HIGHER TECHNICAL INSTITUTE
ELECTRICAL ENGINEERING DEPARTMENT

DIPLOMA PROJECT

FAULT LEVEL CALCULATIONS FOR PROTECTION OF POWER SYSTEM COMPONENTS

KYRIAKIDES ELIAS

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KYRIAKIDES ELIAS

JUNE 1996

To my family

FAULT LEVEL CALCULATIONS FOR PROTECTION OF POWER SYSTEM COMPONENTS

Project report submitted by:

KYRIAKIDES ELIAS

In part satisfaction of the award of
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KYRIAKIDES ELIAS

OBJECTIVES:

- Familiarise with the structure of a power system.
- Apply the per unit system in power system analysis.
- Build models of power system components for the purpose of fault calculations.
- Make use of a Power System Analysis (PSA) package to determine expected fault levels for a typical power system configuration.
- Effort on representing the PSA output into graphical form.
- Examine case studies and decide on methods to limit excess fault levels in the system.

FAULT LEVEL CALCULATIONS FOR PROTECTION OF POWER SYSTEM COMPONENTS

by KYRIAKIDES ELIAS

SUMMARY

This project deals with calculating the expected fault levels at the busbars of the system under study, this being part of the Generation, Transmission and Distribution system of the Electricity Authority of Cyprus. These expected fault levels are required for the accurate adjustment of the protective relays which will work during the transient period following the fault. These relays are very important since they are responsible for clearing faults and protecting the system. As M. Kaufmann[1] once said, the protective relays and the protective equipment in general, is the ambulance at the foot of the cliff rather than the fence at the top. This implies that their function is not preventive since they take action only once a fault has occurred. Therefore special consideration should be given in adjusting the protective equipment according to the expected fault levels.

The project will concentrate on the modelling of power system components for the purpose of fault calculations. A Power System Analysis (PSA) package was used to calculate the expected fault levels.

The main conclusions drawn by this study, are that having more than one busbar at the Distribution side of a substation and deparalleling the feeders outgoing from these busbars, results in reduced fault levels due to increase of the impedance seen by the fault. Finally, as will be shown, no need exists in changing the circuit breakers of the District Office substation for the period under consideration.

[1] Power System Protection, Volume 1 Principles and Components, page 1

INTRODUCTION

Electricity has become, during the last few decades, one of the most important and vital forms of energy since it is extensively used in offering lighting energy, heating energy, energy for electrical machines and even entertainment through television or other means of massive or individual entertainment. Its uses are in fact much more and it can be said that humanity is now so dependent on electricity and its uses, that life cannot be imagined without electricity and no further progress whatsoever can be achieved.

That is why an electrical system of generation, transmission and distribution must be so designed that optimum conditions of supply will exist at all times. In case a fault occurs at any part of the system, supply should not be interrupted at any other part of the system than in the faulty part. Moreover, that part of the circuit should not be destroyed and become unusable, but it should become re-effective when normal conditions are restored.

In order to achieve this, protective devices called circuit breakers, are needed to be placed at various key points of the system which will isolate the faulty part when a signal is received from the protective relays, which are the responsible devices to detect the fault current.

The protective relays should be so adjusted, so as to clear the fault in such a way, that no permanent damage is done in the circuit due to excessive current that the cables will not be able to withstand. Consequently, in order to wisely adjust the relays, the system should be studied and the fault levels at each busbar established accurately for the worst conditions, so that the fault will be successfully cleared no matter what loading conditions exist.

In respect of the above, part of the Electricity Authority of Cyprus (EAC) network was examined and the effort of this project is to calculate the expected fault levels at all the busbars shown on drawings no.1 and no.2 (pages 7 and 8) which represent the network to be studied. The network under study is as it will appear in 1998 prior to the erection of the new power plant at Vasiliko.

In order to calculate the fault levels, a specific Power System Analysis (PSA) package will be used. This is available at the Electricity Authority of Cyprus and is especially designed to calculate the fault levels of the system.

The project is divided into ten chapters, each one dealing with a major area of fault calculations. At the end, three case studies were performed to see the effect of modifying certain configurations of the system.

The procedure followed, the results obtained and the conclusions drawn during this effort can be seen in the chapters to follow.