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PLANNING AND COORDINATION OF RELAY IN DISTRIBUTION SYSTEM USING ETAP

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ABSTRACT

This novel speaks about protection of power system network which carries protective relays that isolates the faulted portion of the network to prevent equipment damage, injury to operators and to ensure minimum system disruption enabling continuity of service for healthier portion of the network. The protective relays must also be able to discriminate between criticized and standard operating conditions.When many relay are involved, co-ordination of all relay operation in a particular zone is complex and requires optimization. This problem is studied and the protection coordination problem is formulated and simulated in ETAP.Load flow analysis test and short circuit analysis test was carried out and analyzed.

Key Words -Power System Network, relay, Load Flow analysis, Short circuit analysis,ETAP.

INTRODUCTION

Nowadays, distributed generation has recently gained a lot of attention related to its connection to distribution network. Although distributed generation units have many benefits such as stability and economy, it suffers from some critical problems that may affect these benefits.

A power system involves generation, distribution, transmission, and customer usage. For conveying uninterrupted electricity to the customer's faultless operation is required, damage the equipment's of the power system components. In such cases, fault should be smoothly cleared and faulty portion must be isolated(J. Sadeh et al., 2011).

In all power distribution system networks the relay protect all the important components. There are majorly primary and backup protection provided in the system. If primary relay does not operate and clear the fault on appropriate time, then the backup relays located in the backup zone must operate to isolate the fault(Mazen Abdel-Salam et al., 2015).

It is capable of optimally identifying set of relay settings for both Primary and back-up Protection. Identification of the fault location is paramount for ensuring protection. Proper allocation of time delay for backup protection is also essential.

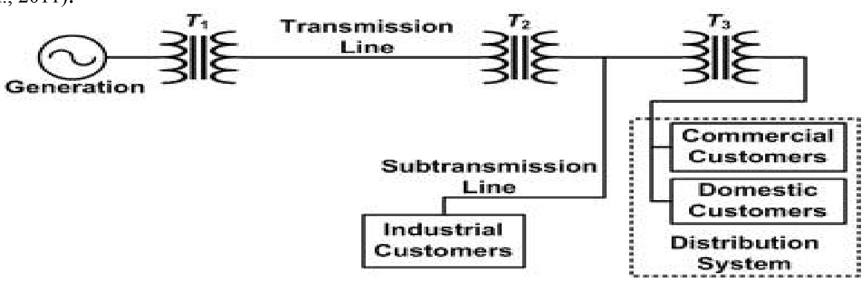

Figure 1. General Overview of Power Generation and Distribution

POWER SYSTEM PROTECTION

The objective of power system protection is to isolate a faulty section of electrical power system from rest of the live system so that the rest portion can function satisfactorily without any severer damage due to fault current(H. laaksonen et al., 2014).

Actually circuit breaker isolates the faulty system and the circuit breaker automatically opens during fault condition due to its trip signal comes from protection relay. The main philosophy about protection is that it only can prevent the continuation of flowing of fault current by quickly disconnect the short circuit path from the system.

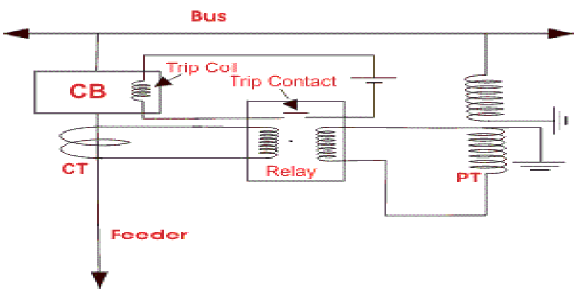

Figure 2. General Connection diagram of protection relay

To limit the extent of the power system that is disconnected when a fault occurs, protection is arranged in zones(ManijehAlipour et al., 2015). Ideally, the zones of protection should overlap each other so that no part of the power system is left unprotected. For practical physical and economic reasons, the accommodation for current transformers being in some cases available only on one side of the circuit breakers.

