International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 02 | February - 2024 SJIF Rating: 8.176 ISSN: 2582-3930

# Testing and Analysis of Harmonics at Utility Substation

**Parag Chawhan[1], Anurag Ambhire[2], Harsh Yadav[3], Vedant Chikhalkar[4]**

**Project Guide: Prof. Nirajan Samudre[5]**

Department of Electrical Engineering, Atharva College of Engineering, Malad (W), Mumbai - 400095, Maharashtra, India.
**Email:** paragchawhan-elec@atharvacoe.ac.in[1], anuragambhire-elec@atharvacoe.ac.in[2], harshyadav-elec@atharvacoe.ac.in[3]
vedantchikhalkar-elec@atharvacoe.ac.in[4], nirajansamudre@atharvacoe.ac.in[5]

***Abstract: This paper is about auditing electrical quality in substations. A Fluke 1748 Energy Analyze is used for power quality audits. The quality audit will be performed according to IEEE Standard 519 2022. The specific purpose of power quality is the cleanliness of the power supply, including voltage fluctuations and waveform distortion. Harmonics occurs whenever non-sinusoidal currents and/or voltages are generated in a power system. This is commonly referred to as harmonic distortion. The main conditions that cause harmonic problems in power systems are non-linear loading, phase imbalance, high input voltage or current, and resonance. Electrical energy is key to industry, commerce and development, so maintaining the quality of electricity flow is important. Having power quality indicators is very important when identifying hazards and possible defects in electrical installations.***

**Keywords:** IEEE 519 2022, Harmonics, Power Quality

## I. INTRODUCTION

In today's systems, more than ever before, electronic equipment and computing devices are used in all types of industrial processes. This has been instrumental in making these processes more than just a type of industrial process. This was important to improve the productivity, efficiency and safety of these processes. However, this trend makes production processes and equipment more vulnerable to real-world power quality conditions. Power quality is related to fluctuations in the form of power supply. To guide the design of power systems with nonlinear loads, a power quality audit according to IEEE Standard 519-2022 is recommended.

The limits stated are for steady-state operation and are recommended under worst-case conditions. Transient conditions may occur that exceed these limits. These recommended practices should be applied at all points of interaction between the system owner or operator and power system users.

• **Power quality:** The quality of electricity supplied has two characteristics. factors, namely the "continuity" of the power supply and the "quality" of the voltage. As specified in the IEEE 1100 standard, power quality has the following characteristics: "The idea is to control and install sensitive power supplies in a way that is convenient for the operation of the equipment."

• **Power quality issues:** There are many reasons why power quality may deteriorate. The occurrence of such problems in power grids is almost inevitable.

Therefore, to maintain power quality, care must be taken to ensure that the appropriate devices continue to operate to prevent the effects of these problems. Below is an overview of various power quality issues and their causes and effects.

• **Change frequency**: Electrical networks are designed to operate in certain modes. Frequency value (50Hz). The frame frequency is identified as the rotational speed of the generator within the system. Frequency changes occur when there is an imbalance between supply and demand. Generator failures or sudden load switching cause large frequency fluctuations.

• **Ad hoc processes:** Transients are instantaneous changes in voltage and current signals in a power system over a short period of time. These transients are divided into two types: pulsed and oscillatory. Impulsive transients are unidirectional, whereas oscillatory transients oscillate with rapid changes in polarity.

**Cause:** There are many reasons why transients occur.
Energy systems they-
• Arc between switch contacts.
• Sudden load switching.
• Poor or loose connections.

**Result:**
• Electronic devices may be affected, producing incorrect results.
• The engine operates at higher temperatures.
• Fluorescent lamp ballast failure.
• Reduced efficiency and equipment life.

• **Voltage drop:** Voltage drop is defined as the drop in voltage level using the formula: From 10% to 90% for more than half a cycle.

**Cause:** Causes of voltage drop:
• Start motors that draw more current.
• Defects in the power system.

• **Increase voltage:** A voltage surge is defined as an increase in voltage beyond a limit. Normal values are 10-80% for more than half a cycle.

**Cause:**
• Bulk load shedding
• Turn on the capacitor bank
• Sudden interruption of electrical current. result:
• Electronic components are damaged due to over voltage.
• Insulation breakdown
• Overheating

• **Voltage imbalance:** Voltage imbalance is defined as the following situations: The magnitude and phase angle between voltage signals of different phases are not the same.

**Cause:**
• Presence of large single phase load.
• Malfunctions occurring in the system result:
• Presence of harmonics
• Reduced system efficiency
• Increased power loss
• Reduced equipment lifespan

• **Voltage fluctuations:** It is a series of random voltage fluctuations that exist within a specified voltage range.

**Cause:** they are called
• Frequency start/stop of electric ballasts
• Oscillating load furnace

high quality of electrical energy is achieved only if the following conditions are met: a good initial design, effective corrective action, cooperation with the supplier, frequent monitoring and proper maintenance. In other words, high quality is only guaranteed under the use of a holistic, all-encompassing approach. To that extent, to improve the quality of electrical energy, it is important to have an adequate understanding of its common problems. Using the latest technology in assessing harmonic distortion from unpleasant flickers to very harmful (fire) hazardous malfunctions, we should detect all problems and facilitate clever solutions to establish an optimal flow of electricity billed, and the record is zeroed to begin a new eight-hour billingperiod.

In this project, we have used class A Fluke power quality analyzer 1748 and the aim of our project was to find out the power quality, health and energy scenario of the feeder at utility substations.

