NPS Form 10-900-b
(March 1992)

OMB No. 1024-0018

United States Department of the Interior
National Parks Service

National Register of Historic Places
Multiple Property Documentation Form

This form is used for documenting multiple property groups relating to one or several historic contexts. See instructions in *How to Complete the Multiple Property Documentation Form* (National Register Bulletin 16B). Complete each item by entering the requested information. For additional space, use continuation sheets (Form 10-900-a). Use a typewriter, word processor, or computer to complete all items.

__X__ New Submission ____ Amended Submission

A. Name of Multiple Property Listing

Bonneville Power Administration [BPA] Pacific Northwest Transmission System

B. Associated Historic Contexts

(Name each associated historic context, identifying theme, geographical area, and chronological period for each.)

Hydroelectric Plants in Washington State MPS, 1890-1938 MPS.

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D. D. Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this documentation form meets the National Register documentation standards and sets forth requirements for the listing of related properties consistent with the National Register criteria. This submission meets the procedural and professional requirements set forth in 36 CFR Part 60 and the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation. (See continuation sheet for additional comments.)

____________________ ____________________ ____________
Signature and title of certifying official Date

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State or Federal Agency or Tribal government

I hereby certify that this multiple property documentation form has been approved by the National Register as a basis for evaluating related properties for listing in the National Register.

________________________ ________________
Signature of the Keeper Date of Action

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United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
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Section __E_ Page __1_ Bonneville Power Administration [BPA] Transmission System
Pacific Northwest (Multiple States)

E. Statement of Historic Contexts

The Bonneville Power Administration, a Federal agency created by Congress in 1937, operates more than 15,000 circuit miles of electrical transmission lines spread over all or portions of eight states. The BPA Transmission System, including thousands of individual built elements, transmits power generated by Federal and partner hydroelectric facilities within the Columbia River Basin and provides the majority of electricity throughout the Pacific Northwest.

Introduction

The built resources of the Bonneville Power Administration [BPA] Transmission System, primarily located in Oregon, Washington, Idaho and western Montana, extend into portions of California, Nevada, Utah and Wyoming and are additionally inter-connected with systems located across the U.S.-Canadian border in British Columbia. The BPA system transmits electric power generated by the Federal Columbia River Power System and partner entities, both private and public, throughout the Pacific Northwest. The BPA system transmits the majority of the electric power supply to a multi-state area covering about 300,000 square miles and containing more than twelve million people.

BPA was created by the U.S. Congress during Franklin Roosevelt's New Deal. Envisioned as an interim entity prior to the establishment of a more comprehensive agency to be modeled upon the Tennessee Valley Authority, BPA was initially limited to transmitting and marketing the generation capacity of the Bonneville Dam, operated by the U.S. Army Corps of Engineers. In 1940 BPA's authority was expanded to include similar responsibilities for electricity generated at the Grand Coulee Dam, operated by the U.S. Bureau of Reclamation.

While still in the process of its initial construction, BPA played an important role in the nation's defense preparedness before and during WWII, supplying electricity that brought massive industrial development to the region and greatly adding to the U.S. war effort. After the war, as those industries were disbanded or converted to peacetime uses, BPA continued to play a significant role in the development of the aluminum industry, agriculture, and the expansion and modernization of the Pacific Northwest's natural resource-based timber industry. Building upon the original development of BPA's "Master Grid" to supply WWII-era defense needs during the 1940s, the BPA transmission system was the focus of near continual expansion to meet the demands of a growing regional population and to transmit increased output from new power generation projects within the Columbia River system that included the McNary Dam, the Hungry Horse Dam and the John Day Dam, among many others. Through its pivotal role in the Northwest Power Pool, as well as its wheeling function, whereby the BPA system transmits power for other utilities, the high-voltage BPA Transmission System solidified its position of the functional backbone of the entire regional power grid. Over the course of the past seventy-plus years, BPA's operations and development have been impacted by changing regional and national priorities and have expanded to take advantage of new electric distribution and management technologies, some of which were of BPA's own invention. By its inherent nature and function, the BPA transmission system is dynamic, constantly being upgraded, expanded and changed in response to energy, economic, and other needs.

As the primary distributor of electrical power in the region, and a major element of the Northwest Power Pool, the history and development of the Bonneville Power Administration is interwoven with the economic development of the Pacific Northwest. The establishment and continuation of the Bonneville Power Administration has also had a role in the history of electrical transmission more broadly.

Today the Bonneville Power Administration Transmission System includes hundreds of individual built resources interconnected by more than 15,000 circuit miles of transmission lines that largely connect the Pacific Northwest and British Columbia into a single operational entity for electrical transmission. Again, the development of this transmission system has been dynamic over time and remains dynamic even today, as expansions, upgrades, and repairs are needed for continued functionality. From its initial creation as what was seen as an "interim" agency, BPA has become, in some cases, a model for other transmission networks, establishing standards of practice, maintenance, and environmental stewardship that can influence the government-private partnerships that now largely characterize the electrical distribution system of the United States.

As described in detail in the subsequent sections, this submittal documents built resources constructed during the period 1938 to 1974 within the BPA Transmission System that are eligible for listing on the National Register provided they meet the identified registration requirements. Further, it establishes a framework for evaluating those built resources of the System for potential significance under eligibility criterion "A" for their association with the design, constructions and operation during the period 1938 to 1974; some resources may additionally have significance under criterion "C". Section F sets forth the registration requirements for each major built resource type, identifying character-defining elements, and integrity standards. As evaluated on a case-by-case basis, resources that meet the eligibility and integrity standards for that property type will likely be determined eligible, and those that do not meet both will likely be determined not eligible. Built resources that are not included under the typology of Section F are not considered eligible under this Multiple Property framework. Using this framework, it is anticipated that there will be routine or customary maintenance or repair activities undertaken by BPA on built resources that do not alter or diminish historic character, and do not impact historic integrity as defined here.

TEMPORAL CONTEXT (Periods of Significance)

The temporal boundaries of this submittal encompass two related but largely sequential periods of development that collectively span the period from 1938, the initial design and construction of the Bonneville Power Administration Transmission System, through 1974, the completion of the Dittmer Control Center and passage of Public Law 93-454. These two Periods of Significance reflect the following;

Master Grid Development: 1938-1945:

This period encompasses the establishment of the Bonneville Power Administration as a Federal agency empowered with the marketing and transmission of electricity generated at the Bonneville Dam and then, after 1940, from the Grand Coulee Dam. Resources relating to this period include the "Master Grid" transmission network that BPA built to transmit power between the generation facilities and the major load

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centers of the Pacific Northwest including Seattle, Spokane and Portland via a 230-kV "loop" with radiating 115-kV lines that served smaller loads as far south as Eugene, Oregon. The high-voltage lines of the Master Grid, along with the numerous substations and related structures that allowed the system to function effectively, played a significant role both directly and as the backbone of the Northwest Power Pool, to support U.S. military preparedness and industrial capacity during World War II. These include BPA's association with the successful operation at the Hanford Nuclear Reservation and the processing of material for the atomic bomb. Construction of the final elements of the Master Grid, as designed and begun in 1938, were not completed until 1945, marking the end of the period.

System Expansion: 1946-1974:
This period encompasses the expansion of the Bonneville Power Administration Transmission System to incorporate and serve new generation facilities on the Columbia River and its tributaries as the Federal Columbia River Power System grew to meet post-war growth in the Pacific Northwest. This period also includes development related to the Public Utility District movement, particularly in Washington, and the Congressional approval of "wheeling" that solidified BPA's role in the nation's first fully interconnected public-private electrical transmission grid. After 1960, as the result of the signing of the Canadian Treaty and then the technological advancements that resulted in the Pacific Northwest-Pacific Southwest Intertie, BPA's network expanded even further. The period ends with the dedication of the Dittmer Control Center, among the world's most sophisticated, computer-based, management systems for power transmission and the signing of P.L. 93-454 that modified the funding and operation of the Bonneville Power Administration from what it had been.

As discussed in Section F, several associated property types occur during both development periods yet demonstrate specific association within the temporal period through design and, in some cases, technology. Other resources, such as those associated with the development of the Pacific Northwest-Pacific South Intertie exist only within one temporal period, despite an overall association to the development and operation of the Bonneville Power Administration Transmission System.

GEOGRAPHIC CONTEXT

The Bonneville Power Administration, with administrative headquarters in northeast Portland, Oregon, operates a far-flung network of electrical transmission lines that includes built elements in eight western states. The bulk of the system is located within Oregon, Washington, Idaho and western Montana although there are also system elements in portions of California, Nevada, Utah and Wyoming. The Bonneville Power Administration System operates as a unified network composed of transmission lines, substations, converters and other built resources that are either directly related to the delivery of electrical energy or contain a range of ancillary structures that include maintenance, communications, and operations facilities required for the system's continued function. This is a dynamic system, by its very functional nature subject to ongoing upgrades, repairs, and expansions.

HISTORIC CONTEXT: The Bonneville Power Administration Transmission System 1938-1974

The Establishment of the Bonneville Power Administration-1937

The drive for public development of the hydroelectric potential of the Columbia River occurred within a larger national discussion about the relative roles of the government and private industry in the delivery of electricity. For much of the first quarter of the 20th century, as electricity became an ever-more important part of daily life in America, "public power advocates" railed against the perceived excesses of "Big Power," the investor-owned utilities that through merger and acquisition came to almost completely dominate the majority of the nation's electrical supply system.

Early advocates for the development of the Columbia River, predominately centered in eastern Washington, believed that the construction of a dam at Grand Coulee would provide economic benefit through the ability for increased irrigation for agriculture yet they received little political support for Federal investment in the project. This was at least partially a cost issue, as the expense of developing such a dam was large, but it was also political, as the well-established private utilities in Oregon and Washington were opposed to government competition that could undermine their rate structure. Federal power, sold at cost, could have a serious impact on the private utilities' ability to sell their power at potential profits. This was especially true if an efficient transmission network was constructed that allowed the region's power to be shipped to other, larger, population centers.

Public power, however, did have supporters in the region, particularly in the Puget Sound area where Seattle City Light and Tacoma Power, both municipal systems, had been providing some of the lowest cost power in the nation since the late-19th century. Moreover, the hydroelectric potential of the Columbia River, flowing steadily from Canada to the Pacific, was large. Although the river passed through states with just three percent of the nation's population, its flow represented forty-one percent of the entire hydroelectric potential of the nation, some 114 billion kilowatt hours.

As the nation's mood toward public investment, and more importantly towards public power, changed after the onset of the Great Depression in late 1929, the concept of a series of multi-purpose dams on the Columbia River gained increased acceptance. Earlier, in 1925, project advocates achieved a milestone when Congress included funding to study the possibilities of the development of the Columbia River as a part of the River and Harbors Act. The U.S. Army Corps of Engineers was directed to investigate navigation and hydroelectric opportunities on the river. Its report, known as the 308 Report (after the section of the bill that authorized the study) was released to the public in February 1932. The 308 Report called for a system of ten multi-purpose dams on the Columbia River between the Canadian border and the Pacific Ocean, beginning at Grand Coulee and ending at what would become the Bonneville Dam, east of Portland.

With the election of Franklin Roosevelt as President of the United States in 1932, the Columbia River project took a major step toward reality. FDR understood that the development of the Columbia had the potential to change the economy of the Pacific Northwest, then a largely rural, sparsely populated corner of the continent that had been hit hard by the Depression. In September 1932, while campaigning in the Pacific

Northwest, FDR told crowds that "the next great hydroelectric development to be undertaken by the Federal government must be that of the Columbia River" (*Oregonian*, 22-September-1932, 6:1-8). In the November 1932, FDR carried both Oregon and Washington by large margins.[1]

In fulfillment of his campaign promise, President Roosevelt authorized funding for the construction of the Grand Coulee Dam in June 1933. Then, in August 1933, as a result of regional pressures from Oregon, FDR approved additional funding for a second dam at Bonneville, nearer to Portland. Both dams were expected to repay their construction costs through the sale of electricity, underwriting the costs of their irrigation and navigation functions. While actual excavation began at Grand Coulee first, construction at Bonneville proceeded at a more rapid pace. Round-the-clock crews of thousands of men at both sites brought much needed employment to the region and the two massive dams slowly rose from bedrock.

> The Columbia River offers the biggest potential hydroelectric supply in the United States and some surveys have estimated its power possibilities as more than five times that of the Tennessee Valley, the key territory of the TVA. Territory five times the size of England is drained by the Columbia and this territory will be studded by steel-latticed transmission poles when Grand Coulee is completed (Neuberger, Feb 1937:252-53).

As the size and cost of the dams became clear, the sheer scale of what FDR and his administration had envisioned and were building on the Columbia River, far from any major population center, became more controversial. Proponents pointed out that the taxpayers would eventually be reimbursed, indeed might even expect a profit, from the sale of electricity that would be used to retire the project's debt to the Treasury. But critics, such as reported in a *Reader's Digest* article entitled "Dam of Doubt," complained the project would be unlikely to pay off its construction costs any time soon, saddling taxpayers with huge expense. "Although on paper, the various projects will pay for themselves in a century or two, there is no certainty that they will not become enormous white elephants" (Marshall, 1937:94). Another writer, Northwesterner Richard L. Neuberger, who would later work for BPA, wrote extensively, and more even-handedly, about the Columbia River projects during their planning and construction phases.[2]

> The whole country has a stake in the outcome, for the development of the Columbia River is the New Deal's most pretentious undertaking. The total outlay of taxpayers' money for navigation, hydroelectric power, reclamation and flood control will be about $479,000,000. This is more than it cost to dig the Panama Canal (Neuberger, 1938a).

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[1] Democrat FDR carried Washington 57.46% to 33.9% for Herbert Hoover, the Republican incumbent. FDR carried Oregon 57.99% to 36.88% and Idaho 58.66% to 38.27%. In each case FDR's margin of victory in the Pacific Northwest exceeded his national winning percentage of 57.41%.

[2] Neuberger (1912-1960) wrote numerous articles on Northwest issues for *Colliers*, *Harpers*, and the *New York Times*, among other national publications all through the 1930s and 1940s. In 1941, he was elected to the Oregon legislature and in 1954 was elected to the U.S. Senate as a Democrat, the first to represent Oregon since 1914. He died of a stroke in 1960, while campaigning for re-election, and was succeed by his wife, Maxine Brown Neuberger, who served in the U.S. Senate until 1966.

The multi-purpose focus of the development of the Columbia River created some complications as to how best to manage the hydroelectric output. Grand Coulee was being built under the management of the Bureau of Reclamation [BOR], which already had some role in the development of public power through its operation in Minidoka, Idaho. Bonneville Dam, in Oregon, was to be operated by the U.S. Army Corps of Engineers, largely due to the construction of the Bonneville Locks, a key element in the river's navigation improvement. Inter-agency rivalries between Army Corps and BOR, exacerbated by political and economic interests and the regional rivalry between Oregon and Washington, created challenges as to what entity within the Federal government would be responsible for the distribution of electricity from the two large hydroelectric projects. In general, Washington political leaders preferred the Bureau of the Reclamation while Oregon leaders, including powerful Republican Senator Charles L. McNary, preferred that the project be managed by the Army Corps of Engineers.[3] Of a differing view, FDR and his Secretary of the Interior Harold Ickes preferred to develop an umbrella agency that would be responsible for the entire drainage similar to the Tennessee Valley Authority in the southeastern United States. FDR's interest in what was called the Columbia Valley Authority, or CVA, was stymied by regional opposition, much of it stemming from Sen. McNary and the opposition of the Northwest's powerful investor-owned utilities and business groups. As completion of Bonneville Dam neared, and as its generators were soon to be developing power, FDR and Ickes worked with members of the Oregon and Washington congressional delegation to create what nearly everyone assumed would serve as an interim body to develop the transmission network for the Bonneville Dam's power output; the Bonneville Power Administration.

BPA was established by the Bonneville Project Act (P.L. 75-329), signed into law by President Roosevelt on August 20, 1937. The government's view of the long-term prospects for the Administration in its original form was fairly clearly spelled out in the act. "The form of administration herein established for the Bonneville Project is intended to be provisional pending the establishment of a permanent administration for Bonneville and other projects in the Columbia River Basin" (Bonneville Project Act, 160 S.C. §2ca). Perhaps because of its temporary intent, and unlike the three-person board that manages the Tennessee Valley Authority, BPA was to be governed by a single individual, the "Administrator," who while reporting to the Secretary of the Interior would be near personally responsible for most of BPA's operations. FDR appointed John Delmage Ross, then at Seattle City Light, one of the largest and best managed public power providers in America, to serve as the first BPA Administrator. Knowledgeable about the utility business with three decades of experience, well-connected to the White House, physically imposing, even-tempered, likeable, and doggedly persistent, Ross was, when he came to the position of BPA Administrator, the near perfect candidate for the job.

Ross envisioned the Pacific Northwest, with its potential abundance of low-cost hydropower, as a "powerhouse" that could supply electricity to the entire nation. In 1935 Ross prophesied a coming era of public power in the Northwest and a year later he proposed a massive interconnected system of Northwest generation facilities on the Columbia with the existing municipal systems west of the Cascades to form a network that could transmit power throughout the continent. "For many years [this] writer has urged that

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[3] McNary (1874-1944) was first elected to the U.S. Senate in 1917. He served as Minority Leader from 1932 until his death. McNary ran for Vice-President, unsuccessfully, on the Republican ticket headed by Wendell Wilkie in 1940.

the people of the Pacific Coast keep in mind the building of a super-power transmission line from Canada to Mexico, west of the Cascade Mountains" (Ross, 1936). Ross's vision, even in these early years before the creation of the Administration, included a reliance on the development of High Voltage Direct Current (HVDC) to transmit Columbia River Power thousands of miles, as far east as Chicago. The fact that such technology did not yet exist did not dissuade Ross from a conviction that "…the whole nation could have Columbia Power in its factories and homes" (Ross, 1939). With his appointment as BPA Administrator, Ross brought not only decades of familiarity with running a huge utility in the Northwest and a level of professional experience that was hard for the private power advocates to dismiss, but an unquestioned commitment to the benefits of low-cost public power and its ability to transform the region and bring all its citizens into the modern, electric-powered, world. Ross, by almost any reasoned accounting, was something of a visionary on the potential of public power and the development of the Columbia River to benefit both it and the nation. As one later historian put it, "As BPA Administrator, Ross gave off ideas the way the Coulee gave off power. He almost overflowed" (Willingham, 1983:39).

After his appointment to BPA, Ross arrived in Portland and began to pull together a highly competent team of engineers and policy consultants, many coming from Seattle City Light. Others came from the Northwest Regional Planning Commission, a body that had been looking into regional power solutions concerning the Columbia River projects for several years. Ross's initial tasks at BPA were not simply to oversee the physical construction of BPA's transmission system but to determine its best design, to establish a pricing framework to sell Bonneville Power, to support the formation of public utility districts in both Washington and Oregon, to support the efforts of the Rural Electrification Administration to bring power to farmers, and, finally, to help establish a strong industrial market that could use a super-abundance of low-cost power to economically strengthen the communities of the Pacific Northwest. It was a large, almost daunting, set of tasks that Ross and his team quickly began working diligently to accomplish.

Construction of the Master Grid 1938-1945

In 1935 Ross delivered an influential address entitled "How Long is the Yardstick?" that outlined his belief that the costs of *generating* electricity paled in comparison to the costs of *transmitting* it, concluding that control of the transmission system controlled the major costs of supplying electricity to users. It was, in Ross's opinion, absolutely essential that the public own and manage the transmission systems delivering public power from the Columbia River if BPA was to meet its mandate of providing low-cost hydropower to the Northwest.[4] Given broad authority under the Bonneville Power Act to establish a pricing structure, Ross denied the efforts of existing utilities and much of the business community, who favored a "buss bar" rate, where the further from the point of generation, the more expensive the cost per kilowatt. Instead he adopted what has become known as the "postage stamp" rate; power was priced uniformly, independent of the distance transmitted, a policy that has essentially been the national standard ever since. Ross and BPA established a modest pricing structure that set a basic rate of $17.50 per kilowatt hour, a rate that BPA would

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[4] President Roosevelt adopted the concept of Ross's "Yardstick" that claimed generating power amounted to just four of five inches of cost whereas transmitting it cost the other thirty one inches, an amount that could be reduced by over 1/3 through efficient, public, ownership. "The 'yardstick' metaphor would become a staple of New Deal rhetoric" (Smith, 2008:237).

maintain unchanged until 1965, or nearly thirty years,. The BPA rate schedule was "….based on the philosophy of abundance instead of scarcity in recognition of the huge steady flow of water in the Columbia River" (Davis, 1944:III-4). This was a significant benefit to small rural, electric cooperatives and the many Public Utility Districts, the creation of which Ross and BPA encouraged specifically to take advantage of the new source of public power on the Columbia.