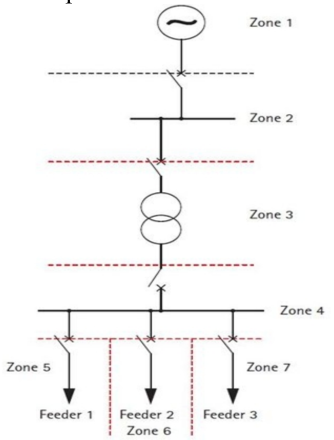

Figure 3. General Schematic of protection in each zones

RELAY COORDINATION

Over current phase and earth fault relay coordination is necessary to achieve proper fault identification and fault clearance sequence(A. H. Askarian et al., 2002; A. Noghabi et al., 2010). These relays must be able to distinguish between the normal operating currents including short time currents that may appear due to certain equipment normal operation and over current due to fault conditions during fault conditions.These relays must operate quickly isolating the faulted section of the network only and for continued operation of the healthy circuits.

In the event of failure of primary relays meant for isolating the fault within its primary zone of protection, backup relays must operate after providing for sufficient time discrimination for the operation of primary relays(A. Urdaneta et al., 1988). Hence, the operation of backup relays must be coordinated with those of the operation of the primary relays. The primary protection device next to the fault and backup protection devices next in the line(B. Chattopadhyay et al., 1996). The flexible settings of the relays must be set to achieve the objectives stated in this section.

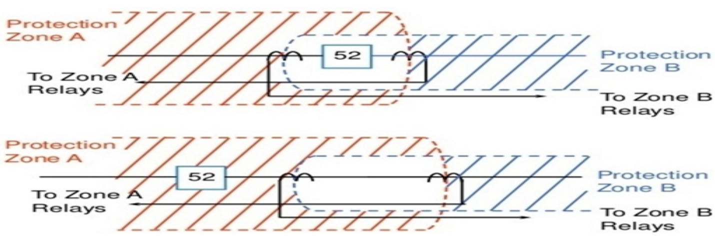

Figure 4 Primary and Backup Protection Zone

Once the relays are coordinated, the discrimination in the operation of primary and backup relays and their coordination with the maximum possible load currents will be plotted on the time current characteristics (TCC's)(M. M. Mansour et al., 2007). Relay coordination needs to be evaluated for maximum and minimum fault conditions and for various possible network configurations. When a network has several levels of primary and backup relay levels, the source end relay operation can become quite delayed due to successive time discrimination at downstream load end coordination levels(D. Birla et al., 2006). In such cases it may be necessary to ensure isolation of fault at the earliest by possibly coordinating the source end relays with much faster dedicated equipment relays in the downstream.

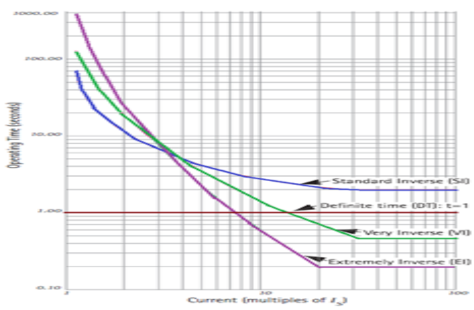

Figure5. Current Vs Time Characteristics Graph

Co-ordinate protection will make the nearest relay to operate on fault first, to minimizes the amount of system disconnection so that outage of power is minimized(A.A.M. Hassana et al., 2015). Fault Current limiters is also used in coordination of relay by that it decreases the intensity of the fault condition.

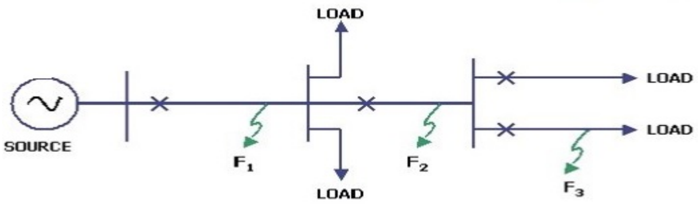

Figure6. Coordination of Relay

SYSTEM DESCRIPTION

- No: of buses: 46.
- It consists of: 220kV, 110kV, 33kV, 11kV, 415V
- Load: 23.336MW and 23.082MVAr.

