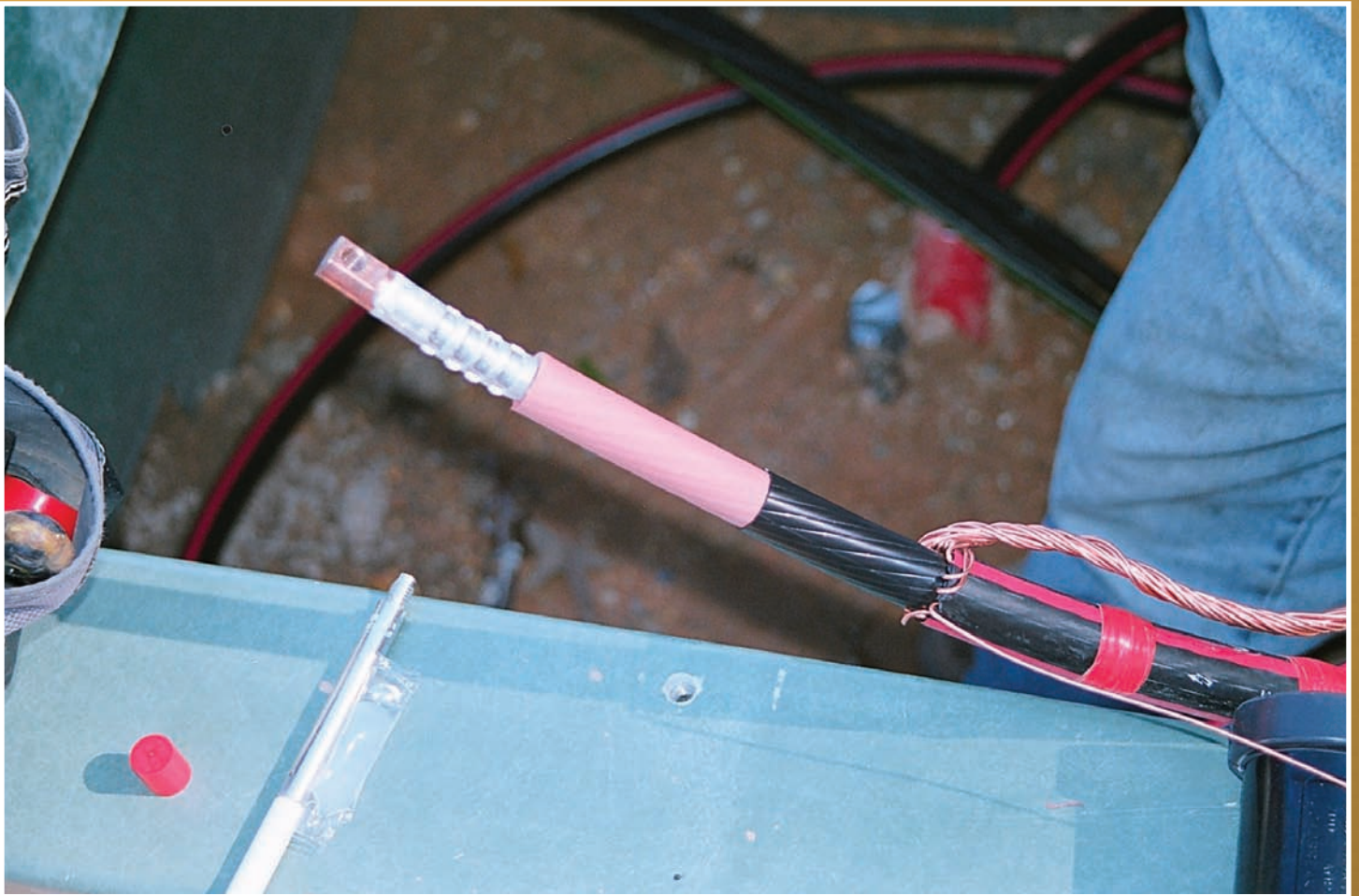


EPRI Underground Distribution Systems Reference Book



EPRI Underground Distribution Systems Reference Book

1012306

Technical Update, December 2006

EPRI Project Manager

M. Olearczyk

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ABSTRACT

EPRI is sponsoring the development of a first edition of the *Underground Distribution Systems Reference Book*. The first volume will be published in 2008 and join the EPRI colored book series and become commonly known throughout the industry as “the EPRI Brown Book.”

In 1931, the first definitive treatise had been published as the *Underground Systems Reference Book* by the National Electric Light Association. As operating voltages and load demands increased after the Second World War, changes were then driven by technical improvements of insulating materials and protection devices to increase the reliability of service. At the same time, the need for the optimization of safety and aesthetics drove distribution systems underground with a designed life expectancy of 40 years. The original industry reference noted above was revised by the Edison Electric Institute in 1957. Unknown to the designers of those early underground distribution systems; customer demand would exceed their projections, the weather phenomenon of what was coined as a “heat storm” would occur repeatedly at the turn of the 21st century, with no signs of reversal, and the utilities would be deregulated, experience more frequent operational disruptions, and witness the loss of its experienced staff.

It is well appreciated that each utility is unique and that its distribution systems must reflect the requirements of its customers. However, all utilities share the same customer demands and technical resources, and indeed the same type of equipment and cables, hence the same problems. This has become a very serious reliability and maintainability issue for all distributions power utilities now operating in a deregulated industry.

EPRI is very aware of this dilemma from its members and the industry as a whole.

EPRI intends to provide a definitive reference book from the best sources of current information and thinking for the benefit of those now responsible and future caretakers of underground distribution systems. The final deliverable publication is being written as a training tool for new engineers, operators and planners, as well as a reference manual for experienced personnel. Publication and release of this document is currently scheduled for December 2008.

CONTENTS

1 INTRODUCTION	1-1
Objectives and Approach	1-2
2 HISTORICAL PERSPECTIVE	2-1
3 EVALUATION METHODOLOGY	3-1
4 PROJECT PLANS	4-1
Production Launch Workshop	4-1
5 PRODUCTION	5-1
General Approach to Production	5-1
A PROPOSED TABLE OF CONTENTS	A-1
B PUBLICATIONS REVIEWED	B-1
C SAMPLE STATEMENT OF WORK FOR AUTHORS AND REVIEWERS	C-1
D AUTHOR'S GUIDE	D-1

1

INTRODUCTION

EPRI is sponsoring the development of a first edition of the *Underground Distribution Systems Reference Book*. The plan is to publish the reference book in 2008 and add it to the EPRI colored book series commonly known throughout the industry. This publication will be called the EPRI Brown Book. There have been significant changes in both technology and the needs of utilities since the last relevant publication on this topic. This project will compile the most up-to-date technical information on underground distribution systems. The main thrust this year was to complete a comprehensive and detailed historical background review on relevant industry publications to identify a meaningful and appropriate “Table of Contents” for the Brown Book publication. Effort was also directed to developing a production approach to create the first edition of the book based on a 2008 completion schedule.

Utility companies that own and operate underground distribution systems face a number of challenges. They must reduce costs, improve system reliability, increase power throughput, and ensure health and safety. At the same time, many of these companies are losing their core of experienced cable engineers. The Edison Electric Institute published several underground distribution industry reference books in the past which have provided underground distribution companies with a valuable tool for meeting these challenges. The EEI books provide a desk and field compendium on the general principles involved in the planning, design, manufacture, installation design, installation, testing, operation, and maintenance of underground cable systems. The books were written by leading utility and industry experts, and represent practices from all parts of the United States. However, despite the value and popularity of the EEI books, elements of the books’ content have become increasingly outdated, and do not reflect the latest developments in technology and utility practices. Furthermore, the EEI books were last updated in 1957 and no other body of work is available for utilities today. EPRI intends to bridge this gap with the Brown Book. The Brown Book will join as another in a series of landmark EPRI reference “colored” books published for the industry. The EPRI reference colored books—on topics such as overhead line transmission, underground transmission, wind-induced conductor motion, and compact line design—brought together leading experts to compile state-of-science information on the design, construction, and maintenance of these systems.

The EPRI Brown Book will compile a wealth of information, however, it is not intended to provide an exhaustive treatment of all subjects associated with underground distribution systems; more detail is available in the references cited in the book. Instead the book will serve as a handy reference guide, compiling a large amount of information in one place.

The book will also serve as basis for training new distribution engineers in underground distribution systems. When used in conjunction with in-house training, it enables new engineers to come up to speed more quickly, thereby saving time and money.

Objectives and Approach

The goal of the EPRI *Underground Distribution Systems Reference Book* will be to document the latest information on underground distribution theory and practice, and to ensure the functionality and ease-of-use of the book.

The approach to publish the *Underground Distribution Systems Reference Book* is as follows.

- **Historical Review Stage.** In 2006, EPRI selected industry experts to review the most relevant underground distribution reference books and determine what materials were still relevant and what updating and changes are needed to the existing available content and what new information needs to be added. The reviewers were chosen to review particular references based on their knowledge and experience in specific aspects of underground distribution systems. The review identified changes required, missing information, errors, dated information, etc. This stage was completed at end 2006 and follows in Chapter 2.
- **Macro-Review Stage.** In early 2007, EPRI will convene a meeting of the reviewers— together with the EPRI *Underground Distribution Systems Reference Book* Working Group and EPRI staff—to present and debate the content and make-up of the proposed chapters derived from the Historical Review Stage. The meeting is intended as a first step to develop a consensus on the scope and scale of the initial chapters, a final table of contents for the book, content and scope of new chapters, new information to be provided across chapters, and the level of effort needed. The meeting is also intended to begin identification of experts interested in writing and reviewing the new edition.
- **Chapter Production Stage.** A Statement of Work has been developed for revision of existing reference books and production of new materials, and contract offers will be issued to selected prospective authors and reviewers. Teams of one to three experts, depending on the chapter, will be hired to write the chapters. The start date for writing is March 2007. One or more meetings of writing teams and project advisors will be held during 2007 to discuss issues arising in the writing and to review drafts. In addition, periodic teleconferences will be held during the year to review progress and share results among the writing teams. A technical writer has been retained and assigned to the project to help with the drafting and layout of each chapter. The current schedule calls for writing of half the book to be complete by 2007, and for the publishing stage to be complete by the end of 2008.

