**POWER QUALITY MONITOR REPORT**

**1.** **INTRODUCTION**

**ALTERNATIVEPOWER SOLUTIONS, INC.** performed power quality measurement on  **MAIN, VFD1 AND VFD2** of this pump station.

The Power Quality Analyzer used was **FLUKE 430-II**.

The objectives of the assessment were to be able to perform the following:

1.1 Record the voltage and current profile on the load side of **Circuit Breaker** with the recording interval set every five (10) minutes.

1.2 Record power profile (KW, KVA, KVAR) on the load side of **Circuit Breaker** with the recording interval set every ten (10) minutes.

1.3 Record Total Harmonic Distortion (THD)

1.4 Record Values of Short Duration Voltage Variation that will exceed the limit set by Philippine Distribution code

1.5 Record values of Long Duration Voltage Variation that will exceed the limit set by the Philippine Distribution Code

1.6 Record values of Frequency Variation that will exceed the limit set by Philippine Distribution code

1.7. Record Transient voltage Surge defined by PDC and using Computer Business Equipment Manufacturer’s Association(CBEMA) and Information Technology Industry Council (ITIC) Curve International Standard

1.8 Compute for Voltage Unbalance and compare it on the Voltage unbalance limit set by PDC

1.9 Recommendations

**2. STANDARDS**

The assessments made in this report are in accordance to IEEE Standard 1159-1995 “IEEE Recommended Practice for Monitoring Electric Power Quality”

The Philippine Distribution Code was used as the local reference for power quality standards. According to the Philippine Distribution Code, a power quality problem exists when at least one of the categories in the table below is present during the normal operation of the electrical system

**3.** **PARAMETERS AND RESULTS**

Any values outside these limits are noted in the report. Values within the limits are considered to be within safe operating range.

1. RMS VOLTAGE COMPLIANCE

The steady-state rms voltage must remain within the range of 90.00% to 110.00%.

* Over Voltage – if the RMS value of the voltage is greater than or equal to 110% of the nominal value
* Under Voltage – if the RMS value of the voltage is less than or equal to 90% of the nominal voltage

MAIN 250 AMPERES measured on 1/21/2019

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| RMS VOLTAGE  (460 VOLTS) | **AB** | 449.94 | 465.3 | 474.84 | **±10%**  **(414-506V)** | **WITHIN LIMITS** |
| **BC** | 457.72 | 471.4 | 477.32 |
| **CA** | 449.94 | 465.3 | 474.84 |

VFD1(LINE SIDE) measured on 1/21/2019

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| RMS VOLTAGE  (460 VOLTS) | **AB** | 449.68 | 460.18 | 474.76 | **±10% (414-506V)** | **OUTSIDE LIMITS** |
| **BC** | 387.66\* | 408.04 | 468.34 |
| **CA** | 449.68 | 460.18 | 474.76 |

\* Should be cause for concern. Value reached voltage limitation. The incident was recorded on 1/21/2019, 8:214:31PM

VFD2 (LINE SIDE) measured on 11/29-30/2018

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| RMS VOLTAGE  (460 VOLTS) | **AB** | 455.48 | 466.18 | 474.70 | **±10% (414-506V)** | **WITHIN LIMITS** |
| **BC** | 463.28 | 470.61 | 477.76 |
| **CA** | 455.48 | 466.18 | 474.70 |

B) VOLTAGE UNBALANCE COMPLIANCE

Voltage Unbalance shall be defined as the maximum deviation from the average of the three phase voltages divided by the average of the three phase voltages expressed in percent. The maximum voltage unbalance at the connection point of any user, excluding the voltage unbalance passed on from the grid shall not exceed 2.5% during normal operating conditions.

