PALO VERDE NUCLEAR GENERATING STATION

ENVIRONMENTAL REPORT OPERATING LICENSE STAGE

VOLUME III

ARIZONA PUBLIC SERVICE COMPANY
PROJECT MANAGER AND OPERATING AGENT

8001090 295

CHAPTER 3

THE STATION

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TABLES

FIGURES

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3. THE STATION

3.1 EXTERNAL APPEARANCE

The external design of PVNGS has not changed significantly from that presented in ER-CP Section 3.1 and the FES. The external design is summarized in this section.

3.1.1 DESIGN OBJECTIVES

Design objectives for PVNGS ensure that plant facilities and landscape are compatible with the existing environment. These objectives have been to:

- Organize buildings, exposed equipment, roads, parking, and railroad to create a pleasing visual image
- Incorporate regional architecture, building materials, and colors into plant design
- Allow the site to revegetate naturally, without extensive landscaping
- Arrange the areas of water impoundments on the site in a manner to enhance the overall appearance of the terrain.

Figure 3.1-1 is an artist's conception of PVNGS.

3.1.2 SOURCES OF PUBLIC EXPOSURE

A recent oblique aerial photograph of the site area is shown on figure 3.1-2 and the vicinity map is shown in figure 3.1-3. The general arrangement of the site is shown in figure 3.1-4.

Major areas from which the plant is normally visible to the public are Buckeye-Salome Road, north of the station; and Ward (Elliot) Road, south of the station. The plant is also visible from segments of Interstate 10, in the vicinity of the station.

There are no major roads west of the station. The flat land between the station site and the rugged Palo Verde Hills is partly used for agriculture. The Phoenix Valley West development noted in the ER-CP is no longer planned. Figure 3.1-5 shows the lines-of-sight from which the profiles of figure 3.1-6 were derived.

3.1.2.1 View From Wintersburg

Wintersburg is located at the intersection of Buckeye-Salome and Wintersburg Roads, approximately 2 miles north of the station. The station is only partially visible from this line-of-site because the hills at the north boundary of the station site interrupt the sight lines (see figure 3.1-6, profile 1).

3.1.2.2 View From Northeast

PVNGS is visible to the public travelling on Buckeye-Salome Road along a 2-mile stretch northeast of the station, looking southwest through the gap between hills north and east of the site. Distance to the station is 2 to 3 miles, and the highest structures of the station appear much lower than the Palo Verde Hills in the background (see figure 3.1-6, profile 2).

3.1.2.3 View From Ward Road

Ward Road is a rural road south of the station site and serves the agricultural area west of the site. The station is visible from Ward Road at a distance of 3 miles and looking north (see figure 3.1-6, profile 3).

3.1.3 SPECIFIC FEATURES

PVNGS consists of three identical power blocks arranged in a circular arc near the northwest portion of the site as

shown on the site general arrangement plan in figure 3.1-4. Figure 3.1-7 shows a typical power block in isometric form.

Figures 3.1-8 through 3.1-11 illustrate the four main elevations of the power block.

3.1.3.1 Power Block Complex

Each power block complex consists of the following major structures:

- Containment building
- Auxiliary building
- Fuel building
- Control building
- Turbine building
- Diesel generator building
- Radwaste building
- A laundry and decontamination facility at Unit 1 only

The containment is a cylindrical concrete structure with a hemispherical dome and is the highest part of the power block. The containment is surrounded by lower power block structures. With the exception of the turbine building, all other structures of the power block are constructed of concrete. The turbine building consists of a structural steel frame enclosed with concrete base and metal siding walls of a color to complement the other structures within the complex.

The locations of the release points for gaseous wastes are illustrated on figure 3.1-9.

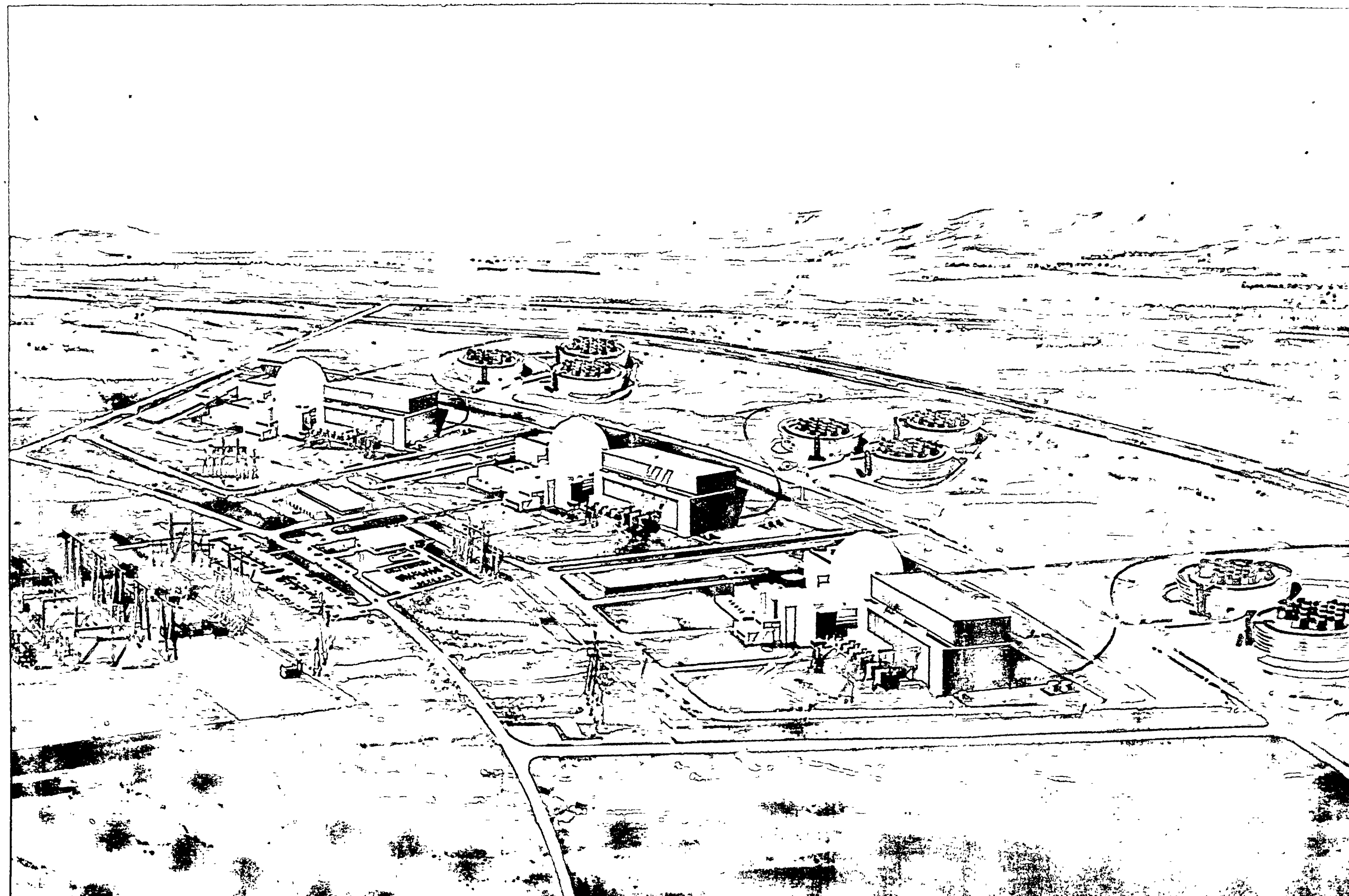
3.1.3.2 Other Structures

Each power block is served by cooling towers located west or northwest of the power block. Other structures in the plant area include the administration building, the guardhouse, service warehouse building, water reclamation plant, switchyard structures, and miscellaneous ancillary buildings. These structures have low silhouettes.

3.1.4 CONCLUSION

Because of the distances of the vantage points from the station and the high Palo Verde Hills backdrop, the visual impact to the public is negligible.

No properties listed in the National Register of Historic Places exist near the vicinity of the site, therefore there is no visual or aesthetic plant impact upon these properties.



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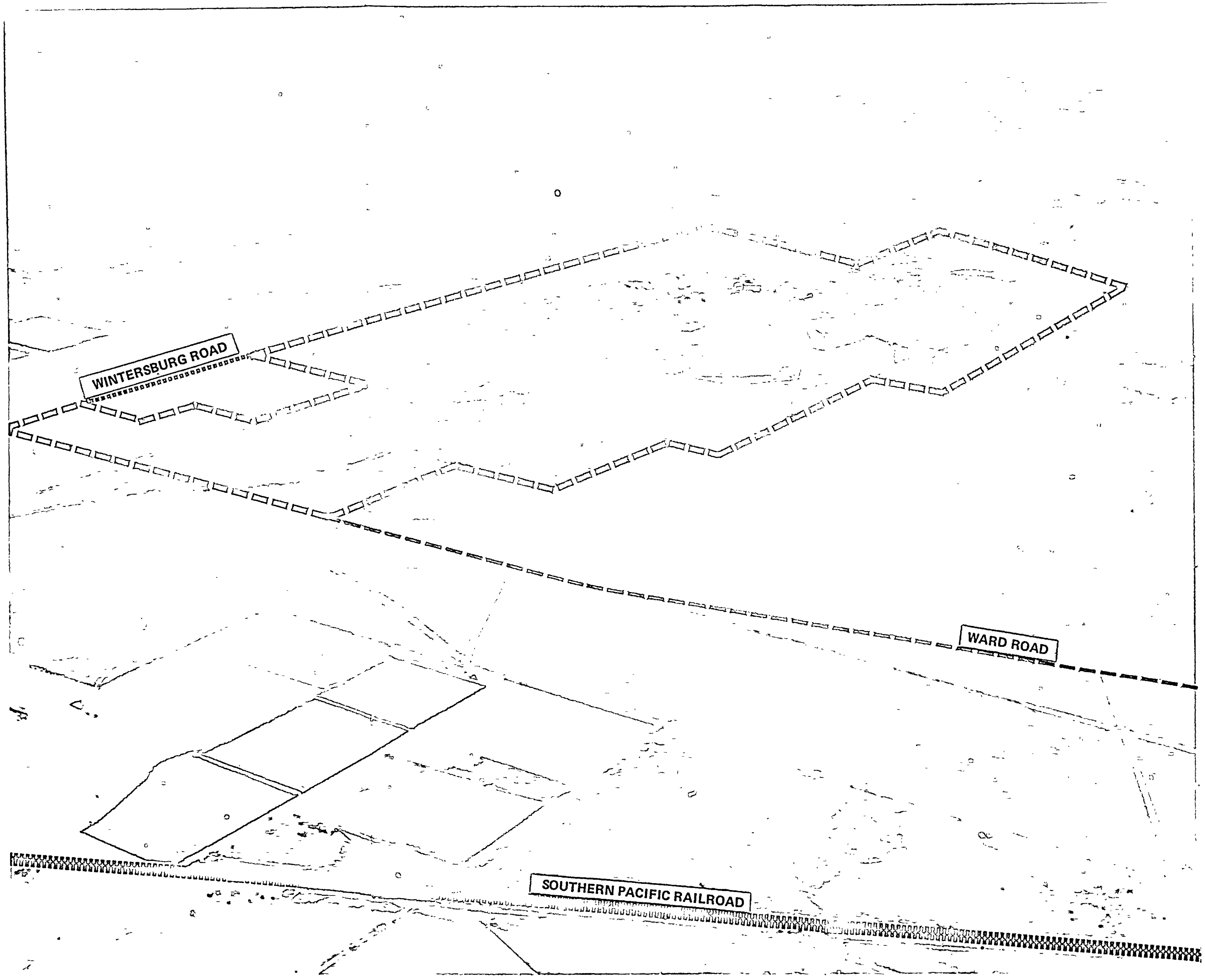
ARTIST'S CONCEPTION OF PVNGS

Figure 3.1-1



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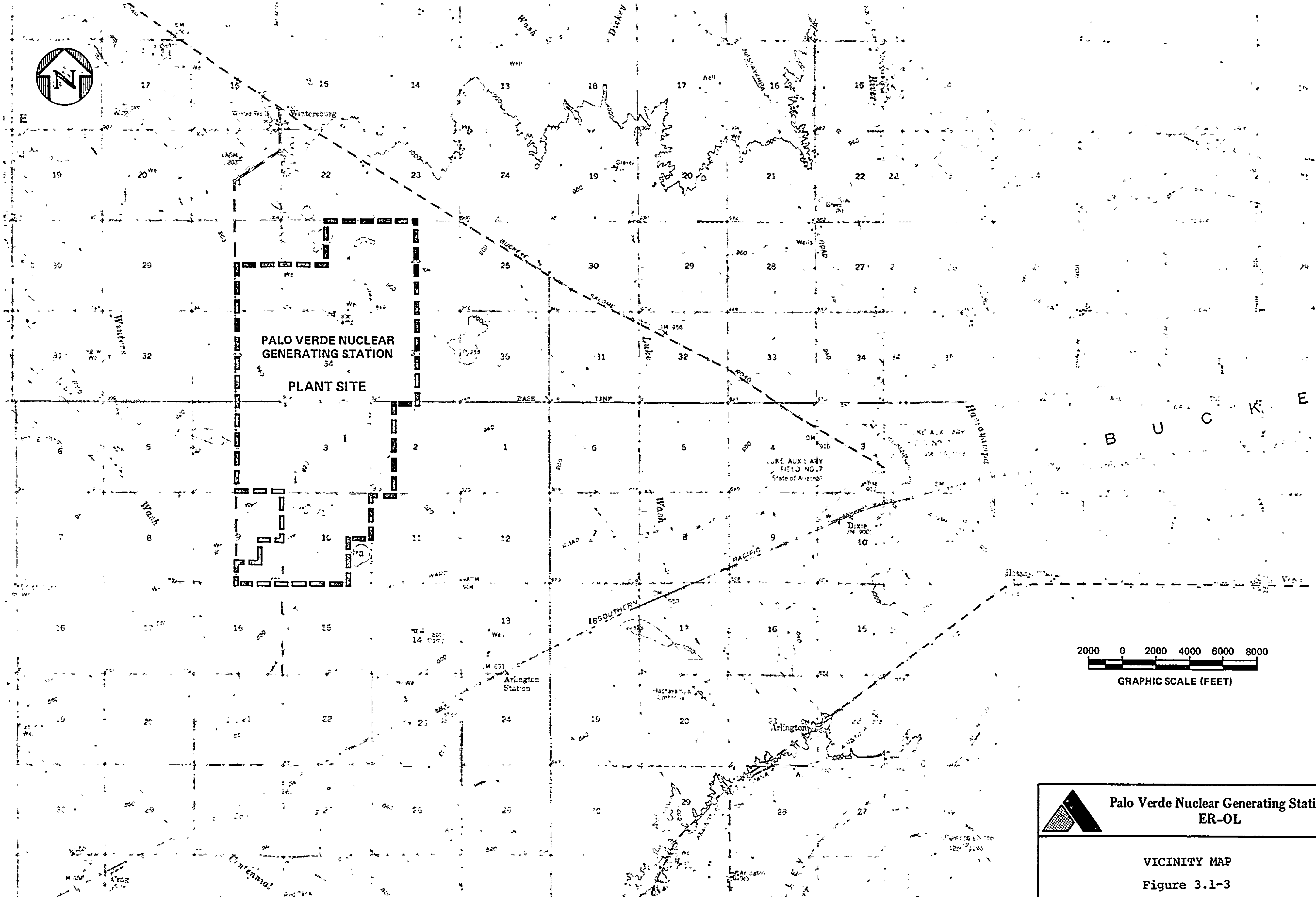
OBLIQUE AERIAL VIEW

Figure 3.1-2



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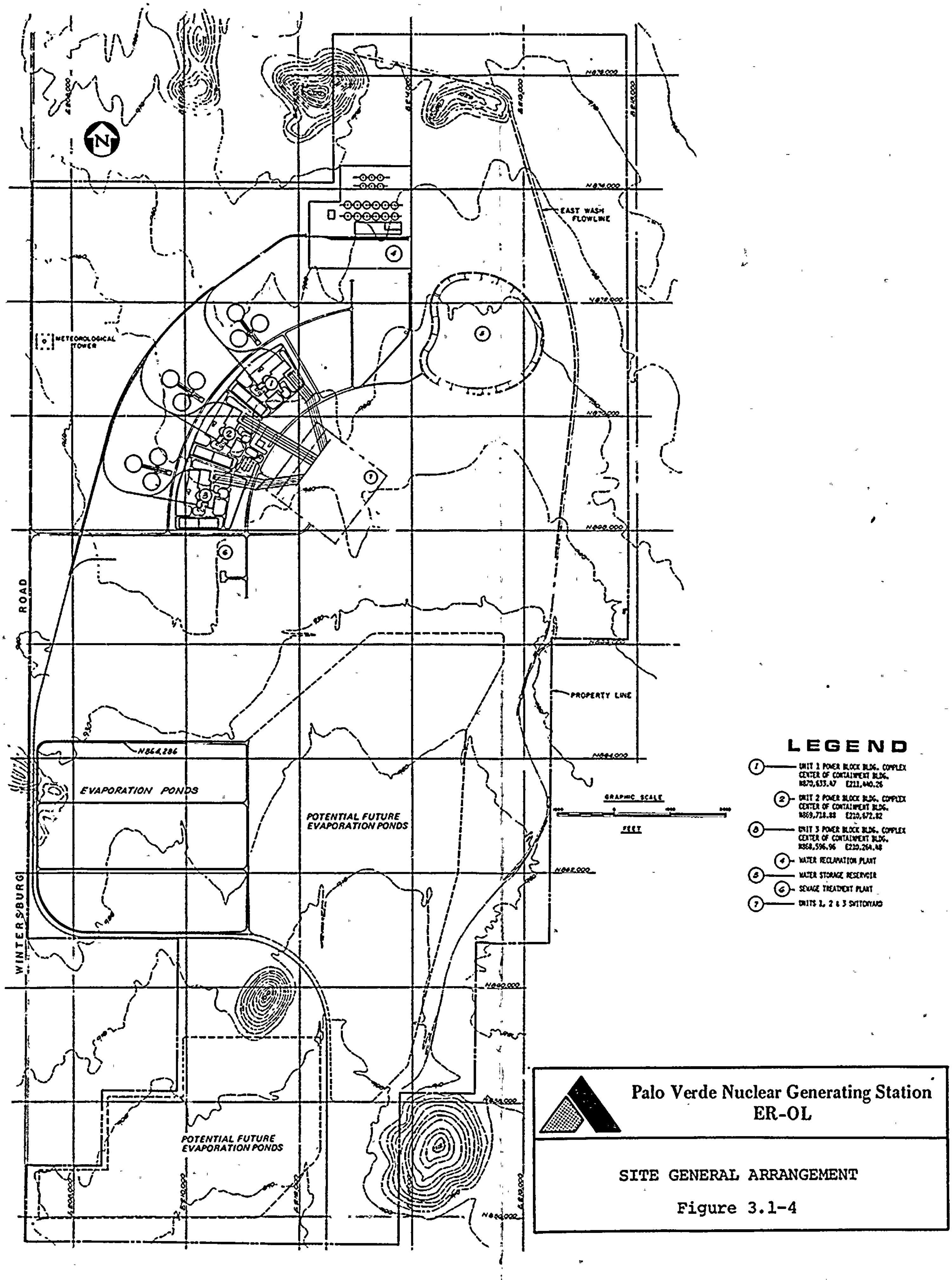
VICINITY MAP

Figure 3.1-3



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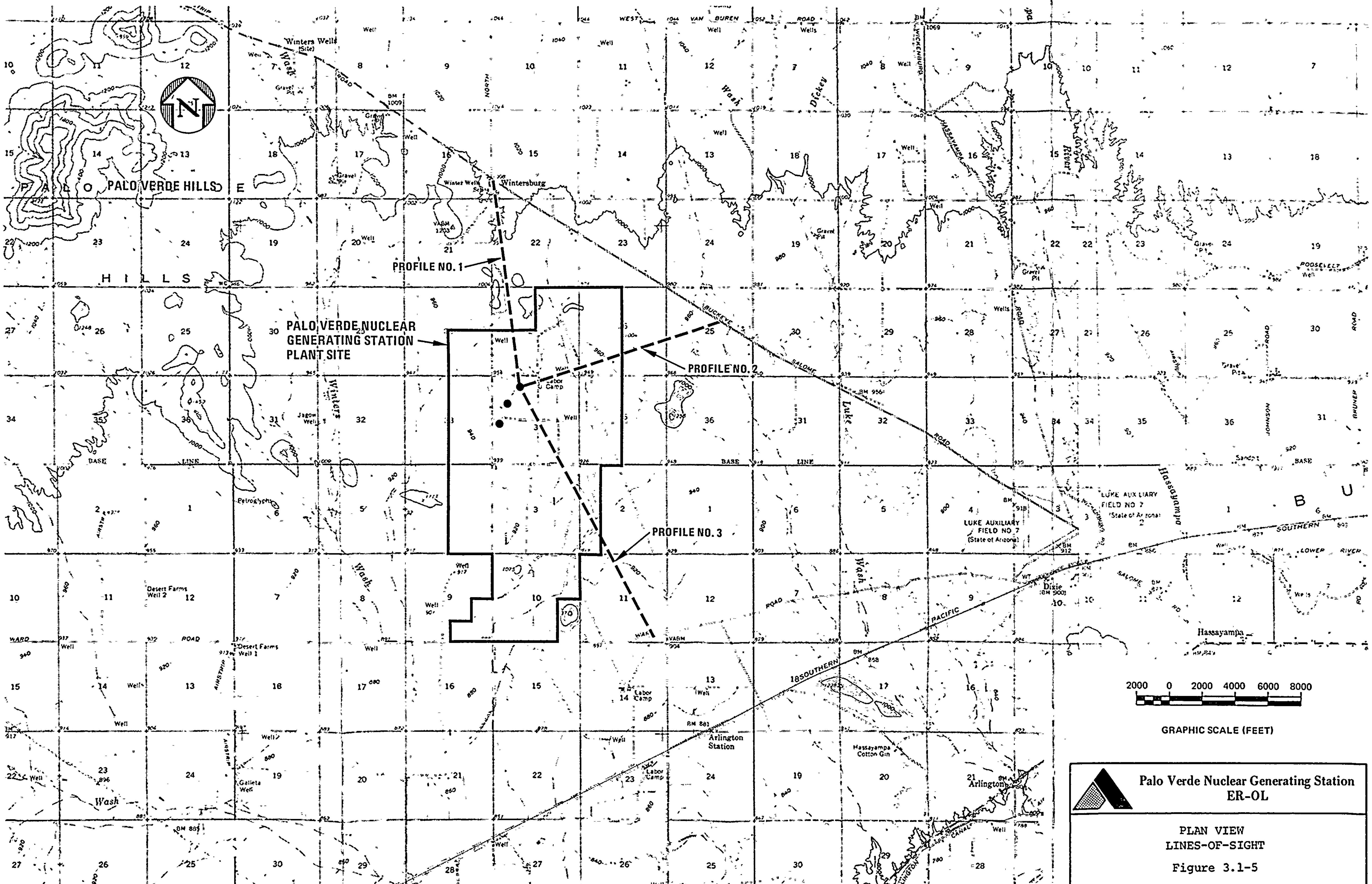
SITE GENERAL ARRANGEMENT

Figure 3.1-4



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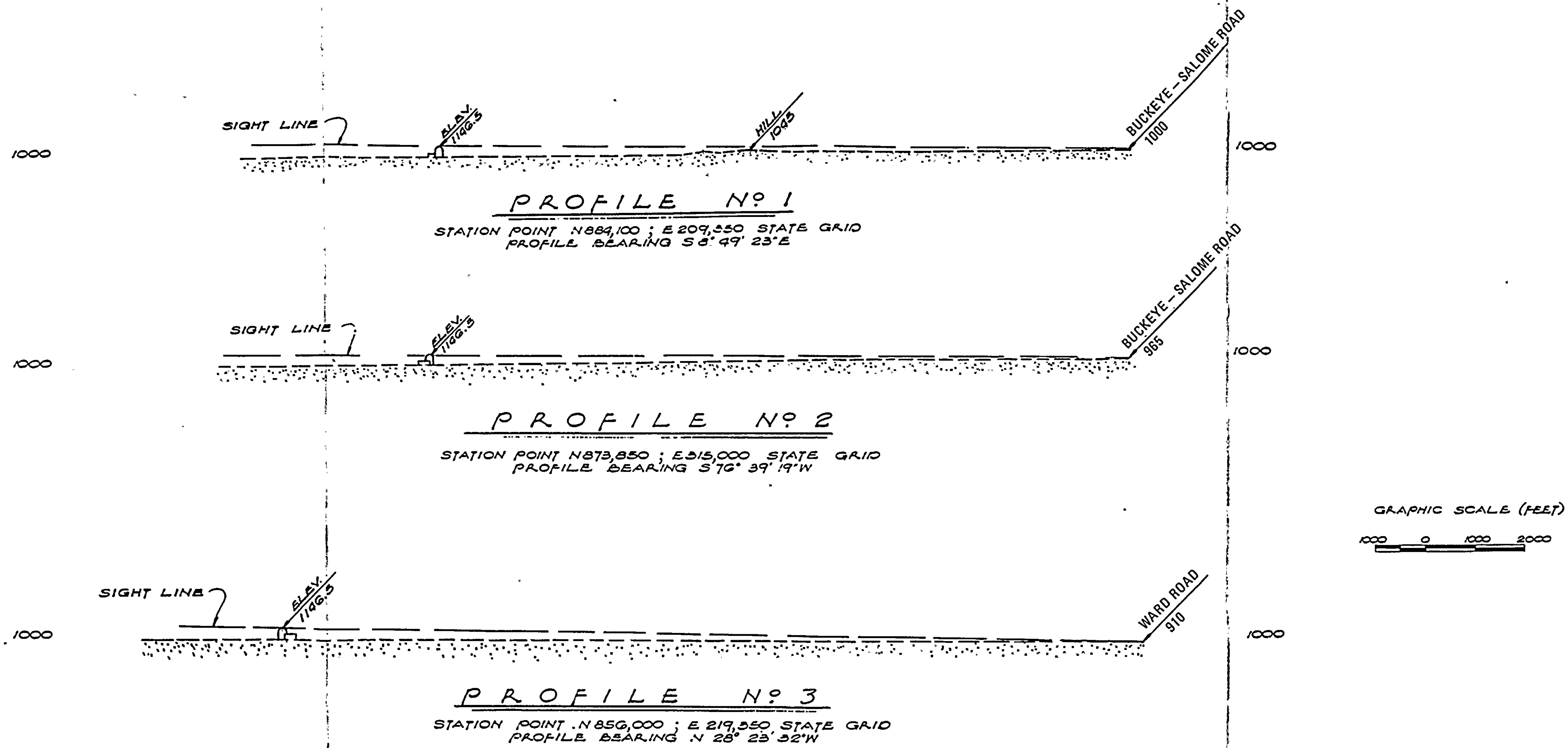
PLAN VIEW
LINES-OF-SIGHT

Figure 3.1-5



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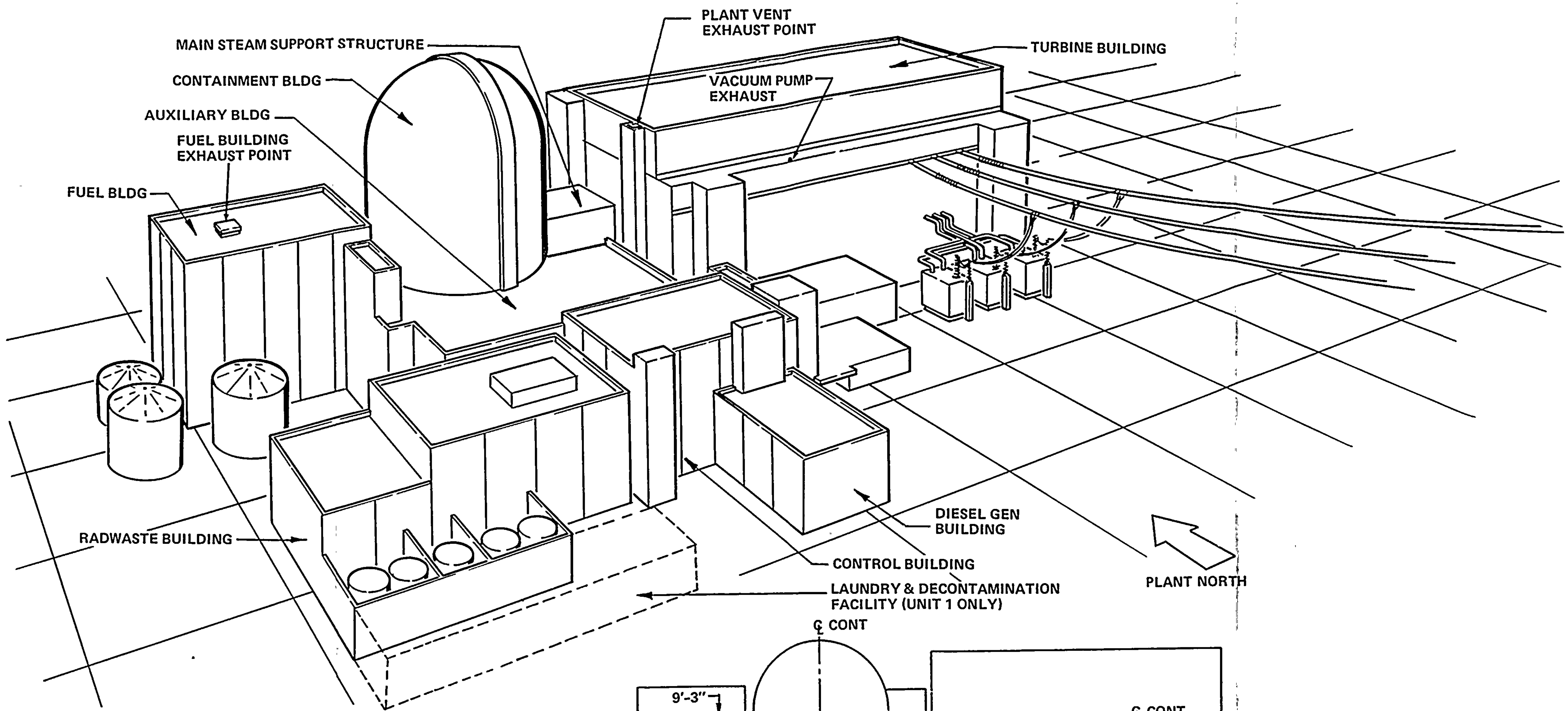
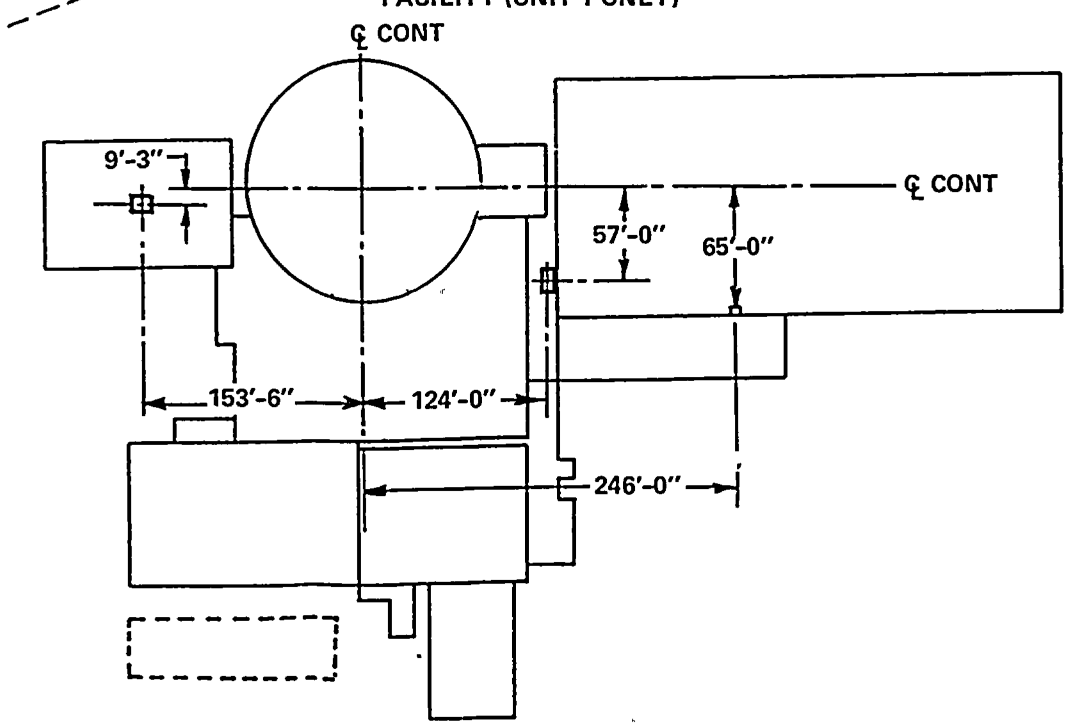
LINE-OF-SIGHT PROFILES

Figure 3.1-6





EXHAUST POINTS KEY PLAN

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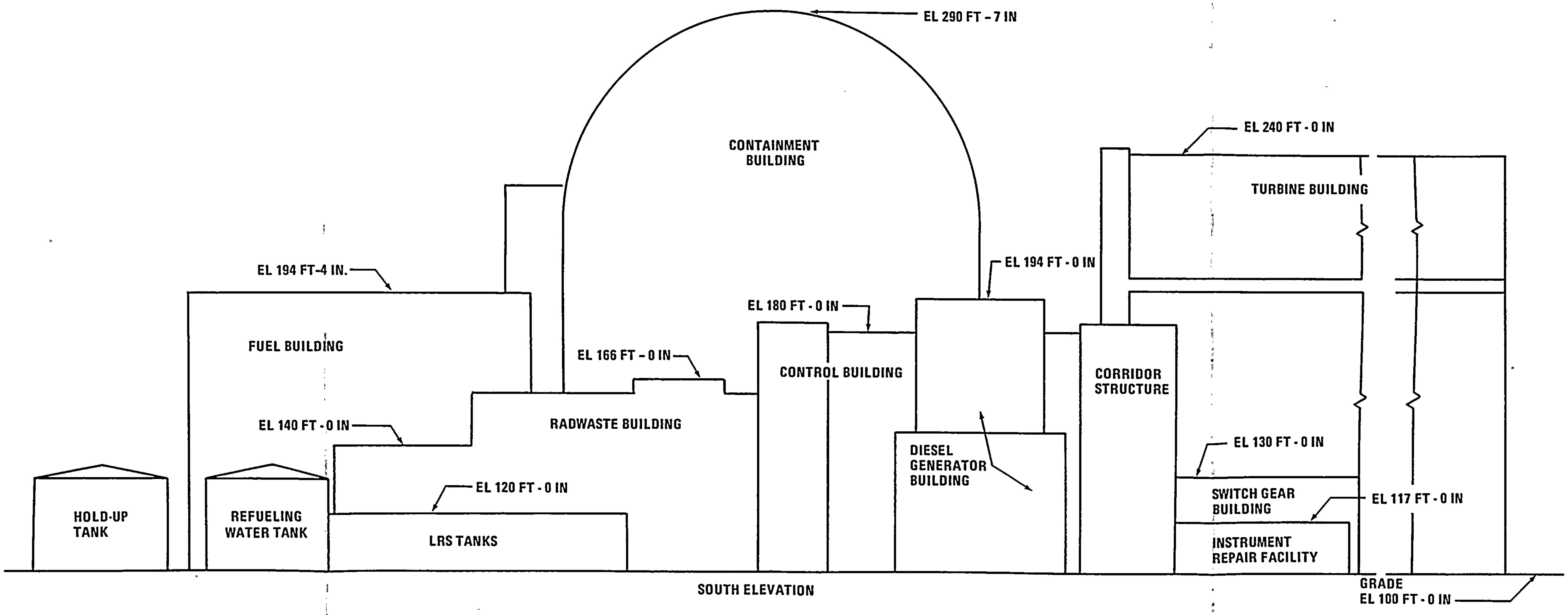
TYPICAL POWER BLOCK

Figure 3.1-7



SOUTH ELEVATION

SCALE 1/32" = 1'-0"

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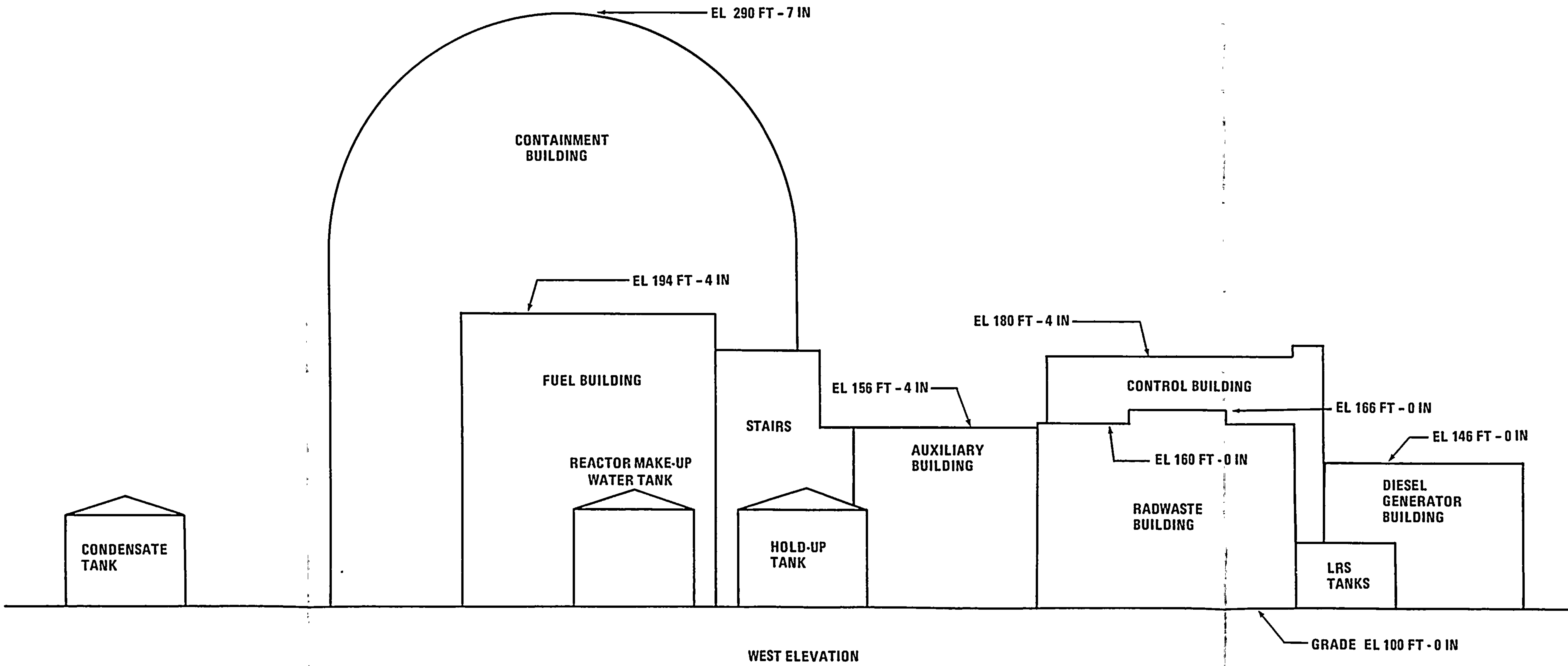
SOUTH ELEVATION
OF TYPICAL UNIT