2

HISTORICAL PERSPECTIVE

The history of electric power distribution systems in the United States indicates that they were first designed, constructed and operated by the Edison Companies to serve urban areas of major cities about 100 years ago. Overhead installations became commonplace by the First World War and underground installations were limited. By 1931 the first definitive treatise had been published as the Underground Systems Reference Book by the National Electric Light Association. As operating voltages and load demands increased after the Second World War, changes were then driven by technical improvements of insulating materials and protection devices to increase the reliability of service. At the same time, the need for the optimization of safety and aesthetics drove distribution systems underground with a designed life expectancy of 40 years. The original industry reference noted above was revised by the Edison Electric Institute in 1957. Unknown to the designers of those early underground distribution systems; customer demand would exceed their projections, the weather phenomenon of what was coined as a “heat storm” would occur repeatedly at the turn of the 21st century, with no signs of reversal, and the utilities would be deregulated, experience more frequent operational disruptions, and witness the loss of its experienced staff.

Most notably, since 1990 there have been an increasing number of underground distribution system failures resulting in large blackouts lasting days. With the current level of knowledge it is clear that these outages will most likely continue and perhaps accelerate if proper measures are not taken to improve service reliability. It is well appreciated that each utility is unique and that its distribution systems must reflect the requirements of its customers. However, all utilities share the same customer demands and technical resources, and indeed the same type of equipment and cables, hence the same problems. This has become a very serious reliability and maintainability issue for all distributions power utilities now operating in a deregulated industry. EPRI is very aware of this dilemma from its members and the industry as a whole. At this point in time the brain trust for all the experience and knowledge related to the existing underground power distribution systems has been depleted by most utilities due to attrition and downsizing, and some underground equipment manufacturers no longer exist. To help remedy this situation for its members, and the industry as a whole, EPRI intends to provide a definitive reference book from the best sources of current information and thinking for the benefit of those now in charge and future caretakers of underground distribution systems. The final deliverable publication is being written as a training tool for new engineers, operators and planners, as well as a reference manual for experienced personnel. Publication and release of this document is currently scheduled for December 2008.

The history of electric power distribution systems has been understandably driven by that of its lifeline of power delivery, the electric cable. The nature of the electrical insulation employed in medium voltage distribution cables has changed dramatically over the years. Today, the major insulation materials used are either tree-retardant crosslinked polyethylene (TR-XLPE) or ethylene-propylene rubber (EPR). Prior to this, many different insulation types were used by utilities.

First efforts to achieve insulations for underground application were focused on telegraph lines in the early to mid 1800s. These early efforts applied a variety of materials available at the time, and were designed to protect the metallic component. As summarized in the 1931 Underground Systems Reference book, materials employed in those early days included India rubber, glass sealed in wax (in a creosote-containing wood trough), cotton saturated with shellac or rosin, jute saturated in pitch (tar) covered with India rubber strips, and cotton or jute in lead-filled tubes filled with rosin or beeswax. None of these approaches, as might be assumed with today's knowledge, were satisfactory. By the mid-1800s, gutta percha was used and was found to be susceptible to oxidation over time. Edison's early work in lower Manhattan in the late 1800s, which focused on low voltage power distribution, employed gutta percha but it softened at elevated temperatures (apparently not an issue for the telegraph lines). Further approaches employed copper rods wrapped in jute and covered with bitumen in a pipe. Eventually, the concept changed as it was realized that a better approach was to apply a superior covering to the conductor itself, for best insulation and moisture resistance properties. Paper was applied helically around the conductor and saturated in rosin-based oil, and placed in a lead pipe. The construction is similar to that being used today for PILC cables. Paper-insulated lead covered (PILC) cables were first employed for distribution voltages at the beginning of the 20th century. By the early 1930s, three types of insulations dominated the distribution cable system (a) natural rubber (simply referred to as 'rubber' as synthetic rubbers had not yet been developed), (b) varnished cambric (woven cotton cloth coated with varnish and with a moisture repellent material between the layers), and (c) oil-impregnated paper. The natural rubber was compounded with (~40%) fillers to achieve mechanical strength (much like today's EPRs). However, oil-impregnated paper was favored due to its lower cost and superior high temperature resistance.

Of interest also in reviewing the almost 80 year old literature (1931 handbook) is how lessons of that day still apply today (and have either been forgotten or not emphasized adequately). For example it is stated "Any unqualified statement about breakdown strength of a piece of cable is meaningless. Any statement about breakdown strength must be accompanied by qualification as to frequency, time of application and rate of raising voltage etc. if it is to have any significance". Use of the term 'meaningless' is pretty strong language. This is a lesson that applies equally well today regardless of the advances in insulation materials, shields, jackets, and manufacturing technology and total distribution system designs.

As noted, small quantities of PILC are still used today, but the market has been overshadowed by use of synthetic polymers. Butyl rubber was the first synthetic polymeric elastomer to be used, and this was later replaced by EPR (late 1950s-early 1960s). EPR had maintained a constant share of the market until the early 1980s when its use started to increase. Polyethylene (PE) was developed prior to World War 2, and its application as an insulation material became immediately apparent due to its low dielectric constant, low power factor, and high dielectric strength. It was initially used for communication cables. PE was demonstrated to be resistant to water transmission, had high dielectric strength, low dissipation factor and was easier to handle (install and maintain) than paper-insulated cables. Among other things, it allowed for the elimination of a lead sheath. In the 1960s it rapidly replaced PILC for utility use at distribution voltages. It was used for low voltages (600V to 46 kV). Most installations to this time were overhead, but during the Johnson administration in the mid-1960s, a move accelerated to 'beautify' the landscape/environment, and high molecular weight polyethylene (HMWPE) insulated cables were installed underground and direct buried. Unlike today, these cables wereunjacketed.

By the early 1970s it was becoming apparent the PE-insulated cables were failing much sooner than their projected (40 year) life; although HMWPE had excellent resistant to moisture transmission, when applied as insulation and operating under applied voltage stress, water did indeed penetrate into the insulation and induced a slow but steady degradation process called 'water treeing'. This slow degradation process led to a reduction in the dielectric strength and eventually to premature failures. Laboratory work had demonstrated that XLPE was more resistant to water treeing than HMWPE; it became available as a substitute for HMWPE in the late 1960s-early 1970s, and resistance to water treeing in service aged cables did indeed improve. XLPE gradually became accepted as replacement insulation for HMWPE. Nevertheless, over time, XLPE insulation was also demonstrated to be susceptible to water treeing. In the 1970s, jackets were coming into use more often in underground cables (to reduce water penetration) on primary cable constructions and, while jackets did assist in extending the life of the extruded cables, their use did not prevent premature failures. Different polymeric materials were used for jackets; e.g., low, medium or high density polyethylene or polyvinyl chloride, and each possessed a different degree of resistance to water penetration. It was later demonstrated that XLPE-insulated cables of the same construction survived longer with a superior jacket, or if installed in ducts. It perhaps should be noted that even though the nature of the insulation employed for new cables improved, the utilities still had significant quantities of the older insulated cables installed. When a failure occurred and the failed section removed, it often became necessary to splice older constructions to newer (improved) constructions. The need for improvements advanced on several fronts in the late 70s-late 80s. The search for means to keep water out of the insulation led to changes in the manufacturing process, it had been common to produce XLPE-insulated cables by inducing crosslinking via steam processing in a catenary tube (followed by cooling in a water trough). It was felt that water could be introduced into the construction in that manner. A move away from steam curing to dry curing took place.

The nature of the shield materials gained more attention also, and it was learned that the commonly used insulation and conductor shield materials were processed in such a manner that they retained ions in the carbon black compounds employed during extrusion. It had previously been shown that ions were contaminants and were water treeing sites; the concern now was that the ions would be migrating into the insulation during normal operation. Suppliers began to modify the manufacturing process to prevent ions from being present. Alternate grades of carbon black were also introduced. Thus the approaches employed were to find better ways to keep water out or, if water entered, prevent the water from inducing migration of ionic contaminants into the insulation. XLPE held the major share of the market into the mid-1980s.

However, a major improvement came with the introduction of TRXLPE insulation in the mid-1980s. Laboratory work, and later field installed cables, demonstrated that TRXLPE was superior to XLPE in preventing water treeing. [Tree retardant properties were generated by incorporating several additives into XLPE; that subject goes beyond the scope of this Chapter] The use of TRXLPE began to grow and steadily replaced XLPE (regardless of shield nature or processing technology). TRXLPE today possesses a major share of the medium voltage market. Note that this approach accepts that some water will enter the insulation and the concept involves technology to mitigate its influence. While these developments were taking place, the use of EPR remained steady at first, but then began to slowly grow. The slow but steady increase in the use of EPR took place throughout the 1980s and 1990s.

By the mid-1990s, EPR usage 'challenged' TRXLPE for the major market share, which exists to this day. As EPR usage has grown, it is necessary to provide some clarification of the term 'EPR'. While XLPE is a single material, and while there may be two or three TRXLPE grades on the market, there is no single EPR compound on the market that is employed by utilities. 'EPR' itself is one of several possible polymer systems that are compounded with 10-20 different ingredients to render it functional as insulation for cables. (TRXLPE is a single polymer type, and has about three to five additives.) In addition, the fact that there is a significant amount of inorganic materials present (mostly special clays) in EPRs to provide the toughness (yet flexibility) needed. Caution should therefore be exercised in referring to 'EPR'. For further information comparing TRXLPE and EPRs, references should be reviewed.

3

EVALUATION METHODOLOGY

The methodology for the evaluation as to relevancy of selected publications of interest included the following six industry reference books:

1. 1931 Underground Systems Reference Book, National Electric and Light Assn
2. 1957 Underground Systems Reference Book, Edison Electric Institute
3. ABB Distribution Handbook, fifth edition
4. 1993 Underground Distribution System Design and Installation Guide, NRECA
5. 2003 EPRI Report 1001890, Fundamentals of Forensic Investigation Procedures Guidebook
6. 2003 Electrical Power Cable Engineering , Ed by W.A.Thue, 2nd Edition

The review process began with a scan of all documents. Then the books were reviewed in the order noted above. The 1931 book and, more pointedly, the 1957 book required most time. When the latter was reviewed, it was determined that much of the information in the 1931 book was superseded by the 1957 volume. Nevertheless (it was concluded) the 1931 book did have some key information to be offered. This was so noted in the evaluation chart. However, both of those books were considered to possess severe limitations in that information on extruded cable systems was missing or minimal (not surprising as those systems did not come into usage until the 1960s).

