

RELIABILITY ASSESSMENT OF LARGE ELECTRIC POWER SYSTEMS

Roy Billinton
and
Ronald N. Allan



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Reliability Assessment Of Large Electric Power Systems

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Reliability Assessment Of Large Electric Power Systems:

Reliability Assessment of Large Electric Power Systems Roy Billinton, Ronald N. Allan, 2012-12-06 We are very pleased to be asked to co author this book for a variety of reasons one of which was that it gave us further opportunity to work together The scope proposed was very wide with the only significant proviso being that the book should be in a monograph style and not a teaching text This requirement has given us the opportunity to compile a wide range of relevant material relating to present day knowledge and application in power system reliability As many readers will be aware we have collaborated in many ways over a relatively long period and have co authored two other books on reliability evaluation Both of these previous books were structured as teaching texts This present book is not a discourse on how to do reliability evaluation but a discussion on why it should be done and what can be done and achieved and as such does not replace or conflict with the previous books The three books are complementary and each enhances the others The material contained in this book is not specifically original since it is based on information which we have published in other forms either jointly or as co authors with various other people particularly our many research students We sincerely acknowledge the important contributions made by all these students and colleagues There are too many to mention individually in this preface but their names appear frequently in the references at the end of each chapter

Reliability Assessment of Electric Power Systems Using Monte Carlo Methods Billinton, W. Li, 1994-11-30 The application of quantitative reliability evaluation in electric power systems has now evolved to the point at which most utilities use these techniques in one or more areas of their planning design and operation Most of the techniques in use are based on analytical models and resulting analytical evaluation procedures Improvements in and availability of high speed digital computers have created the opportunity to analyze many of these problems using stochastic simulation methods and over the last decade there has been increased interest in and use made of Monte Carlo simulation in quantitative power system reliability assessment Monte Carlo simulation is not a new concept and recorded applications have existed for at least 50 yr However localized high speed computers with large capacity storage have made Monte Carlo simulation an available and sometimes preferable option for many power system reliability applications Monte Carlo simulation is also an integral part of a modern undergraduate or graduate course on reliability evaluation of general engineering systems or specialized areas such as electric power systems It is hoped that this textbook will help formalize the many existing applications of Monte Carlo simulation and assist in their integration in teaching programs This book presents the basic concepts associated with Monte Carlo simulation

Reliability Assessment of Large Electric Power Systems Roy Billinton, Ronald N. Allan, 1988-03-31 We are very pleased to be asked to co author this book for a variety of reasons one of which was that it gave us further opportunity to work together The scope proposed was very wide with the only significant proviso being that the book should be in a monograph style and not a teaching text This requirement has given us the opportunity to compile a wide range of relevant material relating to present day knowledge and application

in power system reliability As many readers will be aware we have collaborated in many ways over a relatively long period and have co authored two other books on reliability evaluation Both of these previous books were structured as teaching texts This present book is not a discourse on how to do reliability evaluation but a discussion on why it should be done and what can be done and achieved and as such does not replace or conflict with the previous books The three books are complementary and each enhances the others The material contained in this book is not specifically original since it is based on information which we have published in other forms either jointly or as co authors with various other people particularly our many research students We sincerely acknowledge the important contributions made by all these students and colleagues There are too many to mention individually in this preface but their names appear frequently in the references at the end of each chapter

Power Systems Control and Reliability Isa S. Qamber, 2020-03-13 Focusing on power systems reliability and generating unit commitments which are essential in the design and evaluation of the electric power systems for planning control and operation this informative volume covers the concepts of basic reliability engineering such as power system spinning reserve types of load curves and their objectives and benefits the electric power exchange and the system operation constraints The author explains how the probability theory plays an important role in reliability applications and discusses the probability applications in electric power systems that led to the development of the mathematical models that are illustrated in the book The algorithms that are presented throughout the chapters will help researchers and engineers to implement their own suitable programs where needed and will also be valuable for students The Artificial Neural Networks ANN and Fuzzy Logic FL systems are discussed and a number of load estimation models are built for some cases where their formulas are developed A number of developed models are presented including the Kronecker techniques Fourth Order Runge Kutta System Multiplication Method or Adams Method and components with different connections and different distributions are presented A number of examples are explained showing how to build and evaluate power plants

Reliability of Power Systems G. F. Kovalev, L. M. Lebedeva, 2019 This book presents essential methods and tools for research into the reliability of energy systems It describes in detail the content setting formalisation and use of algorithms for assessing the reliability of modern large and complex electric power systems The book uses a wealth of tables and illustrations to represent results and source information in a clear manner It discusses the main operating conditions which affect the reliability of electric power systems and describes corresponding computing tools which can help solve issues as they arise Further all methodologies presented here are demonstrated in numerical examples Though primarily intended for researchers and practitioners in the field of electric power systems the book will also benefit general readers interested in this area

