

HANDBOOK OF ELECTRICAL POWER SYSTEM DYNAMICS



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HANDBOOK OF ELECTRICAL POWER SYSTEM DYNAMICS

Modeling, Stability, and Control

Edited by

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CONTENTS

Foreword	xxiii
Acknowledgments	xxv
Contributors	xxvii
1. INTRODUCTION	1
<i>Mircea Eremia and Mohammad Shahidehpour</i>	
PART I POWER SYSTEM MODELING AND CONTROL	7
2. SYNCHRONOUS GENERATOR AND INDUCTION MOTOR	9
<i>Mircea Eremia and Constantin Bulac</i>	
2.1. Theory and Modeling of Synchronous Generator	9
2.1.1. Design and Operation Principles	9
2.1.2. Electromechanical Model of Synchronous Generator: Swing Equation	13
2.1.3. Electromagnetic Model of Synchronous Generator	17
2.1.3.1. Basic Equations	17
2.1.3.2. Park Transformation	24
2.1.3.3. Park Equations of Synchronous Generator	27
2.1.3.4. Representation of Synchronous Generator Equations in Per Unit	33
2.1.3.5. Equivalent Circuits for the d - and q -Axes	38
2.1.3.6. Steady-State Operation of the Synchronous Generator	41
2.1.3.7. Synchronous Generator Behavior on Terminal Short Circuit	46
2.1.4. Synchronous Generator Parameters	55
2.1.4.1. Operational Parameters	55
2.1.4.2. Standard Parameters	59
2.1.5. Magnetic Saturation	66
2.1.5.1. Open-Circuit and Short-Circuit Characteristics	67
2.1.5.2. Considering the Saturation in Stability Studies	69
2.1.6. Modeling in Dynamic State	73
2.1.6.1. Simplified Electromagnetic Models	73
2.1.6.2. Detailed Model in Dynamic State	82
2.1.7. Reactive Capability Limits	90

2.1.7.1. Loading Capability Chart	90
2.1.7.2. The V Curves	92
2.1.8. Description and Modeling of the Excitation Systems	93
2.1.8.1. Components and Performances of Excitation Control System	93
2.1.8.2. Types and Modeling of Excitation Systems	94
2.1.8.3. Control and Protective Functions	104
2.1.8.4. Example	112
2.2. Theory and Modeling of the Induction Motor	114
2.2.1. Design and Operation Issues	114
2.2.2. General Equations of the Induction Motor	116
2.2.2.1. Electrical Circuit Equations	116
2.2.2.2. The d - q Transformation	120
2.2.2.3. Basic Equations in the d - q Reference Frame	121
2.2.2.4. Electric Power and Torque	123
2.2.3. Steady-State Operation of the Induction Motor	123
2.2.4. Electromechanical Model of Induction Motor	129
2.2.5. Electromagnetic Model of Induction Motor	131
References	134

3. MODELING THE MAIN COMPONENTS OF THE CLASSICAL POWER PLANTS **137**

Mohammad Shahidehpour, Mircea Eremia, and Lucian Toma

3.1. Introduction	137
3.2. Types of Turbines	138
3.2.1. Steam Turbines	138
3.2.2. Gas Turbines	139
3.2.3. Hydraulic Turbines	140
3.3. Thermal Power Plants	143
3.3.1. Generalities	143
3.3.2. Boiler and Steam Chest Models	145
3.3.3. Steam System Configurations	148
3.3.4. General Steam System Model	151
3.3.5. Governing Systems for Steam Turbines	152
3.3.5.1. Mechanical Hydraulic Control (MHC)	153
3.3.5.2. Electrohydraulic Control (EHC)	155
3.3.5.3. Digital Electrohydraulic Control (DEHC)	157
3.3.5.4. General Model for Speed Governing Systems	157
3.4. Combined-Cycle Power Plants	158
3.4.1. Generalities	158
3.4.2. Configurations of Combined-Cycle Power Plants	159
3.4.3. Model Block Diagrams of Combined-Cycle Power Plant	160

