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Voltage Swells and Transient Research Considering ARC Load

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Abstract – *Generally, normally the electrical energy is supplied via two sources to prevent any noticeable interruption for sensitive loads. Although such costly technique resolves the problem of power interruption, its contribution to mitigate power quality problems is not significant. Voltage swells and transients are amongst the server issues that badly influence sensitive loads. Thus, in this paper the focus is given to them and two different power stations were monitored in order to investigate such events. One of the stations supplies are furnace and rollers for various industrial process while the other supplies a multi-purpose convenient adjustable nuclear reactor and the monitoring was realized by installing power quality analyzers at different buses of the stations and recording the results for 6 to 12 months. The readings are then filtered , analyzed graphed using the Matlab Software. It was found that, the voltage swell and transient are present and the max swell was 150,7% , and less value of 134,4 %. The voltage transient online of 220 V was 211.6 % with a value of 465,746 KV. Using a powerful voltage restorer (DVR and SVC) to mitigate voltage disruptions and isolate all the hypersensitive and critical plenty of nuclear installations*

1. INTRODUCTION

Nowadays, in the age of sophisticated electronics, assessment of power quality has become too important. The widespread use of high-tech devices has complicated all aspect of electrical power and also impact negatively. The traditional, the standard and the typical large-scale generation of electricity at centralized facilities include fossil-fuel-fired power plants, element indivisible power plants, hydroelectric public works, wind farms etc. These are generally now being troubled with the shortage of precious fuel, the exceeding amount of emission and the {electrical energy electric power electricity loss due to long transmission line [1]. "Power Quality" relates pertains makes reference to the electrical anatomy's ability to make a perfect power supply that has a pure quiet sinusoidal wave shape, and is always stable if voltage and frequency is recognized asis known as regarded. However, practically many lots a lot regularly impose disturbances on the systems that make deviations from this ideal power supply [2]. EPRI carried out research a report between 1992 and 1997 in the US and characterized the typical the standard the regular duration of disturbances. The result for a typical site, during this offered period showed that the most important electric power electricity ability quality issue was volts quality electricity stability [2], which requires regulation. Voltage rules are legislation control and mainly afflicted damaged by the balance of reactive power and the time constant of the fermentation system [3]. A case study with blowing wind flow breeze farms and having 12 turbines [4], showed that the harmonic values affected slightly in a negative way. Common Standard Normal distribution of PQ disruptions disorders disorder by its duration shows that disturbances lasting less than one second much significantly considerably outnumbers the others in occurrence [5]. Requirements Specifications Criteria have been introduced to define Power Quality, including the ones defined by IEEE and IEC [6]. Being integrated with the alternative energy power systems such as solar and wind, allocated sent out given away generation (DG) can lead to cleaner {plus more and even more effective successful useful power generation and transmitting indication [1, 7 and 8], along with micro grids [9-11]. Electric power system operators often try to keep a certain portion small fraction small percentage with their generation capacity as Spinning Reserve (SR) for sustaining power quality, and employ custom electrical power electric power electricity devices (CPD) [12].

2. Types of power quality problems:

There are a lot of power quality problems such as: Voltage spikes /surges, Voltage sag (dip), Voltage swell, Under voltage, Over voltage, Voltage modulation, Voltage fluctuations (flicker), Outage, Noise, Notching, Power frequency variations, and Transients [2]. This paper focus mainly on Voltage Swell and Transients.

Voltage swell generally is a momentary increase in voltage outside the normal tolerance more than 110 % up to 180%. Faults turning off heavy electrical equipment, cable and capacitor bank energizing cause voltage swell. The increased energy from a voltage swell often overheats equipment and reduces its life.

However; Transients are sub-cycle disturbances in the AC waveform and can be categorized as either impulsive or

oscillatory. Transients are possibly the most damaging type of voltage disturbance.

3. Power quality solutions:

Design equipment and electrical systems are to prevent electrical disturbances from causing equipment or malfunction. They can also alter their equipment to desensitize it to power quality problem for example; they can design special K factor transformers that tolerate harmonics [1] and determine its cause and solution. Thay can also identify the medium that is transmitting the electrical disturbances and reduce or eliminate the effect of that medium. In addition to that they use of power conditioning equipment. It provides essential protection against disturbances. It can be used to condition the source, the transmitter, or the receiver of the power quality problems.

