OVERCURRENT AND EARTH FAULT RELAY SETTING AND COORDINATION USING PSS-ADEPT

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Abstract -**This paper studies the protective relay setting and coordination using PSS-Adept. Faults and failures normally occur in power system. Power system needs an auxiliary system that must take corrective action on the occurrence of a fault. This auxiliary system is knows as protection system. Protection systems are sets of equipments to detect faults in the protected elements of the power systems, to disconnect the faulted element and to re-establish the service. This paper approach for over current and earth fault as protection system. Protective device coordination is the process of determining the best timing of current interruption when abnormal electrical conditions occur. This paper also using Bus power system distribution network and implement using protection equipment application in power system simulation programmed for planning, design and analysis of distributed system (PSS/Adept).This paper conclude by the result of study carried out on analysis protective relays configuration.**

Keywords –Overcurrent relay,Earth fault relay,Fault, PSS-Adept.

1. INTRODUCTION

The main purpose of power systems is to generate, transmit, and distribute electric energy to customers without interruptions and in the most economical and safe manner[2].To achieve the objective of power systems are divided in generation, transformation, transmission and distribution subsystems[2].Faults and failures normally occur in power system at transformer feeder, transformer, bus section and transmission. Faults and failures normally occur in power systems. Due to the great amounts of energy involved, faults represent a threat to the operation and security of power systems if the faults are not promptly corrected [1].Power systems need an protective relay as protective system that must take corrective actions on the occurrence of a fault. IEEE defines a protective relay as "a relay whose function is to detect defective lines or apparatus or other nature and to initiate appropriate control circuit action [7].This paper approach for overcurrent and earth fault as protection system. The protective relaying which responds to a rise in current flowing through the protected element over a pre-determined value is called overcurrent protection and the relays used for this purpose are known as overcurrent relays[1],[3]. Earth fault protection again requires current transformers and senses an imbalance in a three-phase circuit [1]. Normally a three-phase circuit is in balance, so if a single or multiple phases are connected to earth an imbalance in current is detected [1]. If this imbalance exceeds a pre-determined value a circuit breaker should operate. The design of a comprehensive protection scheme in a power system requires the detailed study of time-current characteristics of the various relays used in the scheme. Thus it is necessary to obtain the time- current characteristics of these relays. The pick-up current setting can thus be varied by the use of such plug multiplier setting [5]. The pick-up current values of earth fault relays are normally quite low [5]. The operating time of all overcurrent relays tends to become asymptotic to a definite minimum value with increase in the value of current [9]. The time-current tripping characteristic of IDMT relays may need to the tripping time required and the characteristics of other protection devices used in the network. For these purposes, IEC 60255 defines a number of standard characteristic as follows standard inverse (SI), very inverse (VI), extremely inverse (EI), Definite time (DT)[5].

A. Objectives

The objectives of this project as follows:

- To setting and coordination of protective relay in the power bus system.
- To analyze the perform of over current and earth fault relay as protective the fault when occur in power system.
- To study how to coordination of protective relay followed by Tenaga NationalBerhad (TNB) standard.

B. Scope of Studies

- To identify the occurrence of faults in the bus system and know the maximum fault currents or short circuit current occur in this location of bus system.
- To setting and coordinating protective relay according to Tenaga National Berhad (TNB) standard.
- To find suitable CT ratio, time dial setting and pick up (tap) for coordinating and setting protective relay.

