NUCLEAR POWER PLANT SYSTEM SOURCEBOOK

PALO VERDE 1, 2 and 3

50-528, 50-529, and 50-530

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PALO VERDE 1, 2 and 3

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

PALO VERDE
RECORD OF REVISIONS

REVISION	ISSUE	COMMENTS
0	12/88	Original report

PALO VERDE 1, 2, & 3 SYSTEM SOURCEBOOK

This sourcebook contains summary information on Palo Verde. 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. Symbol used in the system and layout drawings are defined in Appendix A. Terms used in the data tables are defined in Appendix B.

1. SUMMARY DATA ON PLANT

Basic information on the Palo Verde 1, 2, and 3 nuclear power plants are listed below:

- Docket number	50-528 (1), 50-529 (2), 50-530 (3)
- Operator	Arizona Public Service Company
- Location	Wintersburg, Arizona
- Commercial operation date	1/86 (Unit 1), 9/86 (Unit 2), 1/88 (Unit 3)
- Reactor type	PWR
- NSSS vendor	Combustion Engineering, Inc.
- Number of loops	2
- Power (MWt/MWe)	3800/1270
- Architect-engineer	Bechtel
- Containment type	Reinforced concrete cylinder with steel liner

2. IDENTIFICATION OF SIMILAR NUCLEAR POWER PLANTS

Palo Ve[illegible] 1, 2, and 3 are the only pressurized water reactor plants to utilize Combustion Engi[illegible]ring's System 80 steam supply system. Other Combustion Engineering type P[illegible]k plants in the United States include:

- Fort Calhoun
- Maine Yankee
- Palisades
- Millstone 2
- Calvert Cliffs 1 & 2
- St. Lucie 1 & 2
- ANO-2
- San Onofre 2 & 3
- Waterford 3
- WNP 3

Palo Verde differs from other Combustion Engineering plants in that it uses two independent Seismic Category I essential spray ponds (ESP) per unit as the ultimate heat sink. These ponds are part of the Essential Spray Pond System (ESPS) which is used during normal shutdown or during accident conditions.

3. SYSTEM INFORMATION

This section contains descriptions of selected systems at Palo Verde in terms of general function, operation, system success criteria, major components, and support system requirements. A summary of major systems at the Palo Verde 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 Palo Verde 1, 2, & 3 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 Relief (SSR) Systems	Same	3.2	10.4.9
- Emergency Core Cooling Systems (ECCS)			
- High-Pressure Injection & Recirculation	Same	3.3	6.3
- Low-pressure Injection & Recirculation	Same	3.3	6.3
- Decay Heat Removal (DHR) System (Residual Heat Removal (RHR) System)	Same	3.3	5.4.7, 5.5.7*
- Main Steam and Power Conversion Systems	Main Steam Supply System, Circulating Water System, Condensate and Feedwater System	X	10
- Other Heat Removal Systems	None identified	X	
Reactor Coolant Inventory Control Systems			
- Chemical and Volume Control System (CVCS) (Charging System)	Same	3.4	9.3.4
- ECCS	See ECCS, above	-	-

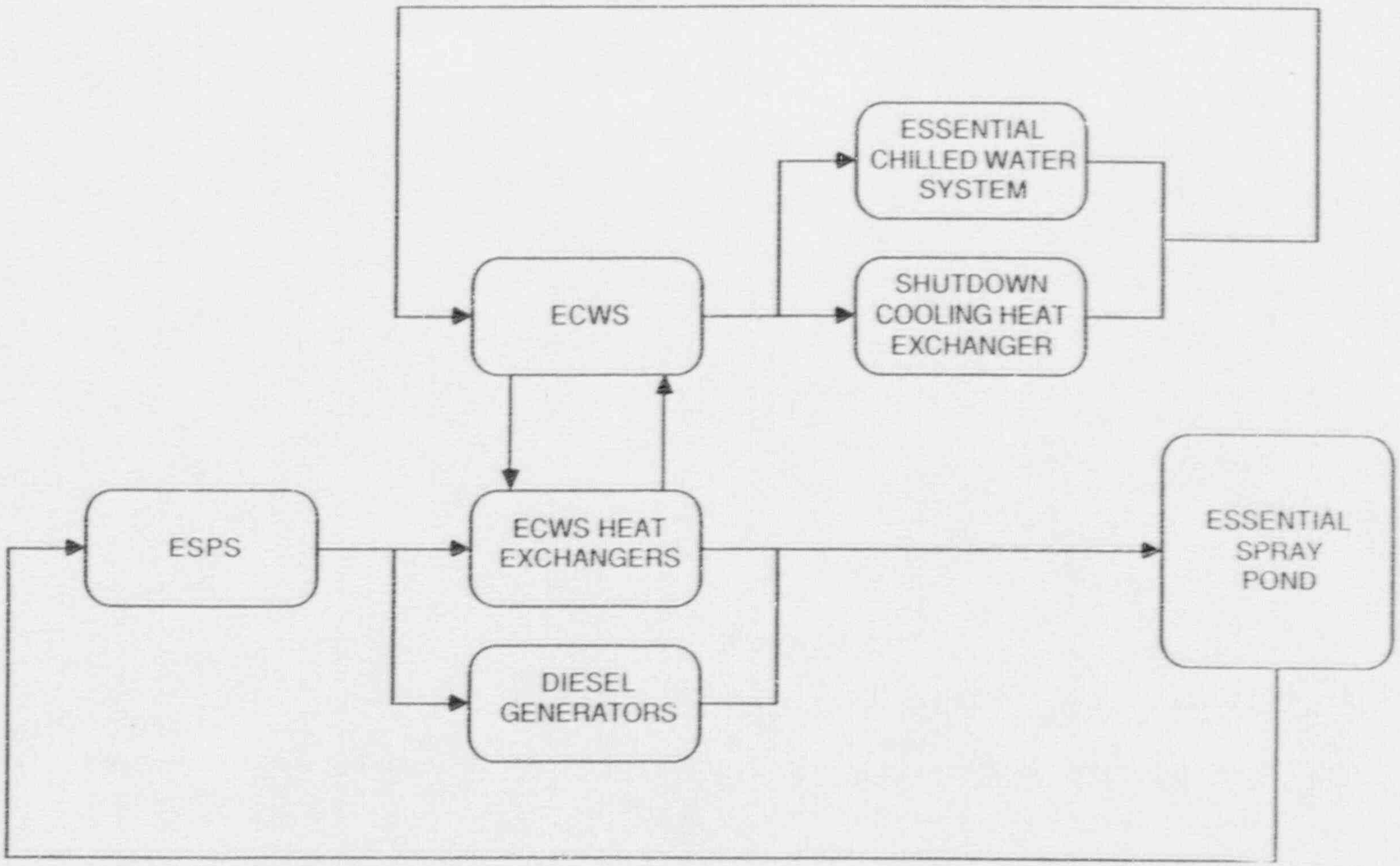
* Reference is from System 80 PSAR CESSAR, Combustion Engineering.

Table 3-1. Summary of Palo Verde 1, 2, & 3 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
- Containment Heat Removal Systems			
- Containment Spray System	Same	X	6.2.2.1, 6.5.2
- Containment Fan Cooler System	None identified	X	X
- Containment Normal Ventilation Systems	None identified	X	X
- Combustible Gas Control Systems	Containment Hydrogen Control System	X	6.2.5
Reactor and Reactivity Control Systems			
- Reactor Core	Same	X	4
- Control Rod System	Control Element Drive Mechanisms (CEDMs)	X	4
- Boration Systems	See CVCS, above	-	-
Instrumentation & Control (I&C) Systems			
- Reactor Protection System (RPS)	Same	3.5	7.2
- Engineered Safety Feature Actuation System (ESFAS)	Same	3.5	7.3
- Remote Shutdown System	Local Control Panels	3.5	7.4

Table 3-1. Summary of Palo Verde 1, 2, & 3 Systems Covered in this Report (Continued)

Generic System Name	Plant-Specific System Name	Report Section	FSAR Section Reference
Instrumentation & Control (I&C) Systems (continued)			
- Other I&C Systems	Various Systems	X	7.6, 7.7
Support Systems			
- Class 1E Electric Power System	Same	3.6	8.2, 8.3
- Non-Class 1E Electric Power System	Same	3.6	8.2, 8.3
- Diesel Generator Auxiliary Systems	Same	3.6	8.3, 9.5.4, 9.5.5, 9.5.6, 9.5.7, 9.5.8
- Component Cooling Water (CCW) System	Essential Cooling Water System	3.7	9.2.2
- Service Water System (SWS)	Essential Spray Pond System	3.8	9.2.1
- Other Cooling Water Systems	Nuclear Cooling Water System, Turbine Cooling Water System, Chilled Water System, Plant Cooling Water System	X	9.2.2
- Fire Protection Systems	Same	X	9.5.1
- Room Heating, Ventilating, and Air-Conditioning (HVAC) Systems	Air Conditioning, Heating, Cooling and Ventilation System	X	9.4
- Instrument and Service Air Systems	Compressed Air System	X	9.3.1
- Refueling and Spent Fuel Systems	Same	X	9.1
- Radioactive Waste Systems	Same	X	11
- Radiation Protection Systems	Same	X	12



ECWS = Essential Chilled Water System
ESPS = Emergency Spray Pond System

Figure 3-1. Cooling Water Systems Functional Diagram for Palo Verde 1, 2 and 3

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) two parallel reactor coolant loops, each containing one steam generator and two reactor coolant pumps, (c) a pressurizer connected to one of the reactor vessel outlet pipes, and (d) associated piping out to a suitable isolation valve boundary. An elevation view of a two-loop Combustion Engineering 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 two reactor coolant pumps in each of the two 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 reactor drain tank through the pressurizer relief valves. There are four simple spring loaded safety valves on the pressurizer.

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 described in terms of LOCA and transient mitigation, as follows:

- An unmitigatible LOCA is not initiated.
- If a mitigatible 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. Volume: 11,643 ft^3 (without pressurizer)
2. Normal operating pressure: 2235 psig

B. Pressurizer
1. Volume: 1800 ft^3

C. Reactor Coolant Pumps (4)
1. Rated flow 111,400 gpm
2. Type: Vertical Centrifugal

D. Safety Valves (4)
1. Set pressure: 2485, 2510, and 2535 psig
2. Relief capacity: 190,000 lb/hr each

E. Steam Generators
1. Type: U-Tube with Integral Economizer

F. Pressurizer Heaters
1. Capacity: Unknown
2. Type: Immersion

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 3.7.

B. Reactor Coolant Pump Seal Injection Water System
The chemical and volume control system supplies seal water to cool the reactor coolant pump shaft seals and to maintain a controlled inleakage of seal water into the RCS. Loss of seal water flow may result in RCS leakage through the pump shaft seals which will resemble a small LOCA.

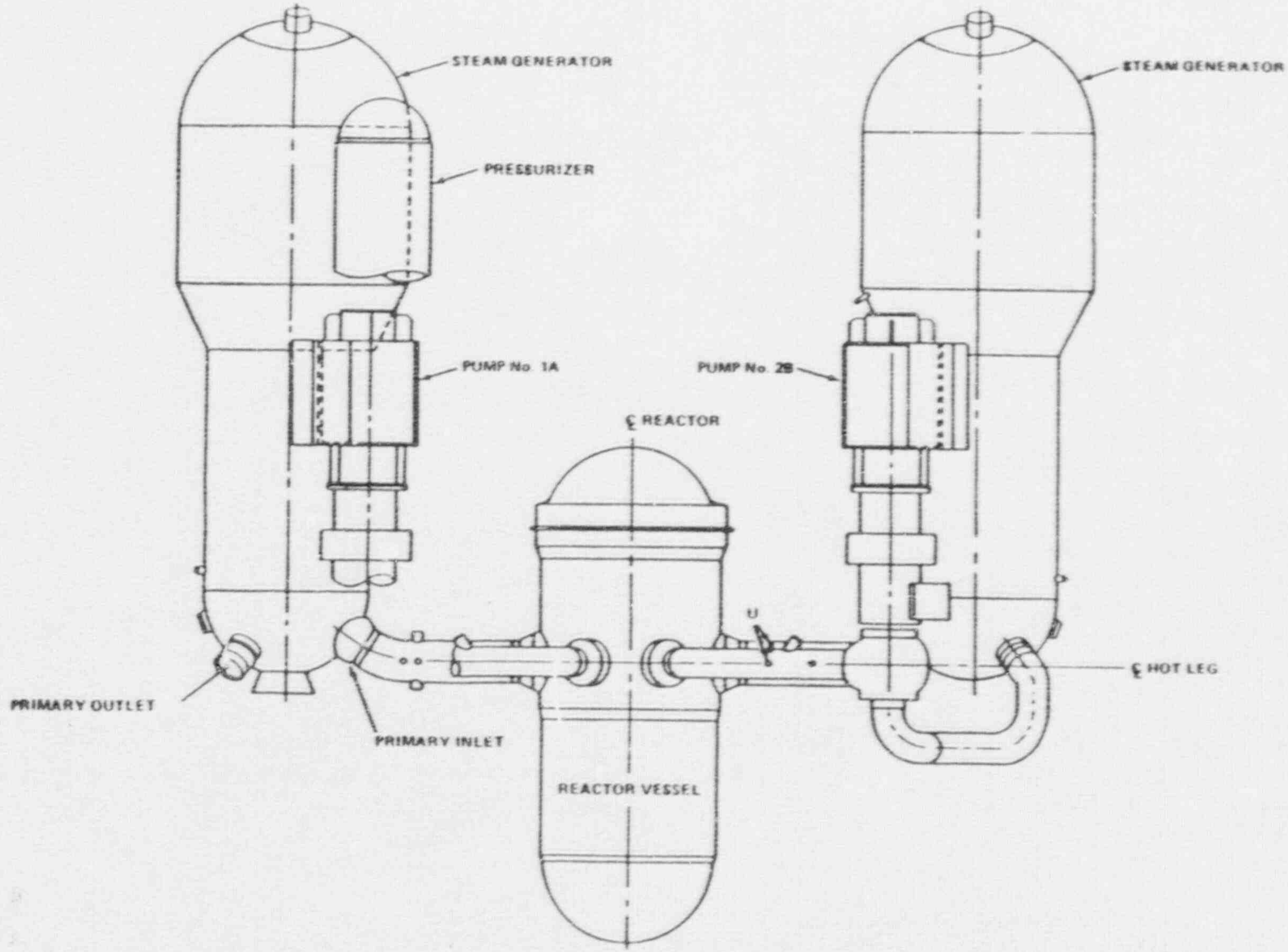


Figure 3.1-1. Elevation View of the RCS of a Typical Combustion Engineering Plant.

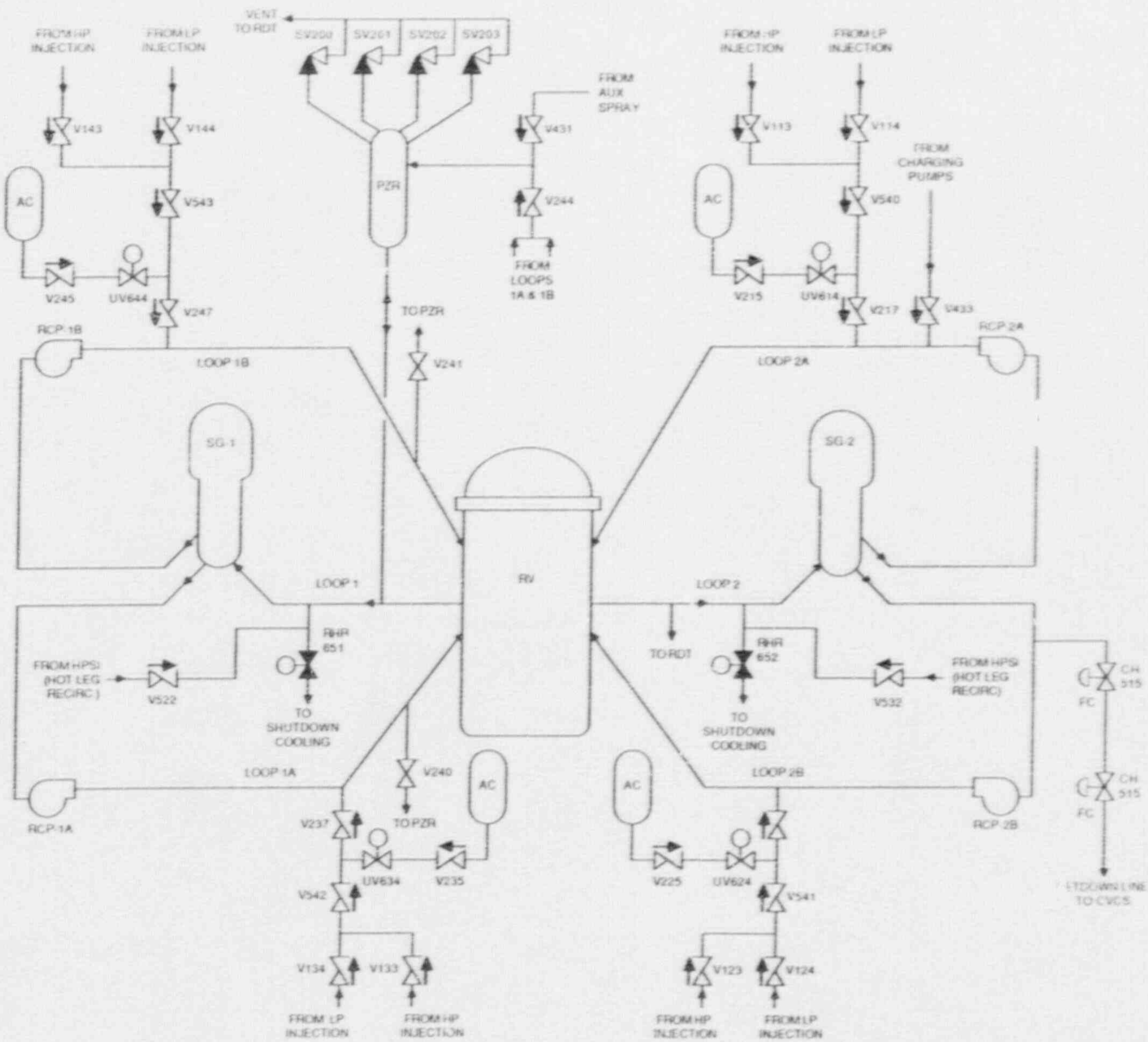


Figure 3.1-2. Palo Verde 1, 2, & 3 Reactor Coolant System

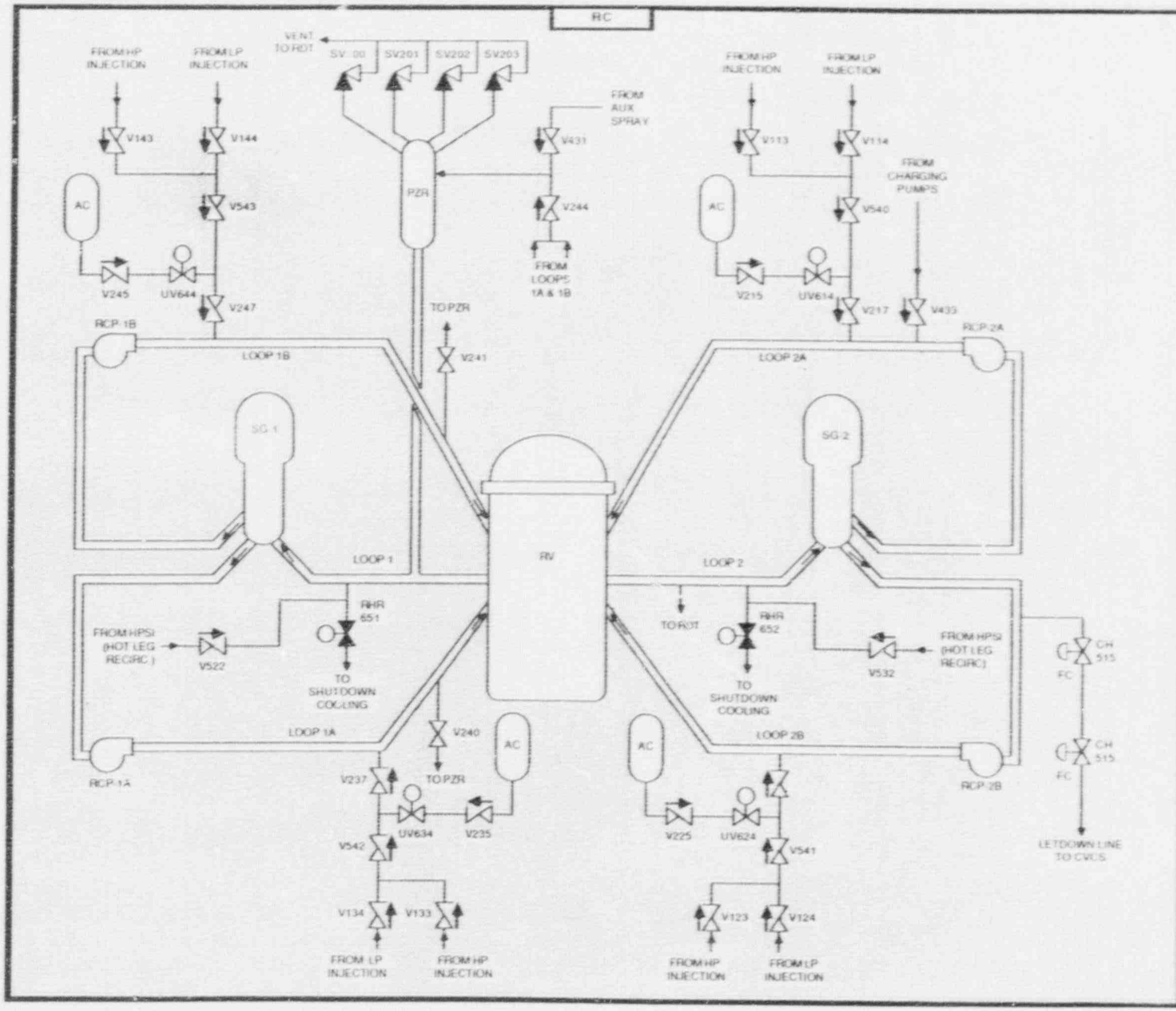


Figure 3.1-3. Palo Verde 1, 2, & 3 Reactor Coolant System Showing Component Locations

Table 3.1-1. Palo Verde Reactor Coolant System Data Summary for Selected Components

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
CH515	NCV	RC				
CH516	NCV	RC				
RCS-VESSEL	RV	RC				
RHR651	MOV	RC	MCC35	480	WELPENRM120	AC/A
RHR652	MOV	RC	MCC36	480	EELPENRM100	AC/B
RHR653	MOV	RC	LC43	125	DCC	DC/C
RHR654	MOV	RC	LC44	125	DCD	DC/D

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

3.2.1 System Function

The AFWS provides an independent means of supplying feedwater to the steam generators in addition to the main feedwater system. The AFWS is intended to provide a sufficient supply of feedwater to permit the plant to operate at hot standby after a transient or small break LOCA for eight hours followed by an orderly plant cooldown to the point where the shutdown cooling system may be initiated. 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. 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 one safety-related Seismic Category I motor-driven pump, one safety related Seismic Category I steam turbine-driven pump , one non-safety related, non-Seismic Category I motor-driven startup feedwater pump, associated piping, controls and instrumentation. Each pump can supply both steam generators. The primary source of auxiliary feedwater is the Seismic Category I condensate storage tank (CST). The secondary or backup source of auxiliary feedwater is the reactor makeup water tank (RMWT).

The SSRS consists of five safety valves and one pneumatically operated atmospheric dump valve on each of four main steam lines (two per steam generator).

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 until the system pumps are actuated by an Automatic Feedwater Actuation Signal (AFAS). This actuation signal automatically starts the motor and turbine driven AFWS pumps and pump room cooling units, opens the AFWS feed regulating valves to the intact steam generator(s), and closes the steam generator blowdown isolation valves.

Steam generator level is maintained automatically after initiation of the AFWS. After conditions stabilize, the operator has the capability of manually controlling the auxiliary feedwater flow.

The primary source of auxiliary feedwater is the condensate storage tank. A minimum capacity of 195,000 gallons is required by the AFWS during emergency shutdown conditions. This provides an orderly RCS cooldown to the shutdown cooling initiation conditions. An additional 105,000 gallons of condensate storage capacity provides sufficient feedwater to maintain the plant at hot standby for eight hours.

The startup feedwater pump is used for startup, hot standby, and normal shutdown operations. This pump is manually started and associated valves are manually operated from the control room.

3.2.4 System Success Criteria

For the decay heat removal function to be successful, both the AFW system and the SSR system must operate successfully. The AFW success criteria are the following (Ref. 1, Section 10.4.9):

- Any one AFW pump can provide adequate flow.
- Water must be provided from the CST or RMWT to the AFW pump suctions
- Makeup to any one steam generator provides adequate decay heat removal from the reactor coolant system.

The SSR system must operate to complete the heat transfer path to the environment. The number of safety valves that must open for the decay heat removal function is not known.

3.2.5 Component Information

A. Motor-driven AFW pump
   1. Rated flow: 750 gpm @ 3280 ft. head (1422 psid)
   2. Type: Centrifugal

B. Turbine-driven AFW pump
   1. Rated flo v: 875 gpm @ 3280 ft. head (1422 psid)
   2. Type: Centrifugal

C. Motor-driven startup feedwater pump
   1. Rated flow: 875 gpm @ 2960 ft. head (1283 psid)
   2. Type: Centrifugal

D. Condensate storage tank
   1. Capacity: 300,000 gallons

E. Reactor makeup water storage tank
   1. Capacity: 480,000 gallons

3.2.6 Support Systems and Interfaces

A. Control Signals
   1. Automatic
      The AFWS pumps are automatically actuated upon receipt of an Auxiliary Feedwater Actuation Signal (AFAS) under the following conditions:

      - Main steam line break
      - Loss of main feedwater
      - Loss of offsite power
      - Loss of all offsite/onsite AC power (TDP only)

      The AFAS appears to be capable of detecting conditions indicative of main feedwater or main steam line breaks and isolating AFWS flow to the affected steam generator.
   2. Remote manual
      The AFWS can be operated from the control room or a remote shutdown station.
   3. Manual
      The AFWS can be manually aligned to the alternate water source, the RMWT.

B. Motive power
   1. The safety-related motor driven AFWS pump and AFWS motor operated valves receive 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 either steam generator upstream of the main steam line isolation valves. The power and controls for the valves associated with this pump receive power from the Class 1E DC buses A and C.

