APPENDIX B

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
PUGET SOUND POWER AND LIGHT COMPANY, et al.	)	Docket Nos. 50-522 50-523
	)	
(Skagit Station Units 1 and 2)	)	

TESTIMONY ON BULK TRANSMISSION SYSTEM REQUIREMENTS ASSOCIATED WITH ALTERNATIVE SITES FOR THE SKAGIT NUCLEAR GENERATING FACILITIES

by

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BACKGROUND

At the request of the NRC Staff, the Bonneville Power Administration (BPA) conducted an examination to estimate the transmission system facilities and associated costs which would be required to integrate the output of a powerplant at each of six sites in the Pacific Northwest bulk power transmission system. The sites were identified for the purpose of this study by the NRC staff and then furnished to BPA. These sites are: Skagit (the proposed site); Pebble Springs (north central

Oregon); Hanford (south central Washington); Cherry Point (northwest Washington); Goshen (northwest Washington); and Ryderwood (southwest Washington).

These alternate sites are in the BPA service area. It is reasonable to expect that each site could be integrated into the BPA 500-kV main grid transmission system, and BPA could provide wheeling services for participants. The participants are:

Unit No. 1 and Unit No. 2

Portland General Electric Company	30.0%
Pacific Power and Light Company	20.0
Puget Sound Power and Light Company	40.0
The Washington Water Power Company	10.0

All the participants presently have wheeling contracts with BPA for other generating resources. Wheeling agreements have not been initiated for the Skagit Nuclear Plant.

The BPA transmission system is the main bulk power transmission grid in the Pacific Northwest. BPA facilities in the States of Oregon, Washington, Idaho, and Montana, interconnect with the non-Federal systems forming a coordinated regional network. About 80 percent of this network is owned and operated by BPA.

Approximately 75 percent of the load in the BPA service area is located west of the Cascade Mountain Range in Oregon and Washington. The remainder is dispersed throughout the region with load concentrations in the Spokane, Yakima, and Tri-Cities areas of Washington and in southern Idaho areas.

Most of the electric power is presently obtained from Federal and non-Federal hydroelectric dams east of the Cascade Mountains. Most of it flows westerly from these dams to serve load located west of the Cascades. This report concentrates on transmission system additions required to interconnect the sites to the main grid and main grid additions that may be required to serve Northwest loads.

INVESTIGATIVE APPROACH

In order to gather information pertinent to this evaluation, the NRC staff met with BPA staff to outline the study approach. It was agreed that the study methodology for transmission requirements should be similar to the methodology used for the Pebble Springs alternative sites.

Precise locations of each site were provided by the NRC staff. Based on this information, BPA conducted several power flow studies for each alternative site to determine transmission requirements. The base cases depict August 1988 and January 1989 system conditions with the assumption that both Skagit units and both Pebble Springs units are in service. Those studies included existing transmission facilities and facilities presently planned or expected to be in service by the commercial operating dates scheduled for the Skagit units. In some cases, the interconnection facilities for the alternate sites interface with planned or programmed transmission facilities not yet constructed. The base data for the power flow studies included the major facilities of all the interconnected utility systems in the Western Systems Coordinating Council (WSCC). That council covers all or parts of the 14 western States and British Columbia, Canada. The studies were, thus, broad in scope.

Stability studies were also conducted to determine dynamic system response for system disturbances at critical locations.

It is important to note that transmission facilities constructed by BPA must undergo the environmental review process. That procedure has not been conducted for any of the sites. Also, plans of service for other projects are tentative at this time. Since the plans for alternative sites interrelate with other transmission projects, not yet in service, they may change if an alternative site is approved and more detailed site specific studies show that a different plan of service is appropriate. However, changes in plans are not likely to significantly impact transmission requirements for alternative sites.

CRITERIA APPLIED

The BPA transmission system is planned and constructed in accordance with two sets of reliability criteria. The two sets of criteria are compatible. The reliability criteria adopted by BPA describe the performance and planning reliability of the BPA system.

The second set of reliability criteria is that adopted by the WSCC. It describes the limitation of the effects that disturbances on one system can have on other member systems.

Studies to assure adherence with the criteria include simulation of all the transmission facilities, generating resources, and loads in the WSCC.

The two sets of reliability criteria are lengthy and relate to many planning considerations. The portions relating to main grid transmission requirements for the Skagit alternative sites are included in Appendix 1 in the form of performance tables. They describe system performance and permissible remedial action for multiple contingencies.

Specific tests to determine adequacy of transmission facilities for each site include:

- Steady state tests (power flow studies) to assure full load operation of the plant with one line out of service.

- Transient stability tests to assure that the plant will maintain synchronous operation (stability studies) when a three-phase fault is cleared by normal automatic circuit-breaker operation.

- Transient stability tests with one line out of service to assure that a single phase-to-ground fault on another line will not limit full load operation of the plant. To satisfy this test, single-pole relaying and single-pole circuit breaker operation is necessary in some cases.

GENERAL PLANNING CONSIDERATIONS

The BPA system is designed and constructed to serve the electric power demands in the Pacific Northwest. Facilities are timed to satisfy that objective reliably and economically. Main grid facilities that are described in the sections of this report that follow are likely to be required at some future date regardless of Skagit or its alternate sites. The sections that follow are therefore presented to assist in the environmental evaluation of alternate sites.

The direct interconnection facilities, on the other hand, are site specific. Those facilities connect each site to the main grid.

Power flows on a transmission system in accordance with the laws of physics. Power generated at any site tends to serve load nearest that site. Power from sources that would otherwise serve those same loads is redistributed on the system to serve other loads. This is the principal of displacement. On this basis, the wheeling cost for sites located near loads is less than for sites located far from loads. The BPA system can be divided into five zones. The lowest transmission cost is in Zone 1. It includes the major load areas in the Puget Sound, Portland and Willamette Valley trough. It is a narrow zone running from the

Canadian border to Eugene, Oregon. Zone 2, includes the Pacific coast, with the exception of the Olympic Peninsula and the western slopes of the Cascade Mountains. Zones 3, 4, and 5 are mostly east of the Cascades. Zone 5 is the highest cost zone.

Skagit, Ryderwood, Cherry Point, and Goshen are in Zone 1 and have the lowest transmission cost. Pebble Springs and Hanford are in Zone 4.

In the long-range, transmission cost will be essentially the same for any site within each zone. The following table uses this concept.

Zone 1	Annual Cost/kW[1/]	Total Annual Cost
Skagit, Ryderwood, Cherry Point, Goshen	$1.70	4,250,000
Zone 4		
Pebble Springs, Hanford	3.50	8,750,000

1/ These rates are being reviewed and may be increased about 50 percent. The above numbers include main grid additions and use of main grid facilities.

COST DATA FOR FACILITY ADDITIONS
(Interconnection and Main Grid)

As a result of the limited availability of right-of-way in the Pacific Northwest, it is appropriate to construct high-capacity transmission facilities. These facilities may exceed the initial transmission capacities required for integrating generating resources. The long-range

effect is to minimize the environmental impact of future transmission facilities.

