Chapter 1
Introduction to Electric Distribution System

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ABSTRACT

Distribution system is the final stage of electric power system, and can be classified based on voltage level, location, number of wires, and types of customers. This chapter explains the various classifications of the distribution system in detail. System reliability is one of the important design concerns for any distribution system. The various methods of design concept to improve reliability are clarified. Reactive power compensation is another main concern in a distribution system. Methods of reactive power compensation are also detailed.

INTRODUCTION

Overview

An electric power system is encompassing the electric power generation in power plants, electric power transmission system is to transmit the generated power from the power plant to load center (over several hundred kilo meters) where the actual load is located, power distribution and utilisation. The Electric Distribution System (EDS) is the final stage of electric power system where the generated power is converted into useful work through distribution lines and feeders. It deals with lower voltage magnitude as reverse of transmission system high voltage (Gonen, 2014, Gers, 2013).

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The IEEE std. 141-1993 describes the various configuration of distribution based on the reliability requirement. These configurations are simple radial systems, expanded radial system, primary selective system, primary loop system, secondary selective system, ring bus system and spot network (IEEE Std, 1994; Khan et al., 2019; Khan et al., 2018; Khan et al., 2017; Banteywalu et al., 2019; Anteneh et al., 2019; Molla et al., 2019, Molla et al., 2018, Jariso et al. 2018). The reliability of radial system is low as compared with ring bus system. If the distribution is designed for low reliability requirement, the number of equipment's required to the system is less and it requires less economics as compared with distribution is designed for high reliability (Kersting, 2001). Based on the reliability requirement, type of distribution system to be selected based on both technical as well as economic considerations (Alhelou et al., 2019; Makdisie et al., 2018; Alhelou et al., 2018; Alhelou et al., 2016; Haes Alhelou et al., 2019; Njenda et al., 2018).

Based on voltage level, power distribution systems are classified into primary distribution system and secondary distribution system (Khan, 2007, Mehta and Mehta, 1982).

- Typically the various voltage levels of primary distribution systems are 6.6 kV, 11 kV, 22 kV and 33 kV.
- Typically the various voltage levels of secondary distribution are 415 V three phase and 240 V single phase.

Based on the type of consumer, power distribution systems are classified into residential, commercial and industrial distribution system (Sivaraman et al., 2017).

Based on the location, power distribution systems are classified into urban distribution system and rural distribution system.

- Urban distribution system comprising the residential, commercial and industrial power systems.
- Rural distribution system comprising the residential, commercial, industrial power systems and also comprising the agricultural usage.

Based on the no of wires used, power distribution systems are classified into 1ϕ 2W system, 3ϕ 3W system and 3ϕ 4W system (Sivaraman et al., 2017).

- Residential system loads are connected in 1ϕ 2W system and 3ϕ 4W system.
- Commercial system loads are connected in 1ϕ 2W system, 3ϕ 3W system and 3ϕ 4W system.
- Industrial system loads are connected in 1ϕ 2W system, 3ϕ 3W system and 3ϕ 4W system.

The concept of Distributed Generation (DG) introduced in last decade to generate the localised power nearer to the load center or end user loads to reduce the energy losses in transmission & distribution lines, improve the voltage profile across the distribution system (Jenkins et al. 2010). Renewable energy resources play an important role in DG especially solar PV systems and wind turbine systems. The power from DG may integrate at either SDS or PDS. For an example, 100kW rooftop solar PV system integration at SDS and 1000kW ground mounted solar PV system at PDS (Bollen and Hassan, 2011).