C. Other
   1. Lubrication, cooling, and ventilation are provided locally for the pumps.

3.2.7 Section 3.2 References

1. Palo Verde Final Safety Analysis Report, Arizona Public Service Company, Phoenix, Arizona.

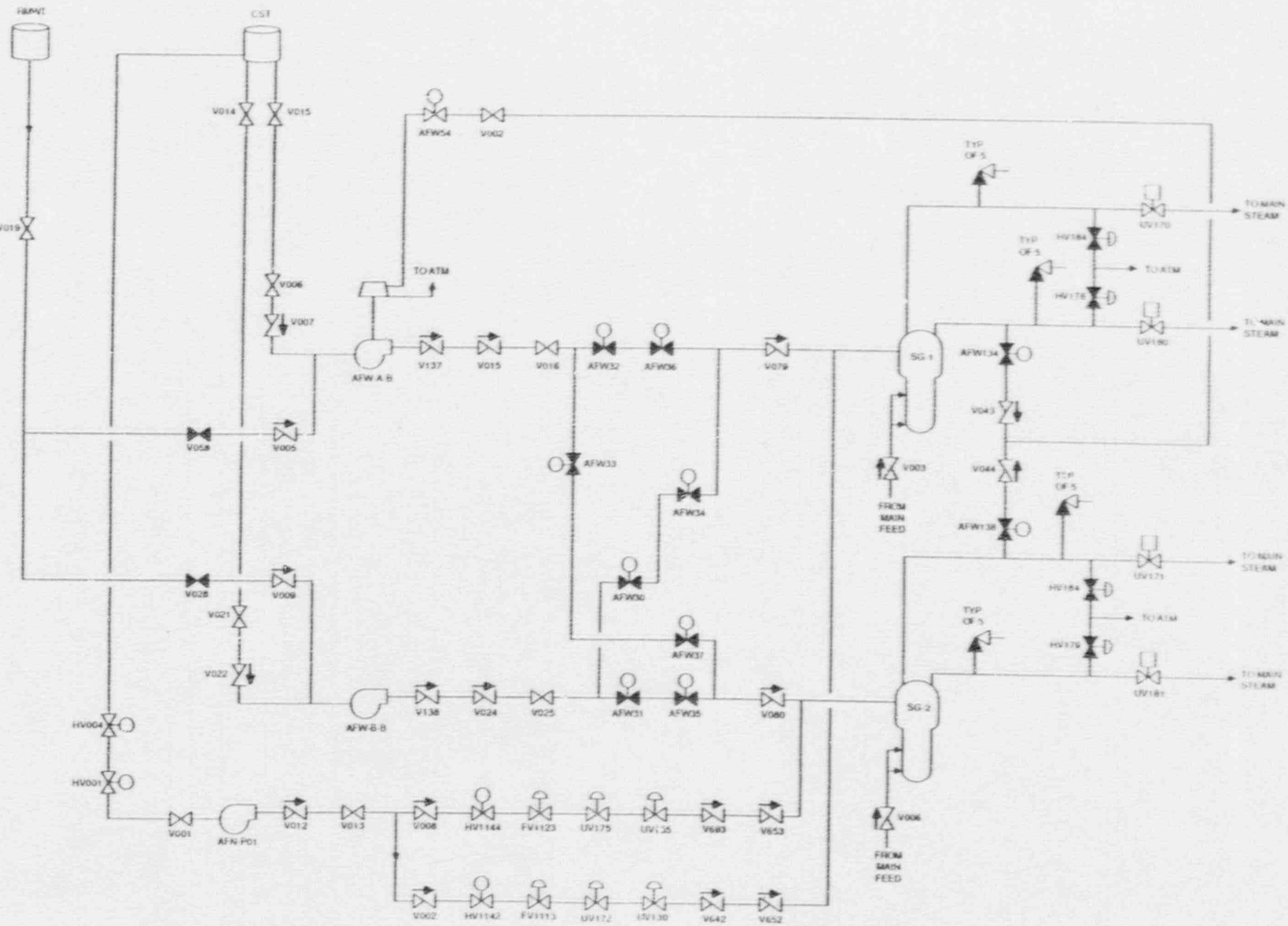


Figure 3.2-1. Palo Verde 1, 2 and 3 Auxiliary Feedwater System

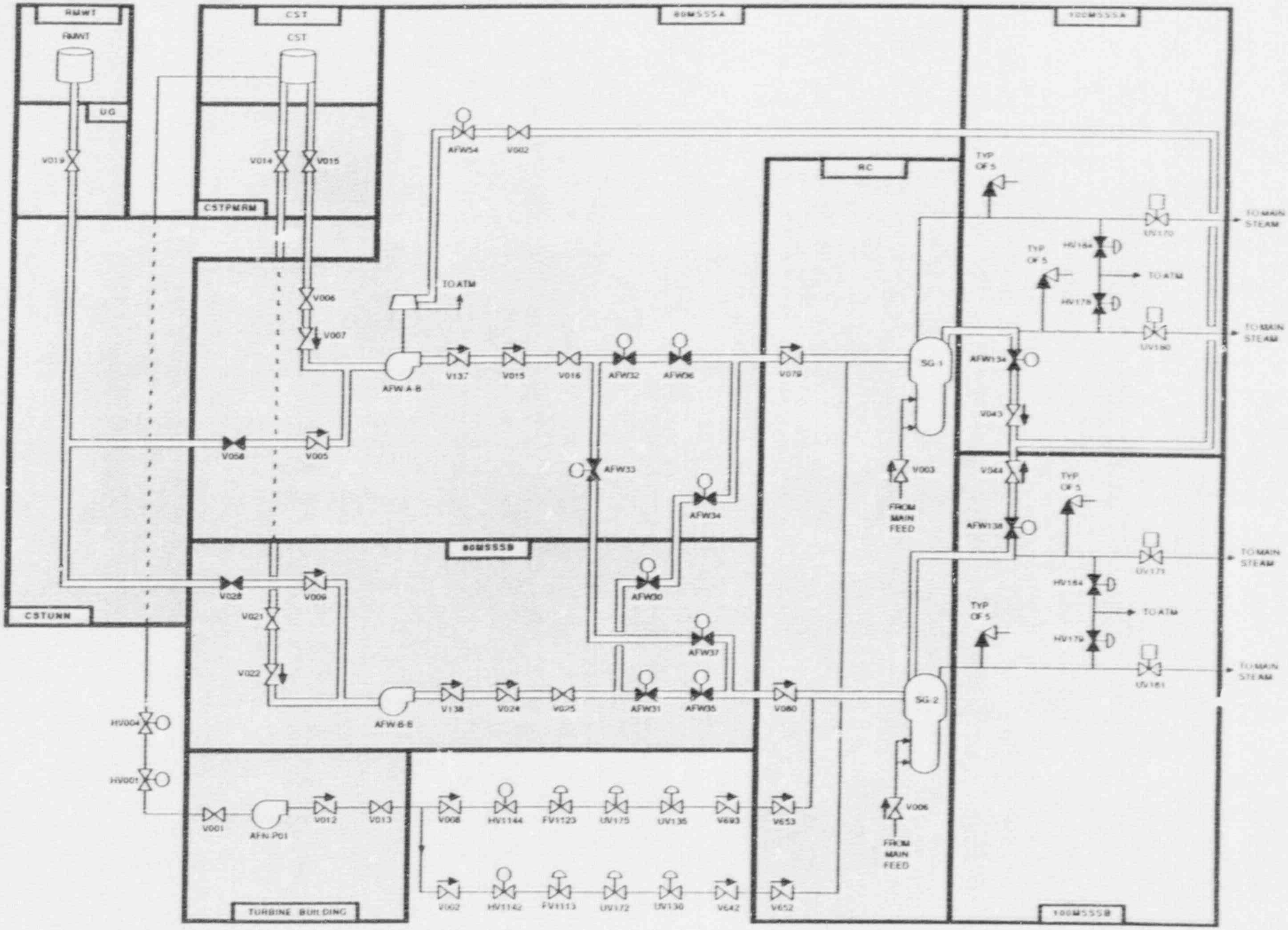


Figure 3.2-2. Palo Verde 1, 2 and 3 Auxiliary Feedwater System Showing Component Locations

Table 3.2-1. Palo Verde Auxiliary Feedwater System Data Summary for Selected Components

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
AFW-A-B	TDP	80MSSSA				
AFW-B-B	MDP	80MSSSB	BUSS04	4160	ESFB	AC/B
AFW134	MOV	100MSSSA	LC41	125	DCA	DC/A
AFW138	MOV	100MSSSB	LC41	125	DCA	DC/A
AFW30	MOV	80MSSSB	MCC34	480	EELPENRM100	AC/B
AFW30	MOV	80MSSSB	MCC34	480	EELPENRM100	AC/B
AFW31	MOV	60MSSSB	MCC34	480	EELPENRM100	AC/B
AFW32	MOV	80MSSSA	LC41	125	DCA	DC/A
AFW33	MOV	80MSSSA	LC43	125	DCC	DC/A
AFW33	MOV	80MSSSA	LC43	125	DCC	DC/A
AFW34	MOV	80MSSSA	MCC38	480	EELPENRM100	AC/B
AFW34	MOV	80MSSSA	MCC38	480	EELPENRM100	AC/B
AFW35	MOV	80MSSSB	MCC38	480	EELPENRM100	AC/B
AFW36	MOV	80MSSSA	LC43	125	DCC	DC/A
AFW37	MOV	80MSSSB	LC41	125	DCA	DC/A
AFW37	MOV	80MSSSB	LC41	125	DCA	DC/A
AFW54	MOV	80MSSSA	LC41	125	DCA	DC/A
CST	TANK	CST				
RMWT	TANK	RMWT				
SG-1	SG	RC				
SG-2	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 spray system.

3.3.2 System Definition

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

- Safety Injection Tanks
- High Pressure Safety Injection (HPSI) system (Train A and Train B)
- Low Pressure Safety Injection (LPSI) system (Train A and Train B)

The HPSI system provides the high pressure coolant injection capability, and the LPSI system perform the low pressure injection function. The Refueling Water Tank (RWT) is the water source for both the high and low pressure injection pumps.

Simplified drawings of the HPSI system are shown in Figures 3.3-1 and 3.3-2. The LPSI system is shown in Figures 3.3-3 and 3.3-4. A summary of data on selected ECCS components is presented in Table 3.3-1.

3.3.3 System Operation

During normal operation, the ECCS is in standby. Following a large LOCA, the ECCS meets short-term cooling requirements primarily in two ways. Initially, the passive safety injection tanks discharge into the cold legs of the RCS to provide core cooling and refill when the reactor pressure falls below the tank pressure. Adequate fluid is contained in the safety injection tanks to accomplish this function with one tank discharging through the LOCA break. Secondly, each train containing one high pressure injection pump and one low pressure injection pump delivers borated makeup water from the RWT to the RCS. One ECCS train is capable of performing this short-term cooling function with one of the injection flow paths discharging through the LOCA break.

Long-term core cooling is accomplished by recirculating water in the containment sump. The switchover from injection to recirculation occurs automatically upon reaching a preset level in the RWT, approximately 20 minutes following LOCA initiation. The ECCS is manually realigned for long-term core cooling within 90 minutes following a LOCA by the initiation of hot leg injection.

The ECCS may be aligned for simultaneous hot leg/cold leg injection which provides effective long-term core cooling independent of the large LOCA break location. This type of injection is accomplished by opening connections between the high pressure safety injection discharge headers and the two shutdown cooling suction lines. Decay heat is rejected to the containment atmosphere. Heat removal from the containment atmosphere is accomplished by the Containment Spray System and the shutdown cooling heat exchangers.

For long term cooling of small breaks, the high pressure safety injection pumps provide make-up while the RCS is cooled down and depressurized to shutdown cooling initiation conditions utilizing the steam generator atmospheric dump valves and the auxiliary feedwater system. This is followed by a normal shutdown cooling operation.

The shutdown cooling (residual heat removal) system operates when the RCS temperature and pressure are below 350°F and 40 psia respectively. This "system" is an operating mode of the LPSI system in which the pump suctions are aligned to the RCS hot legs via the shutdown cooling suction lines. Reactor coolant is circulated through the shutdown cooling heat exchangers and is returned to the RCS through the four cold leg injection paths. Decay heat is transferred from the RCS to the essential cooling water system in the shutdown cooling heat exchangers.

When the RCS temperature is below 200°F, the containment spray pumps can be realigned to provide additional shutdown cooling flow.

3.3.4 System Success Criteria

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

- Three of four safety injection tanks discharge their contents into the RCS cold legs
- At least one low pressure safety injection pump takes suction on the RWT and injects into the cold legs.

If the ECI success criteria is met, then the following large LOCA ECR success criteria will apply (Ref. 1, Section 6.3):

- At least one high pressure safety injection pump is realigned for recirculation and takes a suction on the containment sump and injects into the RCS cold legs.

The success criterion for a small LOCA is:

- At least one high pressure safety injection pump takes suction on the RWT and injects into the RCS cold legs.

It should be noted that:

- The HPSI pump shutoff head is less than RCS normal operating pressure, therefore, a small LOCA must be of sufficient size to cause some RCS depressurization, or the RCS must be depressurized by other means if the HPSI pumps are to provide makeup. The RCS may be cooled with operation of the auxiliary feedwater system (see Section 3.2). Note that there are no power-operated relief valves on the pressurizer (see Section 3.1).
- The combined capacity of the three positive displacement charging pumps (not part of the SIS) is 132 gpm (i.e. 44 gpm each).

3.3.5 Component Information

A. High Pressure Safety Injection pumps 1 and 2
   1. Rated flow: 1130 gpm @ 1580 ft head (685 psid)
   2. Rated capacity: 100%
   3. Type: multistage, horizontal, centrifugal

B. Low Pressure Safety Injection pumps 1 and 2
   1. Rated flow: 5000 gpm @ 290 ft. head (126 psid)
   2. Rated capacity: 100%
   3. Type: Single stage, vertical, centrifugal

C. Containment Spray Pumps 1 and 2
   1. Rated flow: 3740 gpm
   2. Rated Capacity: ~80%

D. Safety Injection Tanks (4)
   1. Volume: 1927 ft^3
   2. Normal operating pressure: 610 psig

E. Refueling water tank
   1. Capacity: 600,000 gallons

F. Shutdown cooling heat exchangers 1 and 2
   1. Design duty: 43.8×10^6 Btu/hr
   2. Rated flow (gpm): 3890 (primary side), 14,400 (ECWS side)
   3. Type: shell and tube

3.3.6 Support Systems and Interfaces

A. Control signals
   1. Automatic
      The ECCS subsystems are automatically actuated by a safety injection actuation signal (SIAS). Conditions initiating an SIAS trip are:

      - Low pressurizer pressure
      - High containment pressure
      - Manual actuation

      The SIAS automatically initiates the following actions:

      - starts the HPSI and LPSI pumps
      - aligns the pumps for injection
      - aligns the pump suction to the RWT

      Switch over to the low pressure recirculation mode occurs automatically on low level in the RWT.

   2. Remote manual
      An SIAS signal can be initiated by remote manual means from the main control room. ECCS operation can be initiated by remote manual means.

B. Motive Power
   1. 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. The shutdown cooling heat exchangers are cooled by the Essential Cooling Water System (see Section 3.7).
   2. Lubrication is provided locally for the ECCS pumps and motors.
   3. Pump room cooling is provided by the Essential Chilled Water System.

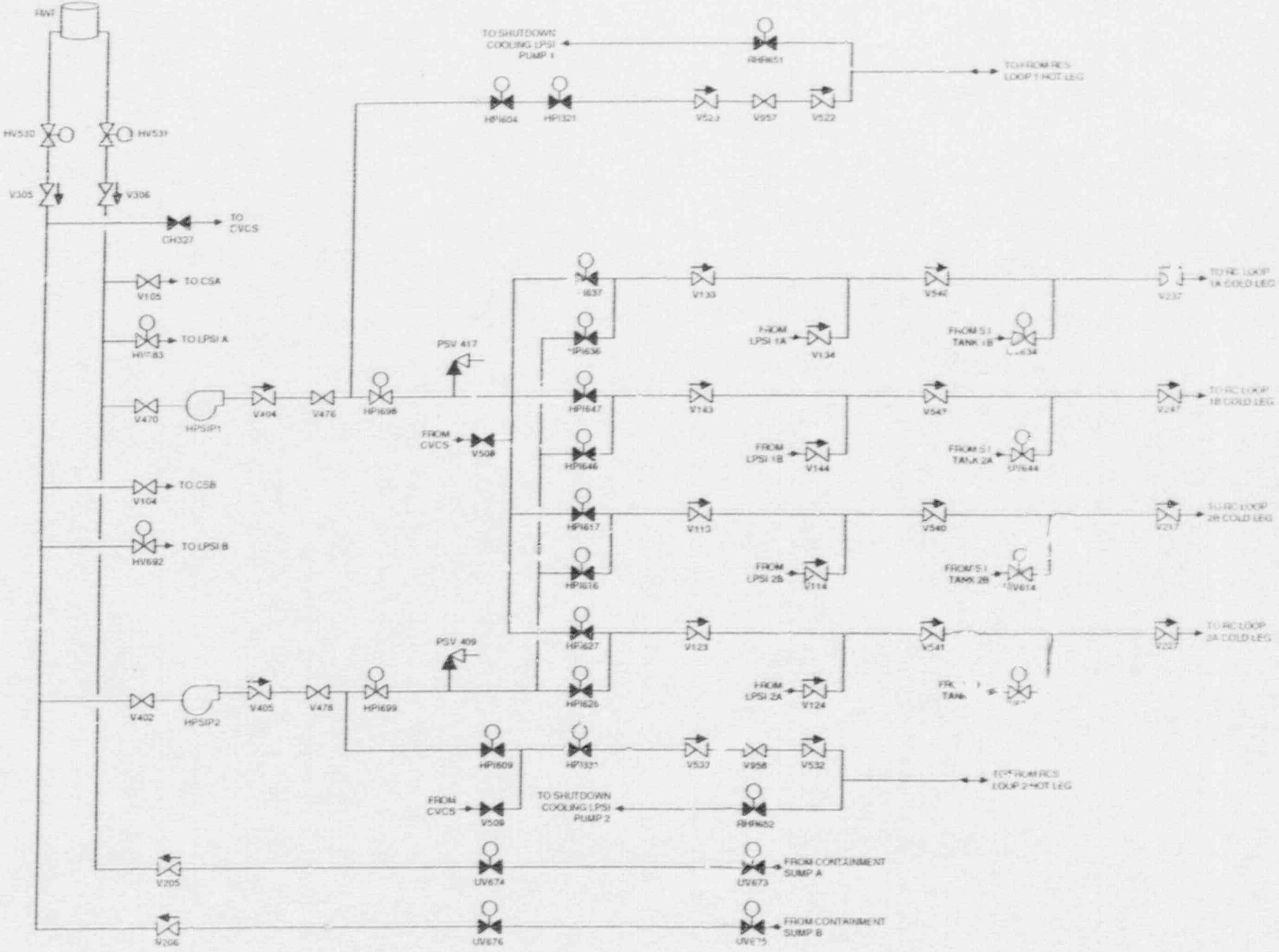


Figure 3.3-1. Palo Verde High Pressure Safety Injection System

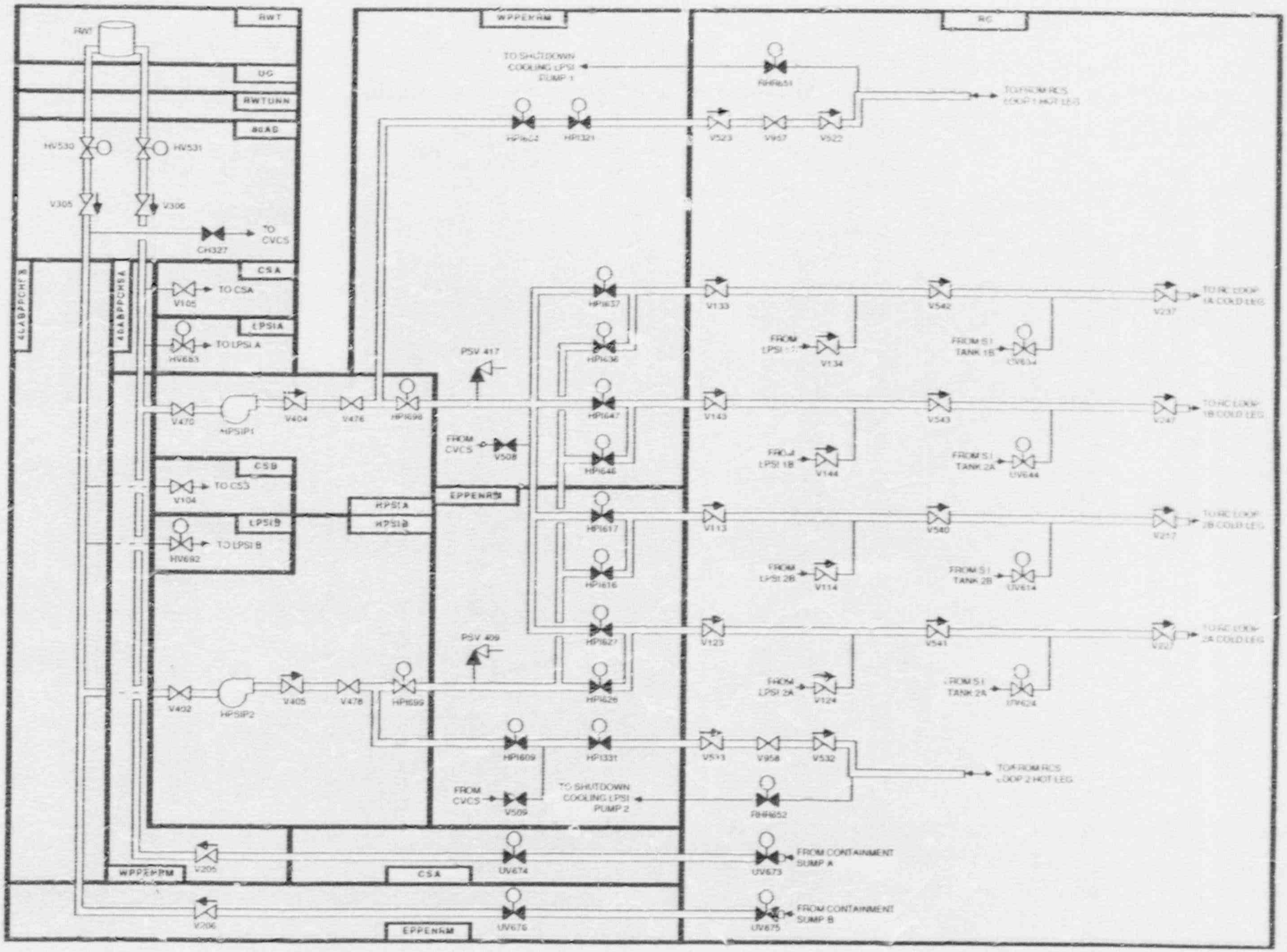


Figure 3.3-2. Palo Verde High Pressure Safety Injection System Showing Component Locations

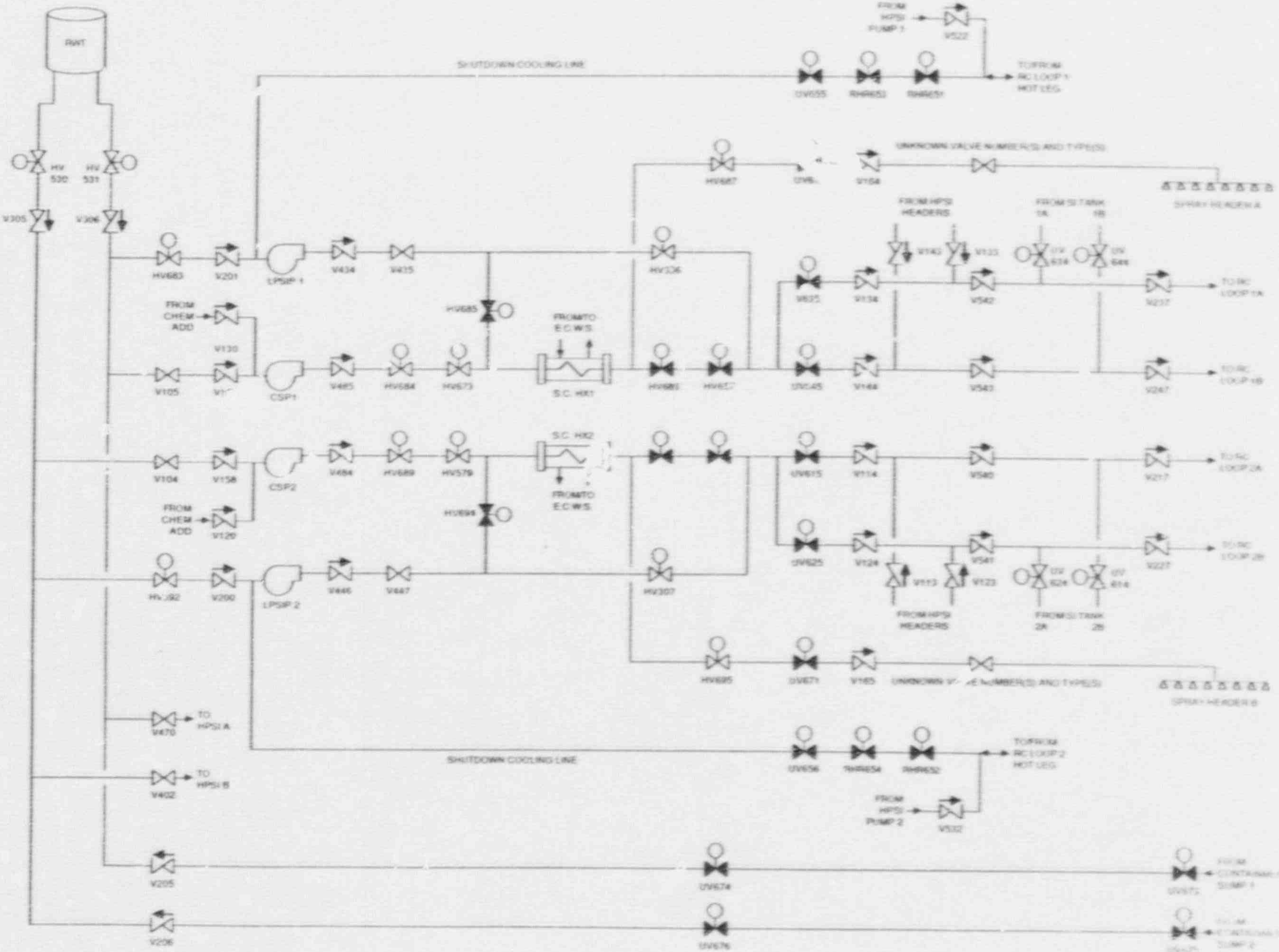


Figure 3.3-3. Palo Verde Low Pressure Safety Injection and Containment Spray Systems

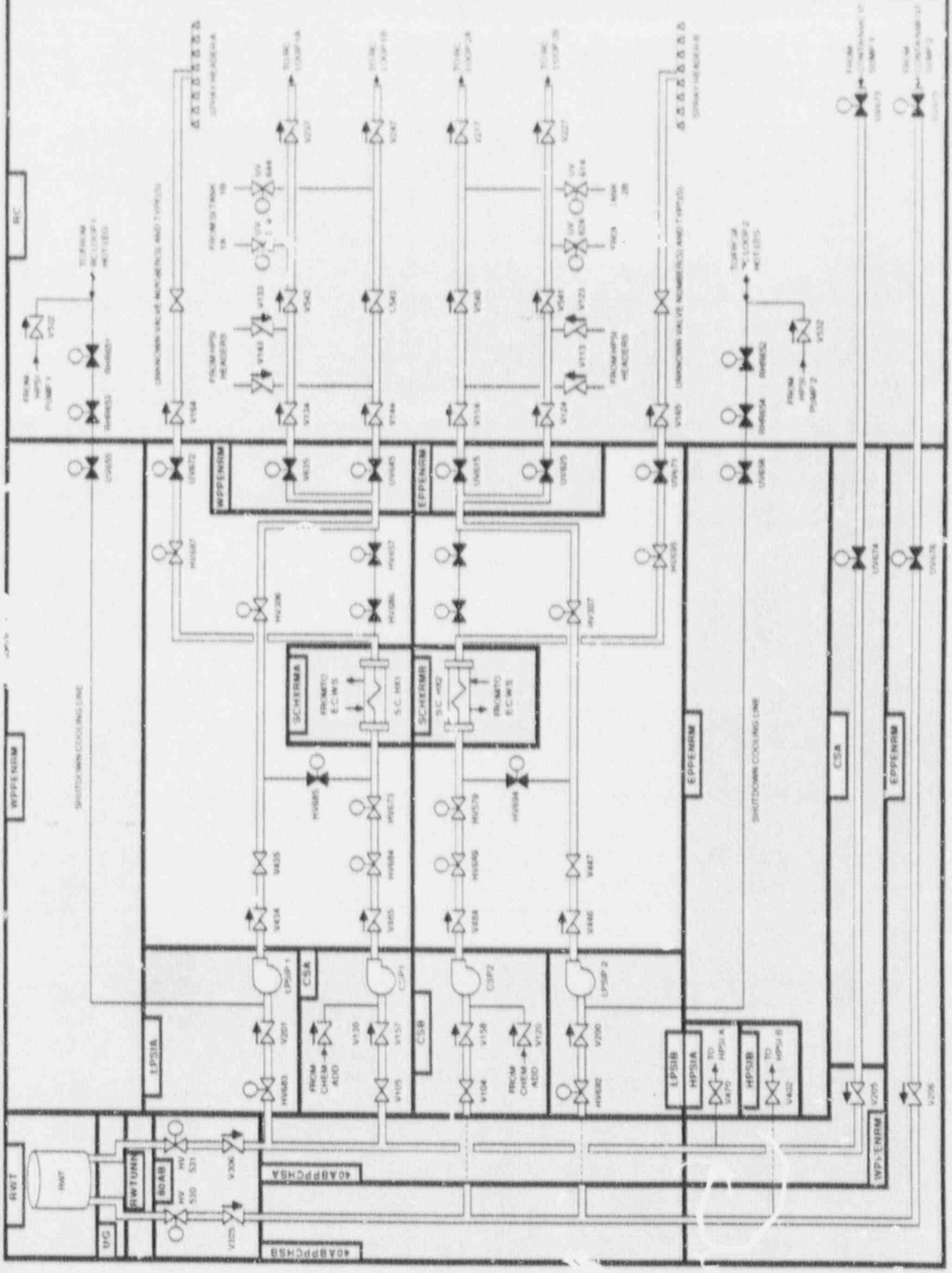


Figure 3.3-4. Palo Verde Low Pressure Safety Injection and Containment Spray Systems Showing Component Locations

Table 3.3-1. Palo Verde Emergency Core Cooling System Data Summary for Selected Components

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
HPI321	MOV	WPPENRM	LC43	125	DCC	DC/A
HPI331	MOV	EPPENRM	LC44	125	DCD	DC/B
HPI530	MOV	80AB	MCC36	480	EELPENRM100	AC/B
HPI531	MOV	80AB	MCC35	480	WELPENRM120	AC/A
HPI604	MOV	WPPENRM	MCC33	480	WELPENRM120	AC/A
HPI609	MOV	EPPENRM	MCC34	480	EELPENRM100	AC/B
HPI616	MOV	EPPENRM	MCC34	480	EELPENRM100	AC/B
HPI617	MOV	EPPENRM	MCC33	480	WELPENRM120	AC/A
HPI626	MOV	EPPENRM	MCC34	480	EELPENRM100	AC/B
HPI627	MOV	EPPENRM	MCC33	480	WELPENRM120	AC/A
HPI637	MOV	WPPENRM	MCC37	480	WELPENRM120	AC/A
HPI646	MOV	WPPENRM	MCC36	480	EELPENRM100	AC/B
HPI647	MOV	WPPENRM	MCC33	480	WELPENRM120	AC/A
HPI698	MOV	HPSIA	MCC37	480	WELPENRM120	AC/A
HPI699	MOV	HPSIB	MCC38	480	EELPENRM100	AC/B
HPSIP1	MDP	HPSIA	BUSS03	4160	ESFA	AC/A
HPSIP2	MDP	HPSIB	BUSS04	4160	ESFB	AC/B

3.4 CHARGING SYSTEM (CVCS)

3.4.1 System Function

The charging system is part of the Chemical and Volume Control System (CVCS). The 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 makeup function of the CVCS is required to maintain the plant in a long-term hot standby condition following a transient.