Figure 3.1-8



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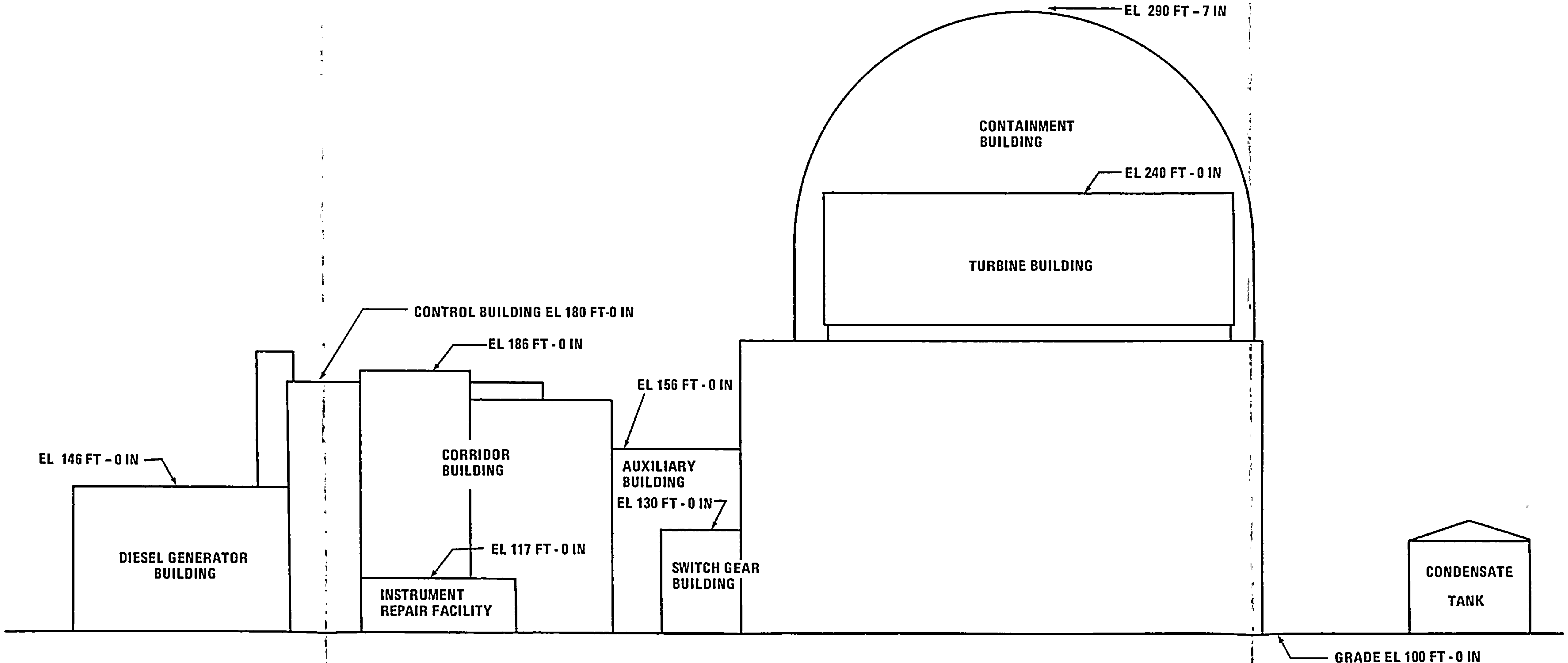
WEST ELEVATION OF
TYPICAL UNIT

Figure 3.1-9



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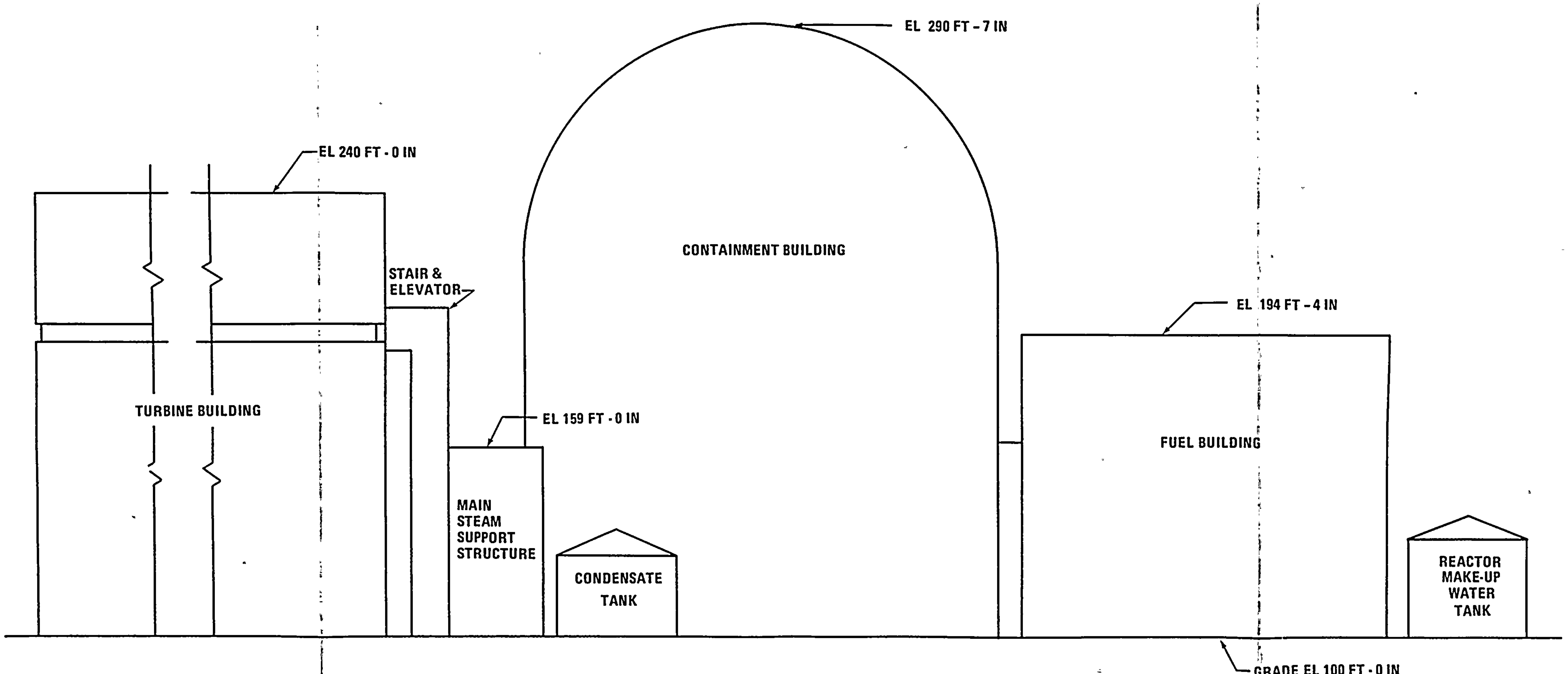
EAST ELEVATION
OF TYPICAL UNIT

Figure 3.1-10



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NORTH ELEVATION
OF TYPICAL UNIT

Figure 3.1-11

3.2 REACTOR AND STEAM-ELECTRIC SYSTEM

Design parameters of the reactor and steam-electric system have not changed significantly since the ER-CP. This section summarizes design details.

Each PVNGS unit contains a nuclear steam supply system (NSSS) powered by a light-water moderated and cooled, pressurized water reactor (PWR). Each reactor is fueled with 102,780 kg of slightly enriched uranium in the form of sintered uranium dioxide (UO_2) pellets clad in 56,876 zircalloy-4 fuel rods.

Four-fingered and 12-fingered control element assemblies (CEAs) are used in the core. The CEAs provide short-term reactivity control under normal and anticipated transient conditions.

Each NSSS has a rated core thermal power of 3800 MWt. The reactor coolant pumps add 17 MWt of heat for an NSSS power level of 3817 MWt. The turbine-generator gross generator output corresponding to 3817 MW is 1304 MWe at design condenser back pressure of 3.5 in. Hg absolute. The nominal net output of each PVNGS unit is 1270 MWe. Each turbine-generator consists of a tandem compound type, six flow exhaust, 1800 r/min, steam turbine with 43-inch last stage buckets (blades). The turbine-generator is hydrogen cooled with a 0.9 power factor and operates at 24 kV, 3-phase and 60 Hz.

The relationship between the station gross heat rate and unit load is summarized in table 3.2-1.

The condenser is a three shell, single pass, multipressure, reheat condenser. The circulating water is divided into two parallel paths for a total design flow of 560,000 gal/min. The heat rejection rate is 8.9×10^9 Btu/h with a temperature rise of 32.1F. The titanium tubes (25,426 per shell) provide a total effective surface area of 1,123,000 ft^2.

The design lifetime of each PVNGS unit is 40 years.

Table 3.2-1

STATION GROSS HEAT RATE VS. POWER LEVEL

Power	Station Gross Heat Rate[a] (Btu/kWh)
60%	11,014
80%	10,320
100% (3817 MWt)	9,987
Stretch (Valves Wide Open)	9,998

a. At design condenser backpressure of 3.5 in. Hg absolute.

3.3 PLANT WATER USE

Parameters of plant water use have not changed substantially from those presented in ER-CP Section 3.3 and the FES. This section provides additional information and summarizes PVNGS water use.

Figure 3.3-1 presents a schematic flow diagram of the basic plant water use and lists the expected maximum, average, minimum, and shutdown flow rates of those water systems that require makeup and/or generate waste.

3.3.1 INFLUENT WATER SOURCES

There are two influent water sources to PVNGS. The primary plant water source is waste water effluent from the City of Phoenix 91st Avenue Sewage Treatment Plant. The processed effluent is delivered to the onsite water reclamation plant via pipeline from the 91st Avenue Sewage Treatment Plant. It is further treated and then stored in the onsite reservoir. No surface diversion occurs. The secondary plant water source is from on-site wells that supply water to the domestic water system. The two onsite wells are shown in figure 3.1-4. The wells are located wholly within the site boundary. No well water will be used offsite. The effect of well water withdrawal on the local groundwater hydrology is discussed in section 5.6. The domestic water system supplies potable water to each generating unit for domestic, utility, and air conditioning services.

The total annual makeup water requirement for PVNGS from the city of Phoenix is estimated at 21,350 acre-feet per year per unit. The average well water requirement is approximately 1300 acre-feet per year for all PVNGS units.

The water reclamation plant and the domestic water system are described in section 3.6.

3.3.2 PLANT WATER USES

3.3.2.1 Circulating Water System

Each unit's circulating water system removes waste heat resulting from normal operation of the unit and rejects it to the atmosphere via the three cooling towers in each system. Heat rejection is accomplished by the evaporation of a portion of the circulating water flow. To maintain the chemical concentration of circulating water at or below 15 times that of makeup water (15 cycles of concentration), a quantity of water, called blowdown, must be discharged from the system. In addition to evaporation and blowdown losses, a small amount of water in the form of entrained droplets (drift) is carried away in the cooling tower air stream. Makeup water to replace these losses in each unit is drawn from the reservoir.

During the period when the reactor is shut down for refueling and maintenance, the circulating water system is not used and makeup water is not required.

3.3.2.2 Essential Spray Pond System

Each generating unit has two spray ponds that provide the ultimate heat sink for cooling the auxiliary systems required for reactor shutdown. The domestic water system provides makeup water to the essential spray ponds. The spray ponds are normally in use only during a reactor shutdown. Hence, makeup from the domestic water system during normal operation is only required to replace water lost by natural surface evaporation and periodic blowdown to the circulating water system. During a reactor shutdown, makeup requirements to the spray ponds are increased because of the increased evaporation to dissipate the imposed heat load and the drift associated with the operation of the ultimate heat sink sprays.

3.3.2.3 Domestic and Demineralized Water Systems

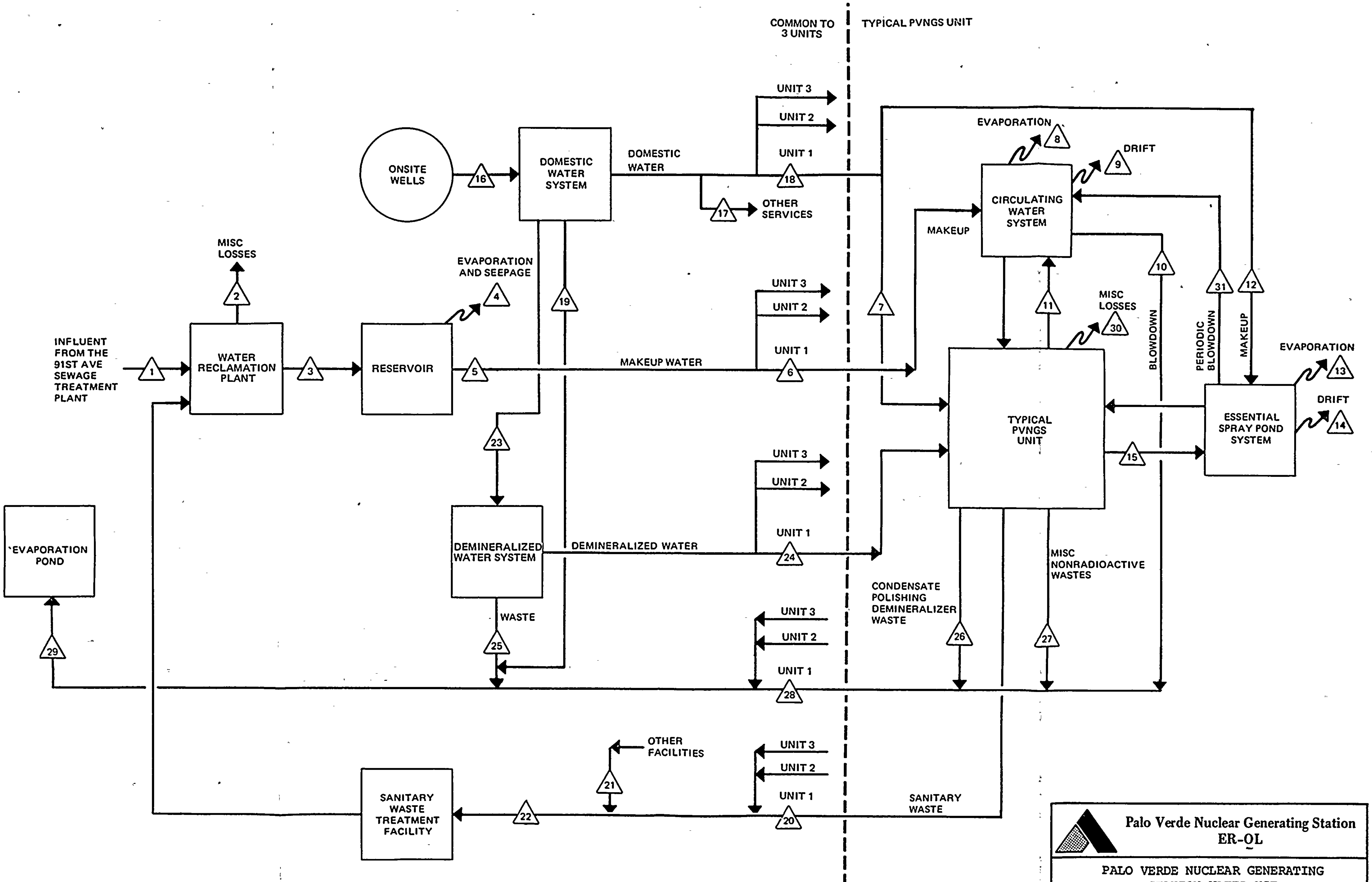
The onsite wells provide makeup to the domestic water system where it is processed in a reverse osmosis system to produce potable water. The product of the reverse osmosis system is used as makeup to the demineralized water system. Demineralized water is supplied to each unit.

3.3.3 PLANT WASTE WATER

The major source of waste water is blowdown from the circulating water system of each unit. Additional waste water is produced from sources such as: Nonradioactive demineralizer regenerants, demineralized water wastes, domestic water wastes and miscellaneous (e.g., floor drains) nonradioactive wastes. This wastewater is directed to the onsite evaporation ponds without requiring any offsite discharges.

Sanitary waste from each unit is kept separate from other plant wastes and is directed to the shared, onsite sanitary waste treatment facility. Liquid effluent from the sanitary waste treatment facility is returned to the water reclamation plant for reuse.

Treatment processes for the circulating water, domestic water, demineralized water, and condensate polishing systems, including chemical consumption, are discussed in section 3.6.



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PALO VERDE NUCLEAR GENERATING STATION WATER USE
(Sheet 1 of 4)

Figure 3.3-1

Plant Operating Conditions		I Maximum Flow Rate (gal/min)(a)(f)	II Average Flow Rate (gal/min)(b)(f)	III Minimum Flow Rate (gal/min)(c)(f)	IV Shutdown Flow Rate (gal/min)(d)(f)
Node Point	Description				
1	Influent from City of Phoenix 91st Avenue sewage treatment plant	59,300	39,700	7,700	31,000
2	Miscellaneous pipeline and reclamation plant losses	90	70	60	70
3	Water reclamation plant effluent	59,200	39,600	7,300	31,100
4	Reservoir evaporation and seepage	280	180	90	180
5	Reservoir discharge	59,000	39,500	7,600	30,800
6	Total per unit makeup water	19,700	13,200	2,500	0(e)
7	Domestic water to power block	230	50	20	230
8	Circulating water system evaporation	18,300	12,300	2,400	0
9	Circulating water system drift	26	24	26	0
10	Circulating water system blowdown	1,300	830	150	0
11	Circulating water system circulating flow	587,000	587,000	587,000	0
12	Essential spray pond system makeup	40	32	32	135
13	Essential spray pond system evaporation	40	8	8	108
14	Essential spray pond system drift	0	0	0	27

a. Three units at valves wide open (VWO) and design ambient conditions, with one unit at maximum condensate polisher flow
b. Three units at 95 percent output and annual average ambient conditions and a one month shutdown for each unit for refueling.
c. Three units at auxiliary load and annual average ambient conditions.
d. Two units at VWO and annual average ambient conditions with one unit shutdown for refueling.
e. Shutdown unit only, refer to column II for average flows for the other units.
f. Flow rates may not balance due to round off.

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PALO VERDE NUCLEAR GENERATING STATION WATER USE
(Sheet 2 of 4)

Figure 3.3-1

Plant Operating Conditions		I Maximum Flow Rate (gal/min) (a)(f)	II Average Flow Rate (gal/min) (b)(f)	III Minimum Flow Rate (gal/min) (c)(f)	IV Shutdown Flow Rate (gal/min) (d)(f)
Node Point	Description				
15	Essential spray pond system circulating flow	0	0	0	16,900 (e)
16	Onsite wells output	1,700	790	500	1,100
17	Domestic water to common facilities	60	10	10	10
18	Per unit domestic water comsumption	270	85	52	365 (e)
19	Domestic water system waste	340	160	100	210
20	Per unit sanitary waste	2	2	2	2 (e)
21	Sanitary waste from common facilities	4	4	4	4
22	Total plant sanitary waste to water reclamation plant	10	10	10	10
23	Influent to demineralized water system from domestic water system	490	370	240	300
24	Per unit demineralized water consumption	230	120	77	50 (e)
25	Demineralized water system waste	30	16	11	13
26	Condensate polishing demineralizer system waste	160	40	0	0
27	Miscellaneous nonradioactive plant wastes	22	12	12	17
28	Total per unit wastewater flow without sanitary waste	1,500	880	160	17 (e)

Palo Verde Nuclear Generating Station
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PALO VERDE NUCLEAR GENERATING STATION WATER USE
(Sheet 3 of 4)

Figure 3.3-1

Plant Operating Conditions		I Maximum Flow Rate (gal/min) (a)(f)	II Average Flow Rate (gal/min) (b)(f)	III Minimum Flow Rate (gal/min) (c)(f)	IV Shutdown Flow Rate (gal/min) (d)(f)
Node Point	Description				
29	Total plant waste to evaporation pond	4,300	2,800	590	2,400
30	Miscellaneous evaporative and in-plant losses	280	120	80	260
31	Periodic essential spray pond system blowdown	intermittent	24	24	0

Palo Verde Nuclear Generating Station
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PALC VERDE NUCLEAR GENERATING STATION WATER USE
(Sheet 4 of 4)

Figure 3.3-1

3.4 HEAT DISSIPATION SYSTEM

Information presented in ER-CP Section 3.4 and the FES remains valid with minor changes except for the description of the cooling towers. This section summarizes and updates that information. In addition, information concerning the circular mechanical draft cooling towers utilized for PVNGS is presented.

The system that removes and rejects waste heat from each unit during normal power generation is the circulating water system. During a plant shutdown, waste heat is removed and rejected by one of two loops of the essential spray pond system. Each of the two redundant loops is capable of providing the cooling required for safe reactor shutdown under normal or accident conditions.

A generalized flow diagram of the major heat dissipation systems is presented in figure 3.4-1 and the arrangement of the heat dissipation facilities on the site is shown in figure 3.1-4.

3.4.1 CIRCULATING WATER SYSTEM

Of the total amount of thermal energy produced by each nuclear steam supply system, approximately one-third is converted into electrical energy. The unconverted thermal energy is transferred via the main condenser to the circulating water system and then to the round, mechanical draft cooling towers where it is dissipated to the atmosphere. The circulating water system consists of the main condenser, cooling towers, circulating water pumps, a chemical injection system, and a makeup and blowdown system. The system diagram for the circulating water system is shown in figure 3.4-2.

3.4.1.1 Main Condenser

The condenser removes approximately 8900 million Btu per hour at 100% power from the turbine exhaust steam. The circulating

water flow through the main condenser is 560,000 gallons per minute at 87.3F design with a temperature rise of 32.1F.

3.4.1.2 Circulating Water Pumps

Circulating water is pumped through the main condenser by four 25% capacity, vertical, wet-pit pumps with a capacity of approximately 140,000 gallons per minute each at approximately 103 feet total dynamic head (tdh).

3.4.1.3 Plant Cooling Water Pumps

Plant cooling water is pumped through the turbine, the condenser vacuum pump seal coolers, and the nuclear cooling water system heat exchangers by two 100% capacity, vertical, wet-pit pumps with a capacity of approximately 29,000 gallons per minute each at approximately 110 feet total dynamic head. The plant cooling water system removes approximately 191 million Btu/h from the two closed-loop cooling water systems and about 4 million Btu/h from the condenser vacuum pump seal water cooler with a temperature rise of approximately 15F.

3.4.1.4 Cooling Towers

The primary heat dissipation system for PVNGS uses round mechanical draft cooling towers. Table 3.4-1 presents the design characteristics of the cooling tower system. The cooling towers dissipate the circulating water system and plant cooling water system heat loads, a design total of approximately 9250 million Btu per hour by cooling approximately 590,000 gallons per minute of water 32F. At the design wet bulb temperature of 75F, the cooling towers cool the circulating water from 118.8F to 87.3F. Figures 3.4-3 and 3.4-4 present curves of design cooling tower performance, cold water temperature versus wet bulb temperature. Figures 3.4-5 and 3.4-6 present evaporation curves. Design cooling tower discharge air temperature is presented in figure 3.4-7.

Table 3.4-1

DESIGN CHARACTERISTICS OF ROUND MECHANICAL DRAFT COOLING TOWER SYSTEM[a]

PVNGS nominal net output, MWe	1270
Tower heat rejection rate, Btu/h	9.25×10^9
Circulating water flow rate, gal/min	587,000
Air flow rate, ft^3/min	64.4×10^6
Exit air temperature, °F	104
Exit air relative humidity, percent	90
Dry bulb temperature, °F	116
Wet bulb temperature, °F	75
Circulating water hot water temperature, °F	118.8
Circulating water cold water temperature, °F	87.3
Circulating water approach to wet bulb temperature, °F	12.3
Cycles of concentration of circulating water	15
Drift loss, percent of circulating water flow rate	0.0044
Number of towers	3
Number of cells per tower	1
Base diameter of tower, ft	303
Exit air discharge height, ft	64
Number of fans, total	48
Horsepower per fan, hp	200
Exit diameter of fan, ft	36

a. All data on a per unit basis at design ambient conditions.

There are three cooling towers per unit. Each tower is approximately 303 feet in base diameter and 64 feet high with 16 fans as shown in figure 3.4-8.

3.4.1.5 Chemical Injection System

The chemical injection system adds chlorine, sulfuric acid, a foam control agent, and a dispersant to the circulating water system. Chlorine is added as sodium hypochlorite to control biological growth, sulfuric acid is added to reduce pH and control corrosion and scaling from calcium carbonate, and the dispersant is added to inhibit scaling of the heat exchanger surfaces. This system is described in more detail in section 3.6.

3.4.1.6 Makeup Water System

Makeup water is treated in the onsite water reclamation plant prior to use. Refer to section 3.6 for a discussion of the water reclamation plant. Makeup to the circulating water system as shown in table 3.4-1 is required as a result of three types of water losses: cooling tower evaporation, blowdown, and drift. Table 3.4-2 presents a summary of the expected average per unit monthly cooling tower evaporation, drift, and total consumptive loss. Table 3.4-3 shows the cumulative distribution of the daily wet bulb temperatures compiled on month-by-month basis.

3.4.1.7 Blowdown System

Blowdown from the circulating water system is directed to the evaporation ponds. As noted in section 3.6, the water quality of cooling tower blowdown is significantly lower than that of makeup due to the 15 cycles of concentration in the circulating water.

Table 3.4-2

ANTICIPATED MONTHLY EVAPORATION VARIATION (1 of 2)

(EACH UNIT)

Month	Temp (F)	RH (%)	Evaporation (GPM)	Blowdown (GPM)	Makeup (GPM)	Circulating Water Temperature (F)
			25% HEAT LOAD			
January	50	51	3820	247	4090	55
February	53	35	4280	280	4590	54
March	60	43	4540	298	4860	60
April	63	28	5050	335	5410	59
May	77	21	6130	412	6570	64
June	88	17	6700	474	7200	68
July	90	35	6350	427	6800	76
August	89	29	6540	441	7010	73
September	84	30	6230	419	6680	71
October	72	35	5400	360	5790	65
November	57	47	4290	280	4600	58
December	49	47	3820	247	4090	54
			50% HEAT LOAD			
January	50	51	6590	445	7060	62
February	53	35	7010	475	7510	61
March	60	43	7370	501	7900	66
April	63	28	7850	535	8410	65
May	77	21	9030	619	9680	70
June	88	17	9970	686	10680	73
July	90	35	9480	651	10160	79
August	89	29	9620	661	10310	77
September	84	30	9260	635	9920	75
October	72	35	8330	569	8930	70
November	57	47	7110	482	7620	65
December	49	47	6570	443	7040	61

Table 3.4-2

ANTICIPATED MONTHLY EVAPORATION VARIATION (2 of 2)

(EACH UNIT)

Month	Temp (F)	RH (%)	Evaporation (GPM)	Blowdown (GPM)	Makeup (GPM)	Circulating Water Temperature (F)
			75% HEAT LOAD			
January	50	51	9420	647	10090	67
February	53	35	9820	676	10520	67
March	60	43	10260	707	10990	70
April	63	28	10710	739	11480	70
May	77	21	11960	828	12810	74
June	88	17	11950	899	12880	77
July	90	35	12580	873	13480	82
August	89	29	12680	880	13590	80
September	84	30	12280	852	13160	78
October	72	35	11280	780	12090	74
November	57	47	9990	687	10700	70
December	49	47	9380	644	10050	66
			100% HEAT LOAD			
January	50	51	12090	838	12950	71
February	53	35	12490	866	13380	70
March	60	43	12980	901	13910	74
April	63	28	13410	932	14370	73
May	77	21	14710	1025	15760	77
June	88	17	15730	1098	16850	79
July	90	35	15450	1078	16550	84
August	89	29	15510	1082	16620	82
September	84	30	15100	1053	16180	80
October	72	35	14050	978	15050	77
November	57	47	12700	881	13610	73
December	49	47	12040	835	12900	70

Table 3.4-3

DAILY WET-BULB CUMULATIVE DISTRIBUTION CHART (1 OF 4)

CUMMULATIVE TOTALS 1948-1973 (BY MONTH)

Ambient Wet Bulb Temp (F)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0
16	1	0	0	0	0	0	0	0	0	0	0	0
17	2	0	0	0	0	0	0	0	0	0	0	0
18	6	0	0	0	0	0	0	0	0	0	0	0
19	10	0	0	0	0	0	0	0	0	0	0	0
20	37	0	0	0	0	0	0	0	0	0	0	0
21	36	1	0	0	0	0	0	0	0	0	0	0
22	35	6	0	0	0	0	0	0	0	0	0	3
23	60	5	0	0	0	0	0	0	0	0	0	13
24	65	16	0	0	0	0	0	0	0	0	3	21
25	80	41	3	0	0	0	0	0	0	0	6	35
26	93	42	9	0	0	0	0	0	0	0	8	49
27	128	79	2	0	0	0	0	0	0	0	8	63
28	167	82	14	0	0	0	0	0	0	0	11	107

Table 3.4-3

DAILY WET-BULB CUMULATIVE DISTRIBUTION CHART (2 OF 4)

CUMMULATIVE TOTALS 1948-1973 (BY MONTH)

Ambient Wet Bulb Temp (F)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
29	257	111	24	0	0	0	0	0	0	3	28	131
30	266	155	45	0	0	0	0	0	0	0	39	203
31	332	165	48	0	0	0	0	0	0	0	68	241
32	399	212	81	0	0	0	0	0	0	3	71	279
33	424	259	89	3	0	0	0	0	0	0	89	392
34	506	321	160	14	3	0	0	0	0	6	139	512
35	553	364	202	32	6	0	0	0	0	11	204	584
36	659	451	220	46	3	0	0	0	0	14	280	636
37	692	446	342	72	8	0	0	0	0	16	241	789
38	789	545	384	111	9	0	0	0	0	30	353	904
39	842	617	473	152	27	0	0	0	0	50	433	900
40	862	758	541	236	25	0	0	0	0	69	555	952
41	924	851	709	265	75	2	0	0	0	76	594	896
42	891	849	767	366	81	2	0	0	0	130	715	983
43	967	864	853	432	114	6	0	0	0	144	768	1039
44	980	909	977	566	146	10	0	0	0	227	821	1049
45	1017	886	1004	663	237	30	0	0	7	279	868	973
46	1003	881	1211	797	371	56	0	0	11	419	1001	956
47	1023	957	1171	843	416	87	0	0	24	444	1071	937
48	922	931	1187	973	548	150	0	0	34	539	1033	908
49	847	896	1138	1159	684	132	0	1	57	590	1070	878
50	733	927	1090	1084	745	231	1	6	102	615	992	781
51	675	754	1079	1157	818	330	5	7	131	718	947	736
52	606	720	1048	1064	1051	377	8	8	150	837	880	647
53	487	664	1065	1232	1109	476	29	8	213	876	913	512
54	381 968	491 1875	880 3408	1278 7450	1135 12,868	540 16,830	39 19,295	13 19,290	282 17,991	957 13,248	866 4,511	376 1143 75F Circ
55	200 (1.2)	447 (1.6)	763 (4.2)	1140 (9.6)	1196 (16.0)	631 (21.6)	59 (23.9)	33 (23.9)	378 (23.1)	1039 (16.4)	831 (5.8)	311 (1.4) Water Temp
56	131	348	596	1074	1248	757	82	44	360	1000	772	191

Table 3.4-3

DAILY WET-BULB CUMULATIVE DISTRIBUTION CHART (3 OF 4)

CUMMULATIVE TOTALS 1948-1973 (BY MONTH)

Ambient Wet Bulb Temp (F)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
57	89	211	471	1041	1237	860	108	62	495	1126	697	102
58	54	149	320	909	1340	882	122	100	550	1122	497	71
59	59	112	196	686	1262	1056	163	116	696	1245	325	52
60	38	61	110	529	1286	1052	194	184	765	1124	220	19
61	13	32	42	400	1088	1122	238	211	833	1057	133	16
62	3	21	28	218	971	1225	250	284	965	913	92	2
63	0	2	2	125	705	1238	381	291	1078	819	46	3
64	0	1	0	41	542	1293	474	460	1183	790	20	0
65	0	0	0	7	405	1171	559	549	1156	589	8	0
66	0	0	0	2	228	1219	754	658	1182	443	3	0
67	0	0	0	0	120	958	1034	867	1230	334	0	0
68	0	0	0	0	55	803	1197	1168	1334	288	1	0
69	0	0	0	0	38	661	1572	1399	1220	193	0	0
70	0	0	0	0	9	526	2090	1967	1185	96	0	0
71	0	0	0	0	2	373	2298	2272	1067	57	0	0
72	0	0	0	0	0	248	2569	2643	841	27	0	0
73	0	0	0	0	1	126	2063	2171	590	15	0	0
74	0	0	0	0	0	50	1647	1793	348	5	0	0
75	0	0	0	0	0	23	873	1155	185	8	0	0
76	0	0	0	0	0	12	371	577	61	1	0	0
77	0	0	0	0	0	1	126	197	7	0	0	0
78	0	0	0	0	0	0	20	58	0	0	0	0
79	0	0	0	0	0	1	5	15	0	0	0	0
80	0	0	0	0	0	0	2	1	0	0	0	0
81	0	0	0	0	0	1	3	0	0	0	0	0
82	0	0	0	0	0	1	2	1	0	0	0	0
83	0	0	0	0	0	0	0	1	0	0	0	0
84	0	0	0	0	0	0	0	0	0	0	0	0

Table 3.4-3
DAILY WET-BULB CUMULATIVE DISTRIBUTION CHART (4 OF 4)

CUMMULATIVE TOTALS 1948-1973 (BY MONTH)

Ambient Wet Bulb Temp (F)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
85	0	0	0	0	0	0	0	0	0	0	0	0
86	0	0	0	0	0	0	0	0	0	0	0	0
87	0	0	0	0	0	0	0	0	0	0	0	0
88	0	0	0	0	0	0	0	0	0	0	0	0
89	0	0	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0
91	0	0	0	0	0	0	0	0	0	0	0	0
92	0	0	0	0	0	0	0	0	0	0	0	0
93	0	0	0	0	0	0	0	0	0	0	0	0
94	0	0	0	0	0	0	0	0	0	0	0	0
95	0	0	0	0	0	0	0	0	0	0	0	0
96	0	0	0	0	0	0	0	0	0	0	0	0
97	0	0	0	0	0	0	0	0	0	0	0	0
98	0	0	0	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0	0	0
Total	19,344	17,640	19,344	18,717	19,344	18,719	19,338	19,320	18,720	19,344	18,720	19,252
DS/MO	744	681.6	744	720	744	720	744	744	720	744	720	744

3.4.2 OTHER COOLING WATER SYSTEMS

Other major cooling water systems in PVNGS include

- Turbine cooling water system
- Nuclear cooling water system
- Essential spray pond system
- Essential cooling water system.

3.4.2.1 Turbine Cooling Water System

The turbine cooling water system is a closed-loop system that removes heat from turbine plant systems such as the main turbine lube oil system, gland steam packing exhauster system, generator hydrogen cooling system, stator cooling system, exciter air coolers, and other nonnuclear related systems. Approximately 80 million Btu per hour are rejected from this system to the plant cooling water system via either one of the two redundant turbine cooling water heat exchangers.

3.4.2.2 Nuclear Cooling Water System

The nuclear cooling water system is a closed-loop system that removes heat from normally operating, nuclear, nonsafety-related systems. Approximately 110 million Btu per hour are rejected from this system to the plant cooling water system via either one of the two redundant nuclear cooling water heat exchangers.

3.4.2.3 Essential Spray Pond System

The essential spray pond system, in conjunction with the essential cooling water system provides the cooling during a reactor shutdown. This system consists of two 100% redundant loops. The major equipment in each loop is one essential spray pond having a sprayed area of approximately 59,000 ft^2, one essential spray pond pump, and one essential cooling water heat exchanger. The system flow diagram is given in figure 3.4-9.

The two loops of the essential spray pond system are not used during normal power generation and are in operation only during reactor shutdown or diesel generator operation. Since each loop is completely redundant, only one loop is required to operate during normal reactor shutdown. During reactor shutdown the flow in each loop of the essential spray pond system is approximately 16,900 gallons per minute.

The spray ponds are rectangular, reinforced concrete, Seismic Category I basins. Each spray pond is provided with distribution piping and four spray headers, each header having 80 hollow cone type spray nozzles.

The pump structures are rectangular reinforced concrete sumps, each one an integral part of its respective pond. They provide a low point for the spray pond basin and serve as a wet pit intake for the pump. Each spray pond is 345 feet long, 172 feet wide and 15.5 feet deep with 2 feet of freeboard and a capacity of 6 x 10^6 gallons.

Each spray pond pump has a capacity of 16,900 gallons per minute. The water quality is given in table 3.4-4.

