Faculty of Electrical and Electronic Engineering Technology

INVESTIGATON OF NEUTRAL TO EARTH VOLTAGE (NTEV) FOR DISTRIBUTION SYSTEM IN AGENSI NUKLEAR MALAYSIA

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Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

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INVESTIGATON OF NEUTRAL TO EARTH VOLTAGE (NTEV) FOR DISTRIBUTION SYSTEM IN AGENSI NUKLEAR MALAYSIA

MUHAMMAD EDZHAM BIN AHAMAD

A project report submitted.
in partial fulfillment of the requirements for the degree of
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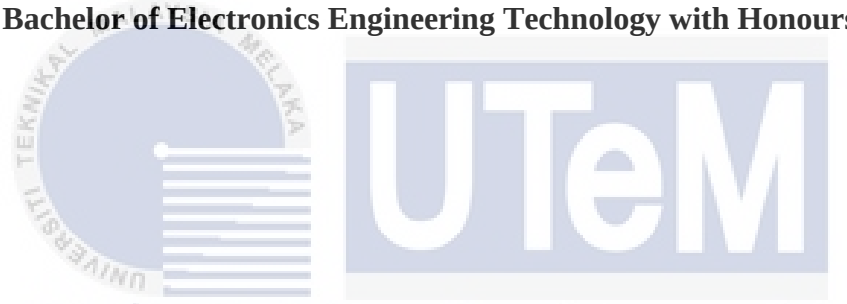

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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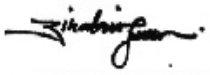
I hereby declare that I have checked this project report and, in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours.

Signature : 

Supervisor Name : DR. ZIKRI ABADI BIN BAHARUDIN

Date : 27.1.2023

Signature :

Co-Supervisor :

Name (if any)

Date :

DEDICATION

My dissertation is dedicated to my beloved family and lots of friends. I am always grateful to my wonderful parents, Hj. Ahamad bin Awi and Hjh. Ruhani binti Tajuddin, whose words of support and tenacity resonated in my ears. My wife, Nursalwana binti Azizan, who is very special for me, and my kids, Muhammad Qhalish and Tiara Nur Medina. I dedicate this Project to all the people who have worked hard to help me complete this research.

ABSTRACT

Elevated neutral-to-earth voltage or simply known as Neutral-To-Earth Voltage (NTEV), and the related phenomenon called stray voltage is typically caused by fundamental frequency currents returning to the source via the neutral conductor and earth. The nature for grounded power systems results in the fact that the neutral conductors are not always at the zero potential with respect to the earth. This study also aims to investigate the effect of Neutral to Earth voltage on power distribution. Using the appropriate measurement equipment, the data logger was attached to Main Switch Boards to record data for 4 days for monitoring, recording, and analyzing frequency, harmonics, and voltage fluctuation. In addition, the data logger for this measurement tool have been installed on the switchboard at the three difference location in Agensi Nuklear Malaysia which are 1st location, 2nd location and 3rd location. This study performed a comparison of peak time (8 a.m - 5p.m) and non-peak time (6 pm - 6 am) and also the correlation between each parameter. Based on the result of standard deviation and mean, all parameters deviate very closely to the mean value. The skewness value provide evidence that the measured data was distributed close to the nominal specification. Through correlation analysis, at the end of this study it was found that the correlation between NTEV and THDV of each phase in the first location has a very high correlation.

ABSTRAK

Voltan neutral-ke-bumi yang dinaikkan atau hanya dikenali sebagai Neutral-To-Earth Voltage (NTEV), dan fenomena berkaitan yang dipanggil voltan sesat biasanya disebabkan oleh arus frekuensi asas yang kembali ke sumber melalui konduktor neutral dan bumi. Sifat untuk sistem kuasa yang dibumikan menyebabkan fakta bahawa konduktor neutral tidak sentiasa pada potensi sifar berkenaan dengan bumi. Kajian ini juga bertujuan untuk mengkaji kesan voltan Neutral to Earth ke atas pengagihan kuasa. Menggunakan peralatan ukuran yang sesuai, pencatat data dipasang pada Papan Suis Utama untuk merekod data selama 4 hari untuk pemantauan, rakaman dan analisis frekuensi, harmonik dan turun naik voltan. Selain itu, data logger untuk alat ukuran ini telah dipasang pada papan suis di lokasi tiga perbezaan di Agensi Nuklear Malaysia iaitu lokasi pertama, lokasi kedua dan lokasi ketiga. Kajian ini melakukan perbandingan waktu puncak (8 pagi - 5 petang) dan waktu bukan puncak (6 petang - 6 pagi) dan juga perkaitan antara setiap parameter. Berdasarkan keputusan sisihan piawai dan purata, semua parameter menyimpang sangat rapat dengan nilai purata. Nilai kecondongan memberikan bukti bahawa data yang diukur telah diedarkan hampir dengan spesifikasi nominal. Melalui analisis korelasi, di akhir kajian ini didapati korelasi antara NTEV dan THDV setiap fasa di lokasi pertama mempunyai korelasi yang sangat tinggi.

