



UNITED STATES GENERAL ACCOUNTING OFFICE  
WASHINGTON, D.C. 20548

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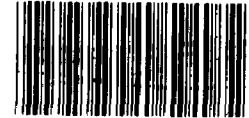
ENERGY AND MINERALS  
DIVISION

May 7, 1982

RELEASED

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118606

The Honorable Max Baucus  
United States Senate

Dear Senator Baucus:

**Subject:** Analysis of Bonneville Power Administration's Estimate to Bury Segments of Transmission Line in Montana (GAO/EMD-82-80).

Your January 22, 1982, letter asked that we analyze Bonneville Power Administration's (BPA's) cost estimates to bury segments of high voltage transmission lines in Montana. We briefed your staff on the results of our work on April 22, 1982, at which time it was requested that we put our results in writing. Specifically, you asked that we

--evaluate the validity of BPA's cost data for burying portions of a "twin" 500 KV 1/ transmission line and

--analyze the general engineering reliability and safety considerations of burying such lines.

We found BPA's estimates of \$7.1 to \$7.4 million per mile to bury the transmission lines are reasonable. However, because this type of installation is not common, uncertainties exist which could make the actual costs higher or lower. For this same reason, little is known about the engineering, reliability, and safety considerations of underground installation for lines of this size.

OBJECTIVES, SCOPE, AND METHODOLOGY

Our objective was to address your specific concerns. We conducted our review in accordance with GAO's "Standards For Audit of Governmental Organizations, Programs, Activities, and Functions."

1/A unit of measure equal to 1,000 volts.

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To address the cost question, we obtained copies of BPA's estimates for undergrounding two short segments of proposed "twin" 500 KV lines in the vicinity of Missoula, Montana, and for overhead construction of a 91.6-mile segment of the same lines. We reviewed BPA's underground estimates and supporting documentation and discussed with BPA officials the methodology used in developing the estimates for burying the lines. To determine the reasonableness of BPA's estimate, we reviewed several reports prepared by the Electric Power Research Institute (EPRI), and a Department of Energy (DOE) report which contained some information on the costs for underground high-voltage transmission lines. In addition, we discussed the costs of underground lines with representatives of three cable manufacturers, EPRI officials, and Bureau of Reclamation (Bureau) officials.

To address the question of engineering, reliability, and safety considerations, we discussed this aspect with officials of BPA, EPRI, cable manufacturers, and the Bureau.

#### BPA'S ESTIMATE FOR UNDERGROUND LINES

In July 1981, BPA identified and prepared cost estimates for two underground segments of "twin" 500 KV lines in the vicinity of Missoula, Montana. One segment was 2.9 miles long, the other 4.5 miles. BPA decided that self-contained, oil-filled cable would best meet its reliability criteria and was the least expensive alternative for undergrounding both segments. BPA's estimated costs were based on installing seven underground cable conductors (three for each circuit of a double circuit and one spare conductor for reliability).

BPA estimated the cost of the 2.9-mile underground segment which would cross Rattlesnake Creek at about \$21.6 million or \$7.4 million per mile. The 4.5-mile segment that would cross the Bitterroot River was estimated at about \$32.1 million or \$7.1 million per mile. Table 1 shows BPA's per mile cost estimate for each underground segment.

In contrast, BPA's latest estimate for overhead construction dated September 1981 shows an estimated cost of \$68.6 million for a 91.6-mile section of the proposed "twin" 500 KV line between Garrison and Townsend, Montana. This amounts to an estimated cost of \$749,000 per mile which is between \$6.4 and \$6.7 million per mile less than BPA's estimate for underground lines.

Table 1

<u>Item</u>	<u>Rattlesnake Creek segment (note a)</u>	<u>Bitterroot River segment (note a)</u>
Site survey	\$ 23,645	\$ 18,131
Design	11,090	7,147
Cable	4,035,862	4,055,333
Other material (note b)	1,376,145	1,135,978
Land acquisition	34,483	17,778
Land clearing	9,669	8,936
Construction	1,469,962	1,435,291
Indirect overhead	362,700	340,813
Direct overhead	<u>124,721</u>	<u>113,927</u>
Gross cost per mile	\$ <u>7,448,277</u>	\$ <u>7,133,334</u>
Total miles	2.9	4.5
Total cost	<u>\$21,600,000</u>	<u>\$32,100,000</u>

a/All cost estimates include labor.

b/Includes items such as substation parts, communications, and oil reservoirs.

