COORDINATION PROTECTION SYSTEM IN INDUSTRIAL PLANTS

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Faculty of Electronic and Computer Engineering
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Dedicated to my beloved family especially my wife and son, my parents, supervisor, FKEKK lecture and also to all my friends.

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ABSTRACT

This case study deals with the proper selection, application, and coordination of the components which represent system protection for industrial plants. System protection and coordination serve to minimize damage to a system and its components in order to limit the amount and duration of any service interruption occurring on any portion of the system. This practice is for use at the system design stage. Information on protection and coordination principles designed to protect industrial power systems against any abnormalities which could be expected to occur in the course of system operation is presented.

ABSTRAK

Kertas kerja penyelidikan ini adalah mengenai kaedah pemilihan yang sesuai, aplikasi dan koordinasi komponen yang dipilih sebagai satu sistem perlindungan terhadap industri perkilangan. Sistem perlindungan dan koordinasinya mempunyai fungsi untuk menghadkan kerosakan ke atas sistem elektrik dan instrumentasi terlibat. Ianya mengurangkan jumlah dan masa gangguan perkhidmatan yang berlaku terhadap mana-mana bahagian sistem tersebut. Kaedah ini digunapakai semasa peringkat merekabentuk sistem elektrik industri perkilangan. Penerangan juga turut mencakupi maklumat mengenai prisip-prinsip perlindungan dan koordinasinya bagi melindungi sistem elektrik industri terhadap jangkaan kerosakan sepanjang sistem itu beroperasi.

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INTRODUCTION

Industrial power systems should be designed to provide the electric energy needed to power equipments in a safe, reliable and economical way. If only normal operation is practiced (without system protection and coordination), system operation would be inadequate because of possible equipment failure or human error. System protection and coordination serves to minimize damage to a system and its components in order to limit the amount and duration of any service interruption occurring to any portion of the system. This practice is implemented at the system design stage. Information on protection and coordination principles are designed to protect industrial power systems against any abnormalities that could be expected to occur in the course of system operation.

Starting with the many simple devices which are employed; and covering the whole area of industrial power system protection; this case study aims to help achieve a thorough understanding of the necessary protection. This case study is done to provide review of how protection devices coordinate with each other in industrial plants. The aim of this study is to serve as a comprehensive resource for students and prospective users in providing information over the field and to demonstrate the correct theoretical approach of which users can utilize to better enhance their general knowledge in power system protection and coordination. This case study also deals with the proper selection, application, and coordination of the components which represent system protection for industrial plants.

1.1 Project background

The design of an electrical power system should minimize the effect of short circuit current that occur on the system itself or on the utilization of equipments that it supplies. One can design into the electric system features that will quickly isolate the affected portion of the system and maintain normal service for as much of the systems as possible and minimize damage to the affected portion of the system. In laying out electric power systems, the designer should keep the final design as simple as would be compatible with safety, reliability, maintainability and economic considerations.

A short circuit is an accidental low-resistance connection between two nodes of an electrical circuit that are meant to be at different voltages. This results in an excessive electric current on the network and potentially causes circuit damage, overheating, fire or explosion. Circuits may become overloaded simply by connecting larger or additional utilization equipment to the circuit. Overloads may be caused by improper installation and maintenance. Improper operating procedures are also a cause of equipment overload or damage.

The isolation of short circuits and overloads requires the application of protective equipment that will both sense that an abnormal current flow exists and then remove the affected portion from the system. Fuse is both a sensing and interrupting device. It is connected in series with the circuit and responds to thermal effects produced by the current flow through it. Its fusible element is designed to open at a predetermined time depending on the amount of current that flows. Fuses may be non-current-limiting or current-limiting, depending upon their design and construction. Fuses are not re-settable since their fusible elements are consumed in the process of interrupting current flow.

Circuit breakers are interrupting devices only and must be used in conjunction with sensing devices to fulfill the detection function. It is an automatically-operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entire city.