3.5. Nuclear Power Plants	167
3.6. Hydraulic Power Plants	169
3.6.1. Generalities	169
3.6.2. Modeling of Hydro Prime Mover Systems and Controls	171
3.6.2.1. General Block Diagram	171
3.6.2.2. Modeling of Turbine Conduit Dynamics	171
3.6.3. Hydro Turbine Governor Control Systems	174
3.6.3.1. Set Point Controller	174
3.6.3.2. The Actuator	176
References	177
4. WIND POWER GENERATION	179
<i>Mohammad Shahidehpour and Mircea Eremia</i>	
4.1. Introduction	179
4.2. Some Characteristics of Wind Power Generation	181
4.3. State of the Art Technologies	184
4.3.1. Overview of Generator Concepts	184
4.3.1.1. General Description	185
4.3.1.2. Squirrel Cage Induction Generator	188
4.3.1.3. Dynamic Slip-Controlled Wound Rotor Induction Generator	189
4.3.1.4. Doubly Fed Induction Generator	190
4.3.1.5. Wound Rotor Synchronous Generator	191
4.3.1.6. Permanent Magnet Synchronous Generator	192
4.3.2. Overview of Wind Turbines Concepts	195
4.3.2.1. Fixed-Speed Wind Turbines	195
4.3.2.2. Variable-Speed Wind Turbines	195
4.3.3. Overview of Power Control Concepts	197
4.4. Modeling the Wind Turbine Generators	200
4.4.1. Model of a Constant-Speed Wind Turbine	200
4.4.2. Modeling the Doubly Fed Induction Generator Wind Turbine System	205
4.4.2.1. DFIG Model	205
4.4.2.2. Drive Train of DFIG	207
4.4.2.3. Power Converter	209
4.4.2.4. Control Strategy for the DFIG	209
4.4.2.5. Aerodynamic Model and Pitch Angle Controller	215
4.4.2.6. Operating Modes	217
4.4.3. Full-Scale Converter Wind Turbine	218
4.4.3.1. General Model	218
4.4.3.2. Model of a Direct-Drive Wind Turbine with Synchronous Generator	219
4.4.3.3. Control of Full-Scale Converter Wind Turbine	221

4.5. Fault Ride-Through Capability	223
4.5.1. Generalities	223
4.5.2. Blade Pitch Angle Control for Fault Ride-Through	225
References	226
5. SHORT-CIRCUIT CURRENTS CALCULATION	229
<i>Nouredine Hadjsaid, Ion Triștiu, and Lucian Toma</i>	
5.1. Introduction	229
5.1.1. The Main Types of Short Circuits	230
5.1.2. Consequences of Short Circuits	231
5.2. Characteristics of Short-Circuit Currents	232
5.3. Methods of Short-Circuit Currents Calculation	236
5.3.1. Basic Assumptions	236
5.3.2. Method of Equivalent Voltage Source	237
5.3.3. Method of Symmetrical Components	239
5.3.3.1. General Principles	239
5.3.3.2. The Symmetrical Components of Unsymmetrical Phasors	241
5.3.3.3. Sequence Impedance of Network Components	247
5.3.3.4. Unsymmetrical Fault Calculations	253
5.4. Calculation of Short-Circuit Current Components	264
5.4.1. Initial Symmetrical Short-Circuit Current I_k''	264
5.4.1.1. Three-Phase Short Circuit	264
5.4.1.2. Phase-to-Phase Short Circuit	267
5.4.1.3. Phase-to-Phase Short Circuit with Earth Connection	268
5.4.1.4. Phase-to-Earth Short Circuit	268
5.4.2. Peak Short-Circuit Current i_p	269
5.4.2.1. Three-Phase Short Circuit	269
5.4.2.2. Phase-to-Phase Short Circuit	271
5.4.2.3. Phase-to-Phase Short Circuit with Earth Connection	271
5.4.2.4. Phase-to-Earth Short Circuit	271
5.4.3. DC Component of the Short-Circuit Current	271
5.4.4. Symmetrical Short-Circuit Breaking Current I_b	272
5.4.4.1. Far-from-Generator Short Circuit	272
5.4.4.2. Near-to-Generator Short Circuit	272
5.4.5. Steady-State Short-Circuit Current I_k	273
5.4.5.1. Three-Phase Short Circuit of One Generator or One Power Station Unit	273
5.4.5.2. Three-Phase Short Circuit in Nonmeshed Networks	276
5.4.5.3. Three-Phase Short Circuit in Meshed Networks	276
5.4.5.4. Unbalanced Short Circuits	277
5.4.6. Applications	277
References	289

