STUDY ON METHODS OF TRANSFORMER PROTECTION

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Abstract- **This paper presents the study on methods of transformer protection. Transformer is a static device which transfers energy from one circuit to another without any change in the frequency of the transformer. Proper protection is needed for economical and safe operation of electrical power system. Power transformer protective relay should block the tripping during external fault or magnetising inrush and speedily operate the tripping during internal faults. The foremost objective of this paper is to analyse protection during internal and external fault and to operate the relay with proper fault discrimination.**

Index Terms- **Transformer, Inrush current, Relay**

I. INTRODUCTION

Transformer is a static device which consists of two or more stationary electric circuits interlinked by a common magnetic circuit for the purpose of transferring electrical enrgy between them. The transfer of energy from one circuit to another takes place without a change in frequency.

Power transformers are used in generating stations or substations at each end of a power transmission line for stepping up or stepping down the voltage. They are put in operation during load periods and are disconnected during light periods. They are designed to have maximum efficiency at or near full load.

The engineer must balance the expense of applying a particular protection scheme against the consequences of relying on other protection sacrificing the transformer. Allowing a protracted fault would increase the damage to the transformer and the possibility of tank rupture with a consequent oil fire and consequent personnel safety risks. There is no rule that says what specific protection scheme is appropriate for a given transformer application. There is some tendency to tie protection schemes to the MVA and primary kV of a transformer. While there is some validity to this approach, there are many other issues to be considered.

Fires in indoor transformer may have high risk of catastrophic facility damage and even higher personnel safety risks, increasing the need for advanced high speed protection. The proximity of flammable process chemicals increases a need for protection schemes that reduce the risk of a tank fire. The failure of a transformer used in a large base load unit-connected generator may cause extended generation-replacement costs; even the loss of a small station service transformer can cause a notable disruption of generation and high economic consequences. Similar economic impacts may also exist at industrial sites. Some transformers are custom designs that may have long lead times, increasing the need for advanced protection schemes.

II. SPECIFIC APPLICATIONS THAT AFFECT PROTECTION

Some specific applications that affect protection are: A tap changer flashover can ordinarily be repaired in the field, but if this fault is allowed to evolve into a winding fault, the transformer will need to be shipped to a repair facility; hence, protection that can rapidly sense a tap change fault is desirable. A high magnitude through fault (external fault fed by the transformer) shakes and heats a transformer winding, and the longer the through fault lasts, the greater the risk of it evolving into an internal transformer fault; hence, fast clearing for close-in external faults is part of the transformer protection scheme. Some transformers are considered disposable and readily replaced, reducing the need for advanced protection schemes. Transformer protection commonly includes some coverage of external bus and cable, and faults in these zones may expose personnel to arc flash hazards.

During transformer‟s differential protection, inrush current only flows through transformer‟s one side. Through current transformer, it will flow into differential circuit in the form of unbalanced current. When the system is operating normally or external fault happens, this current is small. It is only 2%-10% of rated current. But when inputting a non-load transformer or cutting off external fault, inrush current whose value is high (the highest value may be 6-8 times of rated current) will occur.

III. PROTECTION EXAMPLE AND GENERAL CONCEPTS

There are three general categories of protective relay technology that arise in the discussions to follow:

- Electromechanical: uses magnetic flux created from current and voltage to create torques on movable disks and relays, which is the source of the term "relay." Usually single device number functionality
- Solid State: uses low voltage analog signals created from sensed currents and voltages; uses discrete electronics and basic logic circuits; may contain a basic microprocessor for logic and some math. Usually single or dual device number functionality
- Numeric: a multifunction, programmable logic relay; digitizes sensed current and voltage, then calculates an RMS or phasor equivalent value; uses a high-end microprocessor.

IV. CONCEPT OF INRUSH CURRENT

When a transformer is initially energized, there is a sudden inrush of primary current. The maximm value attained by the flux is over twice the normal flux. The core is driven far into saturation with the result that the magnetizing current has a very high peak value. A typical concept for setting the taps for a two winding transformer is to analyze the current seen at the relay for the peak power rating of the transformer.

V. METHODS FOR PROTECTION

5.1 Differential Relay

Differential relays sense the unbalance in the flow of currents in various apparatus or buses. In the absence of a fault in the protected zone, this unbalance tends to be small and the flows into the zone are closely matched to the flows leaving. Accordingly, such relays can be more sensitive than phase overcurrent relays and need not be delayed to coordinate with other relays during external faults, except for some issues associated with transient CT saturation.

5.2 Fuses

Fuses are economical, require little maintenance, and do not need an external power source to clear a fault, which is of great cost and maintenance benefit. As discussed above, MVA of a transformer is an imperfect guide to the appropriate level of transformer protection, but it may be noted that fuses are probably the predominant choice for transformers below 10 MVA. Under 3MVA, breakers on the high side are seen only in special applications (e.g., some small generation sites may use a high side breaker).

5.3 Current matching scheme

The relay's current matching scheme allows different currents on each input to the relay to be seen as effectively the same current. In electromechanical relays, the scheme uses tapped transformers (hence, the source of the term "tap"), where each tap adjusts the number of turns used on the

5.4 Delta/Wye Compensation

A delta wye bank introduces a phase shift in balanced voltages and currents of typically ±30°, depending on system rotation and transformer connections. In electromechanical relays, the common approach to the delta wye winding compensation is to connect the CTs in wye-delta. CT on the delta transformer winding is connected in wye, and the CT on the wye transformer winding is connected in delta. The same concept could be used with solid 8state and numeric relays, but normally such relays have internal delta wye compensation logic**.**

5.5 Digital Differential

The differential protection converts the primary and secondary currents to a common base and compares them. The distinction between these currents is small during normal operating conditions. The variance is also small for external faults, but is larger than the difference for normal operating conditions. However, difference becomes significant during an internal fault in a transformer. The differential protection is then based on matching the primary and secondary current of the transformer for ideal operation. Transformer core generally retains some residual flux when transformer is switched off. Later, the core is likely to saturate when the transformer is re-energized. If the transformer is saturated, the primary windings draw large magnetizing currents from the power system. These results in a large differential current which cause the differential protection relay to operate.

The differential relay actually compares between primary current and secondary current of power transformer, if any unbalance found in between primary and secondary currents the relay will actuate and sends the trip signal to both the primary and secondary circuit breaker of the transformer.

5.6 Probabilistic Neural Network

Probabilistic Neural Network is a kind of feed forward neaural netwrok. The original is a direct network implementation of Parzen nonparametric Probability Density Function estimation and bays classification rule. The standard procedure of PNN requires a single pass over all the patterns of training set. This characteristic renders PNN faster to train as compared to FFBP neaural network and RBFNN. The only drawback of PNN is the requirement of larger storage for exemplar patterns. As the computer memory has become very cheap and effective, the cost and size of large storage are no longer of concern thses days. PNN is widely used in the area of pattern recognition, non linear mapping, fault detection and classification, estimation of probability of class membership and likelihood ratios.

VI. CONCLUSION

We finally conclude with the study of methods of transformer protection. Protection of a transformer is utter concern as the economy of a country depends on the power supply. Without any supply, devices and appliances won't operate. Electricity has become the utmost important for the survival of any country. Protection methods of transformer must always be taken under consideration.

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