AN INTRODUCTION TO
PALO VERDE NUCLEAR GENERATING STATION
LIQUID AND SOLID
RADWASTE MANAGEMENT SYSTEMS

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INTRODUCTION AND GENERAL DESCRIPTION OF PVNGS

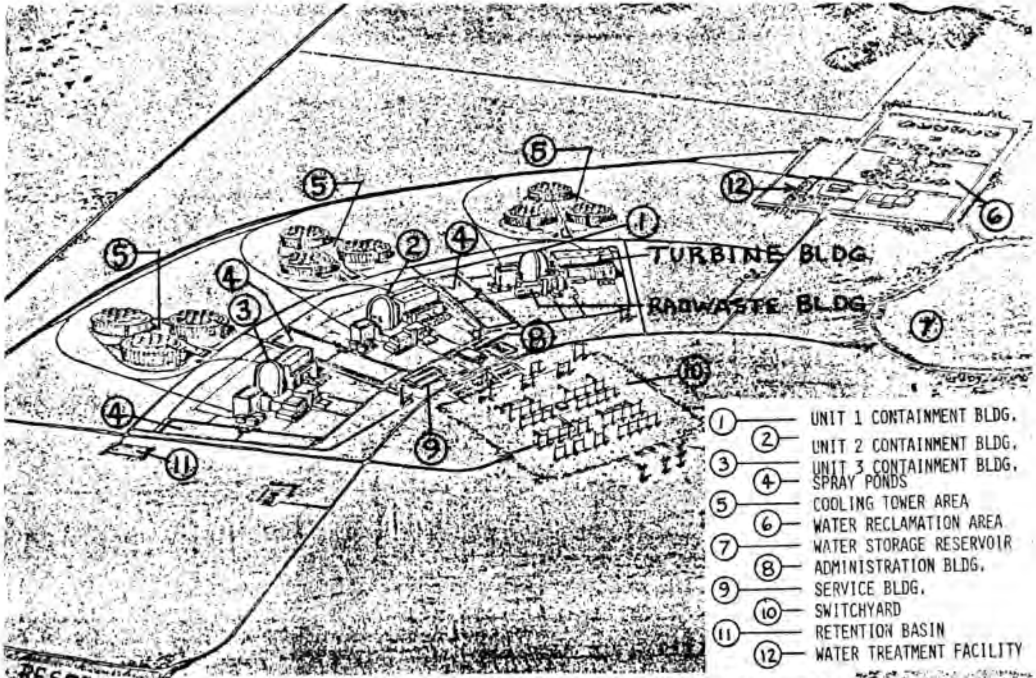
Site Location and Arrangement

Palo Verde Nuclear Generating Station (PVNGS) consist of three identical 1270-MWe (Nominal) units located in Maricopa County, Arizona on a site approximately 36 miles west of the nearest boundary of the City of Phoenix. (Fig. 1 is a general arrangement and vicinity plan for the site depicting the relative location of the various structures comprising the PVNGS.)

The principal structures of the station are the Administration Building, Administration Annex, Containment Buildings, Turbine Buildings, Auxiliary Buildings, Control Buildings, Fuel Buildings, Diesel Generator Buildings, Cooling Towers, Essential Spray Ponds, Radwaste Buildings, Switchyard, Service Buildings, Warehouses, Reservoir, Evaporation Pond, Technical Support Center, and Emergency Operations Facility.

Since there is no large natural body of water in the immediate vicinity of the site, cooling tower makeup will be supplied solely by reclaimed wastewater from the City of Phoenix. A wastewater reclamation plant and conveyance system is also within the scope of the project.

Each of the PVNGS units will utilize a System 80 pressurized water reactor nuclear steam supply system (NSSS) provided by Combustion Engineering, Inc. (CE).



PLANT SITE GENERAL ARRANGEMENT AND VICINITY PLAN
FIG. 1

The Combustion Engineering System 80 Nuclear Steam Supply System consists of a two-loop, four-pump pressurized water reactor and its supporting auxiliary and safety-related systems.

PVNGS, including each of the three units and all property and facilities located thereat, is jointly owned by five utilities who own undivided interests as tenants in common in PVNGS Units 1, 2 & 3.

Scheduled Completion and Commercial Operation Dates

The scheduled completion or fuel loading dates and the scheduled commercial operation dates for PVNGS 1, 2 & 3 are as follows:

PVNGS Unit	Scheduled completion or Fuel Loading Dates	Scheduled Commercial Operation Date
1	Not later than November 1, 1982	Not later than May 1, 1983
2	Not later than November 1, 1983	Not later than May 1, 1984
3	Not later than November 1, 1985	Not later than May 1, 1986

LIQUID RADWASTE SYSTEM INTRODUCTION

System Function and Description

The liquid radwaste system (LRS) collects and processes potentially radioactive liquid wastes generated during all modes of plant operations. (Fig. 2, 3, and 4 are simplified process Flow Diagrams of the Liquid Radwaste System.)