#### Analysis of BPA'S estimate

BPA's cost estimate for the cable--the largest single item--was based on a February 1980 quotation from a Japanese firm for similar type cable. Sumitomo Electric Industries, Ltd., provided BPA with a quotation of \$76.58 per foot as the estimated cost to supply 500 KV self-contained, oil-filled cable for a proposed transmission line crossing the Columbia River. BPA used this quotation and adjusted the price upward to \$110 a foot for use in its Montana underground estimate. The higher price was to reflect cost increases due to inflation, and the larger conductor size required for the Montana lines. Many of the other items in BPA's underground cable estimate were for standard high-voltage electrical transmission components. BPA used its transmission line and substation estimating catalogs to estimate labor and material costs for these items. The costs in estimating catalogs are based on historical costs from BPA's construction program.

#### INFORMATION FROM OTHER SOURCES ON THE COST OF UNDERGROUND LINES

EPRI and BPA officials advised us that very few high-voltage underground transmission lines at the 500 KV level have been installed worldwide--perhaps no more than 10 miles. The only

500 KV self-contained, oil-filled underground cable installed in the United States are lines at the Bureau's Grand Coulee project, which were furnished by Sumitomo Electric Industries, Ltd. According to EPRI and BPA officials, there are presently no domestic sources for this type of cable. While some cost data for 500 KV underground lines were available in the EPRI and DOE reports, this information was several years old and was developed with transmission line design factors, study parameters, and cost assumptions which make a direct comparison with the BPA estimates inappropriate. However, these reports and discussions with EPRI officials, Bureau officials, and representatives of cable manufacturers substantiate that underground lines are much more expensive than overhead lines.

Bureau officials advised us that their 500 KV underground lines at Grand Coulee cost \$6.9 million for materials and installation in 1974. This amounts to a cost of \$110 per conductor foot or the equivalent of \$4.1 million per mile for furnishing and installing six conductors plus a spare. In January 1982, the Bureau estimated that it would cost \$110 per foot for the cable material and \$85 per foot for installation to replace part of the underground lines at Grand Coulee which were damaged in a July 1981 fire. This estimate was made by adjusting the 1974 cost data to reflect current price levels. Based on the Bureau's latest estimate, it would cost about \$7.2 million per mile to furnish and install six conductors plus a spare. The price for the conductor material of \$110 per foot was the same price used in the BPA estimate, even though the Bureau's conductor (cable) size was smaller than BPA's.

We also discussed BPA's estimate with representatives of three cable firms. One firm gave us an oral estimate which for material prices was about 5 percent higher than BPA's but no costs for installation. The other two representatives for cable manufacturers provided no price quotations. One representative stated that the BPA estimate fell within a reasonable price range; the other representative indicated the only way to get a reliable estimate would be by an actual bid solicitation.

#### OBSERVATIONS CONCERNING BPA'S UNDERGROUND LINE ESTIMATES

According to the people we interviewed, the cost of underground cable can be highly variable depending on current raw material prices (copper and aluminum), backlog of orders, and the degree of competition. The underground cable is not a shelf-item; it necessitates custom ordering and manufacturing. However, the information we obtained suggests that the price used by BPA for its underground estimate is within a reasonable price range of what it could cost to bury these two segments of transmission lines.

If the underground alternatives studied by BPA in Montana were to be advertised for competitive bids, the actual cost for the cable could be higher or lower than the costs included in BPA's estimates. However, with the apparent 10 to 1 comparative cost advantage that overhead 500 KV lines have over underground lines, it is reasonable to conclude that a substantial cost premium would have to be paid to underground any portion of the proposed "twin" 500 KV lines.

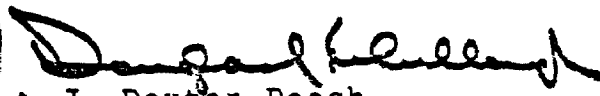
ENGINEERING, RELIABILITY, AND  
SAFETY CONSIDERATIONS

Little concrete data is available on the engineering, reliability, and safety factors associated with the burial of this size line. Due primarily to the dramatic cost differences between underground and overhead installation, the utility industry has not pursued this technology. According to EPRI officials, this trend is likely to continue into the foreseeable future. What information is available indicates concern over significantly higher transmission losses, oil spills (for oil-filled lines), difficulty in repairing cable problems, and leadtimes for manufacturing replacement cables. Due to lack of data, we were unable to quantify the effect of these concerns on the viability of the technology.

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As arranged with your office, we did not obtain BPA's comments and unless you publicly announce its contents earlier, we plan no further distribution of this report for 30 days. At that time, we will send copies to interested parties and make copies available to others upon request.

Sincerely yours,

  
J. Dexter Peach  
Director