3.4.2 System Definition

The CVCS provides a means for injection of control poison in the form of boric acid solution, chemical additions for corrosion control, and reactor coolant cleanup and degasification. The system also maintains the required water inventory in the RCS, reprocesses water that is let down from the RCS, provides seal water injection to the reactor coolant pump seals, and performs an emergency core cooling function.

The CVCS consists of several 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 functions of the CVCS are performed by the following components: (a) the charging pumps, (b) boric acid transfer pumps, (c) volume control tank, (d) boric acid tanks, and (e) various heat exchangers and demineralizers.

Simplified drawings of the CVCS, focusing on the charging portion of the system, are shown in Figures 3.4-1 and 3.4-2. A summary of data on selected charging system components is presented in Table 3.4-1.

3.4.3 System Operation

During normal plant operation, two charging pumps are running with suction aligned to the Volume Control Tank (VCT). The letdown flow from the RCS cold leg is cooled in the tube side of the regenerative heat exchanger, then directed to the VCT. The bulk of the charging flow is pumped back to the RCS through the shell side of the regenerative heat exchanger via one charging line. Portions of the charging flow are directed to the reactor coolant pumps through a seal injection system.

The charging pumps can be aligned to take a suction on the Refueling Water Tank (RWT) and provide long-term makeup to the RCS following a transient. The CVCS letdown line is automatically isolated upon detection of a LOCA.

3.4.4 System Success Criteria

The following success criterion is assumed for CVCS makeup (Ref. 1, Section 9.3.4):

- 1 of 3 positive displacement charging pumps (CHP-1, CHP-2, or CHP-3) is required for adequate post-transient makeup to the RCS.

For post-transient makeup to the RCS the following charging system success criteria is assumed:

- A long-term water source must be available to the charging pumps.
- One of three charging pumps is available.
- A makeup path to the RCS is available.

3.4.5 Component Information

A. Charging Pumps (3)
   1. Rated capacity: 44 gpm
   2. Normal discharge pressure: 2300 psig
   3. Type: Positive Displacement

B. Refueling Water Tank (1)
   1. Volume: 590,000 gallons

C. Regenerative Heat Exchanger (1)
   1. Flow: 84 gpm (letdown), 48 gpm (charging)
   2. Type: Shell and tube, vertical (charging: shell; letdown: tube)

3.4.6 Support Systems and Interfaces

A. Control Signals
   1. Remote Manual
      The charging pumps and motor operated valves can be actuated by remote means from the control room.
   2. Manual
      Manual valves can be actuated by hand at their specific locations.

B. Motive Power
   1. The positive displacement charging pumps and motor operated valves of the CVCS are Class 1E AC loads that can be supplied from the standby diesel generators as described in Section 3.6.

C. Other
   1. No external cooling water or lubrication systems for the charging pumps have been identified.
   2. Pump room cooling systems have not been identified.

3.4.7 Section 3.4 References

1. Palo Verde Final Safety Analysis Report, Arizona Public Service Company, Phoenix, Arizona.

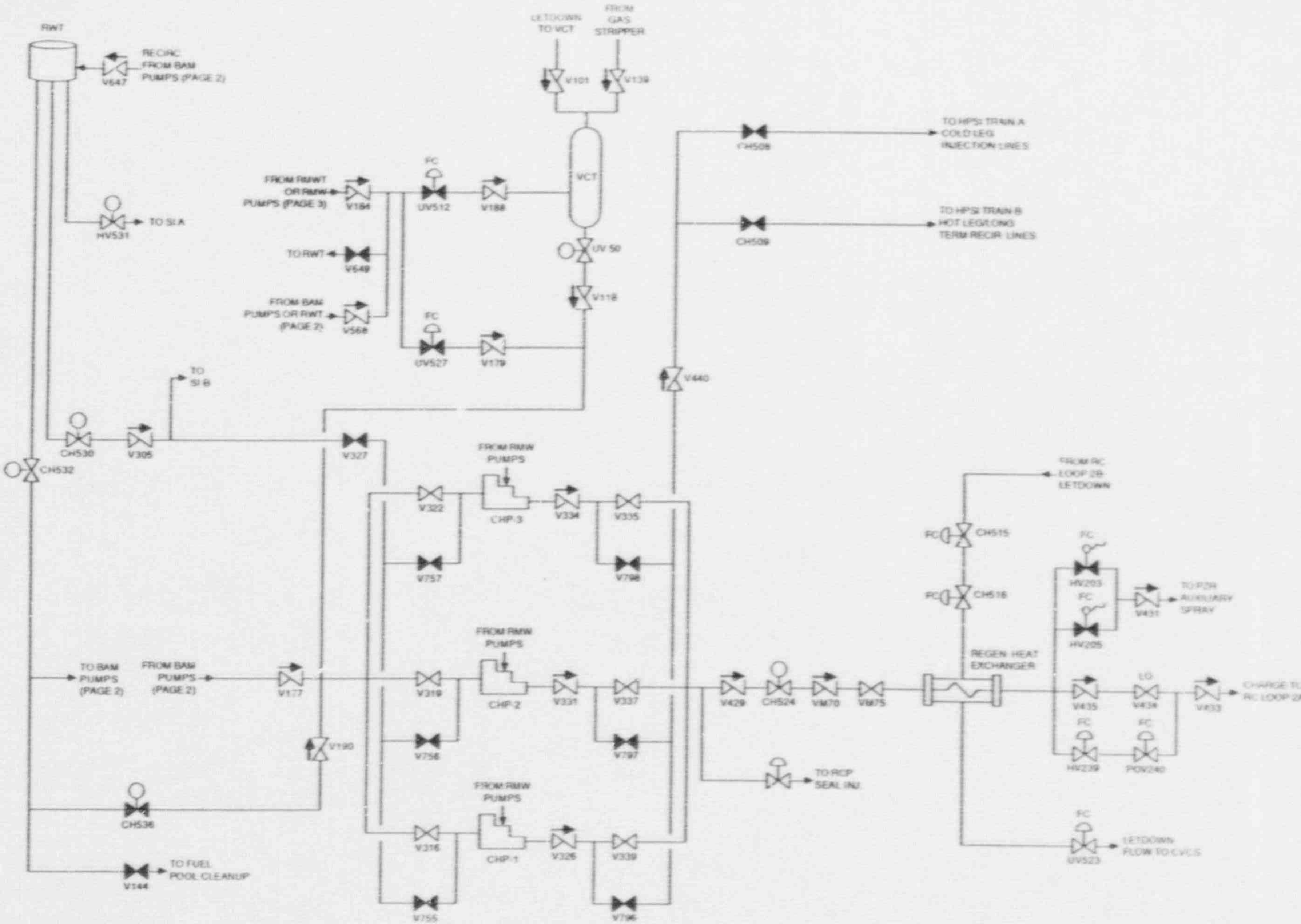


Figure 3.4-1. Palo Verde 1, 2 and 3 Chemical and Volume Control System (Page 1 of 3)

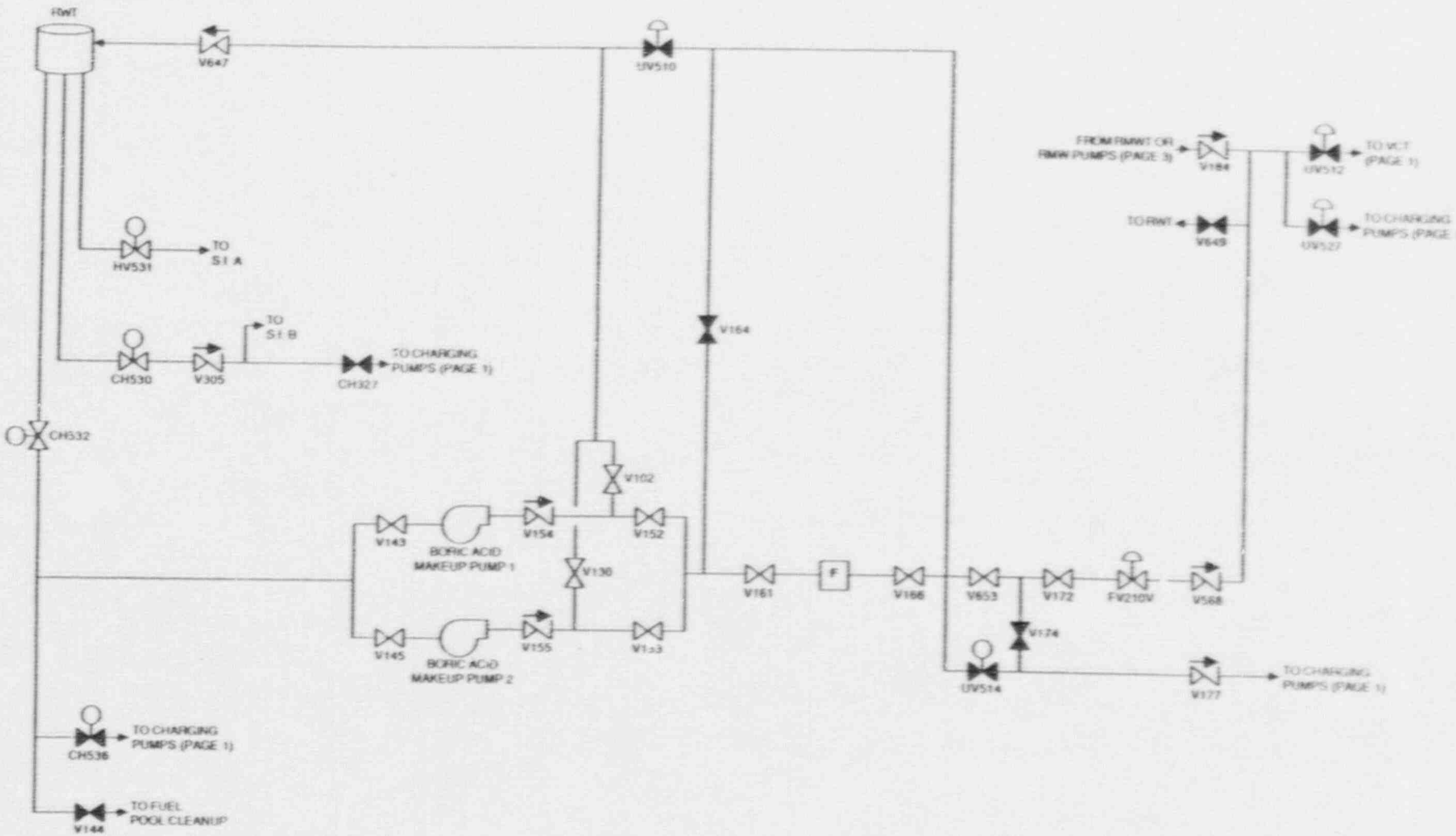


Figure 3.4-1. Palo Verde 1, 2 and 3 Chemical and Volume Control System (Page 2 of 3)

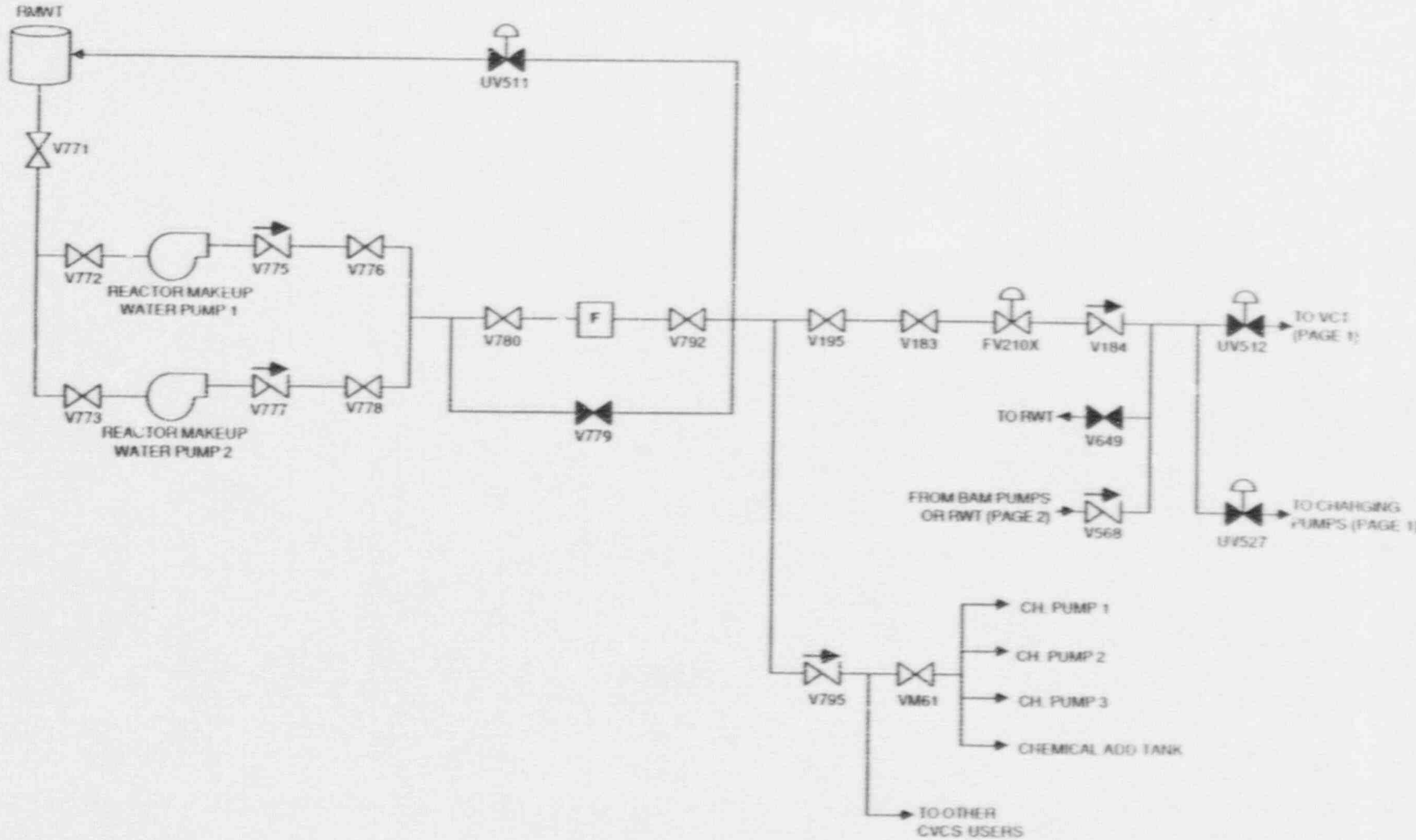


Figure 3.4-1. Palo Verde 1, 2 and 3 Chemical and Volume Control System (Page 3 of 3)

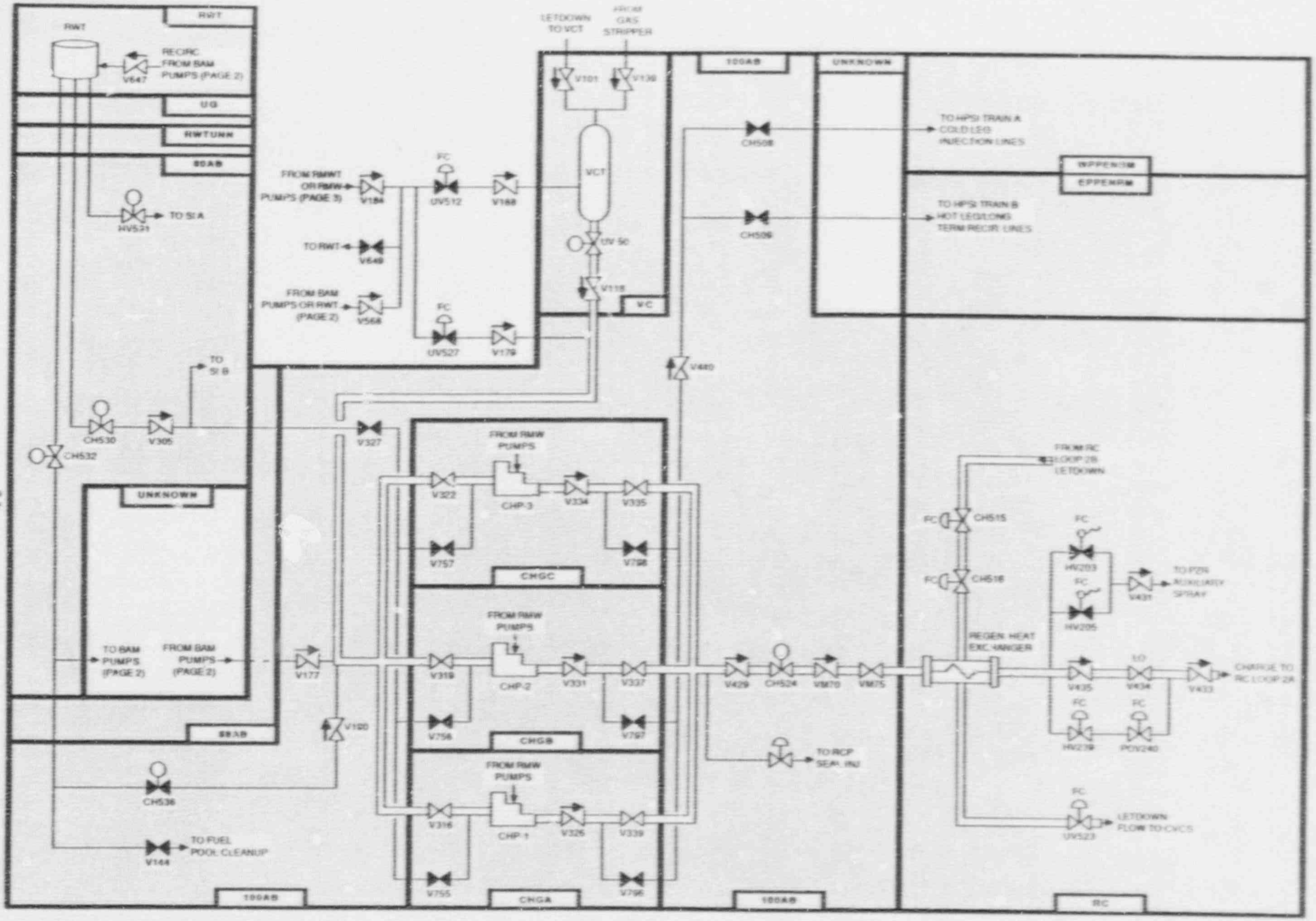


Figure 3.4-2. Palo Verde 1, 2 and 3 Chemical and Volume Control System Showing Component Locations (Page 1 of 3)

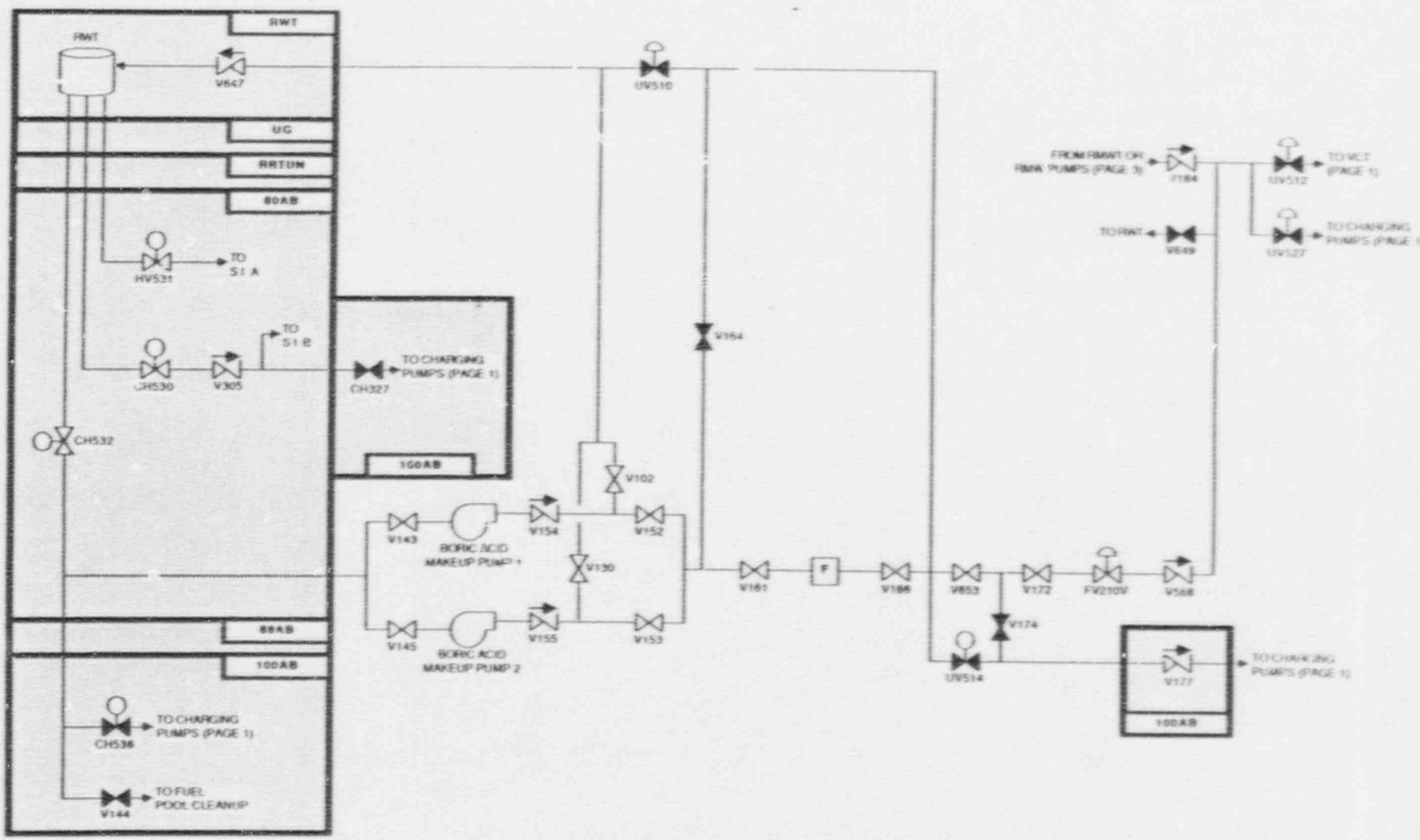


Figure 3.4-2. Palo Verde 1, 2 and 3 Chemical and Volume Control System Showing Component Locations (Page 2 of 3)

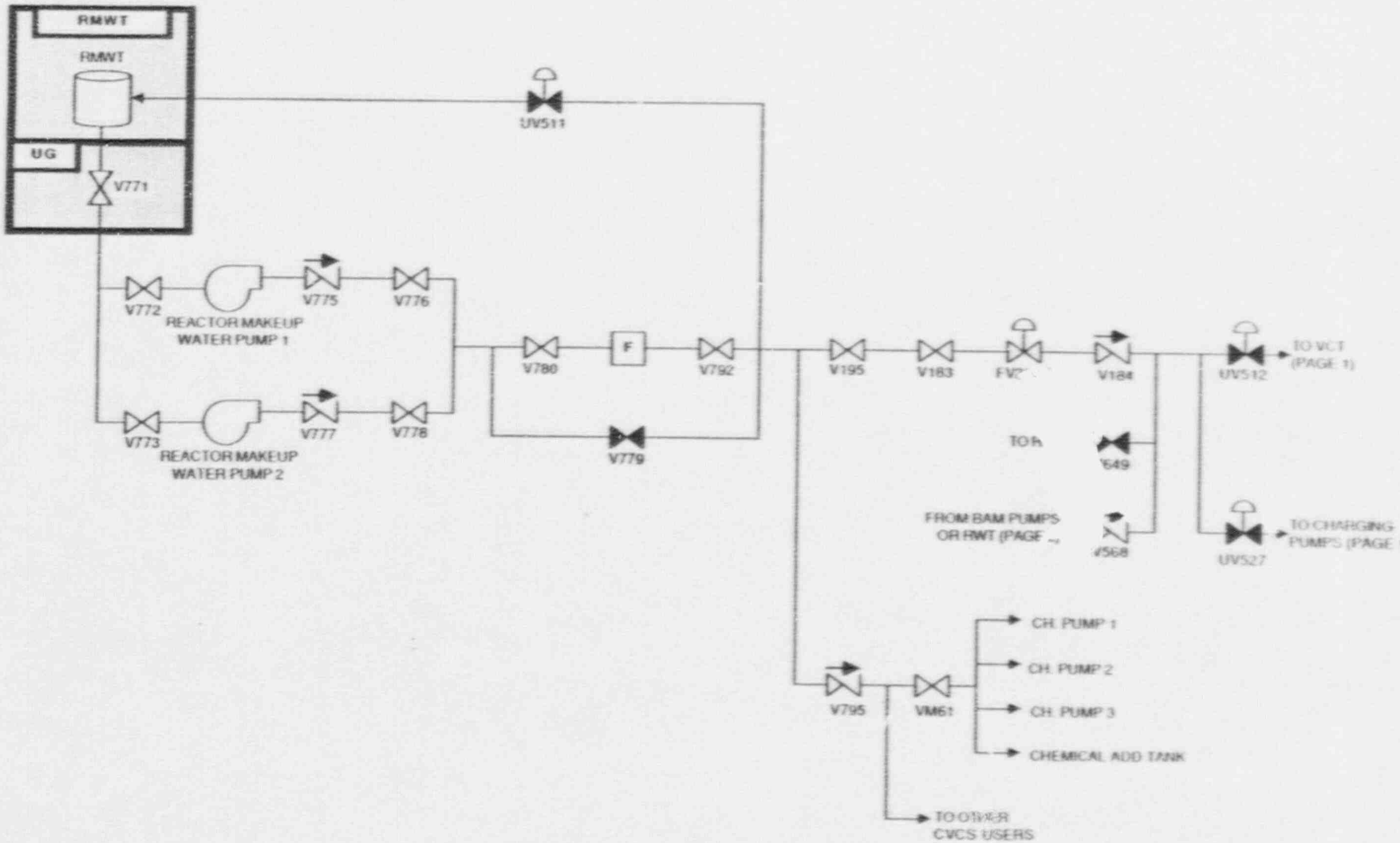


Figure 3.4-2. Palo Verde 1, 2 and 3 Chemical and Volume Control System Showing Component Location (Page 3 of 3)

Table 3.4-1. Palo Verde Charging System Data Summary for Selected Components

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
CH524	MOV	100AB	MCC35	480	WELPENRM120	AC/A
CH530	MOV	80AB	MCC36	480	EELPENRM100	AC/B
CH532	NV	80AB				
CH536	MOV	100AB	MCC35	480	WELPENRM120	AC/A
CHP-1	MDP	CHGA	BUSL31	480	ESFA	AC/A
CHP-2	MSP	CHGB	BUSL32	480	ESFB	AC/B
CHP-3	MDP	CHGC	BUSL36	480	ESFB	AC/B

3.5 INSTRUMENTATION AND CONTROL (I & C) SYSTEMS

3.5.1 System Function

The instrumentation and control systems consist of the Reactor Protection System (RPS), the Engineered Safety Features Actuation System (ESFAS), and systems for the display of plant information to the operators. The RPS and the Engineered Safety Features Actuation System monitor the reactor plant, and alert the operator to take corrective action before specified limits are exceeded. The RPS will initiate an automatic reactor trip (scram) to rapidly shutdown the reactor when plant conditions exceed one or more specified limits. The Engineered Safety Features Actuation System 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 RPS includes sensor and transmitter units, logic units, and output trip relays that operate reactor trip circuit breakers to cause a reactor scram. The Engineered Safety Features Actuation System includes independent se[illegible] and transmitter units, logic units and relays that interface with the control circuits [illegible] the many different sets of components that can be actuated by this system. Operator instrumentation display systems consist of display panels in the control room that are powered by the 120 VAC electric power system (see Section 3.6). The remote shutdown capability is provided by the Remote Shutdown Panel in conjunction with normal automatic systems and local equipment controls (Ref 1).