4. Voltage swells and transients case study:

The study was conducted on two different stations as described in the following categories:

4.1 Station A

The substation contains 6 power transformers and the total power demand is 515 MVA and the details for each transformer are shown below in Table1.

Table -1: Details of the substation transformers.

Tr. no	MVA	V1	V2	Load	Compensator
Tr1	160	220	33	EAF & LF	SVC
Tr2	170	220	33	EAF & LF	Svc
Tr3	35	220	33	EAF &LF	Svc
Tr4	50	220	11	Rolling mill and utility	P .f
Tr5	50	220	11	Rolling mill and utility	P .f
Tr6	50	220	11	Rolling mill and utility	P .f

Figure 1 shows an example of the problems of a recorded Voltage swell at different duration and magnitude. However, Figure 2 shows one of the problems of power quality, specifically (Voltage swell) where the value of increasing the voltage to 112% (1.12pu) and the figure also shows some values before and after the increase of voltage and the occurrence of a problem with the quality of power .

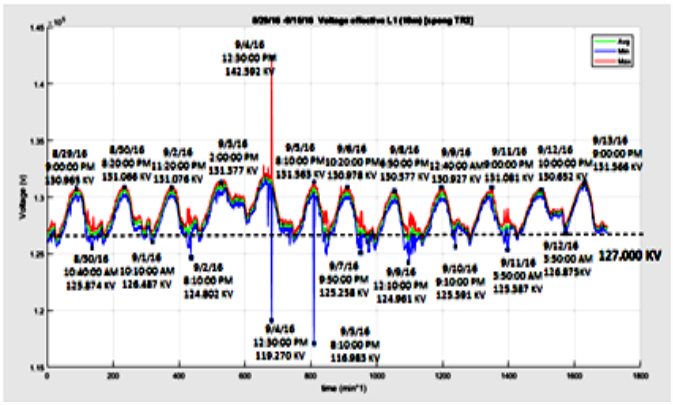

Fig – 1: Voltage swell as a case of power quality problem which the load cause increase of the voltage to 142.592.

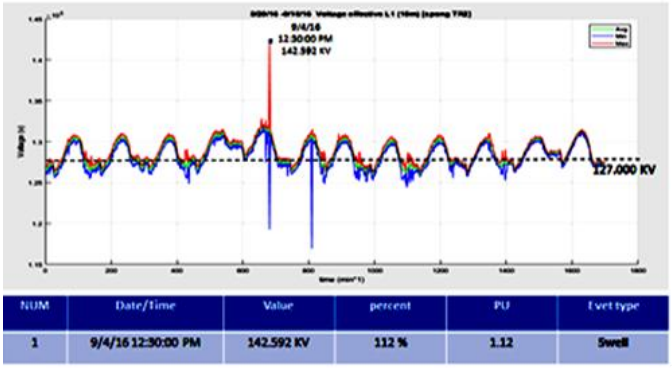

Fig – 2: One of the problems of power quality. (Voltage swell)

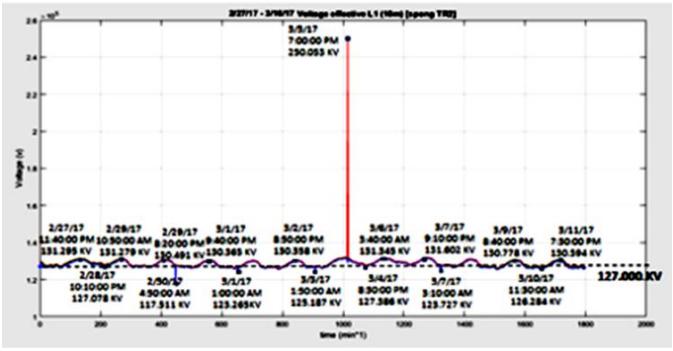

Fig – 3: An example of a recorded transient case.

Figure 3 illustrates an example of a voltage transient where the value of the increase of voltage to 250.053 kV and the figure also shows some values before and after the increase of voltage and the occurrence of a problem with the quality of power.

