STUDY ON THE NON LINEAR CHARACTERISTIC OF POWER TRANSFORMER AND THEIR EFFECT FERRORESONANCE

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A project report submitted in partial fulfilment of the requirement for the award of the degree of Master of Engineering (Electrical Engineering)

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May 2008
ABSTRACT

Ferroresonance can occur in electrical power system and consequently can cause damage such as due to voltage transformer overheating or power transformer overvoltages. This study involves simulation work to simulate various conditions under which ferroresonance can occur in typical extra high voltage substations. The ATP-EMTP simulation program was used to model various power system components and simulate the ferroresonance phenomena. The effects of the non-linear characteristics of power transformers are also studied. Methods to prevent the ferroresonance conditions from occurring and hence avoiding equipment damages and losses were also proposed based on the simulation work.
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1.1 Introduction

A power quality is a term used to describe electrical power that motivates an electrical load and the load’s ability to function properly with that electric power. With a poor power quality, an electrical device (or load) may malfunction, fail prematurely or not operate at all. There are many ways in which electric power can be of poor quality and many more causes of such poor power quality.

As a general statement, any deviation from normal of a voltage source (either DC or AC) categorized as a power quality issue. Power quality issues can be high-speed events such as voltage impulses / transients, high frequency noise, wave shape faults, voltage swells and sags and total power loss. Power quality issues will affect each type of electrical equipment differently. By analyzing the electrical power and evaluating the equipment or load, we can determine if a power quality problem exists.
Power quality problems manifest themselves in variations in the voltage has been obtained. This variation can be in the form of transients due to switching or lightning strikes, sags or swells in the amplitude of the voltage, a complete interruption in the supply, or harmonic distortion caused by non-linear loads in the system which may likely lead to the occurrence of ferroresonance.

1.2 Objective

The main objectives of this project is to simulate the ferroresonance event on extra high voltage substation power transformer based on parameters, features, components and arrangements of the substation power system. An alternative Transient Program- Electromagnetic Transient Program (ATP-EMTP) will be used to carry out the simulation in order to study the phenomenon and therefore to determine methods to minimize or reduce the risk of ferroresonance to power transformers.

1.3 Scope of Work

The main scope of this project is to simulate the various conditions of ferroresonance, which include:

i. To prove or otherwise that ferroresonance can occur at 400kV double circuit substation;

ii. To identify the effect of magnetization characteristic of power transformer on ferroresonance;
iii. To identify method to minimize the impacts of ferroresonance on power transformers.

1.4 Project Flow Chart

To solve the problem, one has to first study the problem and come up with the process flow chart, which will guide the simulator throughout the project. It is also to give the simulator the basic overview of the system and what is required before simulations be completed. The flow chart of this project is as shown in Figure 1.1.

![Project Flow Chart Diagram]

- Review previous work done on Ferroresonance
- Review Ferroresonance simulation done in power system
- Analyze the Ferroresonance work done
- Modelling the ferroresonance circuit arrangement in ATP/EMTP
1.5 Organisation of Thesis

Chapter 2 illustrates previous work done related on ferroresonance phenomenon in voltage transformer and power transformer. Besides, it is also includes some techniques for avoiding or mitigating ferroresonance. Chapter 3 describes the basics of ferroresonance, characteristics and types of ferroresonance. Chapter 4 describes the methods that are used for the simulation. Therefore, all information related the simulation is explained in detail with the operation. Chapter 5 presents the circuits that were used in the simulation and explains how the simulations techniques are implemented. Lastly, chapter 6 describes the conclusion and recommendation that is related to the project done.
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