While Ross devoted his energies to supporting the formation of public power districts and rural cooperatives, he designated Charles Carey as BPA's chief engineer to design the BPA transmission system. Carey had previously worked on the design of a theoretical transmission grid for the Northwest Regional Planning Commission. Just as the debate between public and private power delayed development of the Columbia, there was considerable debate about whether it would be cost effective for BPA to build an entirely separate transmission system to serve the region. Doing so, in the view of BPA critics, would simply duplicate the privately-owned transmission systems already in place, and cost taxpayers money. As noted above, Ross understood that without its own transmission network BPA would be sorely limited in its efforts to support public power, especially in those areas outside the larger cities of the region.[5] Ross determined that BPA would indeed build and control its own transmission system and, further, he intended that it be of significantly more capacity than most of the lines then operated by private utilities.

Largely based on Charles Carey's earlier work, the ultimate design of what would become known as BPA's "Master Grid" relied on the designs of public power systems in both Britain and Canada as well as the work of Dr. E. C. Starr, whom Carey hired to consult with BPA. Dr. Starr had begun his career working with Dr. Frank W. Peek at the Conowingo project, in Maryland, in 1927, a project that provided a model for the 230-kV BPA system (Curran, 1998:51)[6]. The Master Grid was a "loop" system of transmission lines that connected the major cities of the Pacific Northwest and the generation capacity of Bonneville and Grand Coulee dams.

> A skeletal network of 230,000 volt transmission lines linked the major population centers and generation plants into what was referred to as the "loop." Radiating outward from the 230-kV loop would be transmission lines of lesser voltages serving individual customers, such as cities and small towns, industrial plants, and utility districts. The system would be kept in "synchronism," that is

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[5] Another New Deal program, the Rural Electrification Administration or REA, was created to expand the reach of power lines into sparsely populated regions long ignored by investor-owned utilities. REA led to a spike in the formation of electric power "co-ops" and Ross and BPA were to be a major source of low-cost power to serve that new market. BPA would need to control the design of its transmission system so that it could realistically reach these areas that had never been included in any electrical system previously.

[6] Conowingo, developed by the Philadelphia Electric Company and designed by Stone & Webster, of Boston, was begun in 1926 and completed in 1928. Originally producing 252-mW of power (since expanded to 548-mW), Conowingo was the second largest hydro project in the nation when it opened, behind Niagara Falls,`` and remains one the largest non-Federal hydroelectric projects in the nation
(See http://www.exeloncorp.com/ourcompanies/powergen/fossil/hydroelectric_stations/Conowingo/(visited September 2009)).

> stabilized, by state-of-the-art electrical equipment installed at substations scattered at vital locations throughout the network (Holstein and Lenz, 1987).

The design was both stable and flexible, ultimately allowing BPA to expand its network, divert power as needed, and make repairs without interruption, simply by altering the way current flowed through the central loop and its radiating connecting links. At 230-kV, the BPA lines were among the highest voltage lines of the era, effectively dealing with the huge output of the Bonneville and Grand Coulee powerhouses. To include more than 2,000 circuit miles, BPA's Master Grid system represented the largest high voltage transmission network in the nation upon its completion.

To survey and build the hundreds of miles of transmission lines, BPA benefitted from a partnership with another New Deal agency, the Works Progress Administration. Following BPA surveyors, WPA crews cleared corridors, felling trees and grading lines, to make way for the private contractors that were hired to pour concrete footings, erect steel or wood towers and then string conductor cable to connect the substations and generation units. Relying upon Congressional appropriations, the first transmission work that was completed within the BPA system was a small line between the Bonneville Dam and a new substation to serve the City of Cascade Locks, in Oregon. This 15-kV line was activated on July 9, 1938, carrying the first electrical transmission of the Bonneville Power Administration. The small Cascade Locks line was largely symbolic; assuring that at least some portion of Bonneville's output could be put to use while demonstrating BPA's commitment to publicly owned power providers.

Survey work on the main 230-kV lines, including the two Bonneville-Vancouver lines (Nos. 1 and 2), the Bonneville-Coulee line and others, occurred during the Summer of 1938 and established the basic framework for the Master Grid system, although actual construction didn't begin until 1939. Groundbreaking for the construction of Bonneville-Vancouver No. 1, a 230-kV backbone connecting the powerhouse and the Portland metropolitan area occurred on 14-April-1939, when Charles Carey and Vancouver's Mayor, A.N. Stanley gave a signal to a steam shovel operator to start the work. Speedy construction saw the line completed and energized on 1-December 1939, marking the first delivery of Bonneville power to Portland over BPA's own transmission circuits. "Construction involved the erection of steel towers through some of the most rugged terrain in the Columbia River Basin" (*Bonneville Power News*, March 1940).

While Ross laid the groundwork for much of what BPA would eventually become, he didn't live to see his plans realized. He died unexpectedly from complications after surgery at the Mayo Clinic in March 1939. His short tenure at BPA had seen the establishment of the Administration, the design and funding of the Master Grid system, and the adoption of the postage stamp rate that would have a significant impact on the future of power distribution, both private and public, thereafter. His vision for a region-wide direct current system that would transform the Columbia River system into a national power distributor was prescient, as BPA would later demonstrate.

> The sudden death of J.D. Ross takes from the scene, both local and national, one of the strongest of public power advocates. The scheme of Bonneville development, as he saw it, was a part of a greater

> network for the Pacific Northwest and, he [en]visioned, an ultimate national power distribution with public ownership from source to customer (*Oregon Journal*, 15-April-1939).

Two interim administrators, Charles Carey, BPA's engineer, and then Frank Banks, the project manager of the Grand Coulee Dam, stepped into the BPA Administrator role after Ross's death. Together they served about five months, awaiting the appointment of a permanent Administrator. In September 1939, Paul Raver arrived at BPA, his first time in the State of Oregon. Raver would remain BPA Administrator for fourteen years, until 1954.

Raver, unlike Ross, had no direct engineering background in designing hydroelectric systems but was a strong, and highly regarded public power advocate. From Illinois, Raver taught public policy at Northwestern University and was Chair of the Illinois Commerce Commission before arriving at BPA. His experience regulating private utilities left him suspicious of their motives and a convinced that public power was the key to regional growth. Raver brought an enthusiasm to his tasks at BPA, as evidenced by comments broadcast over Portland radio station KEX, less than a week after his arrival.

> Bonneville is not an isolated power plant…Let us remember that. It is the key in the great Columbia River system. And, in my judgment, the future of our Northwest is tied up with the development of that river. In the Columbia is the water to irrigate millions of acres, its dams can produce the power to lighten the tasks of literally thousands of people who will come here to reside and furnish the energy for payroll industries that will support them on a high living standard (Raver, 20-Sept-1939).

Raver was quickly engaged in a broad series of PUD elections throughout the region, to each of which he offered as much support as his position allowed. As those elections were underway BPA was in the middle of the construction on its transmission system, working at a pace rather hard to conceive. For example, in January 1940, in the dead of winter and just four months after Raver's appointment, the BPA Engineering Division reported the following, purposefully quoted at length:

> Design and survey work continued during January on a large number of fronts, with special emphasis on those units of our proposed system where early completion dates have been set such as St. Johns and Salem substations, Astoria-Line and Substation; Vancouver-Kelso-Chehalis-Raymond Line and Raymond Substation; Chehalis Substation; Chehalis-Renton Line; Klickitat Line and Substation and Alcoa Line and substation. However design and survey work continued on the Renton-Coulee Line, Midway-Ellensburg Line, Bonneville-Oregon City Line, St. Johns-Tillamook Line, and on North Bonneville, Midway, Hood River and Ellensburg substations. Preliminary work was started during the month on the Salem-McMinnville Line and McMinnville Substation, and the Salem-Corvallis Line and Monmouth and Corvallis substations; and the Vernita-Hanford line (BPA Report of Accomplishments, January 1940).

From its very first line at Cascade Locks in 1938, BPA's transmission system during the 1940s grew exponentially to accommodate new industrial and defense users. According to summaries published in BPA's Annual Report, by the end of 1941 the Administration had 1,748 miles of transmission lines and 37 substations in its system. By the end of 1945 those numbers grew to 2,839 circuit miles of line and 61 substations. (BPA Annual Reports, 1942, 1946). From its beginning, BPA marketing departments developed surveys of industrial sites and mineral deposits throughout the Pacific Northwest, initially in an effort to develop BPA's market, but ultimately providing critical information for the location of dozens of defense-related plants. "By 1944, starting from zero, the BPA transmission system was capable of delivering 10,000,000,000 kilowatt hours per year, probably the second or third largest system in the United States" (Davis, 1944:V-1).

Architecture, Technology and Design: Master Grid Period
During the late-1930s and 1940s development of the Master Grid and its associated structures, BPA relied upon a group of "in-house" architects and building designers to develop the dozens of new structures that were needed for the system. For its buildings; administrative offices, control houses, untanking towers and other specialized designs, BPA adopted a fairly standardized design idiom that can most appropriately be termed "Art Moderne" or "Streamlined Moderne." Both are related and somewhat inexact terms that have been applied to a wide range of designs that demonstrated the influence of new technologies on architecture during the late-1920s and into the late-1940s.[7]

Although partially stemming from European Art Nouveau and so-called "Purist" architecture, in America the "Moderne" style was highly influenced by the work of leading industrial designers, particularly Raymond Lowey, Norman Bel Geddes and Walter Dorwin Teague, who exploited new industrialized manufacturing techniques to craft a design vocabulary that came to epitomize the "Roaring 1920s" and remained influential for the succeeding decades. Industrial designs for projects as varied as locomotive engines and toasters relied upon "new" materials such as aluminum, plastic, and Bakelite to create smooth and rounded forms that were considered "Futuristic." Such rounded, plastic, designs implied motion and speed.

Rapid development in transportation, communication, and in the case of BPA, electrical generation during the first half of the 20th century resulted in demand for structures to house entirely new and in some cases unprecedented uses ranging from the lowly gas station to radio stations and telephone buildings. During this period, sometimes called "the Machine Age," for its unquestioning embrace of technological progress, architects consciously broke with the past and turned toward new, modernistic, forward-looking designs. This approach gained increased popular support during the Great Depression, as the country struggled to envision a new and brighter future.[8] This "Machine Age" architecture relied upon an informal menu of stylistic elements that could be combined in varying ways in any particular structure. These elements included, most prominently, *streamlining*; the use of rounded, smooth, corners that evoked the movement and freedom of speed found in airplane and automobile designs. Other typical elements included a heavy reliance on "new" materials such as ribbed glass, insulating glass block grouted into banks as windows or

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[7] See http://jan.ucc.nau.edu/~twp/architecture/artdeco/ Art Deco and Art Moderne are related terms, both of which can be traced to the *Exposition Internationale des Arts Decoratifs and Industriels Modernes*, held in Paris, 1925.

[8] The "Machine Age," was in some ways summarized when the influential architect Le Corbusier (Charles-Edouard Jeannert, 1887-1965) famously described his modernistic residential designs as being "Machines for Living."

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transoms, exterior enameled metal panels, chrome, and aluminum. Machine technology was additionally reflected through the use of standardized, panelized, features and manufactured materials ranging from glass (Carrara, Vitriolite), plywood, Masonite, and interior insulating panels marketed under brand names such as Celotex and FirTex. Multi-paned steel windows, long common in warehouse and industrial settings, found new use in smaller commercial, utilitarian and even residential architecture, largely due to the narrow muntins and sash lines that metal allows. Avoiding "old-fashioned" wood windows was, in this future-looking style, in and of itself a design statement. No matter the specific details of any particular design, the key unifying element in "Moderne" was a generally smooth appearing exterior, devoid of the expressed, applied, detail that was typical of earlier building forms.

As BPA began the development of its Master Grid transmission network in the late-1930s, staff engineers were responsible for planning the hundreds of miles of actual transmission line, as well as the dozens of free-standing control, support and maintenance buildings that were required to operate the system. By this time transmission towers themselves were largely standardized in construction. Wood poles were, as the name implies, much unchanged since the earliest days of the electrical system, installed singly or paired in larger lines into what were typically termed "H-Poles," where two vertical, creosote coated, wooden standards were tied together by one or more horizontal beams to form something of an elongated "H" form that would support the conductors. Wood pole lines were inexpensive and comparatively easy to erect, but were inherently limited in height by the material, making them less appropriate for BPA's larger, higher voltage, 230kV Master Grid system, which required steel tower systems. Steel transmission towers are constructed of multiple pieces of galvanized steel, usually angle-iron, that are bolted together into standardized forms, depending on function, and rise from concrete foundations or footings. BPA adopted several tower designs, differing in height, arm configuration (depending upon the sort of conductor or cable that were to be carried) and other factors; dubbing them, alphabetically by type, as A through D towers. Additional specialized forms were required for river crossings, where a transmission line makes a sharp turn in direction, and where a line entered or exited a switchyard.

Like the related Tennessee Valley Authority, BPA recognized that the design of its buildings could reflect the larger socially-beneficial goals that had led to the creation of the Federal power system in the Pacific Northwest. In recognition of that role, BPA, again like TVA, not only established an in-house design team but additionally elected to build the majority of its structures during the Master Grid period by "Force Account," meaning BPA itself would serve as its own contractor, developing the design, hiring the workforce and overseeing the construction. "The almost universal federal practice is otherwise (Craig, 1977:399). BPA buildings were designed by BPA architects and built by BPA workers, giving the agency near total control of the project, from conception to completion of construction.

In January 1941 the Architectural Unit was established as separate unit within the Engineering Division and placed under the control of Emil Jahn, a licensed electrical engineer, with Louis E. Dielschneider as Head Clerk. By the summer the unit had grown and R (ichard) F. Stevens was made the Assistant Chief with Dean R. E. Wright as "Chief, Architectural Unit." Wright, who would remain at BPA for the remainder of his career (through 1968) had earlier worked for the U.S. Forest Service and is notable as one of four named designers of Timberline Lodge, a National Historic Landmark in the Mt. Hood National Forest. Although the Architectural Unit would never be as influential as it had been during BPA's first few years of frenzied building, some element of in-house design remained a part of the Engineering Division throughout the 1940s and 1950s.

BPA's architectural style during the Administration's first decade of existence was largely established by the design of BPA's now-demolished Portland Headquarters Building, which was completed in 1939, at 811 NE Oregon Street. A stucco-clad single story volume with a stepped, central "tower" element at the main entry, the HQ building relied on excessive use of small-pane steel sash glazing, small projecting hoods over the window openings, corner-windows, and a stepped, recessed, entry. The basics of this BPA "style" were informally adopted by the BPA Architectural Unit, a component of the Engineering Division that was almost entirely responsible for the construction program between 1938 and the end of World War II. The scope of BPA's program offered the Architectural Unit many opportunities to perfect its designs through repetition, as well as to experiment with alternative use of materials as they designed dozens of Control Houses, Oil Houses, Untanking Towers and other specialized structures. By June 1942, for example, BPA's Annual Report to Secretary of the Interior documented the completion of thirty-seven substations, virtually all of which included multiple, individually-designed, structures. BPA's designs, at least partially due to wartime materials shortages, includes structures of varied materials included stucco over concrete, stucco over wood frame, and brick, but all in one way or another generally fit within the "Moderne" idiom no matter the material or detailing. By April 1943, with considerably reduced staff due to wartime enlistments, the Architectural Unit was down to just six employees (from a high of more than 30 in 1940) and began work on plans for a "...standard control house." (BPA Engineering Report, April 1943:7).

Building the Market, Fighting the War

Despite BPA's efforts under both Ross and Raver, the development of Public Utility Districts and the success of local communities to form municipal utilities through acquisition of existing private systems slowed after 1938 and then ceased entirely during the World War II. Particularly in Oregon, where state law proved more cumbersome than in Washington, the private utilities were able to maintain their dominant positions in most areas, particularly in the larger cities such of Portland and Salem. Numerous elections in Oregon to form PUDs or to purchase the assets of private utilities, including Portland General Electric, were held but in almost all cases public power plans were defeated, reducing potential demand for BPA power. Opposition to these elections was almost entirely funded by investor-owned utilities. Defeats were used by them to demonstrate the public's opposition to "public power "and to cast doubt on the Federal government's investment on the Columbia River.

While BPA's market from public utilities hadn't materialized as it expected, the Administration still needed to dispose of the power from Bonneville and, soon, from Grand Coulee. It responded by building stronger relationships with private utilities. In 1939 BPA signed short-term (one-year) contracts to provide firm power to both PGE and Washington Water and Power. Administrator Raver also negotiated a retail rate for such power that benefitted regional homeowners and businesses with reduced power rates, no matter where they purchased power.

> Additionally, BPA sought out new industrial development. It had always been the intention of New Deal planners and public-power advocates to establish industrial markets in the Pacific Northwest concurrent with the development of the Columbia River. New industries were expected to provide a market for Bonneville and Grand Coulee power, and in the process stabilize and develop the regional economy (Curran, 1998:64-65).

BPA's mission was largely that of a power wholesaler, with a client base limited to other utilities and large industrial users. BPA was never envisioned as a direct power provider to small or residential users. "Bonneville, by law, is a transmission line agency. The transmission line, of course, under the Bonneville Act, is a tool, or a vehicle, for carrying out the marketing functions which Congress has given this organization" (Raver, Nov. 1949). The preference clause, a major element of the Bonneville Power Act, obligated the Administration to reserve nearly half its power for public utility districts or municipal stations however by 1940 only two such entities were in a position to use BPA power.[9]

> By the close of the calendar year 1939 two municipal systems, namely Cascade Locks and Forest Grove, were being served with Bonneville power. The home, farm, and commercial customers of the municipal systems are thus already securing the benefits of low-cost Columbia River energy in the form of rate reductions ranging as high as 30 to 40 percent (BPA 2nd Annual Report, January 1940).

With excess power to sell, BPA continued its short-term contracts with Portland General Electric, Washington Water & Power and other utilities, supplying these investor-owned systems with power it was not itself currently in a position to sell; however as the PUD movement stalled, especially in Oregon, the marketing division of BPA increasingly looked toward cultivating new industrial users with a focus upon what would come to be called the "electro-process industries," or industries that required large amounts of electricity to process materials, especially low grade minerals.

Beginning in 1938-1939, BPA began the systematic survey of its service area for available mineral deposits, appropriate sites for new industrial developments, available work force, and other factors in a process that nearly transformed BPA into something of a region-wide Chamber of Commerce. National interest in wartime needs, stemming from the growing European conflict, played something of a role as well, as Raver and the BPA staff, not to mention the White House, clearly appreciated the value that Columbia River power could play in successfully transforming the United States into the "Arsenal of Democracy" the president had set as a national goal during a Fireside Chat radio broadcast on December 29, 1940.[10] But Raver also

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[9] BPA, without its own lines in place to serve these community-owned systems, leased lines from PGE and Northwest Electric until its lines were completed (BPA Annual Report, 1939).

[10] Roosevelt's "Arsenal" speech would provide something of a philosophic underpinning for the United States' financial and manufacturing assistance to both Britain and the Soviet Union before the US actually entered WWII. FDR the

understood the long-term benefit to the Pacific Northwest that would result from increasing its industrial economy and moving away from the resource-exporting commerce that up until then had largely characterized the region. Even after the United States' entry into the war in December 1941, Raver continued to foresee the importance of peacetime industrial development in the future of the Northwest. "Twenty-five years ago, when we were fighting World War I, we were too busy to plan for the post-war period. We did nothing during the war to plan for the peace. We will not make that mistake again" (Raver, May 1942).

World War II, which formally began on September 21, 1939, just two weeks after Paul Raver arrived at BPA, would dramatically alter BPA's development. "The impact of the war on the Bonneville Power Administration has one preponderant result. It has telescoped more than 10 years of normal growth into a brief five years" (Davis, 1944, I-1). As part of the ramp up to transform the Northwest into a defense industry center BPA signed its first direct industrial contract to supply power to a new aluminum smelter to be built by Alcoa at Vancouver, Washington, a plant that would have a production capacity of 164,000 tons. To put that amount into perspective, the Vancouver plant, by itself, would be capable of producing more aluminum than every U.S. plant then in operation, effectively doubling America's output of this important defense material.

President Roosevelt declared that airplane production was a key to Allied victory and through 1941 and 1942 BPA worked with the War Department and the Office of Production Management to attract additional aluminum plants to the Northwest, where low-cost and abundant electrical power was available in close proximity to West Coast airplane manufacturing facilities. Eventually five more aluminum plants followed Alcoa's Vancouver operation into the northwest. "[T]wo at Spokane, one each at Longview and Tacoma, Washington and one at Troutdale, Oregon. At the peak of their operation, these six plants consumed nearly 500,000 average kilowatts" (Springer, 1976:47). Each relied upon BPA for direct contracted hydropower and, by 1944, the electrical consumption for aluminum production alone accounted for more than fifty percent of BPA's total revenue. Other electro-process industries developed facilities in the Pacific Northwest too, with many locating on industrial sites identified by BPA's pre-war market studies. These new plants produced vital defense-related products including silica-based materials, manganese, oxygen and acetylene for welding purposes, carbide and more.

BPA's presence and its low-cost power supply was also a key factor in the decision to transform the Portland-Vancouver area into a major shipbuilding center during the war years. Industrialist Henry Kaiser had first gained fame through his association with the construction of both Grand Coulee and Bonneville. By 1940 Kaiser was considered one of the nation's leading businessmen, a "can-do" entrepreneur with a track record of managing huge projects successfully.[11] After President Roosevelt, who knew Kaiser well,

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Lend-Lease program, and the manufacture of Liberty Ships were both key elements in the America's efforts to assist the allies almost two year before the formal declaration of war after the bombing of Pearl Harbor.

