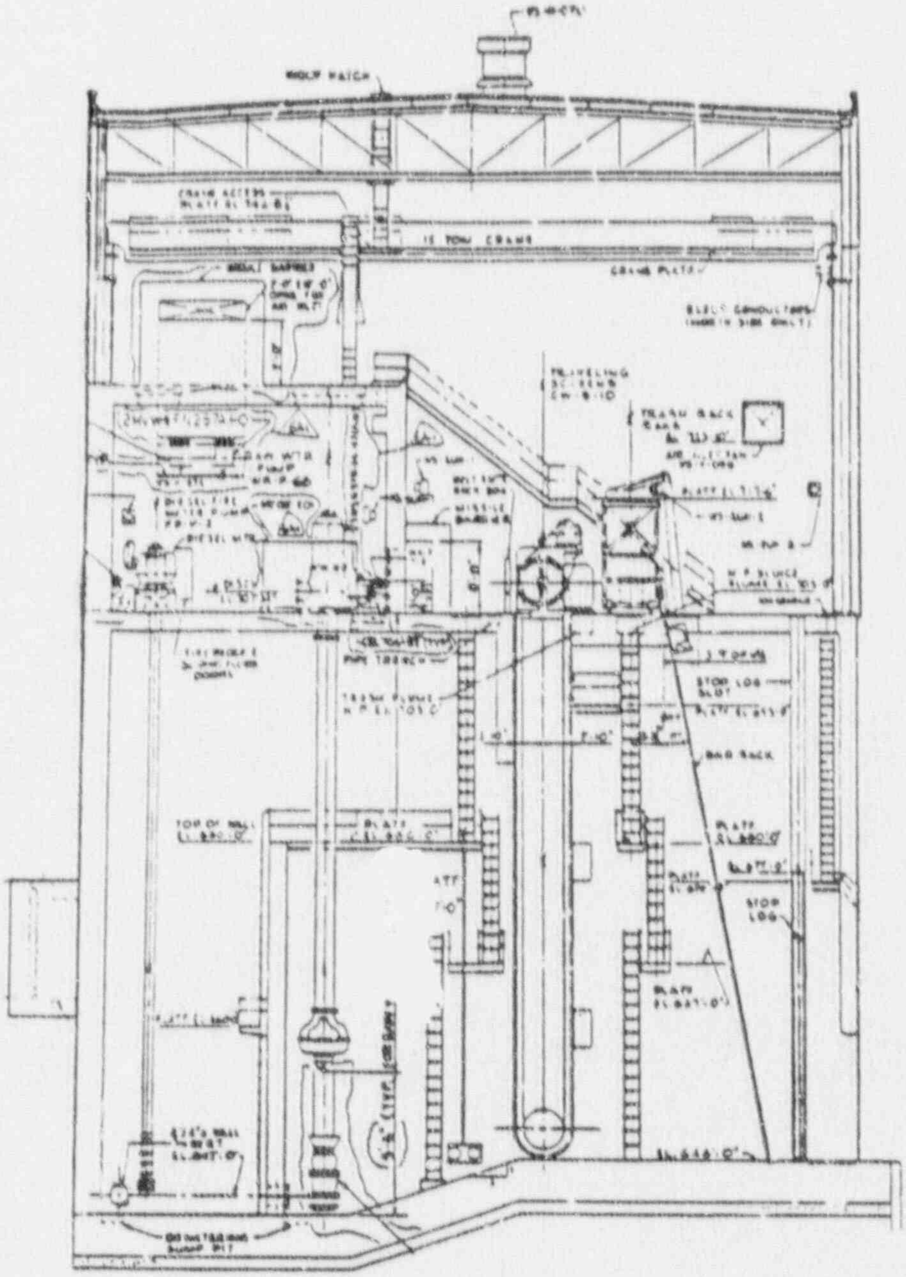

Figure 4-14. Beaver Valley 2 Intake Structure Section

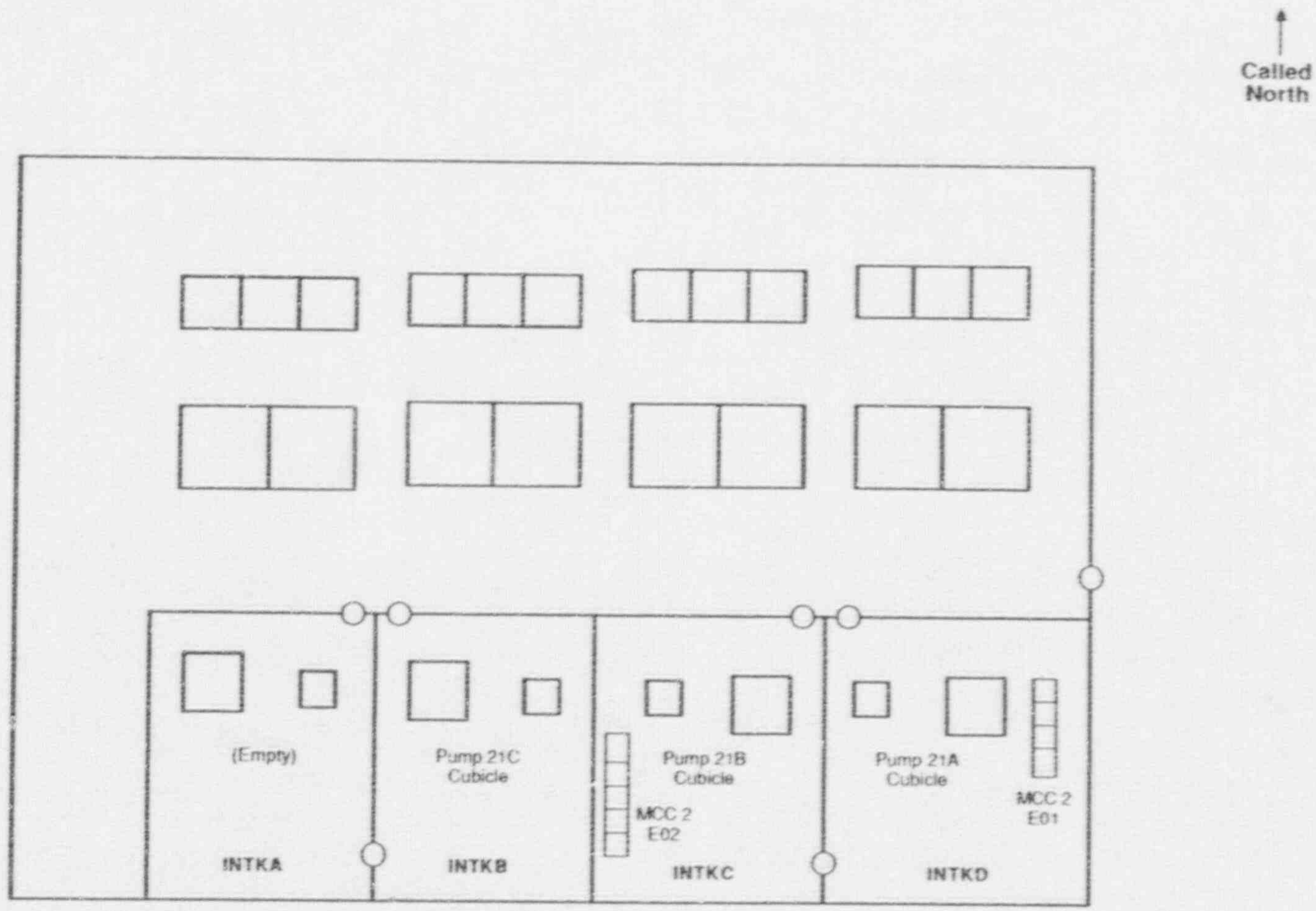


Figure 4-15. Beaver Valley 2 Intake Structure Elevation 705'

## Table 4-1. Definition of Beaver Valley 2 Building and Location Codes

| Abbreviation | Description |
|---|---|
| 1. 707CB | The 707' elevation of the Control Building. |
| 2. 710PAB | The 710' elevation of the Primary Auxiliary Building. |
| 3. 718NSG | The 718' elevation (northern end) of the Safeguards Building. |
| 4. 718PAB | The 718' elevation of the Primary Auxiliary Building. |
| 5. 718RCB | The 718' elevation of the Rod Control Building. |
| 6. 718SSG | The 718' elevation (southern end) of the Safeguards Building. |
| 7. 725CB | The 725' elevation of the Control Building. |
| 8. 735CVPC | The 735' elevation of the Cable Vault Pipe Chase. |
| 9. 735ERCB | The 735' elevation (eastern end) of the Rod Control Building. |
| 10. 735NSG | The 735' elevation (northern end) of the Safeguards Building. |
| 11. 735PAB | The 735' elevation of the Primary Auxiliary Building. |
| 12. 735SSG | The 735' elevation (southern end) of the Safeguards Building. |
| 13. 735WRCB | The 735' elevation (western end) of the Rod Control Building. |
| 14. 745CVPC | The 745' elevation of the Cable Vault Pipe Chase. |
| 15. 755CVPC | The 755' elevation of the Cable Vault Pipe Chase. |
| 16. 755PAB | The 755' elevation of the Primary Auxiliary Building. |
| 17. 755RCB | The 755' elevation of the Rod Control Building. |
| 18. ASPRM | Room containing the auxiliary shutdown panel located at the 755' elevation of the Rod Control Building. |
| 19. BAT21RM | Room containing battery 2-1 located at the 735' elevation of the Service Building. |