Relays are compact analog, digital, and numerical devices that are connected throughout the power system to detect intolerable or unwanted conditions within an assigned area. They are, in effect, a form of active insurance designed to maintain a high degree of service continuity and limit equipment damage. Relay response to an input and causes circuit connection to close or open.

The protective device usually consists of several elements, shown in Figure 2.0 that are arranged to test the system condition, make decisions regarding the normality of observed variables, and take action as required.

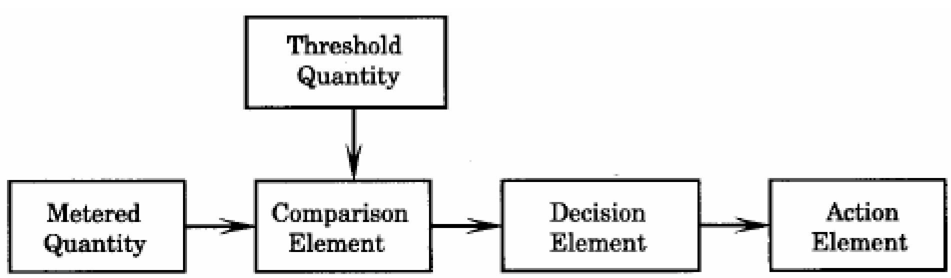

Figure 1.0: Protective device functional elements

The protective system always measures certain system quantities, such as voltages and currents, and compares those or some combination of it, against a threshold setting that is calculated by the protection engineer and is set into the device. If this comparison indicates an alert condition, a decision element is triggered. If all checks are satisfied, an action element is released to operate, which usually means that circuit breakers are instructed to open and isolate a section of the network.

A protective system should be designed to recognize certain system abnormalities which, if undetected, could lead to damage of equipment or extended loss of service. The design and specification of the system components is an important part of the protective strategy. The protective system should also be designed for minimum loss-of-load, as shown in Figure 2.1. There is no need, usually, to de-energize the entire system because of an isolated fault. The system should have selectivity to isolate the fault such that the minimum interruption occurs.

The operation of protective equipment must be accurate and fast. Bulk power system reliability requires that systems survive severe fault conditions without causing a system collapse. This in turn requires fast, reliable protective system operation.

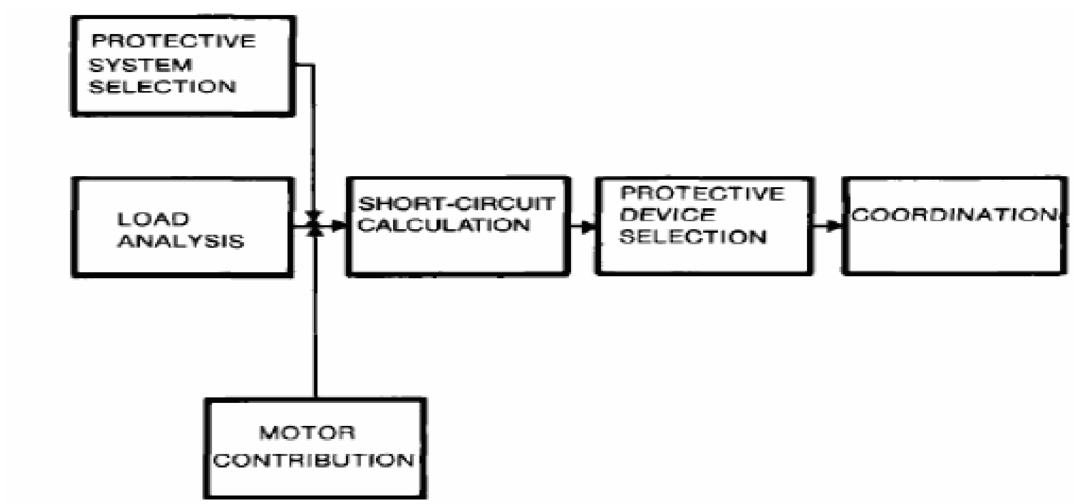

Figure 1.1: Sequence of steps in System Protection and Coordination

1.2 Project Objectives

The objectives of this project are stated below;