**MAIN 250 AMPERES (LOAD SIDE)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM**  **Deviation** | **AVERAGE**  **Deviation** | **MAXIMUM**  **Deviation** | **LIMITS** | **COMMENTS** |
| VOLTAGE UNBALANCE |  | **1.15%** | **0.87%** | **0.35%** | **2.5%** | **WITHIN LIMITS** |

**VFD1 (LINE SIDE)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM**  **Deviation** | **AVERAGE**  **Deviation** | **MAXIMUM**  **Deviation** | **LIMITS** | **COMMENTS** |
| VOLTAGE UNBALANCE |  | **9.64** | **7.85** | **0.91** | **2.5%** | **OUTSIDE LIMITS** |

**VFD2 (LINE SIDE)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM**  **Deviation** | **AVERAGE**  **Deviation** | **MAXIMUM**  **Deviation** | **LIMITS** | **COMMENTS** |
| VOLTAGE UNBALANCE |  | **1.14** | 0.63 | 0.43 | **2.5%** | **WITHIN LIMITS** |

C) CURRENT UNBALANCE COMPLIANCE

Current unbalance should not exceed 10 %.

**MAIN 250A (LOAD SIDE)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM**  **Deviation** | **AVERAGE**  **Deviation** | **MAXIMUM**  **Deviation** | **LIMITS** | **COMMENTS** |
| CURRENT UNBALANCE | **AB** | 0.30 | 0.70 | 2.30 | **≤ 10%** | **WITHIN LIMITS** |
| **BC** | 0.40 | 0.70 | 0.80 |
| **CA** | 0.10 | 0.50 | 1.50 |
| **Current unbalance** | | **1.15%\*** | **1.20%\*** | **2.68%\*** |

**VFD1(LINE SIDE)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM**  **Deviation** | **AVERAGE**  **Deviation** | **MAXIMUM**  **Deviation** | **LIMITS** | **COMMENTS** |
| CURRENT UNBALANCE | **AB** | 1.33 | 1.60 | 2.57 | **≤ 10%** | **WITHIN LIMITS** |
| **BC** | (0.27) | (0.70) | (0.73) |
| **CA** | (1.07) | (0.90) | (1.83) |
| **Current unbalance** | | **3.40%\*** | **3.88%\*** | **4.60%\*** |

**VFD2 (LINE SIDE)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM**  **Deviation** | **AVERAGE**  **Deviation** | **MAXIMUM**  **Deviation** | **LIMITS** | **COMMENTS** |
| CURRENT UNBALANCE | **AB** | 0.50 | (0.23) | 0.90 | **≤ 10%** | **WITHIN LIMITS** |
| **BC** | (0.20) | (0.23) | (0.30) |
| **CA** | (0.30) | (0.33) | (0.60) |
| **Current unbalance** | | **2.18%\*** | **1.36%\*** | **2.83%\*** |

D) HARMONICS -THD COMPLIANCE

Harmonics shall be defined as sinusoidal voltage and currents having frequencies that are integral multiples of the fundamental frequency.

The total harmonic distortion (THD) shall be defined as the ratio of the RMS value of the harmonic content to the RMS value of the fundamental quantity, expressed in percent.

PHILIPPINE DISTRIBUTION CODE sets the THD of the voltage at any user system to not exceed five percent (5%) during normal operating conditions.

**MAIN 250A (LOAD SIDE)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| TOTAL HARMONIC DISTORTION (%) | **AB** | 1.44 | 3.36 | 3.9 | **5%** | **WITHIN LIMITS** |
| **BC** | 1.27 | 2.56 | 2.86 |
| **CA** | 1.53 | 3.36 | 3.9 |
|  |  |  |  |  |

Should be a cause for concern. The harmonic 3rd, 5th  and 7th order were registered dominant. This can cause heating on the equipment.

VFD-1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| TOTAL HARMONIC DISTORTION | **AB** | 3.22 | 3.36 | 3.9 | **5%** | **WITHIN LIMITS** |
| **BC** | 2.89 | 3.01 | 3.37 |
| **CA** | 3.22 | 3.36 | 3.9 |
|  |  |  |  |  |

Should be a cause for concern. The harmonic 3rd, 5th  and 7th order were registered dominant. This can cause heating on the equipment.

