AN AUTOMATIC LOAD SHEDDING SCHEME FOR TITAN PETROCHEMICAL INDUSTRIAL PLANT

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This thesis is dedicated to my parents, brother, and friends who have given me continuous support and encouragement to pursue my dreams.

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ABSTRACT

In view of increasing in load demand, dependence on the reliable electricity supply and deregulation have forced the need for load shedding to maintain the power system stability and provide good system performance. Under normal operation, the total system generation is the sum of total load and losses in the system. The frequency variation of the power system depends on the active power. On occurrence of any disturbance in the power system, there is imbalance between the generation and load. The difference between the generation and load active power causes a sudden change in the system frequency. A higher deviation in the frequency can affect the performance of the power system and cause overall system to collapse. This project proposes fixed and underfrequency load shedding scheme for TITAN Petrochemical during disturbance in power system. In order to control the frequency drop in severe disturbance, appropriate amount of system load is intentionally and automatically curtailed. In order to improve the response time, accurately predicting the system disturbance and follow with calculating the amount of load to be shed, are very essential. PSCAD / EMTDC software is used to analyze the performance of the designed model and load shedding steps. The result shows that designed load shedding scheme maintained power system performance as such distribution voltage and frequency are within permissible operating limit.

ABSTRAK

Memandangkan semakin meningkatnya permintaan beban pada masa sekarang, pergantungan kepada bekalan elektrik yang berkesan telah memaksa kepada penyekatan beban untuk mengekalkan kestabilan sistem kuasa secara keseluruhan untuk prestasi yang baik. Semasa sistem kuasa beroperasi dalam keadaan stabil, jumlah kuasa penjanaan adalah bersamaan dengan jumlah beban dan kehilangan dalam sistem. Perubahan frekuensi sistem kuasa bergantung kepada kuasa sebenar. Apabila berlaku gangguan dalam sistem kuasa, terdapat ketidakseimbangan di antara penjanaan dan beban. Perbezaan antara penjanaan dan kuasa baban sebenar menyebabkan berlakunya perubahan mendadak dalam frekuensi sistem. Perubahan yang mendadak dalam frekuensi boleh menyebabkan keruntuhan sistem secara keseluruhan. Dalam projek ini, skim penyekatan beban dengan kaedah frekuensi tetap dan frekeunsi penurunan diusulkan untuk TITAN Petrochemical. Penyekatan beban secara automatik hendaklah pantas untuk mengelakkan frekuensi menurun secara berlebihan yang mana akan menyebabkan lebihan beban akan disekat. Dalam usaha meningkatkan masa tindakbalas, ramalan tepat pada ganguan sistem and jumpah beban yang patut disekat adalah sangat penting. Perisian PSCAD / EMTDC digunakan untuk menganalisa prestasi model sistem and peraturan penyekatan beban yang diusulkan. Keputusan menunjukkan bahawa, peraturan penyekatan beban yang diusulkan menunjukkan keseimbangan sistem pembahagian secara kesulurahannya ada stabil dimana voltan dan frekuensi adalah stabil.

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LIST OF ABBREVIATIONS

TNB	-	Tenaga Nasional Berhad
GTG	-	Gas Turbine Generator
PSCAD	-	Power System Computer Aided Design
EMTDC	-	Electromagnetic Transients including DC
HVDC	-	High Voltage Direct Current
GUI	-	Graphical User Interface
GT	-	Gas Turbine
PP	-	Poly Propylene
PE	-	Poly Ethylene
PC	-	Petrochemical Cracker
BTX	-	Benzene Toluene Xylene
BD	-	Buthadiene
OCU	-	Ollefin Conversion Unit
AVR	-	Automatic Voltage Regulator
PSS	-	Power System Stabilizer
BUS	-	Busbar

LIST OF SYMBOLS

k	-	Kilo
V	-	Volt
P	-	Real Power
Q	-	Reactive Power
M	-	Mega
W	-	Watt
VAr	-	Volt-ampere-reactive
s	-	second
t	-	time
Hz	-	Hertz
f	-	Frequency
%	-	Percentage
N-m	-	Newton – meter

CHAPTER 1

INTRODUCTION

1.1 General Introduction

The problem of load shedding has been studied for many years both for utility power systems and industrial plants with in-house generation. For large power utilities, load shedding actions are used as the last resort to control the system in the emergency state, although such an event is quite uncommon. For industrial power systems, the loss of the interconnection with the utility can be a critical event when the total plant load is larger than the power generated by in-house generation. In this case, a frequency drop is experienced and depending on the amount of the generation-load mismatch, the frequency decay can reach levels that could lead to instantaneous tripping of generating units by underfrequency protective relays, thus lead to overall system blackout. To prevent a complete blackout of the system or the extended operation at lower than normal frequency, which could lead to turbine internal mechanical parts damages, the primary adopted method is to reduce the connected load through appropriate amounts to restore the frequency to an acceptable value.