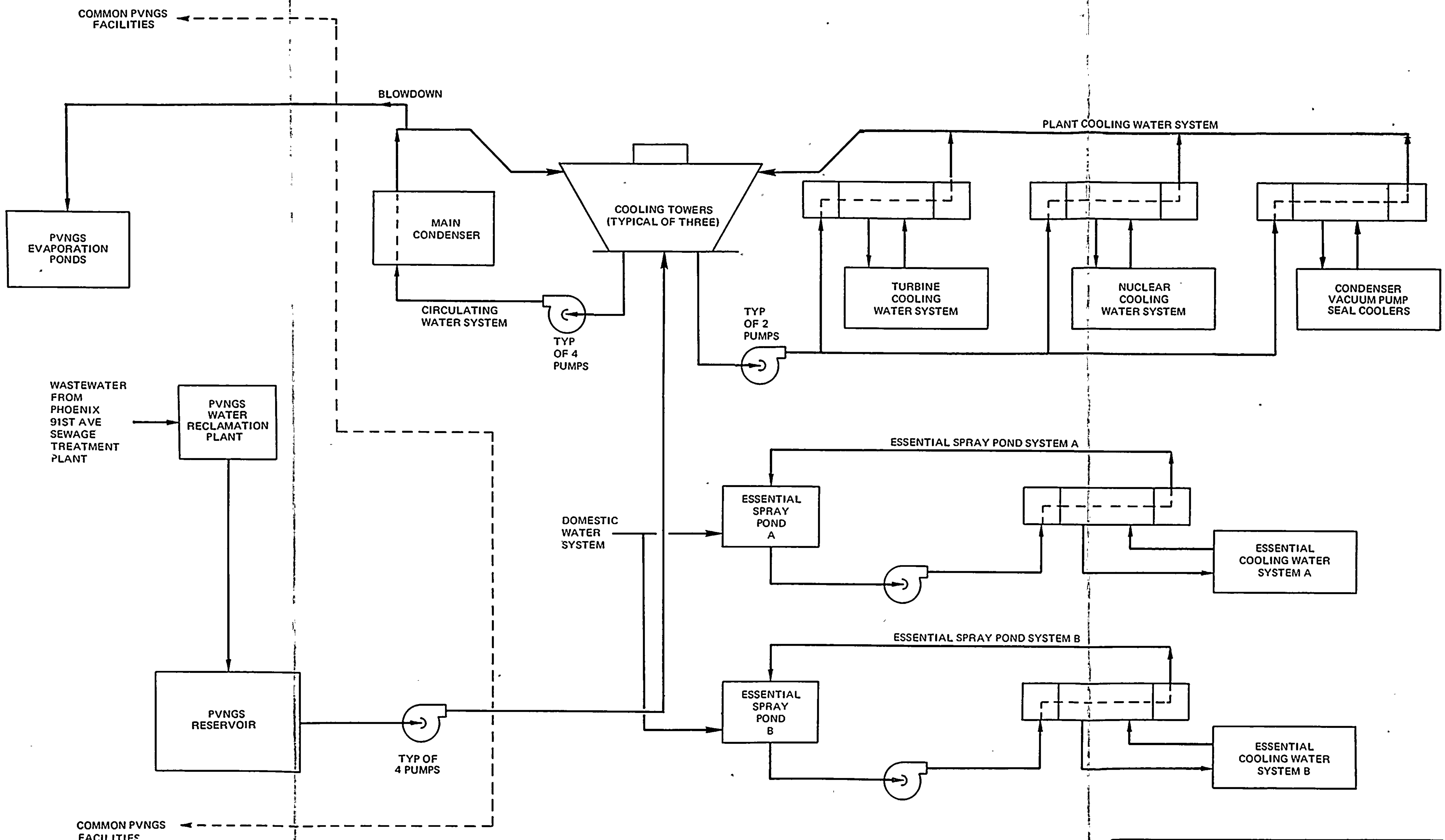
3.4.2.4 Essential Cooling Water System

The essential cooling water system (ECWS) is the closed-loop system that removes heat from the safety related auxiliary systems and rejects it to the essential spray pond system. The system consists of two separate, 100% capacity loops. Heat is rejected from each loop of this system to its respective loop in the essential spray pond system via the essential cooling water heat exchanger.

Table 3.4-4
ESSENTIAL SPRAY POND SYSTEM WATER QUALITY SPECIFICATION

Parameter	Normal Operation	Maximum Following 30 Days w/o Makeup
pH at 77F	7.8	7.5
Conductivity, (μmhos/cm)	650	4545
TDS (ppm)	357	2500
Chlorides, as $CaCO_3$ (ppm)	99	693
Fluorides, as $CaCO_3$ (ppm)	3	21

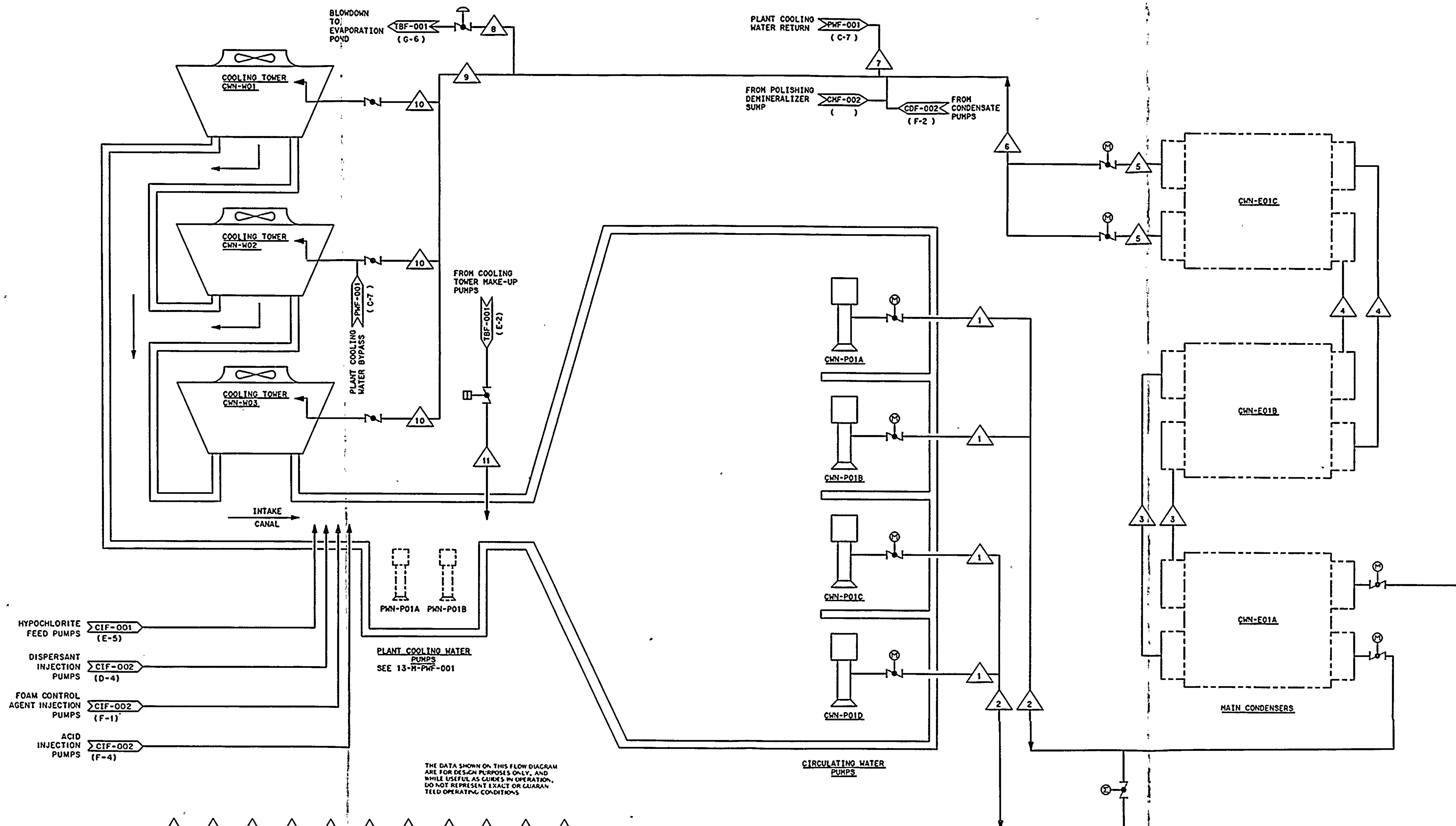
The ECWS is normally in service only during reactor shutdown or diesel generator operation. Since each loop is 100% redundant, only one loop is required to operate during a reactor shutdown. Under emergency conditions, however, both loops are activated along with both loops of the essential spray pond system to remove heat.



Palo Verde Nuclear Generating Station
ER-OL

GENERALIZED HEAT DISSIPATION SYSTEM FLOW DIAGRAM

Figure 3.4-1



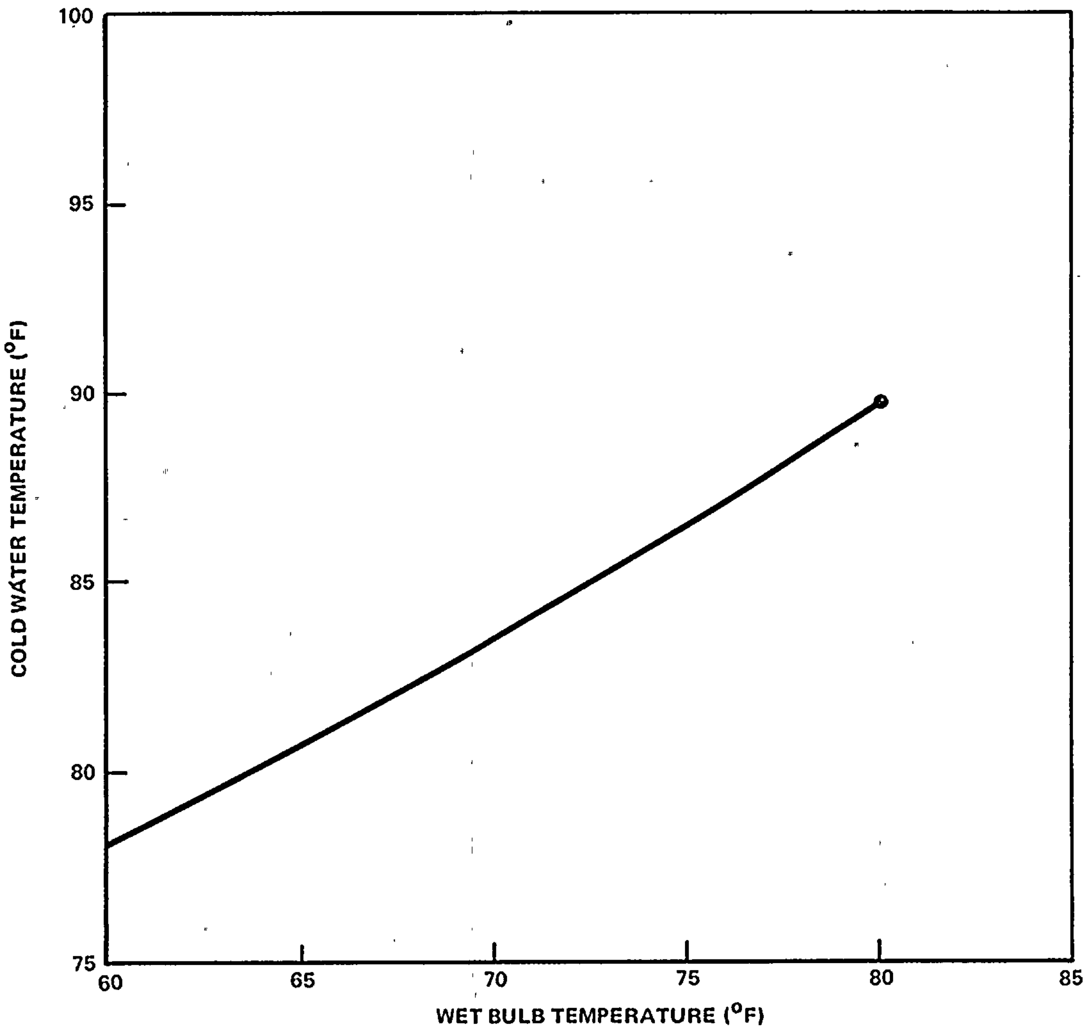
THE DATA SHOWN ON THIS FLOW DIAGRAM ARE FOR DESIGN PURPOSES ONLY, AND WHILE USEFUL AS GUIDES IN OPERATION, DO NOT REPRESENT EXACT OR GUARANTEED OPERATING CONDITIONS

MODE	PARAMETER		1	2	3	4	5	6	7	8	9	10	11
DESIGN	FLOW	(GPM)	140,000	280,000	280,000	280,000	280,000	560,000	29,000	1,300	587,000	196,400	20,000
	TEMPERATURE	(°F)	87	87	98	109	120	120	102	120	120	120	85
	PRESSURE	PSIG	80	80	80	80	80	80	80	80	80	80	5
NORMAL	FLOW	(GPM)	140,000	280,000	280,000	280,000	280,000	560,000	29,000	1,000	588,000	196,000	16,000
	TEMPERATURE	(°F)	75	75	86	97	108	108	90	108	108	108	75
	PRESSURE	PSIG	45	45	40	35	30	30	30	30	30	30	5

Palo Verde Nuclear Generating Station
ER-OL

BASIC FLOW DIAGRAM
CIRCULATING WATER SYSTEM

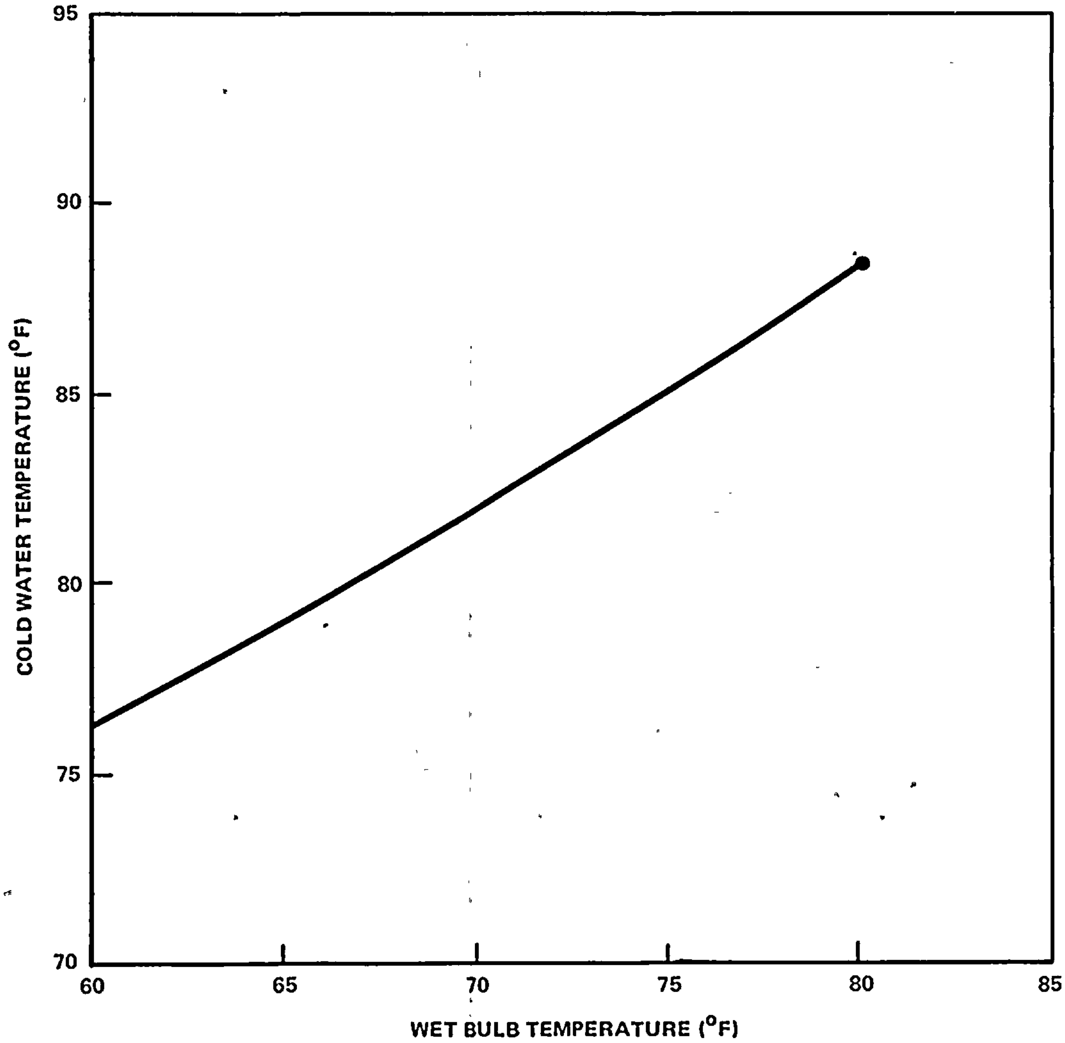
Figure 3.4-2



Palo Verde Nuclear Generating Station
ER-OL

DESIGN RANGE COOLING TOWER
PERFORMANCE CURVE
100% FLOW

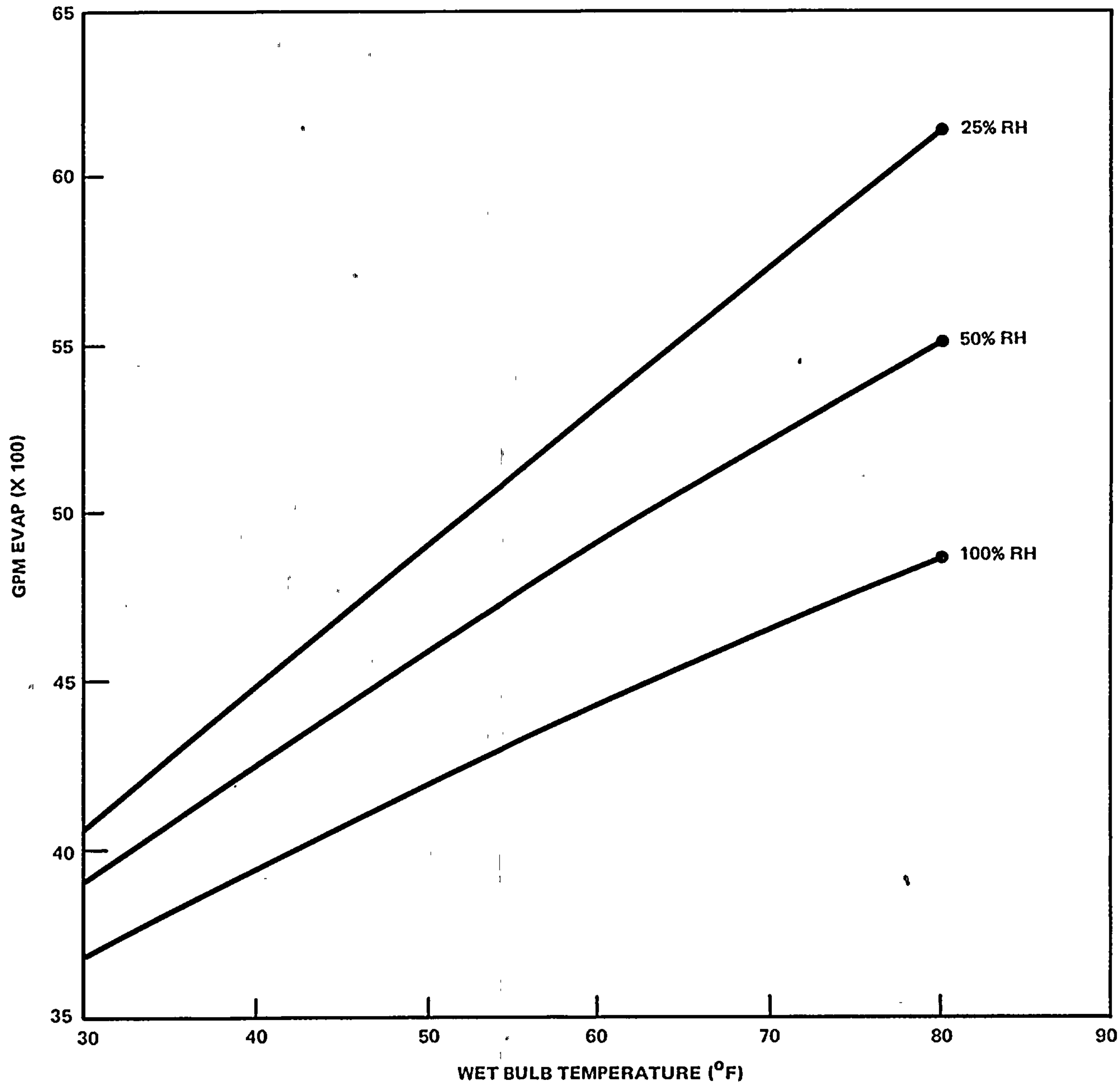
Figure 3.4-3



Palo Verde Nuclear Generating Station
ER-OL

DESIGN RANGE COOLING TOWER
PERFORMANCE CURVE
90% FLOW

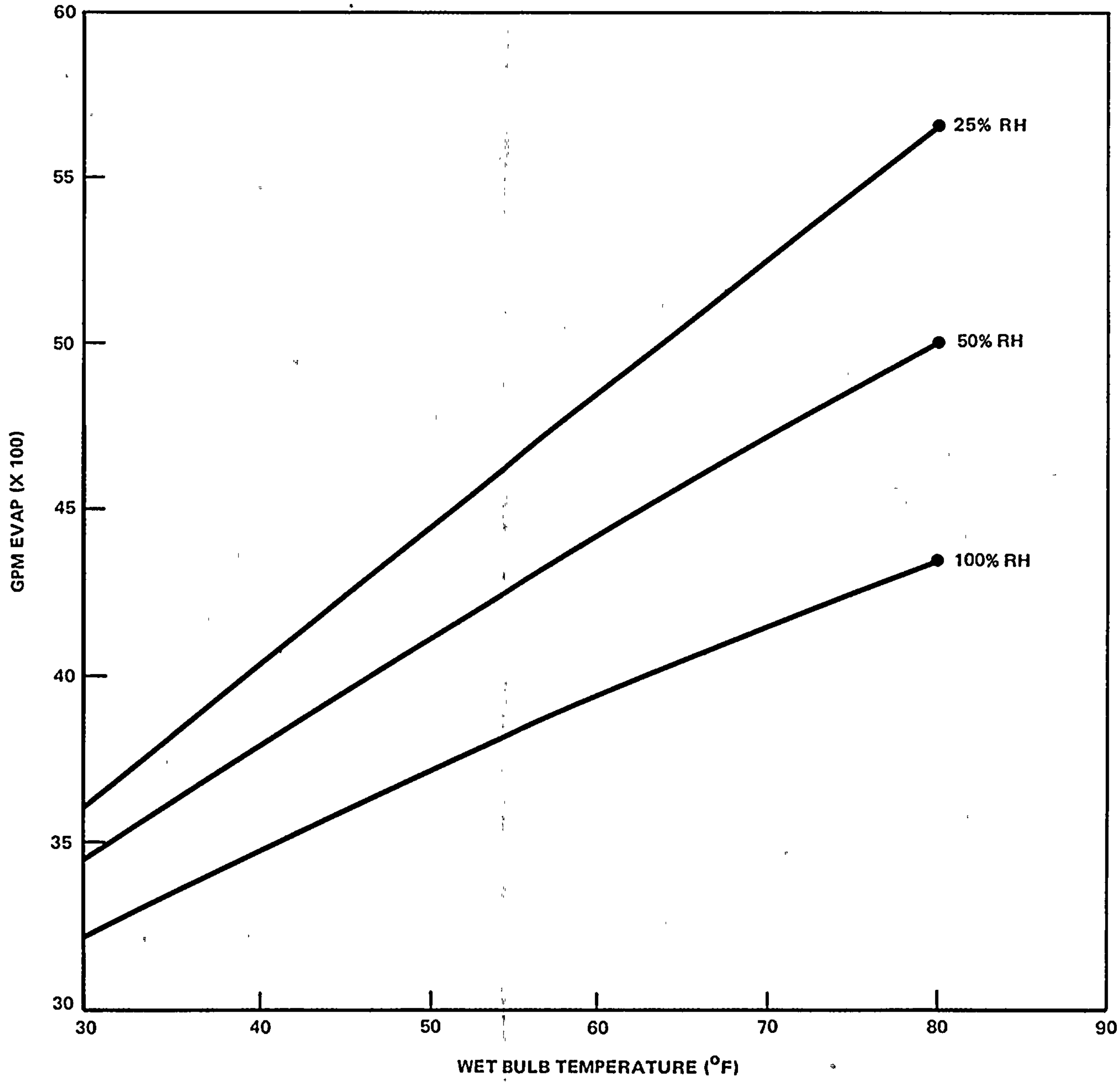
Figure 3.4-4



Palo Verde Nuclear Generating Station
ER-OL

COOLING TOWER
EVAPORATION CURVE
100% FLOW

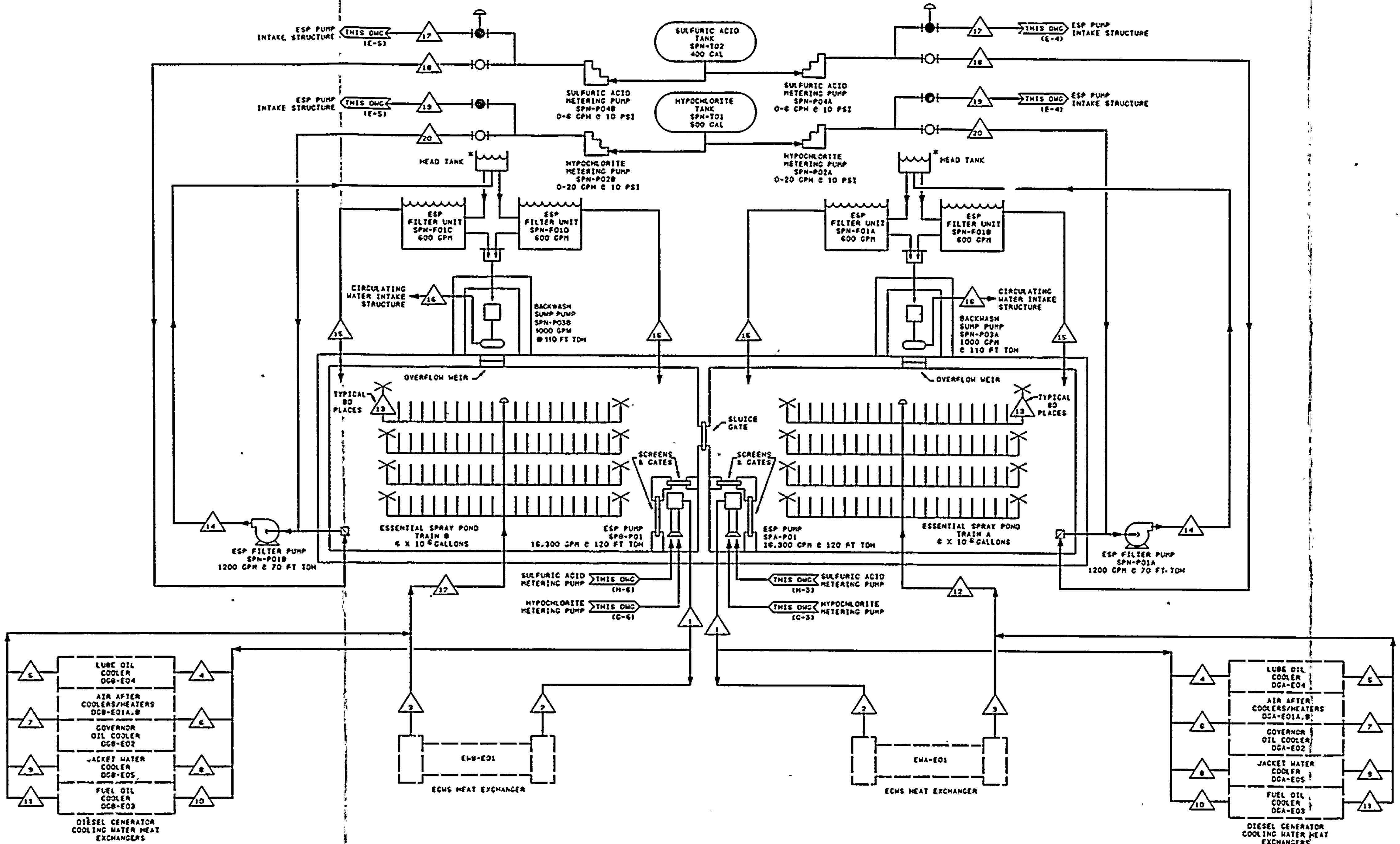
Figure 3.4-5



Palo Verde Nuclear Generating Station
ER-OL

COOLING TOWER
EVAPORATION CURVE
90% FLOW

Figure 3.4-6



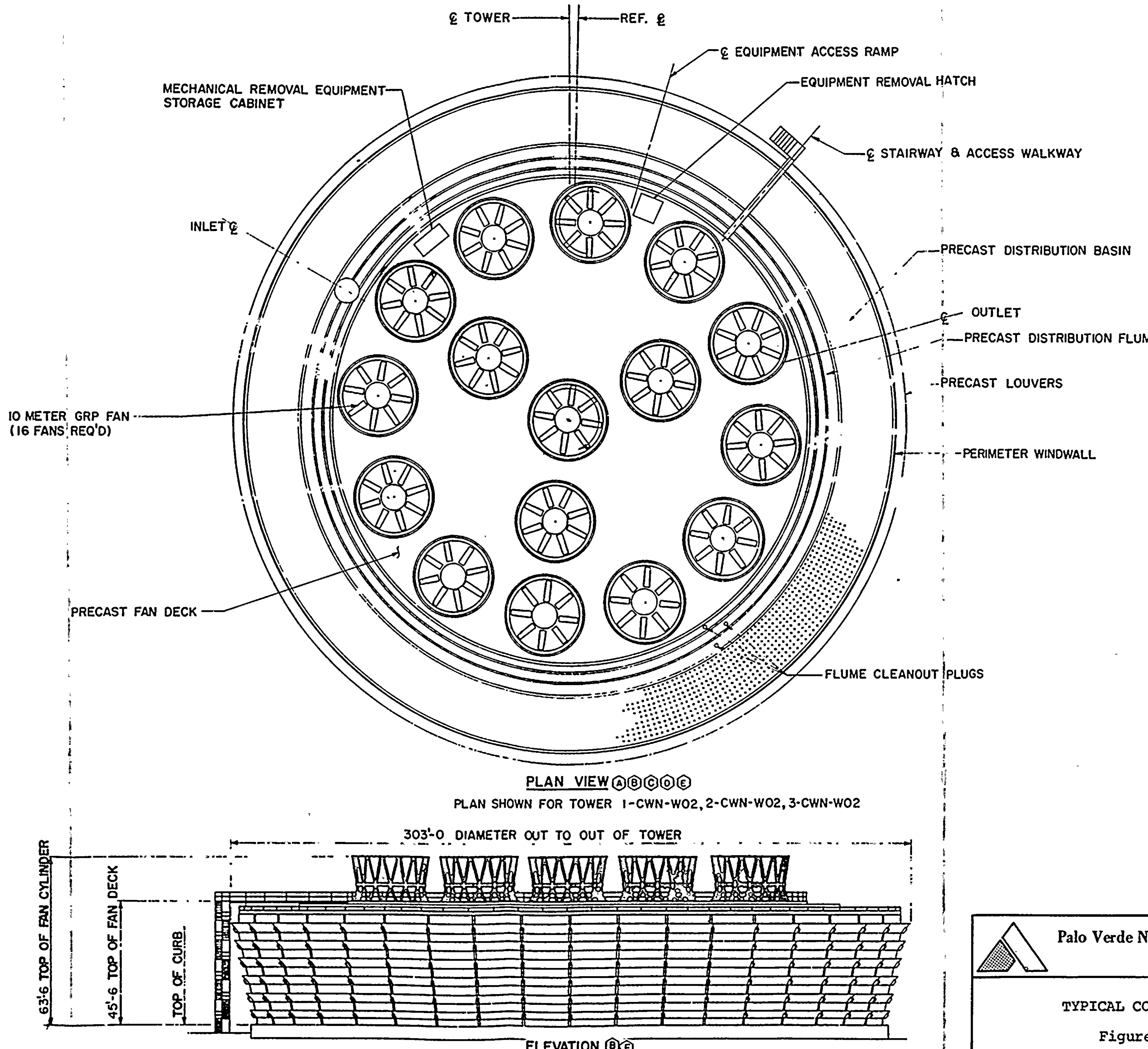
MODE	PARAMETER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
NORMAL SHUTDOWN @ 3.5 HRS	FLOW (GPM)	16900	14890	14890	406	406	560	560	1034	1034	10	10	16900	211	1200	600	1000	-	0-0.1	-	0-0.33
	TEMPERATURE (°F)	80	80	96	80	80	80	80	80	80	80	80	96	96	80	80	80	AMB	AMB	AMB	AMB
	PRESSURE (PSIG)	50	34	24	34	24	34	24	34	24	34	24	8	7	30	AMB	48	AMB	10	AMB	10
LOCA SHUTDOWN	FLOW (GPM)	16900	14890	14890	406	406	560	560	1034	1034	10	10	16900	211	-	-	-	-	-	-	-
	TEMPERATURE (°F)	110	110	135	110	122	110	126	110	121	110	121	133	133	AMB	AMB	AMB	AMB	AMB	AMB	AMB
	PRESSURE (PSIG)	50	34	24	34	24	34	24	34	24	34	24	8	7	AMB	AMB	AMB	AMB	AMB	AMB	AMB
FORCED SHUTDOWN WITH LOP	FLOW (GPM)	16900	14890	14890	406	406	560	560	1034	1034	10	10	16900	211	1200	600	1000	-	0-0.1	-	0-0.33
	TEMPERATURE (°F)	80	80	102	80	92	80	96	80	91	80	91	101	101	80	80	80	AMB	AMB	AMB	AMB
	PRESSURE (PSIG)	50	34	24	34	24	34	24	34	24	34	24	8	7	30	AMB	48	AMB	10	AMB	10
NORMAL SHUTDOWN @ 27.5 HRS	FLOW (GPM)	16900	14890	14890	406	406	560	560	1034	1034	10	10	16900	211	1200	600	1000	-	0-0.1	-	0-0.33
	TEMPERATURE (°F)	90	90	96	90	90	90	90	90	90	90	90	96	96	90	90	90	AMB	AMB	AMB	AMB
	PRESSURE (PSIG)	50	34	24	34	24	34	24	34	24	34	24	8	7	30	AMB	48	AMB	10	AMB	10

THE DATA SHOWN ON THIS FLOW DIAGRAM ARE FOR DESIGN PURPOSES ONLY, AND WHILE USEFUL AS GUIDES IN OPERATION, DO NOT REPRESENT EXACT OR GUARANTEED OPERATING CONDITIONS.

Palo Verde Nuclear Generating Station
ER-OL

BASIC FLOW DIAGRAM
ESSENTIAL SPRAY
POND SYSTEM

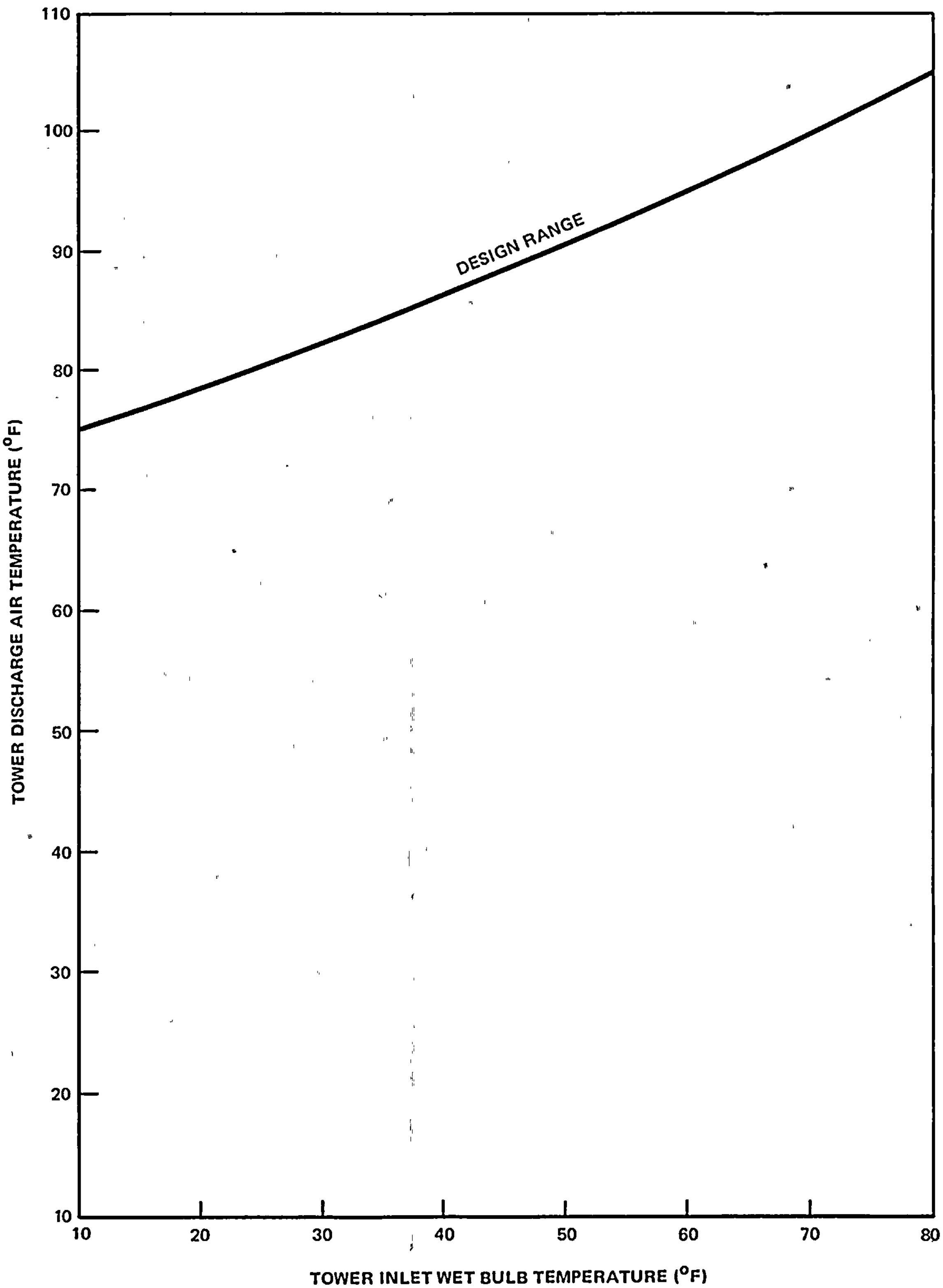
Figure 3.4-9



Palo Verde Nuclear Generating Station
ER-OL

TYPICAL COOLING TOWER

Figure 3.4-8



Palo Verde Nuclear Generating Station
ER-OL

COOLING TOWER DISCHARGE
AIR TEMPERATURE

Figure 3.4-7

3.5 RADWASTE SYSTEMS AND SOURCE TERM

Information presented in ER-CP Section 3.5 and the FES has been revised and updated to reflect changes in the radwaste system due to:

- General system evolution
- Implementation of a dry cleaning laundry facility instead of a wet laundry
- Use of ANSI-N237 source strengths instead of 0.25% failed fuel values as the expected case
- Issuance and implementation of NUREG-0017
- Implementation of a cement binder solid radwaste system
- Minor changes in other PVNGS systems and their operations, which determine the quantity and activity of wastes processed by the radwaste systems.