1. To determine and compare the characteristics, ratings, and settings of over current protective devices.

2. To determine the best method to limit the extent and duration of service interruption.

3. To determine the best system that can minimize damage to the system components involved in the failure

1.3 Problem statement

System protection is one of the most essential features of an electrical system. There is too often a tendency to consider system protection after all other design features have been determined and the basic system design established. Such an approach can result in an unsatisfactory system that cannot be sufficiently protected, and would thus lead to unreasonably high expenditure. Protective devices are assumed to be properly coordinated when the electrical system is built. They do not remain coordinated, however, when additions or system changes are made the system become unstable and not safe for machine and human.

1.4 Scope

In this project, three assumptions are made:

- Basic application of electrical devices like fuse, breaker, relay and motor.
- Compare data between 3 factories.
- Understanding short circuit formula and application.
- Analyze main instrument and device.

There are two limitation levels that cannot be avoided in this project. First is to find information from trusted resources. Each system and machine has their own current supply. To get the real data, manual electric circuit diagram from the industry is taken. Certain information are confidential and not all company/factory are willing to expose their data. Next, data collection is handled by the company staff. I have no control as to when the data is collected and how data collection is handled. Human error that occur when taking the data also affects the analysis.

To analyze data, short circuit formula in industrial power system is used. All formula for each device is applied to this industry data.

1.5 Methodology project

I will also perform a thorough literature study and review on all electric devices that is used in this project. For each component, the general information and power operation in the factory will be discussed. A study on protective system design consideration, selective coordination of protective devices and selection and application of protective device is done.

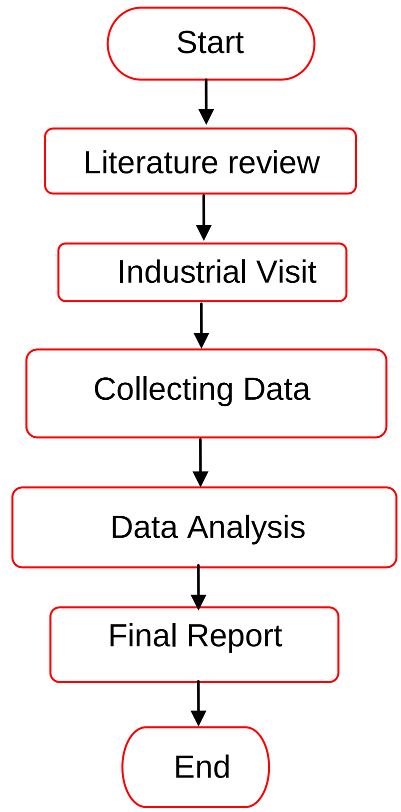

Figure 1.2: Project flowchart

The primary purpose of good selection and selective tripping of protective devices is to minimize system damage and limit the extent and duration of service interruption when failures occur. The minimum safety and reliability requirements should be met to assure satisfactory electrical system performance. Selective coordination technique's main goal is to isolate the affected portion of the system quickly while maintaining normal service for the rest of the system. At the same time, the operation of other parts of the system that are not directly involved must be held until other protective devices are functioning as normal. This is called selectivity.

Minimum as well as maximum short-circuit values are required to predict selective operation of protective devices during fault currents. A short circuit study, therefore, is absolutely necessary for selective coordination settings. A coordination study is necessary to determine the characteristics and settings of all protective devices. The study should indicate the best combination of protection, thus assuring that the least load is interrupted in the least time while clearing any fault in the system. To localize the disturbance, the device should be selective in their operation; the one nearest to the faulty power source should operate first. If this device does not operate, the next device in line should take over.

1.6 Outline of PSM report

This PSM report consists of five chapters. The first chapter discusses about background, objectives, problem statement, scope and methodology of this project. Chapter two discusses more on theory and includes literature reviews that have been done. It also will discuss on components of the analysis and formula used in this project. Chapter three discusses on the result of this project. Chapter four will discuss about project analysis and results. Finally, chapter five discusses conclusion and future work proposal for this project.