COLGATE-OAKLAND TRANSMISSION LINE
From Colgate to Oakland
Dobbins vicinity
Yuba County
Oakland
Alameda County
California

HAER CA-190
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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
PACIFIC WEST REGIONAL OFFICE
National Park Service
U.S. Department of the Interior
1111 Jackson Street, Suite 700
Oakland, CA 94607

HISTORIC AMERICAN ENGINEERING RECORD
COLGATE-OAKLAND TRANSMISSION LINE
HAER No. CA-190

Location: Beginning at Colgate Powerhouse on the Yuba River, 3.0 miles southeast of Dobbins, Yuba County, California, thence 142 miles in a southwesterly direction, ending at Piedmont Powerhouse, 0.15 mile northeast of Interstate 80, near Park Boulevard, Oakland, Alameda County, California.

U.S.G.S.: French Corral, 7.5' Topographic Quadrangle, 1995; UTM coordinates: Zone 10 656000 E, 4354860 N (Colgate Powerhouse) and Oakland East, 7.5' Topographic Quadrangle, 1959; UTM coordinates: Zone 10 567780 E, 4184320 N (Piedmont Powerhouse).

Date of Construction: 1900-1901

Engineer: James D. Galloway, construction engineer, with R. H. Sterling and T. E. Theberath of the Bay County Power Company; The SKC Team of the Stanley Company, principal electrical engineering consultant.

Present Owner: Pacific Gas and Electric Company (PG&E)
77 Beale Street
San Francisco, California 94106

Present Use: Electrical transmission line

Significance: In its heyday, the 142-mile Colgate-Oakland Transmission Line was a world record-breaking feat of engineering. It was the highest voltage and longest line in commercial use, its generators and water wheels were the largest of their respective types in commercial use, and it included the Carquinez Transmission Span, a record-breaker in its own right. The Colgate-Oakland Transmission Line was the brainchild of Eugene de Sabla and John Martin, both instrumental in California hydroelectric development and known as the "fathers" of PG&E. James D. Galloway, construction engineer for the line, was also a leading figure in the development of the PG&E system.

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I. DESCRIPTION

The Colgate-Oakland Transmission Line is located in northern California and extends for 142 miles through six of the state's counties: Yuba, Sutter, Yolo, Solano, Contra Costa and Alameda. The line begins at the Colgate Powerhouse, which is set on the west side of the northern Sierra Nevada mountain range and is located on the north bank of the Yuba River, approximately three miles southeast of the town of Dobbins in Yuba County, California. The transmission line then extends in a southwesterly direction into the Sacramento Valley proceeding into the San Francisco Bay Area. It ends at the Piedmont Powerhouse, which is set in an urban environment and located less than one-quarter of a mile northeast of Interstate 80, near Park Boulevard, in Oakland, Alameda County, California.

En route the Colgate-Oakland Transmission Line crosses several waterways. The crossings at Bear River, Putah Creek and the Sacramento River are each approximately 1,000 feet in length. The longest crossing made by the transmission line is at Carquinez Straits by way of a 4,227-foot-long cable span (see HAER No. CA-191 for a further description of the transmission span over Carquinez Straits).

In this text, the aforementioned waterway and associated cable crossing are called Carquinez Straits and Carquinez Straits Transmission Span respectively. On current maps the waterway is labeled Carquinez Strait (USGS 1959). On historical maps and in historical text the waterway is referred to as Carquinez Straits (Galloway 1901; Low 1901a and 1901b). The latter version of the waterway's spelling was chosen due to its correlation with the associated transmission span's and transmission line's period of significance.

II. ENGINEERING INFORMATION

The 1901 Colgate-Oakland Transmission Line

The Colgate Powerhouse (also called Colgate Power House No. 1) was first operational in 1899 (Low 1901b:148). As of 1901, the powerhouse had a 275-foot by 40-foot rectangular plan. The walls were of rubble masonry and the gabled roof had steel trusses and galvanized corrugated-iron surfacing. A traveling crane, able to lift any weight inside the building, ran the entire length of the powerhouse. A subway was built beneath the floor of the building and contained all of the wire that led to the switching devices at the center of the powerhouse. Associated with the powerhouse were a dwelling house for the workers, a timber dam constructed across the Yuba River, a secondary dammed water source at Lake Frances, a wood flume, a penstock, and pipelines (Galloway 1901:230).