6. ACTIVE POWER AND FREQUENCY CONTROL	291
<i>Les Pereira</i>	
6.1. Introduction	291
6.2. Frequency Deviations in Practice	293
6.2.1. Small Disturbances and Deviations	293
6.2.2. Large Disturbances and Deviations	293
6.3. Typical Standards and Policies for “Active Power and Frequency Control” or “Load Frequency Control”	294
6.3.1. UCTE Load Frequency Control	294
6.3.1.1. Primary Control is by Governors	295
6.3.1.2. Secondary Control by Automatic Generation Controls (AGCs)	295
6.3.1.3. Tertiary Control	296
6.3.1.4. Self-Regulation of the Load	296
6.3.2. NERC (U.S.) Standards	296
6.3.3. Other Countries’ Standards	297
6.4. System Modeling, Inertia, Droop, Regulation, and Dynamic Frequency Response	297
6.4.1. Block Diagram of the System Dynamics and Load Damping	297
6.4.2. Effect of Governor Droop on Regulation	298
6.4.3. Increasing Load by Adjusting Prime Mover Power	298
6.4.4. Parallel Operation of Several Generators	298
6.4.5. Isolated Area Modeling and Response	301
6.5. Governor Modeling	302
6.5.1. Response of a Simple Governor Model with Droop	303
6.5.2. Hydraulic Governor Modeling	304
6.5.2.1. Hydraulic Turbines	304
6.5.2.2. Hydraulic Governors	305
6.5.2.3. Hydraulic Turbine Model	306
6.5.2.4. PID Governor	306
6.5.3. Performance of Hydrogovernors with Parameters Variation	307
6.5.3.1. Isolated System Governor Simulations	307
6.5.3.2. Interconnected System Governor Simulations	309
6.5.4. Thermal Governor Modeling	311
6.5.4.1. General Steam System Model	311
6.5.4.2. Gas Turbine Model	312
6.5.5. Development of a New Thermal Governor Model in the WECC	315
6.5.5.1. The New Thermal Governor Model	315
6.5.5.2. Analysis of Test Data: Thermal Versus Hydro Units	318
6.6. AGC Principles and Modeling	328
6.6.1. AGC in a Single-Area (Isolated) System	329
6.6.2. AGC in a Two-Area System, Tie-Line Control, Frequency Bias	329
6.6.3. AGC in Multiarea Systems	332

6.7. Other Topics of Interest Related to Load Frequency Control	336
6.7.1. Spinning Reserves	336
6.7.2. Underfrequency Load Shedding and Operation in Islanding Conditions	336
References	338

7. VOLTAGE AND REACTIVE POWER CONTROL **340**

Sandro Corsi and Mircea Eremia

7.1. Relationship Between Active and Reactive Powers and Voltage	342
7.1.1. Short Lines	342
7.1.2. Taking into Account the Shunt Admittance	346
7.1.3. Sensitivity Coefficients	346
7.2. Equipments for Voltage and Reactive Power Control	347
7.2.1. Reactive Power Compensation Devices	347
7.2.1.1. Shunt Capacitors	347
7.2.1.2. Shunt Reactors	348
7.2.2. Voltage and Reactive Power Continuous Control Devices	349
7.2.2.1. Synchronous Generators	349
7.2.2.2. Synchronous Compensators	350
7.2.2.3. Static VAR Controllers and FACTS	351
7.2.3. On-Load Tap Changing Transformers	352
7.2.3.1. Generalities	352
7.2.3.2. Switching Technologies	355
7.2.3.3. Determination of the Current Operating Tap	362
7.2.3.4. Static Characteristic of the Transformer	363
7.2.3.5. Various Applications of the OLTC Transformers for Voltage and Reactive Power Control	366
7.2.4. Regulating Transformers	371
7.2.4.1. In-Phase Regulating Transformer (IPRT)	371
7.2.4.2. Phase Shifting Transformers	372
7.3. Grid Voltage and Reactive Power Control Methods	374
7.3.1. General Considerations	374
7.3.2. Voltage–Reactive Power Manual Control	377
7.3.2.1. Manual Voltage Control by Reactive Power Flow	378
7.3.2.2. Manual Voltage Control by Network Topology Modification	378
7.3.3. Voltage–Reactive Power Automatic Control	378
7.3.3.1. Automatic Voltage Control of the Generator Stator Terminals	379
7.3.3.2. Automatic Voltage Control by Generator Line Drop Compensation	385
7.3.3.3. Automatic High-Side Voltage Control at a Power Plant	391

7.4. Grid Hierarchical Voltage Regulation	399
7.4.1. Structure of the Hierarchy	399
7.4.1.1. Generalities	399
7.4.1.2. Basic SVR and TVR Concepts	401
7.4.1.3. Primary Voltage Regulation	402
7.4.1.4. Secondary Voltage Regulation: Architecture and Modeling	405
7.4.1.5. Tertiary Voltage Regulation	417
7.4.2. SVR Control Areas	418
7.4.2.1. Procedure to Select the Pilot Nodes and to Define the Control Areas	418
7.4.2.2. Procedure to Select the Control Generators	420
7.4.3. Power Flow Computation in the Presence of the Secondary Voltage Regulation	422
7.5. Implementation Study of the Secondary Voltage Regulation in Romania	423
7.5.1. Characteristics of the Study System	423
7.5.2. SVR Areas Selection	423
7.6. Examples of Hierarchical Voltage Control in the World	429
7.6.1. The French Power System Hierarchical Voltage Control	429
7.6.1.1. General Overview	429
7.6.1.2. Original Secondary Voltage Regulation	430
7.6.1.3. Coordinated Secondary Voltage Regulation	432
7.6.1.4. Performances and Results of Simulations	434
7.6.1.5. Conclusion on the French Hierarchical Voltage Control System	435
7.6.2. The Italian Hierarchical Voltage Control System	435
7.6.2.1. General Overview	435
7.6.2.2. Improvements in the Power System Operation	438
7.6.2.3. Conclusions on the Italian Hierarchical Voltage Control System	442
7.6.3. The Brazilian Hierarchical Voltage Control System	442
7.6.3.1. General Overview	442
7.6.3.2. Results of the Study Simulations	443
7.6.3.3. Conclusions on the Brazilian Voltage Control System	447
References	447