The radwaste systems are designed to safely collect, process, and dispose of potentially radioactive liquid, gaseous, and solid wastes. The radwaste systems include the following:

- Liquid Radwaste System (LRS)
- Gaseous Radwaste System (GRS)
- Solid Radwaste System (SRS)

A revised description of the radwaste system is presented in this section.

Radwaste systems are not shared between PVNGS units. The PVNGS radwaste systems provide processing for fission products and mobile neutron activation products (crud) produced in the primary coolant as a result of reactor operation. Although other systems will process/accumulate radioactivity during the course of operation, these systems will eventually transfer their radioactivity to the radwaste systems. Thus, the final cleanup and disposal of radioactivity is through the LRS, GRS, and SRS.

The radwaste systems are designed to limit the release of activity from PVNGS to ensure that releases as well as individual and population exposures to restricted and unrestricted areas are as low as is reasonably achievable, in conformance with the guidelines of 10CFR20 and 10CFR50 Appendix I.

The LRS processes radioactive and potentially radioactive liquid wastes. It recovers demineralized water for recycle and concentrates radioactive or chemical liquid wastes for processing by the SRS. There are no radioactive liquid releases from PVNGS.

The GRS collects and processes radioactive and potentially radioactive gaseous wastes prior to release from the plant. High activity waste gas and low activity aerated waste gas are processed separately. The high activity waste gas is collected and stored to permit the decay of short-lived radionuclides prior to release. The low activity gaseous wastes from the containment, auxiliary, and radwaste buildings are sent to ventilation exhaust systems for processing through charcoal and particulate filters, as appropriate, prior to release via the plant stack. Low activity gaseous waste from the condenser air removal system can be processed through charcoal and particulate filters prior to release. In addition, should the level of airborne activity in the fuel building require it, its gaseous waste may also be processed through charcoal and particulate filters prior to release.

The SRS solidifies and encapsulates spent resins, evaporator concentrates, laundry solutions, and spent filter cartridges. The SRS also compacts and packages low activity compressible solid wastes such as rags, paper, or plastics. On-site storage is provided for solid waste which allows decay prior to shipment from the site.

The process and effluent radiation monitors detect and record radioactivity in selected plant processes and in potentially radioactive gaseous effluents to ensure compliance with applicable regulations.

3.5.1 SOURCE TERM

Radioactivity sent to the radwaste systems during normal and anticipated operational occurrences include fission products, and mobile neutron activation products. Expected normal activities in the primary coolant are based on no gas stripping and on the ANSI-N237 model described in FSAR Section 11.1. Models used to determine tritium and nitrogen-16 activities are described in FSAR Section 11.1. Expected primary coolant activities are presented in table 3.5-1.

Other systems will process and/or accumulate radioactivity during operation. The secondary system will become slightly radioactive in the event of steam generator tube leaks. The chemical and volume control system (CVCS) lets down primary coolant to control water chemistry. The spent fuel pool cooling and cleanup system will process the primary coolant during refueling as well as the spent fuel pool water during operation. Radioactive samples and equipment drains and leakages are sent to the LRS which also receives radioactive ion exchanger regenerant wastes from the secondary system. The GRS receives radioactive waste gas from processing equipment of other systems. The SRS receives concentrated liquid waste and spent resins from radioactive systems.

3.5.1.1 Tritium Source Terms and Releases

The tritium concentrations in the plant are dependent on the production rate in the reactor coolant system, the losses due to radioactive decay, discharges from the plant, leakage, and

Table 3.5-1

EXPECTED PRIMARY COOLANT ACTIVITIES (μCi/g)

Radionuclide	Activity	Radionuclide	Activity
Kr-83M	2.1(-02)	Sr-89	3.5(-04)
Kr-85M	1.1(-01)	Sr-90	1.0(-05)
Kr-85	1.5(-01)	Sr-91	6.5(-04)
Kr-87	6.0(-02)	Zr-95	6.0(-05)
Kr-88	2.0(-01)	Nb-95	5.0(-05)
Kr-89	5.0(-03)	Tc-99M	4.8(-02)
Xe-131M	1.1(-01)	Ru-103	4.5(-05)
Xe-133M	2.0(-01)	Ru-106	1.0(-05)
Xe-133	1.8(+01)	Rh-103M	4.5(-05)
Xe-135M	1.3(-02)	Rh-106	1.0(-05)
Xe-135	3.5(-01)	Te-125M	2.9(-05)
Xe-137	9.0(-03)	Te-127M	2.8(-04)
Xe-138	4.4(-02)	Te-127	8.5(-04)
Br-83	4.8(-03)	Te-129M	1.4(-03)
Br-84	2.6(-03)	Te-129	1.6(-03)
Br-85	3.0(-04)	Te-131M	2.5(-03)
I-130	2.1(-03)	Te-131	1.1(-03)
I-131	2.7(-01)	Te-132	2.7(-02)
I-132	1.0(-01)	Ba-137M	1.6(-02)
I-133	3.8(-01)	Ba-140	2.2(-04)
I-134	4.7(-02)	La-140	1.5(-04)
I-135	1.9(-01)	Ce-141	7.0(-05)
Rb-86	8.5(-05)	Ce-143	4.0(-05)
Rb-88	2.0(-01)	Ce-144	3.3(-05)
Cs-134	2.5(-02)	Pr-143	5.0(-05)
Cs-136	1.3(-02)	Pr-144	3.3(-05)
Cs-137	1.8(-02)	Np-239	1.2(-03)
N-16	1.4(+02)	Cr-51	1.9(-03)
H-3	5.4(-01)	Mn-54	3.1(-04)
Y-90	1.2(-06)	Fe-55	1.6(-03)
Y-91M	3.6(-04)	Fe-59	1.0(-03)
Y-91	6.4(-05)	Co-58	1.6(-02)
Y-93	3.4(-05)	Co-60	2.0(-03)
Mo-99	8.2(-02)		

evaporation, and the transfer of water between plant systems. The detailed calculational model used to determine tritium activities in the plant is presented in FSAR Section 11.1.3. The tritium flow balance diagram used to develop the calculational model is shown on figure 3.5-1. Table 3.5-2 lists the expected annual tritium releases by pathway and release point. Tritiated liquid will not be released from PVNGS.

3.5.1.2 Secondary System Sources

The secondary system will become contaminated if steam generator tube leaks occur. Any such primary-to-secondary leakage is expected to be less than 100 lb/day. Equilibrium expected secondary system activities shown in table 3.5-3 have been determined using the calculational model presented in FSAR Section 11.1.8. The flow model used to determine the equilibrium activities is presented in FSAR Section 11.1.8.

3.5.1.3 Fuel Pool Source Terms

The primary source of activity in the refueling and spent fuel pools is demineralized and diluted primary coolant. During refueling, the primary coolant and the water in the refueling water tank are mixed. This diluted radioactive water then mixes with the water in the spent fuel pool through the fuel transfer tube.

Activity in the refueling pool is at a maximum at the start of refueling and the activity in the spent fuel pool reaches a maximum 5 days into the refueling operation. These expected peak activities are listed in table 3.5-4. The detailed bases for these values are presented in FSAR Section 11.1.4.

Activity is released from the pools by evaporation. The only significant source of airborne activity above the pools is tritiated water vapor. Other radionuclides are removed by decay and operation of the fuel pool cooling and cleanup

Table 3.5-2
EXPECTED ANNUAL TRITIUM RELEASES
(Curies per year per unit)

Release Point and Pathway	Activity Released
PLANT VENT	
Containment	
- Normal Operation	1.7
- Refueling	36
Auxiliary/Radwaste Building Exhaust	4.2
Boric Acid Concentrator Distillate Vapor	333
TOTAL	375
FUEL BUILDING	666
TURBINE BUILDING	7.2
TOTAL ANNUAL RELEASE	1048

system. Tritium evolution from the refueling and spent fuel pools during refueling and normal operation is discussed in FSAR Section 11.1.4.

3.5.1.4 Leakage Sources

Systems containing radioactive liquids or gases are potential sources of leakage to the plant buildings and ultimately to the environment through the various ventilation systems. Liquid leakage is generated from such potential sources as pump seals and valve packings. Although a small fraction of the activity in the leakage will evolve and become a source of airborne activity, the majority is collected in radioactive

Table 3.5-3
EXPECTED SECONDARY SYSTEM ACTIVITIES
(μCi/g) (Sheet 1 of 2)

Radionuclide	Steam Generator Liquid	Main Steam	Condensate
Kr-83M	9.5(-09)	9.5(-09)	2.2(-09)
Kr-85M	5.0(-08)	5.0(-08)	1.2(-08)
Kr-85	7.0(-08)	7.0(-08)	1.7(-08)
Kr-87	2.7(-08)	2.7(-08)	6.1(-09)
Kr-88	9.1(-08)	9.1(-08)	2.1(-08)
Kr-89	1.3(-09)	1.3(-09)	1.7(-10)
Xe-131M	5.1(-08)	5.1(-08)	1.2(-08)
Xe-133M	1.0(-07)	1.0(-07)	2.4(-08)
Xe-133	8.4(-06)	8.4(-06)	2.0(-06)
Xe-135M	5.1(-09)	5.1(-09)	1.0(-09)
Xe-135	1.6(-07)	1.6(-07)	3.8(-08)
Xe-137	2.6(-09)	2.6(-09)	3.4(-10)
Xe-138	1.7(-08)	1.7(-08)	3.3(-09)
Br-83	1.5(-07)	1.5(-09)	1.4(-09)
Br-84	2.2(-08)	2.2(-10)	2.0(-10)
Br-85	2.5(-10)	2.5(-12)	1.2(-12)
I-130	1.6(-07)	1.6(-09)	1.6(-09)
I-131	3.1(-05)	3.1(-07)	3.1(-07)
I-132	3.0(-06)	3.0(-08)	2.9(-08)
I-133	3.4(-05)	3.4(-07)	3.4(-07)
I-134	6.3(-07)	6.3(-09)	5.9(-09)
I-135	1.1(-05)	1.1(-07)	1.1(-07)
Rb-86	1.0(-08)	1.0(-11)	1.0(-11)
Rb-88	1.0(-06)	1.0(-09)	8.8(-10)
Cs-134	3.0(-06)	3.0(-09)	3.1(-09)
Cs-136	1.5(-06)	1.5(-09)	1.6(-09)
Cs-137	2.2(-06)	2.2(-09)	2.2(-09)
N-16	4.5(-06)	4.5(-06)	4.2(-08)
H-3	1.3(-03)	1.3(-03)	1.3(-03)
Y-90	1.3(-10)	1.3(-13)	1.3(-13)
Y-91M	4.8(-09)	4.8(-12)	4.5(-12)
Y-91	7.6(-09)	7.6(-12)	7.6(-12)
Y-93	2.4(-09)	2.4(-12)	2.4(-12)
Mo-99	9.1(-06)	9.1(-09)	9.1(-09)
Sr-89	4.2(-08)	4.2(-11)	4.2(-11)
Sr-90	1.2(-09)	1.2(-12)	1.2(-12)
Sr-91	4.6(-08)	4.6(-11)	4.6(-11)
Zr-95	7.2(-09)	7.2(-12)	7.2(-12)
Nb-95	5.9(-09)	5.9(-12)	5.9(-12)

Table 3.5-3

EXPECTED SECONDARY SYSTEM ACTIVITIES

(μCi/g) (Sheet 2 of 2)

Radionuclide	Steam Generator Liquid	Main Steam	Condensate
Tc-99M	2.7(-06)	2.7(-09)	2.7(-09)
Ru-103	5.3(-09)	5.3(-12)	5.4(-12)
Ru-106	1.2(-09)	1.2(-12)	1.2(-12)
Rh-103M	6.7(-10)	6.7(-13)	6.4(-13)
Rh-106	1.5(-12)	1.5(-15)	2.3(-16)
Te-125M	3.5(-09)	3.5(-12)	3.5(-12)
Te-127M	3.3(-08)	3.3(-11)	3.3(-11)
Te-127	6.0(-08)	6.0(-11)	5.9(-11)
Te-129M	1.7(-07)	1.7(-10)	1.7(-10)
Te-129	2.8(-08)	2.8(-11)	2.7(-11)
Te-131M	2.5(-07)	2.5(-10)	2.4(-10)
Te-131	7.7(-09)	7.7(-12)	6.9(-12)
Te-132	3.0(-06)	3.0(-09)	3.0(-09)
Ba-137M	1.2(-08)	1.2(-11)	5.7(-12)
Ba-140	2.6(-08)	2.6(-11)	2.6(-11)
La-140	1.5(-08)	1.5(-11)	1.5(-11)
Ce-141	8.3(-09)	8.3(-12)	8.3(-12)
Ce-143	4.0(-09)	4.0(-12)	4.0(-12)
Ce-144	3.9(-09)	3.9(-12)	3.9(-12)
Pr-143	5.9(-09)	5.9(-12)	5.9(-12)
Pr-144	1.6(-10)	1.6(-13)	1.4(-13)
Np-239	1.3(-07)	1.3(-10)	1.3(-10)
Cr-51	2.3(-07)	2.3(-10)	2.3(-10)
Mn-54	3.7(-08)	3.7(-11)	3.7(-11)
Fe-55	1.9(-07)	1.9(-10)	1.9(-10)
Fe-59	1.2(-07)	1.2(-10)	1.2(-10)
Co-58	1.9(-06)	1.9(-09)	1.9(-09)
Co-60	2.4(-07)	2.4(-10)	2.4(-10)

Table 3.5-4
REFUELING ACTIVITIES (Sheet 1 of 2)

Radionuclide	Expected Peak Refueling Activities (μCi/g)	
	Refueling Pool	Spent Fuel Pool
Kr-83M	3.4(-12)	0.0
Kr-85M	2.4(-7)	0.0
Kr-85	2.2(-4)	3.6(-5)
Kr-87	4.1(-15)	0.0
Kr-88	8.1(-9)	0.0
Kr-89	0.0	0.0
Xe-131M	1.5(-4)	1.8(-5)
Xe-133M	2.1(-4)	6.9(-6)
Xe-133	2.2(-2)	1.9(-3)
Xe-135M	0.0	0.0
Xe-135	2.6(-5)	4.4(-10)
Xe-137	0.0	0.0
Xe-138	0.0	0.0
Br-83	1.1(-10)	0.0
Br-84	0.0	0.0
Br-85	0.0	0.0
I-130	1.7(-6)	2.7(-11)
I-131	2.4(-3)	2.1(-5)
I-132	1.2(-9)	0.0
I-133	8.4(-4)	2.1(-7)
I-134	0.0	0.0
I-135	1.9(-5)	8.4(-13)
Rb-86	1.5(-6)	5.5(-8)
Rb-88	0.0	0.0
Cs-134	6.4(-4)	2.9(-5)
Cs-136	2.2(-4)	7.8(-6)
Cs-137	4.8(-4)	2.2(-5)
N-16	0.0	0.0
H-3	3.8(-1)	3.7(-1)
Y-90	7.2(-9)	2.6(-11)
Y-91M	0.0	0.0
Y-91	9.6(-7)	1.2(-8)
Y-93	1.6(-8)	5.6(-14)
Mb-99	5.2(-4)	1.9(-6)
Sr-89	5.0(-6)	6.2(-8)
Sr-90	3.4(-7)	4.6(-9)
Sr-91	2.6(-7)	5.6(-13)

Table 3.5-4

REFUELING ACTIVITIES (Sheet 2 of 2)

Radionuclide	Expected Peak Refueling Activities (μCi/g)	
	Refueling Pool	Spent Fuel Pool
Zr-95	9.4(-7)	1.2(-8)
Nb-95	9.4(-7)	1.1(-8)
Tc-99M	2.7(-6)	3.6(-14)
Ru-103	5.8(-7)	7.1(-9)
Ru-106	2.7(-7)	3.6(-9)
Rh-103M	0.0	0.0
Rh-106	0.0	0.0
Te-125M	4.3(-7)	5.4(-9)
Te-127M	5.5(-6)	7.1(-8)
Te-127	2.9(-7)	5.5(-13)
Te-129M	1.7(-5)	2.1(-7)
Te-129	0.0	0.0
Te-131M	8.8(-6)	7.3(-9)
Te-131	0.0	0.0
Te-132	1.7(-4)	7.9(-7)
Ba-137M	0.0	0.0
Ba-140	2.1(-6)	2.1(-8)
La-140	6.9(-7)	1.2(-9)
Ce-141	8.4(-7)	1.0(-8)
Ce-143	1.5(-7)	1.7(-10)
Ce-144	8.8(-7)	1.2(-8)
Pr-143	4.8(-7)	5.0(-9)
Pr-144	0.0	0.0
Np-239	6.9(-6)	2.1(-8)
Cr-51	1.6(-5)	1.9(-7)
Mn-54	3.3(-6)	4.3(-8)
Fe-55	1.7(-5)	2.3(-7)
Fe-59	8.8(-6)	1.1(-7)
Co-58	1.5(-4)	1.9(-6)
Co-60	2.2(-5)	3.0(-7)

sumps and sent to the LRS for processing. Gaseous leakage is generated from such potential sources as compressor seals and valve packings. This activity becomes immediately airborne and is eventually released via the building ventilation systems. Using the assumptions listed in table 3.5-5, the airborne concentrations shown in table 3.5-6 were calculated. Credit was taken for filtration where applicable.

3.5.2 LIQUID RADWASTE SYSTEM

System and flow diagrams are shown in figures 3.5-2 and 3.5-3, respectively. Table 3.5-7 lists expected inputs and input activities to the LRS. Maximum radioactive inventories of the LRS tanks are listed in table 3.5-8 based on the maximum source terms given in FSAR Section 11.1 and the assumptions in FSAR Section 11.2. Principal specifications of LRS components are listed in table 3.5-9. A separate laundry waste system is not required as PVNGS will utilize a dry cleaning laundry. There are no liquid releases from PVNGS.

3.5.3 GASEOUS RADWASTE SYSTEM

The GRS has not changed substantially from the ER-CP and FES presentations. P&I and flow diagrams for the GRS are shown in figures 3.5-4 and 3.5-5 respectively. Table 3.5-10 lists expected inputs and input activities to the GRS. Radioactive inventories of the GRS tanks are listed in table 3.5-8 based on the assumptions given in FSAR Section 11.3. Principal specifications of GRS components are listed in table 3.5-11. The estimated annual gaseous releases from PVNGS are shown in table 3.5-12.

Table 3.5-5
ASSUMPTIONS USED IN DETERMINING AIRBORNE
RADIOACTIVITY (Sheet 1 of 2)

Item	Value
Leakage	
Primary to secondary, lb/d	100
Auxiliary and radwaste bldg, (with respect to primary coolant), lb/d	160
Turbine building steam, lb/h	1,700
Charging pump room, gal/h	1
Aux bldg ion exchanger (Ix) valve gallery, gal/h	0.15
Radwaste bldg conc tank valve gallery, gal/h	0.05
Radwaste bldg LRS pump valve gallery, gal/h	0.22
Iodine partition factors	
Steam generators	0.01
All buildings except containment	0.0075
Containment (fraction of RCS iodine released to building atmosphere per day)	0.00001
Noble gas partition factors	
All buildings except containment	1
Containment (fraction of RCS noble gas inventory released to building atmosphere per day)	.01
Bldg/area vent flowrates, ft^3/min	
Containment	
Refueling purge exhaust (high volume)	30,000

Table 3.5-5

ASSUMPTIONS USED IN DETERMINING AIRBORNE RADIOACTIVITY (Sheet 2 of 2)

Item	Value
Normal purge exhaust (low volume)	2,000
Fuel building exhaust	43,500
Auxiliary building exhaust	60,000
Radwaste building exhaust	51,000
Turbine building exhaust	328,000
Charging pump room	1,100
Auxiliary bldg ion exchanger (Ix) valve gallery	400
Radwaste bldg conc tanks valve gallery	250
Radwaste bldg LRS pumps valve gallery	500
Building/area free volumes, ft^3	
Containment	2.6×10^6
Fuel building	7.5×10^5
Turbine building	6.9×10^6
Auxiliary building	1.2×10^6
Charging pump room	8.5×10^3
Ion exchanger valve gallery	4.0×10^3
Radwaste building	4.6×10^5
Concentrate tanks valve gallery	1.5×10^3
LRS pump valve gallery	4.4×10^3

Table 3.5-6

NORMAL AIRBORNE RADIOACTIVITY CONCENTRATIONS ($\mu Ci/cm^3$) (Sheet 1 of 2)

Radio-nuclide	MPC Air ($\mu Ci/cm^3$) (40 h/wk)	Containment Building		Fuel Bldg	Auxiliary Building			Radwaste Building			Turbine Building
		Pre-Access	Refueling		Corridor	Charging Pump Room	Ix Valve Gallery	Corridor	Conc Tk Valve Gallery	LRS Pumps Valve Gallery	Operating Deck
Kr-83m	1(-6)	7.6(-08)	-	-	5.3(-10)	4.0(-08)	3.4(-09)	5.3(-10)	-	-	1.2(-14)
Kr-85m	6(-6)	8.0(-07)	-	-	3.1(-09)	2.2(-07)	1.9(-08)	3.1(-09)	-	-	6.8(-14)
Kr-85	1(-5)	4.6(-06)	-	-	4.5(-09)	3.0(-07)	2.6(-08)	4.5(-09)	-	3.0(-09)	9.9(-14)
Kr-87	1(-6)	1.5(-07)	-	-	1.4(-09)	1.1(-07)	9.6(-09)	1.4(-09)	-	-	3.4(-14)
Kr-88	1(-6)	1.0(-06)	-	-	5.3(-09)	3.9(-07)	3.4(-08)	5.3(-09)	-	1.1(-15)	1.2(-13)
Kr-89	1(-6)	5.5(-10)	-	-	2.1(-11)	3.7(-09)	2.7(-10)	2.1(-11)	-	-	1.4(-15)
Xe-131m	2(-5)	3.4(-06)	-	-	3.2(-09)	2.2(-07)	1.9(-08)	3.2(-09)	-	8.7(-10)	5.3(-14)
Xe-133m	1(-5)	5.5(-06)	-	-	6.4(-09)	4.4(-07)	3.7(-08)	6.4(-09)	-	4.5(-11)	1.4(-13)
Xe-133	1(-5)	5.0(-04)	-	-	5.3(-07)	3.6(-05)	3.1(-06)	5.3(-07)	-	4.5(-08)	1.2(-11)
Xe-135m	1(-6)	7.1(-09)	-	-	1.7(-10)	1.9(-08)	1.6(-09)	1.7(-10)	-	-	5.7(-15)
Xe-135	4(-6)	4.2(-06)	-	-	1.0(-08)	7.0(-07)	6.0(-08)	1.0(-08)	-	6.2(-15)	2.3(-13)
Xe-137	1(-6)	1.2(-09)	-	-	4.3(-11)	7.6(-09)	5.6(-10)	4.3(-11)	-	-	2.7(-15)
Xe-138	1(-6)	2.2(-08)	-	-	5.5(-10)	6.4(-08)	5.1(-09)	5.5(-10)	-	-	1.9(-14)
Br-83	3(-9)	2.4(-11)	-	-	4.5(-12)	7.0(-12)	6.0(-12)	4.5(-12)	-	-	1.5(-15)
Br-84	1(-6)	2.9(-12)	-	-	8.1(-13)	3.4(-12)	2.8(-12)	8.1(-13)	-	-	-
Br-85	1(-6)	3.1(-14)	-	-	9.7(-15)	1.6(-13)	1.1(-13)	9.7(-15)	-	-	-
I-130	3(-9)	5.0(-11)	-	-	3.6(-12)	3.2(-12)	2.7(-12)	3.6(-12)	-	-	1.7(-15)
I-131	9(-9)	4.6(-08)	-	-	5.9(-10)	4.1(-10)	3.5(-10)	5.9(-10)	8.0(-14)	1.0(-11)	3.2(-13)
I-132	2(-7)	4.6(-10)	-	-	9.2(-11)	1.5(-10)	1.2(-10)	9.2(-11)	-	-	3.0(-14)
I-133	3(-8)	1.5(-08)	-	-	7.3(-10)	5.8(-10)	4.9(-10)	7.3(-10)	-	1.1(-14)	3.6(-14)
I-134	5(-7)	8.8(-11)	-	-	2.2(-11)	6.5(-10)	5.4(-11)	2.2(-11)	-	-	6.5(-15)
I-135	1(-7)	2.6(-09)	-	-	2.8(-10)	2.8(-10)	2.4(-10)	2.8(-10)	-	-	1.2(-13)
Co-60	9(-9)	1.4(-09)	-	-	3.8(-11)	4.0(-14)	3.5(-14)	3.8(-11)	2.6(-13)	8.1(-15)	-
Co-58	5(-8)	3.2(-09)	-	-	8.4(-11)	3.2(-13)	2.8(-13)	8.4(-11)	4.1(-13)	3.6(-15)	-
Fe-59	5(-8)	3.2(-10)	-	-	8.4(-12)	2.0(-14)	1.7(-14)	8.4(-12)	2.7(-14)	1.8(-15)	-

Table 3.5-6

NORMAL AIRBORNE RADIOACTIVITY CONCENTRATIONS ($\mu Ci/cm^3$) (Sheet 2 of 2)

Radio-nuclide	MPC Air ($\mu Ci/cm^3$) (40 h/wk)	Containment Building		Fuel Bldg	Auxiliary Building			Radwaste Building			Turbine Building
		Pre-Access	Refueling		Corridor	Charging Pump Room	Ix Valve Gallery	Corridor	Conc Tk Valve Gallery	LRS Pumps Valve Gallery	Operating Deck
Mn-54	4(-8)	9.2(-10)	-	-	2.5(-11)	6.3(-15)	5.4(-15)	2.5(-11)	2.3(-12)	1.1(-15)	-
Cs-137	1(-8)	1.6(-09)	-	-	4.2(-11)	1.8(-12)	3.2(-13)	4.2(-11)	2.7(-12)	7.0(-14)	-
Cs-134	1(-8)	9.2(-10)	-	-	2.5(-11)	2.5(-12)	4.4(-13)	2.5(-11)	1.4(-15)	9.2(-14)	-
Sr-90	1(-9)	1.3(-11)	-	-	2.8(-13)	2.0(-16)	1.7(-16)	2.8(-13)	5.3(-15)	-	-
Sr-89	3(-8)	7.1(-11)	-	-	1.8(-12)	7.1(-15)	6.1(-15)	1.8(-12)	8.6(-10)	-	-
H-3	5(-6)	7.3(-08)	2.5(-06)	1.1(-06)	5.9(-09)	1.2(-07)	2.0(-08)	5.9(-09)	1.1(-14)	1.2(-09)	2.9(-09)
C-14	4(-6)	4.2(-08)	-	-	-	-	-	-	-	-	-
Ar-41	2(-6)	1.1(-06)	-	-	-	-	-	-	-	-	-
Total		5.2(-04)	2.5(-06)	1.1(-06)	6.2(-07)	3.9(-05)	3.3(-06)	5.7(-07)	8.7(-10)	5.0(-08)	2.9(-09)

Table 3.5-7
WASTE INPUTS TO THE LRS (Sheet 1 of 2)

LRS Inputs	Expected Flow (gal/d-unit)	Design Flow (gal/d-unit)	Activity
High TDS Holdup Tanks			
Containment sump	40	40	1 PCA[(a)]
Auxiliary building floor drains	200	200	0.1 PCA
Condensate polisher regenerants	---	20,000	100% of regenerant waste activity
Blowdown demineralizer regenerants	12,000 gal/ 15 days	12,000 gal/ 15 days	100% of regenerant waste activity
Chemical drain tank	115	115	See chemical drain tank inputs
Laboratory drains	400	400	0.002 PCA
Miscellaneous sources	700	700	0.01 PCA
Total	2,255	22,255	
Low TDS Holdup Tank			
Turbine building floor drains	7,200	7,200	100% of main steam activity

a. PCA = Primary Coolant Activity.

Table 3.5-7

WASTE INPUTS TO THE LRS (Sheet 2 of 2)

LRS Inputs	Expected Flow (gal/d-unit)	Design Flow (gal/d-unit)	Activity
Low TDS Holdup Tank (cont.)			
Secondary system samples	300	300	100% of main steam activity
Condensate polisher regenerants	---	36,000	100% of regenerant waste activity
Blowdown demineralizer regenerants	12,000 gal/ 15 days	12,000 gal/ 15 days	100% of regenerant waste activity
Total	8,300	44,300	
Chemical Drain Tanks			
Decon station waste plus showers	100	100	See NUREG 0017, Table 2-20
Primary system samples	15	15	1 PCA
Total	115	115	

Table 3.5-8

MAXIMUM RADIOACTIVITY INVENTORIES OF EQUIPMENT IN THE RADWASTE BUILDING[a] (Ci) (Sheet 1 of 4)

Radio-nuclide	High TDS Holdup Tank	Low TDS Holdup Tank	Concentrate Monitor Tank	Recycle Monitor Tank	LRS Evaporator	High Activity Spent Resin Tank	Low Activity Spent Resin Tank	LRS Mixed Bed Ion Exchanger	LRS Adsorption Bed
Kr-85m	1.2(-1)	4.9(-6)	0.0	4.6(-7)	0.0	0.0	0.0	0.0	0.0
Kr-85	1.2(-1)	9.9(-7)	0.0	5.6(-2)	0.0	0.0	0.0	0.0	0.0
Kr-87	1.8(-2)	8.3(-7)	0.0	2.2(-8)	0.0	0.0	0.0	0.0	0.0
Kr-88	1.2(-1)	5.3(-6)	0.0	3.1(-7)	0.0	0.0	0.0	0.0	0.0
Xe-131m	5.3(-1)	2.9(-6)	0.0	5.9(-2)	0.0	0.0	0.0	0.0	0.0
Xe-133	3.8(+1)	8.5(-4)	0.0	1.9	0.0	0.0	0.0	0.0	0.0
Xe-135	5.9(-1)	3.8(-5)	0.0	7.1(-6)	0.0	0.0	0.0	0.0	0.0
Xe-138	2.3(-3)	9.5(-8)	0.0	4.7(-10)	0.0	0.0	0.0	0.0	0.0
Br-84	2.9(-4)	9.3(-7)	0.0	1.0(-11)	0.0	8.2(-01)	0.0	1.0(-8)	1.0(-8)
I-129	1.2(-5)	3.2(-6)	8.7(-5)	2.5(-9)	5.2(-5)	8.8(-03)	0.0	3.2(-4)	3.2(-4)
I-131	3.0(+1)	8.3	1.4(+1)	6.0(-3)	5.5(+1)	2.9(+04)	4.2(+01)	3.3(+1)	3.3(+1)
I-132	2.6(-2)	9.3(-4)	0.0	4.4(-8)	0.0	7.1(+01)	0.0	4.4(-5)	4.4(-5)
I-133	1.8	5.5(-1)	8.2(-5)	2.0(-4)	3.0(-3)	3.6(+03)	0.0	2.4(-1)	2.4(-1)
I-134	7.8(-3)	5.9(-5)	0.0	1.1(-9)	0.0	2.3(+01)	0.0	1.1(-6)	1.1(-6)
I-135	2.9(-1)	3.0(-2)	1.7(-13)	4.2(-6)	2.0(-11)	7.6(+02)	0.0	4.1(-3)	4.1(-3)
Rb-88	1.2(-2)	1.3(-5)	0.0	3.9(-9)	0.0	2.4(+01)	0.0	3.9(-8)	3.9(-8)
Rb-89	6.1(-4)	2.6(-7)	0.0	7.0(-11)	0.0	1.2	0.0	6.9(-10)	6.9(-10)
Cs-134	2.0(+1)	5.2	1.4(+2)	2.1(-1)	8.4(+1)	1.3(+04)	2.3(+02)	2.3(+2)	2.3(-2)
Cs-136	1.5	4.5(-1)	1.6	1.7(-2)	3.9	5.3(+02)	1.0	1.5	1.5
Cs-137	8.7(+1)	2.3(+1)	6.3(+2)	9.2(-1)	3.8(+2)	3.9(+04)	1.2(+03)	1.2(+3)	1.2(+3)
Cs-138	7.8(-3)	3.0(-5)	0.0	1.7(-8)	0.0	1.4(+01)	0.0	1.7(-7)	1.7(-7)
H-3	2.2	1.4(-1)	3.6(-1)	5.7(-1)	2.2(-1)	0.0	0.0	0.0	0.0
Y-90	9.1(-4)	4.8(-4)	2.6(-5)	2.9(-7)	3.0(-4)	1.2(-01)	0.0	6.3(-4)	6.3(-4)

(a) Based on design basis source terms.