The LRS for each unit is separate and identically designed. The LRS can process waste on either a batch or a continuous basis, utilizing evaporation, ion exchange, and filtration as necessary to effect the required processing of the liquid waste.

The LRS for each unit consists of the following equipment: Chemical Drain Pumps, Recycle Monitor Pump, LRS Holdup Pumps, Concentrate Monitor Tank Pumps, Anti-foam Tank and Pump, concentrate Monitor Tanks, LRS Holdup Tanks, Caustic Tank and Caustic Batch Tank, Acid Tank and Acid Batch Tank, Recycle Monitor Tanks, Chemical Drain Tanks, Desiccant Air Dryers, Y-Strainers, Mixed Bed Ion Exchangers and Adsorption Bed, Ion Exchange Prefilters, and Evaporator Package.

System Operation

1. Normal Operation Liquid Radwaste System

The LRS is designed to be operational during all modes of reactor plant operation. The LRS processes the following liquid waste:

High Total Dissolved Solids (TDS) Wastes
Low TDS Wastes

The high TDS wastes from the chemical waste neutrailizer tanks, chemical drain tanks, and the auxiliary, radwaste, and fuel building sumps are collected in the high TDS holdup tank, (See Fig. 2). An internal mixing header uniformly mixes the tank contents. Acidic or caustic agents may be added for pH control, and anti-foam agents may be added if surfactants exist in the tank contents. The wastes are routed to the LRS evaporator for processing, (See Fig. 3).

The low TDS waste from the turbine building radioactive wastes, auxiliary steam condensate receiver tank, LRS adsorption bed and recycle monitor tank, are collected in the low TDS holdup tank, (See Fig. 2). The tank mixing header uniformly mixes the wastes. The wastes are sampled for conductivity to determine if processing by evaporation is required. If high TDS processing is not required, the wastes are sent through filters to remove insoluble particulates before entering the mixed bed ion exchangers. The processed liquid is collected in the recycle monitor tank that is lined up to receive input. After the tank is full, the contents are recirculated using the recycle monitor tank pump to allow representative sampling of the tank contents. Depending upon plant need and the anlysis of the sample, the water can be used for reactor makeup, or for the decontamination facility (unit 1 only). If the water is unsuitable for reuse, it will be reprocessed by sending it to the low TDS holdup tank, (See Fig. 3).

Decontamination facility wastes (unit 1 only) and laboratory wastes are collected in chemical drain tanks. Normally the contents are sent to the high TDS tank, but if desired may be sent directly to the solidification system for solidification and disposal, (See Fig. 4).

The flow, pressure, level, and temperature instrumentation throughout the system assists the operator in adjusting components for normal operation. Heat tracing is used on all paths carrying evaporator concentrates to prevent concentrates from solidifying in the lines.

2. Abnormal Operation Liquid Radwaste System

Proper instrumentation is included to alert operators of abnormal conditions and to ensure the system is operating normally. Some abnormal conditions and operational modes that may occur are:

Loss of Evaporator Cooling Water. Should the cooling water to the evaporator be lost, the temperature instrumentation on the inlet to the ion exchangers alerts the operators to secure the evaporator. If the flow continues without cooling, it could cause resin degradation and proper ion exchange would be impaired.

Resin Retention Screen Failures. If the adsorption bed or mixed bed resin dilution screens fail, the operators will be alerted by the higher than normal activity levels which will be detected in the valve gallery.