[11] Kaiser was part of the Six Companies, a collective of most of the largest construction firms in the western United States that in addition to Bonneville and Grand Coulee had first partnered on the construction of Hoover Dam. Kaiser's background began in concrete, and his firm built highways and roads throughout North America during the 1910s and 1920s.

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challenged the nation to build a "bridge of ships" to Europe as a method of supporting the British, he turned to Kaiser for help. Kaiser, with no experience whatsoever in shipbuilding, entered into a series of contracts with the U.S Maritime Commission and, armed with British Admiralty-developed plans for an inexpensive ocean-going freighter, acquired the first of what would become three massive Kaiser shipyards near Portland, Oregon in St. Johns.[12]

Kaiser's three large shipyards would collectively build more than 900 ocean-going vessels between 1941 and 1945, including Liberty Ships, Victory Ships, and a modified Liberty Ship hull that was dubbed a "baby Flattop;" a ship the U.S. Navy called a "Kaiser-class" aircraft carrier. Kaiser's Swan Island Yard, on the site of Portland's former airport, built ocean-going fuel tankers. A key factor in the rapid construction of these ships were their welded, not riveted, hulls, a manufacturing technique that required large amounts of electricity for arc welders, not to mention for the production of acetylene and oxygen for gas welding. In both cases the power from the Columbia River, and BPA's low-cost transmission system, played a key role in attracting defense manufacturing to the Pacific Northwest. In addition to the large Kasier yards, other smaller shipyards in Portland, including Commercial Iron Works and Gunderson Brothers, built mine sweepers, destroyers, landing craft and other craft. The Bremerton Navy Yard, on the Puget Sound, outfitted and launched ships for the U.S. Navy while dozens and dozens of Pacific Northwest manufacturers made everything from diesel engines to anchors. The Boeing Company, in Seattle, built thousands of B-17 and B-29 bombers for the war effort, all dependent on the ready supply of low-cost, lightweight, aluminum streaming out the region's new smelters. Collectively these new wartime industries employed hundreds of thousands of new workers who arrived in the area by the train and bus load.[13]

The availability of large amounts of low-cost power in the Pacific Northwest, and the BPA network's ability to transmit it where it was needed, were significant factors in the location of another key military project, the Hanford Engineering Works. In 1943 the War Production Board directed BPA to extend high voltage lines from its Midway Substation to an otherwise empty region of south Central Washington and make available sufficient power for a "mystery load" of between 75-kW and 150-kW.

> This order came as the result of the search by the scientists and engineers from the Manhattan Project for an isolated area where vast quantities of electricity and cooling water were available. They found 'an almost perfect site'….on the Columbia River, near Hanford, Washington (Springer, 1976:47).

Hanford, of course, produced the plutonium required for the construction of "Little Boy" and "Fat Man," the atomic bombs that were dropped on Hiroshima and Nagasaki, bringing World War II to an end in August

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[12] See Kramer, It *Takes More Than Bullets: The WWII Homefront in Portland, Oregon*. Prepared for the Housing Authority of Portland (Eugene, OR: Heritage Research Associates, Inc Report No. 311), 2007.

[13] The WWII-era Housing Authority of Portland alone was the single largest provider of Defense Worker Housing in the United States, developing and managing more than 18,000 housing units by 1943. The Vancouver Housing Authority, just across the Columbia, was the nation's third largest such provider after New York City (Kramer, 2003:14)

1945. As the world reacted to the news of the first atom bomb, BPA's employee newspaper reported "Now It Can Be Told."

> The cataclysm which blew the roofs off most of the houses in Hiroshima and Nagasaki also partially lifted the lid on Bonneville's 'mystery load.' No little credit for helping to maintain the necessary secrecy which has surrounded the Hanford project throughout the war years belongs to those Bonneville employees who worked with the Hanford engineers in getting the great project into operation and helping to carry its product to a logical conclusion…the defeat of Japan (*BPA Currents*, Sept 1945).

Hanford's B Reactor, the world's first full production scale nuclear reactor, was listed on the National Register of Historic Places in 1992. In August 2009, U.S. Secretary of the Interior, Dirk Kempthorne, designated the B Reactor as a National Historic Landmark.[14]

Northwest Power Pool

In late 1939 and 1940, as the prospect of war loomed and America's growing involvement in the production of war materials grew, the demand for power to supply new defense activities pushed the construction of the Master Grid forward at a rapid rate. Both Bonneville and Grand Coulee had originally intended to add generation units at a modest pace, to allow BPA to develop new regional markets. Wartime pressures pushed that plan aside and additional units were placed online at both powerhouses as fast as possible. So great was the demand for electricity in the Pacific Northwest that two generators originally ordered for installation at Shasta Dam, a Bureau of Reclamation project in northern California, were instead shipped to Grand Coulee, where they went into immediate operation. Altogether, the combined name-plate rating at the two Federal powerhouses rose from 84-kW when Bonneville's first two units went into operation in March 1939 to more than 1350-kW by February 1944.

Private power providers in the Northwest, operating their own system of hydroelectric and thermal facilities, also faced huge demand for new power generation as the nation moved toward wartime production. While the major industrial users, such as the aluminum plants, as well as military facilities such as Hanford, were served through direct contracts with BPA, the smaller operations, including most of the smaller Portland-area shipyards, purchased their power from local utilities. Local power providers also had to supply the needs of the thousands of new residents drawn to the area to work in defense plants, along with their families. Transportation facilities in some areas were still electric powered trolleys and overall energy demand in all sectors of the regional economy soared as the result of new residents as well as new industrial users.

Faced with unprecedented demand, squeezing every watt out of the available generation pool was critical, even with the additional capacity of the Grand Coulee and Bonneville dams. One method of accomplishing this was through interconnection of the various public and private utilities. Essentially interconnection allowed both public and private generation systems to coordinate the transmission of power in the most

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[14] See http://www.atomicheritage.org and http://www.b-reactor.org/landmark.htm (visited 12-October-2009).

efficient methods across the entire system, independent of the source of generation or the location of the end user.

Pacific Northwest utilities had become partially interconnected as early as 1915, when Washington Water and Power and Puget Sound Power and Light had joined their systems to provide power to the Milwaukee Railroad (*Electrical West*, March 1944). By the 1920s, most of the region's investor-owned utilities enjoyed some version of interconnection, allowing them to share their power and service loads across the area, balancing regional demand. Since several of the largest utilities shared common ownership under the national holding companies that dominated the industry, it wasn't too difficult for sister entities to share resources. That practice was soon expanded to include virtually all the major private utilities in the Northwest into a loosely connected network.

Looking forward to the likelihood of war, as early as 1940 BPA's Paul Raver had proposed the interconnection of *all* Pacific Northwest power facilities, public and private, to better meet national defense needs (Tollefson, 1987:228). BPA's Master Grid represented the region's first high-voltage 230-kV lines and had been specifically designed for easy expansion and so, by implication, was able to easily accommodate interconnections with the existing private power systems. Variously described as an agreement for the common good among its public and private partners or as a mandated action from the War Production Board, among the more significant results of the interconnected system in late 1941 was the cessation of internal rivalries among the public and private utilities of the Northwest and the creation of the Northwest Power Pool. Whatever its direct cause, by January 1942 the BPA Master Grid had become the "backbone" of the eleven-member Northwest Power Pool, one of the first, if not the first, interconnected public-private power grid in the United States. The effect of the Northwest Power Pool, as intended, was to greatly improve the efficiency of power transmission throughout the region.

> Without building a single power plant, 135,000 horsepower of additional generating capacity has gone to war in the Pacific Northwest through complete interconnection of all major power systems in a five state area (*Electrical West*, March 1944).
>
> It was a pooling of 3,400,000 kilowatts of generating capacity into one of the nation's greatest power reservoirs and combining power resources of all private, municipal and federal systems in the states of Washington, Oregon, Idaho, Montana and Utah (Kramer, 1986:87).

Post-War Changes: 1946-1956

World War II forced BPA and the Pacific Northwest to develop its energy grid at a rate unplanned and unprecedented, with the result being that by the war's end the BPA network was among the largest such systems in the nation, capable of delivering more electrical power than every other system in the Northwest.

> The development of the Bonneville Transmission System has been unparalleled in the history of the electrical industry…it is believed that no single integrated transmission system has even approached Bonneville in rate of growth (Davis, 1944:V-6).

As the war ended and the massive defense industry in the Northwest was largely dismantled, BPA returned to many of its pre-war concerns, including efforts to bolster public power development and rural electrification in the Pacific Northwest. Although the Administration worked to retain the large-scale industrial users that it had attracted during the war, many of those plants closed with the end of fighting and the declining demand for their output. That shift, particularly in the production of aluminum, would have a significant impact on BPA's power sales. At the end of WWII nearly 70 percent of BPA's power was dedicated to the production of war materials.

> Now the war industries are dwindling; aluminum capacity has been cut by half, magnesium by 90%. The loss of this and other emergency loads and electro-chemicals and shipbuilding have caused nearly a million kilowatts of power capacity to go begging (*Fortune*, February 1945:141).

BPA resumed its support and advice on the formation of Public Utility Districts, especially in Washington where many pre-war PUDs, formed between 1936 and 1939, had been delayed by the national emergency. These organizations only developed their facilities and actually went into operation once the war was over. BPA's legal obligations to supply PUDs under the preference clause, as well as its on-going direct contracts with large aluminum plants and others, naturally put the Administration back into direct conflict with the private utilities. As a result, although the Northwest Power Pool remained in force, the positive working relationship between BPA and the investor-owned utilities was again strained. That friction was further exacerbated by national politics as President Truman and members of the 79th Congress renewed action to establish a Columbia Valley Authority that would combine Federal generation and transmission systems under a single umbrella agency.[15]

The closure of wartime industrial facilities and dramatically reduced regional production also brought the return of the pre-war doubts about the economic viability of the Federal development of the Columbia River. This was fueled in no small part by a return of investor-owned utility concerns about the government's role in the region and a concerted effort to undermine the formation of anything approaching a TVA-style entity. The CVA opponents received welcome support in the November 1948 national elections. Despite the surprise re-election of President Harry Truman, the Republican Party, a group generally opposed to public power, took over control of both houses of Congress for the first time since 1931.[16]

At a time of mounting national debt from the cost of WWII and faced, in general, with an anti-public power philosophy in Congress, BPA found it increasingly difficult to obtain funding for new projects in the Northwest. Throughout the postwar period, Paul Raver, still BPA's administrator, petitioned for the construction of additional generation capacity on the river in BPA's Annual Reports, citing both the recommendations of the 308 Report and, more importantly, a looming power shortage that would cripple the

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[15] CVA bills were introduced in 1944 and 1949, the latter by Henry "Scoop" Jackson, who as both a Representative and, later, a U.S. Senator, would remain a staunch supporter of both BPA and public power in the Pacific Northwest. Neither CVA proposal was successful.

[16] The 80th Congress was dubbed the "Do Nothing Congress" by Truman. He fought near continually with its leadership until the 1950 mid-term elections brought the return of Democratic majorities in both houses.

Pacific Northwest if nothing was done. Raver's predictions of power shortage, in the power-rich Northwest, especially given its declining industrial uses, were met with considerable skepticism at the national level that were soon coupled with challenges to Raver's and BPA's motivation. Raver was personally vilified as either a socialist or, even worse in this era of Senator Joseph McCarthy, a communist sympathizer (Kramer, 2010:68).

But the Northwest was indeed heading toward a power shortage, as Raver and others knew. Daytime brownouts and cessation of industrial sales during critical periods allowed BPA to maintain minimal service throughout 1949 and 1950 while many private utility customers fared even worse, particularly in the newly resurgent lumber mills that came to dominate much of the regional economy during the postwar period. Surging construction activity, the result of Federal programs such as GI home loans and changes in banking and mortgage regulation, led to a huge housing and commercial construction boom, much of it needing building materials from the Pacific Northwest. Regional lumber mills, increasing in size and number from pre-war levels, not only required more power in their cutting operations but soon turned to newer electric-powered drying kilns that consumed huge amounts of power. And, of course, the massive population increase throughout the Pacific Northwest in the years after WWII brought with it a sharp increase in domestic demand for electricity.[17]

Raver's pleas for new generation projects on the Columbia did not entirely fail. In 1945 Congress had approved construction of the McNary Dam, east of Umatilla, Oregon, although it did not provide funding for its construction until two years later.[18] The Hungry Horse Dam, on the Flathead River in Montana, had been approved in 1944 and would become the first post-war Federal generation facility in the Northwest to go into operation eight years later. A flood in May 1948 destroyed Vanport, a defense workers housing project north of Portland, and brought renewed concerned for flood control on the Columbia River. The 20-day flood destroyed nearly 5,000 homes, with 32 deaths. President Truman ordered the Army Corps, Bureau of Reclamation and BPA to revisit the 308 Report and make recommendations that resulted in what became known as the "Main Control Plan," providing for the coordinated operation of all flood control, navigation, irrigation and power generation facilities on the river. As a result of the Main Control Plan, the Rivers and Harbors Act of 1950 authorized additional dam development in the Columbia basin, including The Dalles and John Day dams and powerhouses, as well as two new upstream storage dams; Albeni Falls Dam and Libby Dam.

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[17] Idaho's population grew 12.1% between 1940 and 1950 while Washington's population increased more than 37% and Oregon's grew by 39.6%. Regional growth continued throughout the 1950-1960 period, with Idaho adding another 13.35%, Washington 19.94% and Oregon 16.26 percent. The total population of the three states between 1930 and 1960 grew from just under 3 million to 5.2 million, a total increase of fifty-six percent (*U.S. Census data*).

[18] McNary's approval was a part of the Rivers and Harbors Act of 1945, which also approved construction (but not funding) for four dams on the Lower Snake (Ice Harbor, Lower Monumental, Little Goose and Lower Granite). The following year, in 1946, Congress authorized the Chief Joseph Dam, downstream from Grand Coulee (Springer, 1976:53).

While BPA and Paul Raver lamented the slow construction schedules, some work was finally underway at both McNary and Hungry Horse, offering the prospect of increased generation in the near future.[19] And, while the Administration's primary industrial user, the aluminum industry, continued to decline, overall electrical use in the region continued to grow, just as Paul Raver had predicted.[20] Congress, even after the return of Democratic majorities in 1950, remained somewhat resistant to additional expense in light of wartime debt and the mounting cost of the Korean War. That latter conflict, however, did result in Congressional funding for growth in the transmission network as Columbia River power again became a key part of the nation's defense program. In late November 1950, for example, BPA improved its service to the Idaho Panhandle, completing substations at Sandpoint and Athol, along with the Newport-Sandpoint 115-kV line. Line construction within the BPA system also increased throughout the early 1950s.

> The new features assure greater reliability and service and increased power capacity for the Idaho Panhandle and northwestern Montana…Anthol's modern substation, constructed by Hughes and Hughes Electrical Contractors of Spokane, Washington, also features the latest design in equipment… (*BPA Currents*, 10-Nov-1950).

> BPA has announced proposed contract construction work totaling $13,240,000 for calendar year 1951…Transmission line clearing and line construction contracts estimated at $11,161,00 are to be awarded….Substation construction contracts [include] the building of ten new substations and additions to 17 substations.." (*BPA Currents*, 24-Nov-1951).

With the long-awaited construction of McNary and Hungry Horse finally underway, and the promise of additional new generation in the near future, BPA's transmission network grew significantly during the 1950s, partially to provide for new PUD users in Washington but also in preparation for the increased transmission needs down the road. In 1946, BPA's first postwar annual report to the Secretary of the Interior documented 2,839 circuit miles and 61 substations within the system, a fairly remarkable testament to the rapid growth of the system from zero since the start of construction in 1938. BPA's growth during the 1950s was no less impressive. Ten years after the war's end, in 1956, BPA operated 7,195 circuit miles of transmission line, an increase of 253% since 1946. The number of substations that BPA operated grew even more dramatically, from 61 in 1946 to 178 in 1956, an increase of almost 300 percent. The Administration also built its first EHV, or Extra High Voltage line, the 345-kV McNary-Vancouver Line, energized in late 1953 along with the completion of the dam and the addition of its 980-mW output to the Federal Columbia River Power System. In 1955, entirely due to the construction of Hungry Horse Dam and its available power, Anaconda opened a new aluminum plant in Columbia Falls, Montana. This plant was the result of a stipulation in the Hungry Horse appropriation that reserved two-thirds of the dam's output for use within Montana.

Microwave/Radio Network

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[19] The Hungry Horse Dam went into service in October 1952, McNary in November 1953 (BPA, 1980).

[20] From a high of 70% at the end of WWII, aluminum represented just 32.48% of BPA sales a decade later (BPA Annual Report, 1955).

As BPA's transmission system grew in size and complexity, controlling its various elements to work together efficiently became a greater challenge. In February 1950 BPA announced a new microwave radio communication system would be built to link all the major dispatching centers, substations, and Federal power plants in the Pacific Northwest. The microwave system would be built by the Philco Corporation, of Philadelphia, PA, under a $633K contract. Dozens of microwave transmitters, repeater stations and other equipment would be constructed, linking the system with voice communication, relaying, telemetering and fault location channels when the network was completed.

> One of the largest microwave installations of its kind in the nation, the system will provide modern protective and operating devices for network transmission facilities valued at over $100 million (*BPA Currents*, 16-Feb-1950).

BPA expected that the instant detection of transmission and generation faults made possible by the microwave system would have significant benefit in reducing system outages, saving costs in both maintenance and operation. The Administration would continue to expand and improve the microwave system as its transmission network expanded throughout the 1950s. The result was what amounted to a secondary region-wide network that worked in parallel with the transmission system throughout BPA's service area.

National and International Politics 1956-1960
Dwight D. Eisenhower was elected president in 1952, the first Republican to occupy the White House in BPA's history, after FDR and Harry Truman. Longtime BPA Administrator Paul Raver remained in his position until 1954, when he resigned to become the head of Seattle City Light.[21] President Eisenhower replaced Raver with Dr. William Pearl, who assumed his new post on January 15, 1954. Eisenhower also appointed Douglas McKay as his new Secretary of the Interior, the department charged with oversight of the Bonneville Power Administration.[22] McKay, a former Oregon Governor and adamant "private power" supporter, encouraged the President to make significant changes to the way BPA was operated, changes that Ike supported so strongly that he took the trouble to mention them in his first State of the Union address in 1953. In that speech Eisenhower called for a natural resources program that would henceforth be less dependent upon the Federal government.

> The best natural resources program for America will not result from exclusive dependence on Federal bureaucracy. It will involve a partnership of the States and local communities, private citizens, and the Federal Government, all working together. This combined effort will advance the development of the great river valleys of our Nation and the power that they can generate. Likewise, such a partnership can be effective in the expansion throughout the Nation of upstream storage; the sound use of public lands; the wise conservation of minerals; and the sustained yield of our forests (Eisenhower, 1953).

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[21] Raver continued to serve in Seattle, in the position that J.D. Ross had held prior to the formation of BPA, until his death in April 1960.

[22] BPA, formed as a part of the Department of Interior, remained within that agency until 1977 when it was moved to its current position, within the Department of Energy (P.L. 95091, Title II, § 201, Aug. 4, 1977, Stat. 569).

As implemented by Secretary McKay, the new approach of the Eisenhower Administration was dubbed the "partnership" policy. "In simple English, this policy was to reduce federal participation in power development and, since the federal power involvement in the Pacific Northwest was large, the policy did not bode well for public power people" (Billington, 1988:73).

As the Federal government had delayed its investment in new generation on the Columbia since the end of WWII, so too had private utilities largely stopped the construction of new generation plants after the late 1930s. This halt was partially due to economics during the Great Depression, partially due the availability of Bonneville power, partially due to an uncertainty as to their own future in the face of public power, and, finally, and probably most significantly, due to the onset of the war. With the election of a supportive White House, private power providers now rushed their own generation projects to construction with the help of beneficial tax advantages created by the Defense Electric Power Administration. This Eisenhower program allowed fully 65% of the cost of construction of new generation facilities to be written off on a fast-track timeline of five years (Norwood, 1981:192). As a result, while Federal construction stalled, new non-Federal, power projects were rushed forward throughout Pacific Northwest. These included Pacific Power's Yale Project, Portland General Electric's North Fork Project, and Washington Water and Power Company's Cabinet Gorge Project, among many others that collectively added hundreds of megawatts of hydropower to the region's capacity. Perhaps the largest, certainly among the most controversial, of these Eisenhower-era developments that were encouraged by the partnership policy and the Defense Electric Power Administration programs were the Snake River dams constructed by Idaho Power; the Brownlee Dam (completed 1959), the Oxbow Dam (1961), and the Hells Canyon Dam (1967).