The pipelines brought water to a receiving pipe which was built parallel with the powerhouse. The water entered from the receiving pipe into the powerhouse by 14-inch pipes leading to

waterwheels. Included inside the powerhouse were tangential-type waterwheels which were made by the Risdon Iron and Locomotive Company of San Francisco, Stanley brand generators, and Stanley brand transformers of the oil-insulated and water-cooled type (Galloway 1901:230-231).

From the powerhouse, a double-pole transmission line, constructed between 1900 and 1901, carried Colgate's power 142 miles to Oakland (Galloway 1901:230). The two pole lines, generally about 25 feet apart, traversed the entire distance to the Piedmont Powerhouse in Oakland (Low 1901b:167). The standard distance from pole to pole on each line was 132 feet. Duplicate pole lines were erected to ensure against accidental service interruption. The poles were each made of Oregon red cedar, had a 14-inch-diameter butt end and an eight-inch-diameter top end, and were 35 feet long. One-sixth of the length of each pole was set into the ground. The ground end was painted with carbolineum avenarius to prevent decay. The cross-arms, which were treated with hot asphaltum and coal tar, were affixed to each pole so that the passing cables could be set at the apices of an equilateral triangle with sides 42 inches in length. The top of each pole was coned and bound with iron wire. The upper portion of each pole was painted with tar paint (Galloway 1901:231).

Along one side of the double-pole line, a telephone line consisting of a three-strand aluminum cable was carried on double-petticoated insulators set on a cross-arm attached five feet below each power line pole (Galloway 1901:231).

One of the cable lines was of No. 00 medium hard-drawn copper for the entire distance, while the other line was made of aluminum from Colgate to Suisun and of copper for the rest of the distance. Copper was used to avoid the corrosive effects of the San Francisco Bay on the aluminum. The aluminum cable was made of seven strands of wire that together had the conductivity of No. 00 copper wire and was made by the Pittsburg Reduction Company. The cables at the Carquinez Straits Transmission Span were of solid plow steel (Galloway 1901:231-232) (see HAER No. CA-191 for more engineering information on the Carquinez Straits Transmission Span).

The insulators used on the pole line were made under the patents of Mr. Sterling, the superintendant of the Bay Division of the Bay Counties Power Company. The pins used were of California eucalyptus and were boiled in linseed oil (Galloway 1901:231).

The Colgate-Oakland line had to cross several waterways. The crossings at Bear River, Putah Creek and the Sacramento River were each approximately 1,000 feet in length (Galloway 1901:231). The big feat was the crossing at the Straits of Carquinez by way of a 4,227-foot-long cable span. This span alone attained much positive recognition (see HAER No. CA-191 for more information about the Carquinez Straits Transmission Span).

Step-down transformers were located at Woodland, Wheatland, Napa, on both sides of Carquinez Straits and, finally, at Oakland. The double transmission line continued from the south side of the Carquinez Straits Transmission Span to Piedmont Powerhouse in Oakland. In Oakland, the current was transformed to 2,000 volts, which operated three General Electric Company synchronous motors directly connected to 550-volt direct-current generators, each 450 kilowatts (kW). This current was used on the lines of the Oakland Transit Company, which owned all the street car systems of Oakland, Alameda and Berkeley with a total extent of 126 miles (Galloway 1901:231).

The Transmission Line after 1901

Since 1901, several modifications have been made to the Colgate-Oakland Transmission Span. In 1942, a fire damaged the original Colgate Powerhouse enough to warrant the construction of a new powerhouse with a capacity of 25,000 kW (Coleman 1952:143). Later, an underground powerhouse facility replaced the 1942 structure (USGS 1995). The Piedmont Powerhouse is no longer in use. The 1901 Carquinez Straits Transmission Span received its most noticeable modifications in 1914 and between 1922 and 1924 (see HAER No. CA-191 for more information on modifications to the Carquinez Straits Transmission Span.)

III. HISTORY

Hydroelectric plant design started around 1880 when early direct-current stations were being built for arc and incandescent lighting. By the mid-1890s, the western United States had powerful hydroelectric plants in the mountains that were connected to distant urban areas by long, high-voltage, transmission lines. These systems were noted to have extremely high heads, remote powerhouse locations, and sophisticated point-to-point transmission. The longest transmission lines of the time were built in California (Hay 1991:xi, 28).