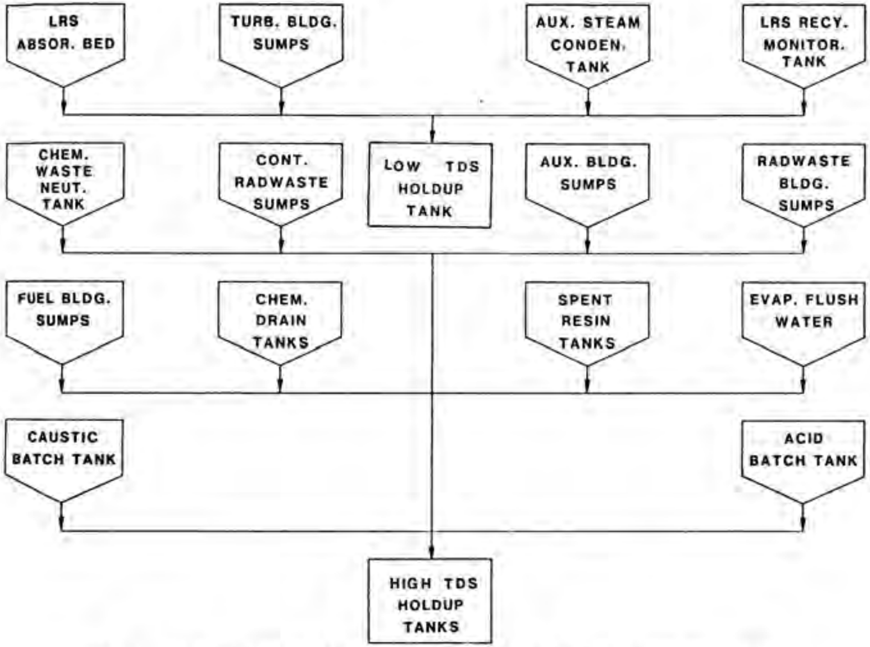


FIG. 2 PROCESS FLOW DIAGRAM LIQUID RADWASTE SYSTEM

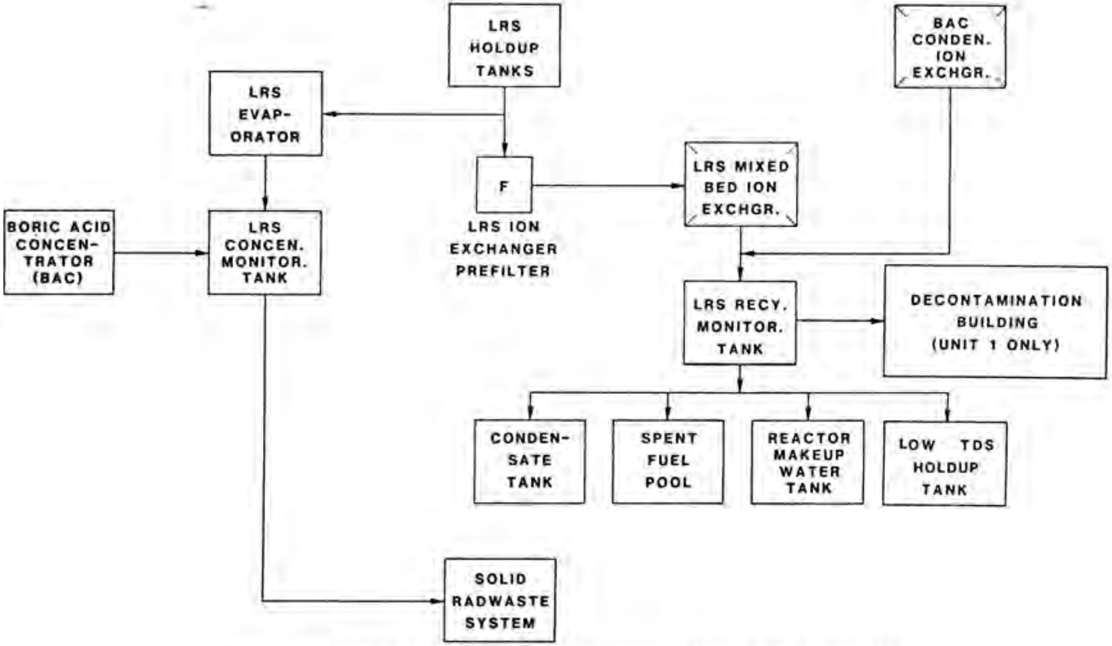


FIG. 3 PROCESS FLOW DIAGRAM LIQUID RADWASTE SYSTEM

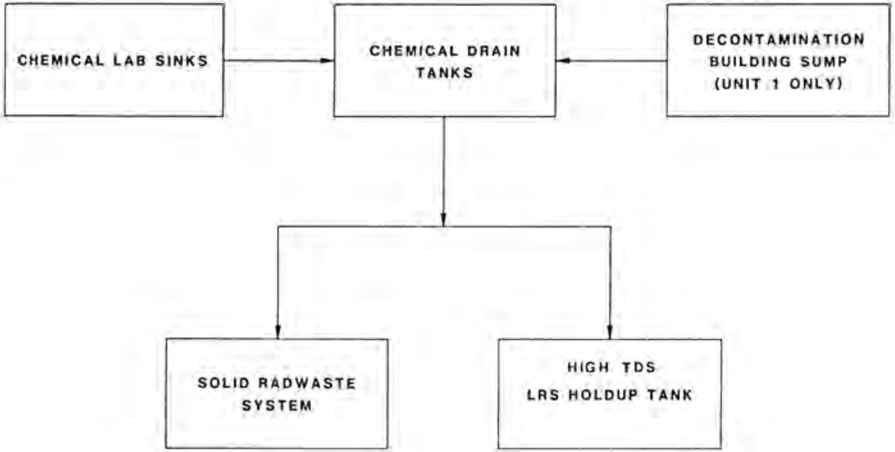


FIG. 4 PROCESS FLOW DIAGRAM LIQUID RADWASTE SYSTEM

Main process outlet retention screen failure is indicated by higher than normal valve gallery radiation levels and by low system flow. Flushable strainers are provided, to prevent uncontrolled loss of resin, on the process outlet piping from each vessel. Vessels would be isolated and the resin bed discharged before checking and repairing screens.

