Merwin Hydroelectric Project
FERC Project No. 935

# FINAL LICENSE APPLICATION

## Exhibit A – Description of Project

PacifiCorp
Portland, Oregon

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## A.1.0 INTRODUCTION

In compliance with the Code of Federal Regulations (18 CFR, Parts 4 and 16), PacifiCorp is applying to the Federal Energy Regulatory Commission (FERC) to relicense the Merwin Hydroelectric Project (FERC Project No. 935) on the North Fork Lewis River, in the State of Washington. The current license for the Merwin Project, which PacifiCorp owns and operates, was issued on October 6, 1983 and expires on May 1, 2006.

PacifiCorp is applying for a new license to continue operation of the project. This Exhibit A presents the response to information required by the FERC as described in 18 Code of Federal Regulations (CFR) Section 4.51(b). It is a description of the Merwin Project and includes the location, general configuration, physical composition, and dimensions of the project structures. The description also includes information on the turbine-generator unit, as well as appurtenant civil, mechanical, and electrical equipment.

Exhibit A is organized in 5 sections that follow the sequence of information requested in the CFR. Following this introduction, the existing facilities are described in Sections A.2.0 and A.3.0. Section A.4.0 describes proposed changes to project facilities. Section A.5.0 contains a statement regarding lands of the United States within the project boundary.

## A.2.0 GENERAL DESCRIPTION

The Merwin Hydroelectric Project is one of 3 PacifiCorp hydro projects located on the North Fork of the Lewis River, approximately 10 miles east of Woodland, Washington and 35 miles northeast of Portland, Oregon. The site is about 20 miles upstream of the confluence of the North Fork Lewis River with the Columbia River. Located at RM 19.5, the Merwin Project is the first in a string of 4 facilities on the Lewis River. The other three projects are Yale (FERC Project No. 2071), Swift No. 1 (FERC Project No. 2111) and Swift No. 2 (FERC Project No 2213), all upstream of Merwin. The Yale Hydroelectric Project is located at RM 34, Swift Hydroelectric Projects No. 1 and 2 are located upstream at RM 47 and RM 44, respectively. Merwin, Yale and Swift No. 1 are owned and operated by PacifiCorp. Swift No. 2 is owned by the Cowlitz County Public Utility District No. 1 (Cowlitz PUD) and maintained and operated by PacifiCorp under contract. The Merwin Project location within the North Fork Lewis River drainage basin is shown on Figure A.2.0-1. Construction of the Merwin Project began in 1929 and was completed with a single unit in 1932. Two additional units were added to the project in 1949 and 1958.