The Snake River projects in particular once again pitted private and public power advocates against each other, this time complicated by the input of a growing environmental movement in the Pacific Northwest. The debate over Snake River, during Ike's first term, received a more positive response for Eisenhower's policies than did the effort to develop the John Day Dam under the partnership program, which Congress flatly rejected. When Congress then refused to "partner" with private utilities on other Federal projects in the Northwest such as those in the Army Corps' Willamette Basin Project, a displeased White House adopted what amounted to a "no new starts" policy, denying funding for any new Federal dam projects, further delaying hydropower development during the latter half of the 1950s.[23] Ultimately Ike's second Secretary of the Interior, Fred Seaton, brought an end to the stalemate and the impact of the partnership program was minimal during Ike's second term, following his re-election in 1957.

Wheeling

Construction of multiple new generation facilities, including both public and private projects, demanded significant expansion of the existing transmission network, a system that was still largely reliant upon the

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[23] Interest in hydropower development during this period, even at BPA, was beginning to wane as both BPA and the private utility industry began to look toward new sources of thermal generation, nuclear powered plants, as a way to create abundant low-cost, electrical power.

WWII-era BPA Master Grid.[24] Initially, investor owned utilities considered building their own transmission network that would exist in tandem with, and essentially duplicate, the BPA network that continued to serve as the backbone of the Northwest Power Pool. In order to avoid the potential for a duplicate and competing system, Roger Conkling, a Raver-era holdover at BPA under William Pearl, proposed "wheeling" non-federal power on the BPA system. "Wheeling is the use of the transmission facilities of one system to transmit power for another system" (Tollefson, 1989:314). Essentially, wheeling allowed the region's private utilities to rent time on the BPA network and, in so doing, avoid the costs of building and maintaining their own transmission systems. BPA would charge the utilities for the use of the lines, but since wheeling rates were significantly less expensive than the cost of construction, ratepayers would benefit from reduced costs while creating an additional income stream for BPA. Wheeling would allow the near unification of the public-private partnership within the Northwest Power Pool system and probably did more to establish a renewed, cooperative, tone between BPA and the regional utilities than any other effort of the Eisenhower era.

> Plans to make the Federal grid available for wheeling non-Federal generation to load centers, wherever most economical and feasible to do so, are progressing rapidly. Joint studies are underway to explore 'wheeling possibilities' with the city of Tacoma Cowlitz projects, Grants County PUD Priest Rapids project, Portland General Electric Company Pelton project and the Pacific Northwest Power Company Mountain Sheep and Pleasant Valley dams (BPA Annual Report, 1955:III).[25]

BPA required Congressional authority to allow wheeling on Federal transmission lines and received it when President Eisenhower signed P.L. 86-16 into law in August 1957. Among the early transmission lines that were constructed for wheeling included those connecting the Priest Rapids Dam (Grants County PUD) and the Rocky Reach Dam (Chelan County PUD), both in Washington. That new line to two public, but non-Federal generation projects, brought nearly 2,000,000-kW of additional power to the Columbia Basin system.

> The authority to wheel power virtually eliminated proposals to build non-Federal transmission lines which would have duplicated Federal lines. It also established the precedent to build Federal transmission lines in part or wholly for wheeling non-Federal power (Springer, 1976:61).

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[24] In addition to the Federal and privately constructed dams already named, many other new generation sites were completed within the Columbia River system during the 1950s. These included The Dalles Dam (1957, 1.8-mW), Priest Rapids Dam (1959, 788,000-kW), Chief Joseph Dam (1956, 1.2-mW), Albeni Falls Dam (1955, 42,000-kW), Moxon Rapids (1959, 282,000-kW), Chandler (1956, 12,000-kW), Roza (1958, 11,200-kW), Palisades (1957, 117,000-kW), Dexter (1955, 15,000-kW), Lookout Point (1954 (120,000- kW) and Swift No. 1 (1958, 204,000- kW). Projects were built by a variety of private and public agencies, including Army Corp, Reclamation, Public Utility Districts and private, investor owned, utilities throughout the Columbia Basin. In the years since, many of these projects have been upgraded or expanded to produce additional power.

[25] In 1953-1954, with the change in Administrator, the *BPA Annual Report* was re-titled the *Columbia River Power System Report*. For ease of citation, these documents remain cited as *BPA Annual Report*, by date.

Canadian Treaty

In the late 1940s and early 1950s, as BPA looked to increase available power for the Northwest and, perhaps more importantly, assure its continued ability to make payments to the U.S. Treasury to retire its construction debts, its interest turned north, to Canada. Hydropower, by its nature, produces seasonal spikes due to the availability of excess water during spring run-off, water that allows for greater generation potential as it flows downstream. That extra power, called "secondary power" by electrical engineers due to its seasonal nature, is in addition to what is called base or "firm" power capacity, the amount of generation that can be relied upon as the minimum output expected under normal conditions on a year-round basis. Firm power is what a utility needs to meet the base demand, or base load, of its customers. During WWII BPA was able to sell much of its "secondary" power to aluminum plants and various utilities or other industries and used the extra income from those sales to "buy down" the costs of its regular customer rate. This extra income also allowed BPA to make advance payments on its debt to the U.S. Treasury while still keeping its rates among the lowest in the nation.

During the 1950s, new generation plants were under construction for firm power to provide for the region's growing base loads. They would additionally create the opportunity for increased amounts of seasonal secondary power during the spring. With reduced aluminum production, there were fewer outlets that could benefit from all of that new secondary power and so, without any identified customers, large amounts of potential power was going to go to waste.[26] Raver, and later Pearl, recognized that it was in the best interests of BPA and the U.S. Treasury to find some method of capturing that secondary potential. BPA's strategy to do so relied upon two related prongs. The first was Canadian storage.

More than one third, 468 miles, of the total length of the Columbia River is located north of the U.S.-Canada boundary in the province of British Columbia. In 1909, long before any significant hydroelectric development on the Columbia River had occurred in either nation, the two nations signed the Boundary Waters Treaty, agreeing that each would forever retain unfettered use of all its own waters, even when rivers flowed across the international boundary.[27] In simple terms, the treaty gave full and total authority for development of that portion of a river within its lands to each of the parties. Under the Boundary Waters Treaty, should Canada so wish, it could dam the entire flow of the Columbia River above the 49th parallel and retain all of the river's waters for its own use.

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[26] Electricity, obviously, cannot be stored but must be used or lost. Without a market for secondary power in Spring Columbia River dams would be required to spill water (send it over the dam) without generating additional power. In the world of power generation this amounts to sending millions of kilowatts, and dollars, out into the ocean.

[27] Formally the parties to the treaty were the United States of America and "His Majesty the King of the United Kingdom of Great Britain and Ireland and of the British Dominions beyond the Seas…" the latter of which still included the Dominion of Canada. The Treaty, in its centennial year at this writing, is regarded as one of the first environmental agreements in the world and a "model of bi-national governance." The Treaty clarifies management of all international rivers between the U.S. and Canada, not just the Columbia. (*Boundary Waters Treaty*, 1909, see also http://oursharedwaters.com (visited October 2009)).

In the late 1940s British Columbia began to explore the potential for new hydroelectric and irrigation projects on the Columbia River. While the Canadian projects would not dam the entire flow of the Columbia, the proposal could still have a potentially devastating effect on a number of existing dams downriver, below the 49th parallel, in the United States. In 1954, as part of an effort to minimize those impacts and arrive at a mutually beneficial solution, President Eisenhower appointed the former Governor of Idaho, Leonard Jordan, to represent the U.S. on the Canadian-American International Joint Commission, a group authorized by the Boundary Waters Treaty and charged with negotiating any issues that arose between the two parties.[28] Governor Jordan, a strong private-power proponent who had played an important, anti-public power, role in the Snake River dam issue in Idaho, was perhaps not as committed to reducing the impact of the Canadian action upon the Federal Columbia River Power System as the position would seem to demand.

As might have been anticipated, Governor Jordan proved to be a somewhat less than effective negotiator on behalf of the Federal/BPA cause. As Canada's interest in hydroelectric generation projects moved forward north of the border, the potential for severe impacts to U.S. generation loomed ever larger.[29] Estimates at the time indicated that reduced water flow as the result of Canadian dam construction could result in losses of over 1,000,000-kW of annual power generation in the United States. Such an impact, most of it coming from the region's firm power base, would have had a significant effect on BPA and the Pacific Northwest.

Part of the impetus to generate additional power on the Canadian portion of the Columbia stemmed from the proposal of Henry Kaiser, the American industrialist who had been involved the construction of both the Grand Coulee and Bonneville dams prior to developing shipyards in Portland and aluminum plants in Washington during World War II. The irrepressible Kaiser was independently negotiating with Canadian interests to pay for the construction of a dam at Arrow Lakes, north of Colville, Washington, to impound water that could be used to support downstream generation to supply one of his company's Spokane, Washington aluminum plants. The United States government, while generally opposed to the Kaiser project, was itself interested in building what would become Libby Dam, in northern Montana, creating an impoundment that would back water north over the international border for more than 45 miles, a project that required Canadian permission to inundate that considerable upstream area. Ultimately, amid all these complex plans, British Columbia independently determined to develop its new hydro facilities on the Peace River, not the Columbia. This allowed Canada to be more accommodating to the U.S. Columbia River interests downstream while still meeting its own needs. That change resulted in renewed negotiations as to how Canada and the U.S. interests on the Columbia River could best work together.

BPA and its partners in the Federal Columbia River Power System primarily wanted to store water at a series of Canadian dams above the border so that spring run-off could be released in a controlled fashion,

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[28] Jordan, (1899-1983) served as Governor 1951-1955 prior to his two-year appointment to the International Joint Commission. In 1962 he was appointed to the U.S. Senate, filling the vacancy caused by the death of Henry Dworshak. Jordan was re-elected once, serving until January 1972.

[29] See Neuberger, 1957:43. In fairness to Jordan, the Commission, which he chaired, was also faced with the development of the St. Lawrence Seaway, however Jordan's disinterest in pursuing a solution to the Columbia River issue is well documented in most period accounts.

increasing firm power within the BPA service area. Typical of the U.S. dams on the Columbia River, the proposed Canadian dams would be multi-purpose, providing additional benefits for recreation, flood control, and irrigation.

In 1958 President Eisenhower and Canadian Prime Minister John Diefenbaker met in Ottawa and agreed to terms for the cooperative use of the Columbia River based on an upstream storage model. Two years later, after funding issues were clarified, the two nations signed the Columbia River Treaty on January 17, 1961, three days before Ike vacated the White House for John F. Kennedy.[30]

> The United States derives two major benefits from the Treaty. One is flood control, ending the danger of serious flooding on both the Columbia and the Kootenay (spelled Kootenai in the United States). The other is power storage — The Treaty dams hold spring run-offs and release them gradually to sustain levels of power generation downstream when stream flows would ordinarily be lower (Springer, 1976:67).

HVDC Intertie 1960-1970

The second "prong" of BPA's strategy to maximize benefit from the Columbia River Treaty and retain low cost public power for the Pacific Northwest was the construction of the Pacific Northwest-Pacific Southwest Intertie, connecting abundant secondary power supplies in the Pacific Northwest with the growing market for power in the Pacific Southwest. The idea of building a high voltage long-distance transmission line that would send excess Northwest power to more populated areas had been part of BPA's original planning prior to World War II. J. D. Ross, BPA's first Administrator, had suggested the idea in 1928, nearly a decade before the passage of the Bonneville Power Act or any Federal investment on the Columbia was a reality. Ross and BPA's first chief engineer, Charles Carey, had even investigated the technology of long-distance direct current transmission as a possible method of creating additional markets for power during BPA's earliest planning period. As noted earlier, the technology for successful long-distance direct current transmission had not yet been developed in the late 1930s, but the value of an intertie to the Pacific Northwest was clearly recognized.

The potential benefit of a west coast intertie between the Columbia River and California was significant. The peak electric loads of the Pacific Northwest, the region served by BPA, and the Pacific Southwest, generally a reference to southern California and the Los Angeles basin, were near mirror-opposites. In the Pacific Northwest, domestic power consumption spiked during the late fall and winter period, when long nights and cold weather brought additional lighting and heating needs. In contrast, southern California, with its milder winter and lower latitudes, saw power demand spike during summer, when air conditioning use increased. The mild winters of California caused secondary power generation to peak from winter rains,

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[30] Funding for the construction of Keenleyside, Mica and Duncan dams in British Columbia, all owned by what is now BC Hydro, was another example of public-private power cooperation. Denied funds from the U.S. Congress due to budget concerns, the partners in the Columbia River system turned to a group of investor-owned utilities in the United States who pre-paid $314 million dollars for 30-years of "entitlement" power from the projects, money which Canada used to build its own Peace River project (Norwood, 1981:235).

while dry summers reduced hydropower generation during the summer months, when load peaked. Electric providers in southern California, both public and private, typically augmented their available hydropower during the summer with thermal generation, mostly coal, to meet base loads. Southern California's thermal generation was reliable and effective, but it was also considerably more costly than hydropower, especially BPA's low-cost hydropower.[31] And, since base usage typically dropped in the Southwest during its mild winters, that region's secondary power went largely unused, costing local utilities through lost revenue.

The mirror-image offsetting seasonal demands and generation cycles of these two regions created a huge opportunity. If an intertie could be made functional, Southern California utilities could supply their customers with lower-cost, cleaner, hydropower during the summer and BPA could sell its secondary power on a regular basis, continue its debt payments, and maintain low power costs for its own customers. Conversely Southern California's winter-time secondary power could, if needed, be sent north, giving BPA and northwestern utilities a lower-cost alternative than their own thermal generation plants. If an Intertie could efficiently transmit power between them, utilities in both regions would profit and consumers in both areas would enjoy lower-cost power

Despite its obvious benefits, the idea of a long-distance intertie between the regions was put on hold during World War II, as BPA focused on more immediate matters. The intertie idea resurfaced later, during the immediate postwar era. In January 1949 Region II of the Bureau of Reclamation, headquartered in Sacramento, California, published a preliminary report on the potential for a long-distance interconnection with BPA's network to provide low-cost Federal power for the Central Valley Project.

> The most important advantage of the proposed interconnection would be that a portion of the waste hydroelectric energy available during periods of high stream flow and reduced load on the Columbia River System could be utilized in California and thus enable a reduction in fuel oil fired steam electric generation estimated at approximately 600,000,000 kilowatt hours per year (BOR, January 1949:II).

Reclamation's plans for this intertie never came to fruition for unknown reasons, despite BOR's strong recommendation in favor of the project at the time. They estimated that even with construction costs of $36 million, an interconnection between the Columbia River System and California would generate power revenues of $98 million dollars over a fifty-year period, the standard Federal repayment schedule (BOR, January 1949:III).

In 1953 the Federal Power Commission again considered the possibility of a long-distance interconnection between the regions, again without resolution perhaps due to the complicated politics of that period. By 1960, with the signing of the Columbia River Treaty and the planned creation of three upstream storage dams in Canada, BPA was again in a position to market massive quantities of secondary power and, once

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[31] The lower latitude of southern California typically yields increased stream flows during winter and fall, when it rains, the reverse of streams in the Pacific Northwest where winter precipitation is stored as snowpack and only released during the Spring and Summer runoff.

again, southern California offered a ready and willing market if the technical aspects of delivery could be overcome.

Planning for what would become the Pacific Northwest-Pacific Southwest Intertie, as the project is known, began in February 1960 when Dr. Pearl and BPA reviewed the concept at the request of the Senate Committee on Interior and Insular Affairs.[32] Pearl's initial report, consistent with the Eisenhower Administration's general reluctance to expand the BPA network, found insufficient benefit to offset construction costs and recommended against pursuing an intertie. Most state interests throughout the west strongly disagreed with BPA's findings. In March 1961, following the election of John Kennedy as President, Dr. Pearl resigned and Charles F. Luce was appointed as the new Administrator of the Bonneville Power Administration. Kennedy's Secretary of the Interior, Stewart Udall, almost immediately named a Special Task Force to revisit the potential for a long-distance intertie between the Pacific Northwest and the Pacific Southwest. Udall appointed Charles F. Luce as its chairman.

The Special Task Force examined how other nations, particularly the Netherlands and the Soviet Union, were succeeding in transmitting direct current over ever-longer distances between point of generation and region of demand. They further noted that while 345-kV lines such as those BPA operated between McNary and Vancouver, Washington were the highest voltages in the United States, other nations including the Soviet Union in particular, had functional lines with voltages as high as 500-kV.[33] By 1960 Direct Current, the technology that J.D. Ross had first explored for the intertie in the 1930s, was both technologically feasible and considered the best method for long-distance use such the intertie, despite the fact that no utility in the world had ever used high-voltage DC for a line as long as what was being proposed for the western United States.

Direct Current was the original form of commercial electrical transmission as developed by Thomas Edison during the last quarter of the 19th century. DC lines carry unidirectional current on two conductors and, significantly, experience lower voltage loss than similar voltage AC, or alternating current lines. "The economic advantages are proportional to the line length, but are offset by the cost of the converting equipment."[34] In simple language, high voltage direct current lines (HVDC) allowed the transmission over smaller, and less-expensive, conductor, a significant factor in a long-distance intertie such as the one that BPA envisioned, but DC transmission required the construction of *converter* stations at either end, in order to be compatible with the AC power of the standard distribution system.

Entirely refuting the earlier Pearl report, the Luce-led Special Task Force determined that an intertie between the Pacific Northwest and the Pacific Southwest would indeed prove beneficial to both regions and

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[32] It should be noted that Henry M. "Scoop" Jackson, Democrat of Washington, a longtime promoter of BPA and public power issues, was a powerful member of this committee, becoming its Chairman in 1963.

[33] In 1961 there were 2500 miles of 345-kV transmission lines in the United States, including 325 within the BPA system. In 1959 the USSR had converted an earlier 400-kV line between Stalingrad and Moscow, about 560 miles, to 500-kV with success (USDI, 1961:68).

[34] See http://www.answers.com/topic/direct-current-picture-transmission (visited 28-October-2009).

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recommended that its construction be authorized. The report suggested three different options including one that relied upon direct current transmission.

> The report stated that three 750-kV DC lines would be the most economical alternative. The second choice was three 500-kV AC lines and the third, of three 345-kV lines, was included as a 'poor choice' (Norwood, 1981:242).

The Task Force submitted its findings and recommendations to the Secretary of the Interior on December 15, 1961. While BPA and its partner utilities in California anticipated funding and construction of the long-sought intertie, regional concerns about the possibility of the Northwest losing its "priority" rights to Columbia River power caused considerable controversy and opposition to the entire plan. Political leaders throughout the Pacific Northwest, but especially in Washington, with its strong network of PUDs and rural cooperatives, feared that California, with its political might, would manipulate the intertie to "rob" the region of its low-cost hydropower beyond the seasonal use periods. This typical editorial reaction, from the *Ellensburg Record*, was published under the headlined "We Don't Like It."

> Our steams are our great natural resource…power is a Northwest birthright, just as oil and climate are California birthrights. We would hate to see any legislation passed that would force the Northwest to sell its birthright for a mess of pottage (*Ellensburg Record*, 1-August-1962).

Ultimately regional concerns were addressed, largely through the efforts of U.S. Senator Henry Jackson, of Washington. On September 2, 1964, President Lyndon Johnson signed a Congressional appropriation providing $45.5 million to begin construction of the estimated $700 million Pacific Northwest-Pacific Southwest Intertie project. The Federal government, through BPA, would commit almost $300 million toward the project, which upon its completion would be the longest electrical transmission line in the world (Tollefson, 1989:338). The remainder of the intertie costs would be paid for by a mixture of public and investor-owned utilities in both California and Oregon.

The final design of the Pacific Northwest-Pacific Southwest Intertie was a distillation of the original concepts presented by the Special Task Force and would include both DC and AC circuits. As completed in 1970, the Intertie allowed for the transmittal of more than 4,000,000 kilowatts among British Columbia and eleven states. "It had essentially become the backbone of the largest electrical grid in the Western world" (Binus, 2008:105). The project as built included Federal and privately-financed lines that ran for nearly 900 miles between its northern starting point at the Celilo Converter Station, near The Dalles, Oregon, where Columbia River power was converted to Direct Current.

> BPA built the 265 miles of the DC line, 267 miles of one AC line and 88 miles of the second AC line in Oregon. Portland General Electric built the remaining 179 miles (Norwood, 1981:245).

At Malin, Oregon, in Klamath County, near the Oregon-California line, the BPA system met lines that were built by investor-owned Pacific Gas & Electric. From that point the Intertie lines continued southward to the Sylmar Converter Station, north of Los Angeles, where the power was converted back to alternating current and tied into the southern California distribution system. Of course, during the winter or as needed, the entire flow could be reversed, sending Pacific Southwest power north.

The construction process for the Intertie included several significant technological hurdles and required years from approval to operation. Among the more significant elements of the project was the 1963 construction of the HVDC current tester at BPA's Big Eddy Substation, a $2 million project that was energized on November 4, 1963. "This facility, first and foremost of its kind in the free world, will establish engineering and operating standards for a new technology of long-distance, high-capacity, power transmission" (BPA Annual Report, 1963:1). The Big Eddy Test Center helped engineers to study new technologies that informed the design of both the Celilo and Sylmar converter stations. Based upon the success of the Big Eddy testing process and the recommendation of ASEA of Sweden and General Electric, design contractors for the intertie project, BPA soon adopted 500-kV A.C. as the new backbone of its primary transmission system, to be operated in parallel with the existing 230-kV Master Grid. Line voltages of 287-kV, 315-kV and 345-kV were discontinued except for existing transmission lines (Norwood, 1981:243).