Table 3.5-8

MAXIMUM RADIOACTIVITY INVENTORIES OF EQUIPMENT IN THE RADWASTE BUILDING[a] (Ci) (Sheet 2 of 4)

Radio-nuclide	High TDS Holdup Tank	Low TDS Holdup Tank	Concentrate Monitor Tank	Recycle Monitor Tank	LRS Evaporator	High Activity Spent Resin Tank	Low Activity Spent Resin Tank	LRS Mixed Bed Ion Exchanger	LRS Adsorption Bed
Y-91	1.7	5.0(-1)	7.4	3.9(-4)	6.8	3.8(+01)	1.3(+01)	1.4(+1)	1.4(+1)
Mo-99	3.8	1.8	1.2(-1)	1.1(-3)	1.4	1.7(+03)	2.0	2.4	2.4
Sr-89	3.0(-1)	8.2(-2)	1.2	6.4(-5)	1.1	2.2(+02)	2.0	2.0	2.0
Sr-90	6.3(-2)	1.7(-2)	4.6(-1)	1.3(-5)	2.7(-1)	3.0(+01)	1.0	1.7	1.7
Sr-91	1.1(-3)	1.1(-4)	2.0(-12)	2.2(-8)	1.6(-10)	2.8	0.0	2.2(-5)	2.2(-5)
Zr-95	5.4(-1)	1.5(-1)	2.4	1.2(-4)	2.1	5.0(+01)	0.0	4.6	4.6
Nb-95	1.2(-5)	0.0	3.6(-5)	1.0(-12)	4.2(-5)	0.0	0.0	4.4(-9)	4.4(-9)
Ru-103	3.7(-1)	1.1(-1)	1.2	8.3(-5)	1.4	2.2(+01)	2.0	2.1	2.1
Ru-106	3.9(-1)	1.1(-1)	2.6	8.3(-5)	1.6	3.0(+01)	8.0	8.1	8.1
Te-129	1.9(-4)	2.8(-6)	0.0	6.8(-11)	0.0	5.2(-01)	0.0	6.7(-8)	6.7(-8)
Te-132	8.4(-1)	3.0(-1)	4.6(-2)	1.9(-4)	4.4(-1)	7.4(+02)	0.0	4.9(-1)	4.9(-1)
Te-134	3.2(-4)	2.4(-6)	0.0	3.5(-11)	0.0	9.5(-01)	0.0	3.5(-8)	3.5(-8)
Ba-140	1.2(-1)	3.4(-2)	1.2(-1)	2.5(-5)	3.0(-1)	7.4(+01)	0.0	2.1(-1)	2.1(-1)
La-140	4.9(-3)	2.6(-3)	1.9(-5)	1.3(-6)	3.6(-4)	3.4	0.0	2.1(-3)	2.1(-3)
Ce-144	8.3(-1)	2.3(-1)	5.3	1.8(-4)	3.5	7.0(+01)	1.6(+01)	1.6(+1)	1.6(+1)
Pr-143	9.0(-2)	2.9(-2)	1.0(-1)	2.1(-5)	2.4(-1)	1.0(+01)	0.0	1.9(-1)	1.9(-1)
Cr-51	7.7(-2)	2.1(-2)	2.0(-1)	1.6(-5)	2.6(-1)	5.5	0.0	2.9(-1)	2.9(-1)
Mn-54	7.2(-2)	1.9(-2)	4.7(-1)	1.5(-5)	3.1(-1)	4.8	1.0	1.4	1.4
Fe-55	4.6(-1)	1.2(-1)	3.2	9.8(-5)	2.0	3.0(+01)	1.1(+01)	1.1(+1)	1.1(+1)
Fe-59	6.6(-2)	1.8(-2)	2.4(-1)	1.4(-5)	2.5(-1)	4.6	0.0	4.0(-1)	4.0(-1)
Co-58	1.6	4.5(-1)	7.6	3.5(-4)	6.5	1.1(+02)	1.4(+01)	1.5(+1)	1.5(+1)
Co-60	6.1(-1)	1.6(-1)	4.3	1.3(-4)	2.6	4.0(+01)	1.5(+01)	1.5(+1)	1.5(+1)

Table 3.5-8

MAXIMUM RADIOACTIVITY INVENTORIES OF EQUIPMENT IN THE RADWASTE BUILDING[a] (Ci) (Sheet 3 of 4)

Radionuclide	Waste Gas Surge Tank	Waste Gas Decay Tank	Boric Acid Condensate Ion Exchanger	Radionuclide	Waste Gas Surge Tank	Waste Gas Decay Tank	Boric Acid Condensate Ion Exchanger
Kr-83m	1.7(+1)	1.1	0.0	Rb-86	4.2(-7)	4.7(-6)	0.0
Kr-85m	1.1(+2)	1.4(+1)	3.3(-8)	Rb-88	3.0(-4)	1.1(-5)	2.9(-8)
Kr-85	1.7(+2)	3.3(+3)	2.9(-8)	Rb-89	0.0	0.0	1.5(-9)
Kr-87	4.5(+1)	2.2	9.2(-9)	Cs-134	1.2(-4)	3.4(-3)	4.5(-7)
Kr-88	1.8(+2)	1.6(+1)	5.7(-8)	Cs-136	6.6(-5)	6.1(-4)	1.9(-7)
Kr-89	3.8(-1)	7.1(-3)	0.0	Cs-137	9.0(-5)	2.6(-3)	1.2(-6)
Xe-131m	1.2(+2)	7.3(+2)	1.3(-7)	Cs-138	0.0	0.0	1.9(-8)
Xe-133m	2.5(+2)	3.2(+2)	0.0	H-3	0.0	0.0	0.0
Xe-133	2.0(+4)	6.2(+4)	9.9(-6)	Y-90	1.8(-8)	9.5(-1)	1.6(-10)
Xe-135m	4.0	9.3(-2)	0.0	Y-91m	2.8(-6)	1.2(-7)	0.0
Xe-135	3.9(+2)	9.3(+1)	2.6(-7)	Y-91	9.4(-7)	1.3(-5)	7.0(-9)
Xe-137	8.7(-1)	1.6(-2)	0.0	Y-93	4.5(-7)	1.4(-7)	0.0
Xe-138	1.2(+1)	2.8(-1)	1.2(-9)	Mo-99	1.2(-3)	2.3(-3)	2.3(-6)
Br-83	5.4(-5)	4.7(-6)	0.0	Sr-89	5.2(-6)	6.7(-5)	4.8(-8)
Br-84	1.6(-5)	5.7(-7)	6.7(-10)	Sr-90	1.5(-7)	3.3(-6)	1.7(-9)
Br-85	2.9(-7)	6.1(-9)	0.0	Sr-91	9.0(-6)	2.6(-6)	4.9(-9)
I-129	0.0	0.0	1.9(-9)	Zr-95	9.0(-7)	1.3(-5)	8.7(-9)
I-130	2.9(-5)	1.1(-5)	0.0	Nb-95	7.3(-7)	8.3(-6)	0.0
I-131	4.1(-3)	2.1(-2)	3.8(-3)	Tc-99m		1.2(-4)	0.0
I-132	1.1(-3)	9.6(-5)	2.4(-7)	Ru-103	6.6(-7)	7.8(-6)	5.7(-9)
I-133	5.4(-3)	3.3(-3)	8.9(-5)	Ru-106	1.5(-7)	3.0(-6)	2.3(-9)
I-134	3.8(-4)	1.7(-5)	3.0(-8)	Rh-103m	3.8(-7)	1.7(-8)	0.0
I-135	2.5(-3)	5.2(-4)	7.1(-6)	Rh-106	1.7(-9)	3.5(-11)	0.0

Table 3.5-8

MAXIMUM RADIOACTIVITY INVENTORIES OF EQUIPMENT
IN THE RADWASTE BUILDING[a] (Ci) (Sheet 4 of 4)

Radionuclide	Waste Gas Surge Tank	Waste Gas Decay Tank	Boric Acid Condensate Ion Exchanger	Radionuclide	Waste Gas Surge Tank	Waste Gas Decay Tank	Boric Acid Condensate Ion Exchanger
Te-125m	4.2(-7)	5.7(-6)	0.0	Ce-141	1.0(-6)	1.1(-5)	0.0
Te-127m	4.2(-6)	6.7(-5)	0.0	Ce-143	5.8(-7)	5.5(-7)	0.0
Te-127	1.2(-5)	3.3(-6)	0.0	Ce-144	4.9(-7)	9.4(-6)	5.5(-9)
Te-129m	2.1(-5)	2.3(-4)	0.0	Pr-143	7.3(-7)	5.3(-6)	6.2(-9)
Te-129	1.5(-5)	7.8(-7)	8.9(-10)	Pr-144	1.4(-7)	4.0(-9)	0.0
Te-131m	3.7(-5)	3.2(-5)	0.0	Np-239	1.7(-5)	2.8(-5)	0.0
Te-131	6.0(-6)	1.9(-7)	0.0	Cr-51	3.2(-4)	2.9(-3)	1.9(-9)
Te-132	4.1(-4)	9.1(-4)	5.6(-5)	Mn-54	5.2(-5)	8.9(-4)	1.9(-9)
Te-134	0.0	0.0	1.0(-9)	Fe-55	2.7(-4)	5.0(-3)	3.7(-10)
Ba-137m	1.3(-5)	2.8(-7)	0.0	Fe-59	1.7(-4)	1.8(-3)	1.1(-9)
Ba-140	3.3(-6)	2.3(-5)	4.8(-8)	Co-58	2.7(-3)	3.4(-2)	1.8(-8)
La-140	2.2(-6)	2.5(-6)	4.9(-9)	Co-60	3.3(-4)	6.3(-3)	2.4(-9)

Table 3.5-9

LIQUID RADWASTE SYSTEM (LRS) EQUIPMENT DESCRIPTIONS

(Sheet 1 of 7)

Tanks		
High TDS Holdup Tanks (T-01 A,B)		
Quantity/unit	=	2
Capacity (each)	=	30,000 gal
Design pressure/temp	=	15 psig/250F
Operating pressure/temp	=	Atmos/80F
Material	=	304 SS
Low TDS Holdup Tank (T-01 C)		
Quantity/unit	=	1
Capacity (each), gal	=	30,000 gal
Design pressure/temp	=	15 psig/250F
Operating pressure/temp	=	Atmos/80F
Material	=	304 SS
Chemical Drain Tanks (T-05 A,B)		
Quantity/unit	=	2
Capacity (each), gal	=	1100 gal
Design pressure/temp	=	15 psig/250F
Operating pressure/temp	=	Atmos/80F
Material	=	304 SS
Anti-Foam Tank (T-07)		
Quantity/unit	=	1
Capacity	=	110 gal of anti-foaming agent
Design pressure/temp	=	Atmos/120F
Operating pressure/temp	=	Atmos/80F
Material	=	304 SS

Table 3.5-9
LIQUID RADWASTE SYSTEM (LRS) EQUIPMENT DESCRIPTIONS
(Sheet 2 of 7)

Tanks (Continued)		
Concentrate Monitor Tanks (T-03 A,B)		
Quantity/unit	=	2
Capacity (each), gal	=	5000
Design pressure/temp	=	15 psig/250F
Operating pressure/temp	=	Atmos/170F
Material	=	Carpenter 20 Cb-3
Caustic Storage Tank (T-08)		
Quantity/unit	=	1
Capacity, gal of caustic	=	2000
Design pressure/temp	=	15 psig/250F
Operating pressure/temp	=	Atmos/120F
Material	=	ASTM A-283-C
Caustic Batch Tank (T-10)		
Quantity/unit	=	1
Capacity, gal	=	25
Design pressure/temp	=	15 psig/120F
Operating pressure/temp	=	Atmos/120F
Material	=	ASTM A53B
Acid Storage Tank (T-06)		
Quantity/unit	=	1
Capacity, gal of acid	=	450
Design pressure/temp	=	15 psig/120F
Operating pressure/temp	=	Atmos/120F
Material	=	ASTM SA-515-70

Table 3.5-9
LIQUID RADWASTE SYSTEM (LRS) EQUIPMENT DESCRIPTIONS
(Sheet 3 of 7)

Tanks (Continued)		
Acid Batch Tank (T-09)		
Quantity/unit	=	1
Capacity	=	25 gal
Design pressure/temp	=	15 psig/120F
Operating pressure/temp	=	Atmos/120F
Material	=	ASTM A53B
Recycle Monitor Tanks (T-04 A,B)		
Quantity/unit	=	2
Capacity/each	=	30,000 gal
Design pressure/temp	=	15 psig/250F
Operating pressure/temp	=	Atmos/80F
Material	=	304 SS
Pumps		
LRS Holdup Pumps (P-01 A,B,C)		
Quantity/unit	=	3
Type	=	Centrifugal
Capacity	=	250 gal/min
Design pressure/temp	=	98 psig/150F
Material	=	316L SS
Motor rpm/bhp	=	3600/25
Chemical Drain Pumps (P-02 A,B)		
Quantity/unit	=	2
Type	=	Centrifugal
Capacity	=	30 gal/min
Design pressure/temp	=	74 psig/150F

Table 3.5-9
LIQUID RADWASTE SYSTEM (LRS) EQUIPMENT DESCRIPTIONS
(Sheet 4 of 7)

Pumps (Continued)

Chemical Drain Pumps (P-02 A,B) (Continued)

Material	=	316L SS
Motor rpm/bhp	=	3600/7.5

Anti-Foam Pump (P-07)

Quantity/unit	=	1
Type	=	Positive displacement
Capacity	=	54 gal/h
Design pressure/temp	=	205 psia/175F
Material	=	316 SS
Motor rpm/bhp	=	1725/0.5

Recycle Monitor Pump (P-03)

Quantity/unit	=	1
Type	=	Centrifugal
Capacity	=	150 gal/min
Design pressure/temp	=	52 psig/150F
Material	=	316L SS
Motor rpm/bhp	=	3600/10

LRS Evaporator Main Recycle Pump (P-08)

Quantity/unit	=	1
Type	=	In-line propeller
Capacity	=	10,500 gal/min
Design pressure/temp	=	40 psig/250F
Material	=	Carpenter 20 Cb-3
Motor rpm/bhp	=	1750/75

Table 3.5-9
LIQUID RADWASTE SYSTEM (LRS) EQUIPMENT DESCRIPTIONS
(Sheet 5 of 7)

Pumps (Continued)

LRS Evaporator Distillate Pumps (P-09 A,B)

Quantity/unit	=	2
Type	=	Centrifugal
Capacity	=	30 gal/min
Design pressure/temp	=	34 psig/250F
Material	=	316 SS
Motor rpm/bhp	=	3500/20

LRS Evaporator Concentrate Pumps (P-10 A,B)

Quantity/unit	=	2
Type	=	Centrifugal
Capacity	=	50 gal/min
Design pressure/temp	=	35 psig/224F
Material	=	Gould-A-Loy 20
Motor rpm/bhp	=	1750/0.75

LRS Steam Condensate Pump (P-11)

Quantity/unit	=	1
Type	=	Centrifugal
Capacity	=	22,000 lb/h
Design pressure/temp	=	35 psig/281F
Material	=	316 SS
Motor rpm/bhp	=	3505/5

Concentrate Monitor Tank Pumps (P-04 A,B)

Quantity/unit	=	2
Type	=	Centrifugal
Capacity	=	50 gal/min
Design pressure/temp	=	43 psig/170F

Table 3.5-9
LIQUID RADWASTE SYSTEM (LRS) EQUIPMENT DESCRIPTIONS
(Sheet 6 of 7)

Pumps (Continued)		
Concentrate Monitor Tank Pumps (P-04 A,B)		
Material	=	316 SS
Motor rpm/bhp	=	3600/5
Filters		
LRS Ion Exchanger Prefilters (F-01 A,B)		
Quantity/unit	=	2
Size	=	5μm 98%, 25 μm 100%
Capacity	=	150 gal/min
Design pressure/temp	=	200 psig/250F
Operating pressure/temp	=	90 psig/125F
Material (shell)	=	304 SS
Ion Exchangers		
LRS Adsorption Bed (D-01)		
Quantity/unit	=	1
Capacity	=	50 ft^3 of activated carbon
Flowrate	=	130 gal/min
Design pressure/temp	=	200 psig/250F
Material (shell)	=	304L SS
Operating pressure/temp	=	90 psig/125F
LRS Mixed Bed Ion Exchangers (D-02 A,B)		
Quantity/unit	=	2
Capacity	=	50 ft^3 of 2:1 cation-to-anion resin
Flowrate	=	130 gal/min
Design pressure/temp	=	200 psig/250F

Table 3.5-9
LIQUID RADWASTE SYSTEM (LRS) EQUIPMENT DESCRIPTIONS
(Sheet 7 of 7)

Ion Exchangers (Continued)		
LRS Mixed Bed Ion Exchangers (D-02 A,B) (Continued)		
Material (shell)	=	304L SS
Operating pressure/temp	=	90 psig/125F
Evaporator		
LRS Evaporator Package		
Quantity/unit	=	1
Capacity	=	30 gal/min
Type	=	forced circulation
Design pressure/temp	=	40 psig/250F
Material	=	Incoloy 825 (concentrate side)
	=	304 SS (distillate side)

Table 3.5-10

MAJOR SOURCES, VOLUMES, AND FLOWRATES OF
GASES TO THE GASEOUS RADWASTE SYSTEM

Source	Gas	Annual Volume (Standard ft^3)	Maximum Flowrate[a] (Standard ft^3/min)	Annual Flowrate (Standard ft^3/min)
Volume control tank	H_2	2,500		0.006
	N_2	610	20	0.002
	O_2	65		1.6E-4
Gas Stripper[b]	H_2	142,000		0.338
	N_2	2,950	20	0.007
	O_2	40		9.5E-5
Reactor drain tank	H_2	0		0
	N_2	7,759	20	0.02
	O_2	0		0
Refueling failed fuel detector	H_2	0		0
	N_2	2,000	20	0.005
	O_2	0		0

a. Flowrates are estimated expected maximums, not continuous.

b. Gas stripper values assume continuous gas stripping.

Table 3.5-11

GASEOUS RADWASTE SYSTEM PROCESS EQUIPMENT DESCRIPTION

Equipment	Quantity	Flowrate/ Capacity	Material of Construction	Design Pressure/ Temperature (psig/°F)
Gas surge tank	1	760 ft^3	Carbon steel with plastic lining	380/200
Compressors	2	10 std ft^3/min	Stainless steel	380/150
Waste gas decay tank	3	760 ft^3	Carbon steel with plastic lining	380/200

3.5.4 SOLID RADWASTE SYSTEM

The Solid Radwaste System (SRS) has not changed substantially from the ER-CP and FES presentations. PVNGS utilizes a cement binder solidification system. System and flow diagrams are shown in figures 3.5-6 and 3.5-7 respectively. Table 3.5-13 lists expected input activities to the SRS. Principal specifications of the SRS components are listed in table 3.5-14. Expected annual shipment activities from the SRS are provided in table 3.5-15.

3.5.5 PROCESS AND EFFLUENT MONITORING

The process and effluent radiation monitors measure the radioactivity of selected process streams and of all principal gaseous effluent discharge paths. For additional information concerning process and effluent monitoring system refer to FSAR Section 11.5.

Table 3.5-12

NORMAL RADIOLOGICAL RELEASES

(Curies per year per unit)

Nuclide	Release Activity
Kr-83m	8.0 (-1)
Kr-85m	4.3
Kr-85	2.0 (+4)
Kr-87	2.2
Kr-88	7.9
Kr-89	8.7 (-2)
Xe-131m	3.3 (+2)
Xe-133m	9.9
Xe-133	1.9 (+3)
Xe-135m	3.5 (-1)
Xe-135	1.5 (+1)
Xe-137	1.7 (-1)
Xe-138	1.2
BR-83	3.1 (-4)
BR-84	9.9 (-5)
BR-85	2.6 (-6)
I-130	2.1 (-4)
I-131	4.0 (-2)
I-132	6.5 (-3)
I-133	4.3 (-2)
I-134	2.2 (-3)
I-135	1.7 (-2)
Cs-134	5.0 (-4)
Cs-137	8.0 (-4)
Sr-89	3.6 (-5)
Sr-90	5.6 (-6)
H-3	1.0 (+3)
C-14	8.0
Ar-41	2.5 (+1)
Mn-54	4.5 (-4)
Fe-59	1.6 (-4)
Co-58	1.6 (-3)
Co-60	7.0 (-4)

Table 3.5-13

SRS INPUT ACTIVITIES[a] (Ci/hr) (Sheet 1 of 4)

(PER UNIT)

Nuclide	Evaporator Concentrates	Spent Resin Beads	SGB IX Regenerants	Cartridge Filters	Disposable Crud Filters	Dry Wastes
BR-83	0.0	0.0	5.9(-06)	0.0	0.0	(b)
BR-84	0.0	4.3(-01)	2.0(-07)	0.0	0.0	(b)
BR-85	0.0	0.0	2.0(-10)	0.0	0.0	(b)
I-129	0.0	4.4(-03)	0.0	0.0	0.0	(b)
I-130	0.0	0.0	3.3(-05)	0.0	0.0	(b)
I-131	1.9(-03)	1.4(+04)	1.0(-01)	0.0	0.0	(b)
I-132	0.0	3.7(-01)	1.1(-04)	0.0	0.0	(b)
I-133	0.0	1.9(+03)	1.2(-02)	0.0	0.0	(b)
I-134	0.0	1.2(+01)	9.2(-08)	0.0	0.0	(b)
I-135	0.0	4.0(+02)	1.2(-03)	0.0	0.0	(b)
RB-86	1.2(-04)	0.0	7.3(-05)	0.0	0.0	(b)
RB-88	0.0	1.3(+01)	4.8(-06)	0.0	0.0	(b)
RB-89	0.0	1.2	0.0	0.0	0.0	(b)
CS-134	4.9	6.7(+03)	2.1(-01)	0.0	0.0	(b)
CS-136	3.2(-03)	2.7(+02)	7.8(-03)	0.0	0.0	(b)

a. Expected waste generation conditions only, maximum waste generation conditions are not tabulated because they are short-term inputs that are not representative of a year's continuous operation.

b. Nuclide breakdown was not made. Total activity is based on WASH 1258 estimates.

Table 3.5-13

SRS INPUT ACTIVITIES[a] (Ci/hr) (Sheet 2 of 4)

(PER UNIT)

Nuclide	Evaporator Concentrates	Spent Resin Beads	SGB IX Regenerants	Cartridge Filters	Disposable Crud Filters	Dry Wastes
CS-137	4.2	1.9(+04)	1.7(-01)	0.0	0.0	(b)
CS-138	0.0	7.5	0.0	0.0	0.0	(b)
N-16	0.0	0.0	0.0	0.0	0.0	(b)
H-3	1.4	0.0	0.0	0.0	0.0	(b)
Y-90	0.0	5.8(-02)	1.5(-07)	0.0	0.0	(b)
Y-91M	0.0	0.0	7.0(-08)	0.0	0.0	(b)
Y-91	2.2(-03)	1.9(+01)	1.8(-04)	0.0	0.0	(b)
Y-93	0.0	0.0	4.3(-07)	0.0	0.0	(b)
MO-99	7.1(-11)	8.5(+02)	1.1(-02)	0.0	0.0	(b)
SR-89	9.6(-03)	1.1(+02)	8.7(-04)	0.0	0.0	(b)
SR-90	2.4(-03)	1.5(+01)	1.0(-04)	0.0	0.0	(b)
SR-91	0.0	1.4	7.8(-06)	0.0	0.0	(b)
ZR-95	2.5(-03)	2.5(+01)	1.9(-04)	2.7	1.7	(b)
NB-95	6.3(-04)	4.4(-09)	8.8(-05)	0.0	0.0	(b)
TC-99M	0.0	0.0	2.9(-04)	0.0	0.0	(b)
RU-103	7.1(-04)	1.1(+01)	8.9(-05)	0.0	0.0	(b)
RU-106	2.2(-03)	1.5(-01)	7.9(-05)	0.0	0.0	(b)
RH-103M	0.0	0.0	1.1(-08)	0.0	0.0	(b)
RH-106	0.0	0.0	2.2(-13)	0.0	0.0	(b)

Table 3.5-13

SRS INPUT ACTIVITIES[a] (Ci/hr) (Sheet 3 of 4)

(PER UNIT)

Nuclide	Evaporator Concentrates	Spent Resin Beads	SGB IX Regenerants	Cartridge Filters	Disposable Crud Filters	Dry Wastes
TE-125M	9.6(-04)	0.0	8.2(-05)	0.0	0.0	(b)
TE-127M	2.2(-02)	0.0	1.3(-03)	0.0	0.0	(b)
TE-127	0.0	0.0	9.9(-06)	0.0	0.0	(b)
TE-129M	1.5(-02)	0.0	2.3(-03)	0.0	0.0	(b)
TE-129	0.0	2.7(-01)	5.8(-07)	0.0	0.0	(b)
TE-131M	0.0	0.0	1.3(-04)	0.0	0.0	(b)
TE-131	0.0	0.0	5.6(-08)	0.0	0.0	(b)
TE-132	8.5(-10)	3.9(+02)	4.1(-03)	0.0	0.0	(b)
TE-134	0.0	5.0(-01)	0.0	0.0	0.0	(b)
BA-137M	0.0	0.0	9.2(-09)	0.0	0.0	(b)
BA-140	4.6(-05)	3.7(+01)	1.4(-04)	0.0	0.0	(b)
LA-140	0.0	1.7	1.1(-05)	0.0	0.0	(b)
CE-141	6.8(-04)	0.0	1.1(-04)	0.0	0.0	(b)
CE-143	0.0	0.0	2.3(-06)	0.0	0.0	(b)
CE-144	6.0(-03)	3.5(+01)	2.4(-04)	0.0	0.0	(b)
PR-143	1.5(-05)	5.0	3.4(-05)	0.0	0.0	(b)
PR-144	0.0	0.0	8.2(-10)	0.0	0.0	(b)
NP-239	2.0(-14)	0.0	1.3(-04)	0.0	0.0	(b)
CR-51	1.2(-02)	2.7	2.6(-03)	2.8(+01)	1.6(+02)	(b)

Table 3.5-13

SRS INPUT ACTIVITIES[a] (Ci/hr) (Sheet 4 of 4)

(PER UNIT)

Nuclide	Evaporator Concentrates	Spent Resin Beads	SGB IX Regenerants	Cartridge Filters	Disposable Crud Filters	Dry Wastes
MN-54	4.9(-02)	2.4	2.3(-03)	2.5(+01)	3.6	(b)
FE-55	3.4(-01)	1.5(+01)	1.5(-02)	1.5(+02)	0.0	(b)
FE-59	2.1(-02)	2.3	2.2(-03)	2.39+01)	2.0	(b)
CO-58	7.4(-01)	5.6(+01)	5.4(-02)	5.6(+02)	3.2(+02)	(b)
CO-60	4.6(-01)	2.0(+01)	1.9(-02)	2.0(+08)	3.6(+01)	(b)
TOTAL	1.2(+01)	4.4(+04)	1.2	1.0(+03)	5.2(+02)	1.0(+01)

Table 3.5-14

SRS OUTPUT ACTIVITIES[a] (Ci/yr/unit) (Sheet 1 of 4)

Nuclide	Evaporator Concentrates	Spent Resin Beads	Cartridge Filters	Disposable Crud Filters	Dry Wastes
BR-83	0.0	0.0	0.0	0.0	(b)
BR-84	0.0	0.0	0.0	0.0	(b)
BR-85	0.0	0.0	0.0	0.0	(b)
I-129	0.0	4.4(-03)	0.0	0.0	(b)
I-130	0.0	0.0	0.0	0.0	(b)
I-131	1.4(-03)	1.9(-04)	0.0	0.0	(b)
I-132	0.0	0.0	0.0	0.0	(b)
I-133	0.0	0.0	0.0	0.0	(b)
I-134	0.0	0.0	0.0	0.0	(b)
I-135	0.0	0.0	0.0	0.0	(b)
RB-86	3.9(-05)	0.0	0.0	0.0	(b)
RB-88	0.0	0.0	0.0	0.0	(b)
RB-89	0.0	0.0	0.0	0.0	(b)
CS-134	4.8	5.5(+03)	0.0	0.0	(b)
CS-136	6.5(-04)	4.1(-03)	0.0	0.0	(b)
CS-137	4.2	1.9(+04)	0.0	0.0	(b)

a. Expected waste generation conditions only. Maximum waste generation conditions are not tabulated because they are short-term inputs that are not representative of 1 year's continuous operation.

b. Nuclide breakdown was not made. Total activity is based on WASH 1268 estimates.

Table 3.5-14

SRS OUTPUT ACTIVITIES[a] (Ci/yr/unit) (Sheet 2 of 4)

Nuclide	Evaporator Concentrates	Spent Resin Beads	Cartridge Filters	Disposable Crud Filters	Dry Wastes
CS-138	0.0	0.0	0.0	0.0	(b)
N-16	0.0	0.0	0.0	0.0	(b)
H-3	1.4	0.0	0.0	0.0	(b)
Y-90	0.0	0.0	0.0	0.0	(b)
Y-91M	0.0	0.0	0.0	0.0	(b)
Y-91	1.5(-03)	1.6	0.0	0.0	(b)
Y-93	0.0	0.0	0.0	0.0	(b)
MO-99	3.6(-14)	0.0	0.0	0.0	(b)
SR-89	6.3(-03)	6.1	0.0	0.0	(b)
SR-90	2.4(-03)	1.5(+01)	0.0	0.0	(b)
SR-91	0.0	0.0	0.0	0.0	(b)
ZR-95	1.8(-03)	2.6	1.4	1.7	(b)
NB-95	3.5(-04)	0.0	0.0	0.0	(b)
TC-99M	0.0	0.0	0.0	0.0	(b)
RU-103	4.2(-04)	2.7(-01)	0.0	0.0	(b)
RU-106	2.1(-03)	1.0(+01)	0.0	0.0	(b)
RH-103M	0.0	0.0	0.0	0.0	(b)
RH-106	0.0	0.0	0.0	0.0	(b)
TE-125M	6.7(-04)	0.0	0.0	0.0	(b)

Table 3.5-14

SRS OUTPUT ACTIVITIES[a] (Ci/yr/unit) (Sheet 3 of 4)

Nuclide	Evaporator Concentrates	Spent Resin Beads	Cartridge Filters	Disposable Crud Filters	Dry Wastes
TE-127M	1.8(-02)	0.0	0.0	0.0	(b)
TE-127	0.0	0.0	0.0	0.0	(b)
TE-129M	7.9(-03)	0.0	0.0	0.0	(b)
TE-129	0.0	4.4(-03)	0.0	0.0	(b)
TE-131M	0.0	0.0	0.0	0.0	(b)
TE-131	0.0	0.0	0.0	0.0	(b)
TE-132	1.5(-12)	0.0	0.0	0.0	(b)
TE-134	0.0	0.0	0.0	0.0	(b)
BA-137M	0.0	0.0	0.0	0.0	(b)
BA-140	9.1(-06)	4.2(-04)	0.0	0.0	(b)
LA-140	0.0	0.0	0.0	0.0	(b)
CE-141	3.6(-04)	0.0	0.0	0.0	(b)
CE-143	0.0	0.0	0.0	0.0	(b)
CE-144	5.6(-03)	2.1(+01)	0.0	0.0	(b)
PR-143	3.2(-06)	1.1(-04)	0.0	0.0	(b)
PR-144	0.0	0.0	0.0	0.0	(b)
NP-239	0.0	0.0	0.0	0.0	(b)
CR-51	5.3(-03)	1.4(-02)	2.7(+01)	1.6(+02)	(b)
MN-54	4.6(-02)	1.5	2.4(+01)	3.6	(b)
FE-55	3.1(-01)	1.3(+01)	1.5(+02)	0.0	(b)

Table 3.5-14

SRS OUTPUT ACTIVITIES[a] (Ci/yr/unit) (Sheet 4 of 4)

Nuclide	Evaporator Concentrates	Spent Resin Beads	Cartridge Filters	Disposable Crud Filters	Dry Wastes
FE-59	1.3(-02)	8.8(-02)	2.3(+01)	2.0	(b)
CO-58	5.5(-01)	7.2	5.6(+02)	3.2(+02)	(b)
CO-60	4.6(-01)	1.9(+01)	2.0(+02)	3.6(+01)	(b)
TOTAL	1.2(+01)	2.5(+04)	9.9(+02)	5.2(+02)	1.0(+01)

Table 3.5-15

SRS EQUIPMENT DESCRIPTIONS (Sheet 1 of 2)

Item	Quantity	Capacity	Materials of Construction
Tanks			
Spent resin tanks,	2	250 ft^3 total 200 ft^3 operating	Stainless Steel
Waste feed tank	1	140 ft^3 total 120 ft^3 operating	Incoloy 825
Chemical addition tank	1	250 gal	Polyethylene
Cement feed tank	1	90 ft^3	Carbon steel
Dry additive feed tank	1	12 ft^3	Carbon steel
Pumps			
Resin transfer/ dewatering pump	1	75 gal/min	Stainless steel, with Buna 'N' stator
Waste feed pump	1	16 gal/min	Stainless steel, with Buna 'N' stator
Chemical feed pump	1	220 gal/h	PVC
Other			
Disposable liners	Consumable	80 ft^3/ 55-gal drum	Carbon steel
Cement/waste mixer	1	250 lb/min	Carbon steel clad with type 316 stainless steel

Table 3.5-15
SRS EQUIPMENT DESCRIPTIONS (Sheet 2 of 2)

Item	Quantity	Capacity	Materials of Construction
Cement screw conveyor	1	0.6-3.6 ft^3/min	Carbon steel
Cement hopper	1	2.6 ft^3/min	Carbon steel
Dry additive hopper	1	0.37 ft^3/min	Carbon steel
Radwaste baler	1	55-gallon drums	Carbon steel and stainless steel

3.5.5.1 Design Objectives

Effluent monitoring is provided during normal operation and anticipated operational occurrences to ensure compliance with applicable regulations.

Design objectives and functional performance requirements for the effluent monitors are to:

A. Alert plant personnel if it appears that technical specification limits may be reached or exceeded

B. Provide a record of the rate, quantity and isotopic identification of radioactive material released to the environment

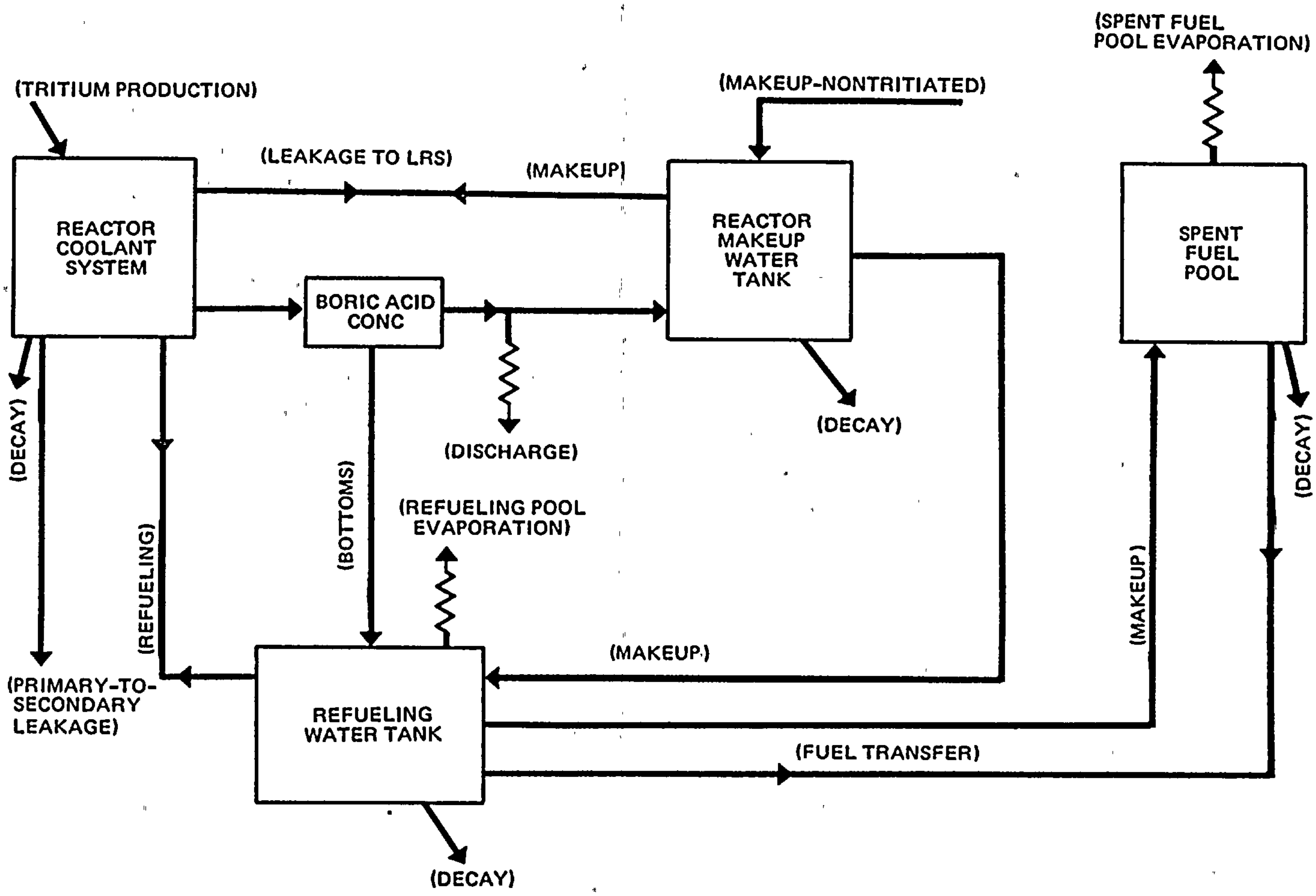
C. Provide control signals that initiate automatic plant actions to terminate releases before technical specification limits are exceeded.

3.5.5.2 System Description

The minimum sensitivities, equipment ranges, and alarm setpoints of the effluent monitors are based on meeting the guidelines of 10CFR50 Appendix I and 10CFR20.

The airborne effluent monitors obtain representative airborne concentrations by sampling plant releases in accordance with ANSI-N13.1.

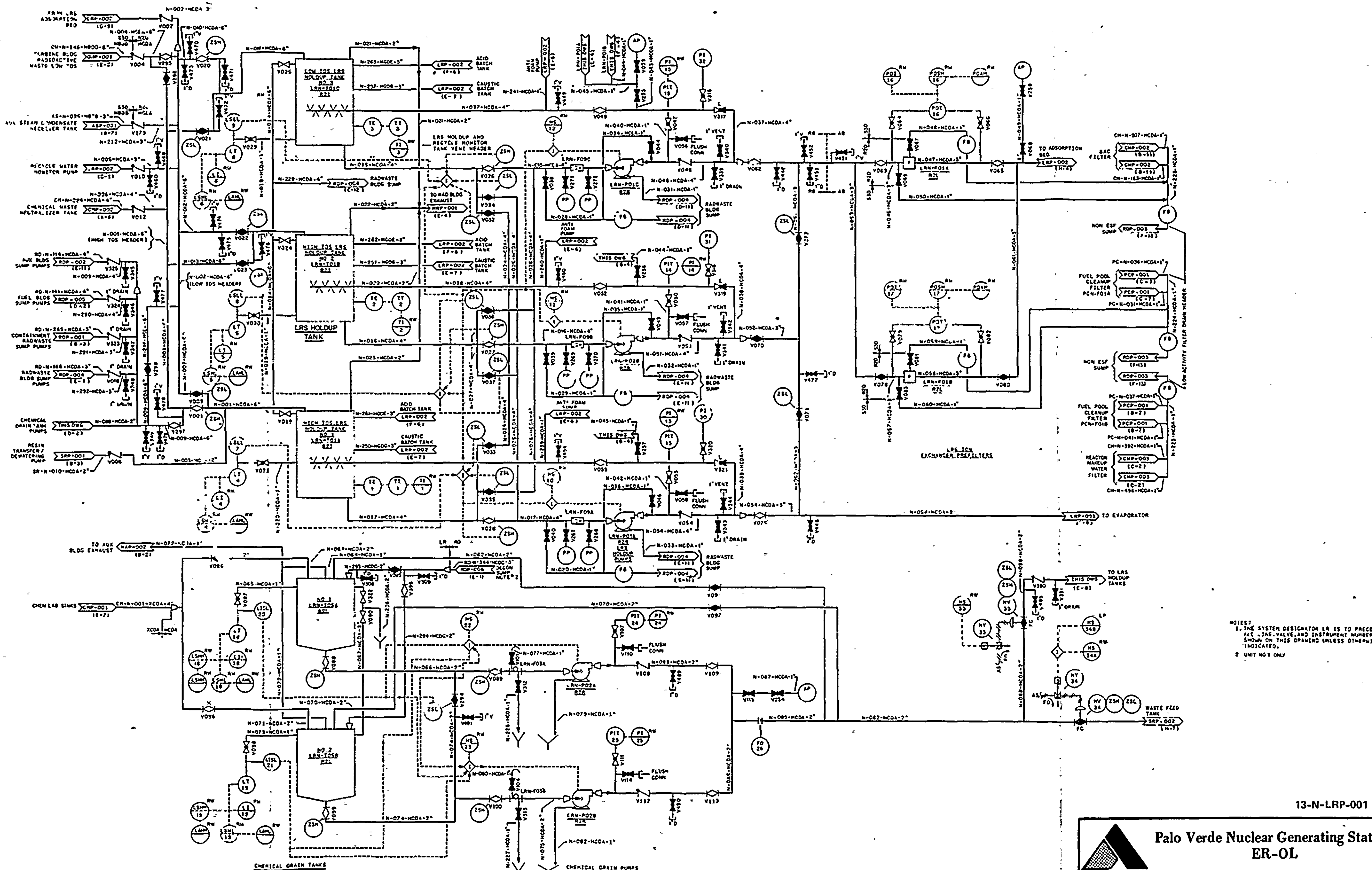
Although there are no pathways for the release of radioactive liquids to the environment from PVNGS and no liquid effluent monitors, several LRS process monitors are provided as described in FSAR Section 11.5.2.