Boric Acid Concentrator Non-Operational. The LRS waste evaporator may be used as a boric acid concentrator if required.

LRS Waste Evaporator Non-Operational. Three means are provided for processing miscellaneous high TDS wastes if the evaporator is non-operational. They are:

1. Direct Solidification

   Chemical regenerants and decontamination solutions would be directly solidified because of their high chemical content.

2. Ion Exchange

   Building sump contents and normal low TDS wastes would be collected in the low TDS tank and processed by filtration and ion exchange. These wastes are predominantly boric acid. Administrative controls would be applied to minimize ingress of chemicals from floor or cask washdown, thus reducing the load on the ion exchange resin.

3. Boric Acid Concentrator (BAC)

   The BAC would be used as a last resort only. The BAC and bottoms piping material of construction are type 304 stainless steel which is susceptible to chloride stress corrosion attack. Secondary regenerants and decontamination solutions may contain up to 10,000 ppm chloride after concentration. In addition, residual weld stresses are difficult to predict so high levels may exist unrecognized.

Building sump wastes can be handled by the BAC, but not all inputs can be controlled and therefore ion exchange would be considered before evaporation.

System Reliability and Availability

All components which are critical to the operation of the system, such as the holdup tanks, have an identical component which is used as a backup if failure of one component occurs or if maintenance requires isolation of a component.

System reliability and availability are assured by providing these standby components. Redundancy is provided for each component as follows:

Component	Redundancy
High TDS and Low TDS Holdup Tanks	Backup Provided
LRS Holdup Pumps	Backup Provided
Chemical Drain Tank	Identical Component
Chemical Drain Pump	Identical Component
Ion Exchange Prefilters	Identical Component
LRS Evaporator	Alternate Operational Modes
Concentrate Monitor Tank and Pump	Identical Component
Recycle Monitor Tanks	Identical Component

System Modifications Due to Industry Changes

Based on recent industry changes to radwaste systems, PVNGS will have built into its Liquid Radwaste System "hookups" used for a portable liquid radwaste system or transportation and handling of liquid radwaste during POST accident conditions. These "hookups" may also be used during normal and abnormal operating conditions if higher than normal radiation conditions exists. Additional sample points will also be added to the LRS for chemistry control and radiation doseage detection.

SOLID RADWASTE SYSTEM INTRODUCTION

System Function and Description

The solid radwaste system (SRS) handles radioactive waste consisting of trash, spent ion exchange resins, waste evaporator concentrates, chemical drain tank effluents, crud tank effluents used filter cartridges, steam generator blowdown demineralizer resins and condensate polishing demineralizer resins. The wastes are solidified in the waste solidification system and stored in shielded storage locations while awaiting shipment off-site. (Fig. 5 is a simplified process flow diagram of the Solid Radwaste System.)

The solid radwaste system for each unit consists of the following equipment: Low Activity Spent Resin Tank, High Activity Spent Resin Tank, Closed Circuit Television System, Chemical Metering Pump, Chemical Storage Tank, Waste Cement Mixer, Resin Transfer/Dewatering Pump, and Container Transfer Cart. The following systems are also part of the SRS.

Waste Solidification System. The waste solidification system functions to solidify radioactive wastes coming from the spent resin tanks, CVCS crud tank, LRS chemical drain tanks, and the LRS concentrate tank, with Portland cement. The solidification package consists of the waste feed tank, waste feed pump, process module, mixer, container fill station, chemical feed skid, secondary flush module, cement storage and feed system, and overhead bridge crane. The waste solification system incorporates automatic system control of mixing of wastes with other inputs. Interlocks are provided to prevent system malfunctions resulting from the loss of utilities.

Drum and Disposable Liner Handling Subsystem. The disposable liner or 55 gallon drum containing solidified waste is moved by a transfer cart to the swipe station, where it is swiped for potential contamination on the outside. After swiping, the container is transferred by overhead crane to the high activity waste storage area.

