WIND TURBINE SYSTEM CONNECTED TO UPS ONBOARD PLATFORM BATTERY

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X

DEDICATION

This project report is dedicated to my mother, who taught me the important of continuing learning for better career in near future. It is also dedicated to my father who gave me a moral support and advise in order to complete this project report. It is also dedicated to my wife who always supporting me in any ways throughout my journey in Master Degree Engineering program. Last but least, dedicated to Assoc Prof Dr Mohd Junaidi Abdul Aziz who always supervise, advise and monitor of my project report.

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ABSTRACT

Wind Turbine System is an alternative energy generator where it converting energy from wind energy into electrical energy. However, the gas generator plays as main power generation to supply electrical energy to the electrical loads for oil and gas platform in Malaysia. This work describes the implementation of Wind Turbine System coupled to an Uninterruptible Power Supply (UPS) at onboard-unmanned oil and gas platform. The existing system uses the Diesel Engine Generator (DEG) during black start it will charge the Uninterruptible Power Supply (UPS) batteries, which provide 24V DC power to telecommunication equipment, instruments and other essential electrical systems. The DEG shall run until the fuel gas for Gas Engine Generator (GEG) is available. At normal operation, Gas Engine Generator (GEG) is used to power all 400V AC motors, charging the battery bank of the 24V DC UPS system and other loads. In case the GEG fails, the DEG should be commenced automatically to supply power to the loads. In case of DEG also fails, all 24V DC loads depending on UPS system which can be sustained in 2.46 hours otherwise the 24V DC UPS battery will drain, which resulted to total shutdown operation. In this project, Wind Turbine system is applied and connected to the UPS battery onboard platform to prolong the UPS battery to keep charging as much as possible and to ensure the UPS battery is reliable and available at all time. Installation and maintenance cost will be calculated and analyzed as well for the total proposed overall project and the performance of the proposed system will be simulated by System Advisor Model (SAM) software.

ABSTRAK

Sistem Penjana Angin merupakan sebuah penjana tenaga alternatif di mana ia menukar tenaga dari tenaga angin kepada tenaga elektrik. Walau bagaimanapun, sumber gas berperanan sebagai sumber utama untuk membekalkan tenaga elektrik kepada peralatan elektrik untuk platform minyak dan gas di Malaysia. Kerja khusus ini menerangkan pelaksanaan Sistem Penjana Angin yang digabungkan dengan Bekalan Kuasa Tidak Terputus (BKTT) di atas platform minyak dan gas. Sistem yang tersedia menggunakan Penjana Enjin Diesel (PED) untuk mengecas bateri Kuasa Tidak Terputus (KTT), yang menyediakan kuasa 24V DC ke peralatan telekomunikasi, instrumen dan sistem elektrik penting yang lain. PED akan beroperasi sehingga sumber bahan bakar untuk Penjana Enjin Gas (PEG) tersedia. Secara normal operasi, Penjana Enjin Gas (PEG) digunakan untuk membekalkan tenaga kepada semua peralatan elektrik motor AC 400V, mengisi bateri sistem UPS 24V DC dan juga peralatan elektrik yang lain. Sekiranya PEG gagal diaktifkan, PED harus dimulakan secara automatik untuk membekalkan tenaga kepada peralatan elektrik. Sekiranya PED juga gagal diaktifkan, semua peralatan elektrik 24V DC bergantung pada sistem BKTT yang dapat bertahan dalam masa 2.46 jam dimana, bateri BKTT 24V DC akan habis, yang mengakibatkan operasi sesebuah platform itu kehabisan bekalan elektrik. Dalam projek ini, Sistem Penjana Angin diterapkan dan disambungkan ke platform bateri BKTT untuk memanjangkan keupayaan bateri BKTT agar terus mengecas sebanyak mungkin dan memastikan bateri BKTT boleh membekalkan tenaga dan tersedia sepanjang masa. Kos pemasangan dan penyelenggaraan akan dikira dan dianalisa bagi keseluruhan projek yang dicadangkan dan prestasi sistem yang dicadangkan akan disimulasikan oleh perisian Model Advisor Model (SAM).