Hence cable, joint and termination technology approaches have changed dramatically. Regardless, the PILC information included and discussed there is relevant today, as many IOUs continue to purchase and employ PILC cables.

Future analysis for this effort will separate the transmission cable discussions that are often woven in with the distribution voltage cable systems. The ABB book was found /determined to have many chapters not considered of relevance, and was 'quickest' to rank the chapters/subjects.

The NRECA book has much useful information and received high grades. The EPRI Forensics Investigation Guidebook possessed a surprising amount of useful information, which almost completely falls under the category of ‘diagnostics’; i.e., how the user should consider proceeding after distribution system equipment fails. The Thue book applies only to cables; as it was developed for the University of Wisconsin course on Power Cable Engineering. It was not intended to be a book on Distribution Systems. However, the concepts therein can be applied to broader Distribution Handbook needs. Several additional EPRI reports were scanned, but input from these was not incorporated into the Draft Table of Contents, as of this date.

To strengthen the material evaluation activity a criteria matrix was used by the expert reviewer panel. Each publication was carefully reviewed and ranked using the matrix. The tables of contents for the six publications of interest were listed and ranked by five criteria. This enabled the expert panel to flesh out the proposed table of contents backed by a quantitative process. The review panel members were encouraged to provide additional comments and identify gaps. The following guidelines were provided to the publications-of-interest reviewers for defining the relevancy of specific sections of text:

Very Relevant – Having high current and future bearing to fully understanding key aspects of Underground Systems; crucially noteworthy or significantly important details with regards to the knowledge of Underground Systems; extremely useful information to prevent the reinvention of wheels.

Relevant – Pertinent and germane information that relates fully and has a direct bearing to understand and operate current Underground Systems.

Partially Relevant – Material that is to a degree, but not totally, relevant and will require editing.

Basics that are Relevant – Look for tutorials or foundational reviews of basic scientific knowledge or fundamental engineering principles and discoveries necessary to understand the technology applied to Underground Systems. This selection criterion is in addition to the three grading levels above.

Not Relevant – These materials were considered and deleted for reason. The content is not applicable to present and future Underground Systems; it may be obsolete and is not important to understanding existing or future systems, equipment and materials.

The results of this effort can be found in Appendix A, Proposed Table of Contents.

4

PROJECT PLANS

Progress was made in 2006 on defining the scope and direction of the *Underground Distribution Systems Reference Book* and in identifying those who will participate in writing and reviewing the book.

Production Launch Workshop

EPRI plans a production launch workshop in early 2007 (location TBD), to discuss the *Underground Distribution Systems Reference Book*. Attendees will include industry experts who had been retained to review chapters. Also participating in the meeting will be EPRI staff and members of the *Underground Distribution Systems Reference Book* Working Group, which consists of utility advisors responsible for guiding the review and rewriting of the book. The purpose of the meeting is to refine and clarify the mission statement for the book—which will further define the audience, level of understanding, and the kind of book to be developed—and to discuss revision of each chapter. Chapters will be discussed one by one, for each chapter; the expert who had reviewed the chapter will make a brief formal presentation, followed by debate and discussion among the group as a whole. One to three hours is planned for each chapter. It's expected that the meeting will result in consensus on the work plan for 2007 and each chapter, including its content and level of effort, will be determined. It's also expected that agreement on new information and chapters will be added to the book.

Following the workshop Statements of Work and contract “offers” will be developed and sent to selected authors and reviewers in early 2007. However, funding for 2007 will determine the scale and scope of work for prospective authors and reviewers.

A number of utility advisors expressed interest in having an electronic version of the *Underground Distribution Systems Reference Book*. In addition, participants have indicated the need for focused training using the *Underground Distribution Systems Reference Book* as text for course and continuing education units. EPRI intends to explore these requests and, if feasible, deliver the volume in electronic media and offer training using the reference as a textbook.

5

PRODUCTION

Utility advisors agreed on the general approach to identification of new chapters and or the revision of each existing chapter, and the organization and table of contents for the new edition would be based largely on the results of the historical review.

General Approach to Production

The general approach to production of the Underground Distribution Reference book includes the following:

- **Audience.** The audience for the update will be utility personnel (primarily underground distribution engineers) and consultants.
- **Purpose.** The book will be an advanced explanatory guide and a ready desk and field reference.
- **International.** The primary focus of the book will be North American designs and practices, but international technologies and methods will be added as needed.
- **Length.** The length of the book is yet to be determined.
- **Level of Information.** The book will not include fundamental derivations and tables.
- **Value judgments.** Value judgments unsupported by facts are to be avoided. The approach should be to state the facts or to define the factors.
- **Chapter Structure.** In each chapter, information that is common to all will be consolidated at the beginning of the chapter. Information on differing issues will be presented after that.
- **Author Recognition Page.** Each chapter will begin with an Author Recognition page, which will consist of a single page having the name, affiliation, contact information, picture and brief bio of each author of that chapter.
- **Figures.** The book will include many new and updated pictures and graphics.
- **Applets.** The book will not be accompanied by “applets,” which are simple software applications.

A

PROPOSED TABLE OF CONTENTS

1. Historical Perspective of Underground Distribution Systems
 - 1.1 Introduction
 - 1.2 Historical Perspective of Underground Distribution (UD) Electrical Cables

2. Cable Materials and Components
 - 2.1 Dielectric Theory
 - 2.2 Types of UD Systems
 - 2.3 Typical Cable Configuration
 - 2.4 Cable Conductors
 - 2.4.1 Conductor Size Destinations
 - 2.4.2 Conductor Materials and Configuration
 - 2.5 Cable Insulation Materials
 - 2.6 Conductor and Insulation Shields
 - 2.7 Cable Jackets
 - 2.8 Shielding of Power Cables

3. Underground Distribution Systems Designs
 - 3.1 Types of Underground Distribution Systems
 - 3.2 Primary and Secondary Network Distribution Systems
 - 3.2.1 Radial
 - 3.2.2 Looped
 - 3.2.3 Primary Selective
 - 3.3 Primary System Design

- 3.4 Network Secondary System Design
 - 3.4.1 Introductions to Underground Secondary Networks
 - 3.4.2 Planning and Initial Secondary Network
 - 3.4.3 Secondary System Design
- 3.5 Underground Distribution System Components
- 3.6 Factors Governing Adoption of Underground Construction
- 3.7 Steps for Layout of a UD System
- 3.8 Site and System Environmental Conditions
- 3.9 Cable Selection and Specifications
- 3.10 Relevant Standards, Codes and Practices
 - 3.10.1 Cable Manufacturing
 - 3.10.2 Cable Acceptance
 - 3.10.3 General Principles for Tagging and Identification-Cables
 - 3.10.4 Reasons for and Benefits of Cable Testing by the User
 - 3.10.5 Primary Cable Tests by the User
 - 3.10.6 Secondary Cable Test by the User
 - 3.10.7 Summary and Recommendations for Cable Testing by the User
- 3.11 Conduit, Duct and Manhole Systems
 - 3.11.1 Factors Governing Adoption of UD Construction
 - 3.11.2 Introduction to Conduits, Ducts and Manholes
 - 3.11.3 Conduit and Duct System Design and Installation
 - 3.11.4 Conduit and Duct Construction
 - 3.11.5 Cable in Shafts and Tunnels
 - 3.11.6 Conduit and Duct Materials
 - 3.11.7 Explosion Mitigation
 - 3.11.8 Cable and Duct Temperatures Including Impact of Steam Lines
 - 3.11.9 Safety Considerations

- 3.12 Vault Design and Construction
 - 3.12.1 Cable and Equipment Layout
 - 3.12.2 Ventilation and Flooding Control
 - 3.12.3 Upgrades and Modifications
 - 3.12.4 Safety Considerations
- 3.13 Economics
 - 3.13.1 Systems Design Economics Comparison
 - 3.13.2 Underground Loss Economics
- 3.14 Summary and Recommendations

4. Installation

- 4.1 Receiving and Handling of Cables
- 4.2 Cable Installation Procedures
- 4.3 Cable Pulling Operations
- 4.4 Cable Duct Equipment for Cable Installation in Compression and Tension
- 4.5 Cable Duct Installation and Withdrawal
- 4.6 Direct Buried Cable
- 4.7 Trenching and Backfill Considerations
 - 4.7.1 Multiple Utilities in the Same Trench Considerations
 - 4.7.2 Plowing
 - 4.7.3 Boring
 - 4.7.4 Vibration
 - 4.7.5 Use of Underground RADAR
 - 4.7.6 Fire Protection
 - 4.7.7 Relevant Codes, Standards and Practices
- 4.8 Safety Considerations

5. Ratings

- 5.1 Ampacities
 - 5.1.1 Primary Cable Ampacity
 - 5.1.2 Secondary Cable Ampacity
- 5.2 Physical Properties/Thermal Loading
- 5.3 Thermal Limitations from Cable and Underground Equipment Loading
- 5.4 Calculations and Load Capabilities
- 5.5 Summary and Recommendations for Equipment Loading
- 5.6 BIL
- 5.7 Capacitance
- 5.8 Bonding

6. Accessories

- 6.1 Introduction
- 6.2 Joint and Termination Design Theory
- 6.3 Practical Considerations
- 6.4 Electrical Design Features
- 6.5 Physical Design Features
- 6.6 Application of Joints, Elbows and Terminations
- 6.7 Joints, Elbows and Terminations for 200 Ampere Primary Circuits
- 6.8 Joints, Elbows and Terminations for 600 Ampere Primary Circuits
- 6.9 Splicing Terminating Accessories
- 6.10 Connectors
- 6.11 Network Protectors
- 6.12 Molded Vacuum Interrupters
- 6.13 Sub-Transmission Sectionalizing Devices
- 6.14 General Sectionalizing Philosophy

- 6.15 Fault Indicators
- 6.16 Switches
- 6.17 Splices - Both Early and Recent Techniques
- 6.18 Summary and Recommendations

7. Transformers

- 7.1 Load Capabilities for Transformers
- 7.2 Testing Instruments and Monitoring Equipment
- 7.3 Pad-Mounted Transformer Sizing
- 7.4 Distribution Transformer Connections
- 7.5 Testing Methods
 - 7.5.1 Power Factor
 - 7.5.2 Megger PI
 - 7.5.3 Oil Testing Program
 - 7.5.4 Interpretation of Test Results for DGA, Moisture, PCB etc.
- 7.6 Oil Leaks, Rust
- 7.7 Cooling