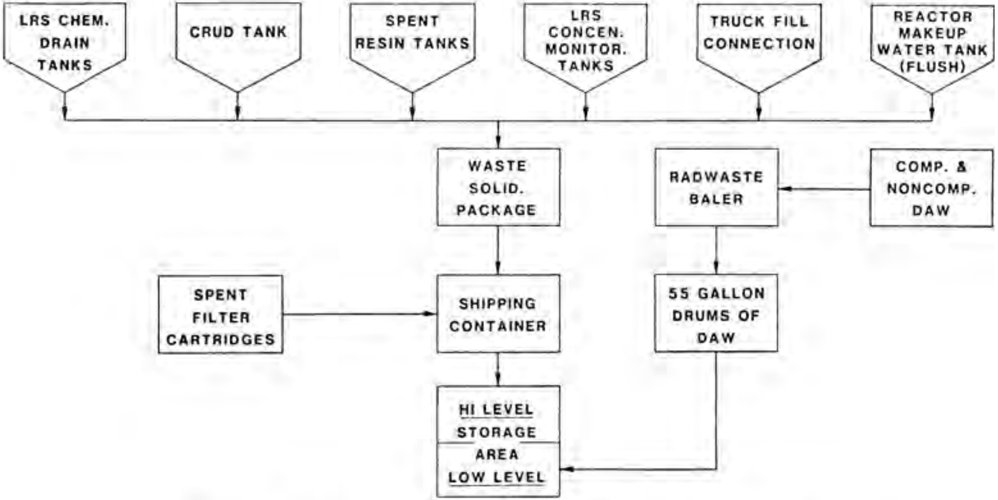


FIG. 5 PROCESS FLOW DIAGRAM SOLID RADWASTE SYSTEM

Radwaste Baling System. Slightly radioactive filters, paper, rags, and small equipment parts are compressed into 55 gallon drums by the radwaste baler, and transferred to the low activity storage area. Storage bins are provided near the baler for storing bags of low activity waste prior to baling. Air escaping from the compressing of the bags in the baler is exhausted by the baler fan to the radwaste building exhaust system.

Cement Handling and Storage System. The cement handling and storage system includes eight 90 cubic foot cement tote tanks which are stored and loaded with cement outside the radwaste building.

Dry Additive Storage and Feed System. This system consists of a variable speed volumetric feed, with a 9 cubic foot storage hopper, capable of metering dry anhydrous sodium meta-silicate, metsobeads, or other similar additives.

Spent Filter Cartridges. Spent filter cartridges are transported from the auxiliary building to the solidification system disposable liner or drum via the overhead monorail.

Spent Resin Transfer Subsystem. Spent resin from the fuel pool cooling system (FPCS), liquid radwaste system ion exchangers, the chemical and volume control system (CVCS) preholdup ion exchanger, deborating ion exchanger and purification ion exchangers are sluiced to the high activity spent resin tank or the low activity spent resin tank. The spent resin tanks hold the resin until it is ready to be sluiced to the waste feed tank.

Condensate demineralizer and blowdown demineralizer resins are transported to the radwaste building via truck and pumped into the waste feed tank by a portable pump via the solid radwaste area tank truck connection.

System Operation

The solid radwaste system is designed to operate during all modes of reactor plant operation.

1. Normal Operation Solid Radwaste System

Radwaste from the crud tank, chemical drain tank, spent resin tanks and concentrates from the liquid radwaste system are piped into the waste feed tank for hold up and chemical treatment prior to solidification. Chemicals (normally caustic) from the chemical addition tank are added to the waste feed tank by the chemical addition pump to adjust pH. The waste feed pump pumps radwaste from the waste feed tank to the cement waste mixer where it is mixed with portland cement and dry chemical additives. After mixing, the cement/radwaste mixture discharges through an air operated bladder valve to either a 55 gallon drum or 80 cubic foot liner. The drums or liners are mounted on the drum transfer cart which transports the waste (via rail) to the swipe station.

The waste solidification process is controlled by sampling and adjusting the chemistry of each batch of radwaste in the waste feed tank prior to solidification. The solidification agents are mixed with the radwaste in predetermined ratios which have been determined experimentally via sampling prior to processing to ensure total solidification of the radwaste and to provide optimum efficiency.

Spent Resin Transfer Operations. Transferring Resin from the Ion Exchange Vessels to the High or Low Activity Spent Resin Tanks (SRT).

Water for transport of spent resins to the spent resin tanks is provided from the reactor makeup water supply header. Water from the reactor makeup water header flows into the bottom of the ion exchange vessel, through the resin, into a top exit line and then to the spent resin tank. This ensures the resin is loose and ready to transport. Excess water from the SRT is pumped to the LRS holdup tanks by the resin transfer/dewatering pump.

Transferring Resin from SRT to the Waste Feed Tank (WFT). During resin transfer, water from the WFT flows to the suction of the spent resin transfer dewatering pump. From the discharge of the pump, water flows to the dilution points and down the outer concentric tube of the SRT. Resin slurry from the SRT is sluiced up the center concentric tube, then exits the spent resin tank and finally flows to the waste feed tank.

2. Abnormal Operation Solid Radwaste System

Proper instrumentation is included to alert operators of abnormal conditions and to ensure the system is operating normally. Some abnormal conditions and operational modes that may occur are:

Resin Transfer/Dewatering Pump Inoperable. The resin transfer/dewatering pump is designed with flanged connections for easy removal and replacement. A spare pump is provided for this purpose.