PART II POWER SYSTEM STABILITY AND PROTECTION 451

8. BACKGROUND OF POWER SYSTEM STABILITY 453

S.S. (Mani) Venkata, Mircea Eremia, and Lucian Toma

8.1. Introduction	453
8.2. Classification of Power Systems Stability	453
8.2.1. Rotor Angle Stability	454

8.2.1.1. Small-Disturbance (or Small-Signal) Rotor Angle Stability	460
8.2.1.2. Large-Disturbance Rotor Angle Stability or Transient Stability	461
8.2.2. Voltage Stability	462
8.2.3. Frequency Stability	467
8.3. Parallelism Between Voltage Stability and Angular Stability	469
8.4. Importance of Security for Power System Stability	469
8.4.1. Power System States	470
8.4.2. Power Flow Security Limits	472
8.4.3. Services to Meet Power System Security Constraints	473
8.4.4. Dynamic Security Assessment	474
References	475

9. SMALL-DISTURBANCE ANGLE STABILITY AND ELECTROMECHANICAL OSCILLATION DAMPING 477

Roberto Marconato and Alberto Berizzi

9.1. Introduction	477
9.2. The Dynamic Matrix	478
9.2.1. Linearized Equations	478
9.2.2. Building the Dynamic Matrix	481
9.3. A General Simplified Approach	482
9.3.1. Inertia and Synchronizing Power Coefficients	483
9.3.2. Electromechanical Oscillations	486
9.3.2.1. Oscillation Modes	486
9.3.2.2. Oscillation Amplitudes and Participation Factors	489
9.3.3. Numerical Examples	493
9.3.3.1. Application 1: Two-Area Test System	494
9.3.3.2. Application 2: Three-Area Test System	497
9.4. Major Factors Affecting the Damping of Electromechanical Oscillations	501
9.4.1. Introduction	501
9.4.2. Single Machine-Infinite Bus System: A Simplified Approach	503
9.4.3. Single Machine-Infinite Bus System: A More Accurate Approach	507
9.4.3.1. Introduction	507
9.4.3.2. Contribution to Damping Due to Generator Structure	512
9.4.3.3. Contribution of the Primary Voltage Control	514
9.4.3.4. Effect of Primary Frequency Control	537
9.4.3.5. Outline of Other Contributions	544
9.4.4. Summary of the Major Factors Affecting the Damping of Electromechanical Oscillations	545
9.5. Damping Improvement	546
9.5.1. Introduction	546
9.5.2. Modal Synthesis Based on the Theory of Small Shift Poles	550

9.5.3. PSSs on Excitation Control	553
9.5.3.1. Base Case and Theory	553
9.5.3.2. Synthesis of PSSs on Excitation Control: General Case	556
9.5.4. Limitation on PSS Gains	561
9.6. Typical Cases of Interarea Or Low-Frequency Electromechanical Oscillations	564
References	568

10. TRANSIENT STABILITY **570**

Nikolai Voropai and Constantin Bulac

10.1. General Aspects	570
10.2. Direct Methods for Transient Stability Assessment	572
10.2.1. Equal Area Criterion	572
10.2.1.1. Fundamentals of Equal Area Criterion	572
10.2.1.2. Calculation of the Fault Clearing Time	575
10.2.1.3. Two Finite Power Synchronous Generators	579
10.2.2. Extended Equal Area Criterion—EEAC	580
10.2.3. The SIME (SIngle - Machine Equivalent) Method	582
10.2.3.1. Method Formulation	583
10.2.3.2. Criteria and Degree of Instability	585
10.2.3.3. Criteria and Corresponding Stability Reserve	585
10.2.3.4. Identification of the OMIB Equivalent	586
10.2.4. Direct Methods Based on Lyapunov's Theory	587
10.2.4.1. Lyapunov's Method	587
10.2.4.2. Designing the Lyapunov Function	590
10.2.4.3. Determination of Equilibrium	594
10.2.4.4. Extension of the Direct Lyapunov's Method	596
10.2.4.5. New Approaches	601
10.3. Integration Methods for Transient Stability Assessment	603
10.3.1. General Considerations	603
10.3.2. Runge–Kutta Methods	608
10.3.3. Implicit Trapezoidal Rule	609
10.3.4. Mixed Adams-BDF Method	611
10.4. Dynamic Equivalents	614
10.4.1. Generalities	614
10.4.2. Simplification of Mathematical Description of a System	617
10.4.2.1. The Disturbance Impact Index	617
10.4.2.2. The Study of the Disturbance Impact Index	617
10.4.3. Estimating the System Element Significance	621
10.4.3.1. Index of the System Structural Connectivity	621
10.4.3.2. Significance of a System Element	622

10.4.4. Coherency Estimation	623
10.4.4.1. Equation of the Mutual Motion of a Pair of Machines	623
10.4.4.2. Coherency Indices	625
10.4.4.3. Clustering of Coherency Indices	628
10.4.5. Equivalencing Criteria	631
10.4.6. Center of Inertia. Parameters of the Equivalent	634
10.5. Transient Stability Assessment of Large Electric Power Systems	638
10.5.1. Characteristics of Large Electric Power System	638
10.5.2. Initial Conditions	639
10.5.3. Standard Conditions for Transient Stability Studies	639
10.5.3.1. Studied Conditions and Disturbances	639
10.5.3.2. Stability Margins	641
10.5.3.3. System Stability Requirements	642
10.5.4. Reducing the Studied Conditions by Structural Analysis	643
10.5.5. Using the Simplified Models and Direct Methods	644
10.6. Application	645
References	651

11. VOLTAGE STABILITY **657**

Mircea Eremia and Constantin Bulac

11.1. Introduction	657
11.2. System Characteristics and Load Modeling	658
11.2.1. System Characteristics	658
11.2.2. Load Modeling	660
11.2.2.1. Load Characteristics	660
11.2.2.2. Static Models	662
11.2.2.3. Dynamic Models	664
11.3. Static Aspects of Voltage Stability	667
11.3.1. Existence of Steady-State Solutions	667
11.3.2. Operating Points and Zones	670
11.4. Voltage Instability Mechanisms: Interaction Between Electrical Network, Loads, and Control Devices	674
11.4.1. Interaction between Electrical Network and Load	674
11.4.2. Influence of the On-Load Tap Changer	676
11.4.2.1. Modeling the On-Load Tap Changing Dynamics	676
11.4.2.2. The Effect of Automatic Tap Changing on the Possible Operating Points	678
11.4.2.3. Influence of On-Load Tap Changing on the Voltage Stability	679
11.4.3. Effect of the Generated Reactive Power Limitation	683
11.4.4. The Minimum Voltage Criteria	686

11.5. Voltage Stability Assessment Methods	688
11.5.1. Overview of Voltage Collapse Criteria	688
11.5.2. Sensitivities Analysis Method: Local Indices	695
11.5.3. Loading Margin as Global Index	698
11.5.4. Some Aspects of the Bifurcations Theory	702
11.5.4.1. Generalities	702
11.5.4.2. Hopf Bifurcation	704
11.5.4.3. Saddle-node Bifurcation	705
11.5.4.4. Singularity Induced Bifurcation	706
11.5.4.5. Global Bifurcations	707
11.5.5. The Smallest Singular Value Technique. VSI Global Index	708
11.5.6. Modal Analysis of the Reduced Jacobian Matrix	711
11.5.6.1. The $V-Q$ Variation Modes of the Power System	712
11.5.6.2. Definition of Participation Factors in Voltage Stability Analysis	714
11.6. Voltage Instability Countermeasures	716
11.6.1. Some Confusions	716
11.6.2. Load Shedding: An Emergency Measure	717
11.6.3. Shunt Capacitor Switching	719
11.6.4. Extending the Voltage Stability Limit by FACTS Devices	719
11.6.5. Countermeasures Against the Destabilizing Effect of the Load Tap Changer	724
11.7. Application	724
References	733

12. POWER SYSTEM PROTECTION **737**

Klaus-Peter Brand and Ivan De Mesmaeker

12.1. Introduction	737
12.1.1. Motivation	737
12.1.2. The Task of Protection	738
12.1.3. Basic Protection Properties and Resulting Requirements	739
12.1.4. From System Supervision to Circuit Breaker Trip	739
12.1.5. Main Operative Requirements	740
12.1.5.1. Selectivity	740
12.1.5.2. Reliability	740
12.1.5.3. Speed and Performance	741
12.1.5.4. Adaptation	741
12.1.5.5. Adaptive Protection	741
12.1.5.6. Backup Protection	741

12.1.5.7. General Remarks About Features Like Performance, Reliability, and Availability	742
12.1.6. Advantages of State-of-the-Art Protection	742
12.2. Summary of IEC 61850	744
12.3. The Protection Chain in Details	746
12.3.1. Copper Wires vs. Serial Links	746
12.3.2. Supervision	746
12.3.3. Values Measured for Protection	748
12.3.3.1. Nonelectrical Values	748
12.3.3.2. Electrical Values	748
12.3.4. Data Acquisition from Sensors	748
12.3.4.1. Sensors	748
12.3.4.2. A/D Conversion and Merging Unit	750
12.3.4.3. Time Synchronization	750
12.3.5. Protection Data Processing	751
12.3.5.1. General	751
12.3.5.2. Trip Decision and Related Information	751
12.3.5.3. Other Data Handling Features	751
12.3.6. Data Sending to the Actuators	751
12.3.7. Process Interface	752
12.3.8. Circuit Breaker	752
12.3.9. Power Supply	753
12.4. Transmission and Distribution Power System Structures	753
12.5. Properties of the Three-Phase Systems Relevant for Protection	755
12.5.1. Symmetries	755
12.5.2. Unbalance	756
12.5.3. Symmetrical Components	758
12.6. Protection Functions Sorted According to the Objects Protected	759
12.6.1. Protection Based on Limits of Locally Measured Values	759
12.6.1.1. Overcurrent and Time Overcurrent Protection	760
12.6.1.2. Overload Protection	760
12.6.1.3. Frequency Protection	761
12.6.1.4. Voltage Protection	761
12.6.1.5. Limit Supervision and Protection	761
12.6.1.6. Protection with Improvement of Selection by Time Delays	762
12.6.1.7. Protection with Improvement of Selection by Communication	763
12.6.2. Protection with Fault Direction Detection	764
12.6.2.1. Directional Protection	764
12.6.2.2. Improvement of Directional Protection by Communication	765

12.6.3. Impedance Protection	766
12.6.3.1. Distance Protection	766
12.6.3.2. Special Impedance-Based Functions	768
12.6.4. Current Differential Functions	768
12.6.4.1. Differential Protection	768
12.6.4.2. Application Issues for Busbar Protection	770
12.6.4.3. Application Issues for Line Differential Protection	771
12.6.4.4. Comparative Protection as Simplified Differential Protection	771
12.6.5. Protection-Related Functions	772
12.6.5.1. Breaker Failure Protection	772
12.6.5.2. Autoreclosing	772
12.6.5.3. Synchrocheck	773
12.7. From Single Protection Functions to System Protection	773
12.7.1. Single Function and Multifunctional Relays	773
12.7.2. Adaptive Protection	774
12.7.3. Distributed Protection	774
12.7.3.1. Differential Object Protection Functions	774
12.7.3.2. Directional Object Protection Functions	775
12.7.4. Wide Area Protection	775
12.7.5. General Guide	776
12.7.5.1. General Recommendations for Protection Application	776
12.7.6. Security and Dependability	779
12.7.7. Summary	780
12.8. Conclusions	780
Annex 12.1. Identification of Protection Functions	780
A.12.1. General Remarks	780
A.12.1.1. IEEE Device Numbers	780
A.12.1.2. IEC Designation	781
A.12.1.3. Logical Nodes Names	781
A.12.2. Identification List	781
References	785
PART III GRID BLACKOUTS AND RESTORATION PROCESS	787
13. MAJOR GRID BLACKOUTS: ANALYSIS, CLASSIFICATION, AND PREVENTION	789
<i>Yvon Besanger, Mircea Eremia, and Nikolai Voropai</i>	
13.1. Introduction	789
13.2. Description of Some Previous Blackouts	792
13.2.1. August 14, 2003 Northeast United States and Canada Blackout	793
13.2.1.1. Precondition	793