TABLE 1: BUS INPUT DATA

ID	TYPE	Nomkv	Bus kv	Sub-sys	%Mag	Ang
Bus1	Load	220.0	220.0	1	100.00	0.00
Bus2-5	Load	110.0	110.0	1	100.00	0.00
Bus6-12	Load	33.0	33.0	1	100.00	0.00
Bus13-20	Load	110.0	110.0	1	100.00	0.00
Bus21-23	Load	0.415	0.433	1	100.00	0.00
Bus26, 28	Load	11.0	11.0	1	100.00	0.00
Bus27, 29	Load	0.4	0.433	1	100.00	0.00
Bus30-31	Load	11.0	11.0	1	100.00	0.00
Bus32-33	Load	110.0	110.0	1	100.00	0.00
Bus35-36	Load	6.6	6.600	1	100.00	0.00
Bus37	Load	0.	0.433	1	100.00	0.00
Bus38-41	Load	0.4	0.433	1	100.00	0.00
Bus42-43	Load	11.0	11.0	1	100.00	0.00
Bus44-46	Load	0.4	0.433	1	100.00	0.00

TABLE 2: INDUCTION MACHINE INPUT DATA

ID	TYPE	Qty	ID	HP/kw	kva	kv	Amp	Pf	R	X	R/X	MW/PP
Mt	Motor	1	Bus 28	750.00	867.66	11.000	45.54	92.4	2.39	15.2	0.16	0.38

TABLE 3: BRANCH CONNECTION DATA

ID	TYPE	FROM BUS	TO BUS	R	X	Z
T1	2W XFMR	Bus1	Bus2	0.32	11.01	11.01
T2	2W XFMR	Bus1	Bus2	0.32	11.01	11.01
T3	2W XFMR	Bus5	Bus6	0.93	25.48	25.50
T4	2W XFMR	Bus13	Bus14	2.58	48.02	48.09
T5	2W XFMR	Bus16	Bus37	50.90	361.3	364.87
T6	2W XFMR	Bus17	Bus38	50.90	361.30	364.87
T7	2W XFMR	Bus18	Bus39	19.64	209.59	210.51
T8	2W XFMR	Bus19	Bus40	19.64	209.59	210.51
T9	2W XFMR	Bus20	Bus41	226.11	698.68	734.36
T10	2W XFMR	Bus20	Bus44	226.11	698.68	734.36
T11	2W XFMR	Bus20	Bus45	226.11	698.68	734.36
T13	2W XFMR	Bus26	Bus27	358.91	1109.0	1165.6
T14	2W XFMR	Bus28	Bus46	226.11	698.68	734.36
T18	2W XFMR	Bus33	Bus42	226.11	21.71	21.72

TABLE 4: POWER GRID INPUT DATA

ID	ID	MVAsc	kw	R	X	R/X
U1	Bus 1	220.000	4890.000	0.05111	2.04435	0.03

LOAD FLOW ANALYSIS

Load flow analysis is performed using ETAP computer software that simulates actual steady-state power system operating conditions, enabling the evaluation of bus voltage profiles, real and reactive power flow and losses. Conducting a load flow analysis using multiple scenarios helps ensure that the power system is adequately designed to satisfy your performance criteria. A properly designed system helps contain initial capital investment and future operating costs.

A load flow analysis determines how the electrical system will perform during normal and emergency operating conditions, providing the information needed to:

- Optimize circuit usage.
- Develop practical voltage profiles.
- Minimize kW and kVar losses.
- Develop equipment specification guidelines.
- Identify transformer tap settings.

SHORT CIRCUIT ANALYSIS

Short-Circuit Currents are currents that introduce large amounts of destructive energy in the forms of heat and magnetic force into a power system.

The reliability and safety of electric power distribution systems depend on accurate and thorough knowledge of short-circuit fault currents that can be present, and on the ability of protective devices to satisfactorily interrupt these currents. Knowledge of the computational methods of power system analysis is ssential to engineers responsible for planning, design, operation, and troubleshooting of distribution systems.

In general, most of the power distribution system are not properly protected against short-circuit currents. These currents can damage or deteriorate equipment. Improperly protected short-circuit currents can injure or kill maintenance personnel. Recently, new initiatives have been taken to require facilities to properly identify these dangerous points within the power distribution of the facility.

Short Circuit analysis is required to ensure that existing and new equipment ratings are adequate to withstand the available short circuit energy available at each point in the electrical system. A Short Circuit Analysis will help to ensure that personnel and equipment are protected by establishing proper interrupting ratings of protective devices (circuit breaker and fuses). If an electrical fault exceeds the interrupting rating of the protective device, the consequences can be devastating. It can be a serious threat to human life and is capable of causing injury, extensive equipment damage, and costly downtime.