The highest capacity standard 500-kV single-circuit transmission line presently used by BPA utilizes three 1.602-inch (Chukar) conductors per phase. The three phases are arranged in a delta configuration that maximizes power transfer capability and minimizes right-of-way width requirements.

Double-circuit 500-kV lines are recommended for some of the alternative sites. These use taller transmission line towers that have one three-phase circuit mounted on each side of the tower. Each phase of both circuits use the same conductors as for the single-phase line configuration described above.

Each circuit of the lines described is capable of transmitting the generating capacity of two units with one circuit out of service. Their design capacity is 2500 MW per circuit.

Lines to provide station service power are required for some sites. These lines are rated for 230-kV operation. They use conductors which are adequate for station service requirements for two units.

Switching facilities are appropriately designed to accommodate the transmission lines connected to them.

The costs for transmission lines represent BPA typical estimates based on 1979 prices. The following table shows the typical per-unit cost of transmission facilities. They exclude land, clearing, site development, and administrative overheads.

	Investment $(000)
500-kV single-circuit line, (3-1780 kcmil conductors/phase)	250/mile
500-kV double-circuit line, (3-1780 kcmil conductors/phase)	480/mile
500-kV Columbia River crossing, (Double-circuit 3-1780 kcmil cond./phase)	1,500 Ea
230-kV single-circuit line, (1-1272 kcmil conductor/phase)	100/mile
500-kv circuit breaker with disconnect switches, substation deadend tower and auxiliary equipment, (3000 amp. rated capacity)	900 Ea

SITE INTERCONNECTION AND MAIN GRID FACILITIES FOR EACH SITE

This section describes transmission system requirements for the proposed Skagit site and each alternate site and is intended to assist the environmental assessment of each site. The interconnection and main grid facilities identified for each site interface with existing system facilities, facilities programmed for construction, or facilities presently planned to be in place before 1989. The best available interutility planning information was used in estimating the facilities. The costs shown in this section pertain to interconnection facilities. The costs shown in Table 1 are the zone costs plus the cost to connect the sites to the main grid.

Skagit Site; the proposed site (See Figure 1)

Interconnection facilities for the Skagit site consist of switching facilities at Skagit Substation and two 500-kV double-circuit lines, one 3-miles long and one 5-miles long, to loop in two existing 500-kV lines into the Skagit site. Puget Sound Power & Light Co. is also planning a 4.5 mile 230 kV high-capacity double-circuit line to their Sedro Wooley substation.

Figure 1 shows the 500-kV transmission system facilities in the vicinity of the Skagit site.

Offsite power for this site would be provided over 230-kV facilities provided by PSP&L.

Land description:

The two 500-kV lines would cross over logged areas and second growth timberland. The routes would avoid rural residences.

Cost estimate:

	Interconnection Facilities
Skagit Substation:	
9 - 500-kV circuit breakers	$ 8,100,000
2 - 500-kV double-circuit lines (8 miles total)	3,840,000
Total	$11,940,000

NOTE: The above estimate includes major facilities and excludes land clearing, site development, and control facilities. It is comparable to the estimates for alternative sites.

Goshen Site; (See Figure 2)

The Goshen site is about 40 miles north of Skagit. Development of Goshen Substation would be about the same as for the Skagit site. The connection diagram is shown in Figure 2.

Two 500-kV double-circuit lines would be extended from the existing 500-kV lines near Bellingham to the Goshen site.

Offsite power is assumed to be provided by PSP&L.

Land description:

The Goshen site would be integrated into the BPA 500-kV system near the Billingham substation. One feasible route follows the valley generally parallel to the Milwaukee railroad about 7 miles to the BPA Monroe-Custer lines. Another route runs south of the plant for about 4 miles then turns westerly to the Monroe-Custer lines. This route is 9½ miles long and avoids crossing diagonally through developed farmland. Lines along either route would cause some disruption to farming.

Cost estimate:

	Interconnection Facilities
Goshen Substation:	
9 - 500-kV circuit breakers	$ 8,100,000
2 - 500-kV double-circuit lines (7 miles each)	6,720,000
Total	$14,820,000

Cherry Point Site; (See Figure 3)

This site is about 40 miles northwest of the Skagit site in the vicinity of the Intalco alumimum reduction plant. Two 500-kV single-circuit lines would be constructed into the BPA Custer Substation. It is assumed that offsite power would be provided over PSP&L facilities.

Land description:

Two 500-kV lines about 8-miles long would be constructed parallel to an existing 230-kV right-of-way. The corridor passes over nearly level ground through rural residential areas. It is likely that several homes would be removed and residents relocated. The route passes near a Washington State game range.

Cost estimate:

	Interconnection Facilities
Cherry Point Substation:	
4 - 500-kV circuit breakers	$ 3,600,000
Custer Substation:	
5 - 500-kV circuit breakers	4,500,000
Two Cherry Point-Custer 500-kV lines (8 miles each)	4,000,000
Total	$12,100,000

Ryderwood Site; (See Figure 4)

The Ryderwood site is located near the city of Ryderwood, Washington. Integration of that site would include two 500-kV lines that would tap the existing 500-kV lines running between the BPA Paul and Allston Substations. Main grid additions would include an additional 500-kV line between Ryderwood and Allston. Switching facilities would be required at Ryderwood.

Land description:

Ryderwood tap lines:

Corridor length	3 miles
Timberlands	3 miles
Access roads required	4 miles

500-kV Ryderwood-Allston line:

Corridor length	23 miles
Timberlands	19 miles
Farmlands	3 miles
River crossing	1 mile

The corridor for the tap would cross 3 miles of rolling, timber covered terrain. A double-circuit line supporting 230 kV on one side for offsite power and the Ryderwood-Allston line on the other side would share this corridor. From the tap point extending 20 miles south to Allston, one 500-kV line would be required parallel to the existing Paul-Allston lines. This stretch is mostly wooded with sparse populations. Near Longview the corridor crosses areas of congestion. It also crosses sensitive soil conditions before spanning the Columbia River.

Cost estimate:

	Interconnection Facilities
Ryderwood Substation:	
4 - 500-kV circuit breakers	$ 3,600,000
Two - 500-kV tap lines (3 miles each)	1,500,000
Total	$ 5,100,000

Pebble Springs Site: (See Figure 5)

If the two Skagit units are moved to the Pebble Springs site, they would be the third and fourth units integrated into the BPA grid at Slatt Substation. The local area portion of the BPA grid would be reinforced with a 30-mile long 500-kV line between Slatt and John Day Substations. Offsite power would be provided for the Pebble Springs units.

Land description:

The Slatt-John Day line would cross about 18 miles of rangeland and 12 miles of dryland wheat farming. The terrain ranges from level to deep canyons in the westerly portion. The line would likely parallel an existing BPA transmission line.