In 1895, the world's largest hydroelectric plant was established at Niagara Falls, New York. Due to high publicity, the Niagara Falls plant stood at the forefront in demonstrating the "economic viability of hydroelectric development coupled with long distance power transmission," establishing "standards for the industry" and highlighting the "fact that hydroelectricity demanded significant changes in hardware and attitudes toward the use of falling water in conjunction with electrical distribution" (Hay 1991:xi).

The time from 1895 to around 1915 saw rapid change in hydroelectric plant design. Innovation and experimentation sparked by the success of earlier plants led to several modifications, including those in waterwheel design, setting and accessories (Hay 1991:xi, 27). It was during this time that California's Colgate-Oakland Transmission Line was established with its beginning at Colgate Powerhouse in Yuba County along the Yuba River, and its end at Piedmont

Powerhouse in Oakland. This 142-mile long transmission line was considered in 1901 "the greatest electrical engineering triumph ever accomplished" (Low 1901b:145).

The Need for Power

The need for electric power in central California largely began in the late 1800s when mining and manufacturing interests found themselves lacking in sufficient fuel supplies for their ventures. Wood was only available as fuel in mountain areas, coal was of poor quality within the state and expensive to import, and at the time oil did not seem a practical power source to explore when viable electrical power systems were already established and available in the United States. California's Sierran rivers became the major source of electrical power for the central part of the state (Low 1901b:145).

In 1891 and 1892 Alphonso A. Tregidgo acquired water rights on the South Yuba River for the development of hydroelectric power which would be transmitted to mines in the Grass Valley and Nevada City districts (Coleman 1952:130; Low 1901b:147). He used Italy's Tivoli-Rome transmission, built in 1886, as the precedent for his project (Low 1901b:147).

On September 22, 1892, the Nevada County Electric Power Company (NCEPC) was incorporated with Tregidgo as president and Eugene J. de Sabla, Jr., a businessman from San Francisco and friend of Tregidgo's, as vice president (Coleman 1952:130). Sufficient capital for the Nevada County project was acquired about three years later through the efforts of de Sabla and his associates (Low 1901b:147). Around 1894, John Martin of San Francisco entered into a contract with NCEPC to provide and install the electrical equipment in the new plant and also to build and equip the transmission line from the plant to Nevada City and Grass Valley (Coleman 1952:133).

Construction of the Nevada plant began in July 1895 (Low 1901b:147). William Stanley of Stanley Electrical Manufacturing Company in Pittsfield, Massachusetts supplied the generators and transformers for the transmission line (Hay 1991:30). By February 1896 this system was supplying 1,000-horsepower to Nevada City and Grass Valley and to nearby mines. The original plant was doubled in capacity in the spring of 1897 and Nevada County industries had electric power at their command to the amount of 2,000-horsepower (Low 1901b:147). This Nevada plant was known by many as the "Rome" plant after Romulus Riggs Colgate, a wealthy New Yorker and financial backer of hydroelectric development (Coleman 1952:135-36).

By 1897, the Martin-de Sabla team secured water rights on the North Yuba River in Brown's Valley to construct another powerhouse to supplement the Nevada plant. The Yuba Power Company, incorporated October 27, 1897, by R. R. Colgate, de Sabla, and Martin, built a 1,500-horsepower plant in Yuba County on an existing irrigation canal where the water dropped 300 feet (Coleman 1952:138-39; Low 1901b:147-148). The Yuba plant, also historically known as

the Yuba-Marysville transmission, was completed by March 21, 1898. In April 1898, this plant began delivering electric power to the Brown's Valley mines and the City of Marysville, 22 miles distant (Coleman 1952:139; Low 1901a:91; Low 1901b:148). The Yuba plant's capacity was soon reached and the power company had to search for new power sources (Low 1901b:148).

As a result, de Sabla and Martin began planning for a new powerhouse. In 1899, the Yuba Power Company was reorganized and renamed the Yuba Electric Power Company. This new company took over the Yuba plant and began to construct a new plant eight miles upstream of the Yuba plant (Coleman 1952:140). The Colgate Powerhouse (also known as Colgate Power House No. 1), named in honor of R. R. Colgate, was built on the north bank of the Yuba River at a point where the old Missouri Bar Trail crossed the river. The Missouri Bar Trail was associated with early California mining history (Coleman 1952:140; Hay 1991:29; Low 1901b:148). The entire Colgate Powerhouse contained 18,000-horsepower by May 1901 (Low 1901a:91). Additional transmission lines were built to Sacramento, 61 miles away, and to the gold districts near Oroville, 30 miles away (Low 1901b:151).