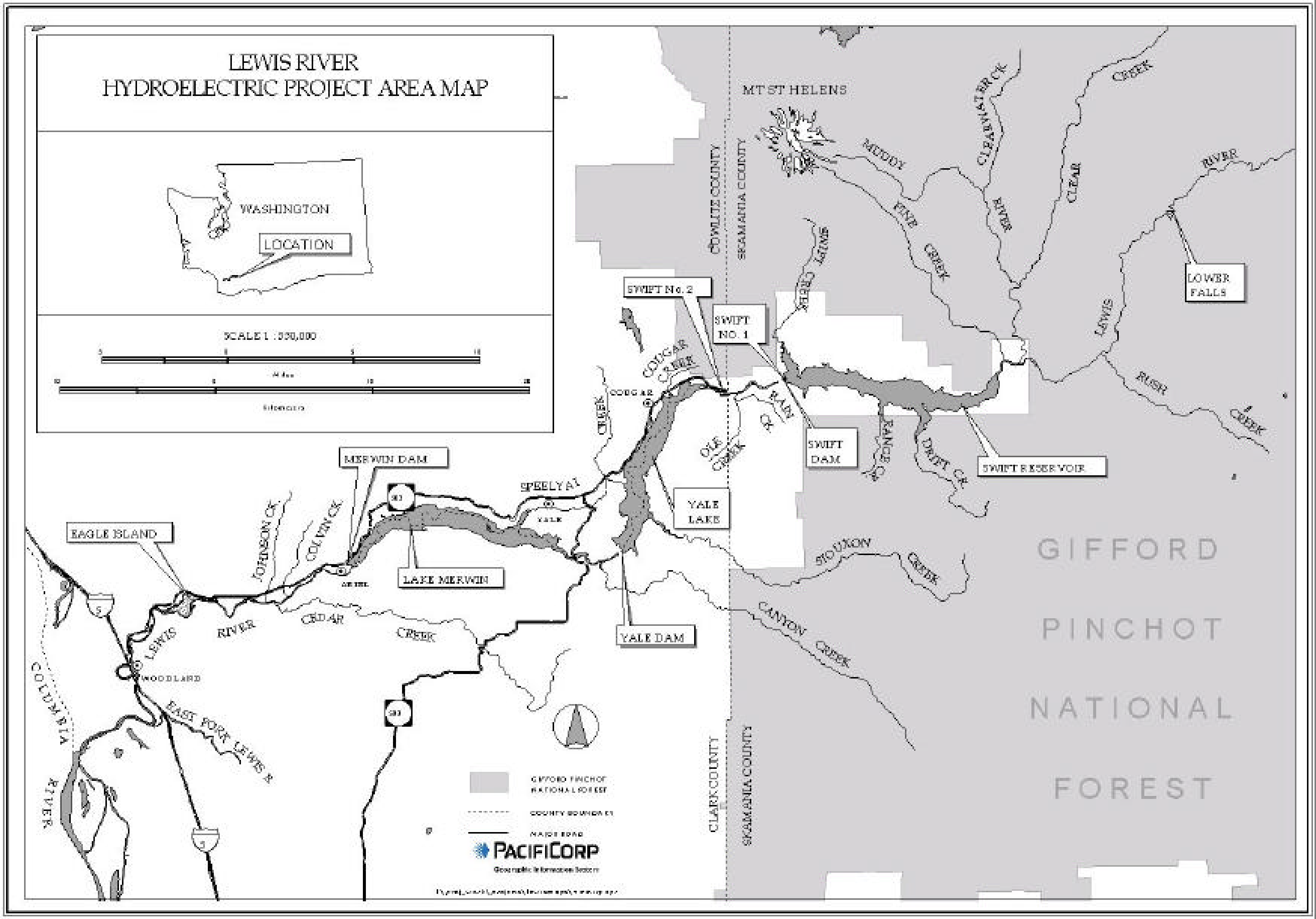


**Figure A.2.0-1. Lewis River Hydroelectric Projects Area Map.**

# A.3.0 EXISTING STRUCTURES

The major components of the Merwin Project include a reservoir, a concrete dam consisting of a 3-unit powerhouse, a variable radius arch dam, a thrust block, a gated spillway, a non-overflow gravity section and an earth dike. The significant project data are listed in Table A.3.0-1. A description of the civil, mechanical, and electrical systems for the major project components and their physical and operating conditions follow.

**Table A.3.0-1. Merwin project data.**

| | | |
|---|---|---|
| **GENERAL** | | |
| Plant name | Merwin | |
| FERC project no./<br>License expiration | 935/<br>2006[1] | |
| Location | Ariel, Washington | |
| Stream name | Lewis River | |
| Drainage area | 726 square miles | |
| Minimum flow requirement (cfs) | Time Period | Minimum Flow Requirements |
| | December 8 –<br>February 28 | 1,500 cfs |
| | March 1 –<br>March 31 | Between 1,000 and 2,000 cfs, depending on runoff volume forecast on March 1 |
| | April 1 –<br>April 30 | Between 1,300 and 2,700 cfs, depending on runoff volume forecast on April 1 |
| | May 1 –<br>May 31 | Between 1,650 and 2,700 cfs, depending on runoff volume forecast on May 1 |
| | June 1 –<br>June 30 | 2,700 cfs, as long as natural flow at Merwin is equal to or greater than 2,000 cfs |
| | July 1 –<br>July 15 | 2,000 cfs, as long as natural flow at Merwin is equal to or greater than 1,600 cfs |
| | July 15 –<br>July 31 | 1,500 cfs, as long as natural flow at Merwin is greater to or equal to 1,200 cfs |
| | August 1 –<br>October 15 | 1,200 cfs |
| | October 16 –<br>October 31 | 2,700 cfs |
| | November 1 –<br>November 15 | Minimum flow is lesser of 4,200 cfs or natural flow at Merwin plus 2,000 cfs |
| | November 16 –<br>December 7 | Minimum flow is the lesser of 5,400 cfs or natural flow at Merwin plus 2,000 cfs |
| Plant data | | |
| Nameplate generating capacity | 136,000 kW | |
| Number of units | 4 (3 main units and a 1 MW house unit) | |
| Rated head | 188 ft | |
| Plant discharge | 11,250 cfs | |
| Average annual gross generation | 511,534 MWh (21 years 1982-2003) | |
| **CIVIL SYSTEMS** | | |
| Reservoir | | |
| Name | Lake Merwin | |
| Gross storage capacity | 422,000 ac-ft. | |
| Usable storage capacity | 263,700 ac-ft | |

