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Introduction

1.1 Objectives

When you have completed this section, you will know the aims and content of this book.

1.2 Introduction

Electricity has become the principal source of energy for modern society, and for most of the population, it is now almost a necessity of life. The distribution system is a part of the electricity supply industry, carrying electricity to most of the customers and therefore having the greatest impact on the quality of service provided to those customers. Although it is the least charismatic of the three main areas of the electricity supply system, namely generation, transmission, and distribution, it attracts a major part of the capital investment in the industry.

The protection system is a fundamental part of any electricity supply system and has an essential role in ensuring that distribution companies achieve an acceptable level of quality at an economic price. It is particularly important for the distribution system, since this is that part of the supply system which suffers from the greatest number of short-circuit faults.

The role of the protection system is principally to ensure that short-circuit faults or other abnormal operating conditions do not detract from the quality of supply to most customers connected to the distribution network. Operations of the protective system either isolate or initiate the isolation of faulted sections of the power supply network to maintain the continuity of supply elsewhere on the system. Power accuracy and coordination of the protection system are essential to ensure that the minimum amount of plant or ideally the faulted Plant only is disconnected from the network due to a short-circuit fault. The protection system

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must operate as quickly as possible to minimize the amount of damage and disturbance caused by the fault and to minimize safety hazards to utility personnel and the general public. However, although speed is important, it is always secondary to accuracy.

The traditional form of protection was all based on electromechanical technology, and many of these schemes are still in use today. The first electronic relays were introduced in the 1970s, and microprocessor-based relays arrived in the 1980s. The introduction of microprocessor relays enabled the relay to monitor the power system's performance, to communicate with remote supervisory and control computers, and in some cases to have settings that can be adjusted remotely.

This book provides a basic introduction to the art and science of the techniques and technologies used in protecting distribution systems; it follows on from the basics in protection provided in book one. It does not attempt to cover all aspects of protection nor the subtleties of the subject, since these can only be acquired from a close involvement with a particular electricity supply system and an understanding of the history behind the development of that system. It is a companion to the next book, which covers the protection of the transmission system.

The book starts with the concepts of protection overlay, unit protection, and nonunit protection. These are explained in the next section, which includes the role and importance of providing backup protection to ensure that the power system is still protected even when the protection system fails. The most widely used protective system is the fuse, and which the subject of the opening part, Section 3. This covers the nonunit protection of distribution feeders and overcurrent protection in particular. Following fuses, the use of time-delayed protection relays is described together with their application to protect both standard and more complex supply networks.

An essential element in the operation of protection relays is the operation of the primary transducers, which are addressed in Section 4.

Section 5 considers unit protection schemes applied to distribution feeders, and the advantages and disadvantages that these provide over the nonunit schemes described in Section 3.

Techniques used to protect specific units of power system plant are considered in Sections 6–8, which cover the protection of transformers, busbars, and motors, respectively. The growth in the use of embedded generation and the difficulties in protecting these systems from both short-circuit faults and abnormal operating conditions are considered in Section 9. Autoreclose schemes are considered in Section 10, and recent advances in the coordination of protection and control schemes are examined in Section 11. This latter area is of growing interest due to the almost revolutionary advances made possible by the use of microprocessor-based relaying systems.

This book provides the basics of the art and science of protection for distribution systems and will enable those interested in this area to delve deeper into the specifics of the subject. Although several leading textbooks cover the topic, the greatest understanding of the subject can be best achieved by working with the schemes and exploring the history behind their development.