Palo Verde Nuclear Generating Station
ER-OL

TRITIUM BALANCE
FLOW DIAGRAM

Figure 3.5-1

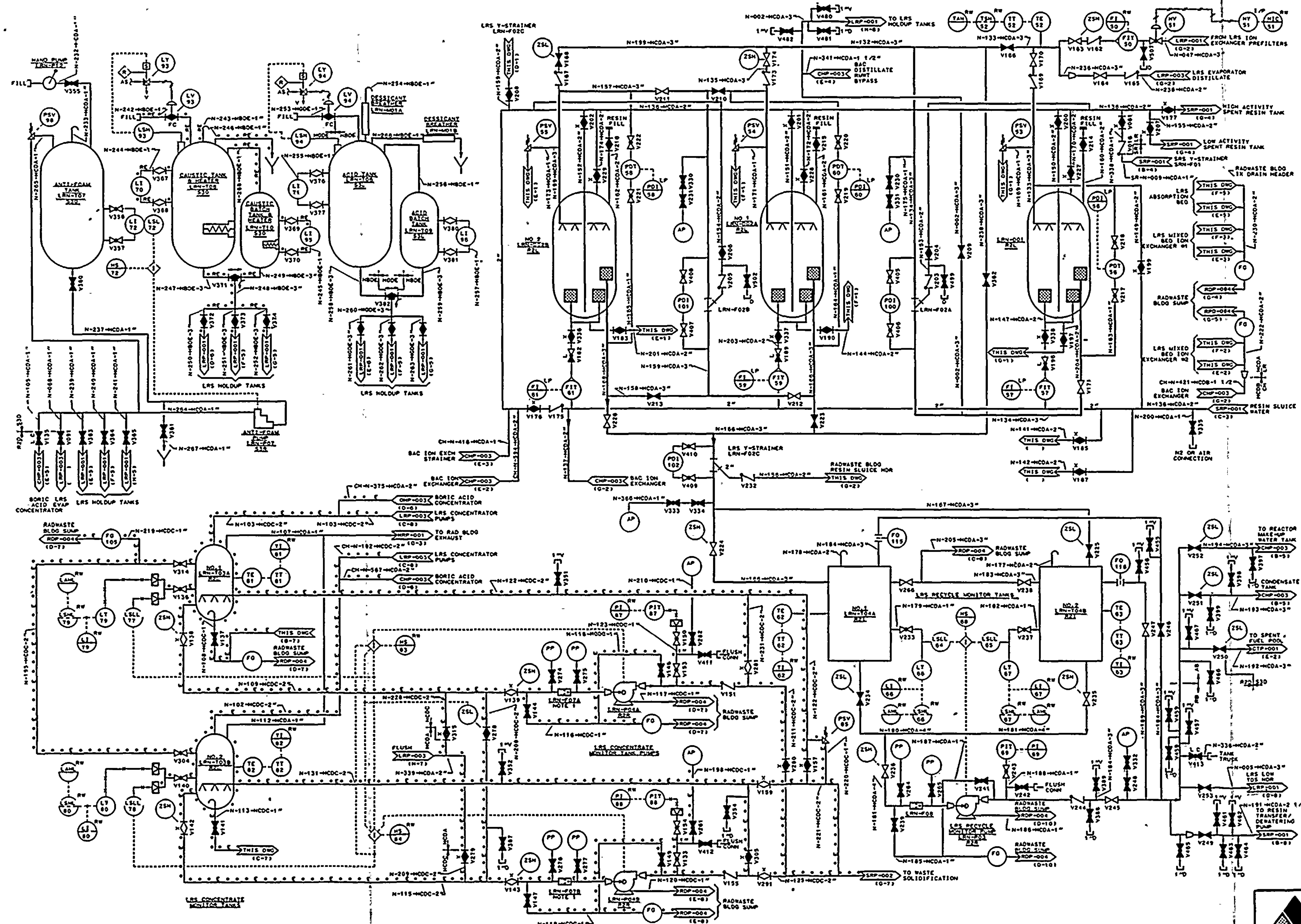


13-N-LRP-001 REV 3

Palo Verde Nuclear Generating Station
ER-OL

P&I DIAGRAM
LIQUID RADWASTE SYSTEM
(Sheet 1 of 3)

Figure 3.5-2



NOTES:

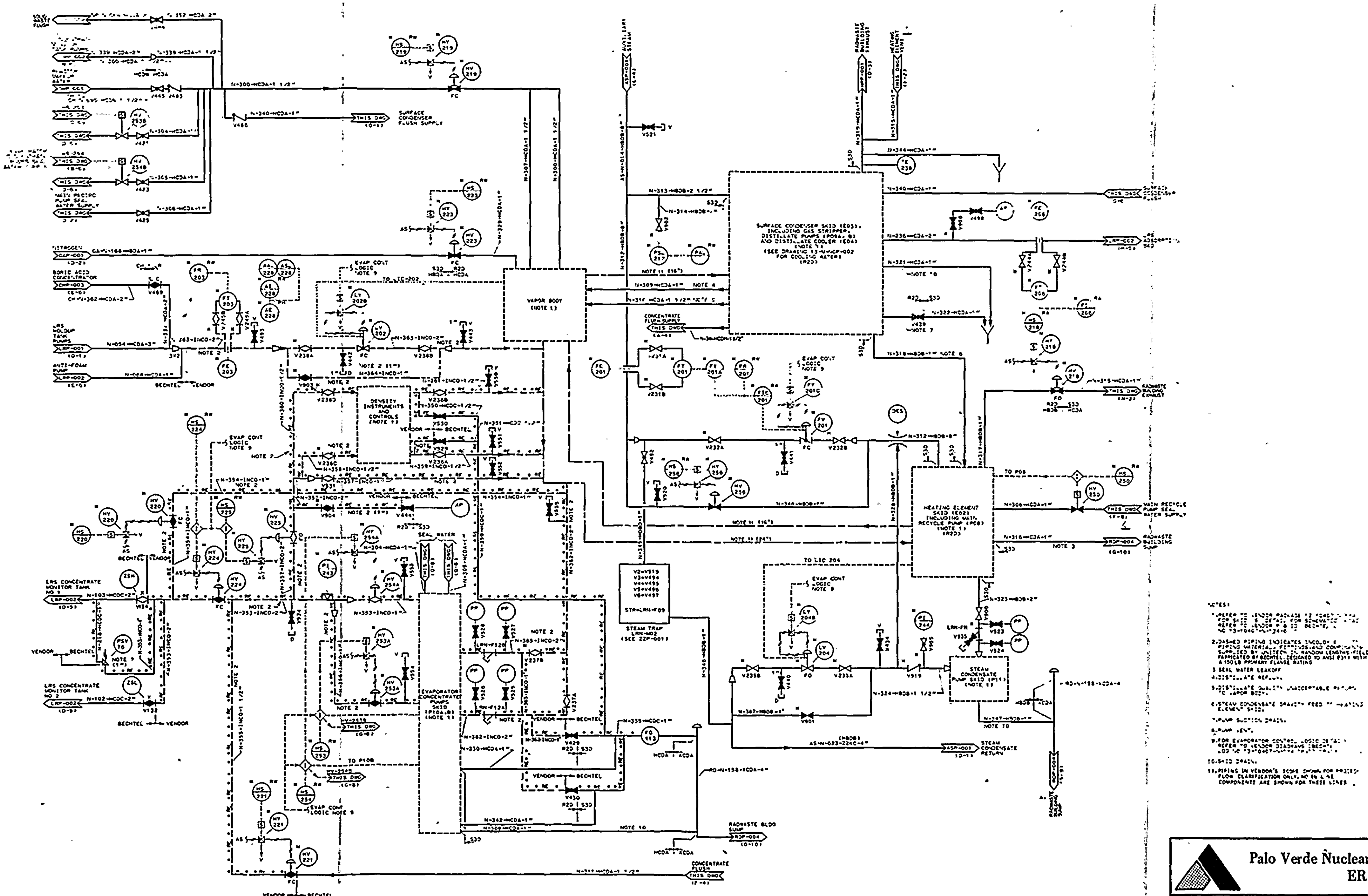
1. THE REMOVABLE STARTUP STRAINERS DOWNSTREAM OF THE LRS CONCENTRATE MONITOR TANKS MUST BE REMOVED BEFORE ANY CONCENTRATE ENTERS THE SYSTEM.
2. THE SYSTEM DESIGNATOR LR IS TO PRECEDE ALL LINE, VALVE, AND INSTRUMENT NUMBERS SHOWN ON THIS DRAWING UNLESS OTHERWISE INDICATED.

13-N-LRP-002 REV 3

Palo Verde Nuclear Generating Station
ER-OL

P&I DIAGRAM
LIQUID RADWASTE SYSTEM
(Sheet 2 of 3)

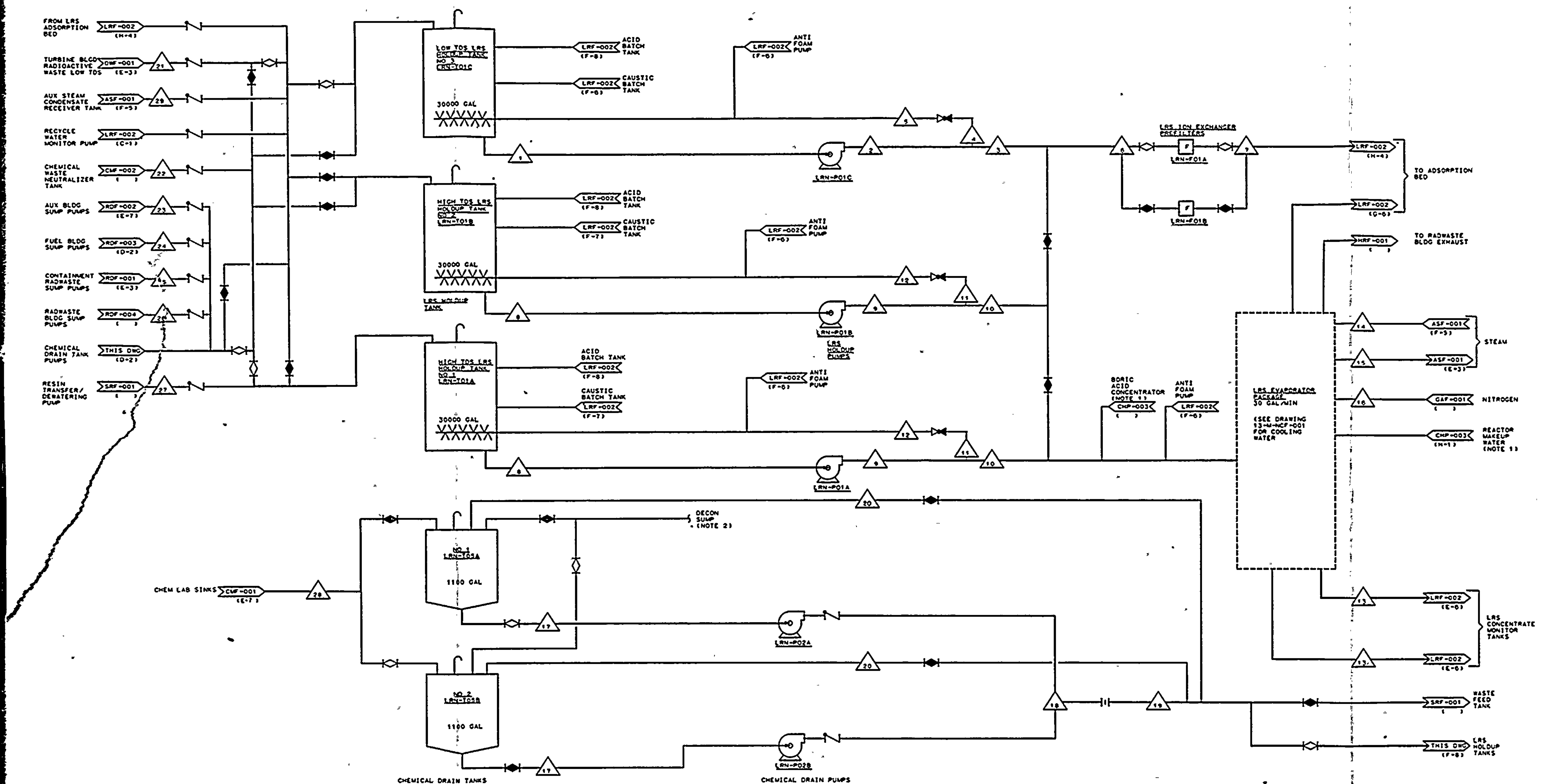
Figure 3.5-2



13-N-LRP-003 REV 1

Palo Verde Nuclear Generating Station
ER-OL

P&I DIAGRAM
LIQUID RADWASTE SYSTEM
(Sheet 3 of 3)
Figure 3.5-2



MODE	PARAMETER	1	2	3	4	5	6	7	8	9	10	11	12	13
		BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	[illegible]
NORMAL OPERATION	FLOW (GPM)	250	250	100	150	150	100	100	250	250	30	220	220	50
	TEMPERATURE (°F)	80	80	80	80	80	80	80	80	80	80	80	80	224
	PRESSURE (PSIA)	18	112	107	107	42	92	67	18	112	107	107	55	50
SAMPLE MODE	FLOW (GPM)	160	160	-	160	160	-	-	230	230	-	230	230	-
	TEMPERATURE (°F)	120	120	-	120	120	-	-	120	120	-	120	120	-
	PRESSURE (PSIA)	14	120	-	117	45	-	-	12	115	-	111	57	-
MAXIMUM DESIGN	FLOW (GPM)	250	250	100	160	160	100	100	250	250	30	230	230	50
	TEMPERATURE (°F)	120	120	120	120	120	120	120	120	120	120	120	120	224
	PRESSURE (PSIA)	24	112	107	117	45	92	67	24	112	107	111	57	50
	FLOW (GPM)													
	TEMPERATURE (°F)													
	PRESSURE (PSIA)													
	FLOW (GPM)													
	TEMPERATURE (°F)													
	PRESSURE (PSIA)													
	FLOW (GPM)													
	TEMPERATURE (°F)													
	PRESSURE (PSIA)													

MODE	PARAMETER	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
		BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	[illegible]	[illegible]	[illegible]	[illegible]	BATCH	[illegible]	[illegible]
NORMAL OPERATION	FLOW (GPM)	22,000 (7)	22,000 (7)	-	30	30	30	-	120 (3)	-	50 (3)	150 (3)	50 (3)	50 (3)	100	6 (9)	-
	TEMPERATURE (°F)	340	300	AMB	80	80	80	-	80	-	80	80	80	80	80	80	-
	PRESSURE (PSIA)	50	50	25 (8)	17	88	65	-	30	-	50	30	33	30	30	15	-
SAMPLE MODE	FLOW (GPM)	-	-	-	55	55	55	55	-	-	-	-	-	-	-	-	-
	TEMPERATURE (°F)	-	-	-	120	120	120	120	-	-	-	-	-	-	-	-	-
	PRESSURE (PSIA)	-	-	-	15	86	21	15	-	-	-	-	-	-	-	-	-
MAXIMUM DESIGN	FLOW (GPM)	22,000 (7)	22,000 (7)	-	55	55	55	55	200 (6)	400	130 (4)	325 (5)	70 (6)	70 (6)	100	6 (9)	100 (7)
	TEMPERATURE (°F)	340	300	AMB	120	120	120	120	120	120	120	140	120	120	120	120	212
	PRESSURE (PSIA)	50	50	25 (8)	15	86	21	15	30	100	100	45	43	65	30	15	80
	FLOW (GPM)																
	TEMPERATURE (°F)																
	PRESSURE (PSIA)																
	FLOW (GPM)																
	TEMPERATURE (°F)																
	PRESSURE (PSIA)																
	FLOW (GPM)																
	TEMPERATURE (°F)																
	PRESSURE (PSIA)																

NOTES:
1. THE CH SYSTEM HAS NO FLOW DIAGRAM
2. UNIT NO. 1 ONLY
3. ONE SUMP PUMP IN OPERATION.
4. SIX SUMP PUMPS IN OPERATION.
5. FOUR SUMP PUMPS IN OPERATION.
6. TWO SUMP PUMPS IN OPERATION
7. LB/HR
8. BATCH DISCHARGE ONLY.
9. GRAVITY FLOW

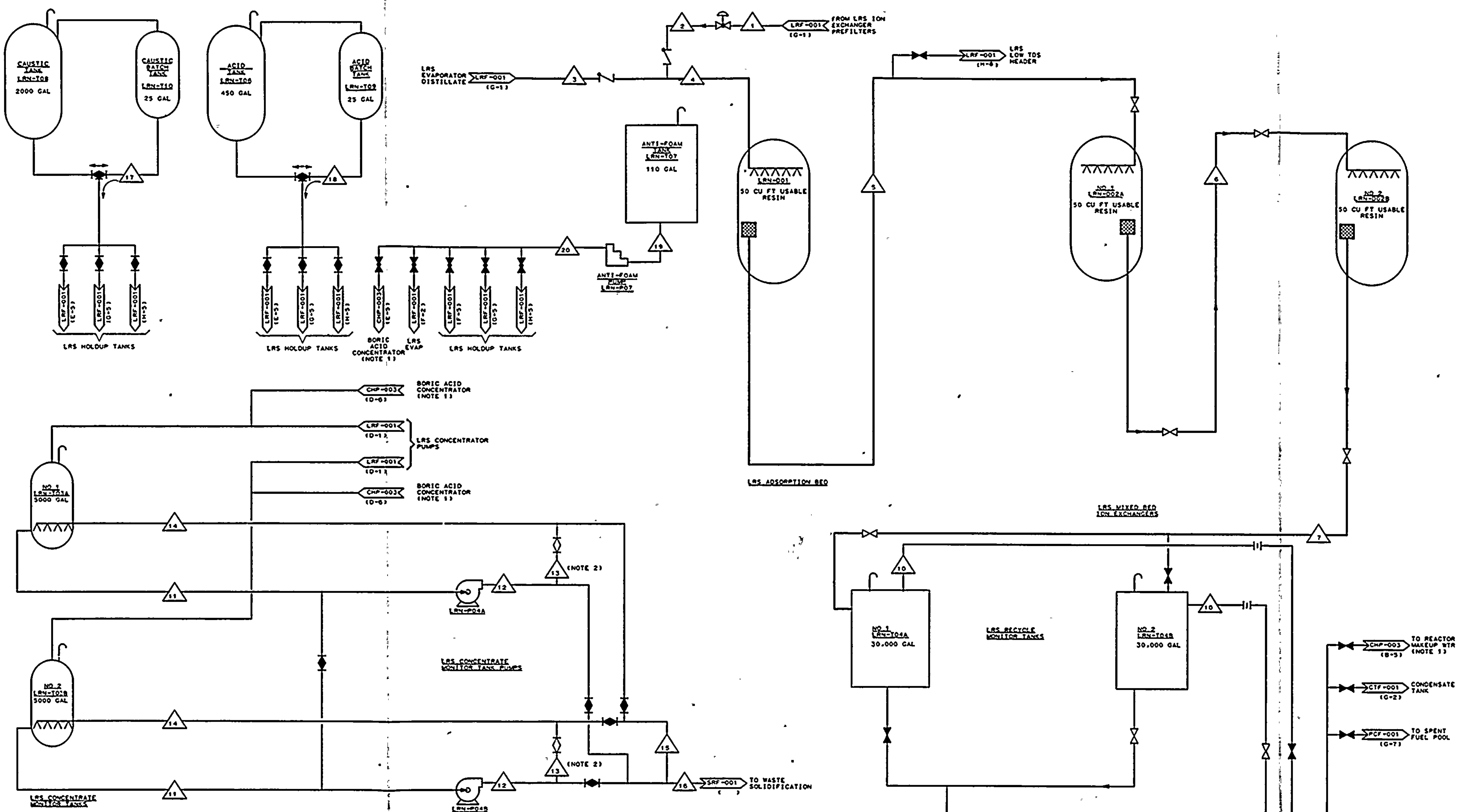
THE DATA SHOWN ON THIS FLOW DIAGRAM ARE FOR DESIGN PURPOSES ONLY, AND WHILE USEFUL AS GUIDES IN OPERATION, DO NOT REPRESENT EXACT OR GUARANTEED OPERATING CONDITIONS.

13-N-LRF-001 REV 0

Palo Verde Nuclear Generating Station
ER-OL

BASIC FLOW DIAGRAM
LIQUID RADWASTE SYSTEM
(Sheet 1 of 2)

Figure 3.5-3



MODE	PARAMETER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20					
		BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH	BATCH					
MAXIMUM DESIGN	FLOW (GPM)	100	100	30	130	130	130	130	160	160	160	60	60	60	60	50	10	G (3)	G (3)	50(4)	50(4)					
	TEMPERATURE (°F)	120	120	125	125	125	125	125	120	120	120	170	170	170	170	170	170	120	120	120	120					
	PRESSURE (PSIA)	63	53	49	49	39	29	15	24	65	15	19	61	57	53	54	54	17	17	17	115					
LOW TDS FLOW ONLY	FLOW (GPM)	100	100	-	100	100	100	100	-	-	-	-	-	-	-	-	-	-	-	-	-					
	TEMPERATURE (°F)	120	120	-	120	120	120	120	-	-	-	-	-	-	-	-	-	-	-	-	-					
	PRESSURE (PSIA)	63	44	-	40	33	26	15	-	-	-	-	-	-	-	-		-	-	-	-					
EVAPORATOR DISTILLATE ONLY	FLOW (GPM)	-	-	30	30	30	30	30	-	-	-	-	-		-	-	-	-	-	-	-					
	TEMPERATURE (°F)	-	-	125	125	125	125	125	-	-	-	-	-	-	-	-		-		-	-					
	PRESSURE (PSIA)	-	-	29	29	25	21	15	-	-	-	-	-	-		-	-	-	-	-	-					
NORMAL OPERATION	FLOW (GPM)	100	100	30	130	130	130	130	150	150	-	60	60	60	60	-	-	G (3)	G (3)	50(4)	50(4)					
	TEMPERATURE (°F)	80	80	125	125	125	125	125	80	80	-	170	170	170	170	-	-	80	80	80	80					
	PRESSURE (PSIA)	63	53	49	49	39	29	15	18	63	-	16	61	57	53	-	-	17	17	17	115					
SAMPLE MODE	FLOW (GPM)	-	-	-	-	-	-	-	160	160	160	60	60	60	60	-	-	-	-	-	-					
	TEMPERATURE (°F)	-	-	-	-	-	-	-	120	120	120	170	170	170	170	-	-		-	-	-					
	PRESSURE (PSIA)	-	-	-	-	-	-	-	18	65	15	16	61	57	53	-	-	-	-	-	-					
CONCENTRATE TRANSFER TO WASTE SOLIDIFICATION	FLOW (GPM)	-	-	-	-	-	-	-	-	-	-	50	50	-	50	50	10	-		-	-					
	TEMPERATURE (°F)	-	-	-	-	-	-	-	-	-	-	170	170	-	170	170	170	-		-	-					
	PRESSURE (PSIA)	-	-	-	-	-			-	-	-	16	64	-	44	54	54	-	-	-						

NOTE:

1. THE CH SYSTEM HAS NO FLOW DIAGRAM
2. WHEN CONCENTRATE SOLUTION CONTAINS A CRYSTALINE SLURRY CONCENTRATE MONITOR TANK CONTENTS MUST BE CONTINUOUSLY RECIRCULATED USING THE SAMPLE MODE RETURN LOOP (VIA NODE 13) TO MAINTAIN SUSPENSION OF CRYSTALS IN SOLUTION.
3. GRAVITY FLOW
4. GAL/HR

THE DATA SHOWN ON THIS FLOW DIAGRAM ARE FOR DESIGN PURPOSES ONLY, AND WHILE USEFUL AS GUIDES IN OPERATION, DO NOT REPRESENT EXACT OR GUARANTEED OPERATING CONDITIONS.

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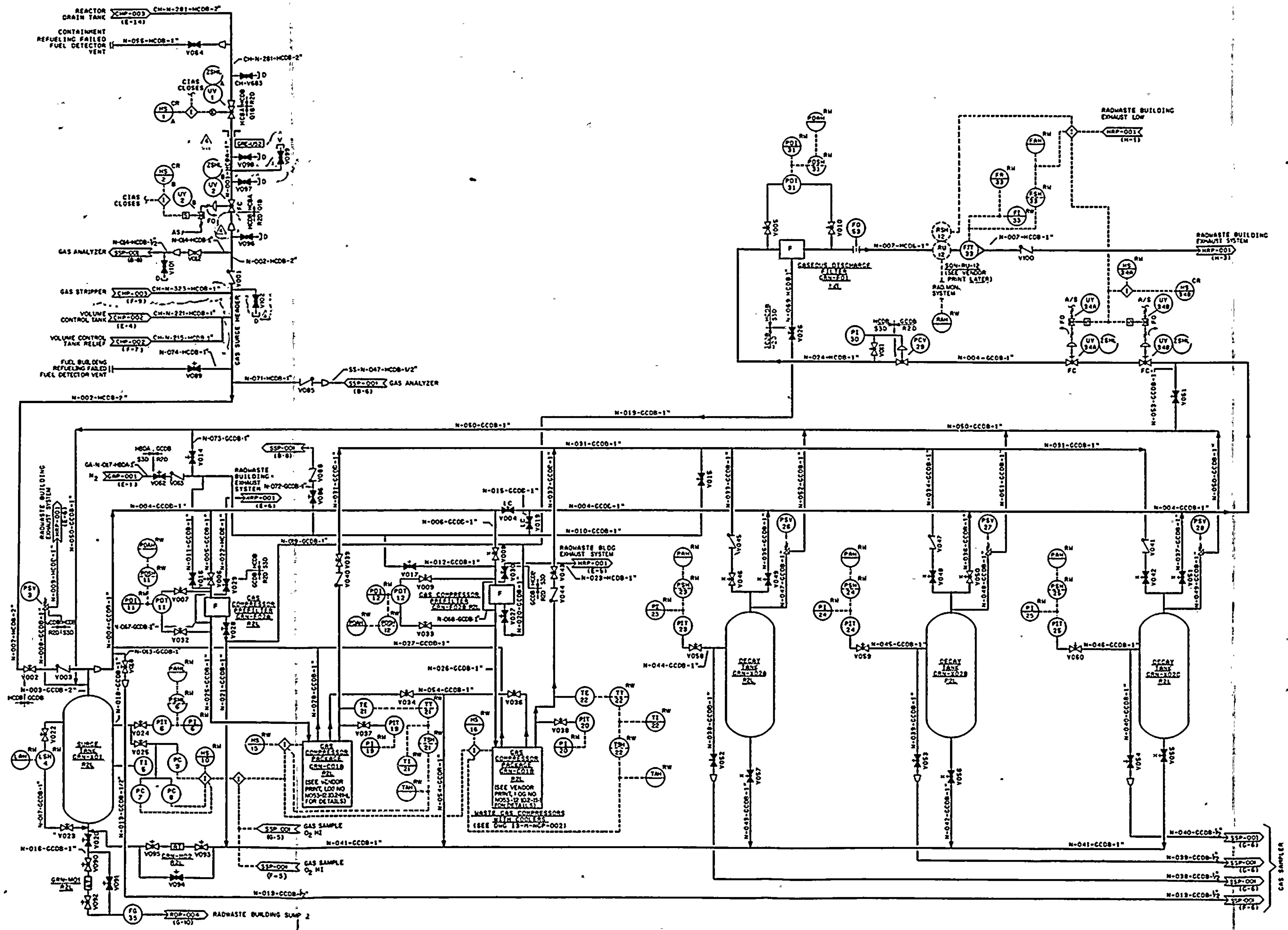
Palo Verde Nuclear Generating Station
ER-OL

FLOW DIAGRAM
LIQUID RADWASTE SYSTEM
(Sheet 2 of 2)
Figure 3.5-3

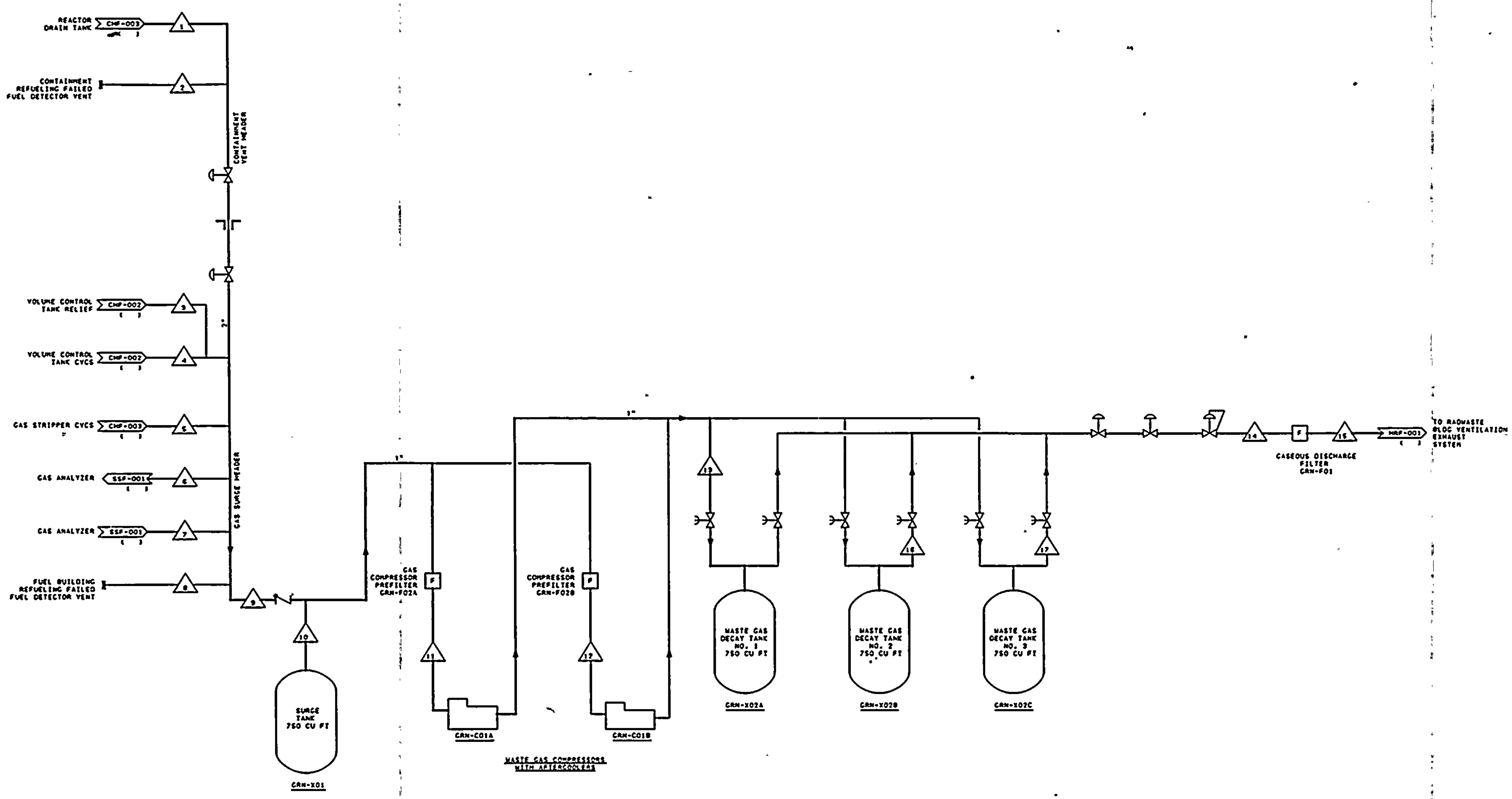


13-N-GRP-001 REV 4

Palo Verde Nuclear Generating Station
ER-OL

P&I DIAGRAM
GASEOUS RADWASTE SYSTEM

Figure 3.5-4



MODE	PARAMETER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
MAXIMUM COLLECTION AND STORAGE	FLOW (SCFM)	20	1	0	0	20	0	0.2	1	42.2	22.2	10	10	20	0	0	0	0
	TEMPERATURE (°F)	120	125	AMB	AMB	145	AMB	145	125	145	145	145	145	171	AMB	AMB	AMB	AMB
	PRESSURE (PSIA)	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	364.7	14.7	14.7	364.7	14.7
NORMAL DISCHARGE	FLOW (SCFM)	0.001	0	0	0	0.34	0	0.04	0	0.38	9.62	10	0	10	50	50	50	0
	TEMPERATURE (°F)	120	AMB	AMB	AMB	145	AMB	145	AMB	145	145	145	AMB	171	25	AMB	AMB	AMB
	PRESSURE (PSIA)	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	364.7	25.3	14.7	364.7	14.7
VENTING VCT	FLOW (SCFM)	0	0	0	20	0	0	0	0	20	0	10	10	20	0	0	0	0
	TEMPERATURE (°F)	120	AMB	AMB	140	145	AMB	145	AMB	145	145	145	145	171	AMB	AMB	AMB	AMB
	PRESSURE (PSIA)	18.2	18.2	74.7	74.7	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	364.7	14.7	14.7	364.7	14.7
RELIEVING VCT	FLOW (SCFM)	0	0	90	0	0	0	0	0	90	70	10	10	20	0	0	0	0
	TEMPERATURE (°F)	120	AMB	140	140	145	AMB	145	AMB	140	140	140	140	171	AMB	AMB	AMB	AMB
	PRESSURE (PSIA)	18.2	18.2	84.7	84.7	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	364.7	14.7	14.7	364.7	14.7
EXPECTED COLLECTION AND STORAGE	FLOW (SCFM)	0.001	0	0	0	0.34	0	0.04	0	0.38	9.62	10 000	0	10	0	0	0	0
	TEMPERATURE (°F)	100	AMB	AMB	AMB	120	AMB	120	AMB	120	100	100	AMB	125	AMB	AMB	AMB	AMB
	PRESSURE (PSIA)	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	200	14.7	14.7	364.7	14.7

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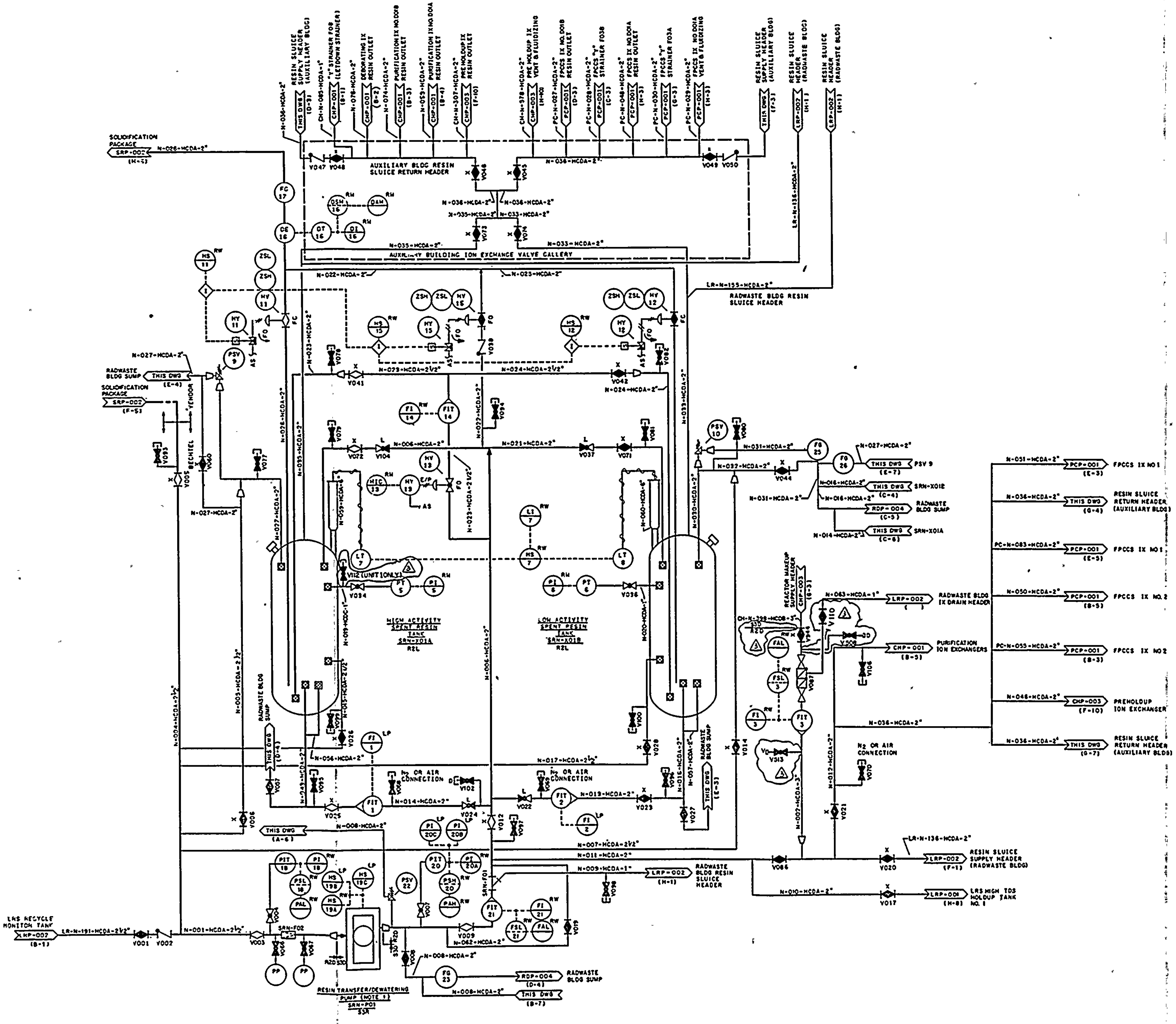
13-N-GRF-001 REV 0

Palo Verde Nuclear Generating Station
ER-OL

BASIC FLOW DIAGRAM
GASEOUS RADWASTE SYSTEM

Figure 3.5-5

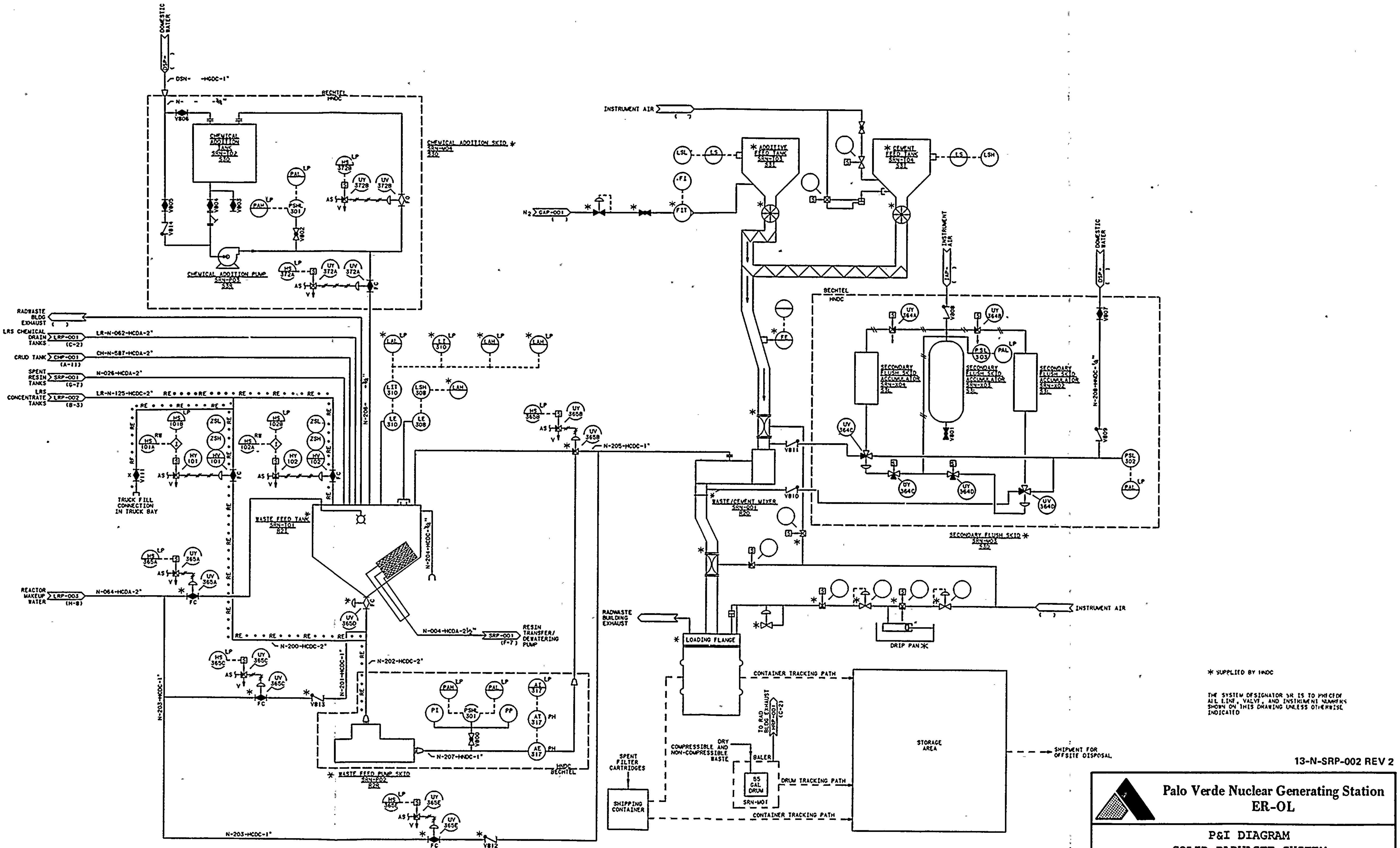


13-N-SRP-001 REV 3

Palo Verde Nuclear Generating Station
ER-OL

P & I DIAGRAM
SOLID RADWASTE SYSTEM
(Sheet 1 of 2)