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δ	-	Voltage angle
Ω	-	Ohm

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V - Voltage

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CHAPTER 1

INTRODUCTION

1.1 Background

Neutral to Earth Voltage is known as stray voltage are categorized one of power quality (PQ) problems in regular distribution system [1]. The condition of the stray voltage is when an electrical current flows through a neutral conductor, it will occur when some voltage leaks to the ground. These leakages produce small amount of electricity. The NTEV give a bad effect to our network system, electrical equipment, humans and animals. Theoretically, the voltage between Neutral to Earth must be 0 V. However, it impossible to get the value 0 V due to many factors. The sources of NTEV/stray voltage may come from the weakness of the grounding system,unbalanced load, transformer connection or neutral impedance.

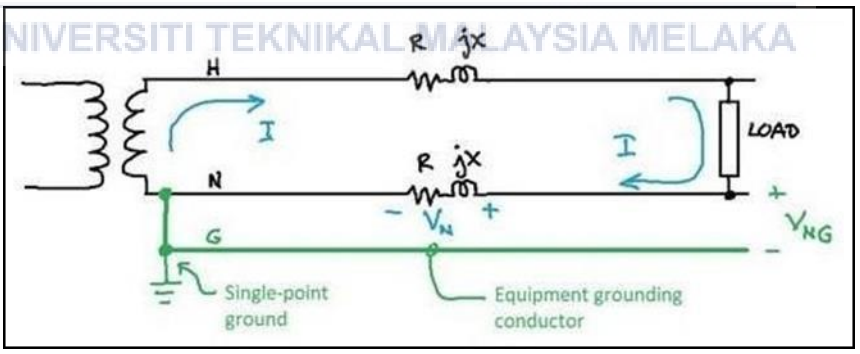

Figure 1.1 Simple Circuit for NTEV

1.2 Power Quality Issues

In IEEE dictionary [2], power quality is defined as “the concept of powering and grounding sensitive equipment in a matter that is suitable to the operation of that

equipment". While, IEC (International Electrotechnical Commission), it is defined as, "set of parameters defining the properties of the power supply as delivered to the user in normal operating conditions in terms of continuity of supply and characteristics of voltage (magnitude, frequency, waveform). In this casethe NTEV problems give an adverse effect to the network system where the phase voltage and harmonic distortion become more imbalance, heating on the conductor cable, and the electrical appliances exposed to damage.

The power supply of system can only control the value or quality of the voltage, it can't control over the currents that particular loads might draw. Therefore, the standards in the power quality are related to maintaining the supply voltage within certain limits.

The electrical equipment from the generators until end user will affect the voltage regulation of the system. Typically, voltage regulation mostly close with the distribution system. In distributionsystem normally have voltage-regulating transformers that can either increase or decrease the voltage that is supplied. It's commonly capable of increasing or decreasing the distribution voltage up to 10%, usually in multiple steps of either 0.625% or1.25% per step.

Definition of voltage imbalance or unbalance is the maximum deviation from the average of the three-phase voltage or currents, divided by the average of the three-phase voltages or current. Theunit in percent. To specify the percentage of unbalance, the ratio of zero- sequence component to the positive-sequence component to be used. In three phase system, the source of voltage unbalanceis from single phase loads.

Another cause of voltage imbalance in a utility distribution system is non transposition of transmission lines. In a transmission system with long circuits with no phase transposition, the coupling with high load balanced current will cause voltage

imbalance and current imbalance.

1.3 Monitoring Power Quality

One of the main aims of this study is to monitor the quality of power involving the parametersof frequency stability, total harmonics distortion and voltage fluctuation. In IEEE Std.1159- 2019, clause 7 has explained the typical monitoring techniques related to the monitoring location, Equipment connection, Measurement thresholds and Installation time frame. This application emphasizing on safety. During the collecting of the data, the safety of person whoinvolved in the installation of the monitoring equipment and public should not be jeopardized. All this are included:

i. Personal safety considerations
ii. OSHA requirements
iii. NFPA requirements
iv. General safety considerations
v. Live parts
vi. Equipment placement
vii. Grounding

The installation of power quality monitoring is dependent on the objective of the survey. In figure 1.2 shows the suggested monitoring location.