> The Celilo Converter Station is one of the first two HV converter terminals in the United States (the other at Sylmar). The line, at 853 miles, is far longer than any AC or DC line ever constructed and the terminal, with a capacity of 1440 MW is the largest DC terminal ever constructed, more than double the size of the previous 600 MW terminal in New Zealand (Breuer, Nov 1966).

The first portion of the Pacific Northwest-Pacific Southwest Intertie, one of the AC lines, was energized on September 20, 1968. The second AC line was energized in May 1969.[35] The first direct current line of the Intertie was energized in May 1970 and the Celilo Converter Station dedication was held on August 25, 1970. The DC line was the first and longest, ultra-high voltage line in the world and marked a major technological milestone in electrical transmission history. "Total project capacity exceeded 3.4 million kilowatts and included nearly 4,200 towers on the DC span running 845 miles (BPA, 2007).

In 1969, even before the cutting-edge DC line was operational, the Intertie AC lines were meeting the needs of both regions and boosting BPA's financial situation. BPA's 1969 Annual Report noted:

> The Intertie is performing valuable services for the two regions it interconnects. It is enabling the marketing of surplus Northwest energy to California. It enables Northwest utilities to sell Canada's share of Canadian Treaty power to California. It makes possible for Northwest industries to maintain production by purchasing energy from California to replace curtailed interruptible deliveries from Bonneville. It permitted importation of up to 700,000 kilowatt during the 1968-69 winter cold snap to meet record high Northwest loads (BPA Annual Report, 1969:5).

Today, nearly four decades since its original concept was completed, the Intertie plays a role in unifying the west coast and extends upon historian Richard White's view of BPA as the "defining" entity of the Pacific Northwest (White, 1995:64). If, as White claimed, BPA defined the Pacific Northwest, the Intertie that BPA

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[35] A third AC line was energized in 1993 (see BPA, July 2007).

long sought to construct and still operates links the entire west into a system not terribly dissimilar from that J.D. Ross first envisioned and promoted in the 1920s.

> Since the creation of the Pacific Intertie, the lives of Westerners have become integrated through an electrical geography most often taken for granted, itself a reflection of the system's reliability. While power lines stretch overhead along our roads, across our mountains, between our homes and even underground, the connections they make between our lives and power systems and environments where the energy is produced go largely unnoticed. Regardless of the attention they draw, the connections are real nonetheless (Binus, 2008:106).

"Beautility" 1965-1974

In the decade immediately following the end of WWII (1945-1955) BPA's Architectural Unit generally remained consistent with the Moderne-inspired designs that it had developed for building projects during the Master Grid program although, as might be expected, the rapid increase in construction led to a subtle simplification, as control houses become less detailed than they had been. Typical of this later simplified streamline approach is the Redmond Control House, completed in 1952. Technology as well played a role in changing BPA's built environment, as transformer design reduced the need for specialized buildings such as untanking and oil houses. By the mid-1950s the Administration's architecture began to move toward a more angular, almost "International" style approach, typified by the concrete control house built at the McNary Substation in 1954. Transmission systems themselves grew larger, as voltages increased, and the steel latticework transmission towers themselves became taller, within broader right-of-ways that made for a more visually prominent impact on the region.

The rapid expansion of the BPA transmission system during the late 1950s, as lines were developed to serve new generation plants and provide for the wheeling of power, led to a profusion of switchyards, transmission corridors and their associated structures. Improved communication, as the result of the microwave system, reduced the need for larger control houses with permanent personnel while support nodes could be further separated, as better roads and vehicles allowed centrally located support facilities to cover larger areas. As a result many mid- to late-1950s control houses were reduced from the streamlined buildings of the Master Grid period to pre-manufactured steel "vaults," that could be built as a unit and simply installed adjacent to fenced-off outdoor switchyard. BPA, in response to the needs of its rapidly expanding system, BPA designed its first "...panelized, demountable, temporary control houses;" small boxy buildings that were constructed at the Ross shops for quick installation (*Electrical World*, 18-June-1949). These simple buildings were functional and efficient for a fast-growing system, but generally lacked the design and landscaped character of BPA's earlier control houses. While many were located in isolated rural areas, as cities expanded, many substations were brought into regular public view. Industrial in character, they lacked in appearance and certainly reflect a change from BPA's architectural approach to design during its early construction.

By the mid-1960s, with increased national awareness of aesthetics as the result of Lady Bird Johnson's America the Beautiful campaign, BPA took the lead among utilities in seeking ways to make its facilities as attractive as possible, given their admittedly functional design. Administrator Luce hired the Portland-based architectural firm of Stanton, Boles, MaGuire and Church to evaluate all of BPA's existing and proposed facilities and make recommendations for siting, materials, landscaping and other design characteristics that would allow them to be visually appealing and more integrated into their surroundings. As BPA's 1966 Annual Report acknowledged, reflecting the work of Jack McFarland, the primary designer for Stanton, Boles, "…transmission lines are a necessary evil associated with power development and a better life for our people" (*BPA Annual Report*, 1966:IV).

McFarland developed a series of recommendations and studies that would guide the design of most of BPA's construction during the next decade—Beautility. Under the Beautility approach, BPA made landscape improvements to many of its existing substations and undertook a program of modernistic designs for new projects that included most of the work associated with the Intertie, such as the Celilo Converter Station.

> It is expected that the size and novelty of the installation will draw many visitors, both engineers and laymen, to the site. Therefore more than the usual effort was made to obtain a design of building and grounds that would be attractive and imaginative without being extravagant **(**Breuer, Nov 1966).

BPA's structures under the "Beautility" process were designed to be modular and, like much commercial and industrial design during this period, shed most pretense toward ornamentation in favor of creative use of materials, with exposed aggregate panels, aluminum windows, and simple, boxy, forms. As regards transmission lines, new tubular tower designs and more streamlined approaches to switchyard buses are introduced in the late-1960s and 1970s, moving toward unit designs such as those at Grand Coulee, and moving away from the so-called "Lattice work" towers of the Master Grid era. These newer support structures relied upon welded, rather than bolted, members and often include sculptural, near "streamlined" qualities that are clearly differentiated from earlier designs, even as the buildings around them are moving in a near opposite direction.

As a result of the Beautility approach, and the temporally concurrent approach to transmission features, BPA resources from the mid-1960s through the end of the period of significance reflect a cohesive, if not entirely unified, approach toward design that can be loosely placed within Mid-Century Modern. Beautility-era resources within the BPA system stand in stark contrast to the Streamline Moderne characteristics that define BPA's earliest period of construction though their approach to design, workmanship, and use of materials.

Dittmer Control Center 1974

Throughout the 1960s BPA was in the process of design and construction for the Pacific Northwest-Pacific Southwest Intertie, preparing for the completion of the BC Hydro storage projects in Canada and also developing transmission lines to serve multiple new generation facilities to be operated by public and private utilities, the U.S. Army Corps of Engineers, and Bureau of Reclamation. BPA was building new substations and adding considerably to its existing transmission line network so as to integrate all these elements into a manageable entity.[36]

> The Pacific Northwest is now in the midst of the greatest dam building program in the nation's history, and BPA is now in the midst of the greatest transmission line building program in its history…There are now under construction…..13 generation projects including eight Federal hydro projects…" (*BPA Annual Report*, 1965).

In light of this massive buildup, in 1965 BPA announced the last major systematic change to its operations as the result of the expansion resulting from the Canadian Treaty and the Intertie — the centralized control of the entire BPA network by computer. Administrator Luce reported "we foresee the day when the entire Bonneville system, including water releases and switching operations, will be computer controlled" (*BPA Annual Report*, 1965:15). The following year, David Black, who replaced Luce as BPA Administrator, was even more to the point about the increasing need for computerized system control.[37]

> The need for system automation within the next few years will exceed anything now utilized or known in the electric utility industry. Continued manual or semi-automatic operation of [BPA's] rapidly developing transmission grid and hydro generating system has about reached its practical limit, and our problems will be compounded by the Intertie [and] the Canadian Treaty storage projects…*humans simply do not have the ability to receive and digest within tolerable time limits the growing amount of system data necessary*…(*BPA Annual Report*, 1966:VI, emphasis added).

BPA had employed cutting edge automation early on, with its own development of an AC analyzer in 1943. The analyzer was an analog model of the BPA Master Grid in miniature that allowed engineers to simulate load conditions and make changes as needed. BPA's leadership in developing new power planning and management technologies continued during the 1950s. "In 1955 BPA mathematicians, using a digital computer, solved the complex problem of power flow and achieved a breakthrough of international import (*BPA Annual Report*, 1966:4). BPA was able to use that same solution to prove that the Intertie would be feasible from a technical standpoint and continued to increase its reliance on computers for modeling throughout the early 1960s. In the process the Administration established cutting edge practices on the use of computers that were adopted throughout the international utility industry.

The growing scope and complexity of the BPA network along with the Administration's increasing understanding of computer technology led to a goal of a "computer center," a facility that could control the entire BPA system from a single location. First mentioned in the 1965 report, a power blackout in the northeastern United States in 1965 led to strong interest in assuring system reliability at the national level and helped to push the computerized control project forward at BPA. BPA's new computer system was to be housed in a new facility, to be called the Dittmer Control Center after the highly regarded BPA Power

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[36] In 1960, at the inception of the Intertie and Canadian Treaty period, BPA's network consisted of 8028 circuit miles. Ten years later, in 1970 that system had grown over 40% in total extent, to 11,482 miles.

[37] In August 1966 Luce as appointed as Undersecretary of the Department of Interior.

Manager William Dittmer (who served from 1946-1953). Construction was planned at the J.D. Ross Substation in Vancouver, Washington. Dittmer was designed in 1966-1967, following the "Beautility" approach and was featured prominently in BPA's 1967 Annual Report. Rep. Julia Butler Hansen, of Washington, presided over the groundbreaking ceremony on April 3, 1970. The 168,000 square foot building was estimated to cost about $5 million.

> The center will contain central units for BPA's advanced power system control and dispatch…It will house the power dispatching center, a central computer complex, power system control circuits and terminals, a supervisory (remote) control for substations in the Portland area, a substation operators training center, a viewing room for visitors and office space for support activities…more than half the floor space…will be underground to assure continuous operation of the control center by protecting its occupants and equipment against storms, earthquakes, fallout and other hazards (*BPA Annual Report*, 1967:9).

The original estimates of cost and the completion date for Dittmer proved overly optimistic. By the time the stark, somewhat modernistic, building was formally dedicated, it had taken four years longer than anticipated and costs had risen to $20 million dollars. The building itself had come in exactly on-budget, the $5 million estimated in 1967, and had been completed in January 1972, only slightly later than anticipated. However "[t]he project is unusual in that time and money to equip center are much greater than required for the building construction" (*Oregonian*, 20-August-1974, 7:4-8). Over $15 million dollars in equipment, including the computers, microwave towers and other "space-age" components cost three times the amount of the building that housed them. A large dedication ceremony for the Dittmer Control Center was held on August 19, 1974. In December of that year the old BPA control center, located in BPA's Portland headquarters, went offline and all operations where shifted to the new "space age" Dittmer center (Tollefson, 1987:362).

> Dittmer adds a dimension of comprehensive electronic coverage to all facets of overseeing operation of more than 12,000 miles of transmission lines and more than 330 substations of the high-voltage electrical power network of BPA (*Oregonian*, 20-August-1974, 7:4-8).

Coincidentally coupled with the delayed opening of Dittmer, major legislative changes adopted in 1974 made significant changes to the way that BPA operated from a financial standpoint. Since its organization in 1937 with the passage of the Bonneville Project Act, BPA had been required to obtain Congressional approval and funding for any expansion or development project and then was required to repay that debt to the U.S. Treasury through annual payments from the proceeds of its power sales. As was shown during the late 1940s and 1950s, when BPA pleaded with minimal success for increased funding, this arrangement occasionally caused issues for the Administration that delayed its projects as the result of other national financial concerns. To address this issue and improve BPA's ability to operate efficiently, Congress passed the Federal Columbia River Transmission System Act [Public Law 93-454, 16 U.S.C. 838 et seq.] in 1974. The Act modified the Administration's funding mechanism, establishing the Bonneville Power Administration

Fund and, essentially, creating the authority for BPA to become self-financing.[38] BPA would henceforth operate on stronger financial model, and the regional needs of the Pacific Northwest would be less impacted by larger, national, issues or politics than has been the case previously.

With the completion of the Dittmer Control Center, the process of expanded power generation and power distribution systems that BPA had initiated in the late-1950s with the wheeling program and then continued through the 1960s, by first the Canadian Treaty and then the construction of the Pacific Northwest-Pacific Southwest Intertie, was largely complete. Paul Raver's years of imploring Congress for more funding and more generation capacity to meet demand, along with the construction of more efficient ways to distribute it to an ever-expanding region, had been largely achieved by his several successors, particularly by Charles F. Luce. The shift in how BPA financed its system, with the passage of the Federal Columbia River Transmission System Act, marked a significant change in the Administration's operations. Later that year, at least in part to finance its own needs, BPA raised its wholesale power rate by 27.5%, only the third rate hike in the BPA's history. Ross's famed $17.50 "postage stamp" rate, first established in 1938, had stood for twenty-seven years, until 1965.

SUMMARY

Since its inception, the Bonneville Power Administration Transmission System has played a significant role in the development of the Pacific Northwest, enabling the development of the region's industrial base, while supporting economic and population growth through the delivery of plentiful, low-cost, electric power. Born as an "interim" agency that reflected Franklin Roosevelt's belief in the power of the Federal government to provide jobs and transform the Northwest, BPA has grown to become the key element in the regional power grid serving a multi-state service area. BPA is a significant example of the New Deal-era push toward a national program of public power that sought to develop the nation's streams for the benefit of citizens through low-cost, broadly accessible, electricity. The construction of the BPA system in the Pacific Northwest resulted in the ascendancy of public power throughout the state of Washington and supported similar, if more localized, efforts in both Oregon and Idaho throughout the late-1930s and 1940s. The BPA Transmission System continues to support municipal and regional public utilities and cooperatives throughout the Pacific Northwest, but also other transmission users. By its nature and function, the system is dynamic, constantly being upgraded, expanded and changed in response to energy, economic, and other needs.

BPA's Transmission System reflects the Administration's phenomenal growth prior to 1945 as the abundant, and low-cost, hydropower of Bonneville and Grand Coulee dams drew major defense industry to the northwest, building hundreds of ocean-going vessels, refining a major portion of the nation's aluminum, and supporting a wide variety of electro-process metals and chemical products that significantly advanced the U.S. war effort. The timely completion of BPA's 230-kV grid served as the backbone for the region's cutting-edge Northwest Power Pool, increasing efficiency and maximizing power deliveries for residential,

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[38] In 1977 Public Law 95-88, the Department of Energy Organizational Act, shifted BPA from the Department of Interior, where it has resided since its creation, to the newly formed Department of Energy, where it remains (See 42 USC 84, Subchapter III, Section 7152 (a)1(C)).

commercial and industrial users throughout the wartime period. The presence of the BPA system and its plentiful power supply was a direct factor in the siting of the Hanford Nuclear Reservation in south central Washington, resulting in the production of the fissionable materials used for the atomic bombs dropped on Japan to end the war.

With the end of WWII and the completion of its initial Master Grid development, the BPA Transmission System continued to expand during the 1950s at a slower pace, while still adopting and promoting new technologies such as microwave radio transmission to improve power delivery and safety. Despite shifting political support at the national level, BPA's successful wheeling program again solidified the Administration's network as the major power transmission system throughout the Pacific Northwest, while expanding to serve new areas and continuing to encourage industrial development.

By 1960, as the culmination of years of planning, BPA's Canadian storage strategy was finally approved and new construction of both upstream storage reservoirs and increased downstream generation facilities greatly expanded power capacity to keep up with the ever-growing demand of the Northwest. BPA's construction of the world's longest High Voltage Direct Current intertie connected Columbia River Basin power with new markets in Southern California, supporting BPA's commitment to providing low-cost power to consumers and expanding its reach. In 1974, with the dedication of the Dittmer Control Center, BPA succeeded in the implementation of high-efficiency computerized control of its far-flung growing network and, with the passage of the Federal Columbia River Transmission System Act, achieved a new financing method that would change the agency's operation for the future.

The Bonneville Power Administration's Transmission System represents a massive investment of taxpayer capital over a period of more than seventy years, creating one of the largest unified electrical transmission networks in the world, a system that even today accounts for more than 50% of the power distribution in BPA's multi-state service area. Integral to virtually every aspect of economic development in the region, the built resources of the Bonneville Power Administration Transmission System, as constructed and modified between 1938 and 1974 and retaining sufficient elements and integrity as identified in registration requirements of this submittal **are eligible for listing on the National Register of Historic Places under Criterion "A**," for their association with the themes of commerce, engineering, industry, military/defense, and government.

Previous studies have considered portions of the BPA Transmission System to be eligible for listing under Criterion B, significance through association with an individual, primarily for association with John Delmage Ross, BPA's first Administrator, or for Charles Carey, primary designer of the Master Grid. The current examination of the system as a whole under the Multiple Property Submittal considerably reduces the connection of any single resource under Criterion B and, even taken as a whole, supports the view of the view of the BPA Transmission Network as a dynamic, evolutionary system that blurs a significant linkage to any one Administrator or designer in most situations (See below). For the most part, although not exclusively, BPA's built resources are historically significant for what they did, and in most cases continue to do, related to the transmission of electrical energy in the region. While the contributions of Ross and Carey (as well as those of Paul Raver, Charles Luce, and others) are surely intrinsic to the design and function of the network as it exists today, that connection does not appear to rise to the level of Criterion B significance.

The development and construction of the Bonneville Power Administration Transmission System relied upon breakthrough technology and design, much of it created by BPA employees. As a result select aspects of the System, particularly those related to the original development of the 230-kV Master Grid and, during the second Period of Significance, the Pacific Northwest-Pacific Southwest HVDC Intertie construction, have **additional significance under National Register eligibility criterion "C"** as examples of important electrical distribution technology. These aspects are also identified in the registration requirements of this submittal. Some built aspects of the system, including Streamline Moderne designs associated with the Master Grid substations and, later, the Beautility influenced structures of the 1960s, may gain additional significance under Criterion C for their design and architectural qualities. Certain elements of the Bonneville Power Administration Transmission System will, or have been, previously determined eligible for listing on the National Register under Criterion "D," for archaeological information related to history or prehistory. Such eligibility, almost by definition, will be in addition or exist in parallel to the qualities of the resource that may result in significance as defined by this Multiple Property Submittal.

The built resources of the Bonneville Power Administration Transmission System should, therefore, primarily be considered, and evaluated, for potential significance under National Register eligibility criterion "A" for their association with the design, construction, and operation of the BPA Transmission System in the Pacific Northwest during the period 1938 to 1974, as detailed here. Some properties, subject to the specific registration requirements of Section 7, may additionally gain significance under Criterion "C" for either their architectural design or, in the case of structures, their association with key technologies in the area of electrical transmission.

F. Associated Property Types

The BPA Transmission System is comprised of hundreds, if not thousands, of individually identified elements depending on how some resource types are defined. Though concentrated in four states (Oregon, Washington, Idaho and Montana), the system extends into portions of four others (California, Nevada, Wyoming and Utah). While the primary function of the network is the efficient transmission of electrical energy from point of generation to point of use, parallel control, management, and maintenance systems including a widely dispersed microwave/radio network, are essential to the operation and administrative processes necessary for the transmission of electricity to occur. Largely consisting of *inter-connected* transmission corridors that lead to and from more traditional "built" resources such as substations and building complexes, the BPA System for the most part functions as a single entity, greatly exceeding the individual significance of its many related parts. As noted by Holstine and Lenz in their earlier effort to document the significance of a portion of the BPA system, the Master Grid;

> Although the components of the [system] may lack individual distinction, together the substations and transmission lines represent a distinguishable entity of considerable technological and historical significance" (Holstein and Lenz, 1987).

Acknowledgement of the inter-relationship of the multiple components of the BPA Transmission System as a single, recognizable, entity is key to understanding and evaluating the system's historic significance. Beginning from its original development and design in the late-1930s, the flexibility and connectedness of the Master Grid formed the backbone for the delivery of Bonneville and Grand Coulee hydropower to the region, enabling rural electrification and the growth of public power systems, supporting a massive WWII-era defense industry and, through its connection to the Hanford Works, playing a key role in the nation's atomic development. The individual lines and substations of the BPA System, including all their various component parts, that were built during the first Period of Significance (1938-1945) worked, and continue to work, as a coordinated entity that is most accurately treated collectively and which are, collectively, significant under the evaluation criteria of the National Register of Historic Places. Resource types enumerated here reflect that significance under Criterion A through their design and continued function. Subject to the specific type registration requirements, such resources should be considered "eligible" and qualify for listing under this submittal.