[1] License expiration was originally 2009.

| | | | |
|---|---|---|---|
| Area | 4,000 acres at 239.6 ft. msl | | |
| Drainage area | 726 sq. miles | | |
| Maximum elevation | 239.6 ft. msl | | |
| Normal summer operating elevation | 235.0 to 239.0 ft. msl | | |
| Normal minimum operating elevation | 220 ft. msl | | |
| Minimum of record (Dec. 1936) | 166.7 ft. msl | | |
| Minimum pool | 165.0 ft. msl | | |
| Dam | | | |
| Type | Concrete variable radius arch | | |
| Height | 313 ft. | | |
| Length | 728 ft. | | |
| Crest elevation | 240 ft. msl | | |
| Gates | | | |
| Number | 5 | | |
| Type | Tainter | | |
| Size | Four 39 ft. x 30 ft. and one 10 ft. x 30 ft.; additionally, there are 5 ft of wooden flashboards. | | |
| Crest elevation | 205.0 ft. msl | | |
| Penstocks | 1 | 2 | 3 |
| Size (diameter x length) | 15.6 ft. x 150 ft. | 15.6 ft. x 150 ft. | 15.6 ft. x 150 ft. |
| Capacity | 3,790 cfs | 3,790 cfs | 3,890 cfs |
| **MECHANICAL SYSTEMS** | | | |
| Unit Number | 1 | 2 | 3 |
| Turbine Manufacturer | S. Morgan Smith | S. Morgan Smith | Allis-Chalmers |
| Turbine rating (power/head) | 61,580 hp/185 ft. | 55,000 hp/170 ft. | 64,000 hp/190 ft. |
| Max turbine discharge | 3,689 cfs | 3,689 cfs | 3,789 cfs |
| Type | Vertical Francis | Vertical Francis | Vertical Francis |
| Speed | 120 rpm | 120 rpm | 120 rpm |
| Runner discharge diameter | 153 inches | 153 inches | 153 inches |
| Wicket gate circle diameter | 190 inches | 190 inches | 188 inches |
| Wicket gate height | 32.72 inches | 32.72 inches | 37.5 inches |
| Distributor elevation | 60 ft. msl | 60 ft. msl | 60 ft. msl |
| Draft tube type | Elbow type | Elbow type | Elbow type |
| Generator manufacturer | General Electric | Westinghouse | General Electric |
| Generator rating | | | |
| kW | 45,000 kW | 45,000 kW | 45,000 kW |
| kVA | 56,250 kVA | 56,250 kVA | 56,250 kVA |
| Power factor | 0.8 | 0.8 | 0.8 |
| Year installed | 1931 | 1949 | 1958 |
| Disassembled & overhauled | | 1971 | |
| Exciter | ABB | Basler | ABB |
| Transformer | | | |
| Type | Single-Phase | Single-Phase | Single-Phase |
| Rating | 56,250 kVA | 56,250 kVA | 60,000 kVA |
| Voltage, volts | 13,200/115,000 | 13,200/115,000 | 13,200/115,000 |
| Manufacturer | General Electric | General Electric & Westinghouse | General Electric |
| Year installed | 1931 | 1949 | 1958 |
| Governor | Woodward Digital | Woodward | Woodward |

## A.3.1 CIVIL SYSTEMS

### A.3.1.1 Reservoir

The reservoir formed by Merwin Dam (Lake Merwin) is approximately 14.5 miles long and has a surface area of 4,000 acres at the operating level of 239.6 (ft. msl), which is the normal maximum elevation. The reservoir's gross and usable storage capacities at this elevation are 422,000 acre-feet and 263,700 acre-feet, respectively. The drainage area for the reservoir is 726 square miles.