3.5.3 System Operation

A. RPS

The RPS has four redundant input instrument channels for each sensed parameter and two output actuation trains (A and B). The A and B logic trains independently generate a reactor trip command when prescribed parameters are outside the safe operating range. Either RPS train is capable of opening a separate and independent reactor trip circuit breaker to cause a scram. The manual scram A and B circuits bypass the RPS logic trains and send a reactor trip command directly to shunt trip circuitry in the reactor trip circuit breakers.

B. ESFAS

The initiation of the Engineered Safety Features Actuation System has three or four input instrument channels for each sensed parameter, and two output actuation trains (A and B). In general, each train controls equipment powered from different Class 1E AC electrical load groups. An individual component usually receives an actuation signal from only one train. The initiation of the Engineered Safety Features Actuation System generates the following signals: (a) safety injection actuation signal (SIAS), (b) containment isolation, and (c) containment spray actuation. The control room operators can manually trip the various logic subsystems. Details regarding actuation logic are included in the system description for the actuated system.

C. Remote Shutdown

Instrumentation and controls are provided external to the control room to achieve and maintain hot shutdown of the reactor should the control room become inaccessible and under the assumption that: (1) the operator trips the reactor prior to evacuation from the control room, and (2) that no other adverse available at the remote shutdown station. The atmospheric dump valve manual loading stations and the auxiliary feedwater turbine speed controller are provided with control transfer from the main control room to the remote shutdown panel.

3.5.4 System Success Criteria

A. RPS

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

B. ESFAS

A single component usually receives a signal from only one ESFAS output train. ESFAS Trains A and B must be available in order to automatically actuate their respective components. ESFAS typically uses hindrance input logic (normal = 1, trip = 0) and transmission output logic (normal = 0, trip = 1). In this case, an input 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). Control power is needed for the ESFAS output channels to send an actuation signal. Note that there may be some ESFAS actuation subsystems that utilize hindrance output logic. For these subsystems, loss of control power will cause system or component actuation, as is the case with the RPS. Details of the ESFAS system for Palo Verde have not been determined.

C. Manually-Initiated Protective Actions

When reasonable time is available, certain protective actions may be performed manually by plant personnel. The control room operators are capable of operating individual components using normal control circuitry, or operating groups of components by manually tripping the RPS or an 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 remote shutdown 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

1. RPS

The RPS input instrument channels are powered from the 120 VAC instrument buses (see Section 3.6). It is assumed that the RPS A and B output logic trains are powered from separate 125 VDC distribution panels.

2. Initiation of Engineered Safety Features Actuation System
The input instrument channels are pow. red from 120 VAC instrument buses. It is assumed that the A and B output logic trains are powered from separate 125 VDC distribution panels.

3. Operator Instrumentation
Operator instrumentation displays are powered from the 120 VAC instrument buses.

3.5.6 Section 3.5 References

1. Palo Verde Final Safety Analysis Report, Arizona Public Service Company, Phoenix, Arizona, Section 7.4.1, 1984

Table 3.5-1. Controls Available on the Palo Verde Remote Shutdown Panels

The following controls are available at remote shutdown panels:

1. Steam Generator (SG) Atmospheric Dump Valve Permissive Controls
2. Auxiliary Feedwater (FW) Regulating Valve Controls
3. Auxiliary FW Isolation Valve Controls
4. SG Atmospheric Steam Dump Modulating Controllers
5. Auxiliary FW Turbine Steam Supply Valve Control
6. Auxiliary FW Turbine Speed Control Transfer Switch
7. Auxiliary FW Turbine Speed Control Potentiometer
8. Auxiliary FW Turbine Trip Valve Control
9. Auxiliary FW Turbine Trip Pushbutton
10. All Channels of Main Steam Isolation System (MSIS) Actuation Pushbuttons
11. Channel A and B Auxiliary Pressurizer Spray Valve Controls
12. Reactor Coolant Pump (RCP) Controlled Bleedoff Containment Isolation Valve Controls
13. Shutdown Cooling Pump (SCP) Controlled and Bleedoff Relief Isolation Valve Control
14. Letdown Isolation Valve Controls
15. Backup Heater Groups 1 and 2 Controls
16. Safety Injection Tank Vent Valve Control and Power Disconnect Switch
17. Shutdown Cooling Pumps Recirculation Valve Controls
18. Steam Generator Pressure Variable Setpoint Reset
19. Pressurizer Pressure Variable Setpoint Reset
20. Low Pressurizer Pressure Bypass

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 onsite Class 1E electric power system consists of two AC load groups. Diesel generator A is connected to 4160 VAC bus PBAS03, and diesel generator B is connected to 4160 VAC bus PBBS04. There are six 480 VAC switchgear buses, designated PGAL31, 33, 35 and PGBL32, 34 and 36. Buses PGAL31, 33 and 35 are connected to 4160 bus PBAS03 through transformers TR-31, 33 and 35 respectively. Buses PGBL32, 34 and 36 are connected to 4160 bus PBBS04 through transformers TR-32, 34 and 36 respectively. Various motor control centers receive their power from the 480 VAC buses.

Emergency power for vital instruments, control, and emergency lighting is supplied by four 125 VDC/120 VAC load groups. Four station batteries energize four DC buses, designated Load Centers PKAM41, PKBM42, PKCM43, and PKDM44. Four 120 VAC instrument panel buses (panels D25, D26, D27, and D28) are connected to the DC buses through inverters.

Simplified one-line diagrams of the electric power system are shown in Figures 3.6-1 and 3.6-2. A summary of data on selected electric power system components is presented in Table 3.6-1. A partial listing of electrical sources and loads is presented in Table 3.5-2.

3.6.3 System Operation

During normal operation, the Class 1E electric power system is supplied from the 525 kV switchyard through two system auxiliary transformers. 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 sized to supply power for up to 2 hours (Ref. 1).

The 120 VAC vital buses normally receive power from the DC buses through respective inverters.

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 bus PBAS03. Load group AC/B contains components powered either directly or indirectly by bus PBBS04. Components receiving DC power are assigned to load groups DC/A, DC/B, DC/C, or DC/D, 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 initially 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. Maximum continuous rating: 5500 kW
   2. 2 hour rating: 6050 kW
   3. Rated voltage: 4160 VAC
   4. Manufacturer: unknown

B. Batteries (4)
   1. Rated voltage: 125 VDC
   2. Rating with design load: 2 hours per battery

3.6.6 Support Systems and Interfaces

A. Control Signals
   1. Automatic
      The standby diesel generators are automatically started based on:
      - Undervoltage on the normal bus, loss of offsite power (LOSPW)
      - Safety injection actuation signal (SIAS)
      - Auxiliary feedwater actuation signal (AFAS)

   2. Remote manual
      The diesel generators can be started, and many distribution circuit breakers can be operated, from the main control room.

B. Diesel Generator Auxiliary Systems
   1. Diesel Cooling Water System
      Heat from both diesel generators is transferred from a jacket water system to the Essential Spray Pond System (ESPS, see Section 3.8). An alternate cooling source is the fire system.
   2. Diesel Starting System
      Each diesel has an air starting system.
   3. Diesel Fuel Oil Transfer and Storage System
      A "day tank" supplies short-term (approximately 7 hours) fuel needs of each diesel. Each day tank can be replenished from two storage tanks during engine operation.
   4. Diesel Lubrication System
      Each diesel generator has its own 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.

3.6.7 Section 3.6 References

1. Palo Verde Final Safety Analysis Report, Arizona Public Service Company, Phoenix, Arizona.

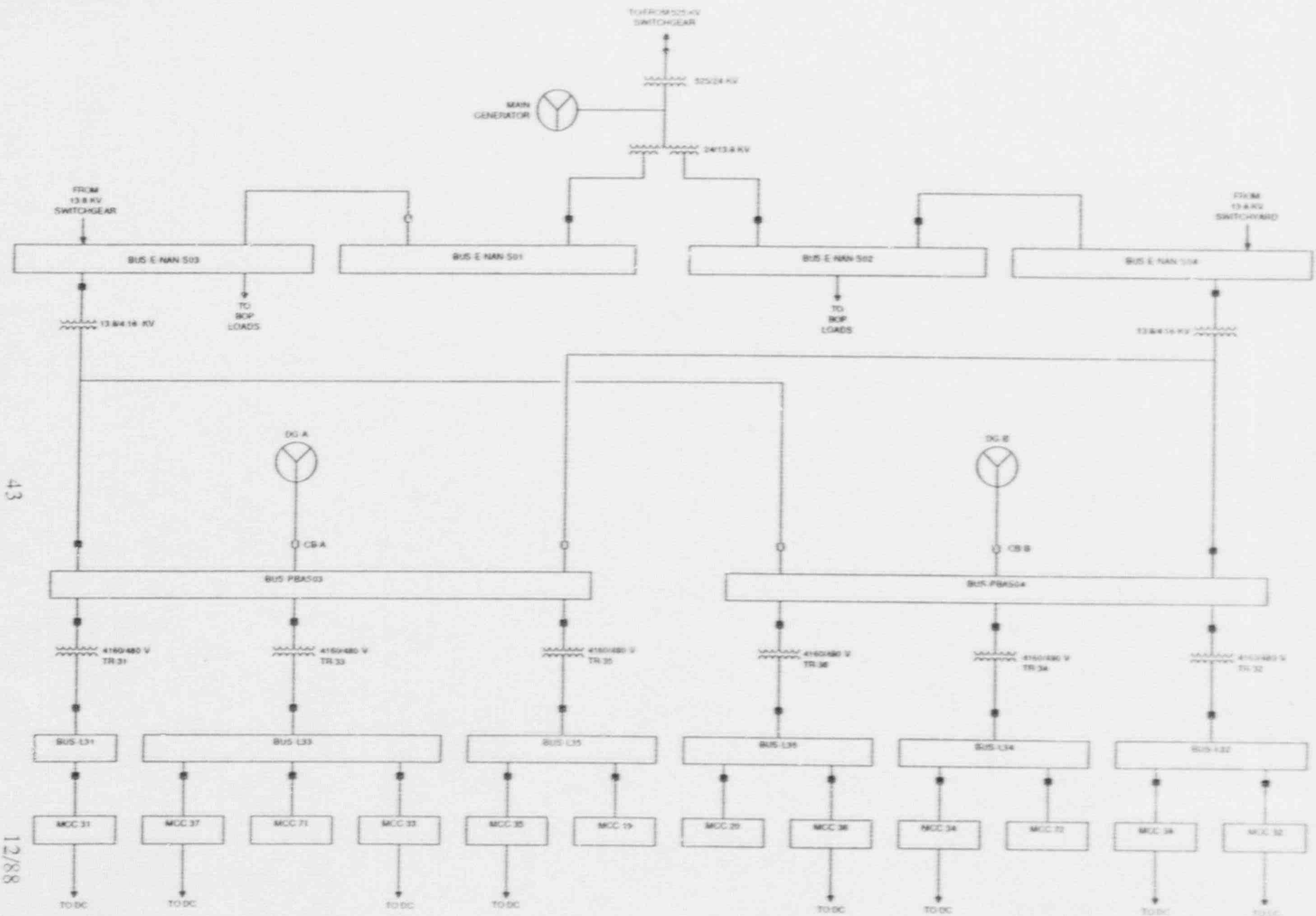


Figure 3.6-1. Palo Verde 1, 2, and 3 Electric Power System (Page 1 of 2)

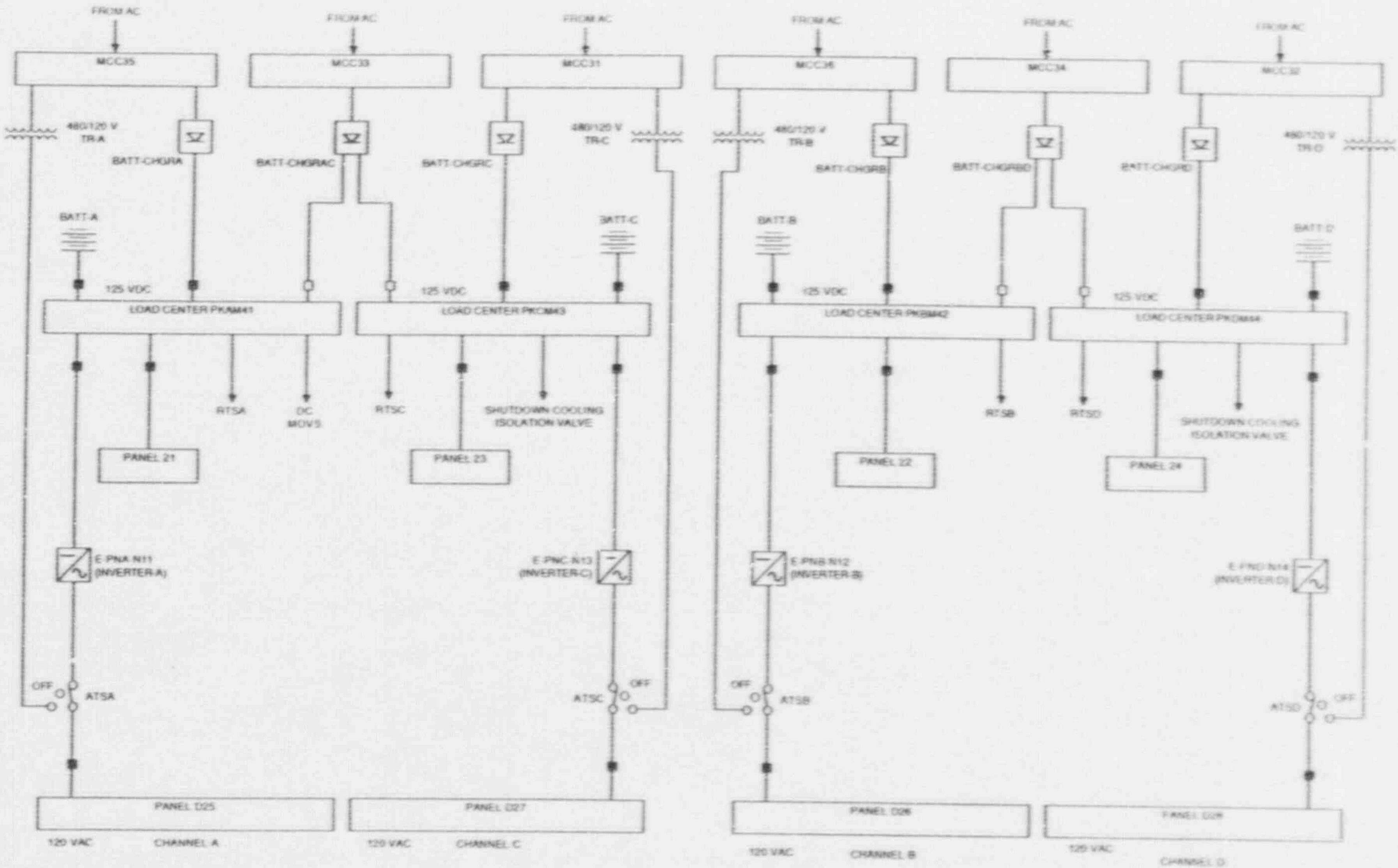


Figure 3.6-1. Palo Verde 1, 2, and 3 Electric Power System (Page 2 of 2)

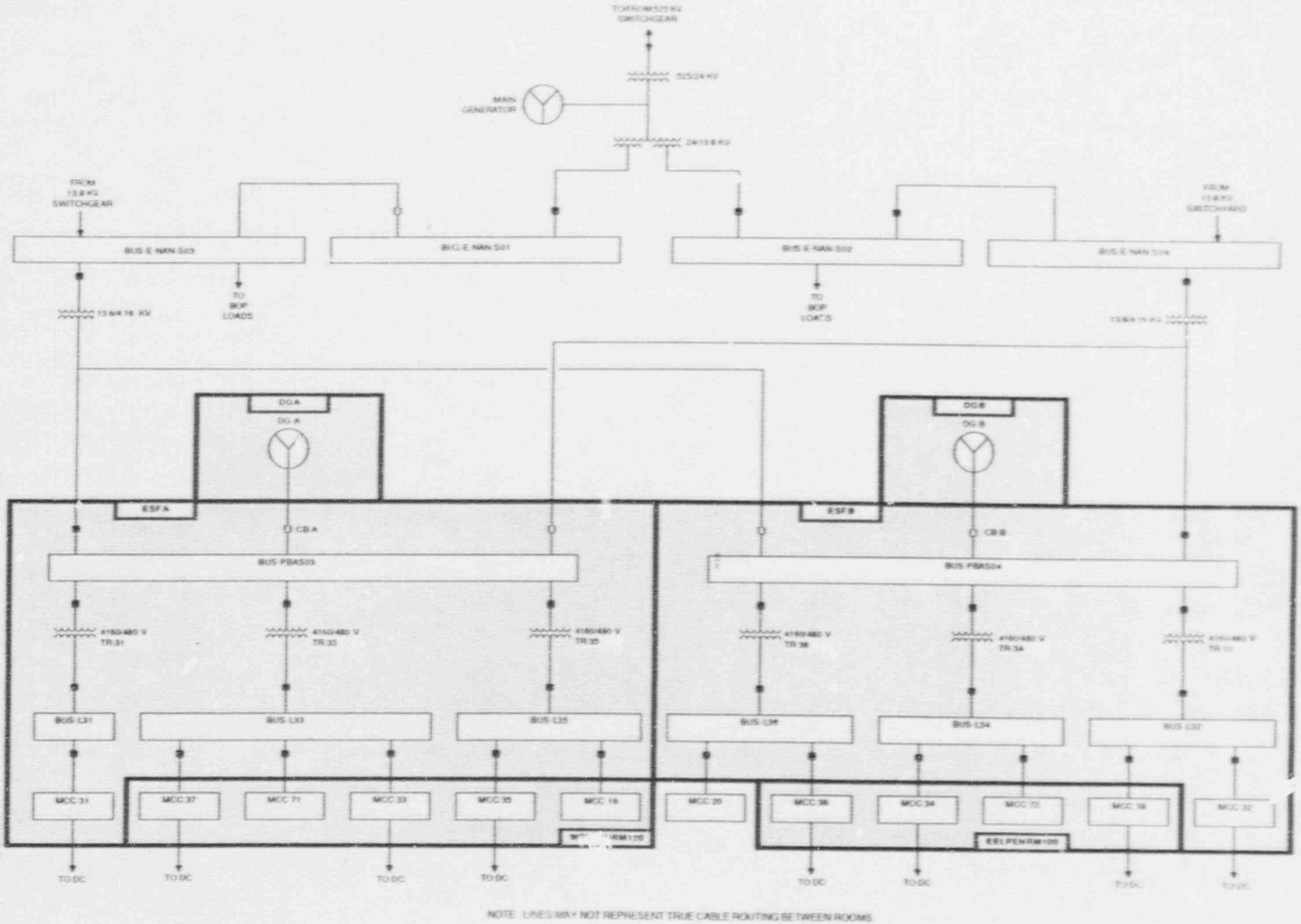
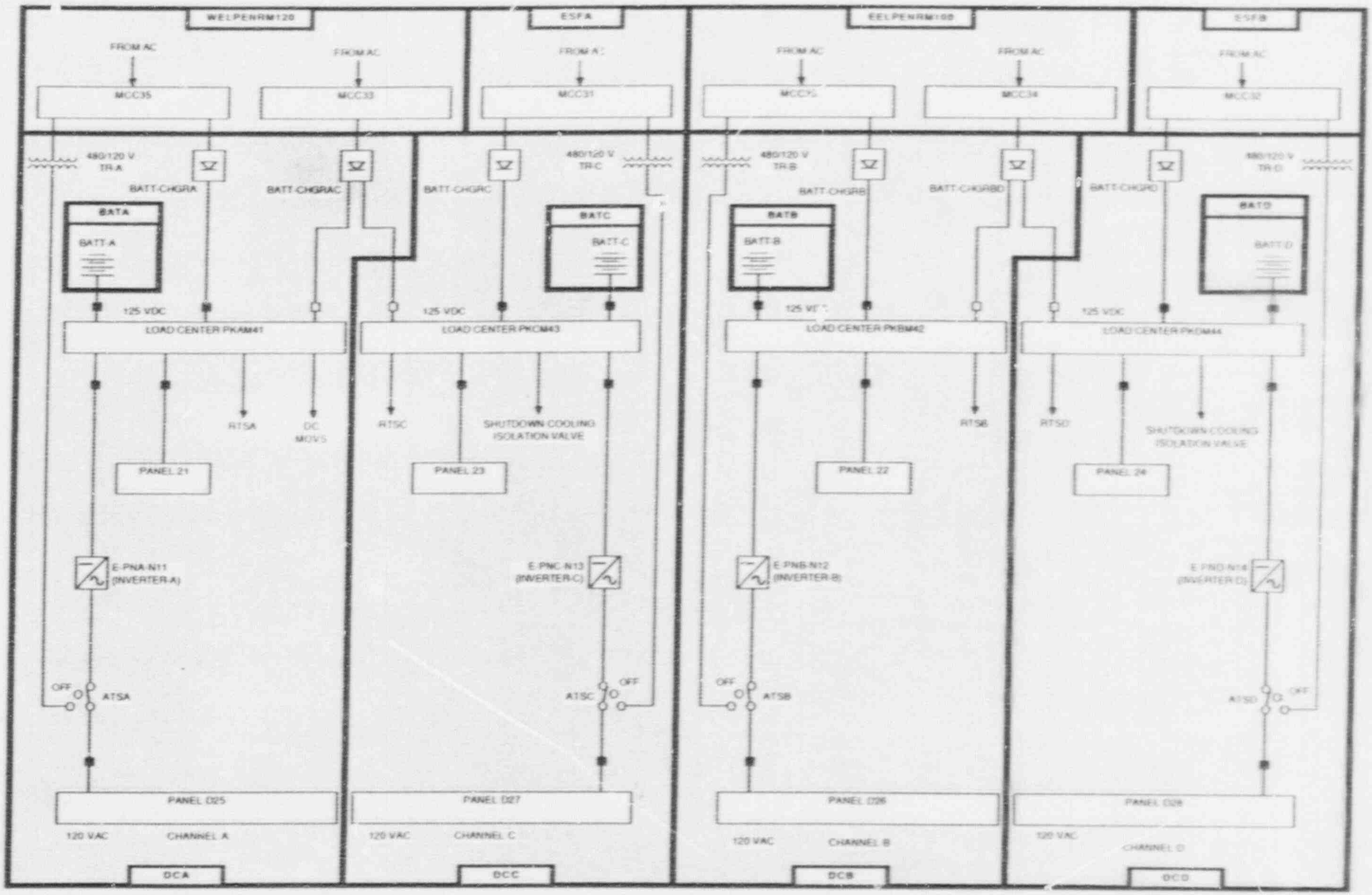


Figure 3.6-2. Palo Verde 1, 2, and 3 Electric Power System. Showing Component Locations (Page 1 of 2)



NOTE: LINES MAY NOT REPRESENT TRUE CABLE ROUTING BETWEEN ROOMS

Figure 3.6-2. Palo Verde 1, 2, and 3 Electric Power System, Showing Component Locations (Page 2 of 2)

Table 3.6-1. Palo Verde Electric Power System Data Summary for Selected Components

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
ASTB	ATS	DCB	INVB	120	DCB	AC/B
ATSA	ATS	DCA	INVA	120	DCA	AC/A
ATSC	ATS	DCC	INVC	120	DCC	AC/A
ATSD	ATS	DCD	INVD	120	DCD	AC/B
BATT-A	BATT	BATA		125		DC/A
BATT-B	BATT	BATB		125		DC/B
BATT-C	BATT	BATC		125		DC/C
BATT-CHGRA	BC	DCA	MCC35	480	WELPENRM120	AC/A
BATT-CHGRAC	BC	DCA	MCC33	480	WELPENRM120	AC/A
BATT-CHGRB	BC	DCB	MCC36	480	EELPENRM100	AC/B
BATT-CHGRBD	BC	DCB	MCC34	480	EELPENRM100	AC/B
BATT-CHGRC	BC	DCC	MCC31	480	ESFA	AC/A
BATT-CHGRD	BC	DCD	MCC32	480	ESFB	AC/B
BATT-D	BATT	BATD		125		DC/D
BUSL31	BUS	ESFA	TR31	480	ESFA	AC/A
BUSL32	BUS	ESFB	TR32	480	ESFB	AC/B
BUSL33	BUS	ESFA	TR33	480	ESFA	AC/A
BUSL34	BUS	ESFB	TR34	480	ESFB	AC/B
BUSL35	BUS	ESFA	TR35	480	ESFA	AC/A
BUSL36	BUS	ESFB	TR36	480	ESFB	AC/B
BUSS03	BUS	ESFA	DGA	4160	ESFA	AC/A
BUSS04	BUS	ESFB	DGB	4160	ESFB	AC/B
CBA	CB	ESFA				AC/A
CBB	CB	ESFB				AC/B
DGA	DG	DGA		4160		AC/A
DGB	DG	DGB		4160		AC/B
INVA	INV	DCA	LC41	125	DCA	DC/A
INVB	INV	DCB	LC42	125	DCB	DC/B

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

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
INVC	INV	DCC	LC43	125	DCC	DC/A
INVD	INV	DCD	LC44	125	DCD	DC/B
LC41	BUS	DCA	BATT-A	125	BATA	DC/A
LC41	BUS	DCA	BATT-CHGRA	125	DCA	DC/A
LC41	BUS	DCA	BATT-CHGRAC	125	DCA	DC/A
LC42	BUS	DCB	BATT-B	125	BATB	DC/B
LC42	BUS	DCB	BATT-CHGRB	125	DCB	DC/B
LC42	BUS	DCB	BATT-CHGRBD	125	DCB	DC/B
LC43	BUS	DCC	BATT-C	125	BATC	DC/C
LC43	BUS	DCC	BATT-CHGRC	125	DCC	DC/C
LC43	BUS	DCC	BATT-CHGRAC	125	DCC	DC/C
LC44	BUS	DCD	BATT-D	125	BATD	DC/D
LC44	BUS	DCD	BATT-CHGRD	125	DCD	DC/D
LC44	BUS	DCD	BATT-CHGRBD	125	DCD	DC/D
MCC31	BUS	ESFA	BUSL31	480	ESFA	AC/A
MCC32	BUS	ESFB	BUSL32	480	ESFB	AC/B
MCC33	BUS	WELPENRM120	BUSL33	480	ESFA	AC/A
MCC34	BUS	EELPENRM100	BUSL34	480	ESFB	AC/B
MCC35	BUS	WELPENRM120	BUSL35	480	ESFA	AC/A
MCC36	BUS	EELPENRM100	BUSL36	480	ESFB	AC/B
MCC38	BUS	EELPENRM100	BUSL32	480	ESFB	AC/B
PNL21	PNL	DCA	LC41	125	DCA	DC/A
PNL22	PNL	DCB	LC42	125	DCB	DC/B
PNL25	PNL	DCA	ASTA	120	DCA	AC/A
PNL26	PNL	DCB	ASTB	120	DCB	AC/B
PNL27	PNL	DCC	ASTC	120	DCC	AC/A
PNL28	PNL	DCD	ASTD	120	DCD	AC/B
TR31	TRAN	ESFA	BUSS03	4160	ESFA	AC/A

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

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
TR32	TRAN	ESFB	BUSS04	4160	ESFB	AC/B
TR33	TRAN	ESFA	BUSS03	4160	ESFA	AC/A
TR34	TRAN	ESFB	BUSS04	4160	ESFB	AC/B
TR35	TRAN	ESFA	BUSS03	4160	ESFA	AC/A
TR36	TRAN	ESFB	BUSS04	4160	ESFB	AC/B
TRA	TRAN	DCA	MCC35	480	WELPENRM120	AC/A
TRB	TRAN	DCB	MCC36	480	EELPENRM100	AC/B
TRC	TRAN	DCC	MCC31	480	ESFA	AC/A
TRD	TRAN	DCD	MCC32	480	ESFB	AC/B