Development of the BPA Transmission System after WWII, during the second Period of Significance (1946-1974), reflects the Pacific Northwest's postwar growth and the economic shift from a rushed, defense-oriented, development pattern into one that had broader, and longer-term, goals that included accommodating population growth and the development of a new industrial base. Building upon the Northwest Power Pool developed during the war with the adoption of a wheeling function, the BPA Transmission System during this period solidified its pre-eminence as the primary backbone of the regional power grid, expanding circuit miles and associated infrastructure to reach an ever larger service area while efficiently transmitting increased capacity from an expanding system of Federal hydroelectric projects in the

Columbia Basin. National policies, including the negotiation of the Canadian Treaty and the development of the HVDC Intertie, further expanded BPA's reach and central role in the transmission of electricity throughout the region while BPA's technological development of its extensive microware/radio network, the Celilo Converter Station and Dittmer Control Center reflect its leadership in transmission technology worldwide. BPA's resources built between 1946 and 1974 reflect significance through their continued original function and minor modifications to these resources do not substantially diminish their integrity or ability to relate the associations for which they are significant under Criterion "A." Such resources contribute to the integrity of the BPA Transmission System and so, subject to the resource-specific registration requirements, are considered "eligible" under this submittal.

Today, the array of resources within the BPA Transmission System as documented in the following identified built Resource Types, remain integral elements in the history and function of the Bonneville Power Administration's electrical transmission system. The evaluation of resources within the BPA Transmission System, especially with regard to evaluation and consideration of integrity, requires recognition of their inherent function and therefore should be undertaken with an understanding of the essential Criterion A associations that make the system *as a whole* significant. Nothing in this document is intended to restrict BPA's continued management and maintenance of its system to assure the efficient transmission of electricity and related functions. Changes in either materials or design that do not substantially alter the overall character of the resource but rather allow its dynamic, continued function within the system should not generally be seen as adversely impacting historic character. Specific guidance on the registration of each associated resource type within the network is provided and should be used to guide evaluations of integrity for resources under this context. Resource types that are not included in this section, including road systems, below-ground infrastructure, and similar systems are, by definition, not considered eligible for listing under these registration requirements.

In a functional sense, the BPA Transmission System is a largely unified, singular, entity. Although incredibly widespread, over portions of eight states, it can also be seen, from a certain point of view, as being geographically coherent; its component elements connected via narrow rights-of-way containing thousands of miles of transmission line that ultimately connect all BPA resources in a more or less direct sense into a single "district." Previous efforts at documenting a smaller, temporally limited, portion of the BPA system, the Master Grid as built prior to 1945, considered the Master Grid to be a "discontiguous historic district." In that smaller document (the 230kV Master Grid exists entirely in Oregon and Washington, primarily in the "loop" system that connected Grand Coulee and Bonneville dams with the three major population centers of Portland, Spokane and Seattle) the discontinuity largely related to evaluatory decisions based on a high degree of Criterion C based design integrity, a process that eliminated multiple lines and built resources from being considered contributing. Even in such cases, however, each resource whatever its evaluation, remained an integral element in the Master Grid from an operational standpoint and, as such, supports a Criterion A evaluation. That later approach is adopted here, recognizing that the primary significance of the Bonneville Power Administration Transmission System, including all its component parts, rests more in what its construction and operation meant for the Pacific Northwest and the nation, than in the design of the individual elements. Provided they meet the minimum eligibility requirements and retain sufficient integrity to relate their original role in the system as a whole as described below, the built resources of the system identified in this document should be considered eligible for listing under this submittal.

As defined here, the built resources within the BPA Transmission System constructed between 1938 and 1974 are significant under Criterion A for their association with the broad themes of this submittal. The specific elements and integrity aspects for individual property types within the BPA system are identified in the requirements for their registration within the framework below. Within the variety of resource types that exist within the BPA Transmission System and, in many cases, the wide variety of internal variation and character within each type over the dual periods of significance, the following requirements are separated out by basic resource type (i.e., "Transmission Lines," "Substations," etc.) and are individually presented to reflect the particular registration and integrity concerns attendant with the evaluation of each system element. As a result the following sections, while covering the same basic concepts for each resource type, do not do so in an entirely uniform manner but reflect the individual, idiosyncratic, nature of each associated resource type.

As also noted within the specific registration requirements by type, some specific BPA resources may additionally have significance under Criterion C. These resources may be significant for their ability to relate design or technological aspects of BPA's history, or of the history of electrical transmission, or for a combination of those two factors. Resources that are additionally significant under Criterion C, for how they are or were designed, are subject to a more detailed registration standards as defined by resource type in each of the subsections below

Documentation of resources under this Multiple Property approach may include a variety of resource types, including buildings, structures, and sites. Individual resource documentation, subject to the nature of the subject (where a 300-mile long transmission line comprised of hundreds of elements strung along a right-of-way is to be treated as "one" resource) will likely account for the majority of submittals under this MPD framework. There will be situations, however, particularly as applies to substations, where a "district" approach of related and geographically contained resources represents a more efficient submittal method. Either approach is appropriate and consistent with the MPD framework.

Although, as documented here, the BPA Transmission System 1938-1974 includes numerous resources that are considered potentially eligible for listing on the National Register as described, the evaluation of individual built resources for eligibility will be accomplished on a case-by-case basis, guided by the requirements of this section. Where a particular element of the BPA Transmission System meets both the minimum eligibility requirements and the integrity considerations associated with that resource type, it is considered eligible for listing. Resources that do not meet the minimum requirements or due to change over time fail to meet the integrity considerations, will be found not eligible for listing. As noted, resources types that are excluded from this section are, by definition, not considered eligible under this Multiple Property framework. Maintenance and repair activities undertaken by BPA that do not alter or diminish historic character, do not impact historic integrity. A separate programmatic agreement to address BPA's maintenance of the transmission system will include a list of excluded maintenance activities.[1]

CLASSIFICATION:
Resources meeting the registration requirements may be nominated under this MPD under any of the permitted resource "types" eligible for listing on the National Register of Historic Places. Specifically, eligible resources may be nominated as;

- BUILDING: Individual buildings may be nominated as such
- DISTRICT: Coherent "groups" or assemblages of related buildings and structures, as might be found at a Substation, may be nominated as a district, including "contributing" and "non-contributing" resources of multiple types as defined in this section.
- SITE: Individual resources (or sites within a district) may be nominated when significantly associated with BPA activity during the Period of Significance. Such sites might include construction camps or testing facilities associated with technological development.
- STRUCTURE: Individual structures (or structures within a district) may be nominated under this submittal.
- OBJECT: Although no objects, as such, have been identified related to BPA's development, where such are identified and otherwise meet the minimum eligibility requirements of this Section, and demonstrate significant association with the development of BPA Transmission System, such objects may qualify for listing under this submittal. Such objects might include early construction vehicles exhibiting significant modification related to transmission line development or transportation systems modified by BPA for its operation or maintenance activities.

Resource types not addressed in this section, including roads, sidewalks, and other minor "built" elements are, by definition, not eligible for individual listing under this Multiple Property Submittal.

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[1] Although still in development, typical activities to be covered by the Programmatic Agreement include replacement of electrical equipment due to PCB leaks, in-kind replacement/upgrade of interior equipment, replacement of tower footings, insulators, grounding systems, spacers, dampeners, guy wires, conductor replacements, in-kind repair of damaged tower elements and similar work.

1. Transmission Line [T-Line]:[2]

Discussion and General Description:

The primary element of the BPA system, Transmission Lines (T-Lines) exist in three major variations (steel pole, wood pole, and HVDC lines, also of steel construction), each of which carries electrical power from point-to-point. T-Lines generally exist within extensive corridors that may contain multiple individual lines running parallel to each other. Many of BPA's transmission corridors exist upon right-of-way easements that run through multiple parcels of land, including both privately-owned lands and land owned by other Federal agencies, not BPA itself. Within the BPA system T-Lines are generally identified by a "name" that is formed by their starting and ending point (typically a generation point or a substation). Thus, the "Kelso-Chehalis" line runs between those two substations in Washington State while the "Chehalis-Raymond" line also terminates at Chehalis with its other terminus at Raymond.[3] Where two lines run between the same two points, as in Bonneville-Vancouver, they are differentiated by number, for example, as in Bonneville-Vancouver No. 1 and No. 2.

T-lines are further differentiated by the voltage that they carry, be it 115-kV, 230-kV, 345-kV, 500-kV or, in the case of the Intertie, High Voltage Direct Current. While typically considered and managed as discrete features, in a larger sense transmission lines, which can be operated bi-directionally in terms of energy flow, are interconnected by design, blurring their individual aspect. Within the BPA Transmission System as defined here, it is probably more accurate to consider individually named transmission lines (i.e. Bonneville-Vancouver No. 1) as *segments* within the overall system rather than as entirely independent entities, although from a management and documentation standpoint lines are, and will continue, to be treated as distinct entities. Obviously it must be stated that no transmission line, shed of its connectivity to the system and isolated as a truly individual feature, would function.

Documentation of any transmission line or segment of the BPA network, acknowledges that such a line is made of multiple component parts that collectively form the "named" line. These elements include the towers or poles, each of which is individually identified and cataloged within the BPA system for management purposes, the actual transmission cable or conductor itself, as well as the insulators and mounting equipment that connect the conductor to the towers that carry it. Each circuit within a line has multiple cables or conductors, typically three, each with its own insulators and related mounting equipment,

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[2] T-Lines are high voltage delivery systems while the majority of lower-voltage lines located within cities and town are termed "Distribution Lines." It is these later lines that typically line city streets, whereas T-Lines typically span far longer distances from the point of generation to the both of use. The BPA network does not, in general, include "distribution lines," as BPA sales are limited to wholesale or heavy-industrial users only.

[3] Transmission lines are generally bi-directional in terms of how energy flows so the use of terms such as "starting point" or "endpoint" are not entirely accurate. Even the word "terminus," implying its opposite as an "origin" point is somewhat problematic.

further complicating the individual nature of any given, named, "line" within the system. And finally all of these elements, stretching over tens or even hundreds of miles, exist within a linear T-line corridor, a cleared route that both reduces potential hazard along the T-Line through isolation from adjacent uses and provides access for maintenance and repair by BPA personnel. From a built resources standpoint, for the purposes of this submittal, the gates, access roads and similar transportation infrastructure that provides access from the public road system to a T-Line corridor is not considered to be a part of the named line.[4]

Individual segments of the BPA Transmission System are referred to here as "Named Lines," meaning that they are indentified within the BPA system by a specific name following the preceding naming conventions (i.e. "Kelso-Chehalis"), and, by definition, incorporate all of the multiple elements from which they are formed. For the purposes of this document, a "transmission line" is considered to be a unified segment of the BPA Transmission System that is treated as a discrete property. Any named transmission line, by definition, includes all of its component parts; cable(s), mounting hardware, insulators, towers (or poles), and the corridor in which they exist.

Range/Variation:

As the primary electrical transmission system in the Pacific Northwest, responsible for the delivery of the entire output of the Federal Columbia River Power System, and more than 50% of the total generation capacity of the region, not to mention it's major role in wheeling power for other utilities, the Bonneville Power Administration Transmission System occurs in virtually all portions of BPA's primary four state service area, with specific concentrations in the Columbia and Snake river basins. Transmission lines stretch from the Canadian border, in northern Washington, to southern Oregon, and run east and west from western Montana to the Pacific Ocean. The BPA system includes more than 15,000 circuit miles of transmission line, more than 12,000 miles of which were completed during the period of significance (BPA, 1974). Other sections of transmission line, some contiguous with the main network and some not, occur in portions of California, Nevada, Wyoming and Utah.[5]

Variation, as it is concerns BPA's transmission lines, largely relates to tower design and voltage, with the design/engineering responses that result from the technical requirements associated with the transmission of different voltages. These variations are generally reflected in tower height, spacing of towers both in linear fashion (dependent upon conductor types and topography) and laterally, when multiple lines occur within a single corridor. In terms of visual impact, the most obvious variation is limited to tower materials, metal or wood, and tower proximity to adjacent lines.

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[4] Many access roads provide access to multiple lines, reducing their association with any single feature.

[5] Non-contiguous lines owned by BPA are nevertheless still connected to the BPA Transmission System via interconnection with other, non-BPA, lines operated by a separate public or investor-owned utility.

Character Defining Elements:
Named lines within the BPA Transmission System contain the following character-defining elements:

- Towers: Steel lattice, steel pole, wood pole, and various permutations thereof. Towers are generally of galvanized, zinc-plated, metal, anchored by plate, grillage, and rock footings, occasionally rising from poured concrete footings, with bolted legs. The majority of the lines consist of tangent suspension structures and dead ends are used at angle points, long crossings, terminal spans (last span into substation), etc. Towers are additionally configured as horizontal delta, vertical with single and double circuit designs, and lattice pole, with varied conductor supports, depending upon voltage and use
- Setting (corridor character): The character of the corridor and relationship of the line to the landscape, topography, adjacent transportation corridors, and surrounding uses.
- Conductor mounting and insulators: The materials, quantity, and visual character of the conductor, insulators.
- Identifying markers: Standardized BPA signage located on the tower leg identifies a named line using four-letter capitalized abbreviations of its name (i.e., KELS-CHEL, SANT-CHEM, etc.) along with line number, mile and tower number. These metal signs identify the line as BPA, and are approximately 5″ x 7″, mounted in vertical orientation, with black lettering on a yellow/orange background.

Minimum Eligibility Requirements:
In order for a named segment or individual line to be eligible, it must, at minimum, meet all of the following standards:

- Designed by or purchased at the direction of the Bonneville Power Administration,
- Owned and operated all or in part by the Bonneville Power Administration,
- Energization prior to 1975,[6]
- Continued original function (i.e. related to the transmission of electricity).

Specific Integrity Issues:
Resources eligible under this type (Transmission Lines) must, in addition to the minimum requirements, meet the following specific integrity issues:

A. LOCATION/SETTING:

- The named line must connect the same endpoints (i.e. Kelso and Chehalis) within the BPA System as originally intended. Lines that have been interrupted by the

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[6] Energization correlates with BPA's "in-service" date.

construction of an intermediate substation or generation feature (and thus have been re-designated) but remained as an integral part of the BPA network prior to 1975, retain integrity of location.

- The named line must remain substantially within the original construction corridor, as it existed at the end of the period of significance.
- Minor realignments that retain the same endpoints, whether to reduce length, straighten curves, or avoid newly installed obstacles within the corridor do not seriously diminish integrity. Realignments are generally considered "minor" when the overall impact amounts to less than 10% of the total named-line distance between endpoints (i.e. a realignment of less than 10 miles total length within a named line with an overall distance of 100 miles is generally considered minor and so does not impact integrity. It is acknowledged that in some highly visible locations, such as at river crossings or proximate to major public right-of-ways or structures, even minor realignments can affect character. Cumulative changes to a named line over time may result in loss of integrity, depending on the nature and location of the realignment. Generally cumulative changes that result in the relocation of more than 20% of the total line length will generally result in diminished integrity, dependent upon the nature of the changes.
- Many lines, as originally constructed, traversed open land, mountains, or rural areas that have now become more developed and impacted original setting. Where the corridor/line remains as originally located, changes in surrounding uses do not impact integrity.

B. DESIGN/MATERIALS/WORKMANSHIP:

- The named line must substantially retain its original design character. Changes made to continue or improve the essential original function, the efficient transmission of energy, are part of this functionality and may acquire significance in their own right. Such changes do not normally constitute a loss of integrity of design.
- Tower design must remain as built, in basic type and material (i.e. Lattice/pole, steel/wood), and general design (i.e. H-poles, suspension towers, etc.). Minor modifications in design do not adversely impact integrity (as in changes in steel latticework tower patterns through the addition of horizontal or vertical elements for structural reinforcement). Entire replacement of one type of tower (steel latticework) for another (steel mono pole) diminishes integrity and reduces or entirely eliminates eligibility depending upon visual impact and the percentage of the whole that is effected (i.e. replacing one or several latticework towers within the entire length of a named-line, particularly when such changes are distant from public vantage points, diminishes integrity but should not eliminate eligibility. Replacing a major percentage of the line with a different pole design or material so adversely impacts character as to make the line not eligible.

- Transmission voltage modifications (i.e. conversion of 230-kV line to 345-kV) do not seriously impact integrity provided other general design characteristics do not change substantially.
- Minor additive features (bird control, spark arrestors, added fiber cable systems for communication, identification and security), designed with a general respect to historic character through use of compatible materials, scale, and sensitive installation, do not adversely impact integrity. This is particularly true when such minor work is done in a uniform and repetitive manner that impacts the entire named line equally.
- Normal, *in-kind*, repair work, such as the replacement of footings, replacement of conductors, insulators, spacers, guy wires, cross-arms etc. is considered normal maintenance that is part of functionality and does not affect integrity.

C. FEELING:

Defined as "…the quality that a historic property has in evoking the aesthetic or historic sense of a past period of time…" (NR Bulletin 16A) feeling, as pertains to transmission lines, involves the ability of the named line to evoke its original construction, but more importantly to retain and convey its character as an element in the larger BPA Transmission System.

- Named lines retain feeling through *uniformity*, supported by largely repetitive elements (towers and attachments) set within a defined corridor that is identifiable as a separate built or constructed feature within the landscape. Views of multiple component elements (i.e. a repetitive corridor of uniform towers connected by a series of conductors or cable lines) visible over a considerable linear distance, particularly from public right-of-way, supports the integrity of feeling.
- Visible uniformity that surmounts landscape elements, as in corridors that rise over a hillside or are visible for great distance parallel to a public roadway, ridge or traversing a valley, convey the feeling of scale and connectedness that supports association within the BPA system.
- Multiple lines within a defined corridor, even where such lines include non-BPA features or lines that are not, in fact, historic, combine to support historic feeling and system connectedness through repetition and visual complexity.

D. ASSOCIATION:

- By definition, any transmission line meeting the eligibility requirements above, that is still owned and operated by BPA, and that remains an integral and functioning part of the Bonneville Power Administration Transmission System, retains high integrity to the associations which make it significant under this context.
- Lines otherwise meeting these requirements *that are no longer part of the BPA System*, through sale or other transfer <u>may</u> be eligible for listing on the National Register but do

not meet the minimum requirements of this Submittal and so must be evaluated independently.

- Normal, *in kind* repair, and maintenance, and upgrades of transmission lines still owned and operated by BPA that are part of functionality do not necessarily affect integrity of the associations.

E. CRITERION C STANDARDS-Transmission lines:

Some transmission lines may gain additional significance under Criterion "C" for their specific design characteristics or, more typically, their association with particular technological improvements related to the transmission of electrical energy during the period(s) of significance. Examples may include highly intact segments of the Master Grid or the HVDC Intertie. Such resources, in addition to meeting the requirements above, must additionally demonstrate at the following qualities:

- Exemplar or early instance of a particular significant technology or construction method. Examples might include the first use of a new transmission tower design, use of a new or improved grounding system, a high-voltage line (345 kV or above) or other significant improvement related to the transmission process.
- A typical line type, particularly within the original 230 kV Master Grid, may merit Criterion C significance through retention of a HIGH level of integrity that relates a typical BPA technology (i.e., minimal subsequent changes do not alter or improve upon the historically significant aspects of the technology, retaining a majority of visual and technical consistency with the original design).

2. Substation:

Discussion and General Description:
Substations are built resource centers within the BPA Transmission system that typically serve as the start and end-point of named transmission lines. Functionally, the primary purpose of most substations is to modulate line voltage, stepping it up or down, depending upon the need, and, in some cases, feeding distribution lines that connect to consumers (in BPA's case, other utilities or large industrial users). All substations include switching mechanisms or circuit breakers that allow line segments to be energized or switched off for maintenance or, automatically, as the result of a fault. Substations are typically arrayed around a switchyard, a steel superstructure and buss-construct framing a series of large metal box-like transformers at ground level. Each named line (or circuit) consists of multiple conductors that arrive at the site as one transmission line "terminates" and another begins. Bushings, capacitors, and other electrical equipment are installed within the switchyard to modulate or control power flow. "At first glance a substation is a bewildering array of hulking steel machines whose function is far from obvious…If you look closer you will find there is a logic to this mélange of equipment" (Hayes, 2005:248).

Beyond their primary electrical role within the BPA Transmission System "substations" often house additional functions that include a wide array of specialized buildings. These facilities can often occur in tandem with Regional or District administrative and maintenance uses, requiring additional specialized structures. Some substations have been expanded to serve other, specific, uses, such as the Big Eddy Testing Center related to the development of the Intertie.

Substation design, for those constructed during the original period of significance and associated with the development of the Master Grid, have built resources that follow the modest "streamlined moderne" style of that era. Typical building designs are of stucco exteriors over wood or masonry frames, with glass block, portal windows, and similar detailing, all built from plans developed by BPA. As might be expected in such a widespread system, variations and use of other material such as brick, are also present.

For later construction, built after 1945 during the second period of significance, substations vary over a broad range of design and materials, including modest, utilitarian and standardized or manufactured structures of metal and concrete during the early 1950s, evolving into more modern, site-built, designs of multiple materials that reflect the Administration's adoption of the Beautility principles discussed in Section E of this document. While some resources built during the earlier portion of this period were still designed by BPA, later structures were done under contract, and so reflect a greater variation of design and aesthetic than that of BPA's earlier development.