8. Operations and Maintenance

- 8.1 Introduction to Records - Repairs and Maintenance
- 8.2 Operating Records
- 8.3 Inspections
- 8.4 Re-Closing Considerations for Cable Longevity
- 8.5 Fuse Considerations
- 8.6 Use of Current Limiting Fuses
- 8.7 Replace or Repair Decisions
- 8.8 Protective Device Response Measurement and Location

- 8.9 Splicing Methods and Craftsmanship
- 8.10 Relays and Computer Controls
 - 8.10.1 Relay Protection
 - 8.10.2 System Electrical Maps and Data Control

9. Reliability

- 9.1 Reliability of UD Systems
- 9.2 System Operations and Maintenance
- 9.3 Cable Performance
- 9.4 Field Assessment of Power Cables
- 9.5 External Factors Beyond Utility Company Control
- 9.6 Relevant Standards, Codes and Procedures
- 9.7 Component Reliability
- 9.8 Evaluation of Cable Life Expectancy
- 9.9 Overhead vs. Underground
- 9.10 Impact of Primary Voltage Levels
- 9.11 Impact of Major Events

10. Cable and Component Aging

- 10.1 Analysis of Cable Failures
- 10.2 Treeing
- 10.3 Wet vs. Dry Environment
- 10.4 Effects of Temperature
- 10.5 Conduit vs. Direct Buried
- 10.6 Soil Thermal Resistivity
- 10.7 Impregnation Technology
- 10.8 Evaluation and Decision Procedures

11. Asset Management

- 11.1 Operation Quality
- 11.2 Load Flow Studies
- 11.3 Service Area Surveys
- 11.4 Planning and Forecasting
- 11.5 Condition Assessment
- 11.6 Transitioning Cable and Equipment Improvements
- 11.7 Economics and Valuation

12. Fault Location

- 12.1 Description of Tracer Methods for Cable Fault Location
- 12.2 Underground System Fault Location
- 12.3 Techniques for Primary and Secondary Fault Location
- 12.4 Cable Testing for Fault Location and Cable Identification
- 12.5 Summary and Recommendations for Underground System Sectionalizing
- 12.6 Fault Recordings
- 12.7 Fault Indicators
 - 12.7.1 Faulted-Circuit Indicators
 - 12.7.2 Faulted-Equipment Indicators
- 12.8 Radar
- 12.9 Thumpers
- 12.10 Hybrids

13. Corrosion

- 13.1 Concentric Neutral Corrosion
- 13.2 Corrosion Causes and Results
- 13.3 Equipment Subject to Cathodic Corrosion

- 13.4 Instruments and Testing Equipment
- 13.5 Types of Cathodic Protection Systems
- 13.6 Cathodic Protection Design with Galvanic Anodes
- 13.7 Cathodic Protection Installation and Follow-up
- 13.8 Calculation of Resistance to Ground
- 13.9 What to Protect Against Cathodic Corrosion
- 13.10 Where to Protect Against Cathodic Corrosion
- 13.11 Amount of Cathodic Protection Required
- 13.12 Summary and Recommendations

14. Over-Current/Voltage Protection and Relaying

- 14.1 Over-Current and Over-Voltage Protection of Cable Systems
- 14.2 Lightning Protection
- 14.3 Arrester Ratings and Types
- 14.4 Impact of Voltage Level on Arrester Protective Margins
- 14.5 Open Point Reflections
- 14.6 Characteristics of Lightning Surges
- 14.7 Characteristics of Switching Surges
- 14.8 Relay Protection Design Scheme
- 14.9 Relay Equipment Selection
- 14.10 Relay Maintenance and Testing
- 14.11 High-Speed Fault Recorders
- 14.12 High-Speed Fault Data Analysis

15. Cable Testing and Diagnostics

- 15.1 Factory Testing of New Cables:
 - 15.1.1 Partial Discharge
 - 15.1.2 1.5 or Other PU Time Test
- 15.2 Field Testing:
 - 15.2.1 Acceptance
 - 15.2.2 Maintenance
- 15.3 Field Testing Methods Non-Predictive:
 - 15.3.1 DC Hi Pot
 - 15.3.2 VLF
 - 15.3.3 Megger
 - 15.3.4 Polarization Index
- 15.4 Field Testing Methods Predictive:
 - 15.4.1 Partial Discharge
 - 15.4.2 Loss Measurement for Low and Variable Frequencies
 - 15.4.3 Pre-Discharge

16. Failure Analysis

- 16.1 Introduction to the Forensics Process for Failure Analysis
- 16.2 Forensic Analysis Process Applied to Electric Power Distribution Systems
- 16.3 Preparation for the Site Investigation
- 16.4 Incident Investigation First Response
- 16.5 Response and Task Prioritization
- 16.6 Site Investigation Procedures
- 16.7 Restoration Coordination
- 16.8 Initial Facts Assembly
- 16.9 Visual Inspections

- 16.10 Documentation
- 16.11 Similar Equipment Comparison
- 16.12 Selected Testing at Incident Site
- 16.13 Evidence and Sample Collection
- 16.14 Incident First Response Report
- 16.15 Data Collection
 - 16.15.1 Original Equipment Manufacturers (OEM) Data
 - 16.15.2 Equipment History as a Class
 - 16.15.3 Relevant Equipment Operation Records
 - 16.15.4 Relevant Systems Maintenance and Commissioning Records
 - 16.15.5 System and Equipment Electrical Conditions
 - 16.15.6 Official Reports and Media Materials
- 16.16 Witness Interviews
 - 16.16.1 Early Identification of Individuals
 - 16.16.2 Procedures for Conducting a Witness Interview
- 16.17 Forensic Root Cause Analysis
- 16.18 Post Event Testing
 - 16.18.1 On-Site Testing
 - 16.18.2 Laboratory Testing
- 16.19 Case Studies of Failure Analysis Investigations
 - 16.19.1 Department Store Feeder Failures
 - 16.19.2 Cable Failure (URD)
 - 16.19.3 Secondary Arcing in a Trench with a Co-Located Gas Line
 - 16.19.4 Improper Storage of a Submarine Cable Samples

17. Ferroresonance

- 17.1 Cause
- 17.2 Impact of Voltage Level and Cable Capacitance
- 17.3 Impact of Transformer Connection and Loading
- 17.4 Allowable Over-Voltages during Ferroresonance
- 17.5 Impact on Arrester Application
- 17.6 Mitigation
- 17.7 Recommendations

18. Maps and Records

- 18.1 GPS
- 18.2 GIS
- 18.3 Cable Identification

19. Grounding

- 19.1 Cable Grounding System Function
- 19.2 Factors Affecting Cable Grounding System Performance
- 19.3 System Ground Resistance Measurement and Calculation
- 19.4 Summary and Recommendations for Grounding Systems
- 19.5 Standards and Practices
- 19.6 Ground Rods
- 19.7 Fault Impedance Considerations
- 19.8 Impact on Fault Levels
- 19.9 Impact on Surges
- 19.10 Stray Voltage Considerations

20. Switching and Sectionalizing

- 20.1 Manual
- 20.2 Automatic
- 20.3 Arrangement and Design
- 20.4 Ferroresonance
- 20.5 Fault Isolation and Grounding
- 20.6 Safety Issues
- 20.7 Stray Voltage Checks
- 20.8 Relaying
- 20.9 Electromechanical
- 20.10 Microprocessors
- 20.11 Distribution Automation SCADA

21. Training

- 21.1 Splicing
- 21.2 Terminations
- 21.3 Elbows
- 21.4 Salvage of Lead and PCB's
- 21.5 Safety

22. Safety

- 22.1 PPE and Arc Deflection and Blast Suppression Blankets
- 22.2 OSHA 1910.269 & .335
- 22.3 ASTM 10.03
- 22.4 NESC

23. Street Lighting Systems

- 23.1 Introduction
- 23.2 Selection of Street Lighting System
- 23.3 Series Street Lighting Systems
- 23.4 Multiple Street Lighting Systems
- 23.5 Design of Street Lighting Systems
- 23.6 Cable Construction for Street Lighting Systems
- 23.7 Maintenance of Street Lighting Systems
- 23.8 Upgrading Street Lighting Systems

24. Planning

- 24.1 Development
- 24.2 Estimated Load Growth
- 24.3 Power Quality Issues
- 24.4 Infrastructure Short and Long Range Issues
- 24.5 Safety Issues
- 24.6 Anticipated Capital Improvements
- 24.7 Studies for Future Performance

25. Future of Underground Power Distribution Systems

APPENDICES

REFERENCES

B

PUBLICATIONS REVIEWED

Publications Reviewed

PUBLICATION TITLES		VERY Relevant (X)	RELEVANT (X)	PARTIALLY Relevant (X)	BASICS Relevant (X)	NOT Relevant (X)	Attach Comments on Separate Page (record line reference as below) EX: A. III. 2.
Underground Systems Reference Book, National Electric Light Association, 1931							
I.	INTRODUCTION						
II.	CABLE AND CABLE INSULATION						
	1. Introduction						
	2. Cable Design						
	3. Theory of Dielectrics						
	4. Characteristics of Paper Insulated Cables and Their Significance						
	5. Specifications						
	6. Acceptance Inspection and Testing of Cables						
	7. Research Activities Paper Insulated Cable						
	8. Trend of Development						
III.	CONDUIT AND MANHOLES						
	1. Historical						
	2. Design – Trunk Lines						
	3. Design – Distribution System (Local)						
	4. Manholes (Cable)						
	5. Manholes (Transformers)						
	6. Conduit Construction						
IV.	CABLE INSTALLATION						
	1. Introduction						
	2. Equipment for Installation of Underground Cable						
	3. Installation and Removal of Cable						
	4. Arrangement and Support of Cable in Manholes						
	5. Installation of Buried Cable						
	6. Installation of Aerial Cable						
	7. Installation of Submarine Cable						
	8. Installation of Cable in Shafts and Tunnels						
	9. Fireproofing of Cables and Duct Entrance Protection						
	10. Bonding						
	11. Cable Salvage						
V.	CABLE SPLICES AND TERMINALS						
	1. Introduction						
	2. Insulating Materials						
	3. Design						
	4. Types of Splices						
	5. Terminal Arrangements						
	6. Training Workmen						
	7. Hardware and Tools						
	8. Duct Splices						
VI.	CABLE OPERATION						