## Table 4-1. Definition of Beaver Valley 2 Building and Location Codes (Continued)

| Abbreviation | Description |
|---|---|
| 20. BAT22RM | Room containing battery 2-2 located at the 735' elevation of the Service Building. |
| 21. BAT23RM | Room containing battery 2-3 located at the 735' elevation of the Service Building. |
| 22. BAT24RM | Room containing battery 2-4 located at the 735' elevation of the Service Building. |
| 23. BITRM | Boron Injection Tank Room located at the 710' elevation of the Primary Auxiliary Building. |
| 24. BLNDRM | Blender Room located at the 710' elevation of the Primary Auxiliary Building. |
| 25. CR | Control Room located at the 735' elevation of the Control Building. |
| 26. CRFRM | Control Room Fan Room located at the 735' elevation of the Control Building. |
| 27. DG21RM | Room containing emergency diesel generator 2-1 located at the 735' elevation of the Diesel Generator Building. |
| 28. DG22RM | Room containing emergency diesel generator 2-2 located at the 735' elevation of the Diesel Generator Building. |
| 29. ESPRM | Room containing emergency shutdown panel located at the 707' elevation of the Control Building. |
| 30. ESWGRME | Emergency Switchgear Room (eastern end) located at the 735' elevation of Service Building. |
| 31. ESWGRMW | Emergency Switchgear Room (western end) located at the 735' elevation of Service Building. |
| 32. HHP21ARM | Room containing the high head safety injection/charging system pump P21A located at the 735' elevation of the Primary Auxiliary Building. |
| 33. HHP21BRM | Room containing the high head safety injection/charging system pump P21B located at the 735' elevation of the Primary Auxiliary Building. |
| 34. HHP21CRM | Room containing the high head safety injection/charging system pump P21C located at the 735' elevation of the Primary Auxiliary Building. |

## Table 4-1. Definition of Beaver Valley 2 Building and Location Codes (Continued)

| Abbreviation | Description |
|---|---|
| 35. INTKB | Room containing the service water system pump 21C located at the 705' elevation of the Intake Structure. |
| 36. INTKC | Room containing the service water system pump 21B located at the 705' elevation of the Intake Structure. |
| 37. INTKD | Room containing the service water system pump 21A located at the 705' elevation of the Intake Structure. |
| 38. MSVA | Main Steam Valve Area Located at the 774' elevation of the Rod Control Building. |
| 39. PENRMA | Penetration Room Located at the 718' elevation of the Rod Control Building. |
| 40. PITRM | Pit Room, containing recirculation spray system suction valves, located at the 692' elevation of the Safeguards Building. |
| 41. PPDWST | Primary Plant Demineralized Water Storage Tank located outdoors at ground level north of the Diesel Generator Building. |
| 42. PPTNL | The underground concrete pipe chase which houses piping connecting the RWST and PPDWST to the Safeguards Building, Diesel Generator Building, and Rod Control Building. |
| 43. RC | Reactor containment. |
| 44. RSSARM | Room containing the recirculation spray system pump P21A located at the 735' elevation of the Safeguards Building. |
| 45. RSSBRM | Room containing the recirculation spray system pump P21B located at the 735' elevation of the Safeguards Building. |
| 46. RSSCRM | Room containing the recirculation spray system pump P21C located at the 735' elevation of the Safeguards Building. |
| 47. RSSDRM | Room containing the recirculation spray system pump P21D located at the 735' elevation of the Safeguards Building. |
| 48. RWST | Refueling Water Storage Tank located outdoors at ground level north of the PPDWST. |

## Table 4-1. Definition of Beaver Valley 2 Building and Location Codes (Continued)

| | Abbreviation | Description |
|---|---|---|
| 49. | SWCRPP | The location at which service water system piping passes vertically through the 718' elevation of the Personnel Access Tunnel. |
| 50. | TLSF | Spent fuel operating floor located at the 766' elevation of the Fuel Building. |
| 51. | VCTRM | Room containing the volume control tank located at the 755' elevation of the Primary Auxiliary Building. |
| 52. | VPITA | Valve Pit A housed under a secured structure located outdoors northeast of the control building. |
| 53. | VPITB | Valve Pit B housed under a secured structure located outdoors northeast of the control building. |

## Table 4-2. Partial Listing of Components by Location at Beaver Valley 2

| LOCATION | SYSTEM | COMPONENT ID | COMP TYPE |
|---|---|---|---|
| 710PAB | SWS | SW-107A | MOV |
| 710PAB | SWS | SW-107C | MOV |
| 710PAB | SWS | SW-107B | MOV |
| 710PAB | SWS | SW-107D | MOV |
| 718NSG | AFWS | AFW-23B | MDP |
| 718NSG | CHRS | QSS-100B | MOV |
| 718NSG | CHRS | QSS-P21B | MDP |
| 718NSG | ECCS | LHSI-863B | MOV |
| 718NSG | ECCS | LHSI-8811B | MOV |
| 718NSG | ECCS | LHSI-863B | MOV |
| 718NSG | ECCS | LHSI-887B | MOV |
| 718NSG | SWS | SW-104B | MOV |
| 718SSG | AFWS | AFW-22 | TDP |
| 718SSG | AFWS | AFW-23A | MDP |
| 718SSG | CHRS | QSS-100A | MOV |
| 718SSG | CHRS | QSS-P21A | MDP |
| 718SSG | ECCS | LHSI-863A | MOV |
| 718SSG | ECCS | LHSI-8811A | MOV |
| 718SSG | ECCS | LHSI-863A | MOV |
| 718SSG | ECCS | LHSI-8887A | MOV |
| 718SSG | SWS | SW-104A | MOV |
| 718SSG | SWS | SW-104C | MOV |
| 718SSG | SWS | SW-104D | MOV |
| 735ERCB | EP | EP-MCC-E6 | MCC |
| 735ERCB | EP | EP-MCC-E14 | MCC |
| 735NSG | EP | EP-MCC-E12 | MCC |
| 735SSG | AFWS | AFW-100E | HV |
| 735SSG | AFWS | AFW-100C | HV |
| 735SSG | AFWS | AFW-100A | HV |
| 735SSG | AFWS | AFW-100F | HV |