II. METHODOLOGY

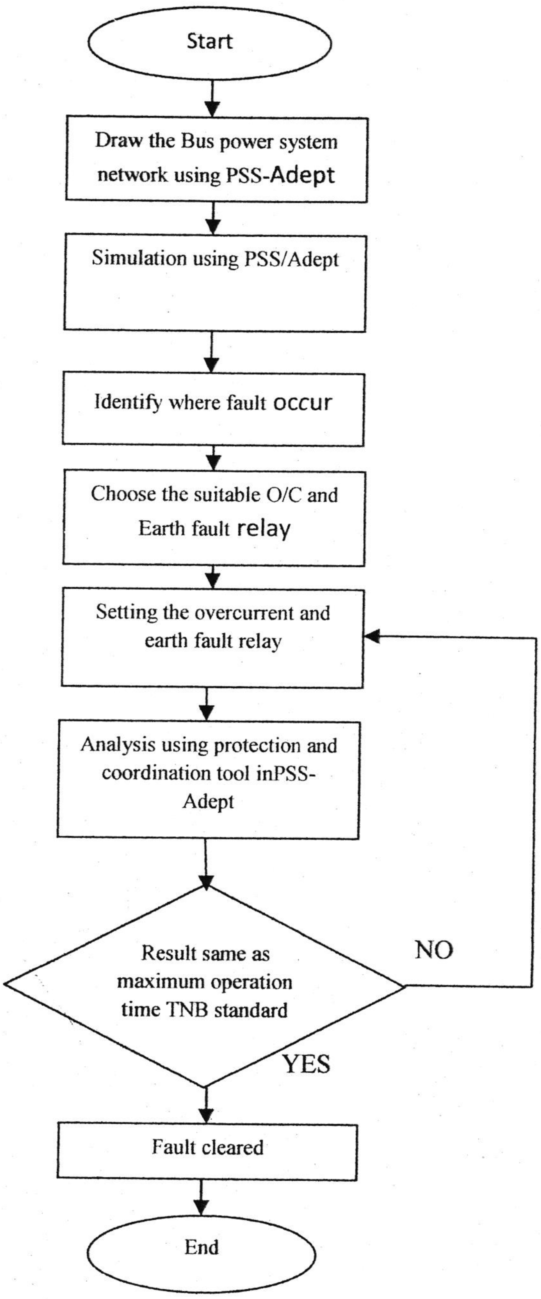

Figure 1.0: Flow chart of protective relay setting and coordination

A. PSS-Adept simulation software

The simulation was executed using a commercial load flow prom called Power System Simulator and Advance Distribution Engineering Productivity Tool (PSS/Adept). The function of this simulation is a network simulation program for planning, designing and analyzing distribution system. PSS/Adept utilities the Gauss-Seidel method for the solving load flow equation. The protection and coordination module is an option in PSS/ADEPT. The protection and coordination module displays the characteristic curves of selected overcurrent relays and fuses along with operating times of these protective devices for use in a coordination study.

B. Network Design

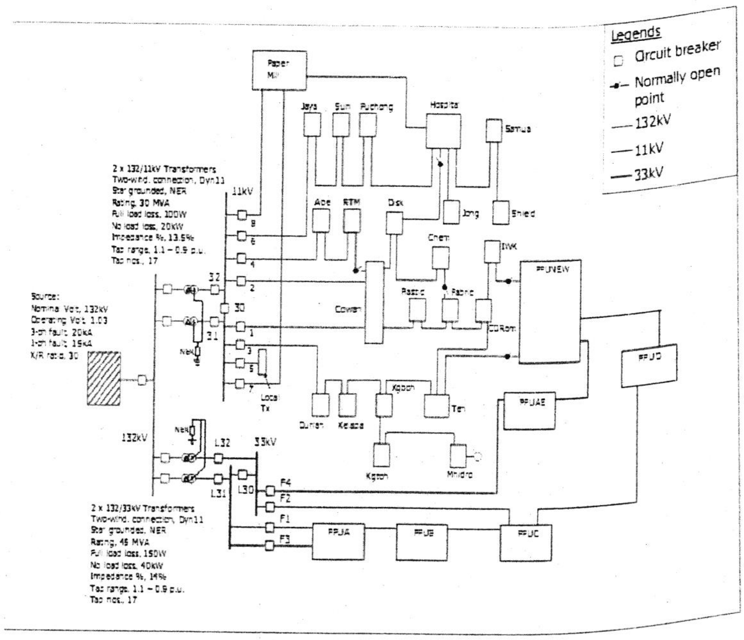

Figure 2.0 Bus power system network

Figure 2.0 shows the Network of Bus power system network. The network model has been design by PSS/Adept software. The main step down substation (in Malaysia normally called main intake substation) is connected to the grid at nominal voltage of 132kV, i.e., the source. The maximum 3-phase currents at the source are indicated in Figure 2.0 which means that on a 3-phase solid fault on the 132kV bus, the fault current that is contributed by the source is 20kA and 15kA on a single-phase to ground fault. The 132kV is stepped down to 11kV using 2 x 30MVA transformers whose parameters are also indicated in Figure 2. A neutral earthing is shared by the two transformers. The value of the NER is such that for any single-line to ground fault on the secondary side of the transformer, the fault current will not exceed the rated capacity of the transformer. It is important that the transformer parameters such as resistance, tap settings and controls are properly modeled. The main intake substation has another voltage transformation is 132/33kV. Parameters for the two 45MVA transformers are also indicated in Figure 2.0. The NER for these two transformers is also seized in accordance to the same principle as for the 132/11kV power transformers.

