PRACTICAL POWER SYSTEM PROTECTION pdf

1: Practical Power System Protection - Leslie Hewitson, Mark Brown, Ramesh Balakrishnan - Google Book

Gain a practical knowledge of the engineering challenges of power system protection: fault types, component types, relay settings, etc. Coverage includes both the fundamentals and the basic fault and design calculations needed to specify, use and maintain power protection systems.

Components[edit] Protection systems usually comprise five components: For parts of a distribution system, fuses are capable of both sensing and disconnecting faults Failures may occur in each part, such as insulation failure, fallen or broken transmission lines, incorrect operation of circuit breakers, short circuits and open circuits. Protection devices are installed with the aims of protection of assets and ensuring continued supply of energy. Switchgear is a combination of electrical disconnect switches, fuses or circuit breakers used to control, protect and isolate electrical equipment. Switches are safe to open under normal load current, while protective devices are safe to open under fault current. A single such device can replace many single-function electromechanical relays, and provides self-testing and communication functions. Protective relays control the tripping of the circuit breakers surrounding the faulted part of the network Automatic operation, such as auto-re-closing or system restart Monitoring equipment which collects data on the system for post event analysis While the operating quality of these devices, and especially of protective relays, is always critical, different strategies are considered for protecting the different parts of the system. Very important equipment may have completely redundant and independent protective systems, while a minor branch distribution line may have very simple low-cost protection. There are three parts to protective devices: Instrument transformers create electrical isolation from the power system, and thus establishing a safer environment for personnel working with the relays. Relays are able to be simpler, smaller, and cheaper given lower-level relay inputs. Power system voltages and currents are accurately reproduced by instrument transformers over large operating ranges. Types of protection[edit] High-voltage transmission network[edit] Protection on the transmission and distribution system serves two functions: At a basic level, protection disconnects equipment which experiences an overload or a short to earth. Some items in substations such as transformers might require additional protection based on temperature or gas pressure, among others. Generator sets[edit] In a power plant, the protective relays are intended to prevent damage to alternators or to the transformers in case of abnormal conditions of operation, due to internal failures, as well as insulating failures or regulation malfunctions. Such failures are unusual, so the protective relays have to operate very rarely. If a protective relay fails to detect a fault, the resulting damage to the alternator or to the transformer might require costly equipment repairs or replacement, as well as income loss from the inability to produce and sell energy. Overload and back-up for distance overcurrent [edit] Overload protection requires a current transformer which simply measures the current in a circuit. There are two types of overload protection: Instantaneous overcurrent requires that the current exceeds a predetermined level for the circuit breaker to operate. Time overcurrent protection operates based on a current vs time curve. Based on this curve, if the measured current exceeds a given level for the preset amount of time, the circuit breaker or fuse will operate. Earth fault "ground fault" in the United States [edit] Earth fault protection also requires current transformers and senses an imbalance in a three-phase circuit. Normally the three phase currents are in balance, i. If one or two phases become connected to earth via a low impedance path, their magnitudes will increase dramatically, as will current imbalance. If this imbalance exceeds a pre-determined value, a circuit breaker should operate. Restricted earth fault protection is a type of earth fault protection which looks for earth fault between two sets of current transformers [4] hence restricted to that zone. Distance impedance relay [edit] Distance protection detects both voltage and current. A fault on a circuit will generally create a sag in the voltage level. If the ratio of voltage to current measured at the relay terminals, which equates to an impedance, lands within a predetermined level the circuit breaker will operate. This is useful for reasonably long lines, lines longer than 10 miles, because their operating characteristics are based on the line characteristics. This means that when a fault appears on the line the impedance setting in the relay is compared to the apparent impedance of the line from the relay terminals to the fault. If the relay setting is determined to be below the apparent impedance it is determined that the fault is within the zone of protection. When the transmission line length is too short, less than 10 miles, distance protection becomes more difficult to coordinate. In these instances the best choice of protection is current differential protection. A circuit breaker or protection relay may fail to operate. In important systems, a failure of primary protection will usually result in the operation of back-up protection. Remote back-up protection will generally remove both the affected and unaffected items of plant to clear the fault. Local back-up protection will remove the affected items of the plant to clear the fault. Low-voltage networks[edit] The low-voltage network generally relies upon fuses or low-voltage circuit breakers to remove both overload and earth faults. Coordination[edit] Protective device coordination is the process of determining the "best fit" timing of current interruption when abnormal electrical conditions occur. The goal is to minimize an outage to the greatest extent possible. Historically, protective device coordination was done on translucent logâ€”log paper. Modern methods normally include detailed computer based analysis and reporting. Protection coordination is also handled through dividing the power system into protective zones. If a fault were to occur in a given zone, necessary actions will be executed to isolate that zone from the entire system. Zone definitions account for generators , buses, transformers , transmission and distribution lines , and motors. Additionally, zones possess the following features: Overlapped regions are created by two sets of instrument transformers and relays for each circuit breaker. They are designed for redundancy to eliminate unprotected areas; however, overlapped regions are devised to remain as small as possible such that when a fault occurs in an overlap region and the two zones which encompass the fault are isolated, the sector of the power system which is lost from service is still small despite two zones being isolated. DME accomplish three main purposes: They define security as the tendency not to operate for out-of-zone faults. Both dependability and security are reliability issues. Fault tree analysis is one tool with which a protection engineer can compare the relative reliability of proposed protection schemes. Quantifying protection reliability is important for making the best decisions on improving a protection system, managing dependability versus security tradeoffs, and getting the best results for the least money. A quantitative understanding is essential in the competitive utility industry. Devices must function consistently when fault conditions occur, regardless of possibly being idle for months or years. Without this reliability, systems may cause costly damages. Devices must avoid unwarranted, false trips. Devices must function quickly to reduce equipment damage and fault duration, with only very precise intentional time delays. Devices must provide maximum protection at minimum cost. Devices must minimize protection circuitry and equipment.

2: Power-system protection - Wikipedia

Plant operators, electricians, field technicians and engineers will gain a practical understanding of the role and workings of power system protection systems from this work.

3: ECE Power System Protection and Relaying, Fall)

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4: Practical Power System Protection : Lesile Hewitson :

This online Practical Power System Protection course offered by IDC Technologies has been designed to give plant operators, electricians, field technicians and engineers a better appreciation of the role played by power system protection systems.

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