Transfer of resin from ion exchange vessel to spent resin tanks. Water for resin transfer is provided from the reactor makeup header. Resin in the ion exchange vessel is sluiced out by the reactor makeup water pump. Excess water will be sent to the liquid radwaste system for processing, if needed.

Transfer of resin from the spent resin tank to the waste feed tank. The system is provided with water for transfer, using reactor makeup water from the supply header. The resin bed is fluidized as usual except the vent valve is opened instead of the pump suction valve. For resin transfer, the system is aligned as before except that the water line supplying the concentric tube is isolated and the locked throttle valves supplying the remaining two lines to the spent resin tank are fully opened.

Air Fluidizing of Spent Resin Tanks or Ion Exchange Vessels. Connections are provided to allow use of air or nitrogen for the purpose of lifting and separating spent beads prior to transfer or for the purpose of mixing fresh resin beads.

If a resin plug occurs that cannot be cleared with the resin transfer pump, air will be used to clear the resin plug.

Resin Line Plug

Spent resin tank to dewatering tank. Resin plugging may occur as a result of inadequate flushing during previous system usage or by high resin concentration. This will be indicated by a higher than normal pressure at the spent resin tank, by high density alarm indication, or low flow alarm.

Ion exchange vessel to spent resin tank. A resin plug may exist upon normal initiation of resin transfer in the resin outlet line from the ion exchange vessels. This will be indicated by a high pressure alarm after opening the resin outlet valve and shutting the fluidizing valve.

Loss of Power to System. If power is lost during transfer of resin from the spent resin tank to the dewatering tank, the transfer mode control switch will be placed in the flush mode. After power is restored, the resin transfer pump and recirculating/flush is started for five minutes before resin flow is initiated.

System Reliability and Availability

The solid radwaste system is operated as required to process radwaste. The two spent resin tanks provide redundant spent resin storage capability. In addition, a spare resin transfer/dewatering pump is supplied. A truck filling connection for evaporator concentrates and for waste feed tank contents is provided in the truck bay as a backup for the waste solidification system.

System Modifications Due to Industry Changes

Based on recent industry changes to radwaste systems, PVNGS will have built into its solid radwaste system "hookups" for using a portable solid radwaste system during POST accident conditions. In addition, these "hookups" may be used during normal and abnormal operating conditions if higher than normal radiation conditions exists. Additional sample points will also be added to the SRS. These sample points are used for chemistry control and radiation doseage detection.

PVNGS ESTIMATED RADWASTE
INPUTS, OUTPUTS, STORAGE CAPACITIES AND DISPOSAL

GENERATED AND PROCESSED LIQUID RADWASTE

The two operating conditions in which liquid waste is generated and processed by the Liquid Radwaste System are normal and abnormal operating conditions. (For the purposes of this paper, it is assumed there will be a primary-to-secondary leak rate less than 100 pounds per day and 500 pounds per hour lasting on the average of two weeks per year.)

1. LRS Inputs Under Normal Operating Conditons

Under normal operating conditions, inputs and estimated expected waste quantities to the LRS come from the following sources:

Floor and Equipment Drains from the Auxiliary, Fuel, Radwaste and Containment Building, and Holdup Tank Area Drains (6,500 gal/day; 2,340 gal/yr of concentrates @ 25 Wt %).
Blowdown Demineralizer Regenerants (800 gal/day; 12,000 gal/yr of concentrates @ 50 Wt %).
Lab Chemicals and Decontamination Drains (500 gal/day; 375 gal/yr of concentrates @ 25 Wt %).
Primary Water From resin Sluicing (500 gal/day; 750 gal/yr of concentrates @ 25 Wt %).

2. LRS Inputs Under Abnormal Operating Conditions

Under abnormal operating conditions, inputs and estimated expected waste quantities to the Liquid Radwaste System come from the following sources:

Turbine Building Floor and Equipment Drains (7,200 gal/day; 20 gal/yr of concentrates @ 50 Wt %).
Condensate Polisher Demineralizer Regenerants (20,000 gal regenerants/day; 11,200 gal/yr of concentrates @ 50 Wt %).

Liquid Radwaste Inputs To The Solid Radwaste System

Under normal and abnormal operating conditions, inputs and estimated expected waste quantities to the SRS are summarized in Table I.

TABLE I

ANNUAL INPUTS TO SOLID RADWASTE SYSTEM PER UNIT

Source		Volume*	Solids*
Radwaste Evaporator Concentrates		26,700 gal	105,000 lbs
Boric Acid Evaporator Concentrates		6,000 gal	6,048 lbs
Crud Tank		1,200 gal	200 lbs
Chemical Drain Tanks		2,200 gal	367 lbs
Spent Resins		1,700 ft^3	35,000 lbs
Dry Active Waste	@ 200 lbs/drum	6,617 ft^3	180,000 lbs
	(@ 360 lbs/drum)	(3,676 ft^3)	180,000 lbs
Filter Cartridges		40 ft^3	N/A

*Estimated Quantities Subject To Change

Solid Radwaste System Outputs

Wastes from PVNGS are packaged in 55 gallon drums and 80 cubic foot liners. (For simplicity purposes, it will be assumed that all wastes are packaged in 55 gallon drums.)