Cost estimate

	Interconnection Facilities
Slatt Substation:	
2 - 500-kV circuit breakers	$1,800,000
Total	$1,800,000

Hanford Site; (See Figure 6)

If the two Skagit units are moved to the Hanford site, they would be the fourth and fifth units integrated into the BPA main grid system at Ashe Substation. The other three units are WNP units 1, 2, and 4. Interconnection of the fourth and fifth units can be accomplished with switching facilities at Ashe Substation. A second Ashe-Hanford 500-kV line would be required for grid reinforcement. Offsite power would be provided from facilities provided for the WNP units.

Land description:

The Ashe-Hanford line would be in the Hanford Nuclear Reservation and cross nearly level desert land for its entire distance.

Offsite power would be similar to that provided for the WNP units.

Cost estimate:

	Interconnection Facilities
Ashe Substation:	
2 - 500-kV circuit breakers	$1,800,000
Total	$1,800,000

Hanford Site; (7-unit development) (See Figure 7)

If the two Skagit units and the two Pebble Springs units are moved to the Hanford site, they would be the fourth, fifth sixth, and seventh units integrated into the BPA grid at Ashe Substation. The connection diagram is shown in Figure 7. Grid reinforcement would include a 500-kV line between Ashe and Hanford Substation.

Land description:

The Ashe-Hanford line would be in the Hanford Nuclear Reservation and cross nearly level desert land for its entire distance.

Cost estimate:

	Interconnection Cost for Skagit Units Located at Hanford
Ashe Substation:	
2 - 500-kV circuit breakers	$1,800,000
Total	$1,800,000

TRANSMISSION INTERCONNECTION COST

Total typical costs to integrate each site are summarized in Table 1. Included are zone wheeling costs for each site and interconnection costs to connect the plant into the BPA main grid. The costs exclude land acquisition, clearing, substation site development, and administrative overhead. Main grid facilities would become an integral part of the main grid and allocable to all system uses and are included as part of the zone wheeling costs. Modifications to reflect ultimate plans of service and line routings may modify the indicated costs. However, modifications are not expected to change the cost ranking of the alternate sites.

INCREMENTAL LOSSES

The NRC Staff requested an evaluation of incremental system losses associated with each alternative site. These losses are shown in Table 2 for the BPA system and the interconnected Pacific Northwest system. They are based on power flow studies for January 1989 for the transmission system configuration and generation schedules that are likely to occur at that time.

All thermal units are assumed to be operating at rated capacity. The hydro units are assumed to be optimized for average water conditions. Deviations from these assumptions may significantly change the incremental losses shown in Table 2.

The value of incremental losses is generally based on the cost of alternative resources. At BPA, we frequently base such costs on fossil fuel displacement in California that could be achieved over the PNW-PSW Intertie.

Assuming a typical system load factor of 75 percent (loss factor of 56 percent), the annual energy associated with the incremental losses would be about 4,900,000 kWh per MW of incremental loss. The typical energy production from one barrel of oil is 600 kWh. Therefore, each megawatt of incremental loss is equivalent to about 8,000 barrels of oil per year. If oil is evaluated at $20 per barrel, then each megawatt of incremental loss can be translated to about $160,000 per year.

The average incremental cost of losses for sites located east versus west of the Cascades would then be in the range of $9,000,000 to $23,000,000 per year.

LAND IMPACT OF TRANSMISSION LINES

The type of terrain and miles of line for each site are discussed under "Site Interconnection and Main Grid Facilities for Each Site."

Table 3 shows the typical areas of land required for interconnection and main grid lines for each site.

TABLE 1

TRANSMISSION COST COMPARISON FOR ALTERNATIVE SITES

Site	Main Grid Wheeling Cost		Interconnection Cost		Total
	Zone	Annual Cost	Investment	Annual Cost	Annual Cost[3]
Skagit	1	4,250,000[2]	11,940,000	1,194,000	5,444,000
Goshen	1	4,250,000	14,820,000	1,482,000	5,732,000
Cherry Point	1	4,250,000	12,100,000	1,210,000	5,460,000
Ryderwood	1	4,250,000	5,100,000[4]	510,000	4,760,000
Pebble Springs	4	8,750,000	1,800,000[4]	180,000	8,930,000
Hanford	4	8,750,000	1,800,000[4]	180,000	8,930,000
Hanford (7-Unit Development)[1]	4	8,750,000	1,800,000[4]	180,000	8,930,000

1/ Cost for Skagit Units only.

2/ Wheeling cost assumes total plant output is wheeled. Puget Sound Power & Light Co. is planning to construct a 230 kV double-circuit line from Skagit to their Sedro Wooley substation and transmit a portion of the plant output over their own facilities, thus reducing the amount to be wheeled. However, the costs tabulated are representative of facilities required to transmit total plant output to load centers.

3/ Annual cost excludes cost of losses.

4/ Additional main grid requirements for each site are given in the text. These costs would be absorbed by main grid wheeling charges. Investment costs may be computed based on data given on page 8.

TABLE 2

INCREMENTAL TRANSMISSION LOSSES
(Based on January 1989 Conditions)

Site	Incremental Losses - MW BPA System	 Total PNW System
Skagit (Base case)	--	--
Goshen	6.5	6.5
Cherry Point	9.5	10.3
Ryderwood	-17.6	-18.0
Pebble Springs[1/]	49.3	57.0
Pebble Springs[2/]	79.4	88.7
Hanford (Figure 6)	88.1	97.1
Hanford (Figure 7)	132.9	144.4

1/ Assumes the addition of a single circuit 500-kV line between SLATT and JOHN DAY.

2/ Assumes no system addition between SLATT and JOHN DAY. This information is provided for comparative purposes.

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TABLE 3

TYPICAL ACREAGE OF LAND IMPACT FOR
INTERCONNECTING AND MAIN GRID LINES

Site	Miles[1/]	Acres[2/]
Skagit	8	121
Goshen	14	212
Cherry Point	16	204
Ryderwood	32	415
Pebble Springs	30	382
Hanford	18	229

1/ Structure miles of transmission lines.