TABLE OF CONTENTS

J

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

DEG	-	Diesel Engine Generator
GEG	-	Gas Engine Generator
UPS	-	Uninterruptible Power Supply
CPP	-	Central Processing Platform
RWHP	-	Remote Wellhead Platform
DS	-	Distributed Storage
WTS	-	Wind Turbine System
UPS	-	Uninterruptible Power Supply
CSP	-	Control System Panel
SAM	-	System Advisor Model
LV	-	Low Voltage
AC	-	Alternative Current
CCVT	-	Combined Cycle Vapor Turbogenerator
TEG	-	Thermal Electric System
DC	-	Direct Current

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Most of the Malaysia oil and gas Remote Wellhead Platform (RWHP) are located at offshore Peninsular Malaysia, Sabah and Sarawak where approximately around 200km away from onshore. Basically, Remote Wellhead Platforms are designed with various types of designs ranging from a very simple platform to more complex installation with processing equipment systems. Typically Remote Wellhead Platform is accessible via either helicopter, boat or both. Normally Remote Wellhead Platform (RWHP) is a standalone unmanned platform which is connected via in-field pipeline and tied back to Central Processing Platform (CPP).

Despite located in the middle of the ocean, typical RWHP is powered by Gas Engine Generator (GEG), Diesel Engine Generator (DEG), Solar Power System, Thermal Electric System (TEG), Combined Cycle Vapor Turbogenerator (CCVT), Uninterruptible Power SUpply (UPS) and some of RWHP's are powered from Central Processing Platform via subsea composite cable. The power generation system on board Remote Wellhead Platform in this research study comprises of two (2) Gas Engine Generator (GEG) and one (1) Diesel Engine Generator (DEG) each rated 20kW (GEG) and 40kW (DEG) 3-phase nominal 400V AC, 50 Hz output where all generators are installed in non-hazardous area. As a start of the Diesel Engine Generator, some amount of diesel is utilized to run the DEG for black starting and emergency use. During black start scenario i.e when Gas Engine Generator (GEG) is completely down and need to be restarted, Diesel Engine Generator (DEG) will be started and will charge Uninterruptible Power Supply (UPS) batteries which provide 24V DC power to instruments, telecommunication and other electrical systems until the fuel gas from the wells become available so that GEG can be started up. In case the DEG becomes unavailable i.e tripped, the DEG batteries will

provide back-up power to DEG Generator Control Panel (GCP) for maximum one (1) hour before shutting down.

In normal operation, one (1) Gas Engine Generator A (GEG) continuously to provide power to 400V AC LV Switch rack, the 24V DC UPS system and other loads while the other one (1) Gas Engine Generator is on standby mode. In case of Gas Engine Generator A is shutting down, the standby Gas Engine Generator B (GEG) will take over automatically controlled by Control System Panel (CSP). If the second GEG B also trips due to any circumstances, the Diesel Engine Generator (DEG) will be remotely started from Central Processing Platform as backup power supply to 24V DC UPS system. Based on the observation, the DEG can supply a backup power to 24V DC UPS system before the DEG is shutting down due any circumstances. RWHP loads are depending to 24V DC UPS where its can sustain supply power 16.05 kW to all RWHP loads which is 2.46 hours of operation whereby the capacity of UPS batteries is around 39.6 kW. Based on this case, Wind Turbine System is proposed to design, study and evaluate either proposed Wind Turbine System manage to integrate with the UPS system to provide continuously charge the UPS batteries from the renewable energy source to ensure availability of UPS batteries at all times supplying the power to 24V DC loads prior to rectify GEG and DEG problems and start back.