### A.3.1.2 Dam and Instrumentation

#### A.3.1.2.1 Merwin Dam

Merwin Dam impounds a southwestward flowing stretch of the Lewis River near Ariel, Washington. The main dam is a concrete variable radius arch dam with a crest length of 728 feet and maximum height of 313 feet. The north (right) abutment of the arch rests against a 75-foot-long concrete gravity thrust block with a maximum height of 145 feet. Immediately north of the thrust block is a 206-foot-long gravity section that contains the gated overflow spillway. North of the spillway, an approximately 209-foot-long non-overflow gravity dam section, with maximum height of 90-feet, ties into the abutment by means of a 33.6-foot-long concrete cantilever wall section followed by a concrete core wall section 2 feet thick and extending 25 feet further into the abutment. A few hundred feet beyond the right abutment, an approximately 3-foot-high impervious dike blends into the natural terrain (see Figure A.3.1-1).

**Figure A.3.1-1. Merwin Dam and Powerhouse.**

#### A.3.1.2.2 Instrumentation

Instrumentation at Merwin includes survey monuments for horizontal and vertical control, instrumentation to monitor seepage and pressure measurements from drain holes. Permanent instrumentation is installed and a program is established for monitoring performance of critical structures. There have been no revisions to the current monitoring program since 1991, when a new program for monitoring pressures at the foundation drains was established. For detailed descriptions of these instruments, see Safety Inspection Report, October 2002, for the Merwin Hydroelectric Project. A brief description is as follows.

Movement – Horizontal and vertical alignments are monitored annually by surveying six monuments along the crest of the dam. Vertical and horizontal control monuments are located in rock on the left and right abutments. Four different line of sight monuments are used to create the baselines for measurements of movement in the upstream-downstream direction.

Seepage – Flow into the drainage gallery is collected and discharged through an outfall pipe in the thrust block at the low point of the gallery. Flow from the outfall pipe is measured with a 12-inch-high, 22.5 degree V notch weir, instrumented with a continuous strip chart recorder.

Discharge from foundations is one of the sources of the total drainage gallery flow. Half of the drains extend to the rock surface, and the remainder are drilled into the rock foundation material. All are interconnected by means of a box drain along the contact between concrete and rock.

In addition to flow from foundation drains, the drainage gallery also captures leakage through construction joints and vertical drains that drain the external area between the parapet walls along the dam crest. Construction joint leakage is conveyed through 4 inch square vertical drain holes formed in the concrete that connect to horizontal drains that run along the horizontal construction joints. Some of the 4-inch vertical drains also drain the external area between the parapet walls along the dam crest. Rainwater is collected on the crest in a center gutter that is intercepted by the vertical dam drains. The drainage gallery flow readings are, therefore, influenced by the inclusion of rainwater drainage from the crest of the dam.

Pressure – There are no permanent piezometers installed in the dam; however, pressures at the foundation contact of the right abutment gravity sections of the dam are monitored at the foundation drains. For drains that are not flowing, the depth to the top of the water level in the drain is measured. The pressure at the foundation contact is then calculated from the hydrostatic level above the contact. For drains that are flowing, the pressure at the foundation contact is measured manually with a packer and pressure gage apparatus.

#### A.3.1.3 Diversion Tunnel

To implement construction of Merwin Dam, river flows were diverted through a diversion tunnel excavated through solid rock under the south end of the dam. The tunnel is 1462 feet between portals, of horseshoe-section, 25 feet wide and 26 feet high, with a circular arch roof. The floor of the intake is El. 30; at the center El. 31 and at the outlet El. 24. The upper 777 feet is lined with an average of 27 inches of concrete.

#### A.3.1.4 Intake Structure and Penstocks

Water is delivered from the reservoir to the generating units via three large penstocks originating at the intake structure and terminating at the turbine spiral cases in the powerhouse. A fourth intake and penstock deliver water to the 1 MW house unit.

The penstock intake structures are located within the central part of the arch dam at elevation 60 feet msl centerline, approximately 187 feet below full pool. Design velocities range from between 10 and 20 feet per second (fps). Each is equipped with an individual trash rack enclosure at the upstream face of the dam.