Table 4-2. Partial Listing of Components by Location at Beaver Valley 2 (Continued)

| LOCATION | SYSTEM | COMPONENT ID | COMP TYPE |
|---|---|---|---|
| 735SSG | AFWS | AFW-100D | HV |
| 735SSG | AFWS | AFW-100B | HV |
| 735SSG | EP | EP-MCC-E11 | MCC |
| 735WRCB | EP | EP-MCC-E5 | MCC |
| 735WRCB | EP | EP-MCC-E13 | MCC |
| 755PAB | EP | EP-MCC-E3 | MCC |
| 755PAB | EP | EP-MCC-E4 | MCC |
| BAT21RM | EP | EP-BT-21 | BATT |
| BAT22RM | EP | EP-BT-22 | BATT |
| BITRM | ECCS | HHSI-841 | MOV |
| BITRM | ECCS | HHSI-867B | MOV |
| BITRM | ECCS | HHSI-867A | MOV |
| BLNDRM | ECCS | HHSI-115B | MOV |
| BLNDRM | ECCS | HHSI-8133A | MOV |
| BLNDRM | ECCS | HHSI-8132A | MOV |
| BLNDRM | ECCS | HHSI-122 | AOV |
| BLNDRM | ECCS | HHSI-115D | MOV |
| BLNDRM | ECCS | HHSI-8130A | MOV |
| BLNDRM | ECCS | HHSI-8130B | MOV |
| BLNDRM | ECCS | HHSI-813A | MOV |
| BLNDRM | ECCS | HHSI-8131B | MOV |
| BLNDRM | ECCS | HHSI-115B | MOV |
| BLNDRM | ECCS | HHSI-115D | MOV |
| BLNDRM | ECCS | HHSI-8133B | MOV |
| BLNDRM | ECCS | HHSI-8132B | MOV |
| DG21RM | EP | EP-DG-21 | DG |
| DG21RM | EP | EP-MCC-E7 | MCC |
| DG21RM | SWS | SW-113A | MOV |
| DG22RM | EP | EP-DG-22 | DG |
| DG22RM | EP | EP-MCC-E8 | MCC |

Table 4-2. Partial Listing of Components by Location at Beaver Valley 2 (Continued)

| LOCATION | SYSTEM | COMPONENT ID | COMP TYPE |
|---|---|---|---|
| DG22RM | SWS | SW-113D | MOV |
| ESWGRME | EP | EP-BS-22 | BUS |
| ESWGRME | EP | EP-BC-22 | BC |
| ESWGRME | EP | EP-VBS-22 | BUS |
| ESWGRME | EP | EP-VBS-24 | BUS |
| ESWGRME | EP | EP-BS-2DF | BUS |
| ESWGRME | EP | EP-CB-2DF | CB |
| ESWGRME | EP | EP-BS-22 | BUS |
| ESWGRME | EP | EP-BS-2P | BUS |
| ESWGRME | EP | EP-TR-29P | TR |
| ESWGRMW | EP | EP-BS-2AE | BUS |
| ESWGRMW | EP | EP-CB-2AE | CB |
| ESWGRMW | EP | EP-BS-21 | BUS |
| ESWGRMW | EP | EP-VBS-21 | BUS |
| ESWGRMW | EP | EP-VBS-23 | BUS |
| ESWGRMW | EP | EP-BS-2N | BUS |
| ESWGRMW | EP | EP-TR-28N | TR |
| ESWGRMW | EP | EP-BC-21 | BC |
| HHP21ARM | ECCS | HHSI-P21A | MDP |
| HHP21ARM | ECCS | HHSI-275A | MOV |
| HHP21BRM | ECCS | HHSI-P21B | MDP |
| HHP21BRM | ECCS | HHSI-275B | MOV |
| HHP21CRM | ECCS | HHSI-P21C | MDP |
| HHP21CRM | ECCS | HHSI-275C | MOV |
| HHP21CRM | ECCS | HHSI-P21C | MDP |
| INTKB | SWS | SW-INTK | TK |
| INTKB | SWS | SW-P21C | MDP |
| INTKB | SWS | SW-102C1 | MOV |
| INTKB | SWS | SW-102C2 | MOV |
| INTKB | SWS | SW-P21C | MDP |