2/ Typical acres per mile - BPA design:

500-kV single-circuit line	12.73
500-kV double-circuit line	15.15

FIGURE 1
500 Kv TRANSMISSION SYSTEM CONNECTIONS
FOR SKAGIT UNITS 1 & 2

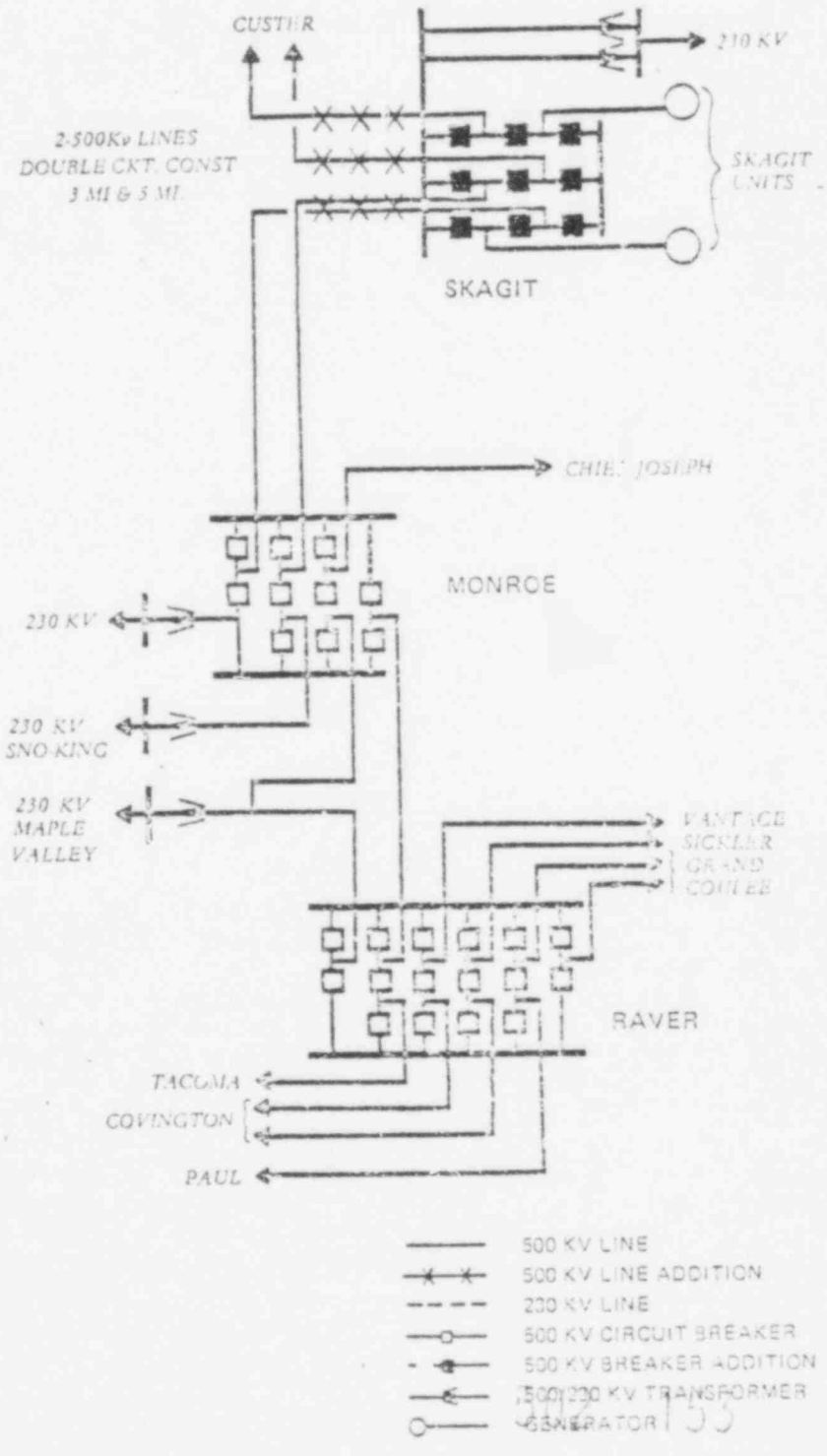

FIGURE 2
500 Kv TRANSMISSION SYSTEM CONNECTIONS
FOR GOSHEN UNITS 1 & 2

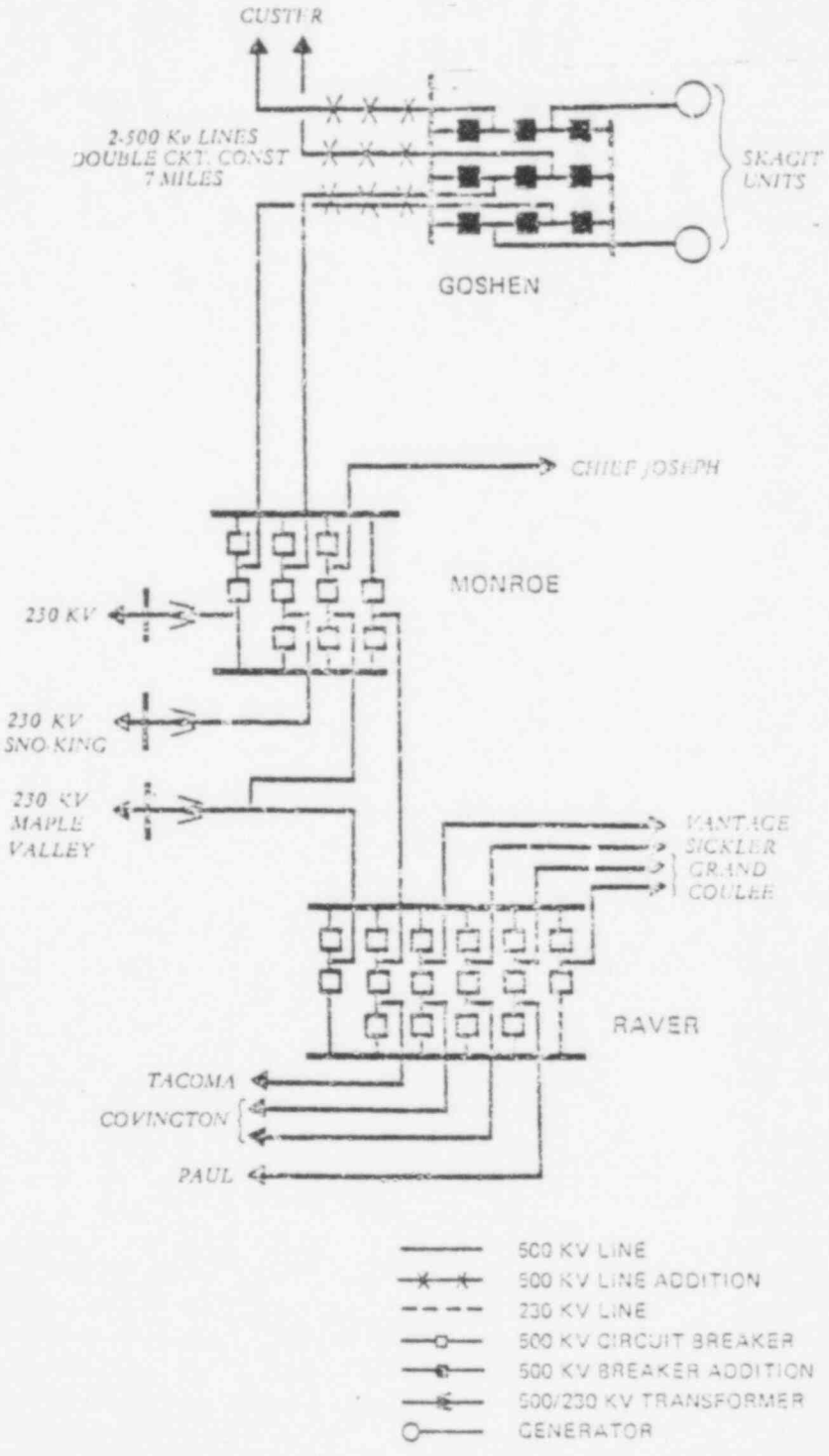

FIGURE 3
500 Kv TRANSMISSION SYSTEM CONNECTIONS
FOR UNITS 1 & 2 AT THE CHERRY POINT
NUCLEAR SITE AS AN ALTERNATE TO SKAGIT 1 & 2