Electric Power Grid Reliability Evaluation Chanan Singh, Panida Jirutitijaroen, Joydeep Mitra, 2018-12-11 The groundbreaking book that details the fundamentals of reliability modeling and evaluation and introduces new and future technologies Electric Power Grid Reliability Evaluation deals with the effective evaluation of the electric power grid and

explores the role that this process plays in the planning and designing of the expansion of the power grid The book is a guide to the theoretical approaches and processes that underpin the electric power grid and reviews the most current and emerging technologies designed to ensure reliability The authors noted experts in the field also present the algorithms that have been developed for analyzing the soundness of the power grid A comprehensive resource the book covers probability theory stochastic processes and a frequency based approach in order to provide a theoretical foundation for reliability analysis Throughout the book the concepts presented are explained with illustrative examples that connect with power systems The authors cover generation adequacy methods and multi node analysis which includes both multi area as well as composite power system reliable evaluation This important book Provides a guide to the basic methods of reliability modeling and evaluation Contains a helpful review of the background of power system reliability evaluation Includes information on new technology sources that have the potential to create a more reliable power grid Addresses renewable energy sources and shows how they affect power outages and blackouts that pose new challenges to the power grid system Written for engineering students and professionals Electric Power Grid Reliability Evaluation is an essential book that explores the processes and algorithms for creating a sound and reliable power grid *Assessment of Power System Reliability* Marko Čepin, 2011-07-29 The importance of power system reliability is demonstrated when our electricity supply is disrupted whether it decreases the comfort of our free time at home or causes the shutdown of our companies and results in huge economic deficits The objective of *Assessment of Power System Reliability* is to contribute to the improvement of power system reliability It consists of six parts divided into twenty chapters The first part introduces the important background issues that affect power system reliability The second part presents the reliability methods that are used for analyses of technical systems and processes The third part discusses power flow analysis methods because the dynamic aspect of a power system is an important part of related reliability assessments The fourth part explores various aspects of the reliability assessment of power systems and their parts The fifth part covers optimization methods The sixth part looks at the application of reliability and optimization methods *Assessment of Power System Reliability* has been written in straightforward language that continues into the mathematical representation of the methods Power engineers and developers will appreciate the emphasis on practical usage while researchers and advanced students will benefit from the simple examples that can facilitate their understanding of the theory behind power system reliability and that outline the procedure for application of the presented methods Reliability Evaluation of Engineering Systems Roy Billinton, Ronald N. Allan, 2014-01-15 Terrorism and the Electric Power Delivery System National Research Council, Division on Engineering and Physical Sciences, Board on Energy and Environmental Systems, Committee on Enhancing the Robustness and Resilience of Future Electrical Transmission and Distribution in the United States to Terrorist Attack, 2012-11-25 The electric power delivery system that carries electricity from large central generators to customers could be severely damaged by a small

number of well informed attackers The system is inherently vulnerable because transmission lines may span hundreds of miles and many key facilities are unguarded This vulnerability is exacerbated by the fact that the power grid most of which was originally designed to meet the needs of individual vertically integrated utilities is being used to move power between regions to support the needs of competitive markets for power generation Primarily because of ambiguities introduced as a result of recent restricting the of the industry and cost pressures from consumers and regulators investment to strengthen and upgrade the grid has lagged with the result that many parts of the bulk high voltage system are heavily stressed Electric systems are not designed to withstand or quickly recover from damage inflicted simultaneously on multiple components Such an attack could be carried out by knowledgeable attackers with little risk of detection or interdiction Further well planned and coordinated attacks by terrorists could leave the electric power system in a large region of the country at least partially disabled for a very long time Although there are many examples of terrorist and military attacks on power systems elsewhere in the world at the time of this study international terrorists have shown limited interest in attacking the U S power grid However that should not be a basis for complacency Because all parts of the economy as well as human health and welfare depend on electricity the results could be devastating Terrorism and the Electric Power Delivery System focuses on measures that could make the power delivery system less vulnerable to attacks restore power faster after an attack and make critical services less vulnerable while the delivery of conventional electric power has been disrupted