TITAN Petrochemical plant is equipped with cogeneration facilities which are designed to produce both electric energy and steam or some other form of useful energy such as heat which is used for industrial process which has large requirements for process steam. The production of steam can be combined with generation of electricity at the industrial plant instead of purchasing electricity completely from utility company to meet plant load demand

A well planned load-shedding scheme, to forestall a cogeneration system blackout and to keep the generators in stable and continuous operation is necessary for a system like TITAN Petrochemical plant which has generation less than its load demand and is connected to an unreliable utility.

Therefore, in this project, conventional load shedding schemes are proposed based on the utilization of discrete underfrequency relays which can be set to detect the decline of frequency at common bus and react automatically to cut loads according to a predetermined priority list. Additional to this, circuit breaker status is taken into consideration as well due to during any plan outages of any power generation unit, plant will experience total generation less than load which shall be prevented immediately by automatic load shedding scheme.

1.2 Background of Study

Load shedding is an emergency control action in power systems to prevent overall power systems from blackouts. Under frequency load shedding schemes have been widely used to restore the stability of power system post disturbances and to avoid frequency instability. Rate of change of frequency is a suitable parameter to enhance the adaptability of under frequency load shedding scheme. A detailed well planned load shedding scheme which consist of fixed frequency and underfrequecy load shedding presented in this project. The test systems used for load shedding scheme is designed, modeled and simulated in The Power System Computer Aided Design, PSCAD / EMTDC.

1.3 Problem Statement

TITAN Petrochemical Plant power generation consist of two (2) nos of TNB Incomer and two (2) nos of GTG which operating in parallel to supply plant total load demand. At all time, utility and in-house cogeneration plant generator power will be in parallel operation to supply total plant load demand which is approximately 57MW. In recent years, due to plant expansion, total load demand has become greater than total power generation especially in the event of either either utility power failure or a combination of utility and in - house generator power failure. The failure could be planned or unplanned outages. As such, a well planned load-shedding scheme to forestall a cogeneration system blackout and to keep the generators in stable and continuous operation is necessary for TITAN Petrochemical plant which has generation less than its total load demand.

1.4 Objective

The main objective of this project is to develop an automatic load shedding for TITAN Petrochemical Plant. To achieve this, followings are the work need to be carried out:

a) to review existing load consumption
b) to develop number of load shedding steps / matrix
c) to review size of load to be shed at each step
d) to calculate and develop under frequency setting
e) to simulate and analyze overall performance with PSCAD / EMTDC simulation software

1.5 Project Scope

To achieve the said objectives, several project and research paper will be studied to get general overview of industrial plant load shedding scheme and relevant formulas for important parameters. Once this has been identified and established, existing plant electrical load consumption for the past three (3) consecutive years would be gathered and analyzed to determine actual load for each plant during maximum production.

From the data gathered, load shedding steps and underfrequency relay setting will be developed to prevent over load condition for the in-house generation unit and sustain critical plant load operation. Finally, simulation will be performed with PSCAD / EMTDC simulation software verify the performance of each load shedding steps to monitor power system parameters performance.

1.6 Report Organization

The organization of this report is as follows:

Chapter 1 presents the introduction to the thesis. It gives and overview and scope of the work. Chapter 2 presents the literature review performed in the scope of the work which includes reviewing previous research paper related to this project. Load shedding operating principle, procedure of formulating load shedding steps contributes some important ideas in successful of this project.

Chapter 3 presents the methodology of this project which explain data gathering, designing load shedding steps and modeling of TITAN Petrochemical distribution network in PSCAD/EMTDC simulation software.

Chapter 4 presents simulation results of each load shedding steps and detail discussion of power system parameters upon load shedding and comparison of

calculated and simulation results at each bus. Chapter 5 presents the contribution of the work with some conclusion. It is also provides some future extension of the present work.

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