All Liquids to be Solidified by the Solid Radwaste System are:

1. Radwaste Evaporator Concentrates
2. Boric Acid Evaporator Concentrates
3. Crud Tank Contents
4. Chemical Drain Tank Contents
5. Spent Resins
6. Filter Cartridges

Table II summarizes the estimated annual output of 55 gallon drums from the Solid Radwaste System per unit.(It is estimated that 33 gallons of radioactive liquid wastes will be solidified in one 55 gallon drum at PVNGS.)

TABLE II

ANNUAL SOLIDIFIED WASTE OUTPUT PER UNIT

Source	55 Gallon Drums/Yr*
Liquid Waste	1,100
Spent Resins	350
Dry Active Waste	(500 @ 360 lbs/drum compaction) 900 @ 200 lbs/drum compaction
Filter Cartridges	6
TOTAL	(1,956 @ 360 lbs/drum of DAW) 2,356 @ 200 lbs/drum of DAW

* Estimated Quantities Subject To Change

Solid Radwaste and Dry Active Waste (DAW) Storage Capacities

PVNGS' total estimated on-site interim storage capacities are summarized in Table III.

TABLE III

TOTAL STORAGE CAPACITY PER UNIT

Source	Drums *	Cu. Ft.*	Days*
Solidified Waste	180	1,323	45
Compacted Waste (DAW)	80	590	32

* Estimated Quantities Subject To Change

PVNGS Plans For Disposal

There are three (3) Low Level Radioactive Waste (LLRW) disposal sites under discussion for shipping LLRW from PVNGS. These disposal sites are Barnwell, Beatty and Hanford.

At the Barnwell, South Carolina site recent restrictions have been placed on the amount of packaged LLRW that will be accepted at this site for disposal. The long-term availability of Beatty, Nevada and Hanford, Washington LLRW disposal sites has become more uncertain. The establishment of additional state and regional LLRW disposal sites are subjects of discussion being held across the country. Although deliberations are being held, operation of these LLRW sites are uncertain.

In view of these uncertainties, APS has established a PVNGS LLRW Task Force to study the issues of an on-site Low Level Radioactive Waste Storage Facility (LLRWSF). These issues include the economics and licensing of a temporary on-site LLRWSF with a capacity to store LLRW generated for up to four (4) reactor-years of operation per unit.

The LLRWSF would only be necessary if disposal sites were not available. Permanent storage of LLRW will not be considered for PVNGS at this time. This decision is based on cost and the licensing implications associated with such a facility. The wastes to be temporarily stored are those Low Level Radioactive Solid Wastes (LLRSW) and DAW that will be incidental to the production of electrical power from PVNGS. In addition, storage of off-site generated wastes in the LLRWSF at PVNGS will not be considered.

Economics of Radwaste Disposal Without Volume Reduction (VR)

The radwaste quantities previously indicated were used to generate the economics of LLRW disposal without VR.

For the purpose of PVNGS economic studies related to disposal costs, the Beatty disposal site will be used. In addition, this site may be the only site available to PVNGS at the time of disposal needs.

Total Estimated Disposal Costs

Table IV summarizes the total estimated PVNGS annual disposal costs per unit in 1981 dollars.

FUTURE PVNGS RADWASTE SYSTEMS

VR Processes Under Consideration for PVNGS

The VR processes under consideration for PVNGS are dehydration and incineration. In order to determine whether VR is economically feasible for PVNGS, the disposal cost savings expected from each VR process must be evaluated.

The estimated annual disposal cost savings associated with the incineration of Dry Active Waste (DAW), dehydration of liquid waste, incineration of resins, and simultaneous dehydration/solidification of liquids and resins are presented in Table V.

The disposal cost savings attributable to the applicable VR processes were converted to equivalent capital investments (ECI) and compared to capital cost estimates of corresponding VR facilities. The ECI of the disposal cost savings due to VR serves as an estimate of the maximum total investment in a VR facility that would be justified by the disposal cost savings.

The estimated ECI of the disposal cost savings for each of five possible VR facilities is compared with the corresponding capital requirements in Table VI.

The final decision on the addition of a VR process at PVNGS is dependent on several criteria. The first criterion is the capital investment required for a VR process must be significantly less than the equivalent capital investment of the disposal cost savings if the VR process is to be found cost effective. The second criterion is that the VR process must be designed to meet state and local environmental considerations. The third criterion is that the VR process must be designed to meet PVNGS design criteria for radioactive waste systems. Finally, the VR process must be able to meet all NRC requirements for radioactive waste treatment systems.