Each of the three large penstock units is 15.6 feet in diameter and 150 feet in length. The capacity of Units Nos. 1 and 2 are 3,790 cfs and the capacity of Unit No. 3 is 3,890 cfs. Penstocks for Unit Nos. 1, 2, and 3 are fitted with butterfly valves at the downstream face of the dam to provide the capability for closure of the penstocks and dewatering the units for inspection and maintenance. Each valve is designed to close automatically in the event of a penstock rupture. The valves are normally controlled from the powerhouse control room. There is a fourth 15.6-foot diameter penstock stub with a semihemispherical bulkhead at the downstream face of the dam for future expansion of a fourth unit. There is also a 3-foot 9-inch diameter penstock for the house unit, and a 12-inch diameter service water pipe. The penstock inlet diameters and the minimum water surface elevation in Lake Merwin allow the intake system to pass more than 150 percent of the existing plant hydraulic capacity.

A single steel head gate at the upstream side of the dam is provided for closure of the penstock openings. The gate is operated from the top of the dam by a 150 ton traveling gantry-style crane. The crane is designed to carry the 100 ton, 24-foot x 24-foot fixed-roller type gate from the storage bracket, around the arch to the gate guides and to lower the gate into position, closing the penstock at elevation 60 feet. This arrangement allows for closing and dewatering one penstock at a time for inspection and maintenance.

### A.3.1.5 Powerhouse

#### A.3.1.5.1 Structure

The powerhouse is a reinforced concrete structure approximately 304 feet long by 104 feet wide, including the substructure for a fourth unit expansion. The powerhouse is a semi-outdoor type and spans a deep channel of the river immediately downstream of the dam and houses three 45 MW generating units and a 1 MW house unit, for a total of 136 MW. The portion of the powerhouse which spans the channel of the river is built on a reinforced concrete arch. Unit Nos. 2 and 3 are situated above this arch. The powerhouse superstructure has removable roof hatches over the generators and erection areas. A machine shop, work area, and toolroom are provided within the powerhouse while a separate building immediately downstream houses the control and protection equipment.

#### A.3.1.5.2 Gantry Crane

The powerhouse includes an outdoor-type traveling gantry crane for unit maintenance. The crane was manufactured by the Whiting Corporation in 1930, has a main hook capacity of 350 tons and an auxiliary hook capacity of 25 tons. Crane rails allow the gantry crane to travel the full length of the powerhouse and the adjacent unloading area.

A.3.1.6 Spillway

The spillway consists of a 206-foot-wide gated overflow section immediately north of the arch dam thrust block. Five 35-foot-high tainter gates (including 5-foot high flashboards) control the outflow, four of which are 39 feet wide and one 10 feet wide. An approximately 300-foot-long concrete-lined spillway chute discharges to the river. Each gate has 5 feet of wood flashboards added to the top.

A.3.1.7 Tailrace

The Merwin power plant and spillway discharge into a deep tailrace pool bounded by steep rock banks. The tailrace discharges into the natural Lewis River channel made up of extensive gravel reaches and deep pools. Normal maximum and minimum tailrace elevations are as follows:

- Minimum no flow: 46.2 feet
- One-unit maximum output: 49.8 feet
- Two-unit maximum output: 51.9 feet
- Three-unit maximum output: 53.3 feet

A.3.1.8 Plant Access Road and Bridge

The Merwin Project is located approximately one half mile east of State Highway 503 and is accessible by means of a paved access road and bridge crossing the lower Lewis River. The road and bridge were installed at the time of construction. An extreme flood in 1933 washed away the left abutment of the downstream access bridge and the bridge itself. A new bridge of longer span and improved alignment was constructed in 1948.

## A.3.2 MAJOR MECHANICAL SYSTEMS

A.3.2.1 Turbine

The Merwin powerhouse contains 3 vertical Francis turbines. Units Nos. 1 and 2 were manufactured by S. Morgan Smith and Unit No. 3 was manufactured by Allis-Chalmers. Unit No. 1 was placed in service in 1931 and has a maximum discharge of 3,689 cfs at 120 rpm. Unit No. 2 was placed in service in 1949 and has a maximum discharge of 3,689 cfs at 120 rpm. Unit No. 3 was placed in service in 1958 and has a maximum discharge of 3,789 cfs at 120 rpm.