Figure 3.5-6

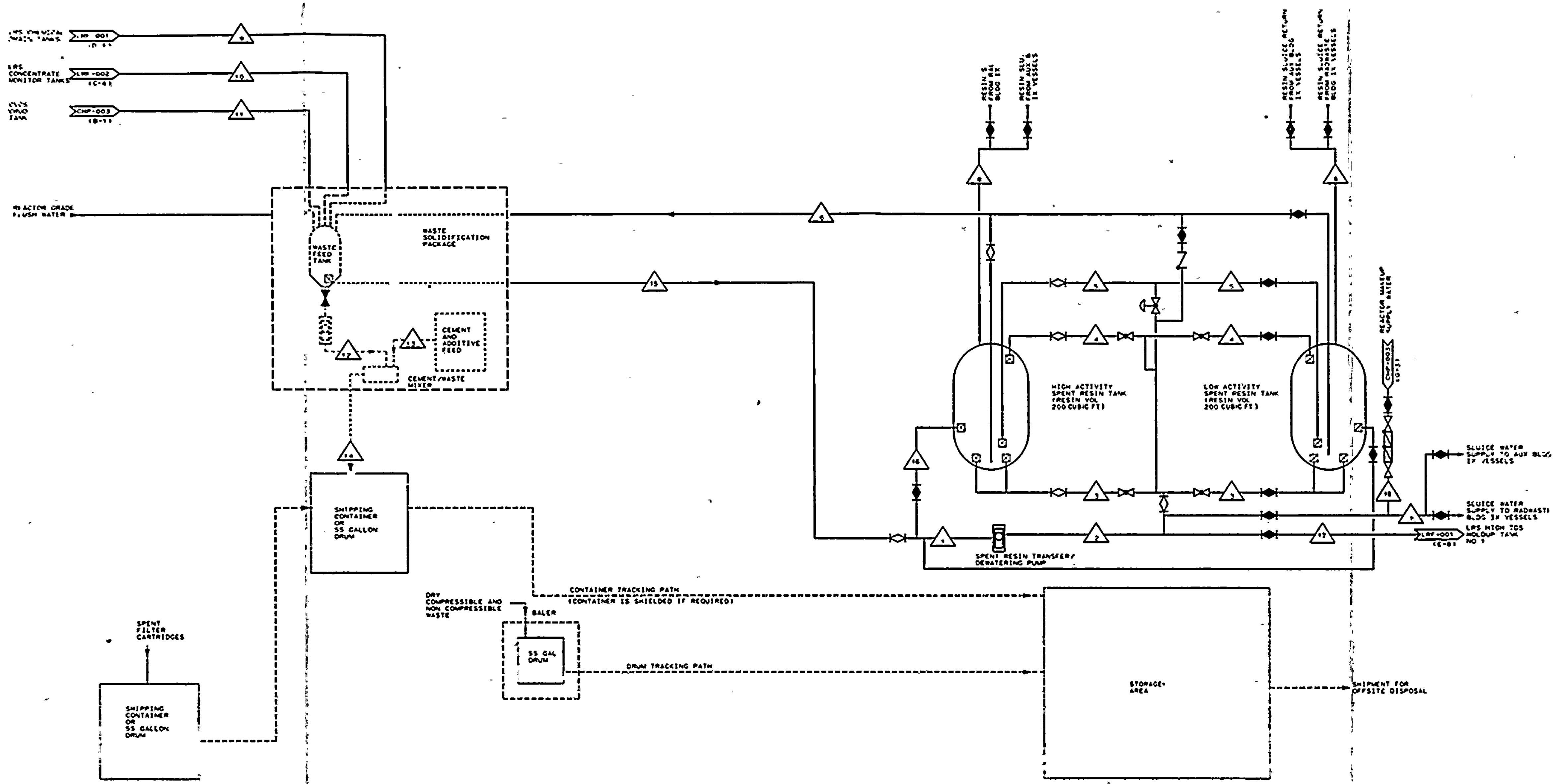


13-N-SRP-002 REV 2

Palo Verde Nuclear Generating Station ER-OL

P&I DIAGRAM
SOLID RADWASTE SYSTEM
(Sheet 2 of 2)

Figure 3.5-6



MODE	PARAMETER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
RECIRCULATING WASTE FEED TANK PRIOR TO RESIN SLUICING	FLOW (GPM)	75	75	0	0	0	75	0	0	0	0	0	0	0	0	75	—	—	—
	TEMPERATURE (°F)	170	170	—	—	—	170	—	—	—	—	—	—	—	—	170	—	—	—
	PRESSURE (PSIA)	109	1212	—	—	—	228	—	—	—	—	—	—	—	—	15	—	—	—
SLUICING RESIN FROM A SPENT RESIN TANK TO WASTE FEED TANK	FLOW (GPM)	75	75	5	15	55	75	0	0	0	0	0	0	0	0	75	—	—	—
	TEMPERATURE (°F)	170	170	170	120	120	120	—	—	—	—	—	—	—	—	170	—	—	—
	PRESSURE (PSIA)	109	1212	831	831	833	228	—	—	—	—	—	—	—	—	15	—	—	—
RESIN TRANSFER FROM RADWASTE BUILDING I.X. TO A SPENT RESIN TANK	FLOW (GPM)	75	75	0	0	0	0	75	75	0	0	0	0	0	0	—	75	75	75
	TEMPERATURE (°F)	120	120	—	—	—	—	120	120	—	—	—	—	—	—	—	120	120	120
	PRESSURE (PSIA)	10	150	—	—	—	—	150	20	—	—	—	—	—	—	—	20	100	130
FLOW INPUTS TO WASTE FEED TANK	FLOW (GPM)	—	—	—	—	—	—	—	—	55	10	50	—	—	—	—	—	—	—
	TEMPERATURE (°F)	—	—	—	—	—	—	—	—	120	170	70	—	—	—	—	—	—	—
	PRESSURE (PSIA)	—	—	—	—	—	—	—	—	65	54	200	—	—	—	—	—	—	—
SOLIDIFICATION SYSTEM PROCESSING WASTE	FLOW (GPM)	—	—	—	—	—	—	—	—	—	—	—	16	250*	380*	—	—	—	—
	TEMPERATURE (°F)	—	—	—	—	—	—	—	—	—	—	—	170	—	—	—	—	—	—
	PRESSURE (PSIA)	—	—	—	—	—	—	—	—	—	—	—	120	—	—	—	—	—	—
SLUICING RESIN FROM AN AUX. BLDG. I.X. TO A SPENT RESIN TANK	FLOW (GPM)	75	75	0	0	0	0	75	75	C	0	0	0	0	0	—	75	75	75
	TEMPERATURE (°F)	170	170	—	—	—	—	70	120	—	—	—	—	—	—	—	70	70	120
	PRESSURE (PSIA)	10	150	—	—	—	—	150	2C		—	—	—	—	—	—	20	150	130

* POUNDS OF CEMENT PER MINUTE

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Palo Verde Nuclear Generating Station
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BASIC FLOW DIAGRAM
SOLID RADWASTE SYSTEM

Figure 3.5-7

3.6 CHEMICAL AND BIOCIDE WASTES

Information presented in ER-CP Section 3.6 and the FES has been updated. As part of this update, detailed parameters such as flowrates, chemical consumption and operational frequencies are presented.

3.6.1 PREOPERATIONAL AND PERIODIC CLEANING WASTES

Prior to the initial startup of each unit, the feedwater system from the condensers to the containment isolation valves (approximately 450,000 gal) will be flushed and chemically cleaned to remove dirt, grease, oil, rust, and mill scale. This will be accomplished by the following operations:

A. Dirt and construction debris, estimated at 7470 lb, will be removed by flushing the piping with a high velocity water flush of approximately two system volumes of demineralized water.

B. Chemical cleaning is not expected to be required. Should it become necessary, however, the following steps would be performed:

   1. Grease, oil, and dirt, estimated at 3735 lb, will be removed by flushing each system with approximately 450,000 gallons of an alkaline phosphate solution of approximately 1% concentration. This will be followed with a rinse of approximately two system volumes of demineralized water.

   2. Rust and mill scale will be removed from each system by circulating a 3% organic acid (2% hydroxyacetic, 1% formic) solution containing a 0.2% acid inhibitor, such as Dow Chemical Co. A-145, for several hours. This will be followed with a rinse of approximately two system volumes of demineralized water containing an estimated 5600 lb of citric acid. An estimated 33,615 lb of iron will be removed.

c. The system may be passivated by filling with demineralized water containing 200-400 ppm hydrazine and 0-60 ppm ammonia, to a pH of 9.0-10.0.

Estimated total water volume used in a complete cleaning would be approximately 4,050,000 gallons.

Wastes from this cleaning process will be directed to the onsite evaporation ponds. Periodic, non-radioactive operational equipment cleaning wastes will be discharged to the evaporation ponds.

3.6.2 NONRADIOACTIVE OPERATIONAL WASTES

The plant is designed to have no requirement for offsite disposal of any chemical or liquid wastes. Operational nonradioactive liquid wastes are collected and discharged to the onsite evaporation ponds.

During normal operation of the plant, nonradioactive wastes come from the following sources:

- Water reclamation plant
- Circulating water system
- Demineralized water system
- Domestic water system
- Condensate polishing demineralizer system
- Laboratories and laundry
- Floor drains

Figure 3.3-1 diagrams all plant water and wastewater flows and includes a tabulation of the respective flow rates at various operating conditions. Table 3.6-1 includes a summary of the expected maximum and average concentrations of dissolved solids in the plant influent water from the City of Phoenix 91st Avenue Sewage Treatment Plant and the onsite wells. The table includes the quality of the circulating water which is discharged as cooling tower blowdown and drift.

Table 3.6-1

ESTIMATED MAXIMUM AND AVERAGE CONCENTRATION OF CHEMICALS IN THE INFLUENT AND EFFLUENT WATER SYSTEMS (ppm) (Sheet 1 of 2)

Chemical	Influent Streams				Effluent Streams	
	Influent from Phoenix 91st Avenue Sewage Treatment Plant		Influent from Onsite Wells		Effluent from Circulating Water System (Cooling Tower Blowdown and Drift)	
	Maximum	Average	Maximum	Average	Maximum (20 cycles)	Average (15 cycles)
Calcium	67.2	52.9	250.0	41.0	356.0	336.0
Magnesium	29.6	22.9	130.0	19.0	34.0	29.0
Sodium	192	186	1,800.0	590.0	5,400.0	4,620.0
Chloride	270	253	3,250.0	740.0	5,140.0	4,650.0
Sulfate	95.0	91.0	1,330.0	220.0	3,500.0	2,750.0
Nitrate	4.20	1.85	200.0	30.0	2,300.0	1,990.0
Silica	32.0	28.8	44.0	40.0	83.0	72.0
Phosphate	68.9	22.1	--	0.1	7.2	5.0
Fluoride	4.8	3.5	10.0	6.2	24.0	18.0
Potassium	14.7	13.8	8.0	3.2	--	--
Copper	0.022	0.017	0.1	0.04	6.0	2.3
Zinc	0.080	0.067	--	--	0.8	0.6
Iron	0.041	0.035	0.1	0.08	3.5	1.0
Arsenic	0.006	0.005	0.02	0.01	0.4	0.3

Table 3.6-1

ESTIMATED MAXIMUM AND AVERAGE CONCENTRATIONS OF CHEMICALS IN THE INFLUENT AND EFFLUENT WATER SYSTEMS (ppm) (Sheet 2 of 2)

Chemical	Influent Streams				Effluent Streams	
	Influent from Phoenix 91st Avenue Sewage Treatment Plant		Influent from Onsite Wells		Effluent from Circulating Water System (Cooling Tower Blowdown and Drift)	
	Maximum	Average	Maximum	Average	Maximum (20 cycles)	Average (15 cycles)
Boron	0.09	0.037	7.0	3.2	5.6	4.2
Ammonia-N	45.4	30.9	0.3	0.08	15.0	12.5
Phenol	0.018	0.009	0.01	0.009	0.01	0.006
Dissolved Oxygen	8.2	6.7	--	--	7.0	7.0
Suspended Solids	68	35.7	--	--	150.0	110.0
COD	187.7	87	14.0	6.0	660.0	514.0
Alkalinity	285	272	230.0	143.0	65.0	38.0
TDS	1,083	1,039	5,980.0	1,520.0	17,000.0	14,600.0

3.6.2.1 Water Reclamation Plant

The water reclamation plant receives the wastewater effluent from the City of Phoenix 91st Avenue Sewage Treatment Plant, processes it further in four stages of treatment, and stores it in the onsite reservoir. This onsite treatment of the station makeup water is required to reduce the concentration levels of calcium, phosphate, silica, magnesium, and ammonia. Some incidental removal of organics occurs. The removal of these compounds allows the treated effluent to be concentrated to approximately 15 cycles in each generating unit circulating water system without excessive scaling or fouling of system components and heat exchangers.

The water reclamation plant process is shown schematically in figure 3.6-1. The four stages of treatment are:

- Biological nitrification
- Lime treatment
- Filtration
- Chlorination

The influent to the water reclamation plant (WRP) consists of effluent from the Phoenix treatment plant which provides primary sedimentation and secondary activated sludge treatment.

No further removal of organics is required in order to use the WRP influent water for cooling purposes in the power plant; therefore, treatment processes in the WRP have not been designed to remove organics. However, some incidental removals will occur in certain processes as estimated by the following:

Treatment Process	Removal
Biological nitrification (see section 3.6.2.1.1)	10 to 20% removal of dissolved (or colloidal) organics, measured as BOD_5 (5-day

Treatment Process	Removal
	bio-chemical oxygen demand) or COD (chemical oxygen demand).
Lime soda softening and clarification (see section 3.6.2.1.2)	Better than 95% removal of suspended organics, measured as volatile suspended solids, and 5 to 10% removal of colloidal BOD_5 and COD.
Entire WRP, considered as a whole	Better than 95% removal of suspended organics, and 10 to 25% removal of dissolved or colloidal organics.

The WRP influent will contain an average of about 30 mg/ℓ BOD_5, 40 mg/ℓ suspended solids, and 100 mg/ℓ COD. Lime clarification should provide high removal rates for viruses and bacteria, so pathogen levels in the WRP effluent are expected to be low. However, this water is expected to contain the broad spectrum of organics which typically occur in secondary sewage effluent due to their relative resistance to biodegradation.

3.6.2.1.1 Biological Nitrification

Biological nitrification refers to the bacterial conversion of ammonia nitrogen to the nitrate nitrogen form. The following equations summarize the two-step reaction:

$$NH_4^+ + 3/2\ O_2 \xrightarrow{\text{bacteria}} NO_2^- + 2H^+ + H_2O$$

$$NO_2^- + 1/2\ O_2 \xrightarrow{\text{bacteria}} NO_3^-$$

For nitrification, the trickling filter process has been selected. In this process, nitrifying bacteria are attached to a solid medium along with other microorganisms. By distribution

of the wastewater effluent over the medium, ammonia comes into contact with the nitrifying bacteria and is oxidized along with organic materials in the water.

3.6.2.1.2 Lime Treatment

Following nitrification, the effluent is passed through a two-stage lime treatment process to reduce the concentrations of calcium, phosphate, silica, and magnesium.

The first stage of treatment is the addition of lime (CaO), which produces a reaction between the calcium ion and the orthophosphate ion to precipitate the insoluble compound hydroxyapatite ($Ca_{10}(OH)_2(PO_4)_6$). Simultaneously, the lime reacts with bicarbonate alkalinity, precipitating calcium carbonate. Because the addition of lime raises the pH, the solubility of the hydroxyapatite decreases. At a pH of approximately 11, most of the phosphate has been converted to this insoluble form. At this pH, the precipitation of magnesium hydroxide occurs and silica is adsorbed in the precipitate.

The water, which still contains some dissolved calcium carbonate and noncarbonate calcium hardness, flows to the second stage solids contact clarifier. Here, soda ash (Na_2CO_3) is added to precipitate the noncarbonate calcium hardness. At the same time, carbon dioxide gas is added to the flow stream to lower the pH and precipitate the excess calcium remaining in the water. The precipitated solids are settled in the clarifier, producing a sludge that is high in calcium carbonate and ideally suited for recalcination.

Following the second stage of lime treatment, the water still contains solids that have not been removed by flocculation and settling. With a pH of approximately 10, the liquid is generally supersaturated with calcium carbonate. Therefore, a small amount of sulfuric acid is added to lower the pH to approximately 9. This increases the solubility of the calcium

carbonate still in solution so it will not precipitate on the succeeding filtration media.

3.6.2.1.3 Chlorination

Chlorination of the reclaimed water is provided for biological growth control of the water prior to storage in the reservoir. A maximum of approximately 1.8 tons of chlorine per day is to be used in the water reclamation plant. Chlorine is added as a sodium hypochlorite solution.

3.6.2.1.4 Filtration

Effluent from the chlorination process is filtered to remove residual amounts of suspended phosphorus, calcium, and other solids as shown in figure 3.6-1. The filtration process increases the reliability of the effluent quality by preventing the possibility of a carryover of suspended solids from the lime treatment process.

The water reclamation plant includes trickling filter units and gravity filtration units. The trickling filter media consist of a PVC plastic tower packing which supports a film of microbiological organisms. The gravity filtration media consists of a 12-inch layer of 0.5 mm diameter silica sand supporting a 24-inch layer of 0.9 mm diameter anthracite coal.

3.6.2.1.5 Wastes Generated

Wastes generated from the water reclamation plant consist of the precipitated solids from the lime softeners. These solids are directed to a recalciner where a portion of the sludge is recalcinated into lime (CaO) and is reused in the lime softeners. Solid waste handling from the water reclamation plant is discussed in section 3.7.

3.6.2.2 Circulating Water System

Each generating unit is provided with an independent circulating water system. This system, shown schematically in figure 3.6-2, removes waste heat developed during normal operation and rejects it to the atmosphere via the three mechanical draft cooling towers. The circulating water system is discussed in section 3.4.

Waste from the circulating water system consists of blowdown and drift from the cooling towers. Blowdown is continuously discharged to the evaporation ponds as required to maintain water quality. Drift is maintained at approximately 0.0044% of the 587,000 gal/min combined flow of the circulating water and plant cooling water system by the use of integral drift eliminators. in the cooling towers. Drift from the cooling towers is discussed in sections 5.1 and 5.3.

Chlorine is added to the circulating system, as a sodium hypochlorite solution, to control biological growth. The amount of chlorine added is dependent upon the rate of biological growth in the circulating water. During the summer, because of increased biological growth on warm days, chlorine is injected in approximately three 40-minute injection periods per day for shock treatment. During the winter, when chlorine demand is low, only two 40-minute injection periods per day are required. It is expected that approximately 3500 pounds per day per unit of chlorine during the summer, and approximately 2300 pounds per day per unit of chlorine during the winter will be required for biogrowth control. The process consists of injecting the chlorine into the circulating water and the plant cooling water pump suctions in sufficient quantity to maintain a chlorine residual at the discharge of the condenser and heat exchangers of approximately 1 to 2 parts per million. Since the chlorine is injected in the hypochlorite form, no elemental chlorine is released to the atmosphere.

Sulfuric acid is added to maintain the pH at approximately 7 to prevent deposition of calcium carbonate scale. Acid, 66° Baumé, is diluted and distributed in the circulating water stream upstream of the circulating water pumps to ensure complete mixing and pH adjustment prior to entering the pumps. A dispersant is added to the circulating water to inhibit the formation of scale on condenser and heat exchanger tube surfaces.

The main condenser and heat exchanger tubes are titanium with negligible corrosion rate. No other sources of corrosion products are expected since the circulating water lines are constructed of concrete and the plant cooling water lines and cooling tower risers are suitably lined, as are all valves and ferrous fittings. Since the rate of corrosion is minimal, it is anticipated that no corrosion inhibitors will need to be added to the system.

3.6.2.3 Domestic Water System

The domestic water system consists of four reverse osmosis modules in parallel. The reverse osmosis product is shared between the domestic and demineralized water systems. Internal valves in the reverse osmosis system allow the output to be distributed on a 1:3, 1:1, or 3:1 basis to the receiving systems. A schematic flow diagram of the domestic water system is shown as figure 3.6-3.

The reverse osmosis modules rated at approximately 200 gallons per minute each, remove approximately 90% of the total dissolved solids (TDS) in the water, to bring the water quality within U.S. Public Health Service limits. The units reject approximately 20% of the incoming water as a concentrate containing the removed dissolved solids. This concentrate is discharged into the evaporation pond. Sodium hypochlorite is added downstream of the reverse osmosis units prior to storage in the domestic water chlorine contact tank.

3.6.2.4 Demineralized Water System

The demineralized water system consists of three mixed bed ion exchangers, two normally operating in series and one on standby. Water is supplied to the demineralized water system from the reverse osmosis units in the domestic water system. A schematic flow diagram of the demineralized water system is shown as figure 3.6-4.

The reverse osmosis product water is next passed through a degasifier, then is pumped through two mixed ion exchangers in series to remove dissolved solids to produce demineralized water.

Periodically, the resins become depleted and the ion exchangers must be regenerated. The regeneration cycle consists of a backwash to remove particulate matter, and to loosen and separate the resins, regeneration with an acid or caustic solution as appropriate, and a rinse to remove the spent regenerant. The backwash, spent regenerant, and rinse water are discharged into the spent regenerant sump. The neutralized waste in the sump is pumped to the evaporation ponds.

It is estimated that the total PVNGS use of regenerant chemicals is approximately 850 lb of sodium hydroxide and 1000 lb of sulfuric acid per day.

3.6.2.5 Condensate Polishing Demineralizer System

The secondary system fullflow condensate polishing demineralizer system, shown in figure 3.6-5, removes dissolved solids in the secondary system. The system consists of six mixed bed demineralizers (five normally in service and one on standby) with the required regeneration equipment.

In the event of a steam generator tube leak, radioactive chemical regenerant waste will be directed to the liquid radwaste system, as discussed in section 3.5. Nonradioactive, concentrated chemical regenerant waste is directed to the evaporation

ponds. Dilute waste is discharged to the main circulating water system.

An additional demineralizer system is provided for the steam generator blowdown. This system consists of a heat exchanger, mixed bed demineralizers, and the required regeneration equipment. Upon depletion of the resin in a given mixed bed, the resin is regenerated in place. The concentrated regenerant wastes are neutralized, analyzed for radioactivity, and are discharged to the evaporation ponds or to the liquid radwaste system as appropriate. Wastes low in dissolved solids are analyzed for radioactivity and are discharged to the radwaste system or to the main circulating water system.

It is estimated that one condensate polisher per unit will be regenerated every 140 hours, and that 1040 lb of sodium hydroxide and 1870 lb of sulfuric acid will be required for each regeneration. It is estimated that a blowdown polisher will be regenerated every 900 hours, using 560 lb of sodium hydroxide and 750 lb of sulfuric acid for each regeneration.

3.6.2.6 Laboratories and Dry Cleaning Laundries

Laboratories are provided for routine chemical analyses. Any radioactive samples are analyzed in separate "hot" laboratories, and all drains are directed to the liquid radwaste system. Other laboratory wastes are directed to the neutralizing tanks in the chemical waste system along with condensate and blowdown demineralizer wastes. The quantity of laboratory wastes is expected to be very small.

The laundries are dry cleaning laundries; sludge wastes are sent to the solid radwaste system.

3.6.2.7 Floor Drains

Floor drains from each unit are routed to the unit's oily-water separator prior to discharge to the evaporation ponds.

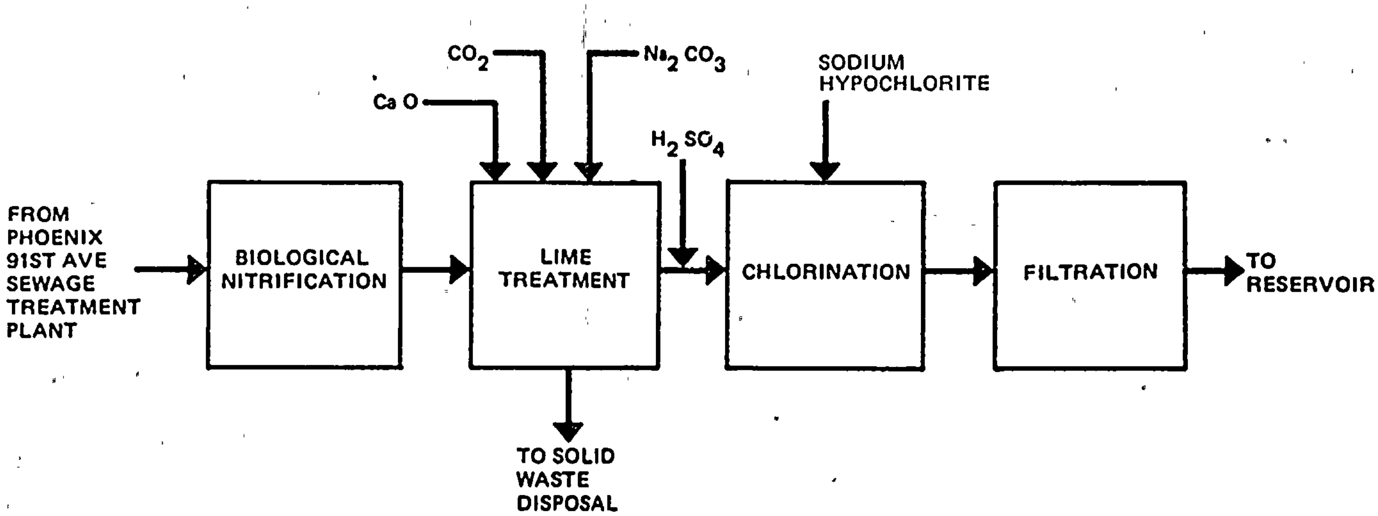
Provisions are made to direct floor drains to the liquid radwaste system or to the neutralizer tanks, if necessary.

3.6.3 NONRADIOACTIVE LIQUID WASTE DISPOSAL

All chemical and liquid waste is disposed of in the onsite evaporation ponds.

3.6.3.1 Evaporation Ponds

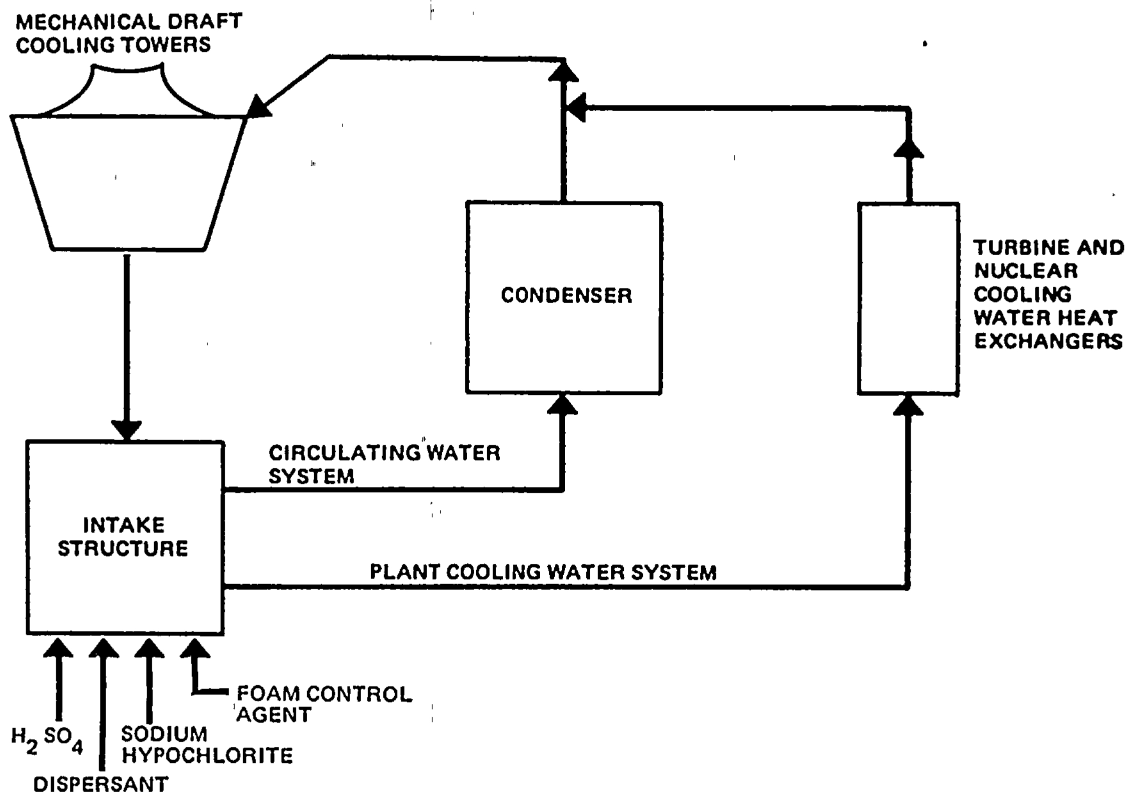
The onsite evaporation ponds receive liquid waste from the generating units and remove moisture by natural evaporation. Initially, 250 acres of evaporation ponds will be constructed. The evaporation ponds may be expanded to contain additional liquid wastes. The ponds will be lined with a suitable material to limit seepage to the groundwater. The evaporation ponds are sized to retain all liquid wastes.



Palo Verde Nuclear Generating Station
ER-OL

WATER RECLAMATION PLANT - SCHEMATIC FLOW DIAGRAM

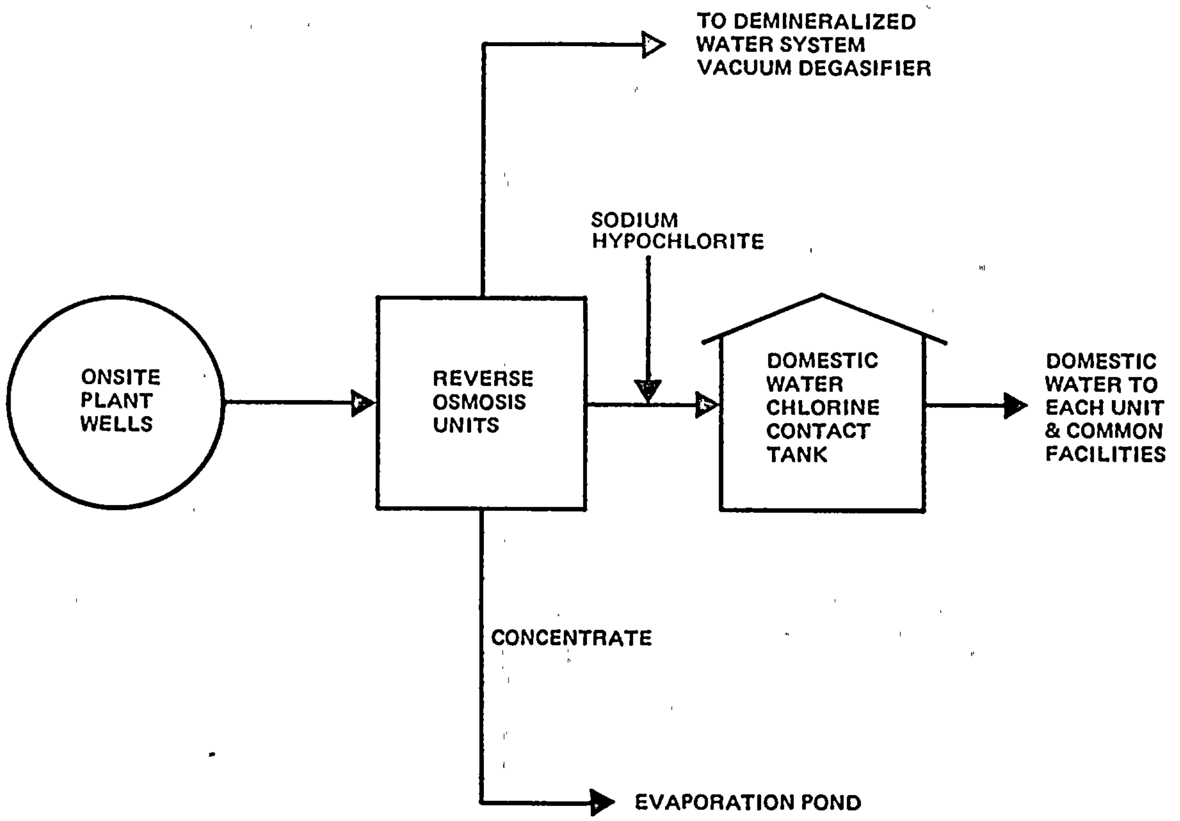
Figure 3.6-1



Palo Verde Nuclear Generating Station
ER-OL

CIRCULATING WATER AND
PLANT COOLING WATER SYSTEMS
SCHEMATIC FLOW DIAGRAM

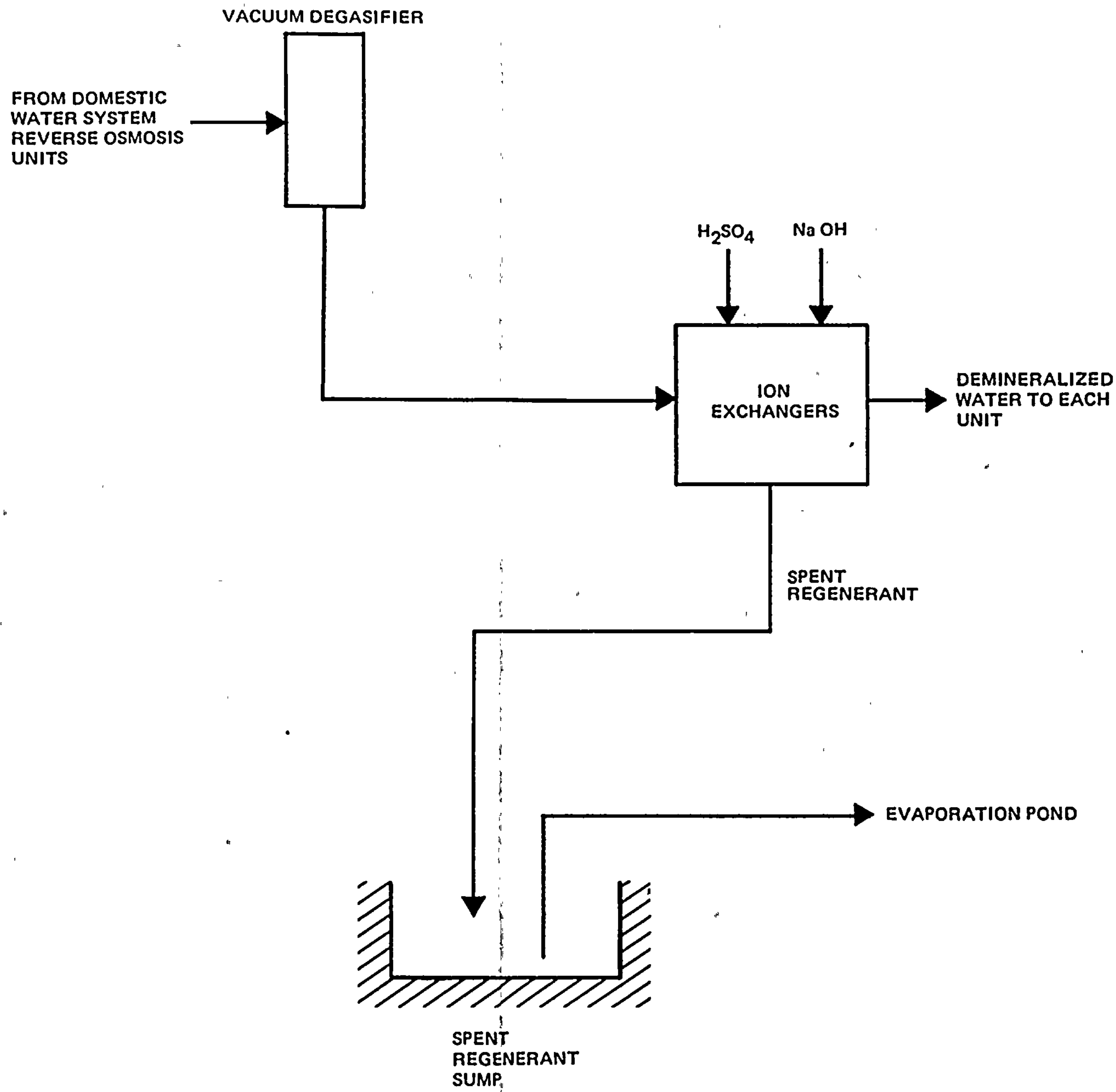
Figure 3.6-2



Palo Verde Nuclear Generating Station
ER-OL

DOMESTIC WATER SYSTEM SCHEMATIC
FLOW DIAGRAM

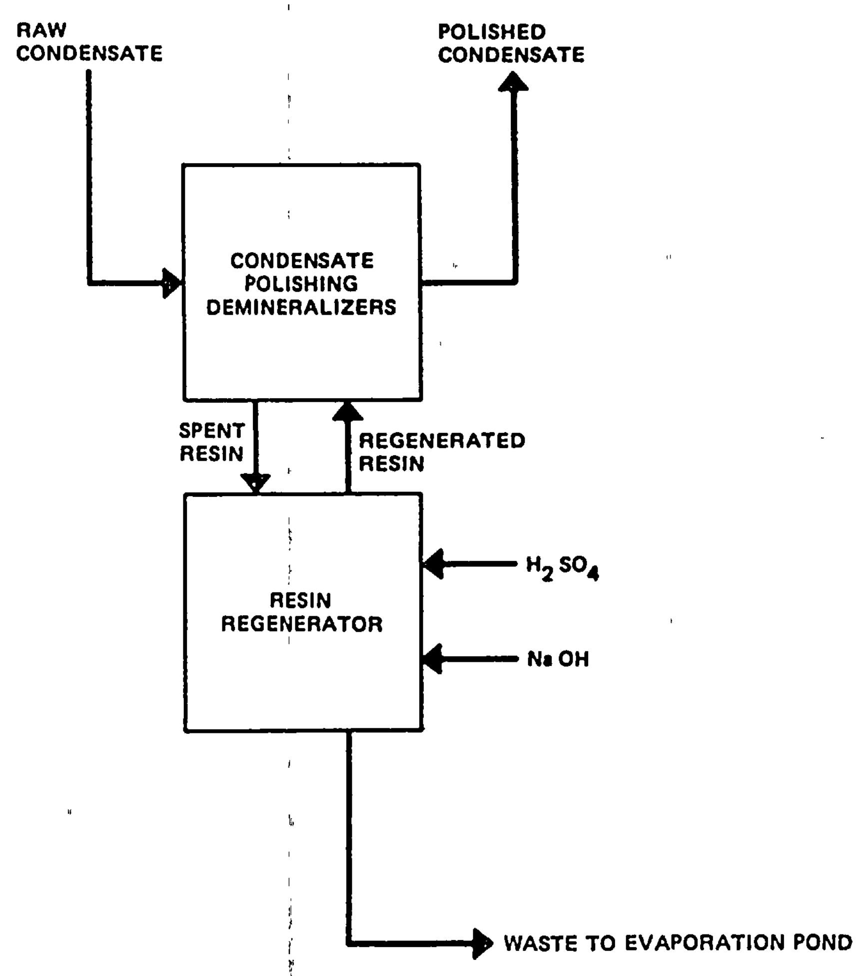
Figure 3.6-3



Palo Verde Nuclear Generating Station
ER-OL

DEMINERALIZED WATER SYSTEM
SCHEMATIC FLOW DIAGRAM

Figure 3.6-4



Palo Verde Nuclear Generating Station
ER-OL

CONDENSATE POLISHING DEMINERALIZER
SYSTEM SCHEMATIC FLOW DIAGRAM

Figure 3.6-5

3.7 SANITARY AND OTHER WASTE SYSTEMS

The information presented in ER-CP Section 3.7 and the FES has been updated to reflect peak construction work force and gaseous effluent quantities based on plant specific equipment data. The information is updated and summarized in this section.