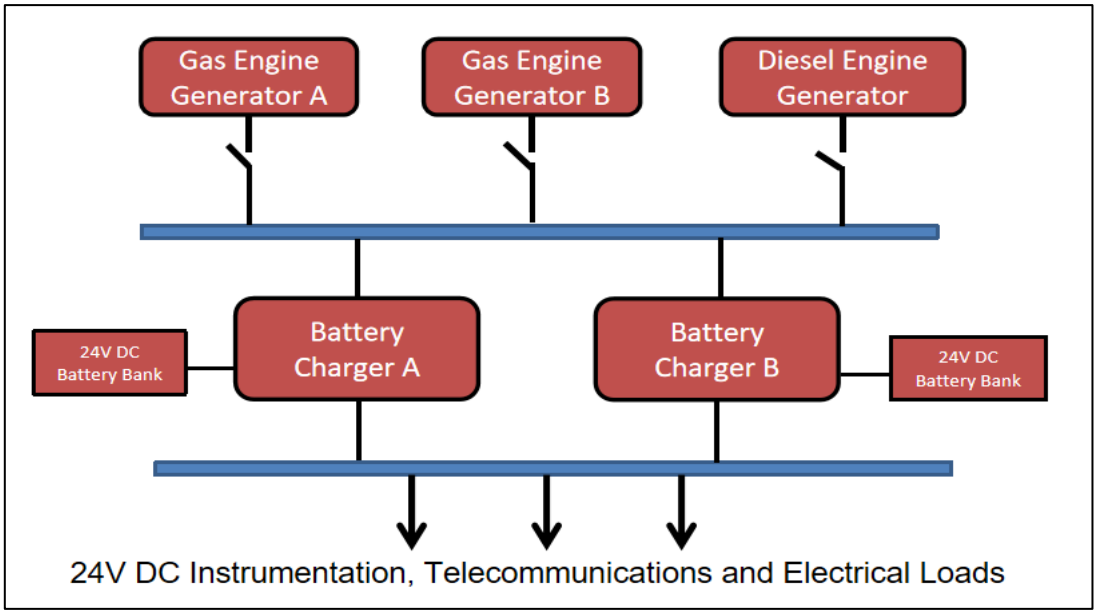

Figure 1.1 Overall RWHP Power Generation System

Figure 1.2 Figure of RWHP Power Generation System

1.2 Problem Statement

Availability and Reliability of electrical power generation system is one of the important concerns on board Remote Wellhead Platform (RWHP) to make sure the platform is continuously live and operating. Non reliable platform power generation will affect production and delivery of oil and gas hydrocarbon from RWHP to CPP. Diesel Engine Generator (DEG) and Gas Engine Generator (GEG) plays as a main role of power generation system to supply power to 400V AC LV Switch rack in order all loads connected to 400V AC switch racks and 24V DC distribution board are fully functioning.

As mentioned, in normal operations Gas Engine Generator (GEG) is the main source of power generation to provide power to 400V AC LV Switch rack. In case both GEG are down or trip due to circumstances, DEG shall take over and supply back-up power to platform electrical loads. The problem is that if DEG is trips and if it not restarted, the DEG batteries will drain out. If DEG is running, the DEG batteries will still be continuously charged by the DEG. Various types of output 24V DC loads is depending on the UPS system that will only survive around 2.46 hours of functioning which UPS have to supply total power around 16.05 kWh to all RWHP loads before UPS battery is completely drain out. To have power generation

back online, the personnel or technicians have to travel to Remote Wellhead Platform approximately three (3) to four (4) hours journey via vessel where overall arrangement rectification and troubleshooting will incur cost of transportation. Cost of maintenance of the both generator GEG and DEG also should be considered part of overall arrangement rectification.

1.3 Objectives

In accordance to the problem statement, a most efficient and reliable to ensure 24V DC UPS batteries are always available at all times, for Uninterruptible Power Supply (UPS) system, Wind Turbine System is proposed to connect to the 24V DC UPS batteries where the 24V DC UPS batteries is continuously charged from renewable sources in the event of loss of main power supply GEG and DEG at RWHP. The objectives of the study are:

1. To analyse proposed Wind Turbine system to UPS system.
2. To design Wind Turbine system connected to the UPS battery.
3. To evaluate power generated from Wind Turbine System from existing WT specification.
4. To analyse prolong time of supplying power to RWHP electrical power generation.
5. Improve of reliability of the platform and low cost in maintenance in long term duration.

1.4 Scope of Project

Designing a Wind Turbine System is a very tedious and time-consuming work due to the number of basic components to be identified such as specification of existing Wind Turbine, Converter or Rectifier (AC to DC), Circuit Breaker and

Cables. On the other hand, suitable location of the Wind Turbine components or structure to be installed on board RWHP also need to be determined and considered in safe area where the system could receive maximum renewable energy source where in this case is wind speed velocity at the location of the Wind Turbine will be installed.

Many models of Wind Turbine System have been developed either onshore or offshore as a power generation system but in this project Wind Turbine System is connected to sustain supplying power to RWHP loads or as a solution to the UPS system generally. The scope for this project is to analyse sustainable power generated of Wind Turbine systems connect to UPS batteries simulated using System Advisor Model (SAM) software by applying the existing Wind Turbine specification and also to compare the power generated by mathematical calculation. The reason of implementation are evaluated and tested to reduce loss of power generation for platform and also to improve reliability of the platform and low cost in maintenance for long term duration.

This Wind Turbine system are modelled to simulate in the simulation System Advisor Model (SAM) software to get the desire power output by applying real wind speed velocity collected.

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