TABLE 3.6-2. PARTIAL LISTING OF ELECTRICAL SOURCES AND LOADS AT PALO VERDE 1, 2 & 3

POWER SOURCE	VOLTAGE	EMERG LOAD GRP	POWER SOURCE LOCATION	LOAD SYSTEM	LOAD COMPONENT ID	COMP TYPE	COMPONENT LOCATION
ASTA	120	AC/A	DCA	EP	PNL25	PNL	DCA
ASTB	120	AC/B	DC[illegible]	EP	PNL26	PNL	DCB
ASTC	120	AC/A	DCC	EP	PNL27	PNL	DCC
ASTD	120	AC/B	DCD	EP	PNL28	PNL	DCD
BATT-A	125	DC/A	[illegible]	EP	LC41	BUS	DCA
BATT-B	125	DC/B	BATB	EP	LC42	BUS	DCB
[illegible]TT-C	125	DC/C	BATC	EP	LC43	BUS	DCC
BATT-CHGRA	125	DC/A	DCA	EP	LC41	BUS	DCA
BATT-CHGRAC	125	DC/A	DCA	EP	LC41	BUS	DCA
BATT-CHGRAC	125	DC/C	DCC	EP	LC43	BUS	DCC
BATT-CHGRB	125	DC/B	DCB	EP	LC42	BUS	DCB
BATT-CHGRBD	125	DC/B	DCB	EP	LC42	BUS	DCB
BATT-CHGRBD	125	DC/D	DCD	EP	LC44	BUS	DCD
BATT-CHGRC	125	DC/[illegible]	DCC	EP	LC43	BUS	DCC
BATT-CHGRD	125	DC/D	DCD	EP	LC44	BUS	DCD
BATT-D	125	DC/D	BATD	EP	LC44	BUS	DCD
BUSL31	480	AC/A	ESFA	CVCS	CHP-1	MDP	CHGA
BUSL31	480	AC/A	ESFA	EP	MCC31	BUS	ESFA
BUSL32	480	AC/B	ESFB	CVCS	CHP-2	MSP	CHGB
BUSL32	480	AC/B	ESFB	EP	MCC32	BUS	ESFB
BUSL32	480	AC/B	ESFB	EP	MCC38	BUS	EELPENRM100
BUSL33	480	AC/A	ESFA	EP	MCC33	BUS	WELPENRM120
BUSL34	480	AC/B	ESFB	EP	MCC34	BUS	EELPENRM100
BUSL35	480	AC/A	ESFA	EP	MCC35	BUS	WELPENRM120
BUSL36	480	AC/B	ESFB	CVCS	CHP-3	MDP	CHGC
BUSL36	480	AC/B	ESFB	EP	MCC36	[illegible]	[illegible]ELPENRM100
BUSS03	4160	AC/A	ESFA	ECCS	HPSIP1	MDP	HPSIA
BUSS03	4160	AC/A	ESFA	EP	TR31	TRAN	ESFA
BUSS03	4160	AC/A	ESFA	EP	TR33	TRAN	ESFA
BUSS03	4160	AC/A	ESFA	EP	TR35	TRAN	ESFA
BUSS03	4160	AC/A	ESFA	ESPS	SPA-P01	MDP	UHSPMPHSEA

TABLE 3.6-2. PARTIAL LISTING OF ELECTRICAL SOURCES AND LOADS AT PALO VERDE 1, 2 & 3 (CONTINUED)

POWER SOURCE	VOLTAGE	EMERG LOAD GRP	POWER SOURCE LOCATION	LOAD SYSTEM	LOAD COMPONENT ID	COMP TYPE	COMPONENT LOCATION
BUSS04	4160	AC/B	ESFB	AFWS	AFW-B-B	MDP	80MSSSB
BUSS04	4160	AC/B	ESFB	ECCS	HPSIP2	MDP	HPSIB
BUSS04	4160	AC/B	ESFB	EP	TR32	TRAN	ESFB
BUSS04	4160	AC/B	ESFB	EP	TR34	TRAN	ESFB
BUSS04	4160	AC/B	ESFB	EP	TR36	TRAN	ESFB
BUSS04	4160	AC/B	ESFB	ESPS	SPB-P01	MDP	UHSPMPHSEB
DGA	4160	AC/A	ESFA	EP	BUSS03	BUS	ESFA
DGB	4160	AC/B	ESFB	EP	BUSS04	BUS	ESFB
INVA	120	AC/A	DCA	EP	ATSA	ATS	DCA
INVB	120	AC/B	DCB	EP	ASTB	ATS	DCB
INVC	120	AC/A	DCC	EP	ATSC	ATS	DCC
INVD	120	AC/B	DCD	EP	ATSD	ATS	DCD
LC41	125	DC/A	DCA	AFWS	AFW134	MOV	100MSSSA
LC41	125	DC/A	DCA	AFWS	AFW138	MOV	100MSSSB
LC41	125	DC/A	DCA	AFWS	AFW32	MOV	80MSSSA
LC41	125	DC/A	DCA	AFWS	AFW37	MOV	80MSSSB
LC41	125	DC/A	DCA	AFWS	AFW37	MOV	80MSSSB
LC41	125	DC/A	DCA	AFWS	AFW54	MOV	80MSSSA
LC41	125	DC/A	DCA	EP	INVA	INV	DCA
LC41	125	DC/A	DCA	EP	PNL21	PNL	DCA
LC42	125	DC/B	DCB	EP	INVB	INV	DCB
LC42	125	DC/B	DCB	EP	PNL22	PNL	DCB
LC43	125	DC/A	DCC	AFWS	AFW33	MOV	80MSSSA
LC43	125	DC/A	DCC	AFWS	AFW33	MOV	80MSSSA
LC43	125	DC/A	DCC	AFWS	AFW36	MOV	80MSSSA
LC43	125	DC/A	DCC	ECCS	HPI321	MOV	WPPENRM
LC43	125	DC/A	DCC	EP	INVC	INV	DCC
LC43	125	DC/C	DCC	RCS	RHR653	MOV	RC
LC44	125	DC/B	DCD	ECCS	HPI331	MOV	EPPENRM
LC44	125	DC/B	DCD	EP	INVD	INV	DCD
LC44	125	DC/D	DCD	RCS	RHR654	MOV	RC

TABLE 3.6-2. PARTIAL LISTING OF ELECTRICAL SOURCES AND LOADS AT PALO VERDE 1, 2 & 3 (CONTINUED)

POWER SOURCE	VOLTAGE	EMERG LOAD GRP	POWER SOURCE LOCATION	LOAD SYSTEM	LOAD COMPONENT ID	COMP TYPE	COMPONENT LOCATION
MCC31	480	AC/A	ESFA	EP	BATT-CHGRC	BC	DCC
MCC31	480	AC/A	ESFA	EP	TRC	TRAN	DCC
MCC31	480	AC/A	ESFA	ESPS	ESP49A	MOV	SPONDVPTA
MCC31	480	AC/A	ESFA	ESPS	ESP49B	MOV	SPONDVPTA
MCC32	480	AC/B	ESFB	EP	BATT-CHGRD	BC	DCD
MCC32	480	AC/B	ESFB	EP	TRD	TRAN	DCD
MCC3[illegible]	480	AC/B	ESFB	ESPS	ESP50A	MOV	SPONDVPTB
MCC32	480	AC/B	ESFB	ESPS	ESP50B	[illegible]	SPONDVPTB
MCC33	480	AC/A	WELPENRM120	ECCS	HPI604	MOV	WPPENRM
MCC33	480	AC/A	WELPENRM120	ECCS	HPI617	MOV	EPPENRM
MCC33	480	AC/A	WELPENRM120	ECCS	HPI627	MOV	EPPENRM
MCC33	480	AC/A	WELPENRM120	ECCS	HPI647	MOV	WPPENRM
MCC33	480	AC/A	WELPENRM120	EP	BATT-CHGRAC	BC	DCA
MCC34	480	AC/B	EELPENRM100	AFWS	AFW30	MOV	80MSSSB
MCC34	480	AC/B	EELPENRM100	AFWS	AFW30	MOV	80MSSSB
MCC34	480	AC/B	EELPENRM100	AFWS	AFW31	MOV	80MSSSB
MCC34	480	AC/B	EELPENRM100	ECCS	HPI609	MOV	EPPENRM
MCC34	480	AC/B	EELPENRM100	ECCS	HPI616	MOV	EPPENRM
MCC34	480	AC/B	EELPENRM100	ECCS	HPI626	MOV	EPPENRM
MCC[illegible]	480	AC/B	EELPENRM100	ECCS	HPI636	AUX	WPPENRM
MCC34	480	AC/B	EELPENRM100	EP	BATT-CHGRBD	BC	DCB
MCC35	480	AC/A	WELPENRM120	CVCS	CH524	MOV	100AB
MCC35	480	AC/A	WELPENRM120	CVCS	CH536	MOV	100AB
[illegible]C35	480	AC/A	WELPENRM120	ECCS	HPI531	MOV	80AB
MCC35	480	AC/A	WELPENRM120	EP	BATT-CHGRA	BC	DCA
MCC35	480	AC/A	WELPENRM120	EP	TRA	TRAN	DCA
MCC35	480	AC/A	WELPENRM120	RCS	RHR651	MOV	RC
MCC36	480	AC/B	EELPENRM100	CVCS	CH530	MOV	80AB
MCC36	480	AC/B	EELPENRM100	ECCS	HPI530	MOV	80AB
MCC36	480	AC/B	EELPENRM100	ECCS	HPI646	MOV	WPPENRM
MCC36	48[illegible]	AC/B	EELPENRM100	EP	BATT-CHGRB	BC	DCB

TABLE 3.6-2. PARTIAL LISTING OF ELECTRICAL SOURCES AND LOADS AT PALO VERDE 1, 2 & 3 (CONTINUED)

POWER SOURCE	VOLTAGE	EMERG LOAD GRP	POWER SOURCE LOCATION	LOAD SYSTEM	LOAD COMPONENT ID	COMP TYPE	COMPONENT LOCATION
MCC36	480	AC/B	EELPENRM100	EP	TRB	TRAN	DCB
MCC36	480	AC/B	EELPENRM100	RCS	RHR652	MOV	RC
MCC37	480	AC/A	WELPENRM120	ECCS	HPI637	MOV	WPPENRM
MCC37	480	AC/A	WELPENRM120	ECCS	HPI698	MOV	HPSIA
MCC38	480	AC/B	EELPENRM100	AFWS	AFW34	MOV	80MSSSA
MCC38	480	AC/B	EELPENRM100	AFWS	AFW34	MOV	80MSSSA
MCC38	480	AC/B	EELPENRM100	AFWS	AFW35	MOV	80MSSSB
MCC38	480	AC/B	EELPENRM100	ECCS	HPI699	MOV	HPSIB
TR31	480	AC/A	ESFA	EP	BUSL31	BUS	ESFA
TR32	480	AC/B	ESFB	EP	BUSL32	BUS	ESFB
TR33	480	AC/A	ESFA	EP	BUSL33	BUS	ESFA
TR34	480	AC/B	ESFB	EP	BUSL34	BUS	ESFB
TR35	480	AC/A	ESFA	EP	BUSL35	BUS	ESFA
TR36	480	AC/B	ESFB	EP	BUSL36	BUS	ESFB

3.7 ESSENTIAL COOLING WATER SYSTEM (ECWS)

3.7.1 System Function

The essential cooling water system (ECWS) forms an intermediate cooling water loop for transferring heat from various safety related heat loads, including the shutdown cooling heat exchanger, to the Essential Spray Pond System (ESPS) which serves as an ultimate heat sink. The ECWS provides indirect cooling, through heat exchangers, of those reactor auxiliaries that carry radioactive or potentially radioactive fluids.

3.7.2 System Definition

The ECWS consists of two separate, independent, closed-loop, safety-related trains. Each train of the ECWS consists of a heat exchanger, surge tank, pump, chemical addition tank, piping, valves, controls, and instrumentation. Simplified drawing of the ECWS are shown in Figures 3.7-1 and 3.7-2.

3.7.3 System Operation

During normal operation, the ECWS is in standby. Although either train has a 100% heat dissipation capacity, an emergency reactor shutdown is normally accomplished by initial operation of both trains of the ECWS and ESPS. For shutdown and cooldown over an extended period of time, use of a single train is possible.

Each train of the ECWS provides cooling for the following redundant components:

- Shutdown cooling heat exchangers (one per train)
- Essential chillers (one per train)
- Fuel pool heat exchangers (one per train) if NCWS is unavailable
- Normal chiller
- Reactor coolant pumps (seals and motor)
- Control element drive mechanism (CEDM) air coolers

In the event the Nuclear Cooling Water System (NCWS) is unavailable the operator can align train A or train B of the ECWS (never both) to supply cooling water to the NCWS and act as a heat sink for NCWS heat loads.

3.7.4 System Success Criteria

The system success criteria can be defined on a per train basis. Either train can maintain an extended hot shutdown. The success criteria for each train requires that the ECW pump operates, the associated Essential Spray Pond System removes heat from the ECW heat exchanger, and the piping and valves provide an adequate flow path in the specific train (Ref. 1, Section 9.2.2.1).

3.7.5 Component Information

A. ECWS pumps 1 and 2
   1. Design flow: 14,500 gpm@ 154 ft head (68 psid)
   2. Rated capacity: 100%
   3. Type: centrifugal

B. ECWS Heat Exchangers 1 and 2
   1. Capacity: 100%
   2. Type: Shell (ECWS) and Tube (ESPS)

C. Surge Tanks 1 and 2
   1. Capacity: 1000 gallons
   2. Type: Vertical cylindrical

D. Chemical Addition Tanks 1 and 2
   1. Capacity: 11 gallons
   2. Type: Ball Feeder

3.7.6 Support Systems and Interfaces

A. Control Signals
   1. Automatic
      The ECWS is actuated automatically.

   2. Remote manual
      Control and instrumentation necessary for the operation of the ECWS pumps are located in the control room.

   3. Local
      Local instrumentation and controls are provided at the ECWS pumps.

B. Motive power
   1. The ECWS motor-driven pumps and motor-operated valves (65 and 145) are Class 1E AC loads that can be supplied from the standby diesel generators as described in Section 3.6.

C. Other
   1. No external systems for ECWS pump lubrication and cooling water have been identified.

3.7.7 Section 3.7 References

1. Palo Verde Final Safety Analysis Report, Arizona Public Service Company, Phoenix, Arizona.

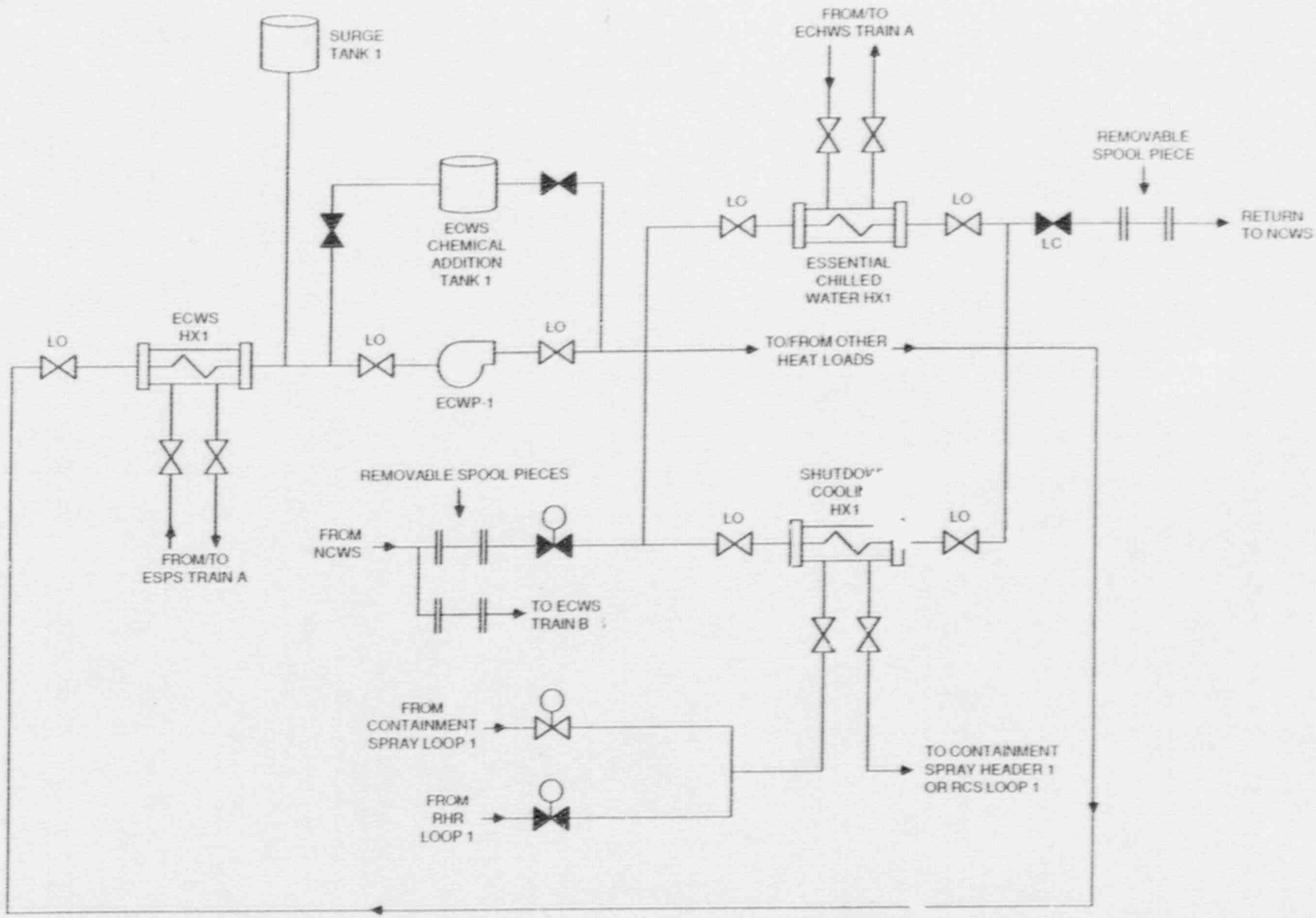


Figure 3.7-1. Palo Verde 1, 2, & 3 Essential Cooling Water System (Train A)

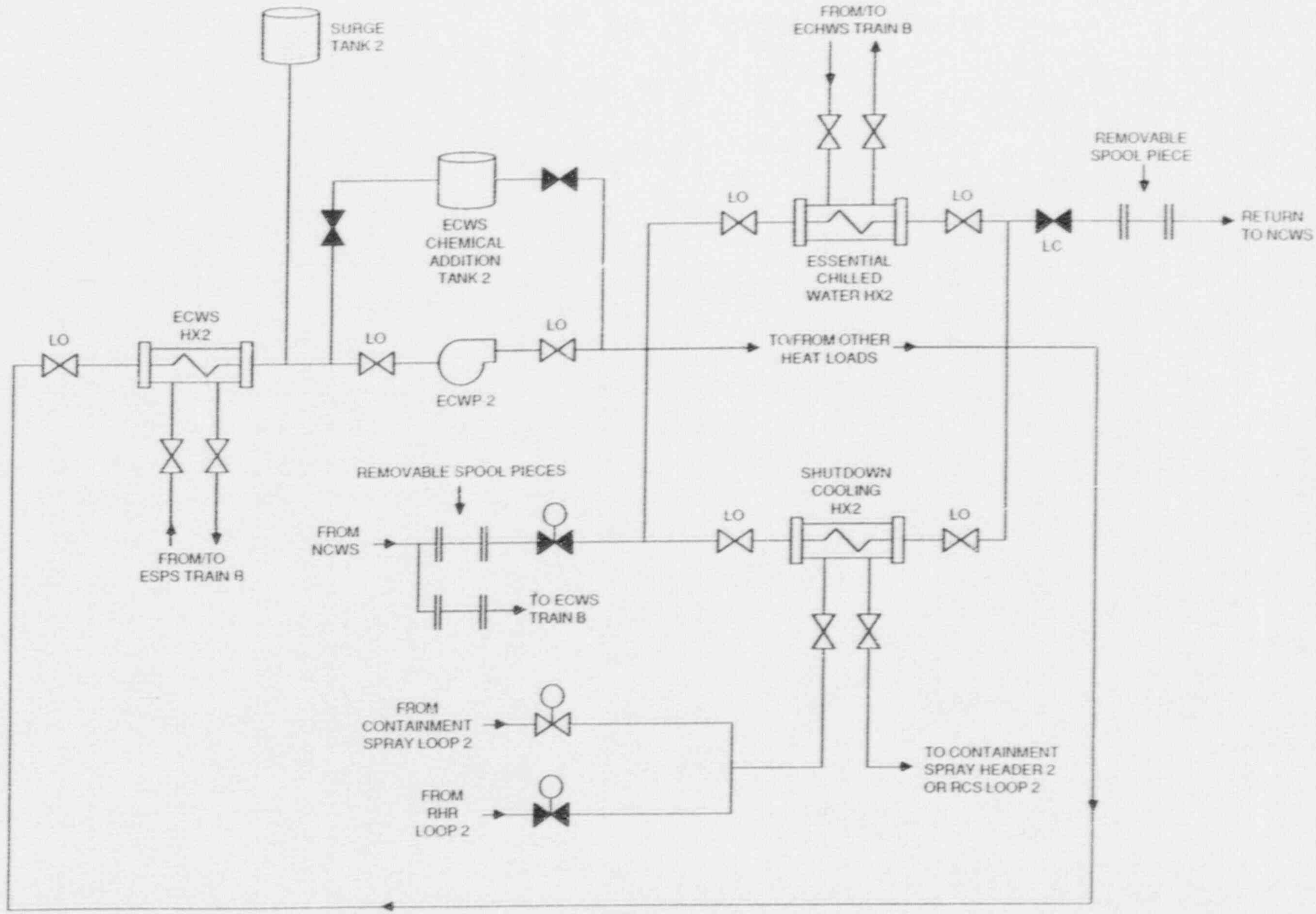


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Figure 3.7-2. Palo Verde 1, 2, & 3 Essential Cooling Water System (Train B)

3.8 ESSENTIAL SPRAY POND SYSTEM (ESPS)

3.8.1 System Function

The Essential Spray Pond System removes heat from the diesel generators and the Essential Cooling Water System and dissipates it to the atmosphere via the essential spray ponds. A separate essential spray pond system is provided for each unit.

3.8.2 System Definition

The ESPS consists of two spray ponds and two separate, redundant cooling water trains. There are no interconnections between trains or cross connections with any other unit's ESPS. Each train is comprised of an ESPS pump, pump structure, piping, valves, instrumentation, and controls to provide cooling water to specific nuclear safety-related components. Simplified drawings of the ESPS are shown in Figures 3.8-1 and 3.8-2. A summary of data on selected ESPS components is presented in Table 3.8-1.

3.8.3 System Operation

During normal operation, the ESPS is in standby. Each ESPS train is capable of supporting 100% of the cooling functions required for a safe reactor shutdown or following a LOCA. During an emergency operation a normal reactor shutdown, or each time the standby diesel generators are started and there is a loss of offsite power, the ESPS provides cooling water directly to the cooling systems of the diesel generators and to the ECWS indirectly through the ECWS heat exchangers. Cooling water for the ESPS is supplied from the ultimate heat sink or essential spray ponds. Each pond serves one train of the ESPS. Return flow from components serviced by the ESPS is returned to the ESPS spray cooling subsystems and to the ultimate heat sink for reuse. Each heat sink holds water inventory to meet 15 days of operation without makeup.

3.8.4 System Success Criteria

Dependencies of components on the ESPS are defined in other system models. For a specific ESPS loop, the respective ESPS pump must operate and one of two motor-operated valves in the return path to the respective spray pond must be open (Ref. 1, Section 9.2.1).

3.8.5 Component Information

A. ESPS pumps A and B
   1. Rated flow: 16,300 gpm @ 120 ft head (52 psid)
   2. Type: vertical wet pit

B. Ultimate Heat Sink - Spray Ponds A and B

3.8.6 Support System and Interfaces

A. Control Signals
   1. Automatic
      Both trains of the ESPS are automatically actuated.

   2. Remote Manual
      Manual start and stop actuation of the two ESPS trains from the control room overrides the automatic mode. Spray header isolation and bypass valves can be manually operated from the control room.

3. Manual
   Valves in supply lines from the ESPS pumps and in the return lines to the ESPS spray ponds or the ECWS heat exchangers are locked open.

B. Motive Power
   Each ESPS pump 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. No external systems for ESPS pump lubrication and cooling water have been identified.
   2. The ESPS pump house coolers are supplied by the Essential Chilled Water System.

3.8.7 Section 3.8 References

1. Palo Verde Final Safety Analysis Report, Arizona Public Service Company, Phoenix, Arizona.

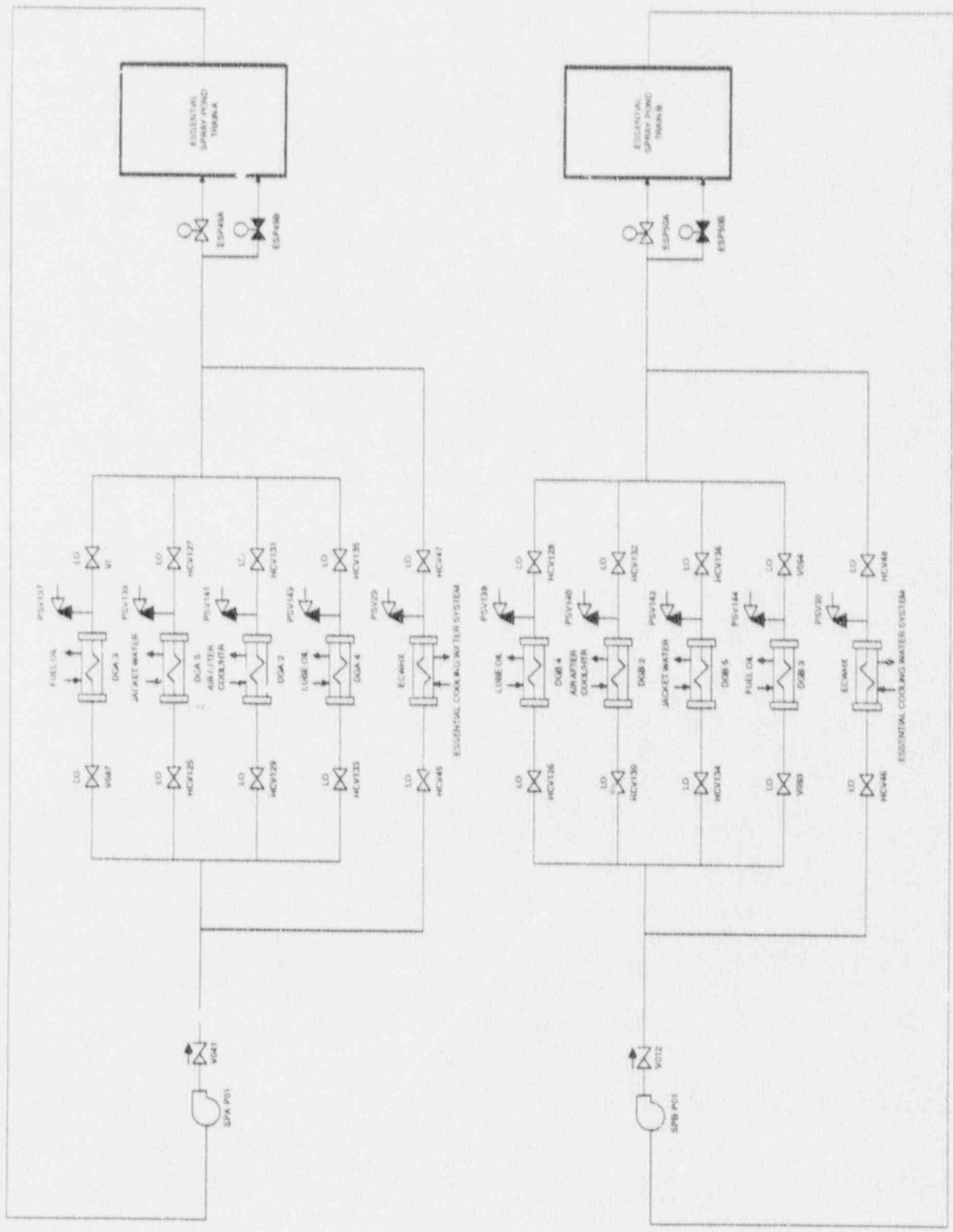


Figure 3.8-1. Palo Verde 1, 2, and 3 Essential Spray Pond System (Train A and Train B)