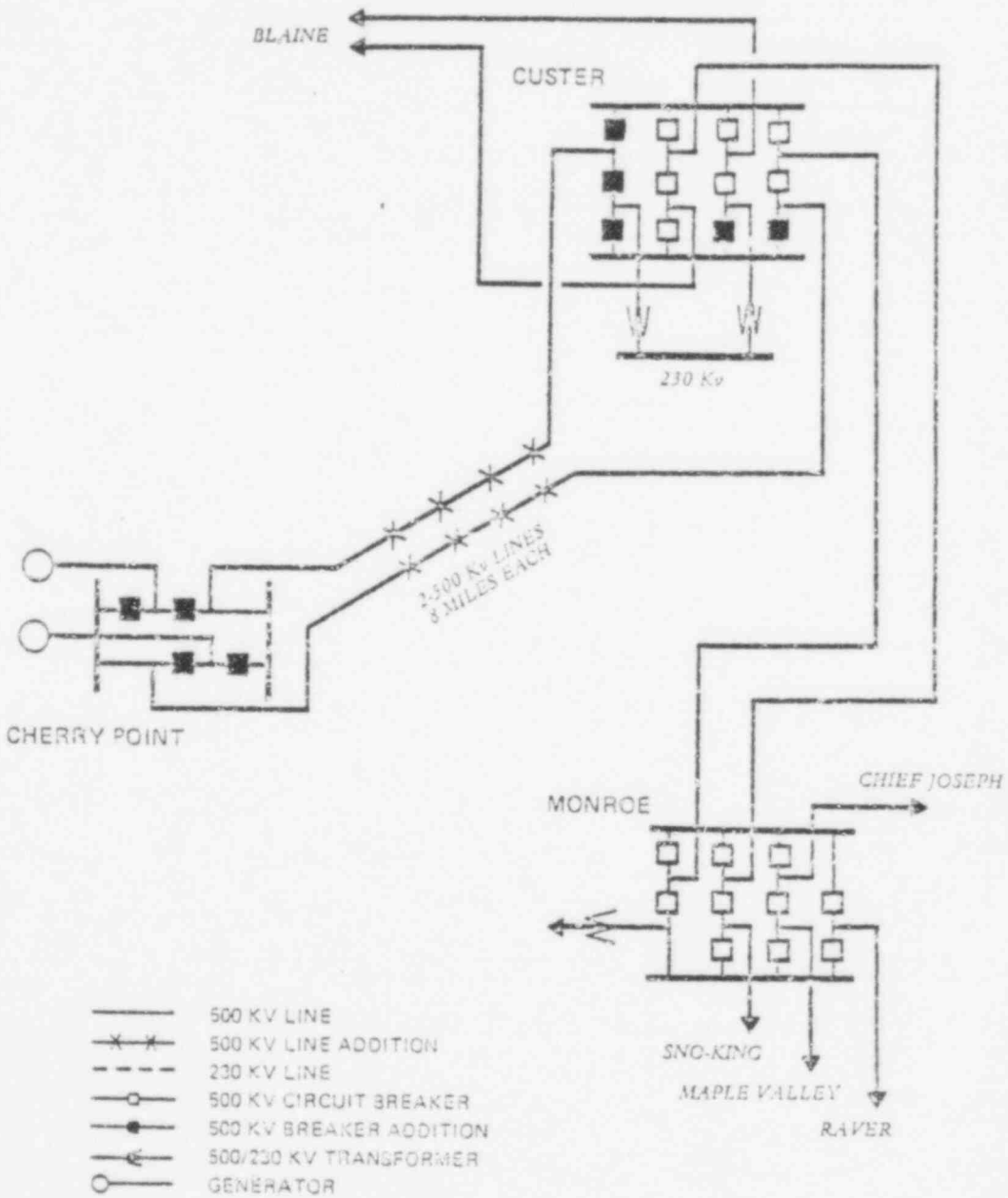

FIGURE 4
500 Kv TRANSMISSION SYSTEM CONNECTIONS
FOR UNITS 1 & 2 AT THE RYDERWOOD NUCLEAR SITE
AS AN ALTERNATE TO SKAGIT UNITS 1 & 2