3.7.1 LIQUID WASTES

3.7.1.1 Sanitary Wastes

Facilities are provided to treat sanitary wastes produced during construction and operation except for that produced by field construction workers. Chemical toilets are used by field construction workers; wastes from the chemical toilets are hauled approximately 10 miles to the Maricopa county land fill site for disposal.

The peak construction workforce (office plus field) was about 6200. The estimated quantity from chemical toilets is 34,000 gal/d based on 3400 field workers at 10 gal/d. It is estimated that a peak sanitary waste flowrate of 30,000 gal/d will be processed by the onsite sewage treatment package plants. This sanitary waste will contain approximately 300 ppm of 5-day BOD and 300 ppm suspended solids.

During construction, two package sewage treatment plants will be used, each with a rated capacity of 17,500 gal/d for a total capacity of 35,000 gal/d. During normal plant operation, the expected sewage load will be less than 15,000 gal/d. The treated effluent is recycled to the onsite water reclamation plant. Solid wastes are transported to the onsite solid waste disposal area discussed in section 3.7.2.2.

3.7.1.2 Other Liquid Wastes

Chemical laboratory wastes, dry cleaning waste, and decontamination solutions are described in section 3.6.2.

3.7.2 SOLID WASTES

3.7.2.1 Sources of Solid Waste

3.7.2.1.1 Water Reclamation Plant

Sludge produced by the two-stage lime treatment process from the water reclamation plant is further concentrated in a classification centrifuge. A portion of the concentrated sludge is recalcined to recover lime for reuse in the lime softening process. Approximately 15,500 tons of sludge per PVNGS unit requiring disposal is produced annually at the water reclamation plant.

3.7.2.1.2 Sanitary Waste Treatment Plant

Sanitary sludge is produced in the package sewage treatment plants. Approximately 8 tons of dried sludge are produced annually during normal plant operation.

3.7.2.1.3 Service Buildings

Wastes from the service buildings consist of paper, rags, grit, and other nonrecyclable materials. This waste essentially is in solid form. Approximately 150 tons per year are expected from this source.

3.7.2.1.4 Miscellaneous

Various other solid wastes, such as those obtained in intermittent cleaning of the plant cooling tower basins and water storage reservoir, are anticipated and require disposal. The quantities produced will be small compared to other sources.

3.7.2.2 Solid Waste Disposal Area

The solid waste disposal area is approximately 200 acres. Sludge waste will be spread in the area to dry out. Water reclamation plant waste is centrifuge dried prior to disposal in the solid waste disposal area.

3.7.3 GASEOUS EFFLUENTS

3.7.3.1 Diesel Generators

Each diesel generator (two per unit) nominally operates for test purposes once a month for approximately 1 hour, and discharges approximately 2300 pounds NO_x, 540 pounds SO_x, and 35 pounds of hydrocarbons annually. Each diesel generator discharges through its own stack approximately 93 feet above plant grade.

3.7.3.2 Auxiliary Boilers

During operation, the auxiliary boilers are available for backup and are not normally used after initial startup. The three units share one set of two auxiliary boilers. When the boilers operate (approximately 8 days per unit per initial startup) they will produce about 2300 pounds NO_x, 2812 pounds SO_x, and 682 pounds of hydrocarbons anually. The auxiliary boilers discharge through their own stacks 50 feet above plant grade.

3.7.3.3 Water Reclamation Plant

Gaseous wastes from the wastewater reclamation system will be generated from the lime recalcination operations. The furnace exhaust gas discharged will contain a maximum of 84 pounds particulate matter, 144 pounds SO_x, 23 pounds CO, 17 pounds

hydrocarbons, and 456 pounds NO_x, daily, after treatment in a wet scrubber. Under normal plant operating conditions, the major portion of the exhaust gases will be injected into the water in the second stage solids contact clarifiers as a source of CO_2 for recarbination. This will tend to reduce the discharges of all of the above pollutants from the maximum levels specified.

3.8 REPORTING OF RADIOACTIVE MATERIAL MOVEMENT

The transportation of new fuel to the site and irradiated fuel from the site and the transportation of solid radioactive wastes from the site to a waste disposal site is within the scope of paragraph (G) of 10CFR51.20. The environmental effects of such transportation are as set forth in summary table S-4 of 10CFR Part 51.

3.9 TRANSMISSION FACILITIES

3.9.1 ELECTRIC TRANSMISSION FACILITIES

Information presented in ER-CP Section 3.9.1 and the FES has been updated to reflect final line routings and the addition of a transmission line from PVNGS to Devers substation in California. The descriptions of the transmission system associated with PVNGS are updated and summarized in this section.

The transmission system associated with PVNGS is composed of

- Project 1
  - PVNGS to Westwing
  - PVNGS to Kyrene
  - PVNGS to Saguaro
- Project 3
  - Greenlee to Rio Grande
- PVNGS to Devers

Projects 1 and 3 are described in the ER-CP and FES. A final route description for the PVNGS to Westwing line and a preliminary route description for the PVNGS to Kyrene line were provided (as required by the FES) to the Nuclear Regulatory Commission in letters from E. E. Van Brunt, Jr., Vice President, Arizona Public Service Company, dated December 7, 1978 and December 3, 1979, respectively.

Projects 2 and 4, described in the ER-CP and FES, are no longer under consideration. Project 2, a proposed 525 kV line from the Saguaro Generating Station to a proposed Winchester Substation, is no longer under consideration as a result of Tucson Gas and Electric Company's sale of its 15.4% interest in PVNGS to Southern California Edison. Project 4, a proposed 525 kV line from the Mohave Generating Station to a proposed

Red Lake Canyon Substation, is no longer under consideration as a result of the indefinite suspension of the Kaiparowits Project. Project 4 has been replaced by a proposed 525 kV line from PVNGS to Devers Substation.

Information concerning the impacts of the PVNGS to Devers line is presented in the U.S. Department of Interior, Bureau of Land Management and U.S. Nuclear Regulatory Commission Final Environment Statement, Palo Verde-Devers 500 kV Transmission Line, February, 1979. Final route approval has yet to be issued by the Bureau of Land Management.

Pursuant to an agreement between the Department of Water and Power of the City of Los Angeles (LADWP) and the Salt River Project (SRP), LADWP will acquire from SRP a 5.7% interest in PVNGS at such time as Unit 1 is placed into commercial operation. LADWP will transmit its energy over existing or currently planned transmission lines.

In addition to the transmission system associated with PVNGS, another transmission line is currently planned to connect the PVNGS switchyard with the San Diego Gas & Electric (SDG&E) Miguel substation. This line is scheduled to be in service by May, 1984, for the purposes of transmitting power purchased or sold by SDG&E from utilities in Arizona (other than APS), New Mexico, and West Texas, power exchange between APS and SDG&E, and improving the power supply to the Yuma, Arizona area. This interconnection has not been finalized, but it is anticipated that the interconnection will utilize one of the spare line positions available in the PVNGS switchyard.

3.9.1.1 Transmission Route Descriptions

3.9.1.1.1 Project 1

PVNGS TO WESTWING

A detailed description and analysis of the final corridor alignments for the PVNGS-Westwing lines was submitted to the

Nuclear Regulatory Commission (NRC) by Arizona Public Service Co. (APS) on December 8, 1978.(1) Approval of this analysis was reported to APS by the NRC Environmental Projects Branch 2 on January 4, 1979.(2)

The existing Westwing Substation is situated northwest of Phoenix in Maricopa County. The Westwing transmission line route (figure 3.9-1) leaves PVNGS in an easterly direction, 2 miles from the plant the line turns northeast crossing the Hassayampa River and Interstate Highway 10 (I-10). At mile 11 the line heads north, passing to the west of the White Tank Mountains. At mile 26 the route turns east, passing to the north of the White Tank Mountains. The line crosses U.S. Highway 60, 4 miles before entering the Westwing Substation.

Construction of the 44 mile long PVNGS-Westwing line No. 1 commenced in January, 1979 and was complete in November 1979.

Transmission system planning subsequent to the PVNGS 1,2&3 ER-CP indicates the PVNGS-Westwing line No. 2 is currently not required for transmission of power from PVNGS. However, the route and its associated environmental impacts have been analyzed for a two line corridor. Should future planning indicate a need for this previously approved line, it will be constructed in the existing right-of-way of the PVNGS-Westwing line.

PVNGS TO KYRENE

Changes in the PVNGS-Kyrene corridor were necessary subsequent to the ER-CP. The majority of the new corridor was originally described as an alternate in the PVNGS Transmission System Environmental Analysis. Subsequent to the change, further environmental studies on the new segments of the corridor were conducted and a detailed description and analysis of the corridor alignments were reported to the NRC on December 3, 1979.(3)

The existing Kyrene Generating Station and Substation are located in the southern part of Tempe, Arizona, and east of South Mountain Park, in Maricopa County. The Kyrene transmission line route (figure 3.9-1) leaves PVNGS in a common corridor with the Saguaro line to the south, crossing the Gila River south of Gillespie Dam at mile 12 and Arizona Highway 85 at mile 21, 10 miles south of Buckeye. From mile 7 to mile 24.6 the corridor parallels an El Paso Natural Gas Company (EPNG) pipeline route in a generally easterly direction. At this point the line turns in a northeasterly direction, passing through Rainbow Valley, and traversing 10 miles to an EPNG pipeline route, which it parallels for 2.1 miles (miles 34.6 to 36.7). A Tucson Electric Power Company 345 kV line is then parallel for about 3.5 miles. The route then turns east, paralleling a United States Bureau of Reclamation (USBR) 230 kV for 4.7 miles. The line then turns southeastward and proceeds about 9.5 miles to the boundary of the Gila River Indian Reservation.

The line then turns eastward, proceeding in a easterly direction for about 10 miles, where, at mile 69 it crosses I-10. The line turns northeastward 1/2 mile later and reaches Kyrene Substation at mile 74.

Construction of the PVNGS-Kyrene line is scheduled to commence in April 1981, with completion anticipated by August 1982.

PVNGS TO SAGUARO

The existing Saguaro Substation is on the east side of I-10 in the southern part of Pinal County. As shown in figure 3.9-1 the Saguaro transmission line route leaves the PVNGS to the south in a common corridor with the Kyrene line. From mile 7 to mile 50 the corridor parallels an EPNG pipeline route in a southeasterly direction through the southern extent of the Rainbow Valley along the foothills of the Maricopa Mountains.

For 45 miles the line will be adjacent to the 345 kV transmission line from Westwing to Vail. The route passes east of the Table Top Mountain range and crosses the intersection of Interstate Highway 8 (I-8) and Highway 84 at mile 64. Continuing in a southeasterly direction, the route passes through the northeast corner of the Papago Indian Reservation and crosses Route 15 at mile 84.

At mile 95, the Saguaro route turns east, following an existing 230 kV wood pole transmission line, passing to the north of the Silver Bell Mountains. The Saguaro route crosses the Santa Cruz River at mile 118 in the Avra Valley and I-10 south of Red Rock, then terminating at Saguaro Substation located just east of I-10. The transmission line from PVNGS to Saguaro will be 121 miles long.

Construction is to start in June 1984, with completion expected in April 1986.

3.9.1.1.2 Project 3

GREENLEE TO RIO GRANDE

From the existing Greenlee Substation, located approximately 2 miles northeast of Greenlee County Airport, the route (see figure 3.9-2 runs parallel to the existing Greenlee-Newman 345 kV line south-southeast 15 miles to a point 2 miles northwest of Duncan, Arizona. There it crosses U.S. Highways 70 and 75, the Gila River, and the Southern Pacific Railroad. The route continues south-southeastward, roughly paralleling the railroad for approximately 20 miles to Summit, New Mexico (mile 35). Here the line turns easterly for about 18 miles, crossing U.S. Highway 70, New Mexico road 464 and U.S. Highway 180, to where it intersects with an EPNG pipeline route at mile 53, about 6 miles north of Lordsburg.

Still paralleling the Greenlee-Newman line, Project 3 follows the pipeline to the compressor station 15 miles west of Deming, at mile 97. It then crosses State Highway 26 and U.S. Highway 260, about 2.5 miles north of Deming, continuing due east to Carne at mile 122. At this point, the line turns slightly south, again paralleling the railroad to a point of intersection with the EPNG pipeline, at mile 157. The Project 3 line then leaves the Greenlee-Newman line, turning southeastward and generally paralleling the railroad, to the Rio Grande Substation, located on the Rio Grande River near the International Boundary between the United States and Mexico, in Township 29 South, Range 4 East, New Mexico.

The Greenlee to Rio Grande Line will be 195 miles long; construction is to begin in January, 1983 with completion expected in May, 1984.

3.9.1.1.3 PVNGS To Devers

Information concerning the PVNGS to Devers line is contained in the U.S. Department of Interior Bureau of Land Management and U.S. Nuclear Regulatory Commission Final Environmental Statement, Palo Verde-Devers 500 kV Transmission Line, February 1979. Descriptions are presented for preferred and alternate routes. Final route approval has not been received from the Bureau of Land Management.

3.9.1.2 Land Impact

3.9.1.2.1 Projects 1 and 3

Portions of each transmission line will require new access roads. Existing public and private roads will be used to the greatest extent possible for access during construction. The paralleling of existing and proposed transportation and utility rights-of-way and corridors will permit the use of existing maintenance roads thereby limiting the length of new access

roads for each system. A 12 to 14 foot wide road will be constructed along the rights-of-way in those segments in which maintenance roads do not exist. No clear cutting of trees or vegetation within the transmission right-of-way is required. Clearing of vegetation will only be required within the construction roads, at tower sites, at pulling sites, and within other areas where construction activities at batching plants and staging areas are actually taking place. The environmental effects of construction and operation of the PVNGS transmission system is discussed further in section 5.5.

3.9.1.2.2 PVNGS to Devers

Information concerning the PVNGS to Devers line is contained in the U.S. Department of Interior Bureau of Land Management and U.S. Nuclear Regulatory Commission Final Environmental Statement, Palo Verde-Devers 500 kV Transmission Line, February 1979. Descriptions are presented for preferred and alternate routes. Final route approval has not been received from the Bureau of Land Management.

3.9.1.3 Visibility

3.9.1.3.1 Project 1

PVNGS To WESTWING

There will be three highway crossings on the Westwing route. The first crossing is the Buckeye-Salome Road east of Wintersburg. The second is I-10, about 1 mile east of the Hassayampa River, between Wintersburg and Buckeye. The third highway crossing is at U.S. 60, 4 miles west of the Westwing Substation. The White Tank Mountains are visible to the south and the Heiroglyphic Mountains to the north, although the views are interrupted by transmission lines and billboards. This area provides a modified appearance from the road.

PVNGS TO KYRENE

The Kyrene/Saguaro common corridor crosses old US 80 near Gillespie Dam. The crossing is of above average scenic quality related to long views of hills and mountains in the distance, and to riparian vegetation associated with the Gila River. Nine miles east of this crossing, the Kyrene/Saguaro common corridor crosses Arizona 85. This crossing is of average scenic quality.

The Kyrene line crosses I-10 approximately 5 miles south of Tempe. The line parallels I-10 at approximately 1-1/2 miles from this crossing into Kyrene Station. There is a modified appearance from the road in this area.

PVNGS TO SAGUARO

After separating from the Kyrene line, the Saguaro line will cross two highways and a reservation road. The first crossing occurs at the intersection of I-8 and State Highway 84 in an area characterized by clear views of the Table Top Mountains. Vegetation and topography with a background of mountain views are of above average visual quality at this crossing. The second crossing occurs on Reservation Route 15 in the Silver Reef Valley and the Papago Indian Reservation. Views of the nearby Tat Momoli and Silver Reef Mountains occur at this crossing. The high scenic quality of this area is modified by an existing transmission line and a soon to be built Westwing-Vail transmission line which will be paralleled through the area.

The Saguaro line crosses I-10 at the Saguaro Generating Station. Views of the Picacho Peak and Picacho Mountains are modified at this crossing by billboards, existing transmission lines and industrial facilities. The scenic quality at this mileage point is rated as modified.

3.9.1.3.2 Project 3

This route was divided into the nine segments indicated in figure 3.9-2. Each segment is discussed separately. The transmission line will follow an existing 345 kV line except through segments 8 and 9, which will modify the visual impact of this additional 345 kV line.

Segment 1 and segment 2 will not intersect frequently traveled public roads. Segment 3 will have a low visual impact on the agricultural land located at Highways 70 and 75. The presence of a second power line could also detract from the scenic Gila River Valley. Aesthetic modification could also occur at the points where the line crosses these.

The major part of segment 4 will cover isolated desert lands. Visual interference to motorists will be almost nonexistent. However, the line does intersect U.S. Highway 70 north of Lordsburg.

Segment 5 will create only slight visual effects from frequently traveled public roads. The initial 3 to 5 miles of the eastern portion is within 1 to 2 miles of the highway. However, telephone wires and poles immediately border this highway, already obstructing the view of the motorist. The remainder of this segment is in a very remote area beyond the view of the motorist.

Segment 6 will have the greatest aesthetic impact where the line will cross State Roads 26 and 260 about 2 miles north of Deming. For the greater portion of this segment, infringement on the landscape will be minimized by the remote location of the line.

Segment 7 will intersect I-10 at a point 2 miles west of the Luna-Dona Ana County line. Some visual disruption is likely to occur at this intersection point. Segment 8 will not cross frequently traveled public roads. In segment 9 the Anapra area will be subject to the highest visual modification from frequently traveled public roads.

3.9.1.3.3 PVNGS To Devers

Information concerning the PVNGS to Devers line is contained in the U.S. Department of Interior Bureau of Land Management and U.S. Nuclear Regulatory Commision Final Environmental Statement, Palo Verde-Devers 500 kV Transmission Line, February, 1979. Descriptions are presented for preferred and alternate routes. Final route approval has not been received from the Bureau of Land Management.

3.9.1.4 Structures

3.9.1.4.1 Project 1 Structures

Figure 3.9-3 illustrates the structures which will be used for the Project 1 Lines. The transmission towers will be of open lattice-type construction, with dull finish. Grey shaded suspension insulators will be used on the towers. These features will tend to make the transmission lines less visible from a distance against the desert backdrop, and the blending effect of the lattice construction and color help make the line less noticeable when visually compared with other man-made features which are more opaque, or of a more contrasting color.

The self-supporting steel lattice towers average approximately 129 feet high. The towers used on straight portions of the transmission line are tangent structures, which support the conductor vertically and absorb other loads such as wind forces or ice loads on the conductor. This is the basic type of tower used on the line.

Each tower will have five attachments for cables. There will be three sets of conductors (a total of at least six conductors) with each set attached to a separate point on the tower. Two statics will be suspended above the three sets of conductors. The average length of conductor span from tower to tower will vary from approximately 1280 to 1650 feet.

WESTWING SUBSTATION

The Arizona Public Service Company (APS) Westwing Substation is located in Maricopa County approximately 8 miles north of Sun City. The substation is on flat desert terrain and is relatively isolated from land use development except for scattered rural dwellings located primarily to the east. The immediate area around the substation has been landscaped.

KYRENE SUBSTATION

The Kyrene Generating Station and Substation, owned by the Salt River Project, is located in the City of Tempe. The Generating Station is surrounded by a 1/4 mile radius buffer zone on the north and east sides. Within the buffer zone, the City of Tempe has constructed a municipal golf course. Beyond the buffer zone, to the north and east, tracts of single family dwellings have been constructed. Substation expansion will be into agricultural land to the south and/or west of the existing substation. In either case, the substation will be adjacent to Elliott Road, a paved east-west road. The substation will be visible from Elliott and also from Kyrene and Rural Roads, which are paved, north-south roads. The substation expansion will also be visible from I-10 which is approximately two miles to the west of the existing substation.

SAGUARO SUBSTATION

The Saguaro Generating Station and Substation is owned by APS. The station is located on the east side of I-10, approximately 3 miles northeast of the Marana Airport and 2.5 miles southeast of Red Rock in Pinal County. The substation is surrounded by vacant desert terrain.

3.9.1.4.2 Project 3 Structures

Transmission line towers used in Project 3 will be of 345 kV modified wooden H-frame construction, as shown in figure 3.9-4. The towers will use Douglas fir poles, and will be full length treated with pentachlorophenol.

Towers will be located and sized to provide a minimum final ground clearance of 30 feet to any conductor at 60F, resulting in a typical tower approximately 70 feet high and 47 feet wide. When ground terrain requires, or at road crossings or other lines, taller towers may have to be used, although the width will remain the same. There will normally be 6.6 structures per mile, with an average span of 800 feet.

3.9.1.4.2.1 Greenlee Substation. Greenlee Substation is a compensation point in Tucson Gas & Electric Company lines from San Juan Power Station to Vail, Arizona. It is located 2 miles northeast of Greenlee County Airport and is situated 1 mile south of the nearest paved road. The substation is not visible from the airport or any public road in the area. Project 3 will require the addition of one 345 kV circuit breaker and a shunt compensating reactor to the Greenlee Substation. No increase in fenced area is anticipated.

3.9.1.4.2.2 Rio Grande Substation. The Rio Grande Substation is a part of Rio Grande Power Station. The station is located on the Rio Grande River, near the intersection of the Texas, New Mexico, and Mexico borders. The addition of the 345 kV terminal to the Rio Grande switchyard will be accomplished within the fenced site and will be difficult to distinguish in the panorama of generating station facilities already present on the site.

3.9.1.4.3 PVNGS To Devers Structure

Information concerning the PVNGS to Devers line is contained in the U.S. Department of Interior Bureau of Land Management and U.S. Nuclear Regulatory Commission Final Environmental Statement, Palo Verde-Devers 500 kV Transmission Line, February, 1979. Descriptions are presented for preferred and laternate routes. Final route approval has not been received from the Bureau of Land Management.

3.9.2 PVNGS WASTEWATER CONVEYANCE SYSTEM

Information presented in ER-CP Section 3.9.2 and the FES has been updated to reflect final pipeline routing. Description of the wastewater conveyance system is updated and summarized in this section.

As shown in figure 3.9-5, the wastewater conveyance system route extends from the City of Phoenix 91st Avenue Sewage Treatment Plant approximately 36.5 miles to the PVNGS site.

A 114-inch diameter pipeline leaves the 91st Avenue Sewage Treatment Plant, conveying treated wastewater effluent by gravity flow for about 6 miles, where it is reduced to a 96-inch diameter. The 96-inch diameter pipeline continues gravity flow for about 4 miles to a turnout for delivery of effluent to the Buckeye Irrigation Company (BIC) canal. From the turnout, the 96-inch pipeline proceeds by gravity flow generally parallel to the BIC canal for about 18.5 miles to a pumping station near the Hassayampa River. The remaining 8 miles to the PVNGS site are traversed by a 66-inch diameter pipeline. The entire 36.5 miles of pipeline will be underground with above ground structures limited to manholes approximately each 1/2 mile and vents, at high points, about 6 feet above grade; these are anticipated to have minimal visual impact. A 50 foot wide permanent access right-of-way will be required for the entire length of the pipeline.

The majority of the wastewater conveyance pipeline passes through agricultural land. The remaining areas are scattered residential, mostly associated with the agricultural activities, and some scattered light industry. There are no existing recreational areas along the route. After construction the right-of-way will be regraded, and topsoil will be replaced in agricultural areas for future cultivation. Table 3.9-1 lists the land types and the distances associated with the wastewater conveyance pipeline route.

Table 3.9-1

LAND TYPE ADJACENT TO WASTEWATER CONVEYANCE PIPELINE

Land Use Types	Route
Open land	12.5 miles
Agricultural land	19.0 miles
Residential areas	3.5 miles
Industrial areas	0.5 mile
Other	1.0 mile

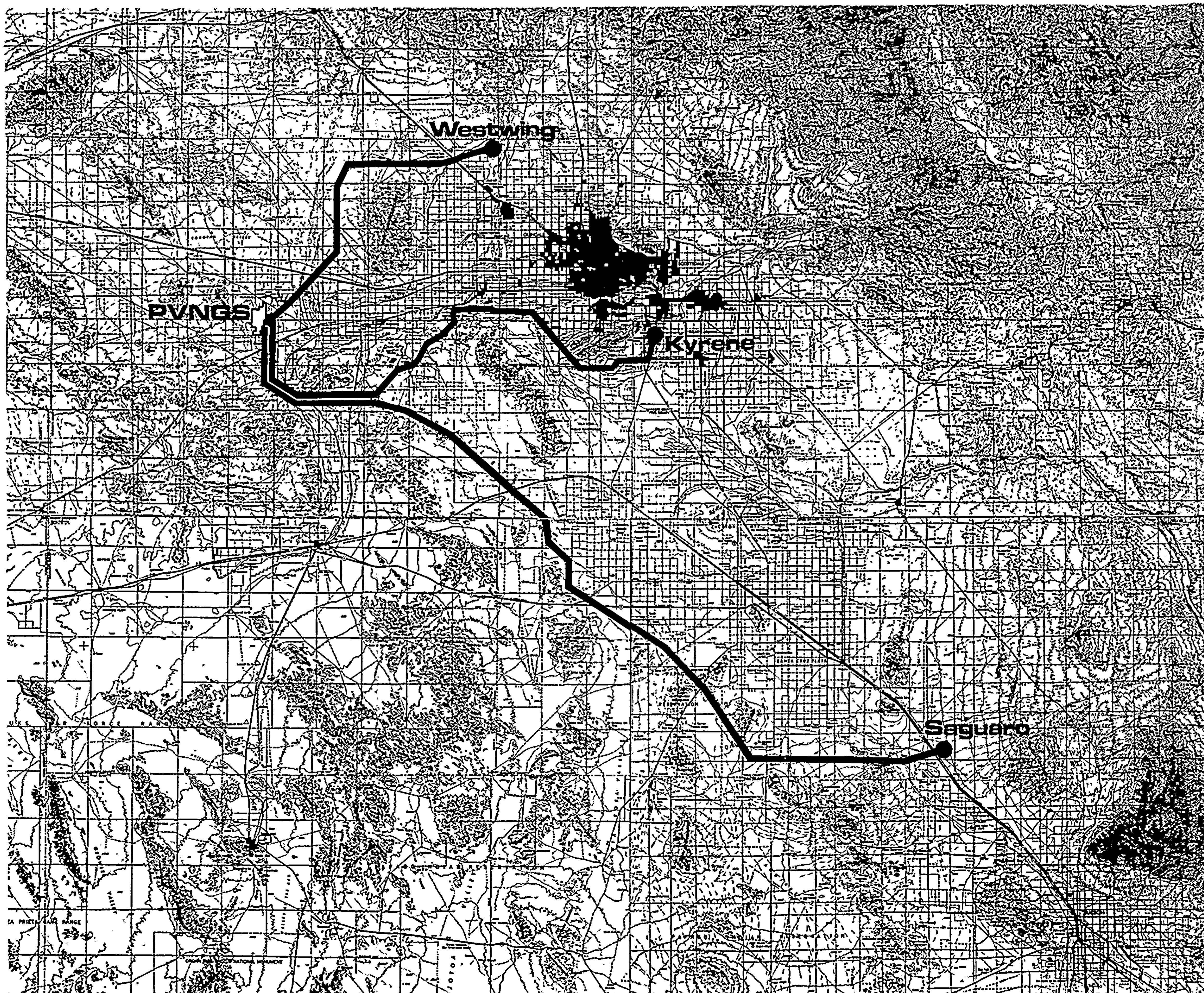
3.9.3 REFERENCES

1. Letter dated December 7, 1978 from E. E. Van Brunt, Jr., Arizona Public Service Company, Vice President, Nuclear Projects to Dr. Robert A. Gilbert, Project Manager, Environmental Projects Branch 3, U.S. Nuclear Regulatory Commission.

2. Letter dated January 4, 1979 from W. H. Regan, Jr., Chief, Environmental Projects Branch 2, U.S. Nuclear Regulatory Commission to E. E. Van Brunt, Jr.

3. Letter dated December 3, 1979 from E. E. Van Brunt, Jr., Arizona Public Service Company, Vice President, Nuclear Projects to Dr. Robert A. Gilbert, Project Manager, Environmental Projects Branch 3, U.S. Nuclear Regulatory Commission.

4. <u>Final Environmental Statement Palo Verde-Devers 500 kV Transmission Line</u>, United States Department of the Interior (Bureau of Land Management) and the Nuclear Regulatory Commission, February, 1979.



Palo Verde Nuclear Generating Station
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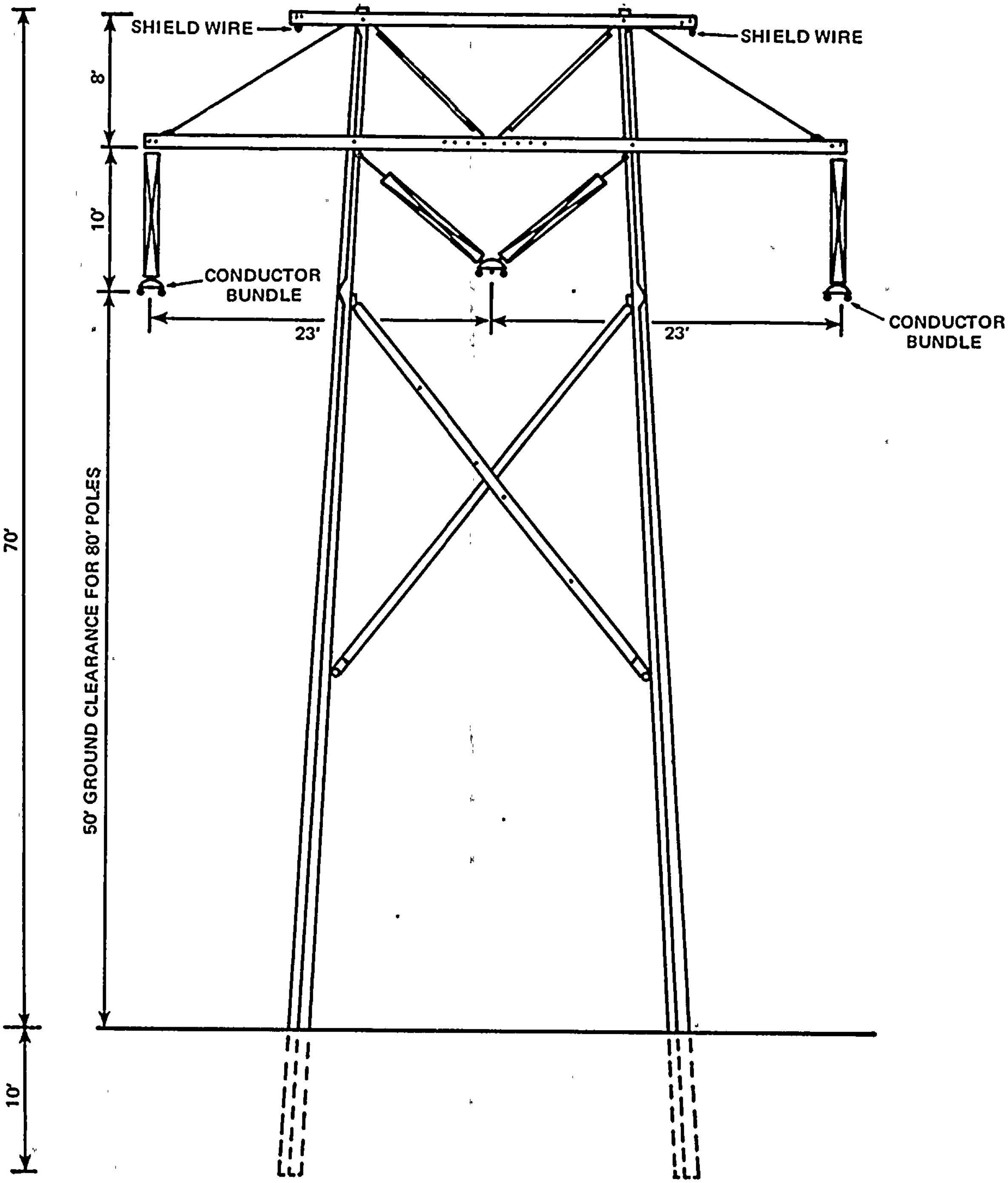
TRANSMISSION LINE ROUTES
PROJECT 1

Figure 3.9-1



Palo Verde Nuclear Generating Station
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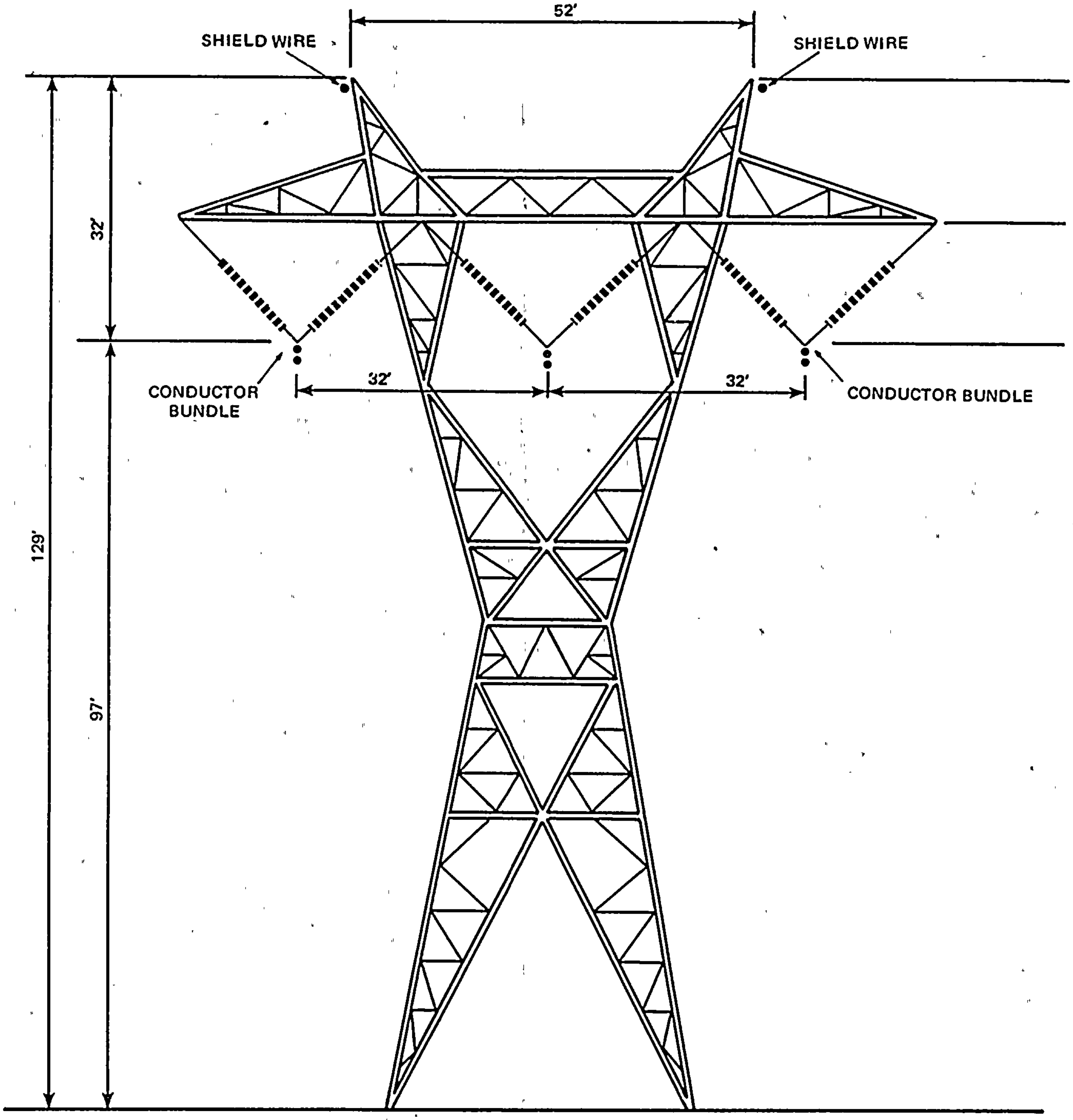
345 kV TRANSMISSION
LINE STRUCTURE

Figure 3.9-4



Palo Verde Nuclear Generating Station
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500 kV STEEL LATTICE TOWER
PROJECT 1

Figure 3.9-3

APPENDIX 3A

RESPONSES TO NRC QUESTIONS