TABLE IV

TOTAL ANNUAL DISPOSAL COSTS*
(1981 Dollars/Unit)

	450 Mile Trip	700 Mile Trip	DAW Drums/Yr.
Transportation	$271,161	$367,644	900
	(262,818)	(356,304)	(500)
Burial	197,625	197,625	900
	(172,725)	(172,725)	(500)
Operation & Material Costs	161,090	161,090	900
	(141,090)	(141,090)	(500)
TOTAL	$629,876	$726,359	900
	(576,633)	(670,119)	(500)

*Estimated Costs Subject To Change

TABLE V

VOLUME REDUCTION PROCESSES ANNUAL DISPOSAL COST SAVINGS*
(1981 Dollars)

Process	Total Savings For These Units		Savings/Unit		
	450-Mile Trip	700-Mile Trip	450-Mile Trip	700-Mile Trip	Drums/Yr. Basis
Incineration of DAW Only (Common Facility)	$350,400 (346,000)	$361,200 (358,000)	$116,800 (115,333)	$120,400 (119,333)	2,700 (1,500)
Dehydration of Liquid Wastes (Replicate Facilities)	488,400	597,900	162,800	199,300	
Incineration of Resins Only (Replicate Facilities)	398,700	463,800	132,900	154,600	
Simultaneous Dehydration/Solidification of Resins and of Liquids (Replicate Facilities)					
Resins	76,200	75,900	25,400	25,300	
Liquids	309,600	351,000	103,200	117,000	
TOTAL	$385,800 (381,400)	$426,900 (423,700)	$128,600 (127,133)	$142,300 (141,233)	2,700 (1,500)

* Estimated Costs Subject To Change

TABLE VI

VOLUME REDUCTION PROCESSES
ECI OF DISPOSAL COST SAVINGS VS. ESTIMATED CAPITAL REQUIREMENTS*
(1986 Dollars)

VR Facility	ECI Of Savings/Facility 450-Mile Trip	 700-Mile Trip	Drums/Yr. Basis	Est. Capital Req./Facility	Total Est. Capital Req.
1. Incineration of DAW Only (Common Facility)	9,183,600 (6,439,302)	9,466,300 (6,753,801)	2,700 (1,500)	11,500,000	11,500,000
2. Incineration of DAW and All Resins (Replicate Facility)	6,531,100 [a] (5,616,334)	7,207,700 [a] (6,303,567)	2,700 (1,500)	14,100,000	42,300,000
3. Dehydration of Liquids Only (Replicate Facility)	4,266,000	5,228,900		16,700,000	50,100,000
4. Incineration and Dehydration, Total VR (All Resins) (Replicate Facility)	10,797,100 [a] (9,882,334)	12,436,600 [a] (11,532,467)	2,700 (1,500)	21,100,000	63,300,000
5. Simultaneous Dehydration/ Solidification (Replicate Facility	3,370,900	3,729,100		12,300,000	36,900,000

* Estimated Costs Subject To Change

[a] These values will be lower by about 15% to 30% assuming 30% of the resins are too radioactive to incenerate.

SUMMARY

In summary, Table VI indicates the common DAW incineration facility appears to be most nearly economical for PVNGS. The Liquid and Solid Radwaste Management Systems at PVNGS are and will be capable of handling all forms of low-level radioactive waste generated by the various systems in the plant. PVNGS' proposed effective capability of handling POST Accident generated wastes will not pose a threat to the future operation of the liquid and solid radwaste systems. All the radwaste outputs from PVNGS are packaged in a form acceptable for off-site disposal and on-site storage. APS, as Operating Agent of PVNGS, has committed to work closely with the radwaste industry to improve PVNGS' Radwaste Management Systems and to comply with all state, local and NRC requirements.

BIBLIOGRAPHY

1. Palo Verde Nuclear Generating Station Final Safety Analysis Report - Chapters 1, 2, 11, and 12.

2. Palo Verde Nuclear Generating Station Design Criteria Manual - Volume I, II, and III.

3. Palo Verde Nuclear Generating Station System Description Manual - volume IV and V.

4. Palo Verde Nuclear Generating Station Radwaste Management Study - Final Report (SL-3869) prepared by Sargent & Lundy, October 6, 1981.

5. Palo Verde Nuclear Generating Station Radwaste Solidification System Operating and Maintenance Manual Volume I and II.

6. Palo Verde Nuclear Generating Station Liquid Radwaste Evaporator System Operating and Maintenance Manual - Volume I and II.

7. Palo Verde Nuclear Generating Station Dry Waste Compactor System Installation, Operation and Parts List Manual - Volume I.

8. Palo Verde Nuclear Generating Station Radwaste Task Force - Bi-Monthly Meeting Minutes for 1981.