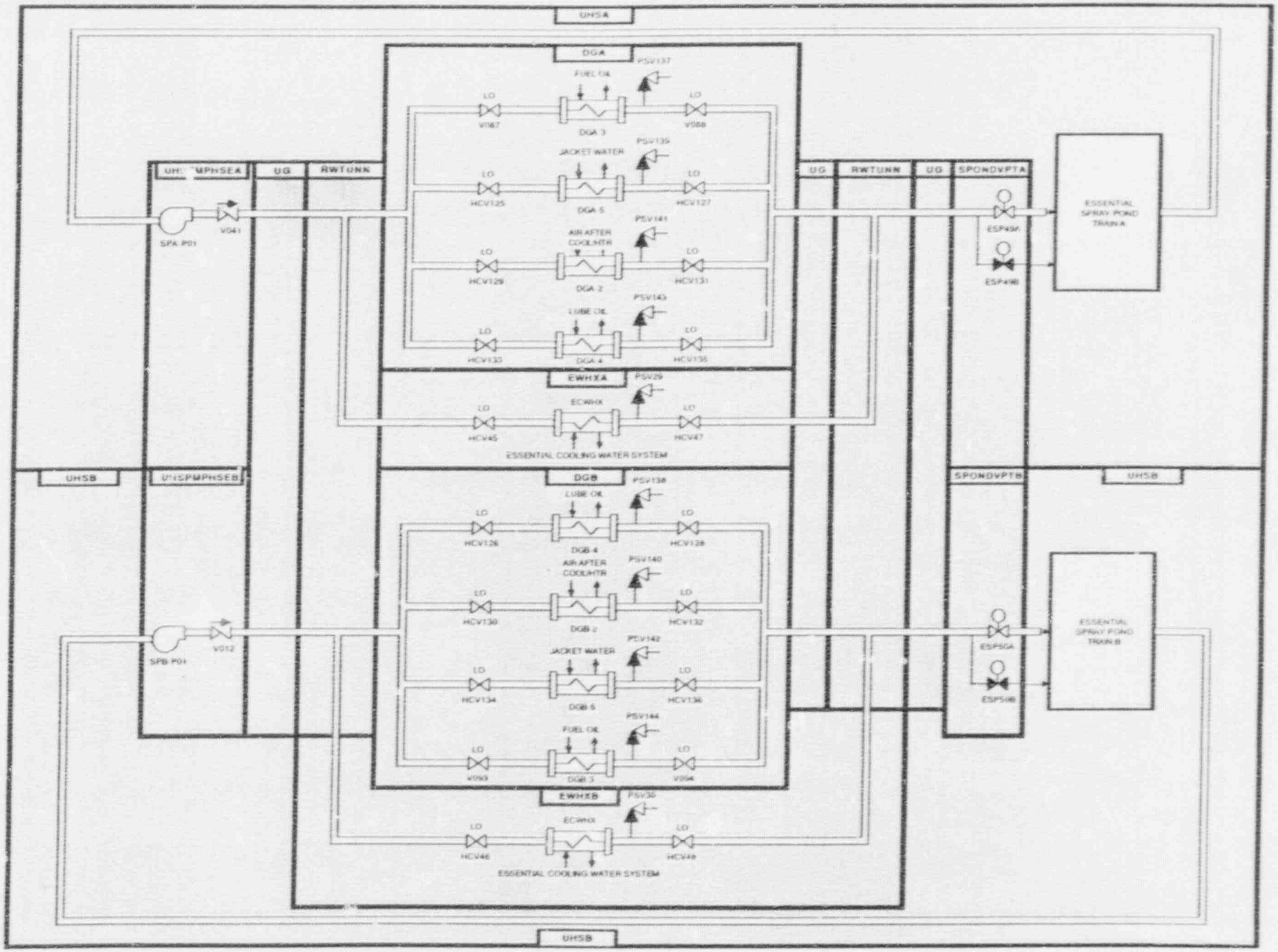


Figure 3.8-2. Palo Verde 1, 2, and 3 Essential Spray Pond System (Train A and Train B), Showing Component Locations

Table 3.8-1. Palo Verde Essential Spray Pond System Data Summary for Selected Components

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMERG. LOAD GRP.
ESP49A	MOV	SPONDVPTA	MCC31	480	ESFA	AC/A
ESP49B	MOV	SPONDVPTA	MCC31	480	ESFA	AC/A
ESP50A	MOV	SPONDVPTB	MCC32	480	ESFB	AC/B
ESP50B	MOV	SPONDVPTB	MCC32	480	ESFB	AC/B
SPA-P01	MDP	UHSPMPHSEA	BUSS03	4160	ESFA	AC/A
SPB-P01	MDP	UHSPMPHSEB	BUSS04	4160	ESFB	AC/B

4. PLANT INFORMATION

4.1 SITE AND BUILDING SUMMARY

The Palo Verde site is located 34 miles west of the nearest boundary of the city of Phoenix, Arizona. The site contains three PWR plants. Figure 4-1 shows a general view of the site, with Figures 4-2 and 4-3 showing more details of the site buildings.

The auxiliary building is located adjacent to the containment building. This building primarily houses the ESF and CVCS equipment, and the power block controlled access facility.

The control building is located adjacent to the radwaste and auxiliary buildings. This building primarily houses the control room, computer room, upper and lower cable spreading rooms, battery rooms, electrical equipment rooms and ventilation equipment rooms.

Two identical essential spray ponds are provided for each unit. Each pond removes heat from the Engineered Safety Features (ESF) and safety related components. Three cooling towers serving each unit are the heat sink for the power conversion system.

The diesel generator building is located adjacent to the control building. This building primarily houses the two standby diesel generators.

The condensate storage tank (CST), located northwest of the reactor building, primarily supplies water for the auxiliary feedwater system. It is also a redundant source of demineralized water for the essential cooling water system, essential chilled water system, diesel generator system and the fuel pool. It also is used for maintaining proper feedwater inventory in the secondary system during startup, shutdown, hot standby, and normal power operations.

The refueling water storage tank (RWT), located southwest of the containment building, primarily services the safety injection pumps.

The reactor makeup water storage tank (RMWT) is located southwest of the containment building and services the auxiliary feedwater system and the chemical volume and control system.

4.2 FACILITY LAYOUT DRAWINGS

Figures 4-4 through 4-15 are section views and simplified building layout drawings for the Palo Verde containment, auxiliary building and intake structure. The turbine and service building, maintenance shop, and technical support building are not shown on these drawings. Major rooms, stairways, elevators, and doorways are shown in the simplified layout drawings however, many interior walls have been omitted for clarity. Labels printed in uppercase correspond to the location codes listed in Table 4-1 and used in the component data listings and system drawings in Section 3. 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.

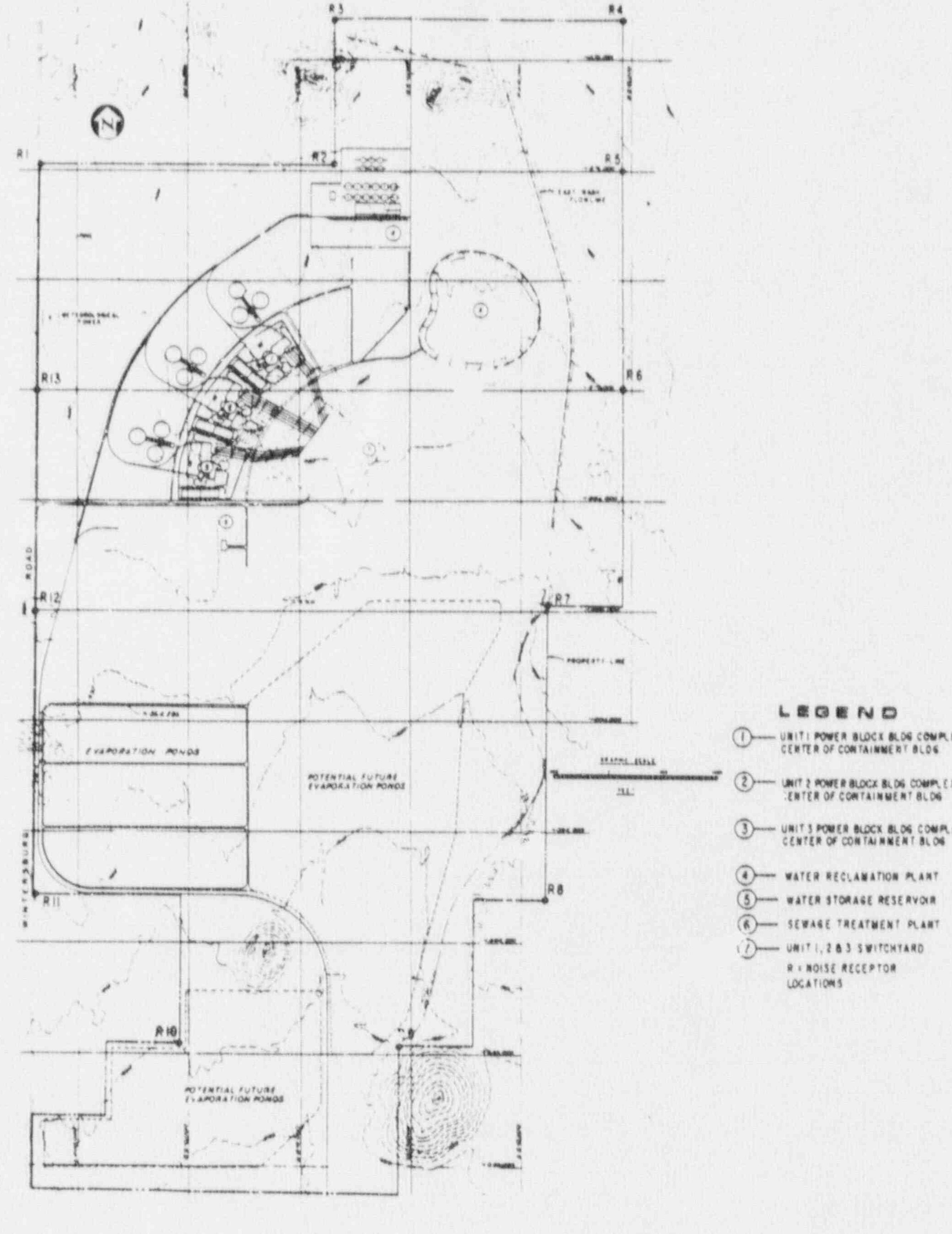


Figure 4-1 Plot Plan for Palo Verde Nuclear Generating System

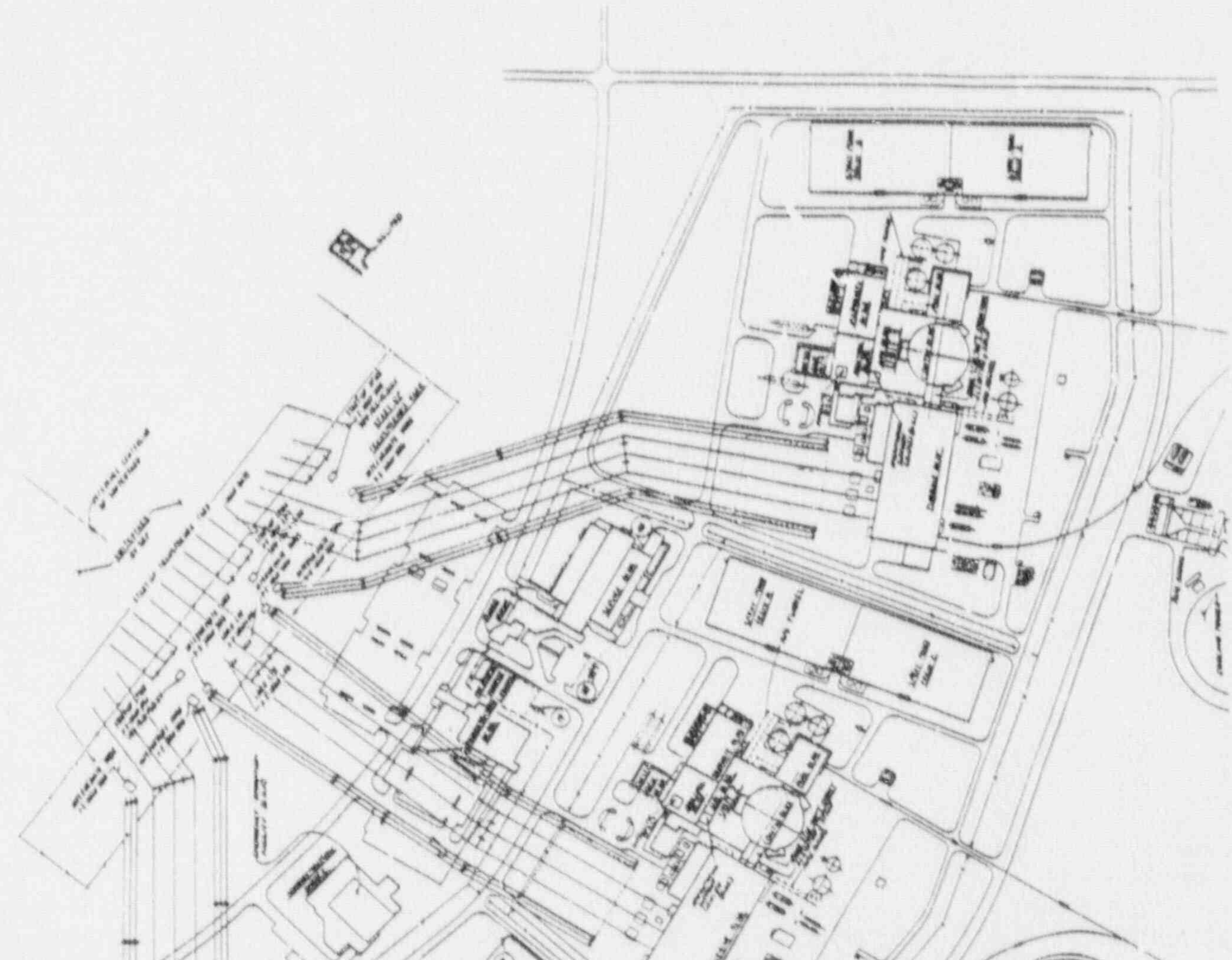


Figure 4-2. Palo Verde Site General Arrangement
(Power Block Site Plan)

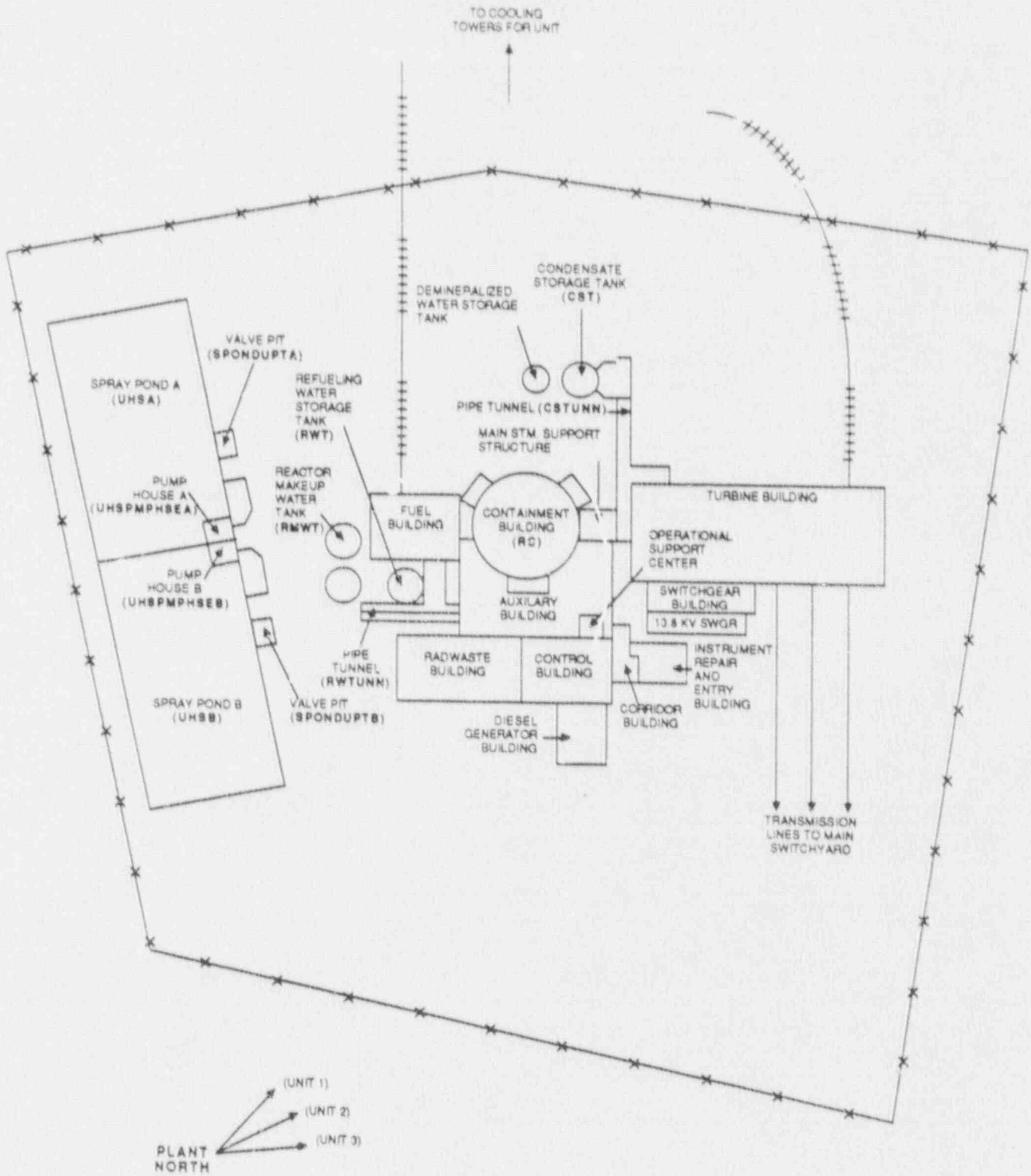


Figure 4-3. Simplified Arrangement Drawing for a Single Unit at the Palo Verde Site (Typical for Units 1, 2, and 3)

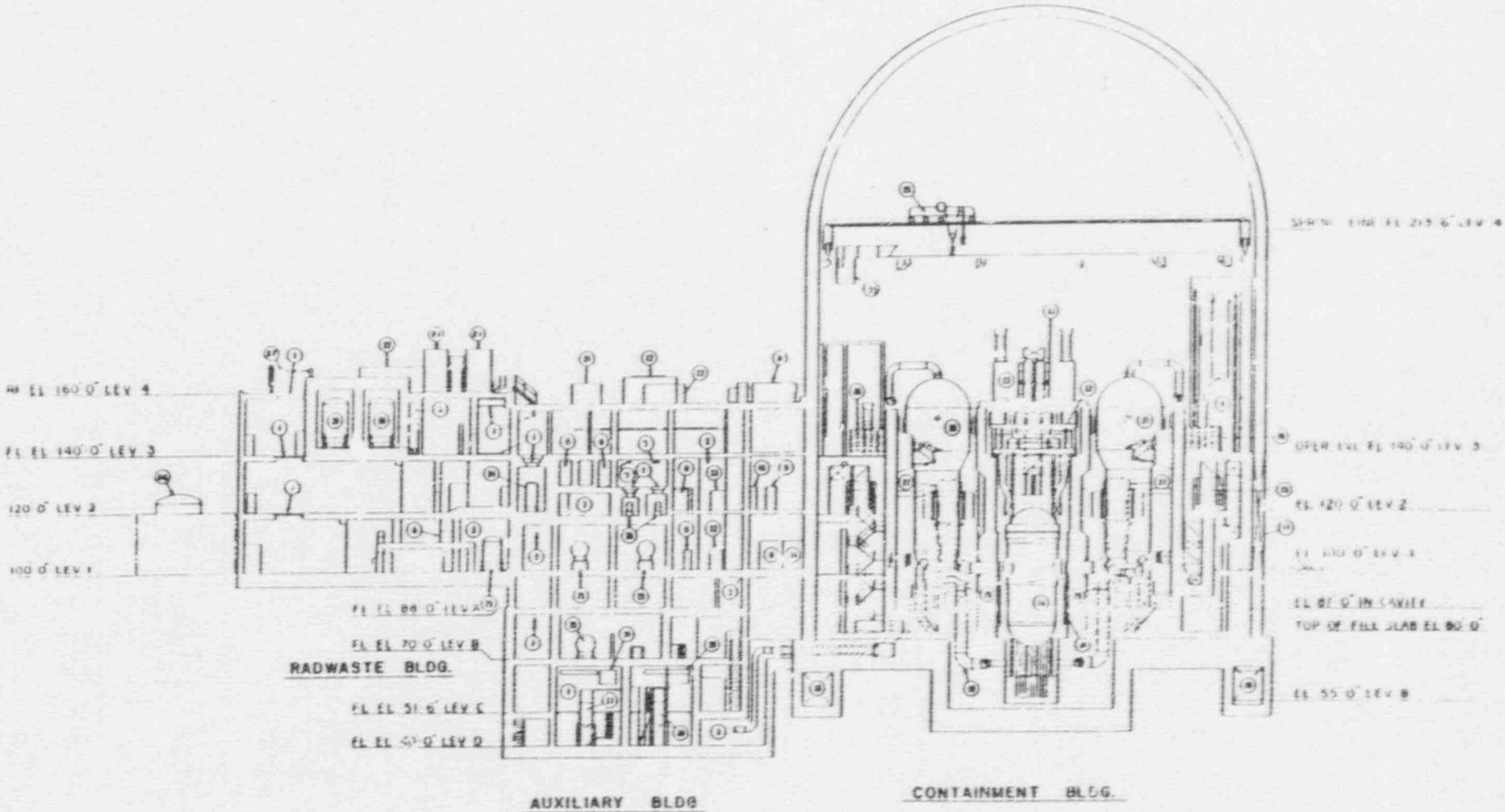


Figure 4-4 Elevation View of the Containment, Auxilary Building, and Radwaste Building at Palo Verde

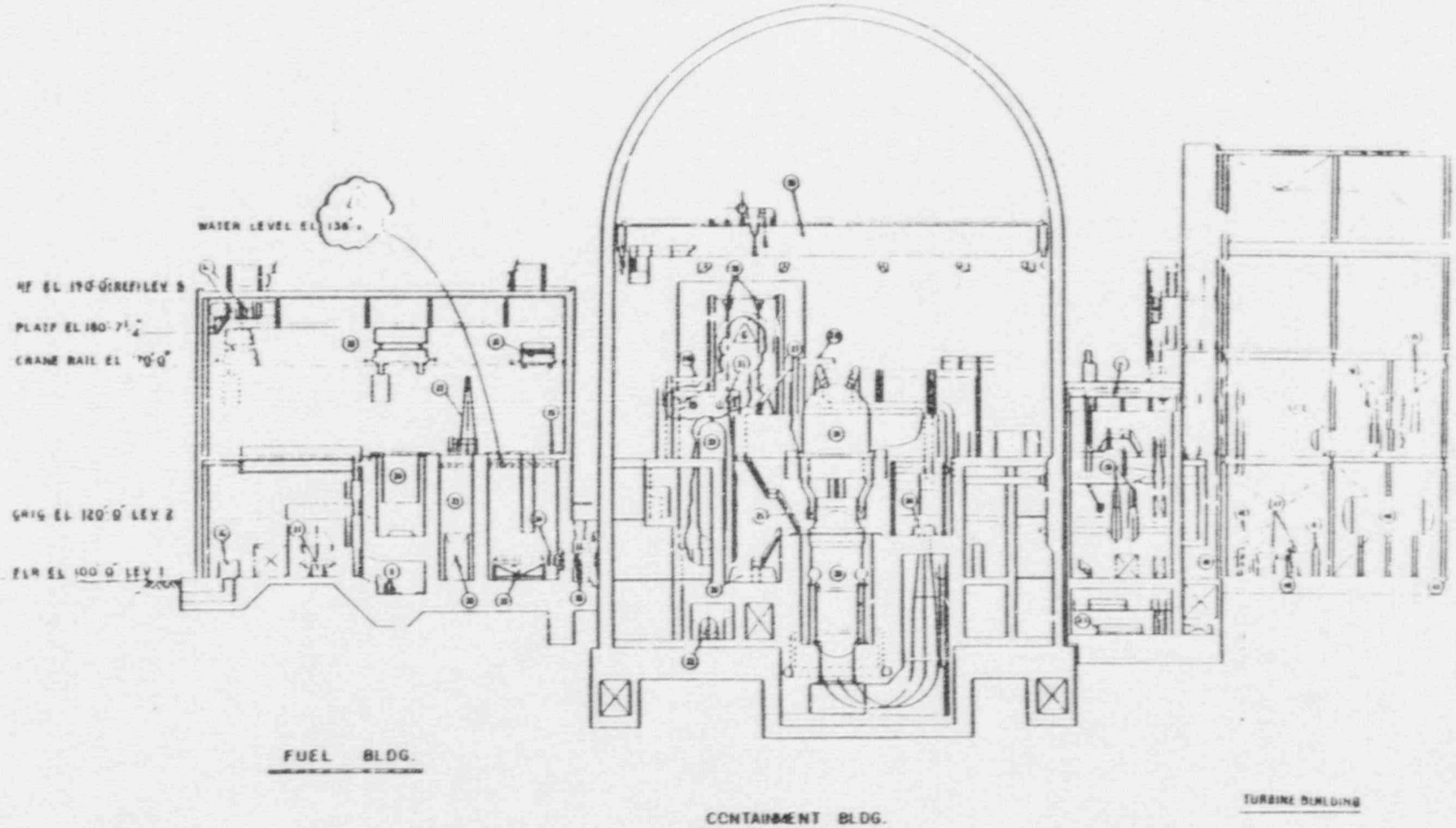


Figure 4-5. Elevation View of the Containment and Fuel Buildings and Partial Turbine Building at Palo Verde

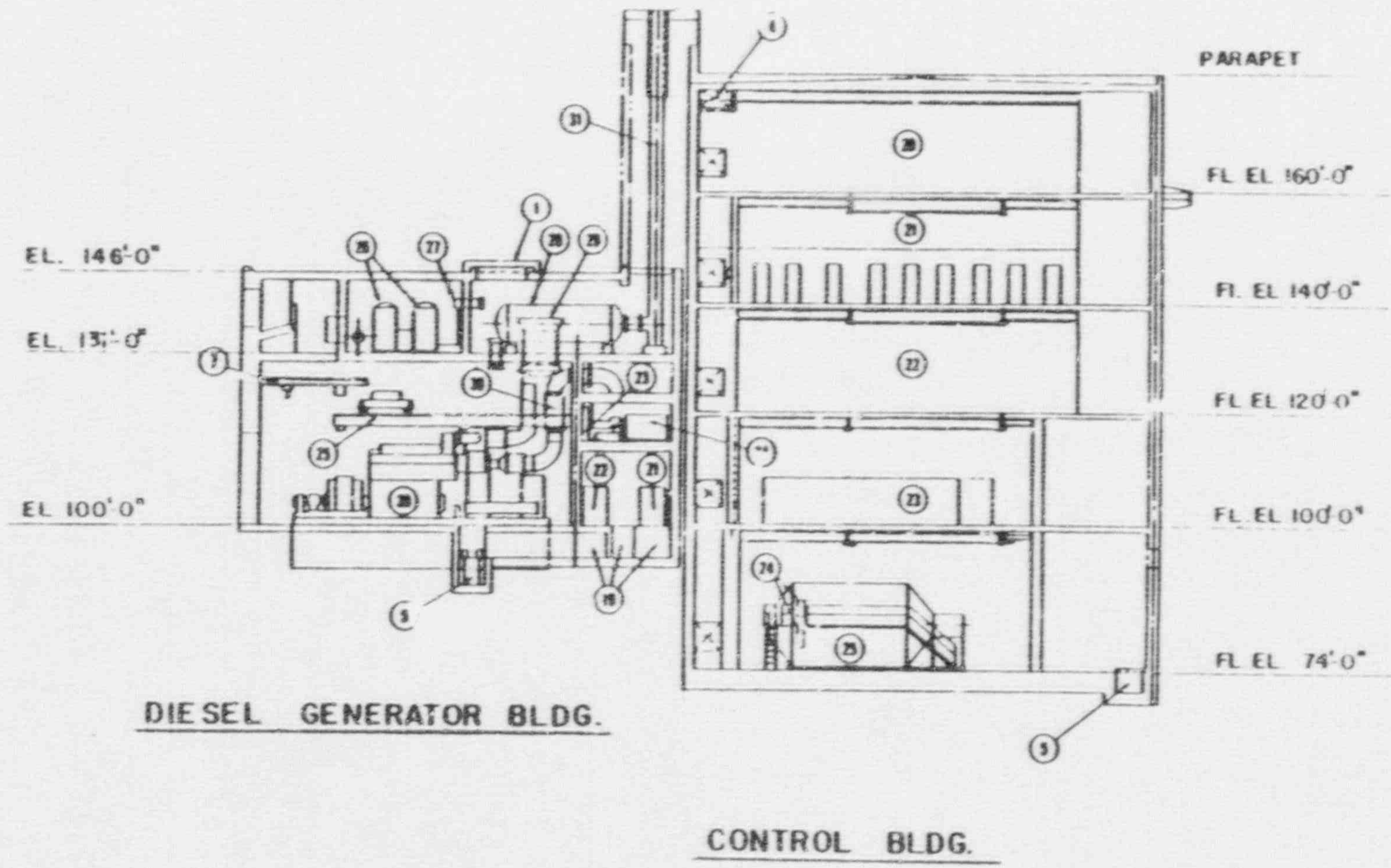
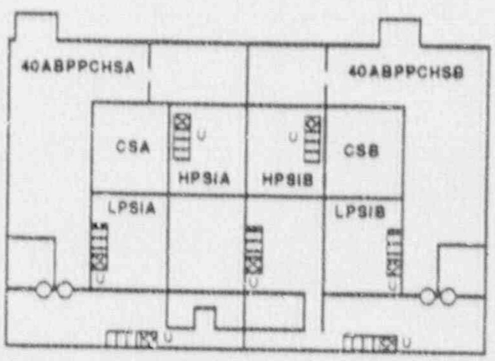