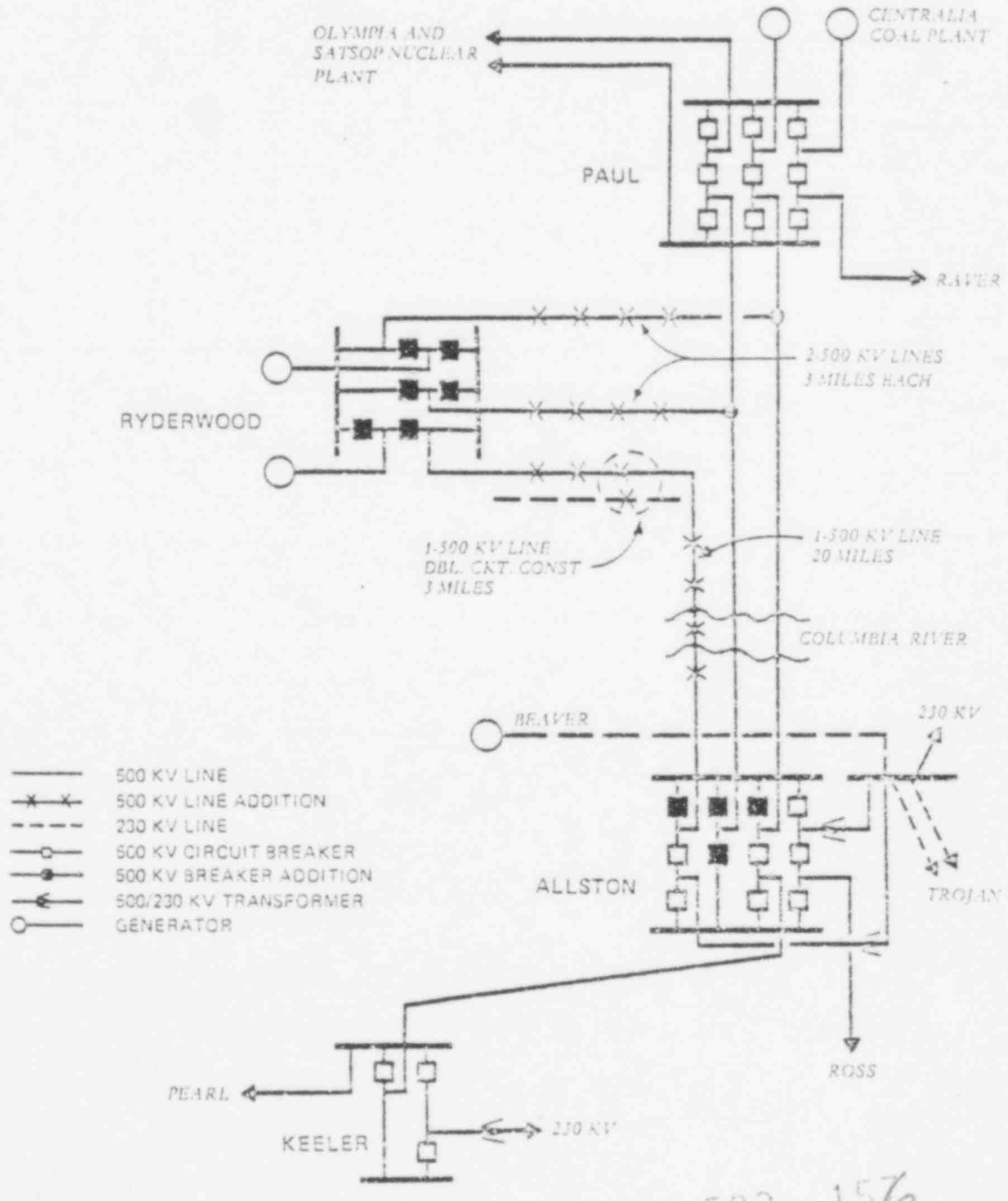

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FIGURE 5
500 Kv TRANSMISSION SYSTEM CONNECTIONS
FOR UNITS 3 & 4 AT THE PEBBLE SPRINGS NUCLEAR
SITE AS AN ALTERNATE TO SKAGIT UNITS 1 & 2

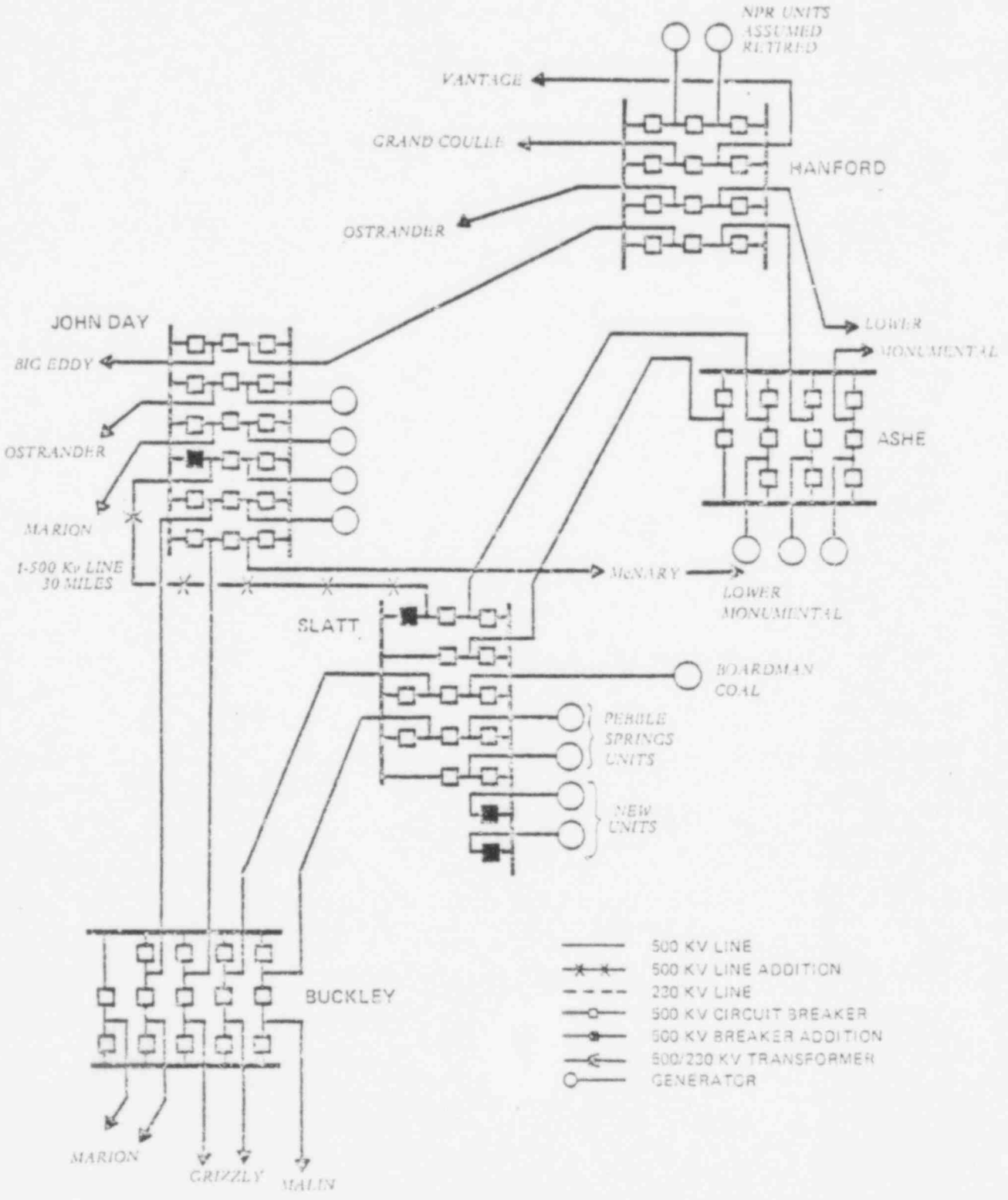


FIGURE 6
500 Kv TRANSMISSION SYSTEM CONNECTIONS
FOR UNITS 4 & 5 AT THE HANFORD NUCLEAR PLANT
AS AN ALTERNATE TO SKAGIT UNITS 1 & 2