Handbook of Reliability Engineering Hoang Pham,2003-04-17 An effective reliability programme is an essential component of every product s design testing and efficient production From the failure analysis of a microelectronic device to software fault tolerance and from the accelerated life testing of mechanical components to hardware verification a common underlying philosophy of reliability applies Defining both fundamental and applied work across the entire systems reliability arena this state of the art reference presents methodologies for quality maintainability and dependability Featuring Contributions from 60 leading reliability experts in academia and industry giving comprehensive and authoritative coverage A distinguished international Editorial Board ensuring clarity and precision throughout Extensive references to the theoretical foundations recent research and future directions described in each chapter Comprehensive subject index providing maximum utility to the reader Applications and examples across all branches of engineering including IT power automotive and aerospace sectors The handbook s cross disciplinary scope will ensure that it serves as an indispensable tool for researchers in industrial electrical electronics computer civil mechanical and systems engineering It will also aid professional engineers to find creative reliability solutions and management to evaluate systems reliability and to improve processes For student research projects it will be the ideal starting point whether addressing basic questions in communications and electronics or learning advanced applications in micro electro mechanical systems MEMS manufacturing and high assurance engineering systems

Electric Power Distribution Reliability Richard E. Brown,2017-12-19 Due to its high impact on the cost of electricity and its direct

correlation with customer satisfaction distribution reliability continues to be one of the most important topics in the electric power industry Continuing in the unique tradition of the bestselling first edition *Electric Power Distribution Reliability Second Edition* consolidates all pertinent topics on electric power distribution into one comprehensive volume balancing theory practical knowledge and real world applications Updated and expanded with new information on benchmarking system hardening underground conversion and aging infrastructure this timely reference enables you to Manage aging infrastructure Harden electric power distribution systems Avoid common benchmarking pitfalls Apply effective risk management The electric power industry will continue to make distribution system reliability and customer level reliability a top priority Presenting a wealth of useful knowledge *Electric Power Distribution Reliability Second Edition* remains the only book that is completely dedicated to this important topic

Applied Reliability Assessment in Electric Power Systems Roy Billinton, Ronald Norman Allan, Luigi Salvaderi, 1990

Risk Assessment Of Power Systems Wenyan Li, 2005 Risk Assessment of Power Systems closes the gap between risk theory and real world application As a leading authority in power system risk evaluation for more than fifteen years and the author of a considerable number of papers and more than fifty technical reports on power system risk and reliability evaluation Wenyan Li is uniquely qualified to present this material Following the models and methods developed from the author's hands on experience readers learn how to evaluate power system risk in planning design operations and maintenance activities to keep risk at targeted levels

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Reliability Assessment of Electric Power Systems Using Monte Carlo Methods Billinton, W. Li, 2013-06-29 The application of quantitative reliability evaluation in electric power systems has now evolved to the point at which most utilities use these techniques in one or more areas of their planning design and operation Most of the techniques in use are based on analytical models and resulting analytical evaluation procedures Improvements in and availability of high speed digital computers have created the opportunity to analyze many of these problems using stochastic simulation methods and over the last decade there has been increased interest in and use made of Monte Carlo simulation in quantitative power system reliability assessment Monte Carlo simulation is not a new concept and recorded applications have existed for at least 50 yr However localized high speed computers with large capacity storage have made Monte Carlo simulation an available and sometimes preferable option for many power system reliability applications Monte Carlo simulation is also an integral part of a modern undergraduate or graduate course on reliability evaluation of general engineering systems or specialized areas such as electric power systems It is hoped that this textbook will help formalize the many existing applications of Monte Carlo simulation and assist in their integration in teaching programs This book presents the basic concepts associated with Monte Carlo simulation

Reliability Analysis for Asset Management of Electric Power Grids Robert Ross, 2019-03-18 A practical guide to facilitate statistically well founded decisions in the management of assets of an electricity grid Effective and economic electric grid asset management and incident management involve many complex decisions on inspection

maintenance repair and replacement This timely reference provides statistically well founded tried and tested analysis methodologies for improved decision making and asset management strategy for optimum grid reliability and availability The techniques described are also sufficiently robust to apply to small data sets enabling asset managers to deal with early failures or testing with limited sample sets The book describes the background concepts and statistical techniques to evaluate failure distributions probabilities remaining lifetime similarity and compliancy of observed data with specifications asymptotic behavior of parameter estimators effectiveness of network configurations and stocks of spare parts It also shows how the graphical representation and parameter estimation from analysis of data can be made consistent as well as explaining modern upcoming methodologies such as the Health Index and Risk Index Key features Offers hands on tools and techniques for data analysis similarity index failure forecasting health and risk indices and the resulting maintenance strategies End of chapter problems and solutions to facilitate self study via a book companion website The book is essential reading for advanced undergraduate and graduate students in electrical engineering quality engineers utilities and industry strategists transmission and distribution system planners asset managers and risk managers *Power Systems Resilience* Naser Mahdavi Tabatabaei, Sajad Najafi Ravadanegh, Nicu Bizon, 2018-08-16 This book presents intuitive explanations of the principles and applications of power system resiliency as well as a number of straightforward and practical methods for the impact analysis of risk events on power system operations It also describes the challenges of modelling distribution networks optimal scheduling multi stage planning deliberate attacks cyber physical systems and SCADA based smart grids and how to overcome these challenges Further it highlights the resiliency issues using various methods including strengthening the system against high impact events with low frequency and the fast recovery of the system properties A large number of specialists have collaborated to provide innovative solutions and research in power systems resiliency They discuss the fundamentals and contemporary materials of power systems resiliency theoretical and practical issues as well as current issues and methods for controlling the risk attacks and other threats to AC power systems The book includes theoretical research significant results case studies and practical implementation processes to offer insights into electric power and engineering and energy systems Showing how systems should respond in case of malicious attacks and helping readers to decide on the best approaches this book is essential reading for electrical engineers researchers and specialists The book is also useful as a reference for undergraduate and graduate students studying the resiliency and reliability of power systems