C. Setting and Coordination of protective relay

Relay operating characteristics and their setting must be carefully coordinated in order to achieve selectivity [4]. The aim is basically to switch off only the faulted component and to leave the rest of the power system in service in order to minimize supply interruptions and to assure stability[4]. The type of relay, CT setting, time dial setting and pick up (Tap) need to setting before analysis this network.

III. RESULTS AND DISCUSSION

A. Overcurrent Relay Coordination

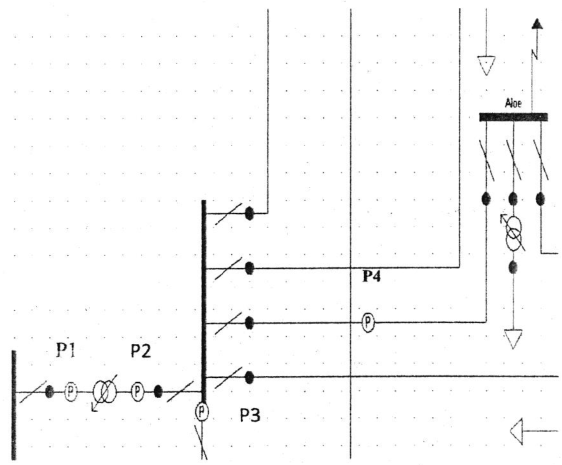

Figure 1: Protective Relays : P1,P2,P3,P4

This project uses four protective relay of normail inverse characteristics. Protective relay installed in the transformer feeder, transformer, transmission feeder and bus section.

- P1 install at transformer feeder.
- P2 install at transformer.
- P3 install at bus section
- P4 install at transmission feeder.

When coordinating overcurrent relays, fault is set to 3-phase-to-ground and all protective relays use the same device. In Tenaga National Berhad (TNB) standards, the protective relay at the main intake P1 is set to operate ideally at 2.0 seconds[10]. For the protective relay at transformer feeder. P2, is set to operate ideally at 1.6 seconds whereas for the protective relays that resides at the bus section, is set to be initialized at 1.4 seconds which is slightly faster than transformer feeder's relay and slightly slower when compared to outgoing feeder's relay[10]. The outgoing feeder's relay must be initialized ideally at 1.2 seconds [10]. TNB also using Normail Inverse for type of relay characteristics.

TABLE 1: Overcurrent Protective Relays Configurations

Relay	CT Settings	Time Dial (s)	Pick Up (Tap)	Relay Characteristics	Max Operation Time (s)
P1	200/5	0.14	5	NORMAIL INVERSE	2.060
P2	1600/5	0.2	5	NORMAIL INVERSE	1.577
P3	1600/5	0.19	5	NORMAIL INVERSE	1.396
P4	600/5	0.45	5	NORMAIL INVERSE	1.213

Table 1 show the overcurrent protective relay configuration. The over current unit has three values to be set, the CT ratio setting the pickup current value (Ip), and the time dial setting and pick up tap. The maximum operation time of P1 is 2.060 second, P2 is 1.577second ,P3 is 1.396second and P4 is 1.213second .This result obtained from analysis using PSS-Adept same as operation time(s) TNB standard. CT ratios are expressed as a ratio of the rated primary current to the rated secondary current. Current transformers are instrument transformers that are used to supply a reduced value of current to protective relay. The most common CT secondary full-load current is 5 amps which matches the standard 5 amp full -scale current rating of protective relay[8]. Current of 10 to 20 times (or grater) normal rating often occur in CT winding for few cycles during short circuits [8].Ideally, CT ratio setting depend on short circuit current or fault current and follow by CT ratio standard. The maximum secondary current is taken from maximum fault current occur at location of fault using by PSS-Adept simulation. The equation1 as Normail Inverse protective relay. This equation is related the analysis using PSS-Adept simulation.

$$t = \frac{0.14}{(\frac{I}{Ip})^{0.02} - 1} \times Tp(s) ......(\text{Equation 1})$$

t = Tripping time
Tp = Setting value of the time multiplier
I = Fault current
Ip = Setting value of the current