On large systems, short circuit analysis is required to determine both the switchgear ratings and the relay settings. No substation equipment can be installed without knowledge of the complete short circuit values for the entire power distribution system. The short circuit calculations must be maintained and periodically updated to protect the equipment and the lives. It is not safe to assume that new equipment is properly rated.

TABLE 5: POWER GRID INPUT DATA

From Bus ID	To Bus ID	%V from Bus	kA Real	kA Imaginary	X/R Ratio	kA Magnitute
Bus11	Total	0	0.781	-8.07	10.3	8.108
Bus7	Bus11	1.86	0.722	-7.473	10.4	7.507
Lump4	Bus11	100	0.06	-0.597	10	0
Bus6	Bus7	1.95	0.451	-5.031	11.2	5.051
Bus8	Bus7	1.98	0.054	-0.489	9.1	0.492
Bus9	Bus7	2.1	0.217	-1.953	9	1.965
Bus10	Bus7	1.86	0	0	999.9	0
Bus10	Bus12	1.86	0	0	9999.0	0

CALCULATION OF RELAY OPERATING TIME

In order to calculate the actual relay operating time(A. H. Askarian et al., 2002), the following things must be known.

- Time / PSM Curve
- Plug Setting
- Time Setting
- Fault Current
- Current Transformer Ratio

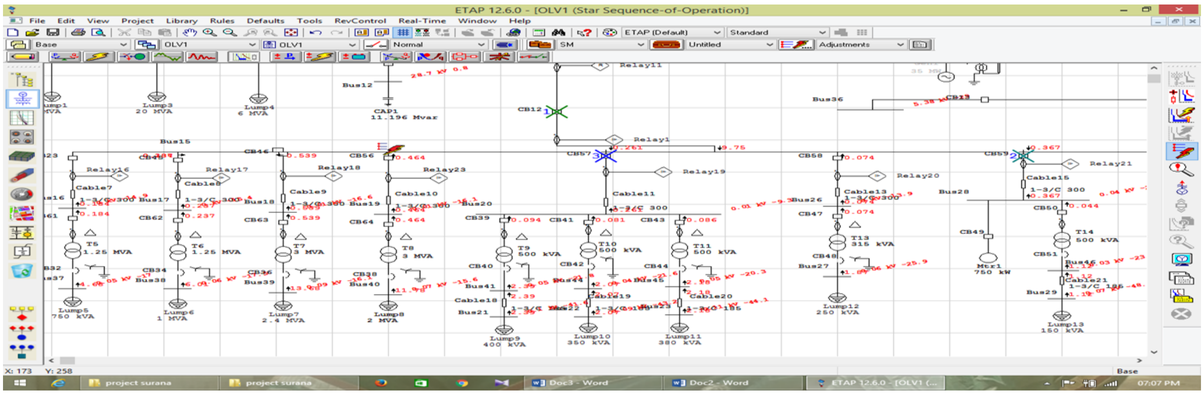

Figure7. Relay Working for Fault Insertion

CONCLUSION

The protection is done by relays and circuit breakers. The design of sizing and number depends upon the power distribution system and it varies from system to system, however the fault is isolated by the relay.

To clear the fault, the exact location must be localized. Type of relay depends upon the system conditions. Various algorithms are there to protect the system. By using short circuit and load flow analysis the coordination of relay was done. When a fault occurs the primary relay must need to isolate the fault but during failure of primary, the backup relay to clear a fault.

The current limiter will isolate the current in case of failure occurs in order to minimize outage. Methods of load flow analysis, short circuit analysis and selection of current transformer is also must be taken to protect the equipment.