## II. METHODOLOGY

Class A Fluke make 1748 Energy and Power Quality Analyzer (Equipment serial no. 46534906) was used in the testing. The meter was connected at control panel of outgoing feeder at utility substation for 24hrs according to IEEE 514 2022 standard. 28801 sample readings were recorded in the given period.

The analyzer is complained to IEC 62586 standard. While doing the connections of CT probes and voltage crocodile clamps, proper safety measures were taken care of. The settings of the meter were configured as follow,

• Nominal Voltage settings: 19053V/50Hz
• Voltage ratio: 300:1
• Current ratio: 800:1 (L123), 1:1 (N)
• Flicker lamp model voltage: 230V
• Harmonics grouping mode: Sub grouped, Inter-harmonics
• Trend: 3 Seconds
• Demand: 30 minutes
• PQ- study: 10 minutes
• Dip: 90%
• Swell: 110%
• Interruption: 10%
• Event hysteresis: 2%
• Inrush current: 1500A
• Rapid change voltage: 5%
• Waveform deviation: 10%

Fluke Energy Analyze Plus 3.6.4 was used to track and analyze the measurements

## III. CIRCUIT DIAGRAM

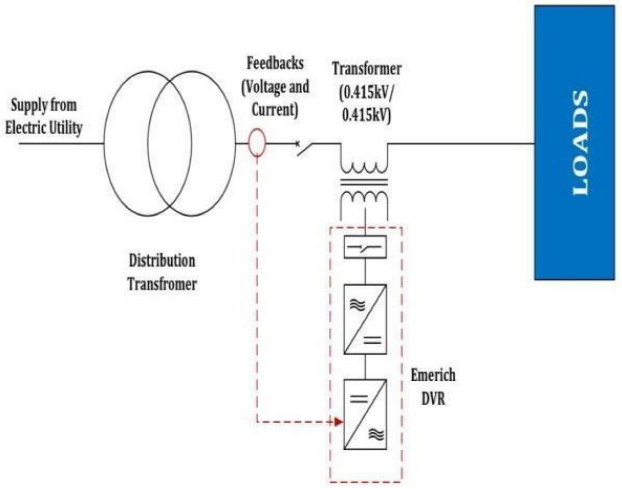


Fig 1 Circuit diagram

## IV. PROBLEM STATEMENT

High levels of harmonic distortion in mains voltages can cause problems in sensitive electronic devices. In this case, low-quality supply voltage can lead to operational errors, which can lead to resets, interference, calculation errors, etc. According to MERC Order No. 195 of September 2018, this is now mandatory for utilities. Supports spurious harmonics at IEEE 514-2022 standard level. The presence of harmonics reduces power quality and causes damage to end-user equipment. Harmonic distortion causes voltage distortion that causes harmonic currents to flow in other linearly and non-linearly connected loads. IEEE Standard 514-2022 requires a minimum of 7 days of data logging for harmonic testing, but 24 hours is required because 7 days of continuous data logging is not possible. So, conduct a 1-day cycle test.

## V. RESULTS

In analysis of harmonics at the utility substation, the following parameter values can be measured.

- Number of trend intervals as configured
- Number of trend intervals as present
- Trend interval length
- Number of demand intervals as configured:
- Number of demand intervals as present:
- Demand interval
- Number of PQ intervals as configured:
- Number of PQ intervals as present:
- PQ interval length: 10min
- Number of PQ 10sec Free Intervals as present:
- Voltage Harmonics: FAIL/PASS
- Voltage Harmonics (3s): FAIL/PASS
- Current Harmonics: FAIL/PASS
- Current Harmonics (3s): FAIL/PASS
- Result: FAIL/PASS

## VII. CONCLUSION

The demand for electricity is growing exponentially, and at the same time, the quality of the power supplied is becoming the most important issue in the power sector. Therefore, in order to maintain power quality, problems affecting power quality must be effectively resolved. Among various power quality issues, harmonics are one of the major issues affecting the performance of end-user devices.

This determines the total harmonics of voltage and current according to the IEEE 519
standard 2022.
The following conclusions can be drawn from this project:
• Voltage and current harmonics are present on the outgoing feeder.
• Low voltage harmonic total harmonic THD
Distortion limit.
• Presence of odd and even currents.
• Harmonics in the circuit.
• Failures were recorded during testing but were below limits.
• R/Y/B phase blinking
• Maximum current in R/Y/B phase
• Maximum voltage of R/Y/B phase
• Maximum frequency
• Voltage THD Phase R/Y/B
• Complete voltage asymmetry.

## VIII. REFERENCES

[1] Power Quality and Harmonic Distortion on Distribution Systems James K. Phipps, Member, IEEE, John P. Nelson, Senior Member, IEEE, and Pankaj K. Sen, Senior Member, IEEE (1994).

[2] Total Harmonic Distortion Decomposition Depending

[3] on Distortion Origin Alfredo Ortiz, Cristina Gerizim, Mario Manama, Carlos J. Reendow, L. Ignacio Eguíluz, and Ronnie J. M. Belmans, Fellow, IEEE (2005).

[4] Electrical Power System and Quality. Roger C Dugan, Mark
F McGranaghan.

[5] Priorities of Power Quality Research in the integrated Grid presented by Mark McGranaghan and organised by PQ CELL AISSMS IOIT – Prof. Sachin Shelar.

[6] Power Quality Demonstrations presented by Dan Carnival (Manager, Eaton Corporation USA) and organized by PQ CELL AISSMS IO