Figure 4-6. Elevation View of the Control and Diesel Generator Buildings at Palo Verde



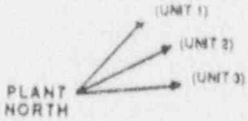


Figure 4-7. Palo Verde Power Block (Except Turbine Building), 40 ft. Elevation

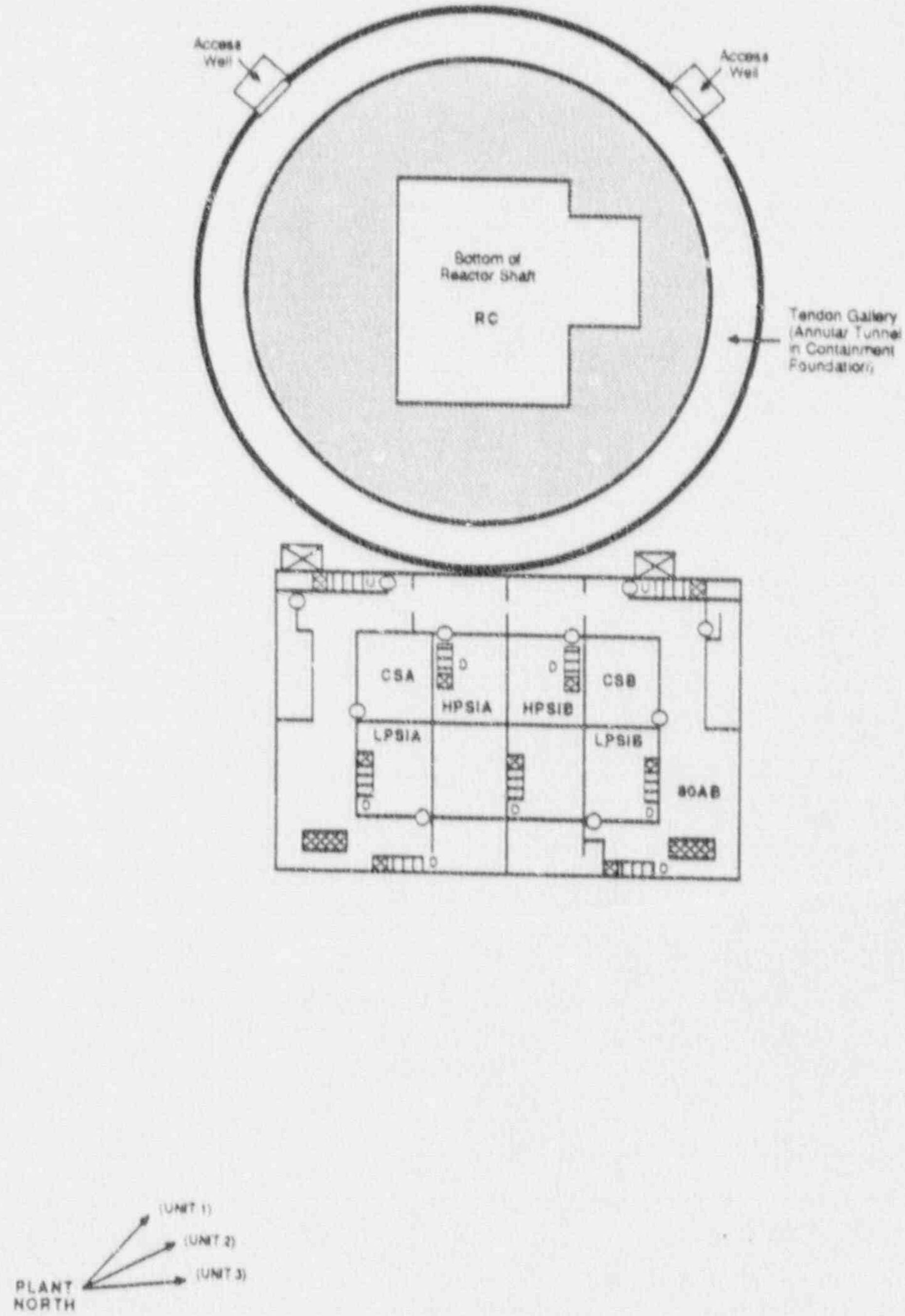


Figure 4-8. Palo Verde Power Block (Except Turbine Building), 51 ft., 6 in. Elevation

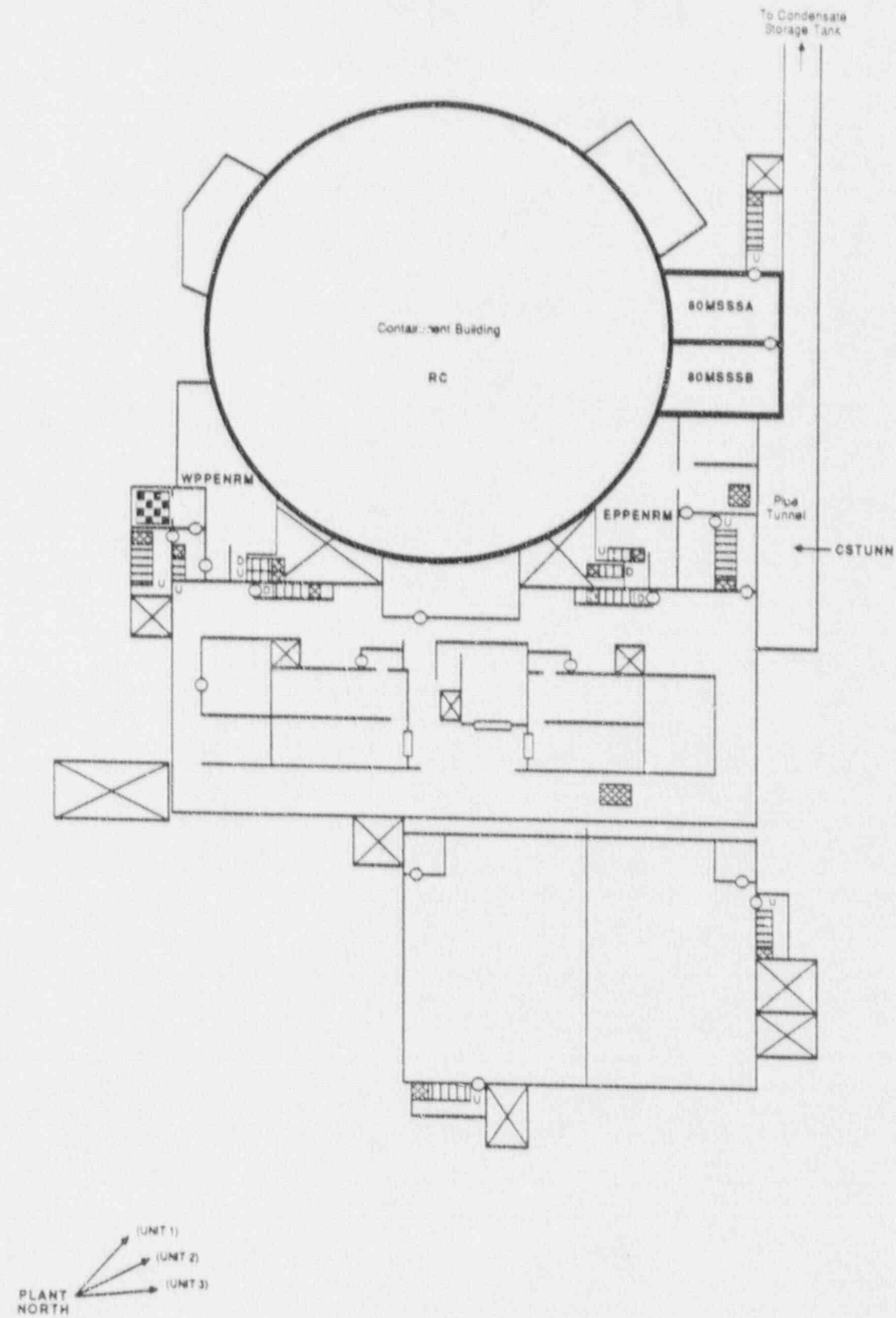


Figure 4-9. Palo Verde Power Block (Except Turbine Building), 80 ft. Elevation

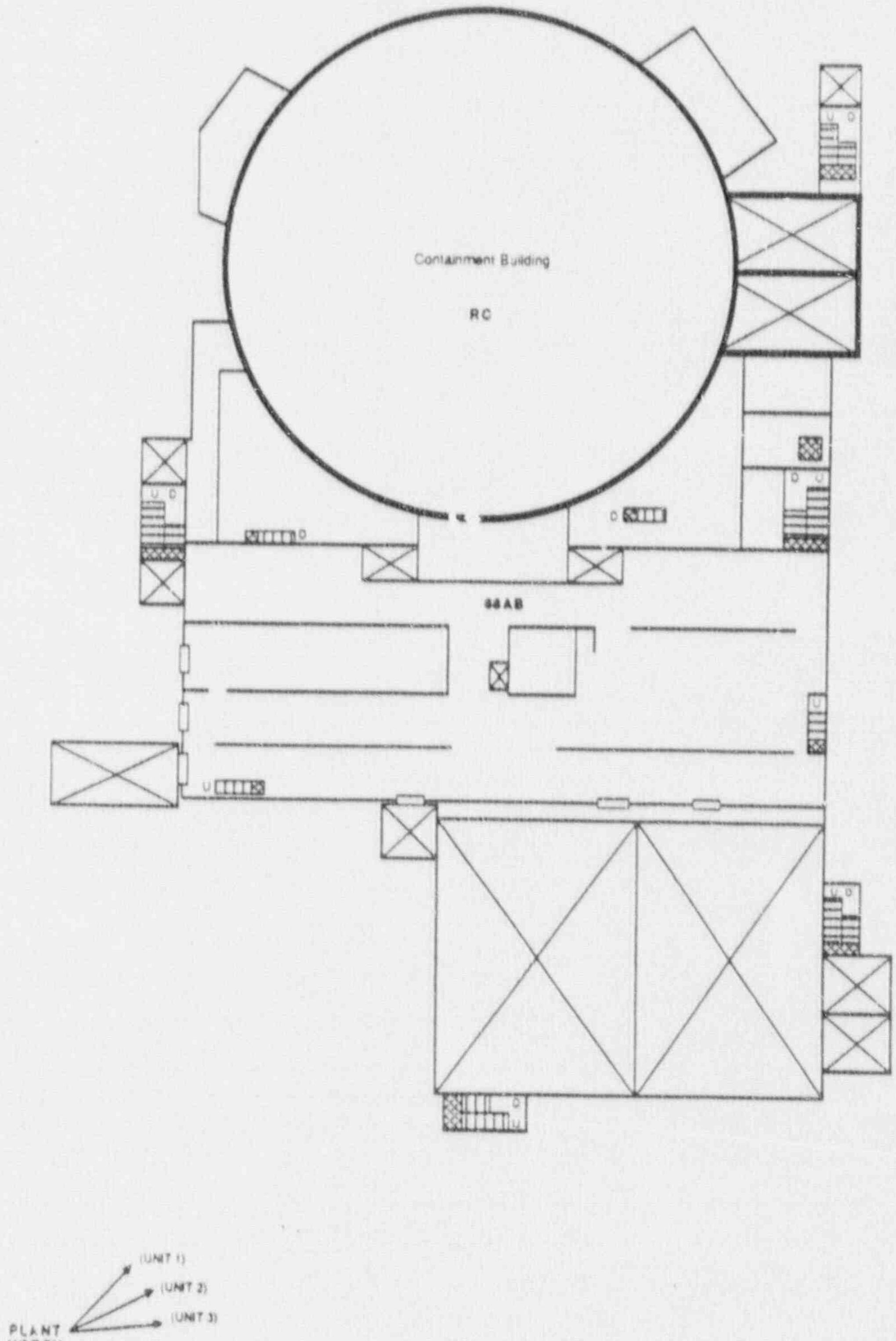


Figure 4-10. Palo Verde Power Block (Except Turbine Building), 88 ft. Elevation

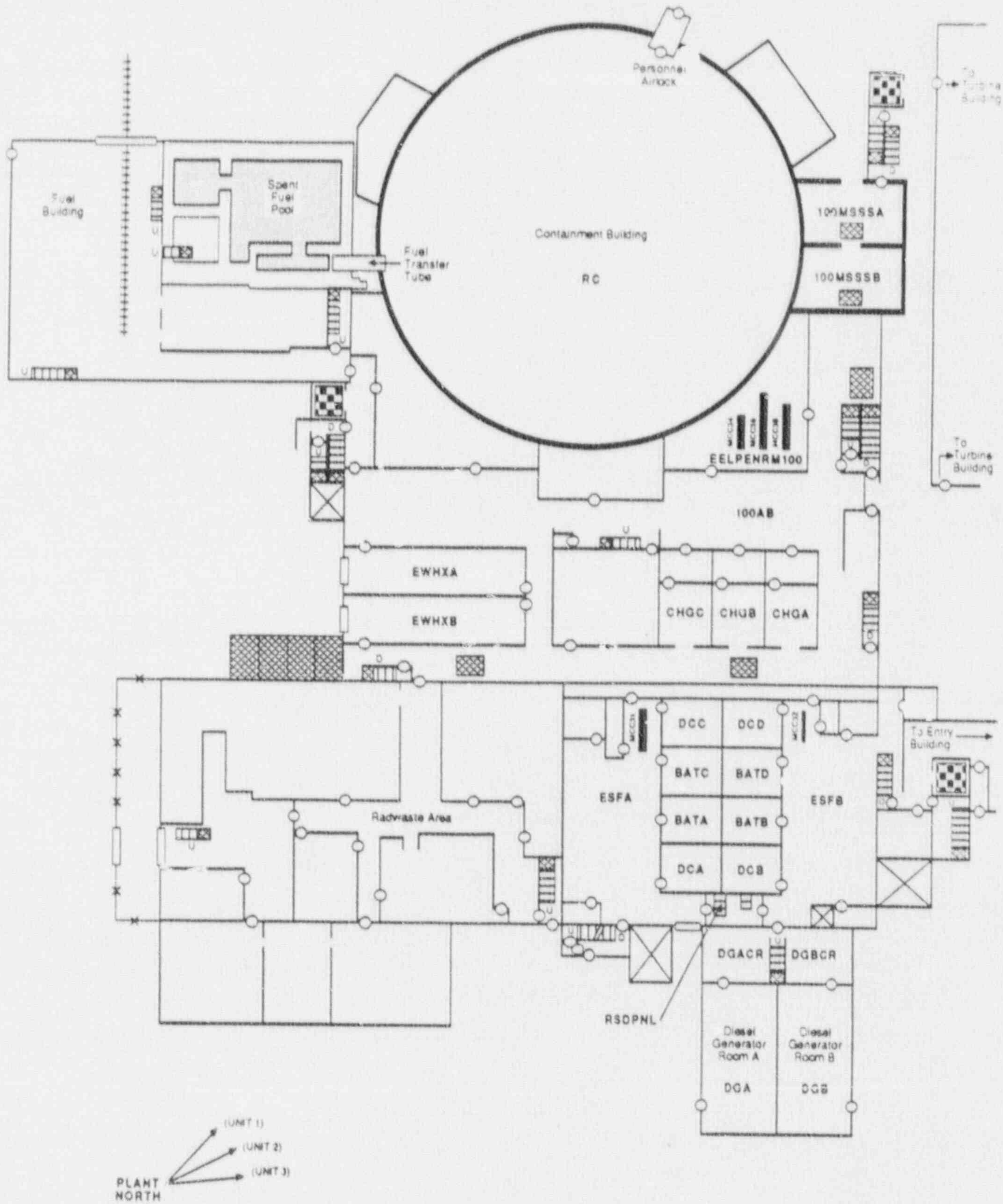


Figure 4-11. Palo Verde Power Block (Except Turbine Building), 100 ft. Elevation (Grade Level)