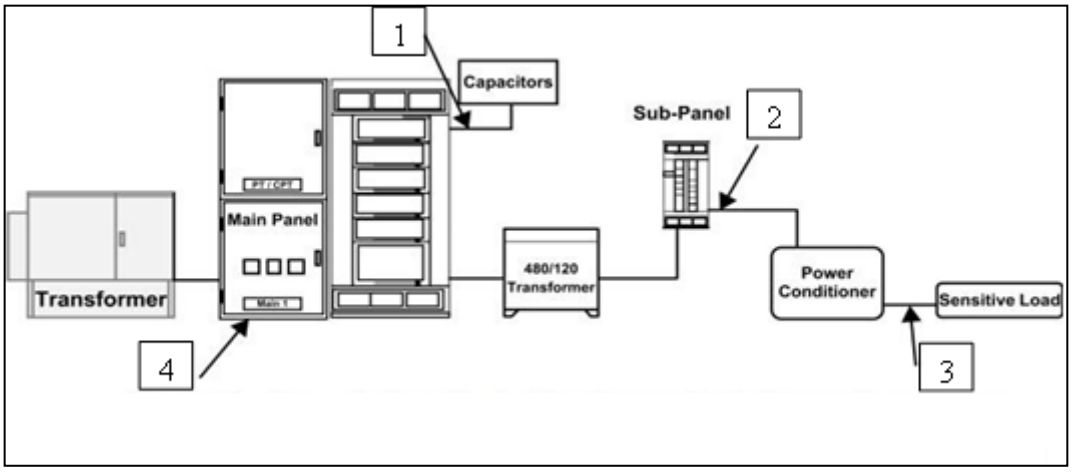

Figure 1.2 Suggested location on typical low-voltage system

1.4 Problem Statement

Typically, an electrical apparatus damages are due to lightning and surges either permanently or temporary. However, the voltage generated at neutral to earth (NTEV) can also cause damage to the electrical equipment even though the potential voltage (between neutral and earth) is low. According to informal report in JKR Melaka [4], there have been several reports of NTEV especially in domestic or residential area, however the potential does not trigger the circuit breaker under good and normal condition.

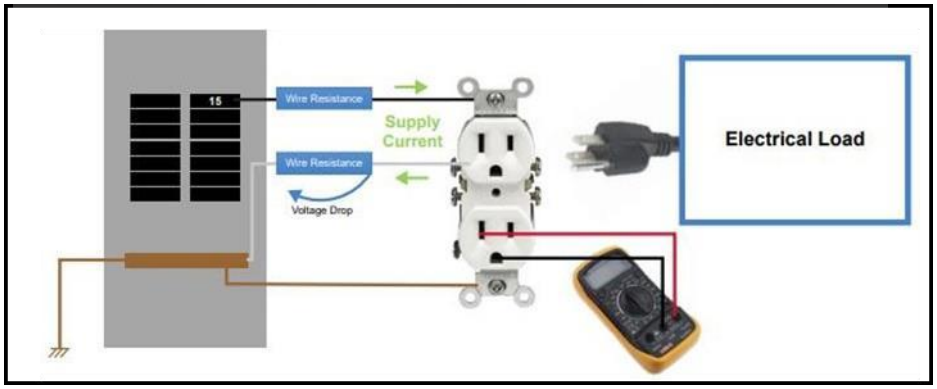

Figure 1.3 NTEV caused by increased wire resistance [5]

Other than terminal connection is not in proper installation, one of the sources of NTEV is the practice of neutral sharing from the power supply. Power quality in term of device, equipment or system performance can be defined as the ability to maintain a sinusoidal

waveform at rated voltage and frequency without introducing electromagnetic disturbances. While, poor power quality includes fluctuation of the fundamental voltage, losses, heating, and noise, resonance and ferro-resonance, flicker, and harmonic instability [3]. Power quality parameters must be measured and controlled within the specification and must comply to all standard from IEEE, IEC, SEMI or Engineering Recommendations. One of that is IEEE Std. 1159 – 2019 – IEEE Recommended Practice for Monitoring Electric Power Quality [6].

1.5 Project Objective

Since power quality assessment is one of the main criteria to determining the level of performanceof a system, there is a need to carry out detailed studies to identify the Neutral to Earth Voltage (NTEV) and its solution. The objectives are

1. To investigate the existence Neutral to Earth Voltage (NTEV) to power distributionespecially in Agensi Nuklear Malaysia, Bangi.
2. To compare the condition of Neutral to Earth Voltage (NTEV) under peak condition (8am – 5pm) and off-peak condition (after working hours).
3. To identify the root cause of the existence of Neutral to Earth Voltage (NTEV) as well as the correlation with other parameters through the method of correlation analysis.

1.6 Scope of Project

Power quality is a general requirement to ensure the system performance in good condition. This research however will focus on: