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(Revision of
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IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

Sponsor

Industrial and Commercial Power Systems Department
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Abstract: The principles of system protection and the proper selection, application, and coordination of components that may be required to protect industrial and commercial power systems against abnormalities that could reasonably be expected to occur in the course of system operation are presented in a in a simple, yet comprehensive, format. The principles presented apply to both new electrical system design and to the changing, upgrading, or expansion of an existing electrical distribution system.
Keywords: bus protection, cable protection, calibration, conductor protection, coordinating time intervals, current transformers, current-limiting fuses, fuse coordination, fuse selectivity, generator grounding, generator protection, high-voltage fuses, liquid preservation systems, low-voltage motor protection, medium-voltage motor protection, motor protection, overcurrent protection, potential transformers, power fuses, protective relays, relay application principles, relay operating principles, service protection, short-circuit protection, switchgear protection, system design, system protection, transformer protection, voltage transformers

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Table 10-1 from National Electrical Manufacturers Assocation.

Figure 10-14, Figure 10-15, and Figure 10-18 from Bentley-Nevada.

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Introduction

(This introduction is not a part of IEEE Std 242-2001, IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.)

IEEE Std 242-2001, the *IEEE Buff Book*™ , has been extensively revised and updated since it was first published in 1975. The *IEEE Buff Book* deals with the proper selection, application, and coordination of the components that constitute system protection for industrial plants and commercial buildings. System protection and coordination serve to minimize damage to a system and its components in order to limit the extent and duration of any service interruption occurring on any portion of the system.

A valuable, comprehensive sourcebook for use at the system design stage as well as in modifying existing operations, the *IEEE Buff Book* is arranged in a convenient step-by-step format. It presents complete information on protection and coordination principles designed to protect industrial and commercial power systems against any abnormalities that could reasonably be expected to occur in the course of system operation.

Design features are provided for
- Quick isolation of the affected portion of the system while maintaining normal operation elsewhere
- Reduction of the short-circuit current to minimize damage to the system, its components, and the utilization equipment it supplies
- Provision of alternate circuits, automatic throwovers, and automatic reclosing devices

Participants

At the time this recomended practice was approved, the IEEE Working Group on Protection and Coordination of Industrial and Commercial Power Systems had the following members and contributors:

Carey Cook, *Chair*

Chapter 1: First principles—**Robert G. Hoerauf**, *Chair*; R. G. (Jerry) Irvine

Chapter 2: Short-circuit calculations—**Louie J. Powell**, *Chair*; David S. Baker, Chet Davis, John F. Witte

Chapter 3: Instrument transformers—**James D. Bailey** and **David S. Baker,** *Cochairs;* B. J. Behroon, Louie J. Powell, Marcelo Valdes

Chapter 4: Selection and application of protective relays—**Keith R. Cooper**, **N. T. (Terry) Stringer**, **John F. Witte**, *Cochairs*; Bruce G. Bailey, David S. Baker, James W. Brosnahan, Carey J. Cook, David D. Shipp, John F. Witte

Chapter 5: Low-voltage fuses—**Vincent J. Saporita**, *Chair*; Robert L. Smith, Alan F. Wilkinson

Chapter 6: High-voltage fuses—**John R. Cooper**, *Chair*; Carey J. Cook, Herb Pflanz, Kris Ranjan, John F. Witte

Chapter 7: Low-voltage circuit breakers—**George D. Gregory**, *Chair*; Bruce G. Bailey, John Chiloyan, Keith R. Cooper, R. G. (Jerry) Irvine, Steve Schaffer

Chapter 8: Ground-fault protection—**Shaun P. Slattery**, *Chair*; James P. Brosnahan, John Chiloyan, Edward Gaylon, Daniel. J. Love, Elliot Rappaport, Steven Schaffer, S. I. Venugopalan

Chapter 9: Conductor protection—**William Reardon**, *Chair*; John Chiloyan, George D. Gregory, Alan C. Pierce, Vincent J. Saporita

Chapter 10: Motor protection—**Daniel J. Love**, *Chair*; Al Hughes, Alan C. Pierce, Lorraine K. Padden, Joseph S. Dudor, R. G. (Jerry) Irvine

Chapter 11: Transformer protection—**Alan C. Pierce**, *Chair*; Carey J. Cook, John R. Cooper, Jerry Frank, Vincent J. Saporita, N. T. (Terry) Stringer, Ralph H. Young

Chapter 12: Generator protection—**Alan C. Pierce**, *Chairs*; Jay D. Fisher, Robert G. Hoerauf, Danial J. Love, Robert L. Simpson, Ralph H. Young

Chapter 13: Bus and switchgear protection—**Robert L. Smith, Jr**., *Chair*; Edward Gaylon, Steve Schaffer, John Steele

Chapter 14: Service supply line protection—**Lorraine K. Padden**, *Chair*; Consumer Interface Protection and Relaying Practices Subcommittees of the IEEE Power Systems Relaying Committee

Chapter 15: Overcurrent coordination—**N. T. (Terry) Stringer**, *Chair*; Bruce G. Bailey, Keith R. Cooper, Joseph S. Dudor, Douglas Durand, Tim Fink, Jay D. Fisher, George D. Gregory, William M. Hall, Steve Schaffer, John F. Witte, Ralph H. Young

Chapter 16: Maintenance, testing, and calibration—**R. G. (Jerry) Irvine**, *Chair*; Donald J. Akers, Jerry S. Baskin, Roderic L. Hageman, Ted Olsen, Gabe Paoletti, Elliot Rappaport, David, L. Swindler, Neil H. Woodley

The following members of the balloting group voted on this standard. Balloters may have voted for approval, disapproval, or abstention:

Bruce G. Bailey
James D. Bailey
David S. Baker
Ray M. Clark
Carey J. Cook
John R. Cooper
Chet Davis
George D. Gregory
Robert G. Hoerauf
R. G. (Jerry) Irvine
Daniel J. Love
Lorraine K. Padden
Alan C. Pierce
Louie J. Powell
William Reardon
Vincent J. Saporita
David D. Shipp
Shaun P. Slattery
Robert L. Smith, Jr.
N. T. (Terry) Stringer
John F. Witte
Ralph H. Young

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First principles

1.1 Overview

1.1.1 Scope

IEEE Std 242-2001, commonly known as the *IEEE Buff Book*™ , is published by the Institute of Electrical and Electronics Engineers (IEEE) as a reference source to provide a better understanding of the purpose for and techniques involved in the protection and coordination of industrial and commercial power systems.

IEEE Std 242-2001 has been prepared on a voluntary basis by engineers and designers functioning as a working group within the IEEE, under the Industrial and Commercial Power Systems Department of the Industry Applications Society. This recommended practice is not intended as a replacement for the many excellent texts available in this field. IEEE Std 242-2001 complements the other standards in the *IEEE Color Book Series*™ , and it emphasizes up-to-date techniques in power system protection and coordination that are most applicable to industrial and commercial power systems. Coverage is limited to system protection and coordination as it pertains to system design treated in IEEE Std 141-1993[1] and IEEE Std 241-1990. No attempt is made to cover utility systems or residential systems, although much of the material presented is applicable to these systems.

This publication presents in a step-by-step, simplified, yet comprehensive, form the principles of system protection and the proper application and coordination of those components that may be required to protect industrial and commercial power systems against abnormalities that could reasonably be expected to occur in the course of system operation. The principles presented are applicable to both new electrical system design and to the changing, upgrading, or expansion of an existing electrical distribution system.

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[1]Information on references can be found in 1.8.

plant or commercial business. Some operations can afford limited service interruptions to minimize the possibility of equipment repair or replacement costs, while others would regard such an expense as small compared with even a brief interruption of service.

In most cases, electrical protection should be designed for the best compromise between equipment damage and service continuity. One of the prime objectives of system protection is to obtain selectivity to minimize the extent of equipment shutdown in case of a fault. Therefore, many protection engineers would prefer that faulted equipment be de-energized as soon as the fault is detected.

However, for certain continuous process industry plants, high-resistance grounding systems that allow the first ground fault to be alarmed instead of automatically cleared are employed. These systems are described in Chapter 8.

1.1.2.3 Economic and reliability considerations

The cost of system protection determines the degree of protection that can be feasibly designed into a system. Many features may be added that improve system performance, reliability, and flexibility, but incur an increased initial cost. However, failure to design into a system at least the minimum safety and reliability requirements inevitably results in unsatisfactory performance, with a higher probability of expensive downtime. Modifying a system that proves inadequate is more expensive and, in most cases, less satisfactory than initially designing these features into a system.

The system should always be designed to isolate faults with a minimum disturbance to the system and should have features to give the maximum dependability consistent with the plant requirements and justifiable costs. Evaluation of costs should also include equipment maintenance requirements. In many instances, plant requirements make planned system outages for routine maintenance difficult to schedule. Such factors should weigh into the economic-versus-reliability decision process.

When costs of downtime and equipment maintenance are factored into the protection system cost evaluation, decisions can then be based upon total cost over the useful life of the equipment rather than simply the first cost of the system. In-depth coverage of reliability-versus-economic decisions can be found in IEEE Std 493-1997.

1.2 Protection against abnormalities

The principal electrical system abnormalities to protect against are short circuits and overloads. Short circuits may be caused in many ways, including failure of insulation due to excessive heat or moisture, mechanical damage to electrical distribution equipment, and failure of utilization equipment as a result of overloading or other abuse. Circuits may become overloaded simply by connecting larger or additional utilization equipment to the circuit. Overloads may also be caused by improper installation and maintenance, such as misaligned shafts and worn bearings. Improper operating procedures (e.g., too frequent starting,