**AYALA ALABANG R1P PUMP STATION**

**1.8 Power quality analysis**

Power quality analysis has been conducted on  **MAIN system, VFD1, VFD2 AND softstarter** of this pump station. The Power Quality Analyzer used was **FLUKE 430-II**. Figure 1.20 shows the analyzer during the course of measurement for the station.

1.81 The objectives and expected outcomes

* Record the voltage and current profile on the load side of **Circuit Breaker** with the recording interval set every ten (10) minutes.
* Record power profile (KW, KVA, KVAR) on the load side of **Circuit Breaker** with the recording interval set every ten (10) minutes.
* Record Total Harmonic Distortion (THD)
* Record Values of Short Duration Voltage Variation that will exceed the limit set by Philippine Distribution code
* Record values of Long Duration Voltage Variation that will exceed the limit set by the Philippine Distribution Code
* Record values of Frequency Variation that will exceed the limit set by Philippine Distribution code
* 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
* Compute for Voltage Unbalance and compare it on the Voltage unbalance limit set by PDC
* Recommendations

**1.8.2 Basic**

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

**1.8.3** **Results**

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

1.8.3.1 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

Results are shown in Table 1.14

Table 1.14: Power quality – RMS Voltage Compliance



1.8.3.2 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.

Results are shown in Table 1.15

Table 1.15: Power quality – Voltage Unbalance Compliance



1.8.3.3 CURRENT UNBALANCE COMPLIANCE

Results are shown in Table 1.16 with note that current unbalance should not exceed 10 %.

Table 1.16: Power quality – Current Unbalance Compliance

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Current Unbalance | MINIMUM Deviation | AVERAGE Deviation | MAXIMUM Deviation | LIMITS (%) | REMARKS |
| MAIN ATS 1250A (Load Side) | 3.74 | 5.84 | 2.01 | ±10% | Within Limits |
| VFD-1 | 6.27 | 6.11 | 5.99 | ±10% | Within Limits |
| VFD-2 | 3.63 | 3.46 | 3.61 | ±10% | Within Limits |
| Softstarter | 5.96 | 5.96 | 1.17 | ±10% | Within Limits |

1.8.3.4 HARMONICS -THD COMPLIANCE

Results are shown in Table 1.17 with the following notes:

* 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.

Table 1.17: Power quality – Total Harmonic Distortion Compliance



1.8.3.5 Harmonics -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.

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.

Table 1.18: Power quality – Total Demand Distortion Compliance



In this situation, results of TDD are significant higher than the limit of 5%, indicating a

certain degree of probability that there is an existing issue.

1.8.3.6 100% POWER FREQUENCY (HZ) COMPLIANCE

Results are shown in Table 1.19 with the following notes:

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

Table 1.19 Power Quality-Frequency compliance



Loads and other electrical equipment are usually designed to operate at a particular frequency. Off-nominal frequency operation causes electrical loads to deviate from the desired output such as for pumps.

1.8.3.7 POWER FACTOR

Results are shown in Table 1.20 with the following notes:

* 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.

Table 1.20 Power Quality- Power factor Compliance



1.8.3.8 FLICKER

Results are shown in Table 1.21 with the following notes:

* 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.

Table 1.21 Flicker Compliance



**1.8.4 Conclusions and recommendations**

* 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.
* 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.
* 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".
* 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.

* The measured power factor is low for Main ATS 1250A. Consider addressing first the issues on harmonics if any before improving the power factor.
* 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 variable frequency drive.



* Investigate TDD again on the low-voltage side of the transformer serving each motor, and at the meter where utility service is being received, to get a better sense of how the distortion has perpetuated throughout the system. If distortion is high at the meter, investigate further by installing harmonic filtration equipment. An active filter (cancellation of all harmonics) can be considered altogether.

a. PQA installation –VFD1 b.PQA installation –Softstarter

c..PQA installation –Main ATS