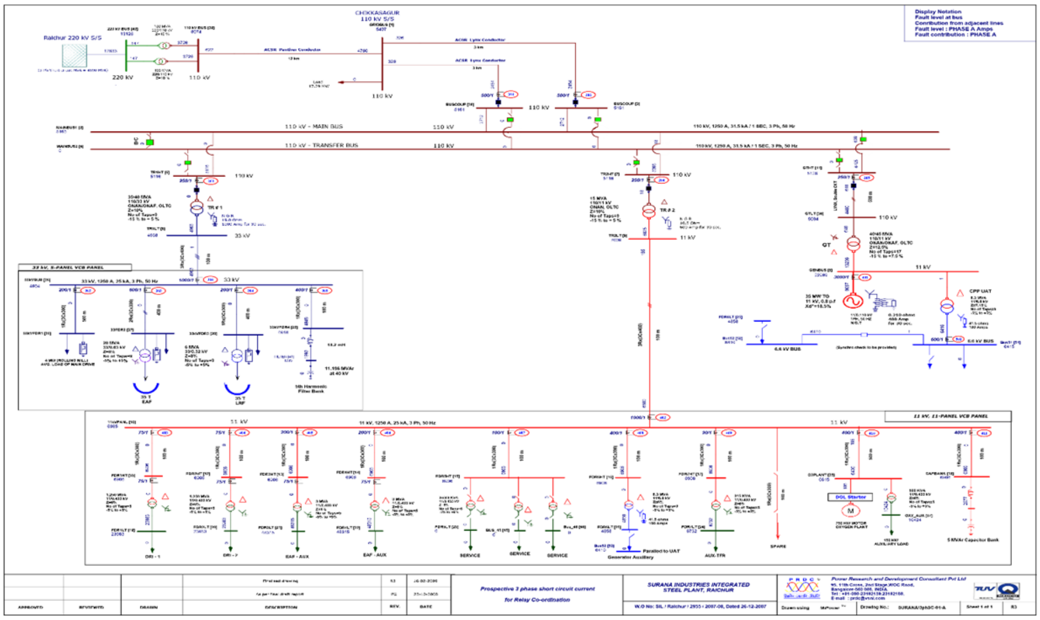

Figure 8. ETAP test system for distributed power system

REFERENCES

A. H. Askarian, M. Al-Dabbagh, K. H. Kazemi, H. S. S. Hesameddin and R. A. J. Khan, A new optimal approach for coordination of overcurrent relays in interconnected power systems. IEEE Power Eng. Rev. **22**(6): 60 (2002).

A. Noghabi, H. Mashhadi and J. Sadeh, Optimal coordination of directional overcurrent relays considering different network topologies using interval linear programming. IEEE Trans. Power Del. **25**(3): 1348–1354 (2010).

A. Urdaneta, R. Nadira and L. P. Jimenez, Optimal coordination of directional overcurrent relays in interconnected power systems. IEEE Trans. Power Del. **3**(3): 903–911 (1988).

B. Chattopadhyay, M. Sachdev and T. Sidhu, An on-line relay coordination algorithm for adaptive protection using linear programming technique. IEEE Trans. Power Del. **11**(1): 165–173 (1996).

D. Birla, R. Maheshwari and H. Gupta, A new nonlinear directional overcurrent relay coordination technique, and banes and boons of nearend faults based approach. IEEE Trans. Power Del. **21**(3): 1176–1182 (2006).

H. Laaksonen, D. Ishchenko and A. Oudalov, Adaptive protection and microgrid control design for Hailuoto Island. IEEE Trans. Smart Grid **5**(3): 1486–1493 (2014).

M. M. Mansour, S. Mekhamer and N.-S. El-Kharbawe, A modified particle swarm optimizer for the coordination of directional overcurrent relays. IEEE Trans. Power Del. **22**(3): 1400–1410 (2007).

J. Sadeh, V. Aminotojari and M. Bashir, Optimal coordination of overcurrent and distance relays with hybrid genetic algorithm," in Proc. 10th Int. Conf. Environ. Elect. Eng. (EEEIC), Pp. 1–5 May (2011)

Mazen Abdel-Salam, Ahmed Abdallah, Rashad Kamel and Mohamed Hashem, Improvement of Protection Coordination for a Distribution System Connected to a Microgrid using Unidirectional Fault Current Limiter. Ain Shams Engineering Journal Pp. 1-10 (2015) .doi:10.1016/j.asej.

Alipour, Saeed Teimourzadeh, and Heresh Seyedi, Improved group search optimization algorithm for coordination of directional overcurrent relays. Swarm and Evolutionary Computation **23**: 40–49 (2015)

A.A.M. Hassana and Tarek A. Kandeel, Effectiveness of frequency relays on networks with multiple distributed generation. **2**(1): 75-85 (2015),