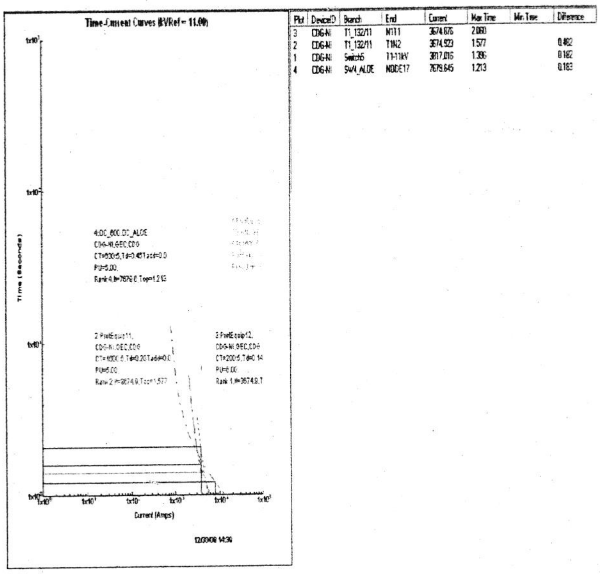

Figure 2: Time verse current curve for overcurrent protective relay

Figure 2 show the time verse current for overcurrent protective relay. The overcurrent relay 4(P4) is set at shortest time delay when fault occur in bus power system and clear the fault before the relay P3,P2 and P1 have time to operate.

B.Earth Fault Relay Coordination

The coordinating earth fault relays, fault is set to 3-phase-to-ground and all protective relays use the earth fault relay device ID. In TNB standards, the protective relay at transformer feeder P2, is set to operate ideally at 1.6 seconds[8]. Beside that outgoing feeder's relay must be initialized ideally at 1.2 seconds [8]. Firstly, only P2 and P4 have to be replaced with earth fault device. Table 2 show the maximum time from four protective earth fault relay .The result obtained from setting CT ratio, time dial setting and pick up (Tap) before analysis by using PSS-Adept. The maximum operation time of P1 is 1.606 second and P2 is 1.199second. This result obtained from analysis using PSS-Adept same as operation (s) as TNB standard. Figure 3 show the time verse current curve for overcurrent protective relay. The earth fault relay 4(P4) is set at shortest time delay when fault occur in bus power system and clear the fault before the relay P2 have time to operate.

TABLE 2: Earth Fault Protective Relays Configurations

Relay	CT Setting	Time Dial (s)	Pick Up (Tap)	Relay Characteristics	Max Operation Time (s)
P2	1600/5	0.34	1	NI	1.606
P4	600/5	0.54	1	NI	1.199

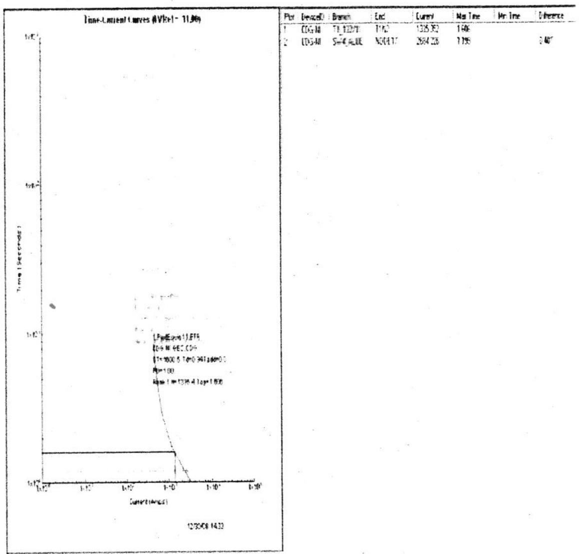

Figure 3: Time verse current curve for earth fault protective relay.

IV. CONCLUSION

This project is expected to analyze and predict the protective relay coordination and setting by using PSS/Adept. The performance of relay will be known and compare with trip current at other bus network in same system. At the same time to study about to setting CT setting, time dial, pick up (tap) and characteristic of protective relay. As a result show the coordination and setting protective relay same as TNB standard. Simulated and analysis examples help students increase their understanding of over current and earth fault system protection operation, fundamentals of relay system and its application into bus network system, providing them a complete view of relay system protection in power system.

V. RECOMMENDATIONS

The basic rules for correct relay co-ordination can generally be stated use the relay with the same operating characteristic in series in each other. Besides that, make sure that the relay farthest from the source has current setting equal or less than the relay behind it, that is, relay in front is always equal to or less than primary current required to operate the relay behind it.

VI. ACKNOWLEDGMENT

Big thanks to En. Nik Fasdi Bin Nik Ismail for his guidance, suggestion, and encouragement in accomplishment of this study. Acknowledgement also goes to the author's parents and cooperative discussions with project members.

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