Table 4-2. Partial Listing of Components by Location at Beaver Valley 2 (Continued)

| LOCATION | SYSTEM | COMPONENT ID | COMP TYPE |
|---|---|---|---|
| INTKB | SWS | SW-102C1 | MOV |
| INTKB | SWS | SW-102C2 | MOV |
| INTKC | EP | EP-MCC-E2 | MCC |
| INTKC | SWS | SW-INTK | TK |
| INTKC | SWS | SW-P21B | MDP |
| INTKC | SWS | SW-102B | MOV |
| INTKD | EP | EP-MCC-E1 | MCC |
| INTKD | SWS | SW-INTK | TK |
| INTKD | SWS | SW-P21A | MDP |
| INTKD | SWS | SW-102A | MOV |
| MSVA | AFWS | AFW-105A | SOV |
| MSVA | AFWS | AFW-105D | SOV |
| MSVA | AFWS | AFW-105B | SOV |
| MSVA | AFWS | AFW-105E | SOV |
| MSVA | AFWS | AFW-105C | SOV |
| MSVA | AFWS | AFW-105F | SOV |
| PENRMA | ECCS | HHSI-869A | MOV |
| PENRMA | ECCS | HHSI-836 | MOV |
| PENRMA | ECCS | HHSI-869B | MOV |
| PENRMA | ECCS | HHSI-867C | MOV |
| PENRMA | ECCS | HHSI-867D | MOV |
| PITRM | CHRS | RSS-155B | MOV |
| PITRM | CHRS | RSS-155A | MOV |
| PITRM | CHRS | RSS-155C | MOV |
| PITRM | CHRS | RSS-155D | MOV |
| PPDWST | AFWS | AFW-PPDWST | TK |
| RC | AFWS | SG-21A | SG |
| RC | AFWS | SG-21B | SG |
| RC | AFWS | SG-21C | SG |
| RC | CHRS | RSS-SUMP | TK |

Table 4-2. Partial Listing of Components by Location at Beaver Valley 2 (Continued)

| LOCATION | SYSTEM | COMPONENT ID | COMP TYPE |
|---|---|---|---|
| RC | CHRS | RSS-SUMP | TK |
| RC | CHRS | RSS-SUMP | TK |
| RC | CHRS | RSS-SUMP | TK |
| RC | ECCS | HHSI-310 | MOV |
| RC | ECCS | HHSI-259 | MOV |
| RC | RCS | RCS-VESSEL | RV |
| RC | RCS | RHR-701A | MOV |
| RC | RCS | RHR-702A | MOV |
| RC | RCS | RHR-701B | MOV |
| RC | RCS | RHR-702B | MOV |
| RC | RCS | RCS-PZR | HTR |
| RC | RCS | RCS-455C | NV |
| RC | RCS | RCS-456 | NV |
| RC | RCS | RCS-455D | NV |
| RC | RCS | RCS-537 | MOV |
| RC | RCS | RCS-536 | MOV |
| RC | RCS | RCS-535 | MOV |
| RC | RCS | RHR-702A | MOV |
| RC | RCS | RHR-701B | MOV |
| RC | RCS | RCS-PZR | HTR |
| RSSARM | CHRS | RSS-P21A | MDP |
| RSSARM | CHRS | RSS-HXA | HX |
| RSSARM | CHRS | RSS-156A | MOV |
| RSSARM | CHRS | QSS-101A | MOV |
| RSSARM | SWS | SW-105A | MOV |
| RSSBRM | CHRS | RSS-HXB | HX |
| RSSBRM | CHRS | RSS-P21B | MDP |
| RSSBRM | CHRS | RSS-156B | MOV |
| RSSBRM | CHRS | QSS-101B | MOV |
| RSSBRM | SWS | SW-105B | MOV |

Table 4-2. Partial Listing of Components by Location at Beaver Valley 2 (Continued)

| LOCATION | SYSTEM | COMPONENT ID | COMP TYPE |
|---|---|---|---|
| RSSCRM | CHRS | RSS-P21C | MDP |
| RSSCRM | CHRS | RSS-HXC | HX |
| RSSCRM | CHRS | RSS-156C | MOV |
| RSSCRM | SWS | SW-105C | MOV |
| RSSDRM | CHRS | RSS-P21D | MDP |
| RSSDRM | CHRS | RSS-HXD | HX |
| RSSDRM | CHRS | RSS-156D | MOV |
| RSSDRM | SWS | SW-105D | MOV |
| RWST | CHRS | SI-RWST | TK |
| RWST | CHRS | SI-RWST | TK |
| RWST | ECCS | SI-RWST | TK |
| VPITA | SWS | SW-120A | MOV |
| VPITA | SWS | SW-103A | MOV |
| VPITA | SWS | SW-116A | MOV |
| VPITA | SWS | SW-106A | MOV |
| VPITA | SWS | SW-103A | MOV |
| VPITB | SWS | SW-120B | MOV |
| VPITB | SWS | SW-103B | MOV |
| VPITB | SWS | SW-116B | MOV |
| VPITB | SWS | SW-106B | MOV |
| VPITB | SWS | SW-103B | MOV |

## 5. BIBLIOGRAPHY FOR BEAVER VALLEY 2

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2. NUREG-1094, "Final Environmental Statement Related to the Operation of Beaver Valley Power Station, Unit 2," USNRC Division of Licensing, September 1985.

3. NUREG-1259, "Technical Specifications for Beaver Valley Power Station, Unit 2," USNRC Division of Reactor Projects, May 1987.

4. NUREG-1279, "Technical Specifications for Beaver Valley Power Station, Unit 2," USNRC Division of Reactor Projects, August 1987.