VFD-2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| TOTAL HARMONIC DISTORTION (%) | **AB** | 2.11 | 2.2 | 2.68 | **5%** | **WITHIN LIMITS** |
| **BC** | 1.63 | 1.68 | 1.97 |
| **CA** | 2.11 | 2.2 | 2.68 |
|  |  |  |  |  |

Should be a cause for concern. The 3rd, 5th  and 7th order were registered dominant. This can cause heating on the equipment.

E) TDD COMPLIANCE

The Total Demand Distortion (TDD) shall be defined as the ratio of the RMS value of the harmonic content to the RMS value of the rated or maximum fundamental quantity, expressed in percent.

PHILIPPINE DISTRIBUTION CODE sets the TDD of the current at any user of the system to not exceed five percent (5%) during normal operating conditions.

MAIN 250AMPS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| TOTAL DEMAND DISTORTION (%) | **AB** | 4.98 | 15.38 | 39.19 | **5%** | **OUTSIDE LIMITS** |
| **BC** | 5.24 | 15.77 | 41.65 |
| **CA** | 4.94 | 15.38 | 194.09 |
|  |  |  |  |  |

VFD-1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| TOTAL DEMAND DISTORTION (%) | **AB** | 2.42% | 15.14% | 45.33% | **5%** | **OUTSIDE LIMITS** |
| **BC** | 2.51% | 15.65% | 46.45% |
| **CA** | 2.30% | 15.12% | 193.54% |
|  |  |  |  |  |

VFD-2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| TOTAL DEMAND DISTORTION | **AB** | 17.88% | 19.76% | 46.72% | **5%** | **OUTSIDE LIMITS** |
| **BC** | 18.62% | 20.69% | 45.28% |
| **CA** | 18.36% | 20.59% | 73.81% |
|  |  |  |  |  |

It is important to note that the values obtained for the THD (refer to previous sections) might declare the parameter values within the limits. However, the overall conclusion shall be derived together with the TDD compliance as the values of the TDD coming from the asset while the THD values coming normally from the sources.

F) 100% POWER FREQUENCY (HZ) COMPLIANCE

A nominal fundamental frequency of 60HZ, PHILIPPINE DISTRIBUTION COCE set an acceptable limit of 59.7 HZ. for low frequency and 60.3 hz for high frequency

**MAIN 250A (LOAD SIDE)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| FREQUENCY |  | 59.71 | 60.07 | 60.369 | **59.7- 60.3** | **WITHIN**  **LIMITS** |

VFD-1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| FREQUENCY |  | 59.707 | 60.1 | 60.369 | **59.7- 60.3** | **WITHIN**  **LIMITS** |

VFD-2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| FREQUENCY |  | 59.68 | 60.06 | 60.33 | **59.7- 60.3** | **WITHIN LIMITS** |

G) POWER FACTOR

The ideal situation is a cos phi or DPF equal or close to 1. Utilities may charge additional cost (penalty when var readings are high because they need to provide apparent power (VA, kVA) that does not include both var and W.

**MAIN 250A (LOAD SIDE)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| POWER FACTOR |  | 0.86 | 0.92 | 0.93 | **>0.85** | **WITIHIN LIMITS** |

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VFD-1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| POWER FACTOR |  | 0.75 | 0.89 | 0.9 | **>0.85** | **OUTSIDE LIMITS** |

VFD-2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PARAMETER** | **PHASE** | **MINIMUM** | **AVERAGE** | **MAXIMUM** | **LIMITS** | **COMMENTS** |
| POWER FACTOR |  | 0.21 | 0.92 | 0.92 | **>0.85** | **OUTSIDE LIMITS** |

H) FLICKER

A measuring period of 2 hours (Plt) is useful when there may be more than one

interference source with irregular working cycles and for equipment such as welding

machines. Plt ≤ 1.0 is the limit used in standards like EN15160

The 10 min (Pst) uses a longer measuring period to eliminate the influence of random voltage variations.