	1. Testing and Trouble Finding						
	2. Cable Identification						
	3. Repairs and Maintenance						
	4. Analysis of Cable Failures						
	5. Electrolysis, Bonding and Grounding						
	6. Cable and Duct Temperatures						
VII.	MISCELLANEOUS EQUIPMENT FOR UNDERGROUND INSTALLATIONS						
VIII.	SAFETY PRACTICES						
	1. Accidents						
	2. Safety Organization						
	3. Safe Practices						
	4. Checking of Safety Devices						
	5. First Aid						
	APPENDIX I. GENERAL INFORMATION						

PUBLICATION TITLES		VERY Relevant (X)	RELEVANT (X)	PARTIALLY Relevant (X)	BASICS Relevant (X)	NOT Relevant (X)	Attach Comments on Separate Page (record line reference as below) EX: A. III. 2.
Underground Systems Reference Book, Edison Electric Institute, 1957							
I.	APPLICATIONS FOR CABLE AND CABLE SYSTEMS						
	1. Factors Governing Adoption of Underground Construction						
	2. Types of Transmission and Distribution Systems						
	3. Selection of Type of Cable System and Cable						
	4. Economic Studies						
II.	CABLE AND CABLE INSULATION						
	1. Introduction						
	2. Conductors						
	3. Insulations						
	4. Coverings						
	5. Cable Design and Manufacture						
	6. Specification Tests and Their Significance						
III.	BULK POWER SYSTEMS						
	1. Introduction						
	2. Pipe-Type Systems						
	a) Pipe and Manhole Design						
	b) Pipe and Manhole Construction						
	3. Cable and Accessories						
	a) General Design Features						
	b) General Features of Installation						
	c) Oil-Pressure Systems, Specific Features						
	d) High-Pressure Gas Systems, Specific Features						
	4. Cables in Ducts						
	a) Ducts and Manholes						
	b) Cables and Accessories (General Design Features)						
	c) Medium-Pressure Gas-Filled Systems, Specific Features						
IV.	UNDERGROUND RADIAL AND LOOP SYSTEMS						
	1. Introduction						
	2. Underground Radial and Loop Subtransmission Systems						
	a) Basic Principals of Radial and Loop Systems						
	b) Subtransmission Sectionalizing Devices						
	c) Types of Cable Construction						
	d) Conduit System Design						
	3. Conventional Underground Radial Systems						
	a) Introduction						
	b) Primary System Design						
	c) Transformers						
	d) Secondary System Design						
	4. Underground Distribution in Residential and Rural Areas						
V.	UNDERGROUND SECONDARY NETWORKS						
	1. Introduction						
	2. Network Design						
	a) Planning an Initial Secondary Network						
	b) Secondary System Design						
	c) Primary System Design						
	d) Network Vaults						
	3. Network Equipment						
	a) Network Transformers						
	b) Network Protectors						

	c) Network Supervisory Systems								
VI.	STREET LIGHTING SYSTEMS								
	1. Introduction								
	2. Selection of System								
	3. Series Systems								
	4. Multiple Systems								
	5. Ornamental Poles and Brackets								
VII.	CONDUITS AND MANHOLES								
	1. Introduction								
	2. System Design								
	3. Conduit Construction								
	4. Manholes, Service Boxes, Vaults and Pits								
	5. Construction Methods								
	6. Construction Equipment and Tools								
	7. Specifications for Contracting Conduit Construction								
VIII.	CABLE INSTALLATION								
	1. Introduction								
	2. Duct Cable: Equipment								
	3. Duct Cable: Installation and Withdrawal								
	4. Duct Cable: Arrangement, Support and Protection in Manholes								
	5. Aerial Cable, 5-34.5 Kv								
	6. Buried Cable								
	7. Submarine Cable								
	8. Cable in Shafts and Tunnels								
IX.	CABLE JOINTS AND TERMINATIONS								
	1. Introduction								
	2. Joint and Termination Design Theory								
	3. Joint Design and Installation								
	a) General								
	b) Theoretical Considerations								
	c) Practical Considerations								
	d) Design Tests								
	e) Installation Procedures for Typical Joints								
	4. Termination Design and Installation								
	a) Electrical Design Features								
	b) Physical Design Features								
	c) Typical Design Features								
	5. Materials and Accessories for Joints and Terminations								
	6. Splicer's Tools and Equipment								
	7. Selection and Training of Cable Splicers								
X.	CABLE AND UNDERGROUND EQUIPMENT LOADING								
	1. Introduction								
	2. Buried Conduit, Cables and Pipe Cable Systems								
	3. Cables								
	a) Terminal Limitations								
	b) Calculations and Load Capabilities								
	c) Tables of Load Capabilities								
	4. Buses and Connections								
	5. Transformers								
	a) Thermal Limitations								
	b) Calculations and Load Capabilities								
	c) Load Capabilities for Transformers								
	d) Instruments and Testing Equipment and Their Use								
	6. Network Protectors								
XI.	CABLE TESTING, FAULT LOCATION AND CABLE IDENTIFICATION								
	1. Cable Testing								
	2. Cable Fault Location								
	a) Description of Terminal Measurement Methods								
	b) Description of Tracer Methods								
	c) Description of D-C Sheath Potential Difference Method								
	d) General Considerations								
	3. Cable and Phase Identification								
	4. Analysis of Cable Failures								
XII.	RECORDS, REPAIRS AND MAINTENANCE								
	1. Introduction								
	2. Engineering Records								

	3. Operating Records							
	4. Inspection							
	5. Maintenance and Repair							
	6. Maintenance of Service During Equipment Changes							
	7. Removal and Replacement of Heavy Equipment in Manholes							
	8. Hold Off Procedures							
XIII.	CABLE AND EQUIPMENT RECONDITIONING							
	1. Guiding Principles							
	2. Reconditioning Methods and Equipment							
	a) Cable Salvage							
	b) Duct Splices							
	c) Transformers							
XIV.	CORROSION							
	1. Corrosion Causes and Results							
	2. Instruments and Testing Equipment							
	3. Corrosion Surveys and Tests							
	4. Mitigation Methods							
XV.	SAFETY PRACTICES							
	1. General Principles							
	2. Safety Organization							
	3. Work Area Protection							
	4. Gas Detection and Ventilation							
	5. Protective Equipment							
	6. Fire Fighting							
	7. First Aid, Resuscitation and Rescue							

	PUBLICATION TITLES	VERY Relevant (X)	RELEVANT (X)	PARTIALLY Relevant (X)	BASICS Relevant (X)	NOT Relevant (X)	Attach Comments on Separate Page (record line reference as below) EX: A. III. 2.
	ABB (1997), Fifth Edition, Thirteenth Printing						
I.	General Considerations of Transmission						
II.	Symmetrical Components						
III.	Characteristics of Aerial Lines						
IV.	Electrical Characteristics of Cables						
V.	Power Transformers and Reactors						
VI.	Machine Characteristics						
VII.	Excitation Systems						
VIII.	Application of Capacitors to Power Systems						
IX.	Regulation and Losses of Transmission Lines						
X.	Steady-State Performance of Systems						
XI.	Including Methods of Network Solutions						
XII.	Relay and Circuit Breaker Application						
XIII.	Power-Line Carrier Application						
XIV.	Power-System Stability						
XV.	Power-System Voltages and Currents During Abnormal Conditions						
XVI.	Wave Propagation on Transmission Lines						
XVII.	Lightning Phenomena						
XVIII.	Line Design Based on Direct Strokes						
XIX.	Insulation Coordination						
XX.	Grounding of Power-System Neutrals						
XXI.	Distribution System						
XXII.	Primary and Secondary Network Distribution Systems						
XXIII.	Lamp Flicker on Power Systems						
XXIV.	Coordination of Power and Communication Systems						
XXV.	Characteristics of Distribution Loads						

	PUBLICATION TITLES	VERY Relevant (X)	RELEVANT (X)	PARTIALLY Relevant (X)	BASICS Relevant (X)	NOT Relevant (X)	Attach Comments on Separate Page (record line reference as below) EX: A. III. 2.
	Underground Distribution System Design and Installation Guide, National Rural Electric Cooperative Association, 1993						
I.	DESIGN OF AN UNDERGROUND DISTRIBUTION SYSTEM						
	1. System Components						
	2. Types of UD Systems						
	3. Reliability of UD Systems						
	4. System Operation and Maintenance						
	5. Future Upgrades and Replacements						
	6. Economic Comparison of Different System Configurations						
	7. UD Loss Economics						
	8. Steps for Layout of a UD System						
	9. Summary and Recommendations						
II.	CABLE SELECTION						
	1. Typical Cable Configuration						
	2. Conductor Size Designations						
	3. Conductor Materials and Configuration						
	4. Cable Insulation Materials						
	5. Insulation Fabrication						
	6. Conductor Shields and Insulation Shields						
	7. Cable Specification and Purchasing						
	8. Evaluation of Cable Life Expectancy						
	9. Cable Acceptance						
	10. Summary and Recommendations						
III.	UNDERGROUND SYSTEM SECTIONALIZING						
	1. General Sectionalizing Philosophy						
	2. Overcurrent Protection of Cable System						
	3. Effect of Inrush Current on Sectionalizing Devices						
	4. Selection of Underground Sectionalizing Equipment						
	5. Faulted-Circuit Indicators						
	6. Summary and Recommendations						
IV.	EQUIPMENT LOADINGS						
	1. Primary Cable Anipacity						
	2. Pad-Mounted Transformer Sizing						
	3. Summary and Recommendations						
V.	GROUNDING AND SURGE PROTECTION						
	1. Cable Grounding System Function						
	2. Factors Affecting Cable Grounding System Performance						
	3. Jacked Cable Counterpoise Application						
	4. System Ground Resistance Measurement and Calculation						
	5. Underground Systems Surge Protection						
	6. Summary and Recommendations						
VI.	FERRORESONANCE						
	1. Allowable Overvoltages During Ferroresonance						
	2. Distribution Transformer Connections						
	3. Qualitative Description of Ferroresonance						
	4. Ferroresonance When Switching at the Primary Terminals of Overhead and Underground Transformer Banks						
	5. Ferroresonance with Cable-Fed Three-Phase Transformers with Delta or Underground-Wye Connected Primary Windings						
	6. Ferroresonance with Cable-Fed Three-Phase Transformers						