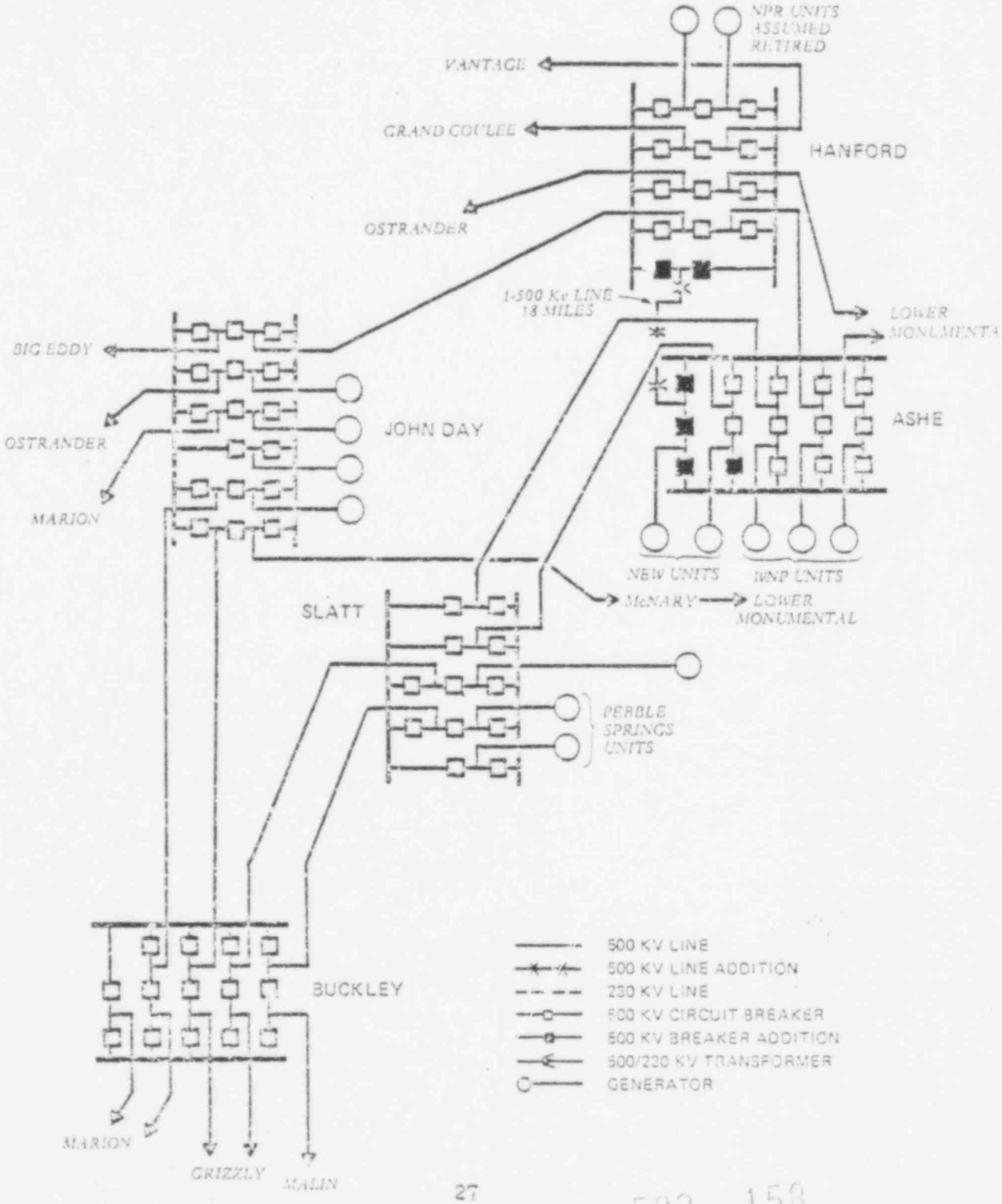
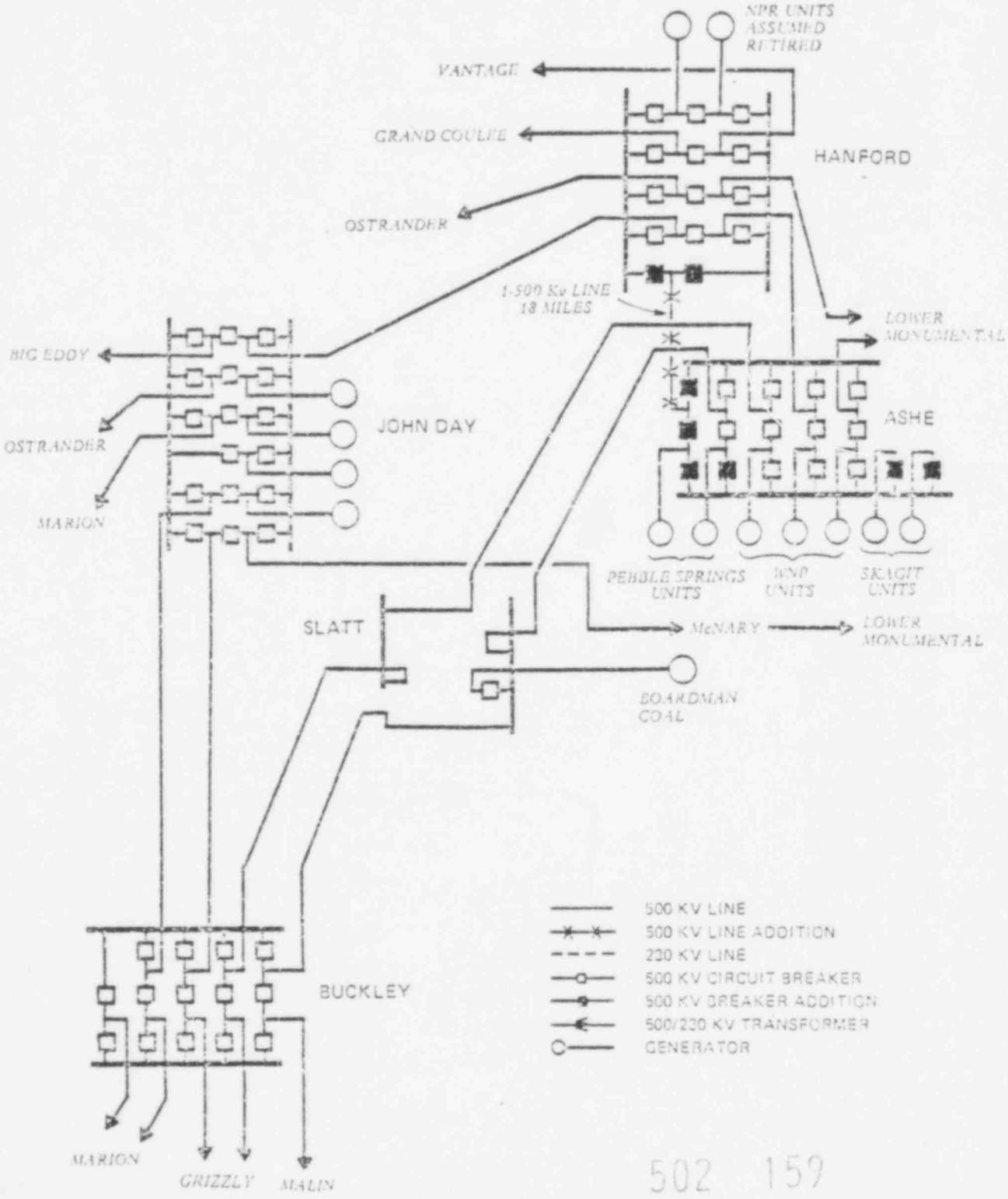


FIGURE 7
500 Kv TRANSMISSION SYSTEM CONNECTIONS
FOR UNITS 4, 5, 6 & 7 AT THE HANFORD NUCLEAR
SITE AS AN ALTERNATE TO PEBBLE SPRINGS 1 & 2
AND SKAGIT 1 & 2



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Appendix 1

Reliability criteria for system planning:

The BPA transmission system is planned and constructed according to two sets of reliability criteria. The first set is the BPA criteria which defines internal system design to serve Pacific Northwest load. The second criteria is the Western Systems Coordinating Council (WSCC) criteria which defines the effects that disturbances on one system can have on other systems.