Both during and subsequent to the Periods of Significance, many "substations" have become larger nodes of operation beyond their primary transmission function, providing a variety of control and support services that enable the management of the far-flung, multi-state, BPA system in an efficient manner. As a result of their multiple functions, multiple eras of construction, and varied modification to reflect changes over time, "Substations" within the BPA Transmission System may include a wide variety of individual or related built resources at any given site. Portions of some substations, many in continuous usage since the original construction of the Master Grid, have been expanded, modified, altered, or even partially abandoned or demolished, with activity occurring both within and beyond the period of significance. Where modifications or alterations do not detract from overall integrity, such resources should be considered "Historic" and potentially contributing under this framework. Resources built after 1974 do not, by definition, meet the requirements of this submittal and should be considered "Non-Historic" under its requirements.

Given the variety of substation design, particularly those that include multiple resources built in varying designs that reflect one or both periods of significance, it may be most appropriate to document a given BPA Substation as an eligible "district" including the entire property boundary and treating each of the discrete built resources within it as either historic contributing or not. In other cases, discrete features of a specific substation, a particular building for example, may best be documented under this context as an individual historic resource. This latter situation will be especially true for individual substation elements determined to have significance under Criterion C, for design or technological association.

Range/Variation
Substations are located throughout the BPA Transmission System, integrated with the transmission line network as required by their function. At this writing, BPA owns and operates more than 400 substations, more than 250 of which were constructed during the periods of significance.

Substations, as a collective term, includes a wide variety of facilities that range from a simple switchyard with a small manufactured control house all the way to a large, multiple structure installations that serve multiple lines in association with maintenance and administration uses spread over dozens, if not hundreds, of acres.

Minimum Eligibility Requirements:
In order for a substation or any "individual" built resource within a substation to be eligible under this Submittal, it must, at minimum, meet all of the following standards:

- Designed by or purchased at the direction of the Bonneville Power Administration,
- Owned and operated all or in part by the Bonneville Power Administration during some portion of the period of significance,[7]

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[7] Resources built and designed by BPA but previously transferred from BPA ownership or management by the Administration may still be eligible for listing on the National Register but are outside the registration requirements of this submittal. Prior to the sale or transfer any current BPA resources should be evaluated for eligibility under this submittal as part of the Section 106 process.

- Energization prior to 1975.
- Continued original function (i.e. related to the transmission of electricity).

Character Defining Elements and Specific Integrity Issues:
The variation of substation character within the periods of significance, limits any universal categorization of "standard" design elements for this resource type. Instead, the following functions and associated built resources may be found at any given BPA substation. It should be stressed that not every substation location will have examples of each of the following resource types.

2.1 Switchyard
Switchyards are, in general, the "works" of the substation, characterized by a vertical superstructure of steel, typically latticework, from which conductor, insulators and other electrical equipment connect incoming and outgoing transmission lines to a series of grade-mounted transformers, circuit breakers, switches and other equipment. From a design standpoint, the superstructure, often painted, especially in the second period of significance (i.e. after 1945), tends to be the most dominant visual element although both earlier and later installations with "box-like" latticework superstructures are equally character-defining. Post-1960s switchyards are characterized by steel frame superstructures, often of welded, cut, plate steel, that stand in stark contrast to earlier multi-element latticework designs. Grade-mounted equipment, including transformers, breakers, bushings, shunt reactors and others, from a design standpoint, form a heterogeneous, repetitive and complex array of elements that lack individual distinction for all but the most knowledgeable of observers.

Integrity Considerations:

A. LOCATION/SETTING:

- The switchyard should remain on its original location, as designed and initially developed by the Bonneville Power Administration. Switchyards developed by others that were acquired by BPA and integrated into the network <u>during the Period(s) of Significance</u> meet this standard.

B. DESIGN/MATERIALS/WORKMANSHIP

- Overall character is defined by a complex arrangement of individual elements that function collectively as a part of the system.
- Use of steel, painted or galvanized, in composite forms to create larger structures.
- Modification, upgrade, replacement or abandonment of individual grade- or buss-mounted equipment to maintain service or upgrade efficiency, when accomplished within the general complex, repetitive, character of the basic type does <u>not</u> adversely impact integrity. Use of generally compatible and historically consistent treatments (paints, coatings, etc.) is a key element in maintaining integrity. Generally in-kind, compatible, replacements of minor built elements such as insulators, cross-arm repairs,

ground wires, guy wires, and similar features is considered part of functionality and appropriate maintenance and does not generally adversely affect integrity. The use of bright or colors that contrast sharply with the surroundings colors, except as required by safety standards, adversely impacts integrity.

- Reductions in scope or removal of equipment, as the result of changing use patterns, do not adversely affect character providing more than 50% of the original scope of the facility survives.

C. FEELING

- Integrity is retained by complexity, uniformity, and repetition of discrete elements that collectively form the whole.

D. ASSOCIATION

- By definition, switchyards retain integrity of association by continuing their essential original function within the BPA Transmission System.

E. CRITERION C STANDARDS-Switchyard

- Switchyards associated with technological improvements in transmission practice, employing new elements or design characteristics may be significant for that association provided they retain high integrity to the pertinent aspect of their design.
- Switchyards designed or redesigned under the Beautility concepts that exemplify that practice within BPA history may be significant for that association.
- Generally in-kind, compatible, replacements of minor built elements such as insulators, cross-arm repairs, ground wires, guy wires, and similar features is considered part of functionality and appropriate maintenance and does not generally adversely affect integrity.

2.2 Control House

At each substation a control house contains operational and monitoring equipment related to the facility. Early control houses built in association with the Master Grid were occupied by station operators and served as the primary “office” space at the facility. Such facilities appear, essentially, as small independent office structures, many with streamlined architecture typical of BPA’s late-1930s-1940s era. Later control houses built during the second period of significance occur in two major variants. Control Houses at larger substations, such as that at McNary, are of similar scale to the Master Grid period, but may reflect different design trends that were consistent with their later construction period. Other control houses, particularly those built as the BPA System moved toward a more centralized operational system aided by microwave and radio, are small boxy volumes of less than 200 square feet. These smaller control houses include pre-

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manufactured steel and glass units as well as site-built frame, concrete, and concrete block units. As working elements of a complex highly-organized technological system, Control Houses are typically subject to modifications over time, related to equipment upgrade or personnel changes.

Range/Variation
Control Houses in some form exist at virtually all BPA substations and as such are located throughout the BPA Transmission System. Facilities range from large office complexes built of masonry to small manufactured steel and glass boxes. Early period (i.e. 1955 and earlier) control houses in many cases have a distinct architectural character that reflects the BPA aesthetic as existed during the Master Grid period, with streamlined moderne detailing such as glass block or ocular windows, mill-finish aluminum doors and window sash, rounded corners, recessed entries with projecting canopies and incised or applied Deco-style signage that identifies the facility. Typical of this period are Control Houses at Eugene, Ross, and Covington. Later period control houses range from a continuation of the Master Grid aesthetic (as at Redmond), mid-50s-era architecture (as at McNary Substation), the Beautility-inspired John Day Substation or small manufactured control houses such as that the Foster Creek Substation.

Integrity Considerations:

A. LOCATION/SETTING

- Control Houses are located at substations through the BPA System and were constructed during both periods of significance. Many are prominently sited within the substation to create the public "face" of the project, facing a right-of-way and offset within a lawn or other landscaped grounds. Integrity of location and setting is retained when Control Houses retain their original site and relationships, particularly when viewed from the public right-of-way.

B. DESIGN/MATERIALS/WORKMANSHIP

- Control Houses should retain *substantial* EXTERIOR integrity in design and building materials. Changes to discrete elements over time can be recognized as significant in their own right when occurring prior to the end of the period of significance. Overall, integrity is present when the predominate character retains original design and materials in sufficient proportion to convey the design as built. Essential volumes and shapes should remain visible (i.e. roof form, rectangular plan, etc.).
- Control Houses include stucco, brick, metal and concrete exterior walls, with some small examples of wood-siding. Roofing, originally tar (BUR) or asphalt shingle has in certain situations been replaced with modern membrane materials as well as metal sheet and pre-painted standing seam. Such changes and repairs to roofing and siding, particularly when done with some attention to consistent visual character, do not seriously impact overall integrity. Roof FORM and building form are considered more

character-defining than materials, however the use of compatible materials and treatments based upon historical character clearly support integrity to high degree.

- Larger Control Houses of all periods typically include prominent entrances, with re-lites, elaborate door treatments, and projecting stucco or metal details including canopies and door surrounds. Banked windows form a dominant exterior element in many examples. Many locations include façade-applied individual lettering identifying the facility as an element in the Columbia River Power System or, for later examples, BPA. All such elements reinforce significance through association with the BPA system and may, in some cases, gain additional Criterion C significance through design.
- Character of the primary entry façade, especially when facing a public right-of-way is a key element in maintaining integrity with more flexibility toward modifications to non-publicly visible side and rear elevations.
- Exterior additions to Control Houses during the periods of significance reflect the normal passage of time and expansion of the system. Additions that meet the Secretary of the Interior's Standards for Rehabilitation and that do not encumber or alter primary elevations and are built of generally compatible materials and scale, do not adversely impact integrity or significance.
- Materials should, for the most part, remain consistent with original design. Wall surfaces, window scale, material and muntin pattern, applied trim, and other detailing should largely remain as-built. Past modifications, particularly during the period of significance, to discrete or individual examples of a feature (i.e., the removal and infill of one or several window openings when multiple other examples remain) do not seriously impact integrity.
- Interior elements of the Control House, especially non-public "back of house" operations areas, are generally not a consideration in the evaluation of integrity under Criterion A. While not an eligibility determinate, good practice dictates that original material should be conserved and retained where ever possible. This is especially true of public, or formerly public, areas such as the building lobby or reception area, when such are present. Changes to the operations/equipment areas of control houses, where practical, should retain original material but technological upgrade related to operational efficiency does not reduce integrity under Criterion A.

C. FEELING:

- Integrity is retained by the continued presence of the Control House within the complex nature of the Substation as a whole. Examples gain integrity when they retain their original visual role within the Substation. Control Houses often serve as public focal point, documenting their key role in the operation of the facility as a component of the BPA system. [8]

D. ASSOCIATION

- Control Houses retain integrity of association by continuing their function and visual relationship to the Substation within the BPA Transmission System.

E. CRITERION C STANDARDS-Control House

The façade of Control Houses are often the most publicly visible element of the substation, may exhibit significant architectural characteristics under Criterion C that compliment their functional role and association within the BPA Transmission System. Individual properties that may be significant under Criterion C, for their design and construction, will meet the following standards:

- Structures that are especially exemplary of BPA standardized design, retaining high integrity in use of materials. This is especially true for period-typical elements associated with either the initial Master Grid development period (i.e. Streamlined Moderne details such as glass block windows, multi-light industrial windows, portal windows, stucco exterior surface with rounded corners, period signage, etc.) or for the later, Beautility period (i.e. use of applied metal, "panel" construction, decorative friezes, etc.)
- Some examples may gain design significance as exemplars of BPA siting, through retention of landscape grounds that reflect the "public" aspect of the original design.
- Examples of BPA's post-1949 standardized "vault" control houses must retain exceptionally high integrity to meet Criterion C requirements.
- Additions and modifications either during or after the periods of significance do not inherently eliminate Criterion C significance provided they are accomplished in a *highly* compatible fashion. Additions to rear and side (secondary) elevations that retain the primacy of the main entry character meet this standard. Additions that obscure the primary elevation, by definition, do not.
- Uniquely designed properties, either through experimental design or, through attrition, that represent rare examples of once typical elements of the BPA Transmission Network will meet the Criterion C standard if they retain essential integrity.

2.3 Untanking Tower:

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[8] Control Houses are often a secondary focal point for those substations built during the first Period of Significance that had or retain an Untanking Tower.

Untanking towers are narrow vertical volumes related to transformer maintenance functions in connection with substations built during the first period of significance. "The enormous size of the equipment being serviced necessitated the extreme height typical of this property type…the style is manifested through symmetrical facades; flat roofs; plain wall surfaces; and fenestration that includes enormous, symmetrical banks of multi-light, steel-sash windows and giant, overhead, steel doors" (Curran, 1998:99).

Range/Variation
Previous studies have documented that there were six Untanking Towers built at various substations of the Bonneville Power Administration between 1939 and 1945. All are of concrete construction.

Integrity Considerations:

A. LOCATION/SETTING:
- Untanking Towers only exist at substations developed during the first, Master Grid, period of significance. They remain prominent elements and reinforce the building specific nature of the first period of significance.

B. DESIGN/MATERIALS/WORKMANSHIP
- Tall, vertical, volumes reflect the original purpose, which is additionally supported by grade-embedded steel rails that lead to the large doors and the building interior, documenting the scale and difficultly of moving large transformers and other equipment from the Switchyard to the Untanking Tower.
- Untanking Towers are of concrete frame, with stucco coat, and gain significant design integrity through the maintenance of exterior surfaces, window and door treatments, and applied details that compliment the associated Control House and reinforce the complex nature of the substation.
- Changes in use that have converted Untanking Towers to other purposes, particularly general maintenance or storage, do not serious effect integrity provided the original design character remains.

C. FEELING
- Untanking Towers retain integrity of feeling through retention of materials, the characteristic vertical volume, and continued importance as visual elements within the substation complex.
- Integrity is supported by a landscaped buffer around the building's façade, particularly the primary entryway.

D. ASSOCIATION

- Untanking Towers use a specific building form that spatially documents the scale of the BPA network and well as the technological improvements in electrical transmission that eliminated their initial purpose. Any surviving untanking tower, by definition, has a strong association to the first period of significance of the BPA Transmission System.

E. CRITERION C STANDARDS-Untanking Tower
Untanking towers are, by definition, visually prominent and increasingly rare elements of BPA substations through attrition and technological obsolescence. Uniformly designed within BPA's early "Master Grid" style, these resources are directly related to the historic (now out-dated) technology associated with oil-filled transformer maintenance of the late-1930s/1940s period. Originally built in limited numbers, any remaining Untanking Tower that retains essential integrity to its original design and meets the above requirements should, by definition, be considered eligible for listing under Criterion C.

2.4 Oil House

This property type housed pumps used to empty early oil-filled equipment, primarily circuit breakers, and replace it after it has been filtered and dried. Oil Houses are typically small masonry buildings partially buried below grade to connect with a supply and waste lines.

Range/Variation

Like Untanking Towers, Oil Houses are only found at the original Master Grid substations, reflecting the technology of electrical transmission during the early development of the BPA Transmission System. Oil Houses were constructed at eight BPA substations between 1939 and 1945, with the possibility of two others built at facilities no longer in BPA ownership (Curran, 1998:109). Uniformly of masonry construction, including both concrete and brick, a variety of sizes and types were reportedly developed. Internal pumping equipment was removed from oil houses in the early 1990 (Curran, 1998:108). As a result, Oil Houses at BPA facilities are no longer operational but as examples of the original technology during the Master Grid build out, they remain strongly associated with history of the Bonneville Power Administration Transmission System. Because of disuse and high likelihood of contamination, environmental remediation and removal of remaining high risk oil houses is planned based on significant environmental, health and safety concerns.

Integrity Considerations:

A. LOCATION/SETTING:

- Oil Houses exist at substations developed during the first, Master Grid, period of significance. Integrity of location and setting is maintained through support of the complex, multi-component, character of substation facilities and can be undermined by disuse or removal or repair related to environmental contamination.
- Oil Houses, partially below grade to facilitate oil flow from electrical equipment to the filtering equipment via gravity, are visually unusual elements within BPA substations.

Their unique architectural character reinforces the building specific nature of the original period of significance.

B. DESIGN/MATERIALS/WORKMANSHIP

- Built of masonry and matched in design to other structures on a site by site basis, key character defining features typically include flat roofs, sunken entry doors and glass block windows.
- Discovery of environmental contamination may require environmental remediation and structural work that might undermine this integrity.

C. FEELING

- Oil Houses, with their unique design, may add to the visual complexity of early BPA Substations, enhancing historic character.
- However, the length of time for cessation of their original function may reduce integrity of feeling in combination with other factors (e.g., structural decay, environmental contamination).

D. ASSOCIATION

- Changes in methodology and operation due to a high susceptibility to flooding and oil leaks from underground pipes have eliminated the original function of Oil Houses, leaving remaining examples with no specific purpose. As a result, surviving oil houses have association only to the first period of significance of the BPA Transmission System and document early transmission technology and the original character of the BPA Master Grid substations. Cessation of original function and environmental remediation may not adversely affect integrity, provided sufficient visual connection and character remains at the substation overall.

E. CRITERION C STANDARDS-Oil House

- Oil Houses are directly related to the historic technology associated with oil-filled breaker maintenance, but are now obsolete because of significant environmental impacts. Built in limited numbers and now rare because of environmental remediation and removal responsibilities, any remaining Oil House that retains essential integrity to its original design may be considered eligible for listing under Criterion C. Where oil houses are found to require environmental remediation or removal for environmental safety, those actions may affect the continued integrity of the individual oil houses. If sufficient design character remains at the substation overall, the oil house removal may not affect the integrity of the associated property.

2.5 Storage Building/Shop

Typical of complex industrial settings, generic "shop" type structures are found at many BPA substations. These range from storage facilities to large vehicle maintenance facilities and shops associated with system repair. In some select situations, specialized building types related to specific construction or engineering activity, are also included under this resource type. Examples include WWII-era Quonset buildings (at Midway), or large construction-related warehouse structures (at Grand Coulee).

Range/Variation

Storage and shop buildings are located at multiple substations throughout the BPA system. In some situations shop buildings may be located in isolation, at former BPA sites related to construction, or testing related activities. Only permanent storage and shop buildings of substantial size (i.e., more than 100 square feet) are covered by this submittal unless buildings of smaller size contribute significantly to the integrity of the substation as a whole.

Integrity Considerations:

A. LOCATION/SETTING:

- Storage buildings are located at substations throughout the BPA network. These structures were built during both periods of significance and add to integrity of location and setting through support of the complex, multi-component, character of substation facilities.

B. DESIGN/MATERIALS/WORKMANSHIP

- Storage buildings exist in multiple configurations and materials. Integrity is present when the structure retains essential integrity to its design and appearance during the period of significance, including both "original" construction/footprint and any modifications or additions that occurred prior to 1974.
- Minor alterations, including roofing and siding material changes that do not substantially alter form, or the addition or removal of window or door openings, do not, in general, change overall design. Given the lesser role of such structures in the function of the BPA System, in general their design is less tied to their significance than is their continued role in the complex multi-element character of the site.
- Total replacement of any design element subsequent to the Period of Significance (i.e. post-1974) as in residing or replacement of all windows with non-compatible/non-historically based designs, adversely impacts integrity.

C. FEELING

- Storage buildings, in varied size and configuration, add to the visual complexity of early BPA Substations, enhancing historic character.

D. ASSOCIATION

- Storage buildings, including shops, maintenance structures, and various specialized facilities not otherwise detailed here, that were built by BPA during the period of significance have strong association with the development of the Transmission System.

E. CRITERION C STANDARDS-Storage Building

- In general, storage buildings are modest, standardized structures that will only rarely exhibit characteristics in design that merit Criterion C eligibility. Examples of standard types, such as Quonset Huts or site-built designs in the Streamlined Modern or Beautility-period styles that exemplify those periods or serve to form a consistent, unified, compound design may merit Criterion C eligibility when they retain high integrity to their original design.

2.6 Administrative Building (Regional HQ/District HQ)

Typically built following internal reorganization, regional and district headquarters buildings, including maintenance offices, are generally larger office structures located within or immediately adjacent to substations that house locally-based office and operations staff. Most of these structures were constructed during the second period of significance (i.e. after 1945) and were completed in connection with BPA's massive expansion during the 1960s and early 1970s. As a result, many Administrative Buildings reflect the Beautility design concepts adopted by the Bonneville Power Administration to guide its construction practices during that period.

Range/Variation

Administration buildings exist at multiple locations throughout the BPA system, typically sited in connection with substations that are additionally designated as regional or district headquarters.

Integrity Considerations:

A. LOCATION/SETTING:

- Administration Buildings are located at substation locations throughout the BPA network. Integrity of location and setting is maintained through support of the complex, multi-component, character of substation facilities.

B. DESIGN/MATERIALS/WORKMANSHIP

- Administration buildings rely upon multiple design and materials, reflecting their period of construction. Integrity is retained when buildings substantially reflect their original design, particularly at the primary façade.

- Minor alterations, additions, or changes that reflect the passage of time do not seriously impact integrity provided they are undertaken using compatible methods and materials that meet the Secretary of the Interior's Standards for Rehabilitation.
- Major additions, either during or subsequent to the Periods of Significance that are designed in compatible form do not inherently affect integrity. Additions located to the side or rear of the primary façade, especially when of reduced scale that maintains the visual primacy of the historic volume, have less impact on integrity than large additions that either through scale or placement hide the original volume, especially from the primary public right-of-way. Additions that obscure or entirely alter the original design significantly impact historic character.
- Minor alterations, including roofing material changes that do not alter roof form, addition or removal of window or door openings, or less than total replacement that do not, in general, change overall design.