	with Grounded-Wye Primary Winding and Five-Legged Core						
	7. Ferroresonance with Cable-Fed Three-Phase Transformers with Grounded-Wye Primary Winding and Triplex Construction						
	8. Ferroresonance in Underground Feeders Having More Than One Transformer						
	9. Summary of techniques for Preventing Ferroresonance in Underground Systems						
	10. Summary and Recommendations						
VII.	CATHODIC PROTECTION REQUIREMENTS						
	1. What to Protect						
	2. Where to Protect						
	3. Types of Cathodic Protection Systems						
	4. Amount of Cathodic Protection						
	5. Cathodic Protection Design with Galvanic Anodes						
	6. Cathodic Protection Installation and Follow-Up						
	7. Calculation of Resistance to Ground						
	8. Summary and Recommendations						
VIII.	UNDERGROUND SYSTEM INSTALLATION PRACTICES						
	1. Receiving and Handling of Cable						
	2. Cable Installation Procedures						
	3. Conduit System Design and Installation						
	4. Cable Pulling						
	5. Summary and Recommendations						
IX.	JOINTS, ELBOWS, AND TERMINATIONS						
	1. Application of Joints, Elbows, and Terminations						
	2. Joints, Elbows, and Terminations for 200-Ampere Primary Circuits						
	3. Joints, Elbows, and Terminations for 600-Ampere Primary Circuits						
	4. Joints, Elbows, and Terminations for Secondary Circuits						
	5. Summary and Recommendations						
X.	TAGGING AND IDENTIFICATION						
	1. General Principals						
	2. Installation						
	3. Operations						
	4. Summary and Recommendations						
XI.	CABLE TESTING						
	1. Reasons for and Benefits of Cable Testing by the User						
	2. Primary Cable Tests by the User						
	3. Secondary Cable Tests by the User						
	4. Tests by the Cable Manufacturer						
	5. Summary and Recommendations						
	APPENDIX A - Calculations for Reliability Studies						
	APPENDIX B - Transformers and Secondary Voltage Drop						
	APPENDIX C - Sample Specification for 600-Volt Underground Power Cable						
	APPENDIX D - Economic Evaluation Methods for Cable Life Expectancy						
	APPENDIX E - Checklist for Information Requirements						
	APPENDIX F - Sample Specification for Tree-Related Cross-Linked Polyethylene \ Insulated Underground Cable						
	APPENDIX G - Sample Specification for Ethylene Propylene Rubber Insulated Underground Cable						
	APPENDIX H - Short-Circuit and Emergency Overload Thermal Damage Curves for Underground Power Cables						
	APPENDIX I - Ampacity Tables						
	APPENDIX J - Industry Specifications						
	APPENDIX K - Component Manufacturers						
	APPENDIX L - Cable Pulling Examples						

PUBLICATION TITLES		VERY Relevant (X)	RELEVANT (X)	PARTIALLY Relevant (X)	BASICS Relevant (X)	NOT Relevant (X)	Attach Comments on Separate Page (record line reference as below) EX: A. III. 2.
Electrical Power Cable Engineering, Edited By W. A. Thue							
I.	Historical Perspective of Electrical Cables						
II.	Basic Dielectric Theory of Cables						
III.	Conductors						
IV.	Cable Characteristics; Electrical						
V.	Electrical Insulation Materials						
VI.	Electrical Properties of Insulating materials						
VII.	Shielding of Power Cables						
VIII.	Sheaths, Jackets Armors						
IX.	Standards and Specifications						
X.	Cable Manufacturing						
XI.	Cable Installation						
XII.	Splicing, Terminating, Accessories						
XIII.	Ampacity of Cables						
XIV.	Thermal Resistivity of Concrete						
XV.	Sheath Bonding and Grounding						
XVI.	Underground System Fault Locating						
XVII.	Field Assessment of Power Cables						
XVIII.	Treeing						
XIX.	Lightning Protection						
XX.	Cable Performance						
XXI.	Concentric Neutral Corrosion						
XXII.	Armor Corrosion of Submarine Cables						
XXIII.	Semiconducting Jackets						
XXIV.	Glossary						
Other Materials Reviewed							
I.	UG Cable Fault Location - TD 153 (1976)						
I.	Surge Behavior of UD Systems - EL-720 (1978)						
I.	Surge Characteristics of Distribution Transformers - EL-3385 (1984)						
I.	Low Voltage Secondary Cable Reliability TR 104833 (1995)						

C

SAMPLE STATEMENT OF WORK FOR AUTHORS AND REVIEWERS

ATTACHMENT A
STATEMENT OF WORK
PROJECT AGREEMENT
Insert EPRI Contractor Number
Insert Contractor Name Here

“Chapter Author(s) for the EPRI Underground Distribution Systems Reference Book”

Introduction & Background

EPRI is presently engaged, through its collaborative membership program, in a project to publish the EPRI Underground Distribution Systems Reference Book (will commonly be referred to in the Industry as the “Brown Book”). The intention is to issue a first volume edition of the Brown Book in 2008.

Special Notice on Author Recognition

Each chapter of the Book will begin with an Author Recognition page. This will consist of a single page having the name, affiliation, contact information, picture and brief bio of each author of that chapter. EPRI views this opportunity for authors and their companies to freely advertise their technical expertise as a substantial part of the total compensation package being negotiated in this contract.

Scope of Work/Task Descriptions

The Contractor, working together with other team members as assigned by EPRI, shall draft and complete the assigned chapter or section as outlined in the Table below.

Version Chap. No.	Chapter Title (Section)	Version Chap. No.	Est. No. of Pages	Anticipated Other Authors	No. of Mtgs
AUTHOR:					

The Table correlates the New Chapter No. with the new chapter number, if applicable. In some cases the New Chapter consists of only part of one or older version chapters.

In cases where Contractor is being asked to share the work effort with another author in a different organization, that author's name and company are shown in the Table. Unless otherwise indicated, the total work for the chapter shall be divided equally among all authors shown in the Table, including the Contractor. Thus, for example, if a chapter is estimated to require 28 pages and one other author is shown in the Table, then the Contractor would be responsible for the equivalent of 14 pages and the other Author 14 pages. In cases where one or more additional team members are assigned to the same chapter, the Contractor shall be responsible to work with the other team member(s) to come up with an equitable distribution of effort. This agreed-upon distribution of effort shall be documented in a formal letter to EPRI, signed by all team members, and submitted to EPRI prior to beginning any work. In the event that changes in the work distribution or assignments agreed upon become necessary during the work, these shall be mutually agreed by all team members and by EPRI. The Contractor shall carry out the work in accordance with the detailed revision and/or scope requirements set forth, including the number of pages and number of new or revised figures. The scope of this contract includes the following tasks; (1) Preparation of work plan and content outline, (2) Preparation of draft, (3) Preparation of final, and (4) Attendance at review meetings.

Task 1: Preparation of Work Plan and Content Outline

The Contractor, working with its team (if applicable), shall thoroughly study the project plans documents. For the specific chapter(s) assigned, the Contractor shall then note the pertinent information and re-write requirements documented. The Contractor shall also review the *Authors Guide*, which documents the requirements for writing the assigned chapter. Questions as to expected content shall be addressed early in the project rather than later, and shall be directed to the EPRI Project Manager for resolution. From this review the Contractor team shall prepare and submit to EPRI two documents:

1. An annotated outline of proposed content for the chapter showing major sections, number of (two-column) pages per section, number of figures and tables per section, and a brief description of section content.
2. A Statement of distribution of effort among team members (if applicable), and identification of the chapter Lead Author. The Lead Author shall be the principal contact with EPRI with respect to questions about chapter content, etc.

The distribution of effort items shall be indicated on the annotated outline as well.

Task 2: Preparation of First Draft

The Contractor, working with its team (if applicable), shall prepare a First Draft of the chapter using Microsoft Word, version 2000 or later (Word 2003 preferred). This draft shall follow the formatting and other guidelines established in the Author's Guide. The content of the draft shall be essentially that envisioned during the Macro-Review stage, as documented in the Minutes. Questions as to content or apparent contradictions shall be directed immediately to the EPRI Project Manager for clarification. Many of the chapters will contain cross-references to other chapters and/or will rely on material developed by other chapter teams. The historical review documents many of these cross-references and content dependencies. Periodic teleconferences and/or review meetings will assist Contractor in communicating with other chapter teams to promote proper cross-referencing and content harmonization. In addition, the Contractor shall actively communicate by email or telephone with other chapter teams to ensure proper coordination among chapters. Some chapters will contain detailed discussions of one or more "Core Topics." However, in any given chapter discussion involving a reference to core topic material in another chapter, specific application or elaboration of the core topic chapter material shall be made as needed and as appropriate. The First Draft shall be fully complete as to all content, including figures, tables, and equations, unless otherwise approved by EPRI. The First Draft shall be submitted to EPRI electronically by uploading to EPRI's dedicated FTP site. At the time of posting to the FTP site the Contractor shall notify both EPRI's Publication Editor and the EPRI Project Manager of the posting. The First Draft will be provided to Reviewers for the review process. EPRI's Publication Editor will be responsible for coordinating reviews and review comment incorporation. Each reviewer's commented version will be posted on the FTP site and the Contractor notified. Reviewers may either mark up the draft using Word's tracking feature, or may draft a detailed review memo, or both. All Reviewer comments will be posted to the FTP site.

Task 3: Preparation of Final

The Contractor shall take the lead in resolving all the review comments to its work. The use of email and telephone is encouraged in this process. The Contractor shall keep both the EPRI Project Manager and the Publications Editor apprised of any problems arising during this process. It shall be the Contractor's responsibility to notify EPRI if its committed delivery schedule is negatively impacted by difficulties in the review process (e.g., slowness of response from the Reviewer). After all review comments are received and resolved, and a consensus achieved as to content among the Contractor team, EPRI, and Reviewers, the Contractor shall prepare the Final Draft for Copyedit, which will revise the text for spelling, punctuation, grammar, and adherence to the style guidelines (see Author's Guide). The copyedited chapter will be posted back on the FTP site for review and approval by the authors before proceeding.

