The Grizzly Mountain HVDC Transmission Research Facility

by Jack M. Lee, Jr., Vernon L. Chartier, and Robert J. Raleigh

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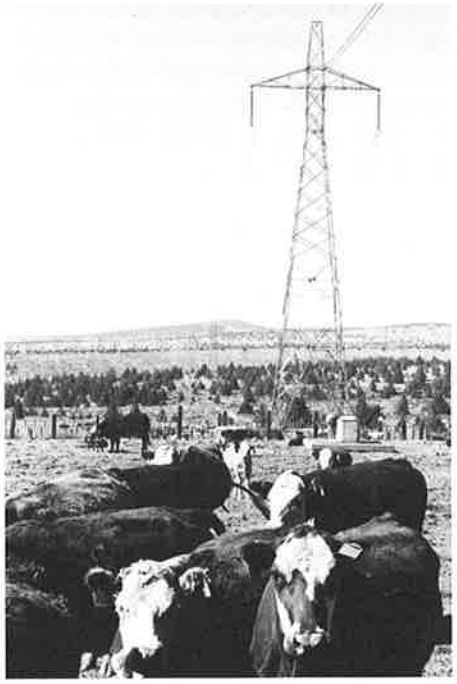

Beef cattle under study at the Grizzly Mt. HVDC Research Facility. Each animal is individually identified by the use of color-coded ear tags.

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This article is about d-c transmission lines and the Grizzly Mountain HVDC Research Facility, where some important new studies are underway. They were begun by Bonneville Power Administration (BPA) and are partly sponsored by a group of utilities interested in finding out more about environmental and electrical effects of a high-voltage, direct-current (HVDC) electrical transmission line. The research facility is located in central Oregon, about 12 miles southeast of Madras. Why the studies were begun, and what they hope to accomplish, are outlined below along with a basic introduction to d-c transmission lines.

Why a D-C line?

Transmission lines provide power from generation sources to load centers. Since they were first used, improvements have been made to carry more power over the lines, to move it more efficiently, and to move it at less cost. Throughout the United States electricity is consumed primarily as alternating current (a-c), and, therefore, most transmission lines carry a.c. The current passing over this line rapidly shifts direction and alternates charges from negative to positive. By contrast, the current in direct current (d-c) lines flows in only one direction; and the charge on the lines' two conductors therefore stays either positive or negative. This results in different electrical effects, including the production of air ions (electrically-charged molecules) by d-c lines. There has been some speculation that different environmental effects might therefore occur around a d-c line.

Actually, the first electrical station in the United States, built by Thomas Edison in 1882, was a d-c system. However, soon after, the development of the transformer and other equipment made a-c systems more practical for most applications. D-c transmission lines can be more efficient and more economical than a-c lines under certain conditions: over a long (several-hundred-mile) distance, where a large power transfer is taking place, and where the power is not tapped off the system at intermediate stations.

The first commercial high voltage d-c line constructed in the United States was the Celilo-Sylmar line. That line, energized in 1970, is part of the Pacific Northwest-Pacific Southwest Intertie. This D-C Intertie transmits large amounts of surplus electrical power from the Northwest over a long distance (846 miles) to the Pacific Southwest. It has brought benefits worth millions of dollars to consumers in both regions. Since the Celilo-Sylmar line was energized, two other d-c lines have been built in the Midwest, and additional d-c lines have been built in the Midwest, and additional d-c lines are

under construction or have been proposed.

Increased Interest in Environmental Effects

In recent years, there has been increased public and scientific interest in the possible environmental effects of high-voltage transmission lines. Most interest and research has involved a-c lines. However, as additional d-c lines have been constructed or proposed, interest in these lines has also developed. A controversial ±400-kV d-c line energized in Minnesota in 1978 is a well-known example.

Changes in the operating capacity of the D-C Interstate prompted decisions to undertake new research. From 1970 until 1985, the line operated at ±400-kV and carried up to 1,600 megawatts of power.[1] During that time, there were no indications that the line had caused any adverse environmental effects. In early 1985, the Intertie voltage was increased to ±500-kV, with a new capacity of 2,000 megawatts. This is approximately the output of two large power plants. The line's good operating record is expected to continue.

This expectation is based on results of electrical research with BPA's ±600-kV d-c test line at The Dalles, Oregon, and successful operation since the late 1970s of a ±400-kV d-c line in North Dakota and a ±450-kV d-c line in Canada. (These latter two lines operate at lower voltage. However, because of their design, the electrical characteristics near the ground are similar to those of the D-C Intertie.) In 1988, more terminal additions may be connected to the Intertie, so the current could be increased to 3,100 amperes, with a new capacity of 3,100 megawatts.

Because few environmental studies of d-c transmission lines have been made, BPA initiated a study to coincide with the 1985 increase in voltage. The study consists of two parts. BPA engineers began to study the electrical environment of the d-c line in 1984. An agricultural study involving cattle and crops, raised on and near the d-c line right-of-way, began in 1985. It is being carried out be scientists from Oregon State University, through an intergovernmental agreement between OSU and BPA. Because the agricultural study is widely applicable, it is being co-sponsored by eight other utility organizations from throughout the United States.

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The Grizzly Mountain Facility

The Grizzly Mountain HVDC (high-voltage, direct-current) Research Facility is located next to the D-C Intertie in central Oregon, approximately 12 miles southeast of Madras and 2 miles east of Highway 26. It is very near the BPA Grizzly Substation, which is located along the A-C Intertie lines. The site is on the Crooked River National Grassland, administered by the U.S. Forest Service. In 1984, the Forest Service issued a permit to BPA to begin the electrical monitoring program. After preparing an Environmental Assessment, the Forest Service issued BPA a land use grant for conducting the agricultural study. The study area has been used for livestock grazing. In past years, it had been cleared and seeded with crested wheatgrass and dryland alfalfa. Stands of western juniper are adjacent to the study area on the south and west. Elevation is around 3,500 feet above sea level. Average annual precipitation for Madras is 9.4 inches, and the average high and low temperatures for January and July are 40°/20°F, and 87°/44°F, respectively.

Study Objectives and Approach

The overall objective of the study is to assess whether the electrical properties of a ±500-kV d-c transmission line result in any significant effects on cattle or crops, under simulated farming and ranching conditions. It is a scientific study using treatment and control groups with large sample sizes, and conducted in a natural environment. It is also the largest experimental agricultural study ever conducted for any transmission line.

The study design compares data collected on cattle and crops living near the d-c line (the treatment group) with data on cattle and crops living in a control area away from the line. The comparison is used to test the hypothesis that the d-c line has no significant effect on the treatment group. Statistical tests are used to see if there are differences, not due to chance, between the two groups. If there are no observed differences between groups, this increases the scientists' confidence in the hypothesis. This would not, however, prove there are absolutely no effects. There could still be