# 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)

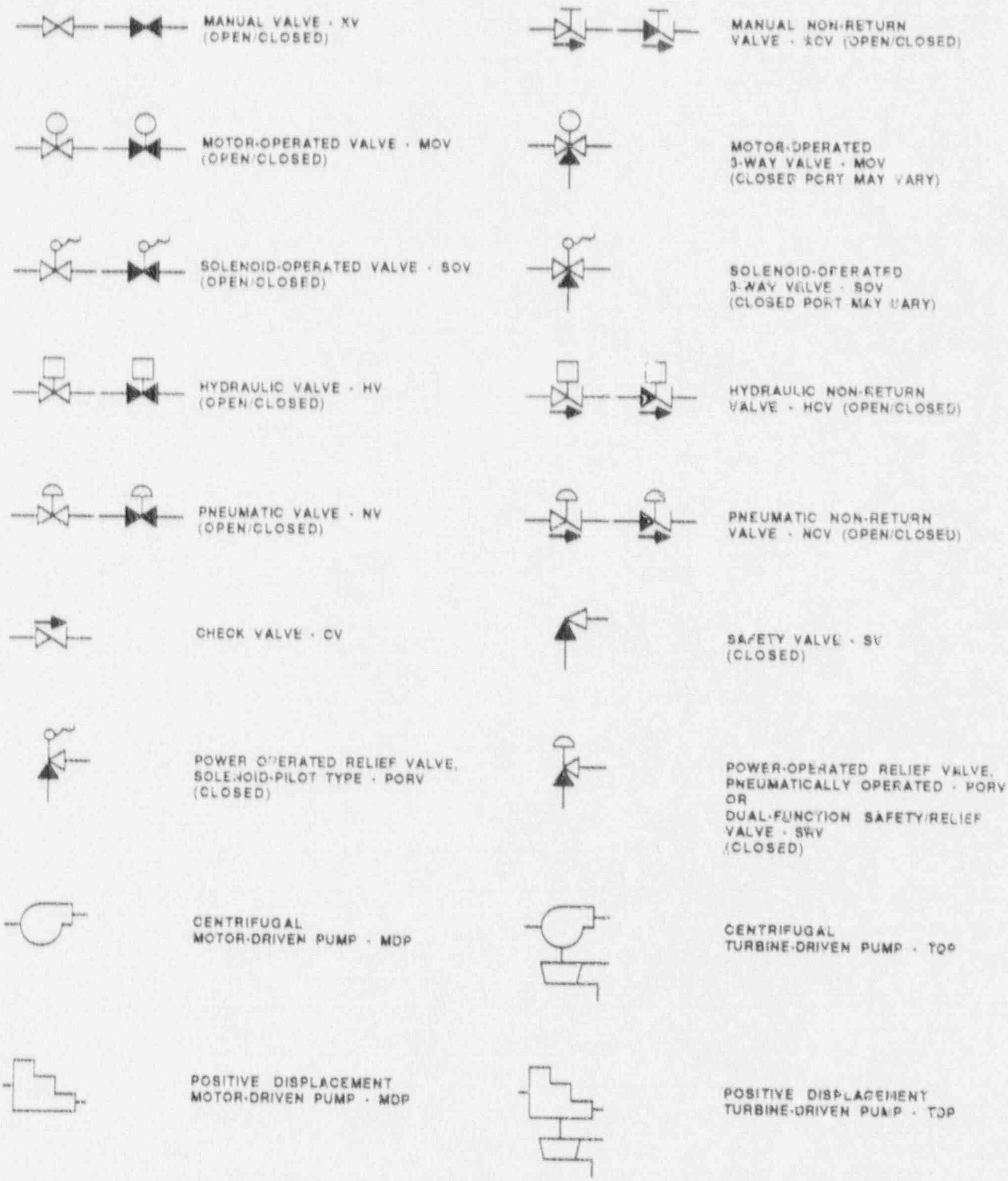


**Figure A-1. Key To Symbols In Fluid System Drawings**

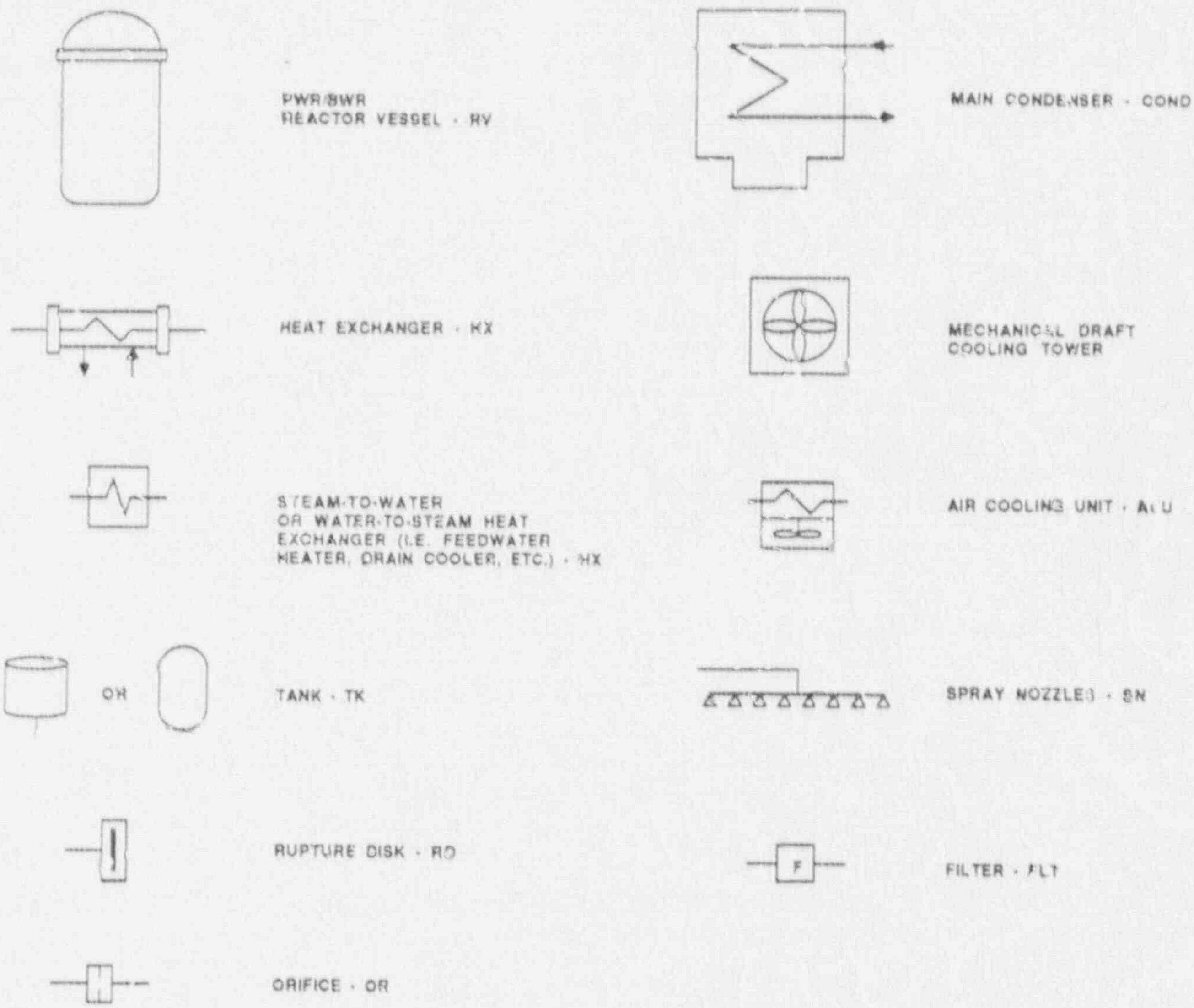


**Figure A-1. Key To Symbols In Fluid System