The Contractor shall review and resolve changes from copyediting, and post the chapter back on the FTP site. The production team will lay out chapters in a two-column page format. Pages will be modeled on the format and look of EPRI's *AC Transmission Line Reference Book, 200 kV*

and Above (Red Book). For review by authors, the book will be converted to Adobe Acrobat 7.0 (commonly known as PDF files). Authors can open and review these files using the Acrobat Reader, which is available free at www.adobe.com. **Important:** Substantive revisions to chapters should be made BEFORE layout—as much as possible. Once the book is in layout, changes are more time consuming. (Compression ratio: The laid-out pages reduce the chapter page counts by about half.)

Task 4: Attendance at Review Meetings

This task involves both face to face review meetings with other chapter authors and reviewers, and periodic teleconferences. Contractor shall attend one or more, 2 to 3-day review meetings, during 2007 in accordance with the number of meetings shown in the Table in the SOW. It is EPRI’s intention to pay for all meals and lodging for these meetings. EPRI will reimburse travel costs (airplane, train, automobile) and any un-reimbursed meals and lodging costs for attendance at these meetings, by means of a separately submitted travel expense report. These Contractor expenses are not included in the fixed price for this contract. The Contractor must obtain EPRI approval in advance for its travel arrangements for which it expects reimbursement and shall submit a standard EPRI expense report form together with original receipts for all expenses over \$25.

Deliverables

Task 1: Outline and Distribution of Effort

Task 2: First Draft of Chapter

Task 3: Delivery to EPRI of Final Draft for Copy-Edit

Task 4: Review of Final Formatted Chapter

Task 5: Attendance at Review Meetings and Teleconferences

Sample Schedule

Task Description	Completion Date
Task 1: Outline and Distribution of Effort	1 month after Award
Task 2: First Draft of Chapter	4 months after Award
Task 3: Delivery to EPRI of Final Draft for Copy-Edit	6 months after Award
Task 4: Review of Final Formatted Chapter	8 months after Award
Task 5: Review Meetings	(Tentative)

D

AUTHOR'S GUIDE

EPRI Underground Distribution Systems Reference Book (Brown Book)

December 2006

Contents

Introduction

Production Process

How to Set Up Files

Format: Headings

Format: Tables and Figures

Format: Equations

SI Units and English Measures

Writing Principles

Language Guidelines

References

Index

Glossary

Copyright Issues

Lessons Learned from Production of EPRI Red Book

Terms

Figures

Figure 1. Production Process

Introduction

This Author's Guide is designed to provide guidelines for authors to follow in the writing of chapters of the *Brown Book*. These guidelines will help to ensure that the completed book has a consistency and uniformity of presentation and style.

Sources

The guidelines are based on several sources—including the EPRI Editorial Style Guide, the 1992 edition of the Green Book, and the EPRI *AC Transmission Line Reference Book, 200 kV and Above* (Red Book).

Production Process

The production process is designed to be easy for authors to use, and to require no additional purchase of software for writing or review. The production will take place in five steps (see Figure 1):

First Drafts

First drafts are written by authors or author-teams. First drafts should not be submitted for production until the entire chapter is complete and the draft has been reviewed and approved by all members of the chapter team.

Technical Review

Once the first draft is complete, post a copy on the FTP site for Technical Review. The reviewer(s) may draft a detailed review memo. Alternately, reviewers may also choose to comment on and suggest revisions using the “Track Changes” mode in Microsoft Word (Tools, Track Changes). Authors will review these suggestions and accept or reject these changes using Track Changes to produce a clean manuscript.

Copyedit

Once you have reviewed and resolved changes from the Technical Review, post the chapter on the FTP site for copyediting. Copyediting will revise the text for spelling, punctuation, grammar, and adherence to the style guidelines. The copyedit will be made in the Track Changes mode. The copyedited chapter will be posted back on the FTP site for review and approval by the authors before proceeding. There will be two files of the chapter—labeled “Markup” and “Clean.” The “Markup” files will show the editorial changes in Track Changes. The “Clean” files will show the changes accepted. Please make your comments in the “Clean” files.

Layout

Once you have reviewed and resolved changes from copyediting, post the chapter back on the FTP site. The production team will lay out chapters in a two-column page format. Pages will be modeled on the format and look of EPRI's *AC Transmission Line Reference Book, 200 kV and Above* (Red Book). For review by authors, the book will be converted to Adobe Acrobat 7.0 (commonly known as PDF files). Authors can open and review these files using the Acrobat Reader, which is available free at www.adobe.com. **Important:** Substantive revisions to chapters should be made BEFORE layout—as much as possible. Once the book is in layout, changes are

more time consuming. (Compression ratio: The laid-out pages reduce the chapter page counts by about half.)

Publication

Once the page layout has been laid out and approved by authors, the book will be published.

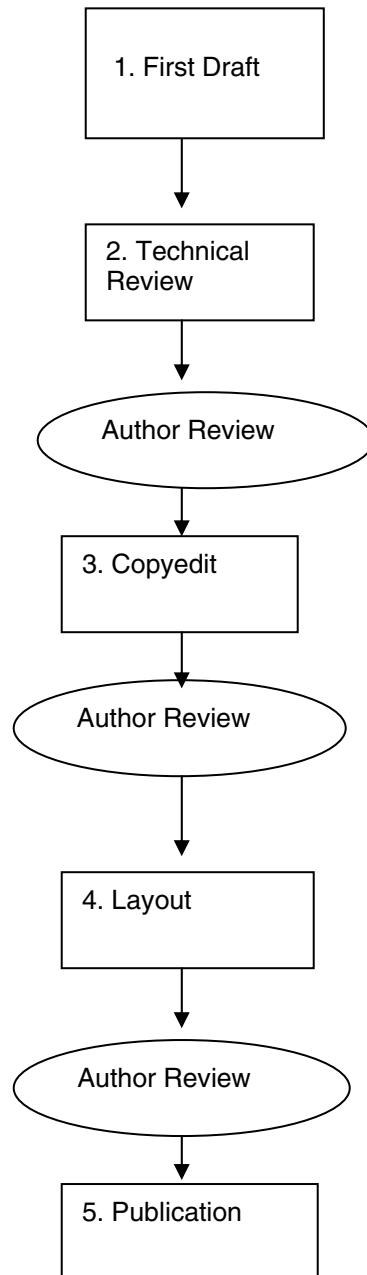


Figure 1. Production Process

How to Set Up Files

When writing first drafts, please use the following guidelines for creating your files:

Text

Write files in Microsoft Word. Drafts should be in 12 point type, Times New Roman, single-spaced, in one column, with 1-inch margins. For new paragraphs, do not indent first line. Just do a double return between paragraphs. Include all text, tables, equations, and figures in the file.

Equations

Write equations in Microsoft Equation 3.0.

Figures—Graphs and Photographs

Important: If graphs or photos are created in any other program than Word, PowerPoint or Excel, please go to File, Save As. Then save files as .tif, .jpg, or .bmp format and insert that figure in the document. (.tif is preferable.)

If you include figures in Excel, supply the original spreadsheet. Annotate graphs. Label parts of the graph. Do not use legends. If necessary, hand-drawn figures may be submitted to EPRI to be drawn. Use the font Helvetica for wording in figures, if possible. Do not use the font Arial; it may lose or change characters during production. If you are using existing figures from the second edition that already in Arial and are difficult to change, leave as is. For photos, use a version as close to the original as possible.

Index

Make an alphabetical list of key words and their section location for an Index.

Glossary

Add important terms and definitions from your chapter to the “rolling” glossary on the FTP site.

Completed Files

Post completed files on the FTP site in the folder for your chapter.

If your completed chapter is large (more than a few MB), please post it in separate section files. This will create files that are more manageable for others to handle.

Format: Headings

For consistency, all chapters should have the same style of main headings and subheadings. There are four levels of headings, as shown below.

Main Heading

One-Decimal Number, All Capital Letters, Boldface

Example: **3.3 INSULATION**

First Subheading

Two-Decimal Number, Capital and Lowercase Letters, Boldface

Example: **3.3.1 Crosslinked Polyethylene**

Second Subheading

Capital and Lowercase Letters, Boldface and Italic

Example: ***Thermal Properties***

Third Subheading

Capital and Lowercase Letters, Italic

Example: *Thermal Expansion*

Format: Tables and Figures

Tables and figures should be numbered with the number of the subsection in which they appear. That is, the first table in Subsection 2.2 would be Table 2.2-1. The first figure in Subsection 2.2 would be Figure 2.2-1.

Tables

Table titles should be initial capped. Example: **Table 3.3-27** Typical Physical Properties of EPR-Insulated HV Cables. Table titles appear above tables. Table footnotes are superscript numbers.

Figures

Figure captions should be first-word-only capped and with a period at the end. Example: **Figure 3.3-17** Specific heat of crosslinked polyethylene insulation. Figure captions appear below figures. Photographs are considered figures.

Format: Equations

Equations should be written using Microsoft Equation 3.0, which is available free with Microsoft Word. (To access it, go to Insert, Object, and select Equation 3.0.) Equations should be numbered to the right of the equation, using the same system as for tables and figures. Example, the third equation in Section 3.4 would be 3.4-3. If equations are long, they may need to be broken in the layout. Please indicate where they can be broken. When identifying symbols in an equation, put them in a vertical list, not run-in on one line.

SI Units and English Measures

Wherever reasonable, use the International System of Units (SI), with the English Units following in parentheses. Please note: If existing tables or figures use English units, leave as is. If conversion to SI units is difficult, leave as is. English units may be used, but SI units are preferred.

SI Base Units

Quantity	Name	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K

SI Derived Units

Derived Quantity	Name	Symbol
area	square meter	m ²
volume	cubic meter	m ³
speed, velocity	meter per second	m/s
acceleration	meter per second squared	m/s ²
wave number	reciprocal meter	m ⁻¹
density, mass density	kilogram per cubic meter	kg/m ³
specific volume	cubic meter per kilogram	m ³ /kg
speed	kilometer per hour or meter per second	km/hr, m/s
moment of inertia	meter to fourth power	m ⁴
weight	newton	N
mass/unit length	kilogram per meter	kg/m
weight/unit length	newton/meter	N/m
Young's modulus	pascal	Pa

SI Derived Units with Special Names and Symbols

Derived Quantity	Name	Symbol
frequency	hertz	Hz
force	newton	N
pressure, stress	pascal	Pa
energy, work, quantity of heat	joule	J
power	watt	W
electric charge	coulomb	C
electric potential difference	volt	V
electric resistance	ohm	Ω
inductance	henry	H
Celsius temperature	Degree Celsius	°C

Usage

Periods are not ordinarily used with abbreviations for units of measure (e.g., m, s, kg). One exception is the abbreviation for inch (in.). When it stands alone (e.g., 6 in.), it should have a period so that it is not confused with the preposition “in”. When used with an exponent (in²) or as part of a compound unit of measure (in/s), the period is omitted.

