corona transmission

covering the subject from three types of lines

THIS BOOK, ABOUT CORONA from overhead transmission systems, is Volume 7 in a series of references books that have been prepared by Eskom Holdings, Ltd and the most comprehensive book on the subject, according to the reviewer.

Corona in Transmission Systems—Theory, Design and Performance

P. Sarma Maruvada, ISBN 978-0-620-49388-8

In my opinion this book is the most comprehensive book written to date on the subject of corona from overhead transmission systems because it covers not only corona phenomena associated with high voltage ac (HVAC) and high voltage dc (HVDC) lines, but it also discusses corona phenomena associated with hybrid ac/dc lines. One can find books and papers that discuss corona from one of the three types of lines, but it is difficult to find books or papers that cover the subject of corona from all three.

Research on corona from overhead lines goes back to the 1920s when F.W. Peek and others conducted research to determine the power loss due to corona. It wasn't until the late 1940s that the industry recognized that corona could cause interference to AM broadcasting, which then became a topic of research. Audible noise due to wet weather corona became a concern in the 1960s when the first 500- and 765-kV lines were energized. Also, during that same time period, wet weather corona was the cause of interference to television reception in rural areas where TV signals were weak. Then in the 1970s ozone generated by corona was brought up by interveners as an issue. All of these issues were quickly addressed by organizations throughout the world conducting corona research.

HVDC lines also generate all of the previously mentioned corona phenomena, but HVDC lines have another unique corona phenomenon that does not occur on HVAC lines. The HVDC conductors produce a corona-generated space charge that fills the space between the conductor and the ground plane. This space charge creates an ion-enhanced electric field and ion currents at ground level. This was recognized in the 1960s when the first HVDC test lines were built.

The ten chapters of the book cover the following topics.

1) "Basic Concepts" reviews the development of HVAC and HVDC transmission lines. The chapter also has a general discussion of the basic concepts of electromagnetic modeling of overhead lines, line design, selection of conductors, and the importance of statistics in characterizing corona phenomena.
2) "Corona and Gap Discharges" reviews the physics of ionization processes and electrical breakdown in air and a description of the different modes of corona discharges occurring on transmission line conductors. Factors that influence the critical corona onset gradient of cylindrical conductors under both ac and dc voltages are discussed. The origin and characteristics of the currents induced in the conductors and other physical and chemical consequences of corona discharges are described. And the occurrence and possible harmful effects of gap discharges on overhead transmission and distribution lines are outlined.
3) "Conductor Surface Electric Fields" covers the factor that has the most influence on the occurrence of corona discharges on the surface of transmission conductors. The chapter discusses various analytical methods to accurately calculate the electric field distribution around conductor bundles such as the Markt/Mengele method, the method of successive images, and the method of moments.
4) "Corona Loss and Ozone from AC Lines" reviews the physical processes in the generation of ac corona loss and theoretical and empirical methods that have been developed over the years to calculate corona losses of practical ac transmission lines. The influence of ambient weather, altitude above sea level, and conductor surface irregularities on corona loss is

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discussed. Finally, ozone and oxides of nitrogen produced by conductor corona is briefly presented.

5) "Electromagnetic Interference from AC Lines" covers the physical and analytical aspects of the generation and propagation of electromagnetic interference (EMI) due to corona on transmission line conductors. Even though there are very complex models available for determining the propagation analysis of corona-generated EMI, the simplified analysis using the lossless transmission line model and the theory of natural modes is discussed and is probably adequate for most engineering applications. The more popular empirical and semi-empirical prediction methods for calculating corona generated EMI are presented.
6) "Audible Noise from AC Lines" covers the corona phenomenon that for moderate-to-wet climates has become the most important design factor for overhead ac lines. This chapter covers the characteristics and methods of predicting audible noise from ac transmission lines.
7) "Space Charge Environment and Corona Losses of DC Lines" is a review of the currents and electric fields produced by the steady flow of space charges due to corona on the HVDC conductors. Methods for analysis and prediction of the space charge environment as well as the corona losses of unipolar (monopolar) and bipolar dc transmission line configurations are presented in this chapter.
8) "RI and AN of DC Lines and Corona Performance of Hybrid AC/DC Lines" describes methods for analyzing the space-charge modified fields when ac and dc lines are in close proximity to each other and methods for calculating radio interference and audible noise for such configurations.
9) "Measurement Methods and Test Techniques for Corona Performance and Evaluation" covers the important area of different test methods, ranging from corona cages to full-scale test and operating lines for evaluating corona performance. This chapter also covers the instrumentation necessary to characterize all of the various corona phenomena.
10) "Corona Design Considerations for AC and DC Lines" describes the impact the various corona phenomena have on line design and the approaches for achieving optimum line design based upon known criteria.

This book would be a valuable addition to the shelf of those who are involved in corona research and line design. It has the necessary technical detail for those conducting corona research, but it also has the practical information needed by line designers who need to calculate the various corona phenomena for any particular line design and who need to evaluate the impact that various corona phenomena have on the operation of lines and on residences near the line.

—Reviewed by Vernon L. Chartier

Corrections to "A Wider Horizon"

In [1], the author name of Timothy Mount was incorrectly listed as Thomas Mount. There was also an error in Figure 4. The correct figure appears below. We apologize for these errors.

Reference

[1] J. McCalley, W. Jewell, T. Mount, D. Osborn, and J. Fleeman, "A wider horizon," *IEEE Power Energy Mag.*, vol. 9, no. 3, pp. 42–54, 2011.

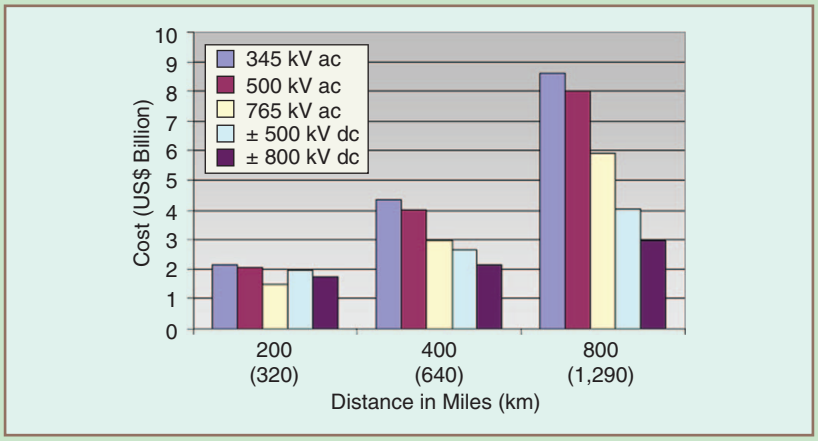

figure 4. Cost comparisons of various HVdc and EHVac distance options for 6,000 MW of capacity.

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