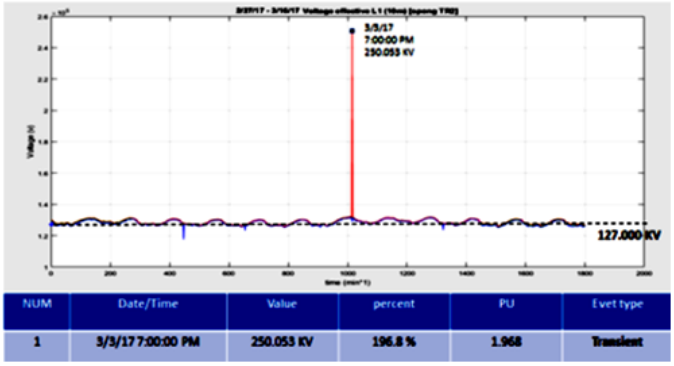

Fig – 4: One of the problems of power quality transient.

Figure 4 shows one of the problems of power quality, specifically (transient) where the value of increasing the voltage to 196.8% (1.968pu) and the figure also shows some values before and after the increase of voltage and the occurrence of a problem with the quality of power .

4.2 Station B

The case research is reviewed and analyzed is the Egypt second subsequent Testing Research Reactor (ETRR-2) www.eaea.org.eg/etrr2.html), also called also referred to as often known as the Multi-purpose Convenient Adjustable Nuclear Reactor (MPR). It is an open pool type reactor, 22 MW thermal power purchased from INVAP Argentina. The airplane is jet is a powerful tool for various researches and applications. Several experimental and production facilities are installed to satisfy the fulfill the requirements of various utilization groups including universities, research institutes, industry, and medical organizations [1]. This part illustrates the analysis and discussion of the results collected by power analyzer and evaluating the power quality according to the international standard specifications. The monitoring process was carried out in the Egypt 2nd Testing Research Reactor (ETRR-2) at two points as follows;

- Incoming feeder from substation1 (source1) for a period of one week.
- Incoming feeder from substation2 (source2) for a period of also one week.

Figure 5 shows the single line diagram of distribution center and measuring points.

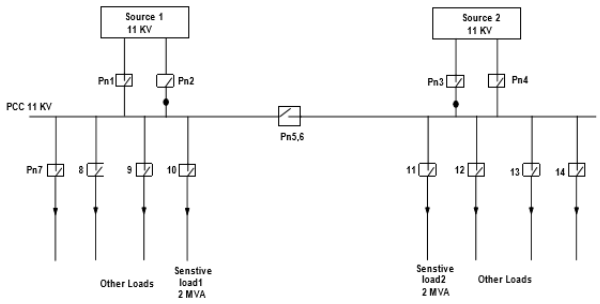

Fig – 5: Single line diagram of distribution center and measuring points.

- **Points of Measurement**

After gathering data, an analysis using MS Excel was done. Generally, the analysis of all the data attained during the survey compared with the power system disturbance suggests that the power quality is relatively good at source of 1.2 with a few irregular occurrences. The discussion of the results and analysis are shown at the following:-

4.3 Voltage swells:

Occurrence of voltage swells on figure 6 is being observed. It was occurred on fourth day at (10:00:22 AM) as shown clearly in figure 6. The percentage of voltage increasing is 25% and lasted for 150 ms. Referring to the trend graphs, the system was stable and the power was about 200 kW and there was no capacitor switched on. The disturbance is occurred at phase 3 only due to network transient. This indicated that this disturbance is imported from the substation and it is observed also that the occurrence of voltage swell increasing is 25%, for duration of 200 ms as shown clearly in figure 7. This disturbance was occurred on 4th day at (17:49:10 PM). Referring to the trend graph, the system was stable and the power was about 250 kW and there was no capacitor switched on. The disturbance is occurred as shown in figure 7 only due to also the transient network. This disturbance is imported from the substation as clear in figure 6.

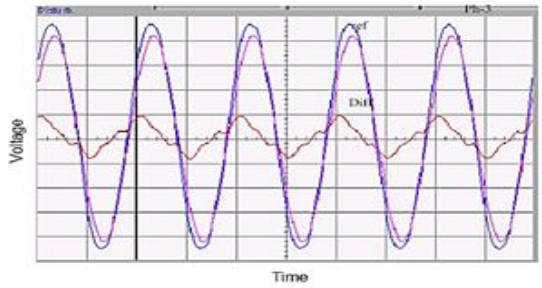

Fig – 6: Voltage swell.