**MAIN 250A (LOAD SIDE)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| .**PARAMETER** | **PHASE** | **A** | **B** | **C** | **LIMITS** | **COMMENTS** |
| Plt |  | 0.194 | 0.192 | 0.183 | **≤ .8** | **WITHIN**  **THE LIMITS** |
| Pst |  | 0.262 | 0.261 | 0.237 | **≤ 1.0** |

**VFD-1**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| .**PARAMETER** | **PHASE** | **A** | **B** | **C** | **LIMITS** | **COMMENTS** |
| Plt |  | 0.257 | 0.711 | 1.829 | **≤ .8** | **OUTSIDE LIMITS** |
| Pst |  | 0.365 | 1.62 | 4.186 | **≤ 1.0** |

**VFD-2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| .**PARAMETER** | **PHASE** | **A** | **B** | **C** | **LIMITS** | **COMMENTS** |
| Plt |  | 0.202 | 0.185 | 0.195 | **≤ .8** | **WITHIN**  **THE LIMITS** |
| Pst |  | 0.239 | 0.234 | 0.325 | **≤ 1.0** |

**4. RECOMMENDATIONS and conclusion.**

1. In general the most efficient way to troubleshoot electrical systems, is to begin at

the load and work towards the building’s service entrance. Measurements are taken along the way to isolate faulty components or loads.

2. Monitoring up to a period of one week is recommended to perform a quality check

That allows you to obtain a good impression of power quality.

3. According to IEEE 519. "Most motor loads are relatively tolerant of harmonics". However, IEEE 519-1992 states further that, "Even in the case of the least susceptible equipment, harmonics can be harmful. Harmonics, can cause dielectric thermal or voltage stress, which causes premature aging of electrical insulation. A major effect of harmonic voltages and currents in rotating machinery (induction and synchronous) is increased heating due to iron and copper losses at the harmonic frequencies. The harmonic components thus affect the machine efficiency, and can also affect the torque developed".

4. In the case of this station, the total demand distortion is outside the limits set in the Philippine Distribution Code. From the application perspective, we're most concerned with the maximum harmonic current levels, and the impact they have on the distribution system. This makes TDD a much more useful metric for power inverter distortion.

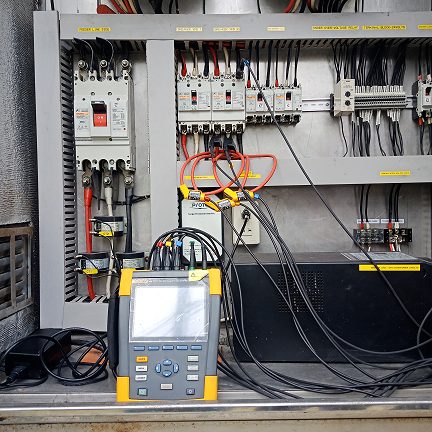
6. Voltage unbalance causes high unbalanced currents in stator windings resulting in overheating and reduced motor life. As in the case of VFD1, voltage deviation which is outside limit were recorded. Check cause of voltage unbalance which is often caused by current unbalance.

7. Crest Factor – A high crest factor value for current was recorded to signify a distorted current waveform. A CF of 1.8 or higher means high waveform distortion. This can be attributed on the current drawn by the rectifier.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Main | VOLTAGE | | CURRENT | |
| Phase | MIN | MAX | MIN | MAX |
| A | 1.41 | 1.44 | 1.42 | 3.27 |
| B | 141 | 1.43 | 1.39 | 2.87 |
| C | 1.41 | 1.43 | 1.40 | 7.22 |

8. Since a filter is already in place (73A VLT, Advance Harmonic Filter AHF005) when the measurements were taken and current harmonics is still high, consider a one week monitoring to validate the values.

. A second filter may be considered to properly address the 3rd, 5th and 7th harmonics. An active filter (cancellation of all harmonics) can be considered altogether.



PQA installation