Before work on this powerhouse was completed, further demands for power arose, especially in Oakland. At this time, the Oakland Transit Company was negotiating for refinancing with the Eastern bond firms of E. H. Rollins & Sons and N. W. Harris & Company. The bankers felt that the street rail system should have cheaper electric power and sent engineers to Yuba and Nevada counties to investigate the ability of the three power plants to supply Oakland's requirements. The report was positive and set the stage for a new and record-breaking transmission project – a 142-mile-long transmission line from the Colgate power plant to Oakland, with an aerial cable crossing over Carquinez Straits (Coleman 1952:144). This resulted in the consolidation of the NCEPC and the Yuba Electric Power Company into the Bay Counties Power Company (Coleman 1952:345; Hay 1991:30; Low 1901b:148).

The Colgate-Oakland Transmission Line

The Bay Counties Power Company was incorporated in June 1900 with a capital stock of $5,000,000. The company's officers and directors included Mr. E. J. de Sabla, Jr., president and general manager, Mr. Wm. M. Pierson, vice president and attorney, Mr. C. A. Grow, secretary and treasurer, and Messrs. J. C. Coleman, Richard N. Hotaling and George A. Batchelder, all of San Francisco, and R. R. Colgate, of New York, directors (Low 1901b:148-49).

The main goal of the Bay Counties Power Company was to create a transmission line that would deliver power from Colgate Powerhouse to Oakland (Galloway 1901:230). William Stanley with John F. Kelley and C.C. Chesney – the SKC Team - served as principal electrical engineering consultants. SKC claimed they could outfit the project with a 60,000-volt transmission line, which was twice the voltage considered safe by General Electric or Westinghouse (Coleman 1952:145; Hay 1991:30).

Within ten months, the Colgate powerhouse capacity was doubled, a double pole line was constructed 142 miles to Piedmont Powerhouse in Oakland, and a transformer plant and crossing were built at Carquinez Straits (Galloway 1901:230) (see HAER No. CA-191 for more historical information on the Carquinez Straits Transmission Span). The first electric power was transmitted on April 27, 1901, and the Colgate-Oakland line was touted by technical press as "the greatest engineering triumph ever accomplished" (Hay 1991:30).

In May 1901, the transmission line's voltage was the highest in commercial use, its transmission line length was almost double that of the longest previously used, its generators were the largest horizontal shaft machines used by any water power plant in the world. Its water wheels were of greater capacity than any other wheels of the tangential type used in the world (Low 1901a:92). By July 1901, the transmission lines of the Bay Counties Power Company operated in, or had connections enabling them to operate in, 16 of the most populous counties in central California, which, at the time contained one-half the population of the entire state (Low 1901a:91; Low 1901b:149). As George P. Low, a writer for the *Journal of Electricity Power and Gas*, stated in 1901, "…[The Colgate-Oakland transmission line's] entire system from one end to the other is, in truth, of the same heroic trend that is characteristic of the span which marks the crossing of its lines over the Straits of Carquinez" (Low 1901a:92).

IV. SOURCES

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V. PROJECT INFORMATION

Due to significant deterioration and maintenance difficulties posed by the existing Carquinez Straits Transmission Span, PG&E is replacing the existing span with a newly constructed span. To mitigate the loss of this historic structure, PG&E is recording the transmission line according to the HABS/HAER standards, and is filing documents with the State of California Office of Historical Preservation and the Western Regional Office of the National Park Service, San Francisco, California. This recordation has been prepared to meet those stipulations.

The written text of this report was prepared by Tracy D. Bakic and Mary L. Maniery. Graphics were prepared by Claire Warshaw. The preceding are all employees of PAR Environmental Services Inc., Sacramento. Photography was prepared by David DeVries, Mesa Technical, Berkeley, California. The documentation is based on a previous investigation conducted by PAR Environmental Services entitled *Cultural Resource Inventory and Evaluation for the Carquinez Straits Transmission Span Replacement Project, Contra Costa and Solano Counties, California* (1998).