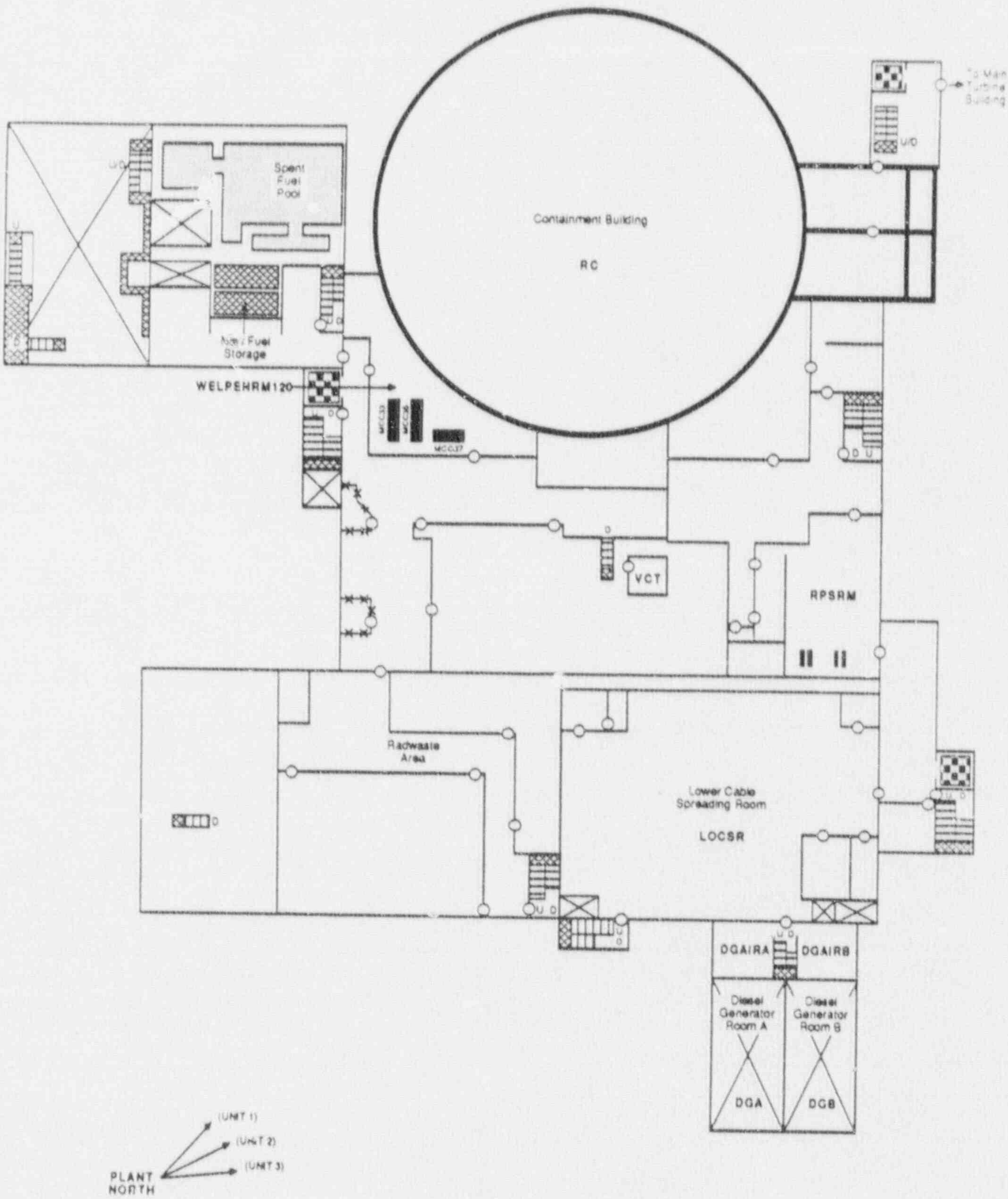


Figure 4-12. Palo Verde Power Block (Except Turbine Building), 120 ft. Elevation

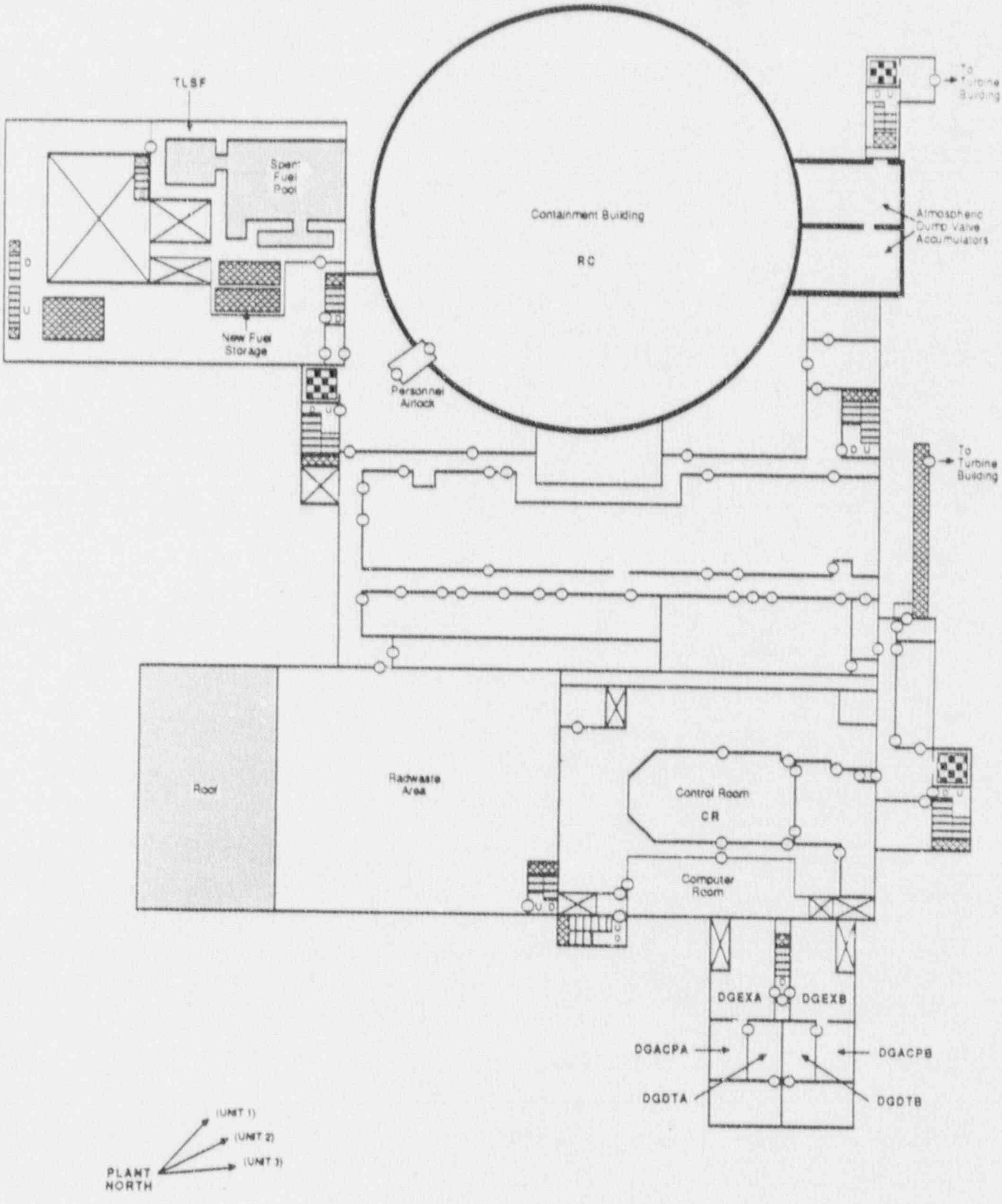


Figure 4-13. Palo Verde Power Block (Except Turbine Building), 140 ft. Elevation

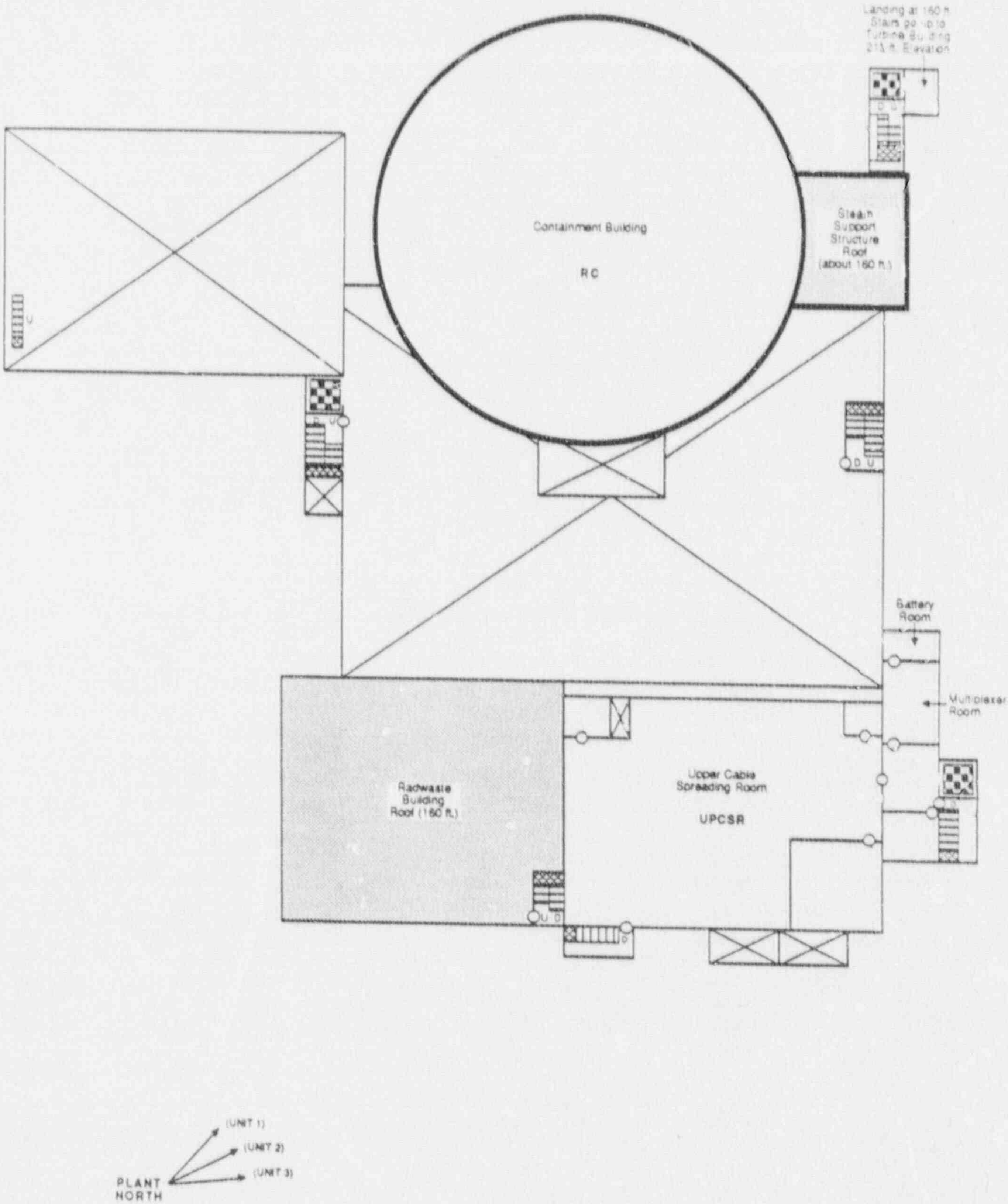


Figure 4-14. Palo Verde Power Block (Except Turbine Building), 160 ft. Elevation

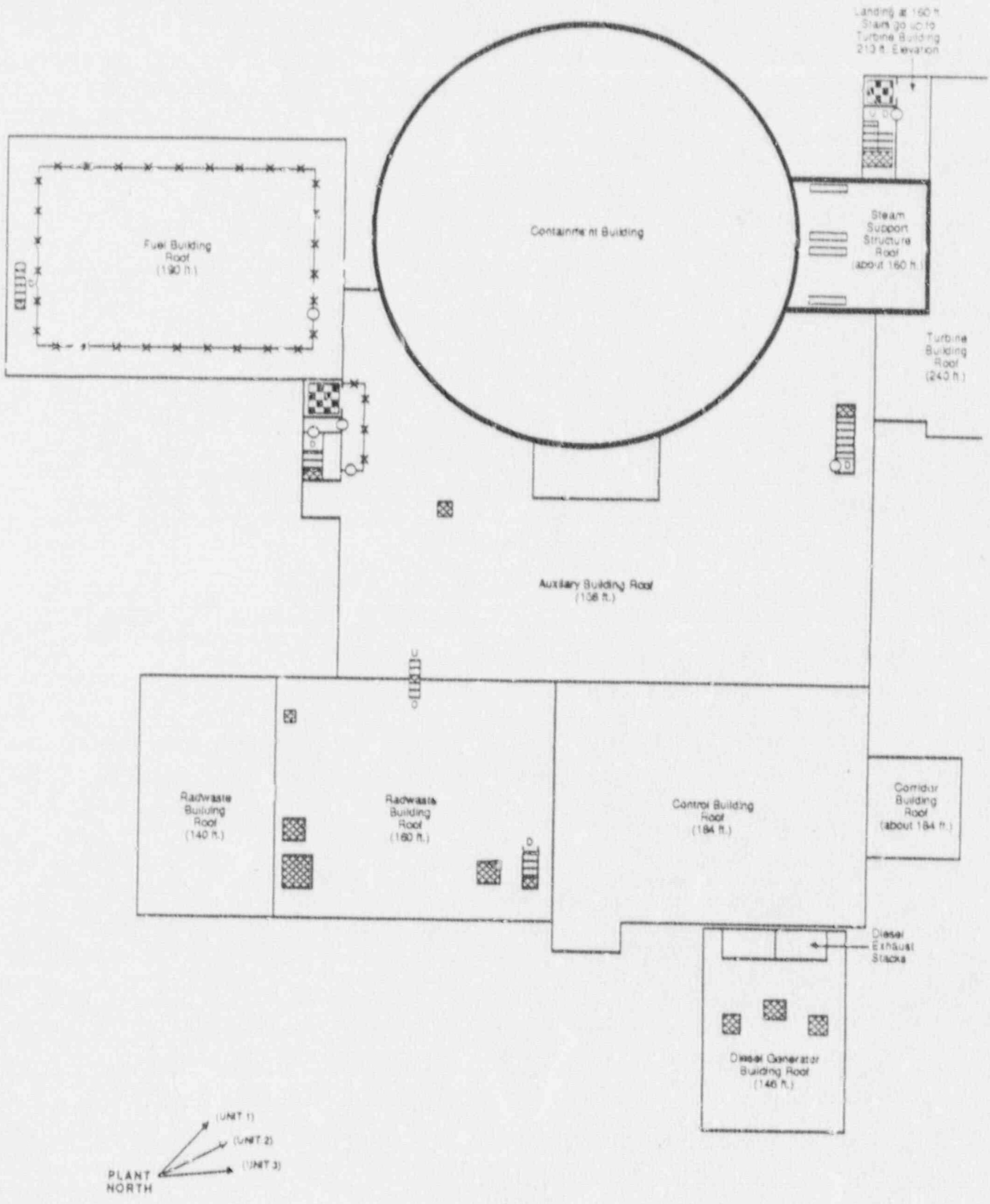


Figure 4-15. Palo Verde Power Block (Except Turbine Building), Roof

Table 4-1. Definition of Palo Verde 1, 2 and 3 Building and Location Codes

	Codes	Descriptions
1.	40ABPPCHSA	40' elevation Auxiliary Building Pipe Chase A
2.	40ABPPCHSB	40' elevation Auxiliary Building Pipe Chase B
3.	80AB	51'-6" elevation of the Auxiliary Building
4.	80MSSSA	Main Steam Support Structure A on the 80' elevation
5.	80MSSSB	Main Steam Support Structure B on the 80' elevation
6.	100MSSSA	Main Steam Support Structure A on the 100' elevation
7.	100MSSSB	Main Steam Support Structure B on the 80' elevation
8.	BATA	Battery Room A, located on the 100' elevation of the Control Building - Central Area
9.	BATB	Battery Room B, located on the 100' elevation of the Control Building - Central Area
10.	BATC	Battery Room C, located on the 100' elevation of the Control Building - Central Area
11.	BATD	Battery Room D, located on the 100' elevation of the Control Building - Central Area
12.	CR	Control Room, located on the 140' elevation of the Control Building
13.	CSA	Containment Spray Pump Room A, located on the 140' elevation of the Auxiliary Building
14.	CSB	Containment Spray Pump Room B, located on the 40' of the Auxiliary Building
15.	CST	Condensate Storage Tank, located northwest of Containment Building
16.	CSTPMRM	Condensate Storage Tank Pump Room, located next to the Condensate Storage Tank
17.	CSTUNN	Condensate Storage Tunnel, tunnel between Condensate Storage Tank and Turbine Building
18.	DCA	D.C. Equipment Room Channel A, located on the 100' elevation of the Control Building - Central Area

Table 4-1. Definition of Palo Verde 1, 2 and 3 Building and Location Codes (Continued)

Codes	Descriptions
19. DCB	D.C. Equipment Room Channel B, located on the 100' elevation of the Control Building at elevation 100' - Central Area
20. DCC	D.C. Equipment Room Channel C, located on the 100' elevation of the Control Building at elevation 100'
21. DCD	D.C. Equipment Room Channel D located on the 100' elevation of the Control Building - Central Area
22. DGA	Diesel Generator A, located on the 100' elevation of the Diesel Generator Building - southwest side
23. DGACPA	Diesel Generator Air Compressor Room A, located on the 100' elevation of the Diesel Generator Building - west side
24. DGACPB	Diesel Generator Air Compressor Room B, located on the 100' elevation of the Diesel Generator Building - east side
25. DGACR	Diesel Generator A Control Room, located on the 100' elevation of the Diesel Generator Building - northwest side
26. DGAIRA	Diesel Generator A Air Intake Filter Room, located in the Diesel Generator Building - northwest side
27. DGAIRB	Diesel Generator B Air Intake Filter Room, located in the Diesel Generator Building - northeast side
28. DGB	Diesel Generator B, located on the 100' elevation of the Diesel Generator Building - southeast side
29. DGBCR	Diesel Generator B Control Room, located on the 100' of the the Diesel Generator Building - northeast side
30. DGDTA	Diesel Generator A Fuel Oil Day Tank, located on the 100' of the Diesel Generator Building - central area
31. DGDTB	Diesel Generator B Fuel Oil Day Tank, located in the Diesel Generator Building - central area
32. DGEXA	Diesel Generator A Exhaust Room, located in the Diesel Generator Building - northwest side
33. DGEXB	Diesel Generator B Exhaust Room, located in the Diesel Generator Building - northeast side
34. EELPENRM100	East Electrical Penetration Room, located on the 100' elevation of the Auxiliary Building - northeast side

Table 4-1. Definition of Palo Verde 1, 2 and 3 Building and Location Codes (Continued)

Codes	Descriptions
35. EPPENRM	East Pipe Penetration Room, located in the Auxiliary Building - northeast side
36. ESFA	ESF Switchgear Room A, located on the 100' of the Control Building - west side
37. ESFB	ESF Switchgear Room B, located on the 100' of the Control Building - east side
38. EWHXA	ECW Heat Exchanger Room A, located on the 100' of the Auxiliary Building elevation 100' - west side
39. EWHXB	ECW Heat Exchanger Room B, located on the 100' of the Auxiliary Building - west side
40. HPSIA	High Pressure Safety Injection Pump Room A, located on the 40' elevation of the Auxiliary Building
41. HPSIB	High Pressure Safety Injection Pump Room B, located on the 40' elevation in the Auxiliary Building
42. LOCSR	Lower Cable Spreading Room, located on the 120' elevation of the Control Building
43. LPSIA	Low Pressure Safety Injection Pump Room A, located on the 40' elevation of the Auxiliary Building
44. LPSIB	Low Pressure Safety Injection Pump Room B, located on the 40' elevation in the Auxiliary Building
45. RC	Reactor Containment
46. RMWT	Reactor Makeup Water Tank, located west of Fuel Building
47. RPS1	Reactor Protection System Panel 1, located in the Auxiliary Building - southeast corner
48. RPS2	Reactor Protection System Panel 2, located in the Auxiliary Building - southeast corner
49. RSDPNLBD	Remote Shutdown Panel BD, located on the 100' elevation of the Control Building - south side
50. RSDPNLAC	Remote Shutdown Panel AC, located on the 100' elevation of the Control Building - south side
52. RWT	Refueling Water Tank, located south of Fuel Building

Table 4-1. Definition of Palo Verde 1, 2 and 3 Building and Location Codes (Continued)

	Codes	Descriptions
53.	RWTUNN	Refueling Water Tunnel, located south of Fuel Building
54	SPONDVPTA	Spray Pond Valve Pit A, located next to Spray Pond A
55.	SPONDVPTB	Spray Pond Valve Pit B, located next to Spray Pond B
56.	TLSF	Spent Fuel operating floor, located in the Fuel Building
57.	UHSA	Ultimate Heat Sink A (Spray Pond A)
58.	UHSB	Ultimate Heat Sink B (Spray Pond B)
59.	UHSPMPHSEA	Ultimate Heat Sink Pump House A, located next to Spray Pond A
60.	UHSPMPHSEB	Ultimate Heat Sink Pump House B, located next to Spray Pond B
61	UPCSR	Upper Cable Spreading Room, located on the 160' elevation of the Control Building
62.	WELPENRM120	West Electrical Penetration Room, located on the 120' elevation of the Auxiliary Building - northwest side
63.	WPPWNRM	West Pipe Penetration Room, located in the Auxiliary Building - northwest side

TABLE 4-2. PARTIAL LISTING OF COMPONENTS BY LOCATION AT PALO VERDE 1, 2 & 3

LOCATION	SYSTEM	COMPONENT ID	COMP TYPE
100AB	CVCS	CH536	MOV
100AB	CVCS	CH524	MOV
100MSSSA	AFWS	AFW134	MOV
100MSSSB	AFWS	AFW138	MOV
80AB	CVCS	CH532	NV
80AB	CVCS	CH530	MOV
80AB	ECCS	HPI531	MOV
80AB	ECCS	HPI530	MOV
80MSSSA	AFWS	AFW33	MOV
80MSSSA	AFWS	AFW34	MOV
80MSSSA	AFWS	AFW32	MOV
80MSSSA	AFWS	AFW36	MOV
80MSSSA	AFWS	AFW33	MOV
80MSSSA	AFWS	AFW34	MOV
80MSSSA	AFWS	AFW-A-B	TDP
80MSSSA	A' WS	AFW54	MOV
80MSSSB	AFWS	AFW30	MOV
80MSSSB	AFWS	AFW31	MOV
80MSSSB	AFWS	AFW35	MOV
80MSSSB	AFWS	AFW37	MOV
80MSSSB	AFWS	AFW-B-B	MDP
80MSSSB	AFWS	AFW30	MOV
80MSSSB	AFWS	AFW37	MOV
BATA	EP	BATT-A	BATT
BATB	EP	BATT-B	BATT
BATC	EP	BATT-C	BATT
BATD	EP	BATT-D	BATT
CHGA	CVCS	CHP-1	MDP
CHGB	CVCS	CHP-2	MSP
CHGC	CVCS	CHP-3	MDP

TABLE 4-2. PARTIAL LISTING OF COMPONENTS BY LOCATION AT PALO VERDE 1, 2 & 3 (CONTINUED)

LOCATION	SYSTEM	COMPONENT ID	COMP TYPE
CST	AFWS	CST	TANK
DCA	EP	PNL25	PNL
DCA	EP	LC41	BUS
DCA	EP	INVA	INV
DCA	EP	BATT-CHGRA	BC
DCA	EP	BATT-CHGRAC	BC
DCA	EP	TRA	TRAN
DCA	EP	PNL21	PNL
DCA	EP	ATSA	ATS
DCA	EP	LC41	BUS
DCA	EP	LC41	BUS
DCB	EP	PNL26	PNL
DCB	EP	LC42	BUS
DCB	EP	INVB	INV
DCB	EP	BATT-CHGRB	BC
DCB	EP	BATT-CHGRBD	BC
DCB	EP	TRB	TRAN
DCB	EP	PNL22	PNL
DCB	EP	ASTB	ATS
DCB	EP	LC42	BUS
DCB	EP	LC42	BUS
DCC	EP	PNL27	PNL
DCC	EP	LC43	BUS
DCC	EP	INVC	INV
DCC	EP	BATT-CHGRC	BC
DCC	EP	TRC	TRAN
DCC	EP	ATSC	ATS
DCC	EP	LC43	BUS
DCC	EP	LC43	BUS
DCD	EP	PNL28	PNL

TABLE 4-2. PARTIAL LISTING OF COMPONENTS BY LOCATION AT PALO VERDE 1, 2 & 3 (CONTINUED)

LOCATION	SYSTEM	COMPONENT ID	COMP TYPE
DCD	EP	LC44	BUS
DCD	EP	INVD	INV
DCD	EP	BATT-CHGRD	BC
DCD	EP	TRD	TRAN
DCD	EP	ATSD	ATS
DCD	EP	LC44	BUS
DCD	EP	LC44	BUS
DGA	EP	DGA	DG
DGB	EP	DGB	DG
EELPENRM100	EP	MCC36	BUS
EELPENRM100	EP	MCC34	BUS
EELPENRM100	EP	MCC38	BUS
EPPENRM	ECCS	HPI617	MOV
EPPENRM	ECCS	HPI627	MOV
EPPENRM	ECCS	HPI331	MOV
EPPENRM	ECCS	HPI609	MOV
EPPENRM	ECCS	HPI616	MOV
EPPENRM	ECCS	HPI626	MOV
ESFA	EP	MCC31	BUS
ESFA	EP	BUSS03	BUS
ESFA	EP	CBA	CB
ESFA	EP	BUSL33	BUS
ESFA	EP	TR33	TRAN
ESFA	EP	BUSL31	BUS
ESFA	EP	TR31	TRAN
ESFA	EP	BUSL35	BUS
ESFA	EP	TR35	TRAN
ESFB	EP	MCC32	BUS
ESFB	EP	BUSS04	BUS
ESFB	EP	CBB	CB

TABLE 4-2. PARTIAL LISTING OF COMPONENTS BY LOCATION AT PALO VERDE 1, 2 & 3 (CONTINUED)

LOCATION	SYSTEM	COMPONENT ID	COMP TYPE
ESFB	EP	BUSL34	BUS
ESFB	EP	TR34	TRAN
ESFB	EP	BUSL36	BUS
ESFB	EP	TR36	TRAN
ESFB	EP	BUSL32	BUS
ESFB	EP	TR32	TRAN
HPSIA	ECCS	HPSIP1	MDP
HPSIA	ECCS	HPI698	MOV
HPSIB	ECCS	HPSIP2	MDP
HPSIB	ECCS	HPI699	MOV
RC	AFWS	SG-1	SG
RC	AFWS	SG-2	SG
RC	RCS	RCS-VESSEL	RV
RC	RCS	CH515	NCV
RC	RCS	CH516	NCV
RC	RCS	RHR652	MOV
RC	RCS	RHR654	MOV
RC	RCS	RHR653	MOV
RC	RCS	RHR651	MOV
RMWT	AFWS	RMWT	TANK
SPONDVPTA	ESPS	ESP49A	MOV
SPONDVPTA	ESPS	ESP49B	MOV
SPONDVPTB	ESPS	ESP50A	MOV
SPONDVPTB	ESPS	ESP50B	MOV
UHSPMPHSEA	ESPS	SPA-P01	MDP
UHSPMPHSEB	ESPS	SPB-P01	MDP
WELPENRM120	EP	MCC35	BUS
WELPENRM120	EP	MCC33	BUS
WPPENRM	ECCS	HPI321	MOV
WPPENRM	ECCS	HPI604	MOV

TABLE 4-2. PARTIAL LISTING OF COMPONENTS BY LOCATION AT PALO VERDE 1, 2 & 3 (CONTINUED)

LOCATION	SYSTEM	COMPONENT ID	COMP TYPE
WPPENRM	ECCS	HPI637	MOV
WPPENRM	ECCS	HPI647	MOV
WPPENRM	ECCS	HPI646	MOV

8. BIBLIOGRAPHY FOR PALO VERDE

1. NUREG-0857, "Safety Evaluation Report Related to the Operation of Palo Verde Nuclear Generating Station, Units 1, 2 and 3", USNRC

2. NUREG-1133, "Technical Specification for Palo Verde Nuclear Generating Station, Unit 1", USNRC, May 1985

3. NUREG-1181, "Technical Specification for Palo Verde Nuclear Generating Station, Unit 2", USNRC

4. NUREG-1287, "Technical Specification for Palo Verde Nuclear Generating Station, Unit 3", USNRC

5. Roscoe, B.J., "Palo Verde Nuclear Generating Station Units 1, 2 and 3 Auxiliary Feedwater System Reliability Study Evalution", NUREG/CR-2322, Sandia National Laboratories, December 1981

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)

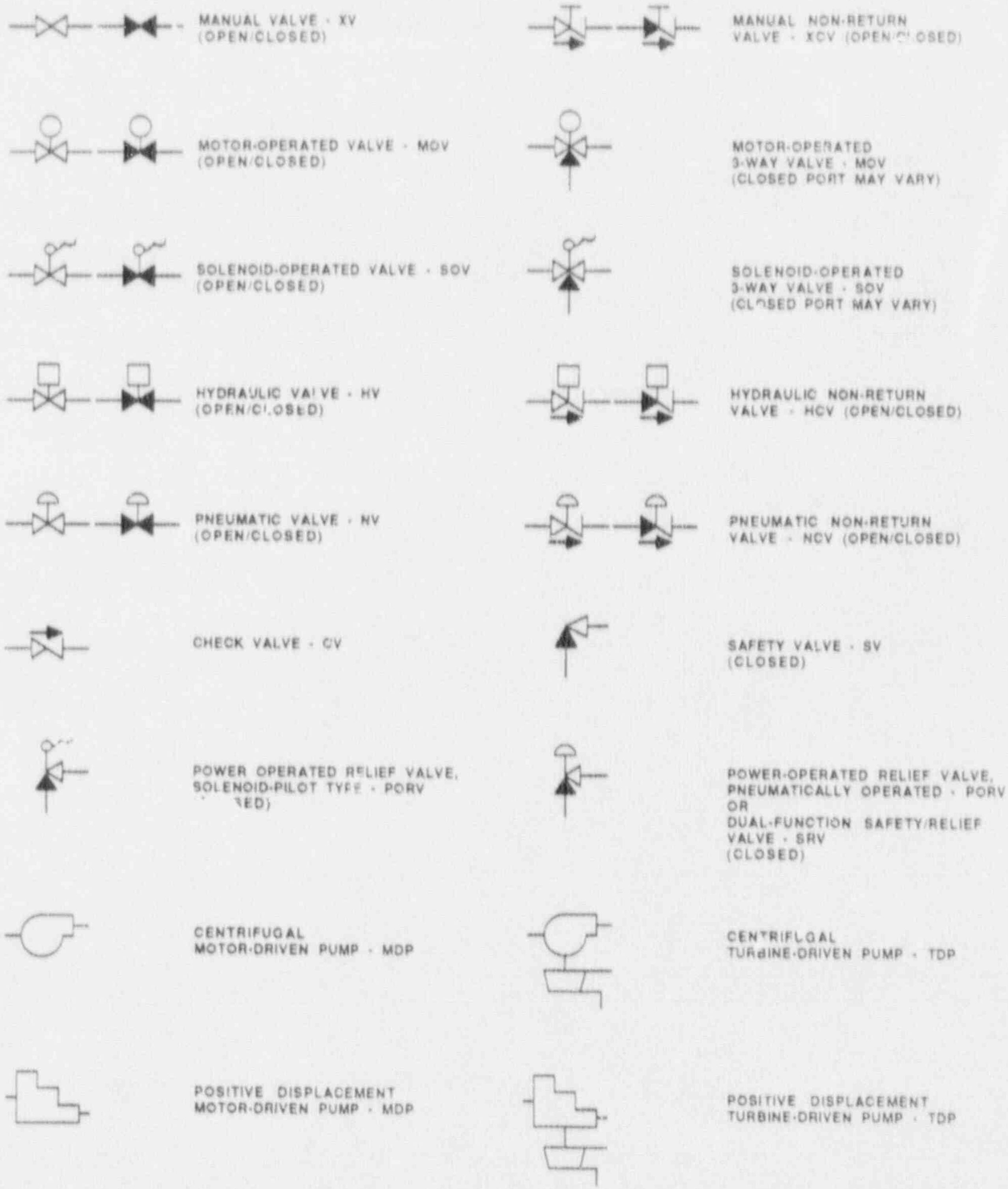


Figure A-1. Key To Symbols In Fluid System Drawings

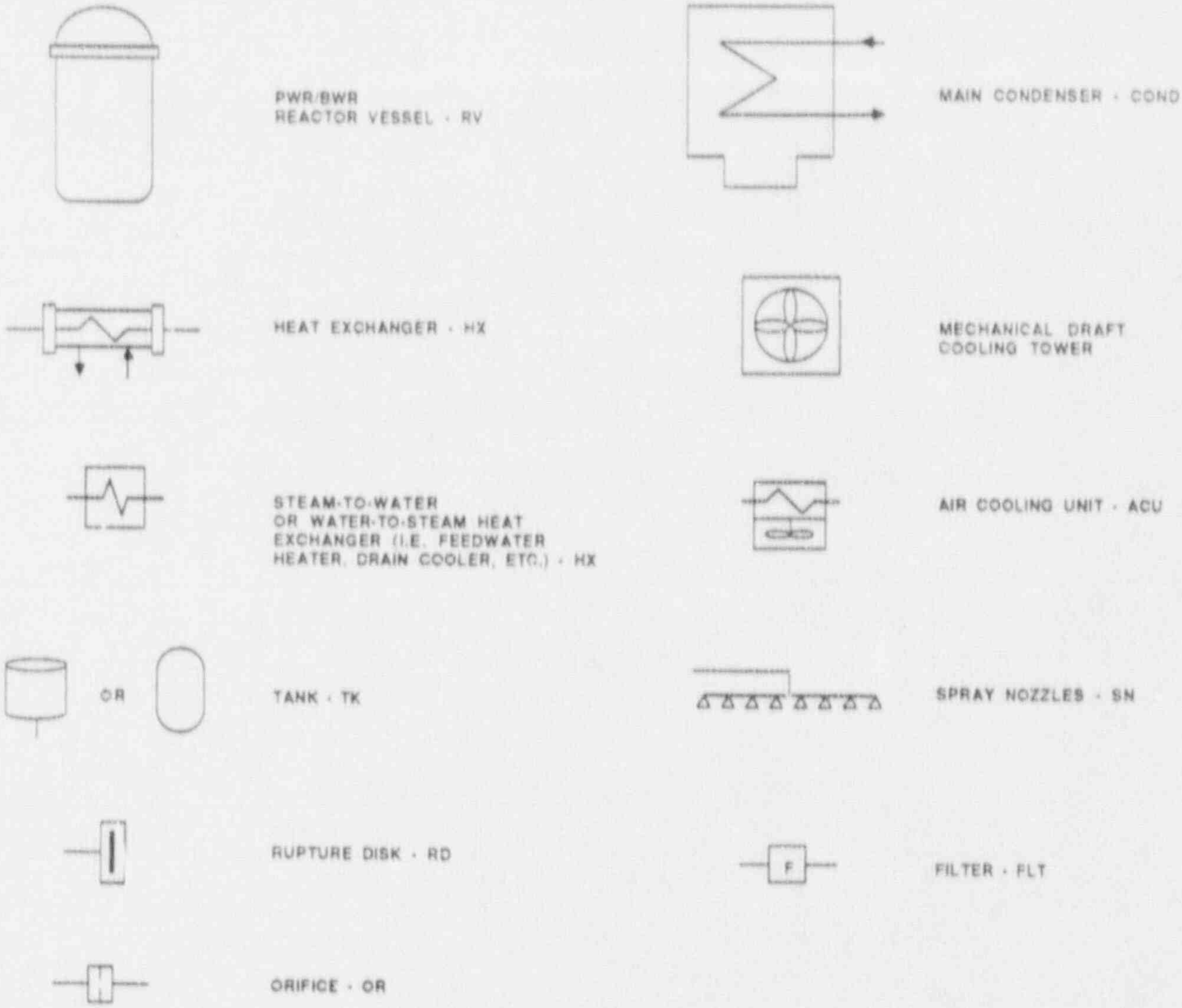


Figure A-1. Key To Symbols In Fluid System Drawings (Continued)

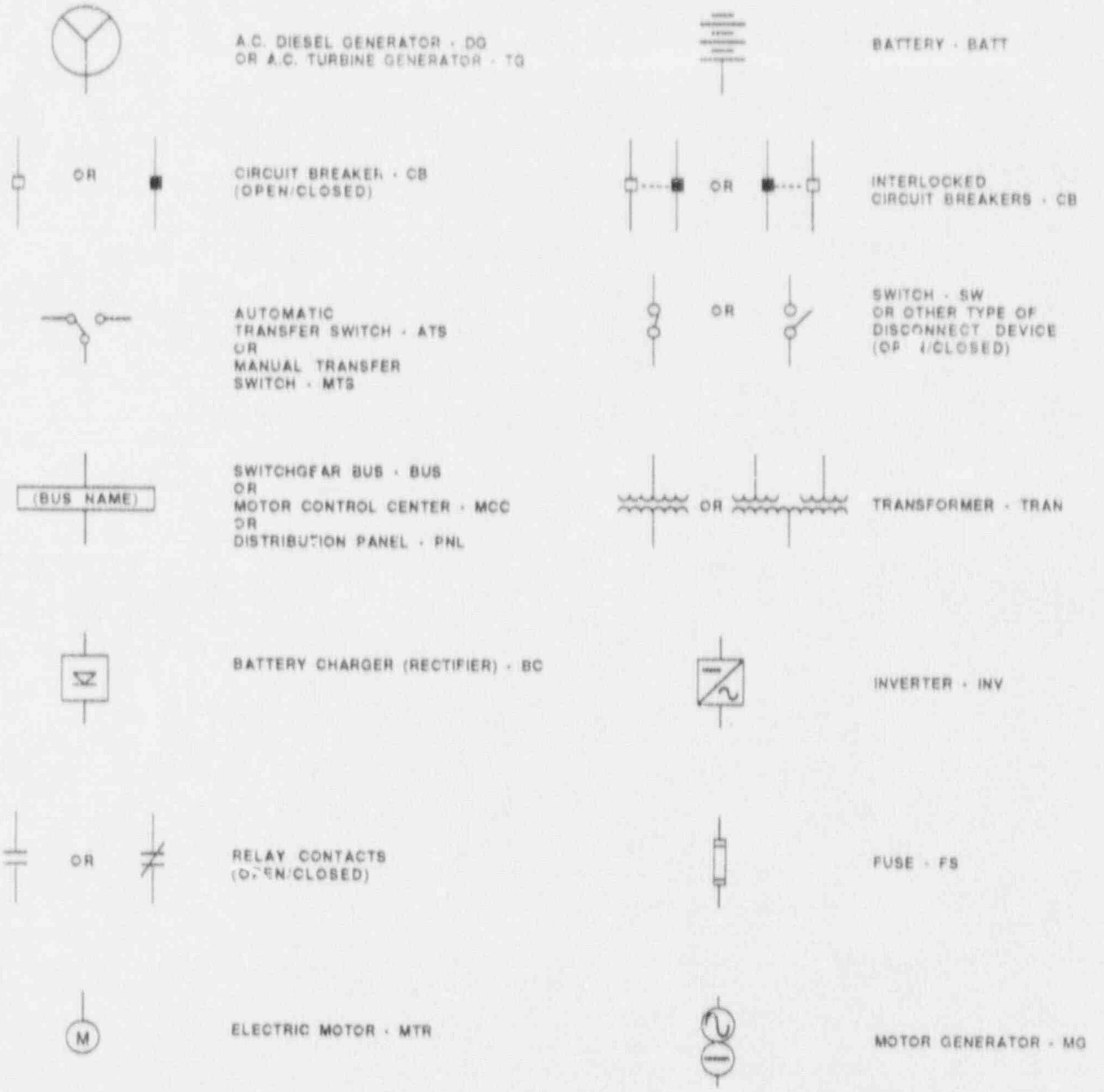


Figure A-2. Key To Symbols In Electrical System Drawings

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

APPENDIX B
DEFINITIONS 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
CVCS	Charging System
EP	Electric Power System
ESPS	Essential Spray Pond 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