C. FEELING

- Administration buildings reinforce the visual complexity of BPA Substations, enhance historic character.

D. ASSOCIATION

- Administration buildings that were built by BPA during the period of significance have strong association with the development of the Transmission System.

E. CRITERION C STANDARDS-Administration Building

Administration Buildings, generally dating from the second period of significance, may be significant under Criterion C, for their design, provided they meet any of the following standards:

- Exemplary design, retaining high integrity in use of materials to convey original character. Individual examples of this type, most designed by contract architects, exhibit "Beautility" concepts in varying methods both in form and materials. Only exceptional examples of design, retaining high integrity, should be considered eligible under Criterion C.

- Additions and modifications either during or after the periods of significance do not inherently eliminate Criterion C significance provided they are accomplished in a *highly* compatible fashion. Additions to rear and side (secondary) elevations that retain the primacy of the main entry character meet this standard. Additions that obscure the primary elevation, by definition, do not.

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3. Compensation Station

Compensation stations are located within the HVDC Intertie corridor and provide additional regulator functions related to the transmission of electricity. "The use of devices such as capacitors or voltage regulators to improve performance of an electric system with respect to some specified characteristic" (BPA Glossary). Compensator stations are, like switchyards, complex arrays of electrical equipment with specific elements in series that mirror the incoming and outgoing transmission lines.

Range/Variation

Compensator Stations are located within the Intertie Corridor, stretching from the Columbia River south, to California.

Minimum Eligibility Requirements:

In order for a Compensation Station to be eligible, it must, at minimum, meet <u>all</u> of the following standards:

- Designed by or purchased at the direction of the Bonneville Power Administration,
- Owned and operated all or in part by the Bonneville Power Administration during some portion of the period of significance
- Energization prior to 1975,
- Continued original function (i.e. related to the transmission of electricity).

Integrity Considerations:

A. LOCATION/SETTING:

- Compensator Stations are integral to the development of the HVDC Intertie line and are located within that corridor. Resources that meet the minimum eligibility requirements meet integrity for location and setting.

B. DESIGN/MATERIALS/WORKMANSHIP

- Compensation Stations appear as specialized "nodes" within an extensive transmission corridor. Stations are characterized by overhead and vertical electrical equipment, placed in multiple series.
- Technological advancements or modifications to Compensation Stations, undertaken to improve safety or efficiency while retaining the basic function, do not impact integrity when they continue to reflect the essential complex nature of the type through repetition and undertaken using compatible methods and materials that meet the Secretary of the Interior's Standards for Rehabilitation.
- Expansions or additions to Compensation Stations, undertaken so as to maintain the serial, repetitive nature of the type, do not seriously impact integrity even when not identical to the original elements of the station.

C. FEELING

- Compensation Stations retain integrity of feeling when they reflect a complex nature comprised of multiple parts.

D. ASSOCIATION

- As integral elements in the BPA Transmission system, Compensation Stations have strong association with its development and significance.

E. CRITERION C STANDARDS-Compensation Station

By definition, Compensation Stations are associated with the development and technology of the HVDC Intertie line and so may be additionally significant from a Criterion C standpoint. Such resources, in addition to meeting the requirements above, must additionally demonstrate at the following qualities:

- Exemplar of a particular significant technology or construction method.
- HIGH level of integrity to relate that technology (i.e., minimal subsequent changes do not alter or improve upon the historically significant aspects of the technology, retaining a majority of visual and technical consistency with the original design).

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4. Testing Station

Testing Stations may occur at varied locations, both in association with substations and independently. Testing Stations include structures developed to test new equipment, especially in connection with the development of the HVDC Intertie or related to new transmission line technologies. Testing stations are highly significant within the development history of the BPA Transmission System through their relationship to the implementation of new technologies and technique in transmitting electricity.

Minimum Eligibility Requirements:
In order for a Testing Station to be eligible, it must, at minimum, meet all of the following standards:

- Designed by or purchased at the direction of the Bonneville Power Administration,
- Owned and operated all or in part by the Bonneville Power Administration during some portion of the period of significance
- Construction initiated prior to 1975,

Range/Variation
Testing Stations may include a variety of resources throughout the BPA network, including either buildings or structures, developed and constructed for the purpose of experimentation or trial installation of electrical transmission equipment.

Integrity Considerations:

A. LOCATION/SETTING:
- Testing stations are, in general, independent and often temporary elements that derive minimal significance from their location. Resources that meet the minimum eligibility requirements meet integrity for location and setting.

B. DESIGN/MATERIALS/WORKMANSHIP
- Testing stations occur in multiple designs and configurations. Resources that maintain essential integrity with their design and construction during the period of significance retain integrity in design/materials and workmanship.
- Given the temporary nature of testing, on-going operation or function is not essential to the retention of integrity for Testing-related resources.

C. FEELING
- Testing stations demonstrate integrity of feeling when they effectively convey their original construction and role in the development of the BPA Transmission System.

D. ASSOCIATION

- Testing stations, reflect the technological innovations and experimentation associated with the development of the BPA Transmission system and, as such, have strong association with its significance.

E. CRITERION C STANDARDS-Testing Station

Testing stations, by definition, are associated with the development and technology of the HVDC Intertie line and so are additionally significant from a Criterion C standpoint. Such resources, in addition to meeting the requirements above, must additionally demonstrate at the following qualities:

- Exemplar of a particular significant technology.
- HIGH level of integrity to relate that technology (i.e., minimal subsequent changes do not alter or improve upon the historically significant aspects of the technology, retaining a majority of visual and technical consistency with the original design).

5. Converter Station

Two converter stations serve as the termini of the HVDC Intertie, at Celilo Falls, in Oregon and at Sylmar, in southern California. Only the former, owned and operated by BPA, meets the requirements of this submittal. Converter Stations are defined by BPA as “The assemblage of equipment used to convert alternating current to direct current or vice versa in a power system” (BPA Glossary). The Celilo Falls Converter Station, located adjacent to the Big Eddy Substation, near Hood River, Oregon, includes a range of buildings and structures, much as does a Substation however should be treated as a individual resource type given its significant role in the BPA Transmission System.[9]

Minimum Eligibility Requirements:

In order for the Converter Station to be eligible, it must, at minimum, meet all of the following standards:

- Designed by or purchased at the direction of the Bonneville Power Administration,
- Owned and operated all or in part by the Bonneville Power Administration during some portion of the period of significance
- Construction initiated prior to 1975,
- Continued original function (i.e. related to the transmission of electricity).

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[9] The Converter Station at Ceilio Falls exists as an identifiable node within a larger Big Eddy Substation and, as such, includes buildings and other structures in addition to the converter itself.

Integrity Considerations:

A. LOCATION/SETTING:

- The Converter Station is integrated into the BPA System. Resources that meet the minimum eligibility requirements meet integrity for location and setting.

B. DESIGN/MATERIALS/WORKMANSHIP

- Converter Stations contain multiple resources with both indoor and outdoor structures and buildings. Integrity in design, materials and workmanship is retained through continued function and essential continuation of original character.
- Buildings associated with Converter Stations retain integrity in design, materials and workmanship when they reflect their original design through continued use of exterior materials and detailing.
- Minor modifications to some elements of the Converter Station, especially upgrade to transmission-related systems for improved efficiency or function, do not effect integrity provided they are undertaken using compatible methods and materials that meet the Secretary of the Interior's Standards for Rehabilitation.
- Addition of entirely new elements that improve efficiency or continue function do not effect integrity when located and installed in an essentially compatible manner, continuing the basic historic character through complexity or serial repetition of individual elements.

C. FEELING

- The Converter Station demonstrates integrity of feeling when it effectively conveys its original construction and its role in the development of the BPA Transmission System.

D. ASSOCIATION

- The Converter Station, reflects the technological innovations and experimentation associated with the development of the BPA Transmission system and, as such, has strong association with its significance.

E. CRITERION C STANDARDS-Converter Station

- A unique resource and significant for its association with the HVDC Intertie and the technology that allows it to function, the Celilo Converter Station is strongly related with important technological advancements in the transmission of HVDC current. Portions of the Converter station also exhibit significant architectural design that reflects the influence of Beautility on BPA during the Period of Significance. As such, provided sufficient integrity remains, this resource should be considered eligible for listing on the National Register of Historic Places under Criterion C, as well as under Criterion A.

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6. Microwave/Radio Station

Beginning in the 1950s, BPA established a microwave/radio network that operated in parallel to the transmission grid, enabling system communication and remote operational control. As noted in Section E, in February 1950 a major contract with Philco marked the beginnings of what would become one of the largest such microwave communications systems in the nation at the time. "The communications requirements of the grid and interties has resulted in an extensive microwave system" (Norwood, 1981:176).

Microwave/Radio Stations in the BPA system occur in two major variants; those that are co-located at other BPA facilities, typically substations, and those that are independently located. Independent locations are often on mountain tops so as to repeat the signal over long distance or severe terrain but also exist independent of terrain in proximity to lengthy T-line corridors, particularly between widely spaced substations. Physically, Microwave/Radio stations consist of two major components; an equipment vault, holding communications and electrical equipment required by the use, and an antenna, being a metal or lattice work tower that elevates the actual antenna array above ground level. BPA microwave/radio stations are typically located within secure chain link fenced areas, whether they exist within a substation or not.
Microwave/Radio Stations are key operational elements within the BPA Transmission System and, by providing connections to the Control Centers (see Resource Type No. 7) are integral to the centralized operation of the BPA Transmission System.

Minimum Eligibility Requirements:
In order for a Microwave/Radio Station to be eligible, it must, at minimum, meet all of the following standards:

- Designed by or purchased at the direction of the Bonneville Power Administration,
- Owned and operated all or in part by the Bonneville Power Administration during some portion of the period of significance
- Construction initiated prior to 1975.

Range/Variation
Microwave/Radio Stations exist throughout the BPA system and include a range of built resource types. Equipment buildings include metal, manufactured, volumes, site-built concrete block, precast panel and other "vault" structures with a variety of roof and finish types. Most equipment buildings are small, utilitarian volumes, with little exterior detail. Some examples may be incorporated into larger buildings for additional storage. Stations located in severe, mountain top, locations are specifically designed for those severe conditions, with varied materials and forms including "snow roofs" and similar designs to withstand extreme climates.

Antenna towers range from steel lattice work structures visually similar to "derricks" in form (i.es tapering upward from a wide base to a narrow top) as well as monopod towers. Stations also have outdoor electrical and switching equipment, creating a complex, multi-component, character.

Integrity Considerations:

A. LOCATION/SETTING:

- Microwave/Radio Stations are integrated into the BPA System. Resources that meet the minimum eligibility requirements meet integrity for location and setting.

B. DESIGN/MATERIALS/WORKMANSHIP

- Microwave/Radio Stations may contain multiple resources with both indoor and outdoor structures and buildings. Integrity in design, materials and workmanship is retained through continued function and essential continuation of original character.
- Modifications, especially upgrade to internal operational equipment for improved efficiency or function, do not effect integrity. Modifications that result in exterior modification for improved function do not generally impact integrity provided they are undertaken using compatible methods and materials that meet the Secretary of the Interior's Standards for Rehabilitation.
- Additions to Microwave/Radio Stations do not effect integrity provided they are designed using compatible methods and materials that meet the Secretary of the Interior's Standards for Rehabilitation.

C. FEELING

- Microwave/Radio Stations demonstrate integrity of feeling when they effectively convey their original construction and their role in the development of the BPA Transmission System.

D. ASSOCIATION

- Microwave/Radio Stations reflect the development of an interconnected, centrally controlled, transmission network and, as such, are associated with the development of the BPA Transmission system and have strong association with its significance.

E. CRITERION C STANDARDS-Microwave/Radio Station

Generally modest in design and character, Microwave/Radio Stations will generally be limited to Criterion A significance. Examples potentially eligible under Criterion C should demonstrate the following:

- Exemplar of a particularly significant technology or key design in the development of the microwave/radio network.

- HIGH level of integrity to relate that technology (i.e., minimal subsequent changes do not alter or improve upon the historically significant aspects of the technology, retaining a majority of visual and technical consistency with the original design).

7. Control Center

The development of a BPA Control Center to supplant earlier operation patterns reflects the shift toward reliance upon computerized control, and marks the culmination of the Bonneville Power Administration Transmission System into a single unified entity as opposed to a collection of related systems. BPA's two Control Centers are the operational and management hub of the system, governing both generation and transmission systems through the use of computer and communication technologies. Control Centers are, for all intents and purpose, the "brain" of the Bonneville Power Administration system from a daily operational standpoint.

> [A Control Center is] the facility from which a power system is monitored and regulated. Dispatchers use computerized displays to match generation with load and to respond to faults in the system. BPA has two control centers, at Vancouver and at Moses Lake, both in Washington (BPA Glossary).

Minimum Eligibility Requirements:
In order for a Control Center to be eligible, it must, at minimum, meet all of the following standards:

- Designed by or at the direction of the Bonneville Power Administration,
- Owned and operated all or in part by the Bonneville Power Administration during some portion of the period of significance
- Construction initiated prior to 1975.

Range/Variation
The nature of Control Centers limits their numbers. The two examples of this type within the BPA Transmission System are, essentially, specialized nodes within a related substation complex. Visually presenting as office buildings, with proximate or integrated communications arrays, Control Centers have no other specific exterior character that differentiates them from other office structures such as Administration Buildings (see Resource No. 2.6, above).

Integrity Considerations:

A. LOCATION/SETTING:

- Control Centers are integral to the BPA System. Resources that meet the minimum eligibility requirements meet integrity for location and setting.

B. DESIGN/MATERIALS/WORKMANSHIP
- Control Centers are typically masonry structures that reflect "modern" architectural style consistent with the Beautility standard.
- Exterior modifications related to improved function, including additions, improved communications facilities, and changes related to security issues, do not impact integrity provided they are undertaken using compatible methods and materials that meet the Secretary of the Interior's Standards for Rehabilitation.

C. FEELING
- Control Centers demonstrate integrity of feeling when they effectively convey their original design and their role in the development of the BPA Transmission System.

D. ASSOCIATION
- The construction of Control Centers and the development of the technology that they represent mark the end of the Period of the Significance.
- Control Centers reflect the development of an interconnected, centrally controlled, transmission network and, as such, are associated with the development of the BPA Transmission system and have strong association with its significance.

E. CRITERION C STANDARDS-Control Center

Control Centers, designed and built during BPA's 1960s-1970s expansion related to the Canadian Treaty, were designed within the "Beautility" period and exhibit the stylistic attributes of that approach. Of limited number, and of key Criterion A importance within the BPA system by definition, such resources may gain additional significance under Criterion C by meeting the following standards:

- HIGH level of integrity to relate the original design (i.e., minimal subsequent changes do not alter or improve upon the historically significant aspects of the technology, retaining a majority of visual and technical consistency with the original design).
- Association, through design, as exemplars of a particular style or use of materials.
- Association to a significant designer or architect.

G. Geographic

The Bonneville Power Administration Transmission System extends through or into all or portions of eight western states, with resources located in incorporated cities as well as unincorporated public and private, Federal and Tribal lands. While some resource types are essentially "nodes," with a single address (often a single tax lot), others, notably transmission lines, extend for hundreds of miles crossing multiple jurisdictions and one or more states. As a result, the geographic scope of resources potentially eligible for listing under this submittal is;

The State of California
Including all Federal, Tribal, City and County geopolitical subdivisions in the following counties:
Modoc

The State of Idaho
Including all Federal, Tribal, City and County geopolitical subdivisions thereof.

The State of Montana
Including all Federal, Tribal, City and County geopolitical subdivisions in the following counties:
Beaverhead Broadwater Deer Lodge Flathead
Glacier Granite Jefferson Lake Lewis & Clark
Lincoln Madison Mineral Missoula
Powell Ravalli Sanders Silver Bow

The State of Nevada
Including all Federal, Tribal, City and County geopolitical subdivisions in the following counties:
Elko Humboldt

The State of Oregon
Including all Federal, Tribal, City and County geopolitical subdivisions thereof.

The State of Utah
Including all Federal, Tribal, City and County geopolitical subdivisions in the following counties:
Box Elder

The State of Washington
Including all Federal, Tribal, City and County geopolitical subdivisions thereof.

The State of Wyoming
Including all Federal, Tribal, City and County geopolitical subdivisions in the following counties:
Lincoln Park Teton

H. Summary of Identification and Evaluation

This multiple property submittal of historically significant elements of the Bonneville Power Administration Transmission System is based, in part, upon an earlier nomination of a portion of that system built prior to 1945, prepared by Craig Holstine and Gloria Lenz in 1987. That document, which identified a discontiguous historic district, focused upon the initial Period of Significance and the construction of the BPA 230-kV Master Grid in Oregon and Washington. Holstine and Lenz identified 2,855 resources, including 24 buildings and 2,831 structures (primarily transmission line towers) as significant under Criteria A, B, and C. An additional eight buildings were evaluated as "non-contributing" due to modification. Holstine and Lenz's documentation focused primarily on physical design and technological significance related to the original construction of the BPA System, eliminating any post-WWII era resources from consideration. Integrity was largely evaluated from a design standpoint, without regard to the potential Criterion A significance of the BPA system as the major supplier of electricity to a multi-state service area. Criterion B significance was through association with J. D. Ross and Charles Carey, BPA's Administrator and Chief Engineer responsible for the original Master Grid design. While Holstein and Lenz's work was reviewed and approved by both Washington and Oregon SHPOs, the nomination was never formally listed on the National Register. As a result the Holstein and Lenz study has, effectively, functioned as a Determination of Eligibility for Master Grid resources for more than two decades.

Building upon Holstein and Lenz, a more systematic effort at evaluating the built resources of the BPA System during the first period of significance was established by Christine Curran, *A Historic Context Statement of the Transmission of Hydroelectricity by the Bonneville Power Administration, 1939-1945*, a Master's Thesis prepared for the Historic Preservation Program at the University of Oregon (1998). Curran created a more detailed evaluation framework for the specific resources of the Master Grid. However, given the temporal limitations of both Holstein and Lenz and the Curran documentation, on-going management issues have required numerous individual resource evaluations within the post-1945 portions of the BPA Transmission System, all without the benefit of a larger, holistic, approach to the system as no such resource specific documentation existed.

Many published sources document the significance of the BPA system to the region, most notably Vera Springer, *Power and the Pacific Northwest* (1976), Gus Norwood *Columbia River Power for the People* (1981) and Gene Tollefson, *BPA and the Struggle for Power at Cost* (1987), all published by the Bonneville Power Administration. Regional histories help record the impact of BPA on the development of industry and local communities. These include Aaron C. Jones' *Inland: The First Forty Years* (1977) and Ken Billington's fine analysis of the history of public power development in the Northwest, *People, Politics and Public Power* (1988), published by the Washington Public Utility Districts' Association. More generalized histories of the electrical transmission system, the conflicts between public and private power and the forces that led to the creation of the Bonneville Power System and the Federal Columbia River Power System are many, most

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notably Charles McKinley, *Uncle Sam in the Pacific Northwest*, Richard Lowitt, *The New Deal and the West*, and Jay Brigham, *Empowering the West: Electrical Politics Before FDR*.

The current effort to evaluate the resources of BPA built after 1945 began with the development of *Corridors of Power: The Bonneville Power Administration and Distribution Network*, a historic context statement prepared by George Kramer under BPA contract 38010-001 (2008). That document, based on extensive review of BPA internal records and sources as well as published secondary material, evaluated the pattern of BPA development and its impacts on the region after 1945, documenting the Administration's extensive growth and network expansion as a part of the Federal Columbia River Power System between the late-1940s and early 1970s. Available BPA databases documenting resource types, quantities, and distribution provided a basis for evaluation of resources with a clear recognition of how the network "works" and what its underlying significant impact has been since the passage of the Bonneville Power Act.

Select examples of all resource types within the BPA System were site-visited during Summer 2009, to develop an appreciation for character, design, and ability to convey significance and well as providing information on the variations within the type, both during and after the periods of significance. Resources in Oregon, Washington, Idaho, and Montana representing both the range of the period of significance as well as construction types were evaluated and compared with available system-wide records through the BPA-VFM Facilities Management Database, an internal on-line resource with substantial data on BPA buildings and structures. Transmission line information was collected through internal database and mapping platforms to determine range and character of that resource type.

Where appropriate, specialized technical materials including both internal BPA engineering and design manuals as well as industry-specific publications and conference proceedings, were reviewed to clarify BPA's role in the development of transmission technology. Two period resources on power line construction and design, *Transmission Towers* by the American Bridge Company (1925) and *Pole and Tower Lines*, by R. D. Coombs (1916) provided a basic nomenclature for tower line construction. Additional nomenclature and definition came from BPA's own online *Power Terminology Glossary*, that can be found at (www.bpa.gov/corporate/pubs/definitions). The limited efforts at comprehensive evaluation of transmission line systems previously documented for consideration to the National Register were located. Lynda Blair's evaluation of eighteen lines between Hoover Dam and the Los Angeles Basin was reviewed at the suggestion of the National Park Service (Blair, 1994).

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