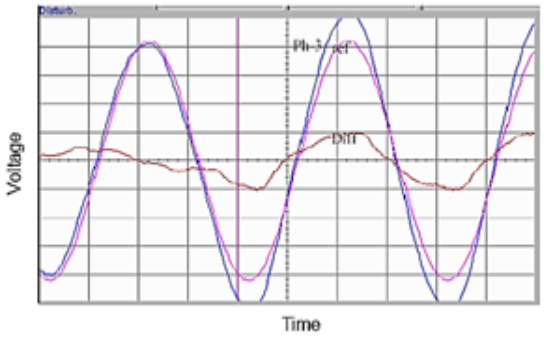

Fig – 7: Voltage swell.

4.4 Voltage Transient

There was a transient voltage observed during the period of monitoring, it is observed the occurrence of voltage transient on the three phases as shown in figures 8 and 9. These disturbances were occurred on 4th day at (08:07:39 AM) and (16:25:03 PM) respectively. Referring to the power trend graphs and the recorded data the ETRR-2 load was stable; there was no starting or any variation. So, this disturbance was imported from the substation also. This disturbance was probably caused by switching or short circuit.

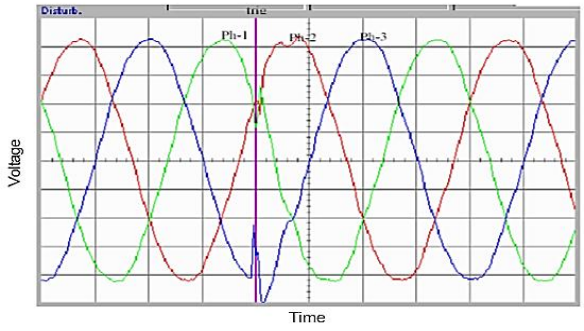

Fig – 8: Voltage transient.

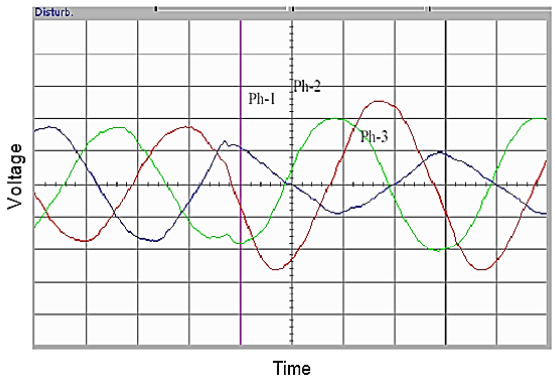

Fig – 9: Voltage transient.

Referring to the results of power quality monitoring of the power system of ETRR-2, and according to the power quality solutions, mitigation techniques are suggested as the following: -

- Install Passive Filters at low voltage side.

- Install (DVR) at medium voltage side.

- All sensitive and critical loads should be isolated and fed through (UPS). DVR is used to protect voltage sags on lines feeding sensitive / critical equipment, the DVR is specifically designed for large loads served at distribution voltage [2]. Normally, UPS are used to interface critical loads such as computers and communication systems to the utility systems. The design of UPS is the double conversion mode.

6. CONCLUSIONS

This paper discusses and presents the assessment of power quality problems on the behavior of the power system of nuclear installations. From the results of the present study, the important conclusions are as follows:

- In station A, there are many loads cause power quality problems such as voltage swell and voltage transient which are considered in this paper considering a real load Arc furnace load which is a high non liner load ,so it causes voltage transient and swell. Power quality analyzer device is used to measure each of voltage swell and transient referring to the measured values of swell and transient and after analyze. It was found that these values exceed the standard values proposed that using the SVC to solve these problems which connected the PCC.
- In station B, there are many loads cause power quality problems such as flickers, voltage sags/swells, under/over voltage, transients and temporary outage (500 ms) are the most severe events and taken into consideration for any evaluation. It is recommended that, mitigation techniques should be done to keep good performance of the power system and avoid operation problems of the nuclear installations. The Passive Filters, (DVR) and (UPS) are most economic and effective solutions to mitigate the power quality problems.

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BIOGRAPHIES

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