13.2.1.2. Initiating Events	794
13.2.1.3. Cascading Events	795
13.2.1.4. Final State	801
13.2.1.5. What Stopped the Cascade Spreading?	801
13.2.1.6. Causes of Blackout	802
13.2.1.7. Recommendations to Prevent Blackouts	804
13.2.2. September 28, 2003 Italy Blackout	805
13.2.2.1. Precondition	805
13.2.2.2. Initiating Events	806
13.2.2.3. Cascading Events	806
13.2.2.4. Final State	810
13.2.2.5. Restoration	811
13.2.2.6. Root Causes of the Blackout	811
13.2.2.7. Recommendations to Prevent Blackouts	811
13.2.3. September 23, 2003 Eastern Denmark and Southern Sweden Blackout	812
13.2.3.1. Precondition	812
13.2.3.2. Initiating Events	812
13.2.3.3. Cascading Events	812
13.2.3.4. Final State	812
13.2.4. January 12, 2003 Blackout in Croatia	812
13.2.4.1. Precondition	812
13.2.4.2. Initiating Events	813
13.2.4.3. Cascading Events	813
13.2.4.4. Final State	813
13.2.5. May 25, 2005 Blackout in Moscow	814
13.2.5.1. Precondition	814
13.2.5.2. Initiating Events	814
13.2.5.3. Cascading Events	816
13.2.5.4. Final State	816
13.2.6. July 12, 2004 Greece Blackout	816
13.2.6.1. Precondition	816
13.2.6.2. Initiating Events	816
13.2.6.3. Cascading Events	817
13.2.6.4. Final State	817
13.2.7. July 2, 1996 Northwest U.S. Blackout	817
13.2.7.1. Precondition	817
13.2.7.2. Initiating Events	817
13.2.7.3. Cascading Events	817
13.2.7.4. Final State	818
13.2.8. August 10, 1996 Northwest U.S. Blackout	818
13.2.8.1. Precondition	818

13.2.8.2. Initiating Events	818
13.2.8.3. Cascading Events	818
13.2.8.4. Final State	818
13.2.9. December 19, 1978 National Blackout in France	819
13.2.9.1. Precondition	819
13.2.9.2. Initiating Events	819
13.2.9.3. Cascading Events	819
13.2.9.4. Final State	820
13.2.9.5. Restoration	820
13.2.9.6. Causes of Blackout	820
13.2.10. January 12, 1987 Western France Blackout	820
13.2.10.1. Precondition	820
13.2.10.2. Initiating Events	820
13.2.10.3. Cascading Events	820
13.2.10.4. Emergency Actions	821
13.2.10.5. Causes of Blackout	821
13.2.11. March 13, 1989 Hydro-Quebec System Blackout Response to Geomagnetic Disturbance	822
13.2.11.1. Precondition	822
13.2.11.2. Initiating and Cascading Events	823
13.2.11.3. Causes of the SVC Tripping	823
13.2.11.4. Equipment Damage	825
13.2.11.5. Lessons Learned	825
13.2.12. January 17, 1995 Japan Blackout After Hanshin Earthquake	826
13.2.12.1. Precondition	826
13.2.12.2. Supply and Demand	826
13.2.12.3. Damage to Electric Power Facilities	827
13.2.12.4. Restoration of Electricity Supply	828
13.2.13. European Incident of November 4, 2006	830
13.2.13.1. Precondition	830
13.2.13.2. Initiating Events	830
13.2.13.3. Cascading Events	832
13.2.13.4. Final State	833
13.2.13.5. Resynchronization	835
13.2.14. Some Lessons Learned	835
13.3. Analysis of Blackouts	835
13.3.1. Classification of Blackouts	836
13.3.1.1. Precondition	836
13.3.1.2. Initiating Events	837
13.3.1.3. Cascading Events	837
13.3.2. Blackouts: Types of Incidents	840
13.3.3. Mechanisms of Blackouts	841

13.3.3.1. Voltage Collapse	842
13.3.3.2. Frequency Collapse	842
13.3.3.3. Cascading Overload	843
13.3.3.4. System Separation	843
13.3.3.5. Loss of Synchronism	843
13.3.3.6. Generalization	844
13.4. Economical and Social Effects	847
13.5. Recommendations for Preventing Blackouts	849
13.6. On Some Defense and Restoration Actions	850
13.6.1. Defense Actions	851
13.6.2. Restoration Actions	854
13.7. Survivability/vulnerability of Electric Power Systems	856
13.7.1. Introduction	856
13.7.2. Conception	857
13.7.3. Technology of Study	858
13.7.4. Concluding Remarks	859
13.8. Conclusions	860
Acknowledgments	860
References	860

14. RESTORATION PROCESSES AFTER BLACKOUTS **864**

Alberto Borghetti, Carlo Alberto Nucci, and Mario Paolone

14.1. Introduction	864
14.2. Overview of The Restoration Process	865
14.2.1. System Restoration Stages, Duration, Tasks, and Typical Problems	866
14.2.2. New Requirements	868
14.3. Black-Start-Up Capabilities of Thermal Power Plant: Modeling and Computer Simulations	869
14.3.1. Black-Start-Up of a Steam Group Repowered by a Gas Turbine	869
14.3.1.1. Black-Start-up Capability of a Single Steam Group	870
14.3.1.2. Black-Start-Up Capability of a Steam Group Repowered by a Gas Turbine	872
14.3.1.3. Control System Modifications to Improve Black-Start-Up Capabilities	874
14.3.2. Black-Start-Up of a Combined-Cycle Power Plant	877
14.3.2.1. Analysis of the Energization Maneuvers	878
14.3.2.2. Analysis of the Islanding Maneuvers	879
14.3.2.3. Description of Some Islanding Tests and Obtained Experimental Results	886
14.4. Description of Computer Simulators	888