Enhancing the Resilience of the Nation's Electricity System National Academies of Sciences, Engineering, and Medicine, Division on Engineering and Physical Sciences, Board on Energy and Environmental Systems, Committee on Enhancing the Resilience of the Nation's Electric Power Transmission and Distribution System, 2017-10-25 Americans safety productivity comfort and convenience depend on the reliable supply of electric power The electric power system is a complex cyber physical system composed of a network of millions of components spread out across the continent These components

are owned, operated and regulated by thousands of different entities. Power system operators work hard to assure safe and reliable service but large outages occasionally happen. Given the nature of the system, there is simply no way that outages can be completely avoided, no matter how much time and money is devoted to such an effort. The system's reliability and resilience can be improved but never made perfect. Thus, system owners, operators and regulators must prioritize their investments based on potential benefits. Enhancing the Resilience of the Nation's Electricity System focuses on identifying, developing and implementing strategies to increase the power system's resilience in the face of events that can cause large area, long duration outages, blackouts that extend over multiple service areas and last several days or longer. Resilience is not just about lessening the likelihood that these outages will occur. It is also about limiting the scope and impact of outages when they do occur, restoring power rapidly afterwards and learning from these experiences to better deal with events in the future.

Handbook of Electrical Power System Dynamics Mircea Eremia, Mohammad Shahidehpour, 2013-04-01. This book aims to provide insights on new trends in power systems operation and control and to present in detail analysis methods of the power system behavior, mainly its dynamics as well as the mathematical models for the main components of power plants and the control systems implemented in dispatch centers. Particularly, evaluation methods for rotor angle stability and voltage stability as well as control mechanism of the frequency and voltage are described. Illustrative examples and graphical representations help readers across many disciplines acquire ample knowledge on the respective subjects.

Transient Stability of Power Systems Mania Pavella, Damien Ernst, Daniel Ruiz-Vega, 2012-12-06. The market liberalization is expected to affect drastically the operation of power systems which, under economical pressure and increasing amount of transactions, are being operated much closer to their limits than previously. These changes put the system operators faced with rather different and much more problematic scenarios than in the past. They have now to calculate available transfer capabilities and manage congestion problems in a near on-line environment while operating the transmission system under extremely stressed conditions. This requires highly reliable and efficient software aids which today are non-existent or not yet in use. One of the most problematic issues, very much needed but not yet encountered today, is on-line dynamic security assessment and control enabling the power system to withstand unexpected contingencies without experiencing voltage or transient instabilities. This monograph is devoted to a unified approach to transient stability assessment and control called Single Machine Equivalent (SIME).

Analytic Research Foundations for the Next-Generation Electric Grid National Academies of Sciences, Engineering, and Medicine, Division on Engineering and Physical Sciences, Board on Mathematical Sciences and Their Applications, Committee on Analytical Research Foundations for the Next-Generation Electric Grid, 2016-05-15. Electricity is the lifeblood of modern society and for the vast majority of people that electricity is obtained from large interconnected power grids. However, the grid that was developed in the 20th century and the incremental improvements made since then, including its underlying analytic foundations, is no longer adequate to completely meet the needs of the 21st

century The next generation electric grid must be more flexible and resilient While fossil fuels will have their place for decades to come the grid of the future will need to accommodate a wider mix of more intermittent generating sources such as wind and distributed solar photovoltaics Achieving this grid of the future will require effort on several fronts There is a need for continued shorter term engineering research and development building on the existing analytic foundations for the grid But there is also a need for more fundamental research to expand these analytic foundations Analytic Research Foundations for the Next Generation Electric Grid provide guidance on the longer term critical areas for research in mathematical and computational sciences that is needed for the next generation grid It offers recommendations that are designed to help direct future research as the grid evolves and to give the nation s research and development infrastructure the tools it needs to effectively develop test and use this research

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Reliability Assessment Of Large Electric Power Systems Introduction

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