For more information, see the 1995 edition of the *Guide for the Use of the International System of Units (SI)*, NIST Special Publication 811, which is available on the web at <http://physics.nist.gov/cuu/pdf/sp811.pdf>. Or, see the 2001 edition of *The International System of Units (SI)*, NIST Special Publication 330, which is available on the web at <http://physics.nist.gov/Pubs/SP330/sp330.pdf>.

Writing Principles

Authors should keep in mind a number of general principles to ensure the clarity and uniformity of the book.

Introduction

Each chapter should begin with a brief (5-10 paragraphs) introduction. The introduction should describe the scope of the chapter and its context within the book. It may describe the topic’s significance and changing attitudes/approaches toward it. In addition, it should provide a quick “roadmap” to the main sections included within the chapter.

Flow

When writing your chapter, be sure the information is developed logically from section to section and within each section. Be aware of the number of sections: Is it within the average of other chapters? Avoid overly long or overly short sections. If you list three topics at the start of a section, discuss them in that order.

Depth

Present information in an appropriate level of detail. Avoid drilling down too deeply in one area and covering another too shallowly. Be aware of total page count, which will be discussed prior to the start of writing: Are you within the expected range?

Tone

Emulate the tone of other chapters and use clear, declarative sentences.

Appendices

Present data, figures, and other detailed information, which would clutter the main text, in appendices.

Language Guidelines

Guidelines for language should follow the *EPRI Editorial Style Guide*, which is at: http://www.epri.com/corporate/discover_epri/epri_facts/reportspecs/styleguide.html.

Specific guidelines are as follows:

Numbers

Use numerals:

- For all numbers 10 and above.

- In tables and figures.
- With units of measure (5 Hz, 12°C)
- With percentages (67%)

Use words to express:

- All numbers zero through nine in text (e.g., “Acetylene blacks have the disadvantage of being two to three times as costly as furnace blacks.”)

A zero is ordinarily used before a decimal point: 0.01%

Percentages

Use %, not percent.

Hyphens

Hyphenate compound adjectives containing units of measure and time.

- a 7.3-m (24-ft) room
- a 2.54-cm (1-in.) diameter pipe
- a 3-m pole

In almost all cases, hyphenate high- and low- adjectival compounds.

- high-voltage distribution

Parallelism

Be aware of parallelism. E.g., if you create a bulleted list in which most lines begin with a verb, start all lines with a verb.

Length

Avoid overly long sentences and paragraphs. Clarity is usually improved by shortening.

Periods/Spaces

Use a single space—not a double space—after the period at the end of a sentence.

Units Spacing

Follow IEEE style. Put one space between number and unit. E.g., 21.1 Hz.

Abbreviations

Follow IEEE spelling. E.g., ac, dc

Page Breaks

In first drafts, do not pay attention to page breaks. Do not worry if tables break over two pages. These breaks will be fixed in page layout.

References

References should be cited using the “author-date” method. The advantages of this system are that it avoids the need to track and revise footnote numbers, and it provides the reference information in the text.

In text, to cite a source, write the author's last name and the date of publication in parentheses. For example: (Whitehead 1951). Two or more authors would be written as: (McMahon and Perkins 1963). If there are more than two authors, use et al. (Silver et al. 1950). If the author has more than one work in one year, use letters to distinguish (Cookson 1950a). If the author is an organization, include enough of the name to enable a reader to locate it in the end-of-chapter list. For example: (IEEE Working Group 1978). If you wish to specify a page number, put that after the date. For example: (Mason 1950, p. 1163).

Citations should be inserted within the sentence as close as possible to the point being referenced. At the end of the chapter, provide a list of references alphabetized by the author's last name. If there is no author, alphabetize by the citation's title. See examples below for the correct format.

Only reference publicly available documents.

Bibliography

If desired, include a Bibliography separate from the References. It should include all major seminal works.

Website References

Website references may be used. In text, include a recognizable short form of the URL. At the end of the chapter, include the full URL.

Reference List Style

Book, One Author

Loeb, L. B. 1965. *Electrical Coronas*. Berkeley, California: University Press. p. 348.

Scientific Journal, One Author

Garton, C. G. 1941. "Dielectric Loss in Thin Films of Insulating Liquids." *Journal of IEE*. Vol. 88. Part 2. pp. 103-120.

Scientific Journal, Multiple Authors

Crine, J. P., S. Pelissou, and H. St. Onge. 1987. "Elemental and Ionic Impurities in Cable Insulation and Shields." *JICABLE*. Paris. September. pp. 206-213.

Conference Paper

Constantinov, T. E. 1964. "Dielectric Materials Measurement and Applications." IEE Conference. London.

Publication, No Author Listed

Allied Chemical Company. 1976. "Sulfur Hexafluoride." Specialty Chemicals Division. Brochure SFBR1. Morristown, New Jersey.

Index

When submitting your chapter, create an alphabetical list of key words and section numbers. This will be merged with lists from other chapters.

Key words in the index will be spelled in adherence with the spelling of the *IEEE Dictionary of Standards Terms*.

Glossary

A glossary, with important terms and definitions, will be developed by the production team for the book. A “rolling glossary” will be maintained on the FTP site. Add your terms and definitions to this glossary. Terms in the glossary will be spelled and defined in adherence with the spelling and definitions of the *IEEE Dictionary of Standards Terms*.

Copyright Issues

If you plan to reproduce figures, photos, or tables from another publication, EPRI will need to seek copyright permissions from the publisher and/or author of the original publication.

The Legal Department of EPRI has a specific form and process for obtaining copyright permissions for reproduction of material. Following completion of the first draft, the production team will work with EPRI Legal to obtain the required permissions.

As an author, your responsibility is to maintain a clear list of references, showing the source of all reproduced material. Required information for books includes author’s name, title, edition, publisher, year, and page number. Required information for journal articles includes author’s name, article title, journal name, volume and issue numbers, and page numbers. Please note that page numbers are required in both forms, and are required in most publisher’s copyright documentation.

Note:

- **Government Sources.** Much material published by government agencies is in the public domain, and does not require copyright permissions. However, please document all reproduced material, so that the production team can verify each case.
- **Author’s Publications.** If you are reproducing material from your own earlier publication, we may still need to obtain permission to publish, because, in some cases, the publisher, not the author, holds the copyright.
- **Denied Permissions.** In some cases, the publisher may deny permission or require an onerous fee or pre-condition. In this event, we may need to create a new figure or table, or paraphrase the information.

Lessons Learned from Production of EPRI Red Book

- **Transferring Files/FTP Site.** The FTP site worked well for exchanging files, and enabled team members to avoid attempting to email large files back and forth.
- **Review Process.** Both methods—inserting comments/suggested changes in Track Changes mode and extended reviewer memos—were effective methods of review. Several reviewers chose to do both.
- **Editing Process.** Editing documents in Track Changes and using “markup” and “clean” files worked well. This method allowed authors to see edits and then see the document with the edits accepted.
- **Authors Guide and Style Sheet.** The Author’s Guide and Style Sheet helped to establish consistent “ground rules” for the large author team (22 writers) to follow. Much discussion among the team members was necessary to find agreement on consistent use of mathematical symbols.
- **Figures.** For the most part, figures were received from authors in a form that was acceptable in terms of clarity and resolution. In some cases, figures had to be redrawn. Due to the large volume of figures included in the book, the team did not insist on consistency in the typeface and size of words and symbols used in the art.
- **Layout Design.** The design of the page layout generally was appropriate to the subject matter, and allowed the substantial increase in overall text length for the book without sacrificing readability. In some cases, exceptions had to be made to the two-column format in order to accommodate very long equations and extended bulleted lists.
- **Compression Ratio.** The compression ratio—from draft Word files to two-column page layout format—was about 2:1. This varied slightly, depending on the type size and margins used by authors, but it was a good rough estimate.
- **Use of Framemaker for Layout.** The software used for page layout, Adobe Framemaker, proved very flexible for the layout. It easily handled very large files, allowed quick revisions, and in most cases was very compatible with Word and graphics files.
- **Greek Symbols.** In some cases, Greek symbols did not transfer from the Word file to the Framemaker layout file and had to be manually rewritten. This required careful proofreading and vigilance by the production editor and authors.
- **Index.** Compilation of the index proceeded smoothly. Use of section numbers, rather than page numbers, allowed the index to be completed during writing, rather than waiting for the final layout.
- **Copyright Permissions.** EPRI obtained permissions to use all reproduced figures, photos, and tables. In all, there were nearly 100 items reproduced from 27 different sources. EPRI

pays an annual subscription fee to the Copyright Clearance Center (CCC), which provides automatic copyright permissions for publications of CCC member organizations (which include IEEE and many major publishers). CCC was able to clear about one-third of required permissions. The process of obtaining the remaining permissions was time consuming.

Terms

Bibliography. List of documents (books, articles, and websites) related to the subject. (See “References.”)

Copyediting. Revision of text to correct spelling and grammar, and to ensure consistency of style, format, and usage.

English Units. Units of measure commonly used in North America (e.g., feet, pounds, miles).

Page Layout. Placement of the text, tables, and figures on pages in a consistent design, with specifications for type size, line spacing, margins, etc.

References. List of documents (books, articles, and websites) cited in the text. (See “Bibliography.”)

SI Units. (*Le Système International d’Unités*, or International System of Units). Metric measurement system, dominant measurement system used in international commerce.

Technical Review. Review of draft documents by experts in the content field.


Export Control Restrictions

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The Electric Power Research Institute (EPRI), with major locations in Palo Alto, California; Charlotte, North Carolina; and Knoxville, Tennessee, was established in 1973 as an independent, nonprofit center for public interest energy and environmental research. EPRI brings together members, participants, the Institute's scientists and engineers, and other leading experts to work collaboratively on solutions to the challenges of electric power. These solutions span nearly every area of electricity generation, delivery, and use, including health, safety, and environment. EPRI's members represent over 90% of the electricity generated in the United States. International participation represents nearly 15% of EPRI's total research, development, and demonstration program.

Together...Shaping the Future of Electricity

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