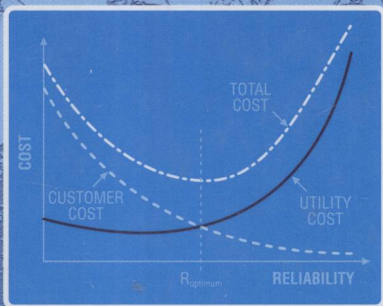
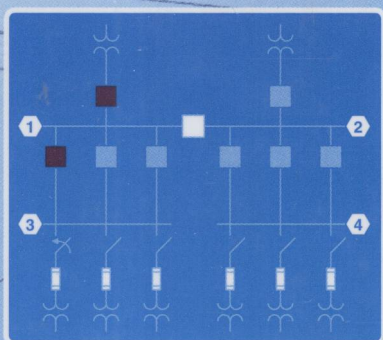


# POWER DISTRIBUTION SYSTEM RELIABILITY

PRACTICAL METHODS AND APPLICATIONS

Ali A. Chowdhury  
Don O. Koval



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Don O. Koval



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*To my wife Razia, daughter Fariha, late parents Hesamuddin Ahmed and Mahfuza Khatun, late elder brother Ali Hyder, and late older sister Chemon Ara Chowdhury*

*—Ali A. Chowdhury*

*To my wife Vivian, my mother Katherine, and late father Peter Koval*

*—Don. O. Koval*

---

# PREFACE

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Historically, the attention to distribution reliability planning was proportional to the operating voltage of utilities and the primary focus was on generation and transmission reliability studies. It has, however, been reported in the technical literature that approximately 80% of the customer interruptions occur due to the problems in the distribution system. Under the new era of deregulation of power utilities, the focus has shifted to distribution systems to economically provide a reliable service. There are not many textbooks in the world dealing with topics in power distribution reliability planning and operation. We found that many of the theoretical examples presented in the literature were not representative of actual distribution systems. These anomalies raise the question of their credibility in modeling these systems. There are reliability programs for calculating customer reliability indices. The details and the assumptions, however, made in some of these computer programs are not revealed. We found in many cases the results of these programs were incorrect. The basic intention of this book is to provide the theory and detailed longhand calculations and their assumptions with many examples that are required in planning and operating distribution system reliably (i.e., reliability cost versus reliability worth) and to validate the results generated by commercial computer programs.

This book evolved from many practical reliability problems and reports written by us while working for various utilities (e.g., Alberta Power Ltd, BC Hydro, SaskPower, and MidAmerican Energy Company) in North America over the past 40 years. Some of the book materials evolved from the content of the reliability courses taught by Dr. Don Koval at the University of Alberta. The book has been written for senior-level undergraduate and graduate-level power engineering students, as well as practicing engineers in the electric power utility industry. It can serve as a complete textbook for either a one-semester or two-semester course.

It is impossible to cover all aspects of distribution system reliability in a single book. The book attempts to include the most important topics of fundamentals of probability and statistics, reliability principles, applications of simple reliability models, engineering economics, reliability analysis of complex network configurations, designing reliability into industrial and commercial power systems, application of zone branch reliability methodology, equipment outage statistics, historical assessment, deterministic planning criteria, important factors related to distribution standards, standards for re-regulated distribution utility, customer interruption cost models for load point reliability assessment, value-based predictive reliability assessment, isolation and restoration procedures, meshed distribution system layout, radial feeder



reconfiguration analysis, distributed generation, models for spare equipment, and voltage sags and surges at industrial and commercial sites that are routinely dealt by distribution engineers in planning, operating and designing distribution systems. The special feature of this book is that many of the numerical examples are based on actual utility data and are presented throughout all chapters in an easy-to-understand manner. Selected problem sets with answers are provided at the end of the book to enable the reader to Review and self-test the material in many of the chapters of the book. The problems range from straightforward applications, similar to the examples in the text, to quite challenging problems requiring insight and refined problem-solving skills. We strongly believe that the book will prove very useful to power distribution engineers in their daily engineering functions of planning, operating, designing, and maintaining distribution systems.

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ALI A. CHOWDHURY  
DON O. KOVAL

*Folsom, California*  
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