14.4.1. Simulator of a Steam Group Repowered with a Gas Turbine	888
14.4.1.1. Gas Turbine Model and Its Validation	889
14.4.1.2. Steam Section Modeling and Its Validation	889
14.4.2. Simulator of a Combined-Cycle Power Plant	892
14.5. Concluding Remarks	896
References	896
15. COMPUTER SIMULATION OF SCALE-BRIDGING TRANSIENTS IN POWER SYSTEMS	900
<i>Kai Strunz and Feng Gao</i>	
15.1. Bridging of Instantaneous and Phasor Signals	901
15.2. Network Modeling	903
15.2.1. Companion Model for Network Branches	903
15.2.2. Direct Construction of Nodal Admittance Matrix	906
15.3. Modeling of Power System Components	909
15.3.1. Multiphase Lumped Elements	909
15.3.2. Transformer	911
15.3.3. Transmission Line	912
15.3.3.1. Single-Phase Line Model	912
15.3.3.2. Multiphase Line Model	916
15.3.4. Synchronous Machine in $dq0$ Domain	918
15.3.4.1. Electromagnetic and Mechanical Machine Equations	918
15.3.4.2. Calculation of Real Part of Stator Current	920
15.3.4.3. Calculation of Imaginary Part of Stator Current	920
15.3.4.4. Calculation of Rotor Speed and Angle	922
15.3.4.5. Integration with AC Network	922
15.3.4.6. Initialization	923
15.4. Application: Simulation of Blackout	923
References	926
Index	929

FOREWORD

Electricity is the driving factor of the modern world. Humanity is demanding more and more energy as the demand for better life quality, and industry development is increasing. The history of modern civilization begun more than one century ago when electricity generators and infrastructure for electricity transmission were invented. As the demand for electrical power has increased, the electrical power systems have been expanded over large distances and become more complex. There has been, thus, a continuous need for innovation to create more efficient and reliable components.

Recently, the electrical power systems have gone through a deregulation process, and electricity market has been created aiming to stimulate competition, achieve fair electrical energy price, encourage the investments for modernization and commissioning new power plants, etc. However, the immediate effects of the electricity market were additional problems in power system operation.

The limited conventional energy resources and the need for environment protection, on one hand, and the advantages of actual robust simulation hardware and software tools, on the other hand, encouraged the humanity to successfully exploit the Aeolian, solar, and other nonconventional resources. The share of electricity generation from renewable energy sources has significantly increased in the last years, and the targets are very ambitious for the future. Large wind farms are developed onshore and offshore, resulting in significant change in the generation pattern and thus changes in the power flow. Moreover, under the increasing share of generation from renewables, changes in power flows may sometimes occur quite often during one hour. This problem, in effect, requires strengthening the transmission grid.

The power system operators are, thus, facing bigger challenges than that in the past, such as limitations in scheduling and handling generation resources due to the electricity market, operation of the transmission networks close to their technical limits due to difficulties in constructing new transmission facilities, and generation uncertainties due to the intermittency and less inaccurate forecasts of the renewable energy sources, or even due to natural forces like earthquakes and storms.

The major grid blackouts experienced in the last years prove that investments and innovation are always required in the power system infrastructure, management, and education. The operational manual of the ENTSO-E network has been updated in order to prevent major incidents that occurred in the past due to permissive rules. In a strongly interconnected continental power system, as it is the ENTSO-E network, collaboration between power system operators based on clear rules is critical.

As a reaction to the technical issues of power systems, new concepts are under development. It is expected that the new ideas for more intelligent electrical networks (Smart Grids) and creation of continental supergrids may improve the power system security while satisfying the customers' needs as regards the quantity and quality. This may be seen as a new era of electricity.

This book is a successful collection of theories and applications, from modeling for dynamic analysis, methods for stability assessment and control strategies that finally help the reader to understand the causes and effects of power system blackouts and, on one hand, to understand why some preventive actions are required in order to ensure appropriate security levels and avoid the blackouts. The authors of this book, both from academia and industry, are active specialists in CIGRE and IEEE-PES activities.

Education has been a critical ingredient for creating a sustainable electricity industry. Investment in education is the minimum condition to create professionals.

André Merlin
President of CIGRE

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