A.3.2.2 Governor

Woodward mechanical hydraulic governors are provided to serve Unit No. 2 and 3. Unit No.1 has been upgraded with a Woodward Model 505 Electronic Governor control system. The governor operating heads are located on the generator floor beside each turbine generator unit. Each of the units is normally operated as a separate system, although the oil piping configuration allows Unit No. 1 and 2 to be operated from either of the pump/receiver/sump systems. Systems for Unit No. 1 and 2 include a 400-gpm horizontal rotary gear type hydraulic pump driven by 100-hp motor maintaining pressure in 950-gallon pressure tanks. The Unit No. 3 system consists of 240-gpm vertical turbine pump driven by a 40-hp motor maintaining pressure in the 950-gallon pressure tank. Nominal system pressure for all the units is 190 psi. Suction for Unit No. 1 and 2 pumps is taken from 3300 gallon governor oil receiving sump tanks and Unit No. 3 pump is mounted directly on the 1300 gallon governor oil receiving sump tank. A permanent magnet generator (PMG) mounted on each generator provides the speed signal to the governor and a speed switch is used to sense creep and provides lock out signal for the creep detection circuits.

The governors are provided with the following controls and instruments:

| **Controls** | **Instruments** |
|---|---|
| Speed droop control | Tachometer |
| Gate limit control | Air brake pressure gauge |
| Speed adjust control | Oil pressure gauge |
| Air brake control | Transfer valve |
| Transfer valve | Gate limit and position indicator |
| Isolating valve | Speed adjust position indicator |
| Oil pump echelon | Isolating valve indicator |
| Oil pump continuous/intermittent | Oil level gauge |
| | Creep detector |

## A.3.3 MAJOR ELECTRICAL SYSTEMS

### A.3.3.1 Generator

The Merwin generator Units Nos. 1 and 3 were manufactured by General Electric and installed in 1931 and 1958, respectively. Unit No. 2 was manufactured by Westinghouse and installed in 1949. Unit No. 2 was rewound in 1971. Each generator has a nameplate rating of 45 MW. Additionally, there is a 1 MW house unit which was installed in 1931. The plant has a total nameplate capacity of 136 MW.

### A.3.3.2 Exciter and Automatic Voltage Regulator

Unit No. 1 main and pilot exciters and automatic voltage regulators were manufactured by General Electric and installed in 1929. They were replaced in 1997 with ABB 212.5 kW at 250 Vdc excitation systems. Unit No. 2 main and pilot exciters and automatic voltage regulators were manufactured by Westinghouse and installed in 1931. These components were replaced in 1991 with Basler 300 kW at 250 Vdc excitation systems. Unit No. 3 main and pilot exciters and automatic voltage regulators were manufactured by General Electric and installed in 1949. These components were replaced in 2001 with ABB 410.6 kW at 375 Vdc excitation systems. These systems contain automatic voltage regulators and power system stabilizers.

### A.3.3.3 Transmission Lines

Each generator has a 115 kV primary line approximately 1000 feet long from each generator step-up transformer to the Merwin substation.

## A.4.0 PROPOSED CHANGES TO PROJECT FACILITIES

As part of this license application, PacifiCorp is not proposing any major modifications or upgrades. However, the Company will continue to evaluate the potential for project upgrades and modifications as future market and other conditions change, to ensure the most cost-effective, efficient and environmentally balanced use of the water resources available.

## A.5.0 LANDS OF THE UNITED STATES

Federal lands within the FERC project boundary are retained by the Bureau of Land Management (BLM) and total 142.65 acres. These lands are identified as:

- Township 6N, Range 2E, Section 24 – Lots 2, 3, 4, 5, and 9
- Township 6N, Range 2E, Section 26 – Lot 8
- Township 6N, Range 3E, Section 28 – Lots 5 and 6
- Township 6N, Range 3E, Section 26 – Lot 8

## A.6.0 LITERATURE CITED

Black & Veatch 2002. Independent Consultant Safety and Inspection Report, Merwin Hydroelectric Project, FERC No. 935. Prepared for PacifiCorp, Portland, Oregon.