Drawings (Continued)**

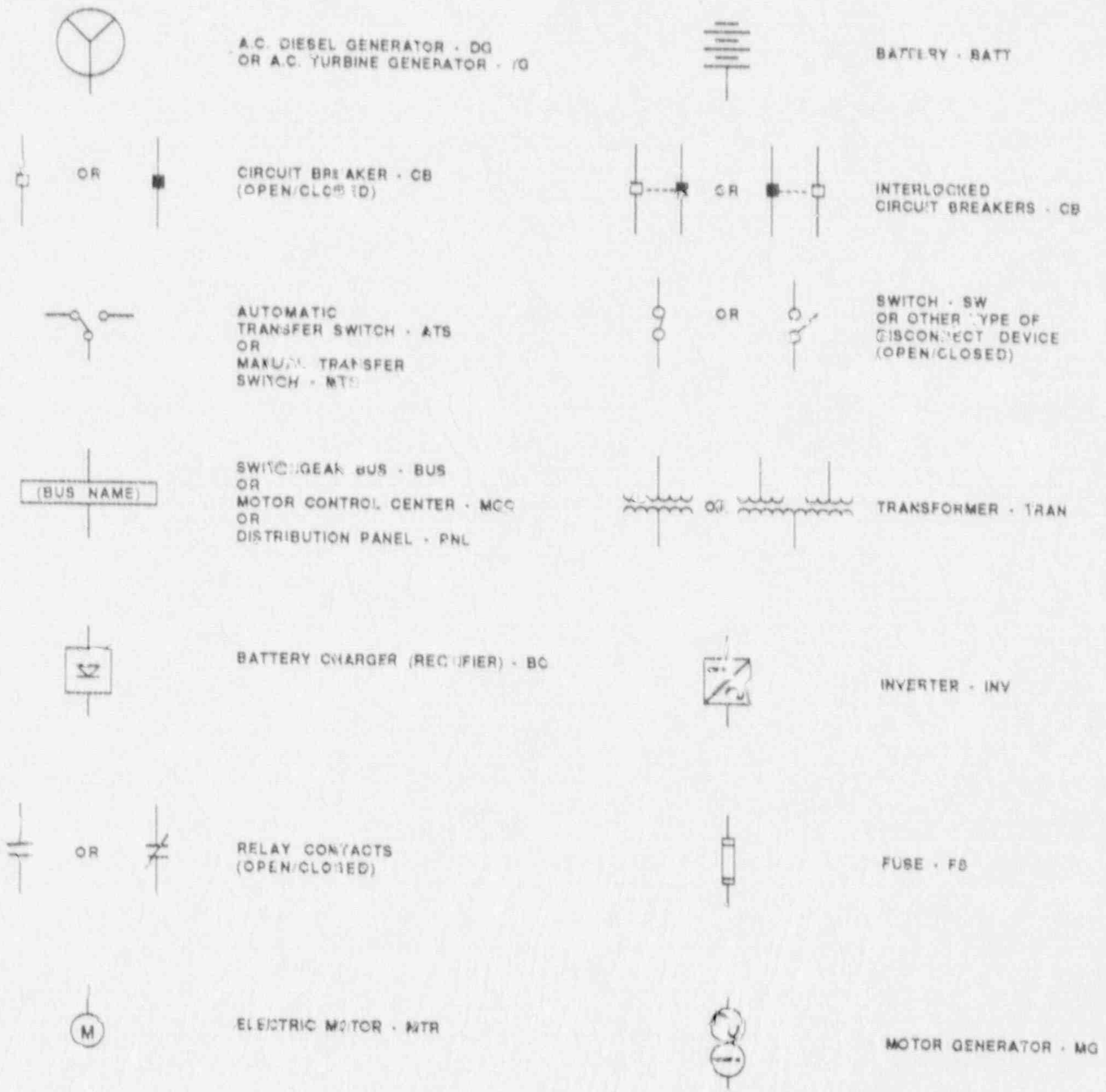


Figure A-2. Key To Symbols In Electrical System Drawings

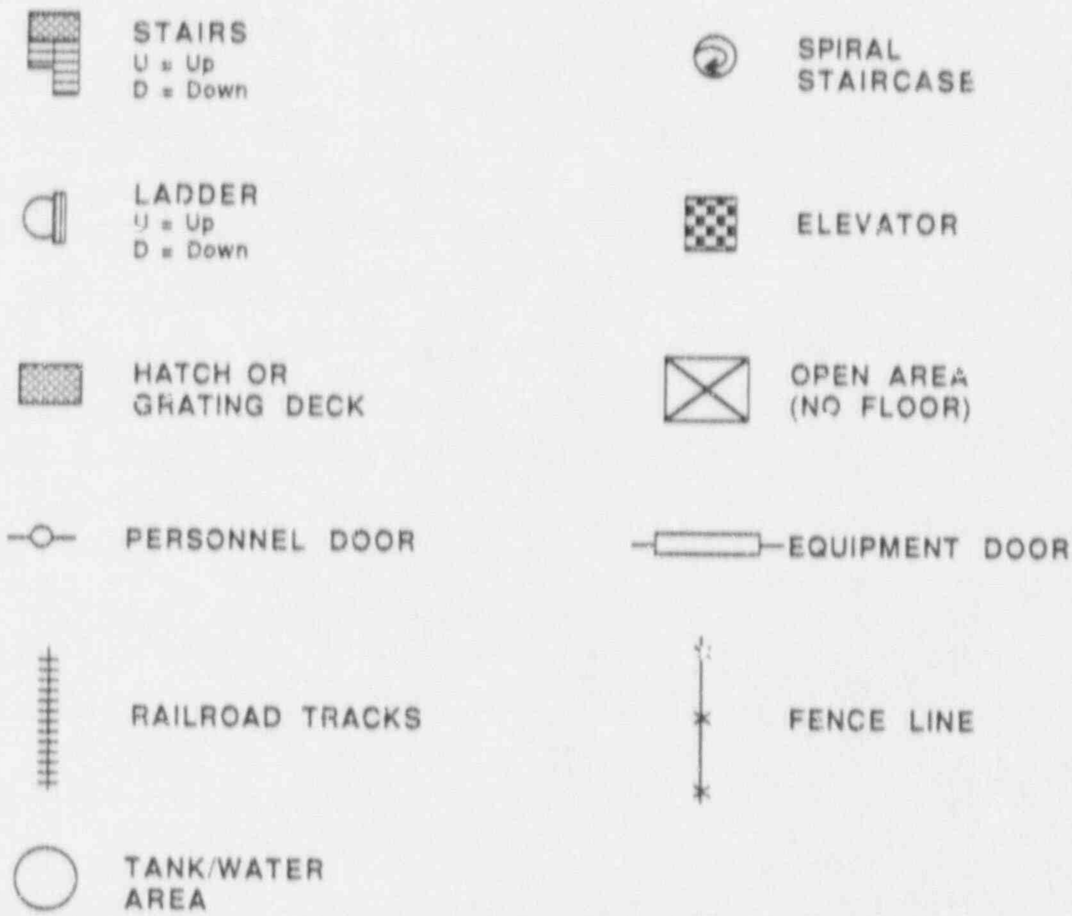


**Figure A-3. Key To Symbols In Facility Layout Drawings**

# 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 HHSI/Charging and LHSI systems) |
| CHRS | Containment Spray Systems (including Quench Spray and Recirculation Spray Systems) |
| EP | Electric Power 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 |