Both criteria are lengthy but summarized in performance tables.

BPA Reliability Performance Table

			OUTAGE TYPE AND LOCATION			
			Same NW Area		Different NW Area	
Item	Facility Outage		System Adjusted After First Outage	Simultaneous Outage	System Adjusted After First Outage	Simultaneous Outage
1.	1 Plant	1 Line	B	C	A	B
2.	1 Plant	1 Plant	B	C	B	B
3.	1 Line	1 Line	C	D	B	C
4.	2 Plants	1 Line	C	D	B	C
5.	1 Plant	2 Lines	D	D	C	D

Plant - Generators 300 MW and larger or all units that can be dropped for loss of a bus section.

Line - Excludes powerhouse lines, includes single circuits of a double-circuit line and single-circuit lines.

A permanent single-contingency outage of any main grid line or any plant will provide performance Level A.

B. Reliability Level: Definitions for Multiple Contingencies

A - Serves all peakloads during abnormal weather

B - Serves all peakloads during normal weather

C - Automatic Load Tripping: Automatic disconnection of certain selected loads to prevent system breakup when critical transmission system components are automatically disconnected.

D - Area Separation: Splitting of one major load area or intermediate load area from the rest of the regional grid.

Interregional Ties and Interconnections:

The Western Systems Coordinating Council "Reliability Criteria for System Design" shall be utilized when determining the performance of the Northwest Grid in relationship to interregional ties and interconnections.

The reliability performance table for the WSCC is reproduced on the following page.

WESTERN SYSTEMS COORDINATING COUNCIL
DISTURBANCE - PERFORMANCE TABLE

DISTURBANCE →	NO FAULT	3-ϕ FAULT W/NORMAL CLEARING OR SLG FAULT W/STUCK BREAKER	3-ϕ FAULT W/NORMAL CLEARING			
PRIOR SYSTEM CONDITION →	NORMAL	NORMAL	ONE GENERATOR OUT		ONE LINE OUT	
			SYSTEM READJUSTED	NOT READJUSTED	SYSTEM READJUSTED	NOT READJUSTED
↓ ELEMENTS LOST OR FAULTED ↓						
1. LOAD	A	A	A	A	A	A
2. TRANSFORMERS	A	A	A	A	A	B
3. LINE	A	A	A	A	B	C
4. GENERATOR	A	A	A	B	A	C
5. BUS SECTION	B	B	B	B	C	C
6. TWO GENERATORS	C	C	C	D	C	D
7. TWO LINES	C	C	C	D	C	D
8. ALL LINES ON RIGHT-OF-WAY	D	D	D	D	D	D
9. ENTIRE SUBSTATION	D	D	D	D	D	D
10. ENTIRE PLANT INCLUDING SWITCH YARD	D	D	D	D	D	D

SEPTEMBER 6, 1972

PERFORMANCE LEVELS

ALLOWABLE CONDITIONS OR ACTIONS ON INTERCONNECTED SYSTEMS (1)	PERFORMANCE LEVEL (2)			
	A	B	C	D
REMEDIAL ACTION	NO	AS PERMITTED BELOW		
DROPPING OF INTERRUPTIBLE LOAD	NO	YES	YES	YES
GEN DROPPING OR EQUIVALENT REDUCTION OF ENERGY INPUT TO THE SYSTEM	NO	YES	YES	YES
CONTROLLED OPENING OF INTERCONNECTIONS AND/OR OTHER LINES INCLUDING SYSTEM ISLANDING AND ATTENDANT UNDERFREQUENCY LOAD DROPPING IF REQUIRED	NO	NO	YES	YES
CONTROLLED DROPPING OF FIRM LOAD	NO	NO	NO	YES
SUB ISLANDING AND GENERATION SEPARATION MAY OCCUR	NO	NO	NO	YES
POST DISTURBANCE LOADINGS AND VOLTAGES OUTSIDE OF EMERGENCY LIMITS PRIOR TO READJUSTMENT	NO	NO	NO	YES

(1) ACTION OR CONDITIONS ON SYSTEMS OTHER THAN ONE ON WHICH DISTURBANCE OCCURRED

(2) A "YES" INDICATES THE ACTION OR CONDITION IS PERMITTED IN SIMULATION TESTING TO MEET THE PERFORMANCE LEVEL IF REQUIRED TO PREVENT CASCADING. A "NO" INDICATES THAT THE ACTION OR CONDITION IS NOT ALLOWED

JUNE 10, 1971

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References - (except for Section 2)

1. "Site Location Study," Prepared for Portland General Electric by Bechtel Corp., San Francisco, October 1966.

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I am an ecologist in the Environmental Impact Studies Division. My current responsibilities include evaluating environmental impacts of nuclear power generation.

I received a Bachelors of Arts degree in Biology from Lawrence University, a Masters of Science degree in Zoology with a specialization in ecology from the University of Georgia, and a Doctor of Philosophy degree in Zoology with a specialization in limnology from the University of California at Davis.

My graduate training included studies in terrestrial, freshwater, and marine ecology. My M.S. thesis was a study of radioactive phosphate uptake in plankton. My Ph.D. dissertation was a study of the productivity of individual species of algae in a subalpine lake. During my Ph.D. studies, I directed field research at the Castle Lake limnology laboratory.

From 1971 to 1978, I held positions of Assistant Professor in the Department of Biological Sciences and the Department of Ecology and Evolutionary Biology at the University of Arizona. During this period, I taught graduate and undergraduate courses in general ecology, limnology, and aquatic ecology. I also have taught aquatic ecology in the Tucson Audubon Society's Institute of Desert Ecology. I supervised the theses of three graduate students in the fields of limnology and marine biology, and I served on the committees of over 30 students in the fields of limnology, marine ecology, ichthyology, fisheries biology, terrestrial ecology, and hydrology. My research publications are in the fields of aquatic productivity, algal floristics, and regional patterns of water quality.

I am a member of the following professional and honorary societies: American Association for the Advancement of Science, Arizona-Nevada Academy of Science, American Society of Limnology and Oceanography, International Association of Theoretical and Applied Limnology, Phycological Society of America, and Sigma Xi.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
PUGET SOUND POWER & LIGHT COMPANY, ET AL.	)	Docket Nos. STN 50-522 STN 50-523
	)	
(Skagit Nuclear Power Project, Units 1 and 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "NRC STAFF SUPPLEMENTAL TESTIMONY ON ALTERNATIVE SITE COMPARISON" in the above-captioned proceeding have been served on the following by deposit in the United States mail, first class, or, as indicated by an asterisk, through deposit in the Nuclear Regulatory Commission's internal mail system, or, as indicated by a double asterisk, via Federal Express, this 2nd day of July, 1979:

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