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UNIT 5

Ques1. Discuss in detail how following equipments are applied for power quality measurement:

(1) Multimeters
(2) Oscilloscopes
(3) Disturbance Analysers
(4) Harmonic Analysers and Spectrum Analysers
(5) Wiring and Grounding Testers
(6) Combination Disturbances and Harmonic Analysers
(7) Flicker Meters.

Ans 1. (1) Multimeters :

After initial tests of wiring integrity, it may also be necessary to make quick checks of the voltage and / or current levels within a facility. Overloading of circuits, overvoltage and undervoltage problems, and unbalances between circuits can be detected in this manner. These measurements just require a simple multimeter. Signals used to check for these include :

(1) Phase - to - ground voltages
(2) Phase - to - neutral voltages
(3) Neutral - to - ground voltages
(4) Phase - to - phase voltages (three phase system)
(5) Phase currents
(6) Neutral currents.

(2) Oscilloscopes :

An oscilloscope is valuable when performing real-time tests. Looking at the voltage and current waveforms can provide much information about what is happening, even without performing detailed harmonic analysis on the waveforms.

One can get the magnitudes of the voltages and currents, look for obvious distortion, and detect any major variations in the signals.

(3) <u>Disturbance Analysers:</u>

Disturbance analysers and disturbance monitors form a category of instruments that have been developed specifically for power quality measurements. They typically can measure a wide variety of system disturbances from very short duration transient voltages to long-duration outages or undervoltages. Thresholds can be set and the instruments left unattended to record disturbances over a period of time. The information is most commonly recorded on a paper tape, but many devices have attachments so that it can be recorded on disk as well. These are of two types:

(1) Conventional analysers
(2) Graphics-based analysers.

(4) <u>Harmonic Analysers and Spectrum Analysers:</u>

Instruments in the disturbance analyser category have very limited harmonic analysis capabilities. Some of the more powerful analysers have add-on modules that can be used for computing fast Fourier transform (FTT) calculations to determine the lower order harmonics. However, any significant harmonic measurement requirements will demand an instrument that is designed for spectral analysis or harmonic analysis.

(5) **Wiring and Grounding Testers:**

Many power quality problems reported by end users are caused by problems with wiring and/or grounding within the facility. These problems can be identified by visual inspection of wiring, connections, and panel boxes and also with special test devices for detecting wiring and grounding problems. Three phase wiring testers should also test for phase rotation and phase-to-phase voltages. These test devices can be quite simple and provide an excellent initial test for circuit integrity.

(6) **Combination Disturbances and Harmonic Analysers:**

The most recent instruments combine harmonic sampling and energy monitoring functions with complete disturbance monitoring functions as well. The output is graphically based and the data are remotely gathered over phone lines into a central database. Statistical analysis can then be performed on the data. The data are also available for input and manipulations into other programs such as spreadsheets and other graphical output processors.

(7) **Flicker Meters:**

Over the years, many different methods for measuring flicker have been developed. These methods range from using very simple rms meters with flicker curves to elaborate flicker meters that use exactly tuned filters and statistical analysis to evaluate the level of voltage flicker.

Ques2. Describe the specific information that should be obtained at sight survey to monitor the power quality about the customer facility.

Ans2. Site surveys are performed to evaluate concerns for power quality and equipment performance throughout a facility. The survey will include inspection of wiring and grounding concerns, equipment connections, and the voltage and current characteristics throughout the facility. Power quality monitoring, along with infrared scans and visual inspections, is an important part of the overall survey.

The initial site survey should be designed to obtain as much information as possible about the customer facility. This information is especially important when the monitoring is intended to address specific power quality problems. This information is summarised below:

(1) Nature of the problems (data loss, nuisance trips, component failures, control system malfunctions, etc)

(2) Characteristics of the sensitive equipment experiencing problems (equipment design information or at least equipment application guide information)

(3) The times at which problems occur.

(4) Coincident problems or known operations (e.g., capacitor switching) that occur at the same time.

(5) Possible sources of power quality variations within the facility (motor starting, capacitor switching, power electronic equipment operation, arcing equipment, etc.)

(6) Existing power conditioning equipment being used.

(7) Electrical system data (one-line diagrams, transformer sizes and impedances, load information, capacitor information, cable data, etc).

Once these basic data have been obtained through discussions with the customer, a site survey should be performed to verify the one-line diagrams, electrical system data, wiring and grounding integrity, load levels, and basic power quality characteristics.

Ques 3. Discuss the common problems and their solutions related to power quality in wiring and grounding of electrical systems.

Ans 3. Typical Wiring and Grounding Problems:

(1) Problems with Conductors and connectors:
One of the first things to be done during a site survey is to inspect the service entrance, main panel, and major subpanels for problems with conductors or connections. A bad connection (faulty, loose or resistive) will result in heating, possible arcing and burning of insulation.

(2) **Missing Safety Ground:**

If the safety ground is missing, a fault in the equipment from the phase conductor to the enclosure results in line potential on the exposed surfaces of the equipment. No breakers will trip, and a hazardous situation results.

(3) **Multiple Neutral-to Ground Connections:**

Unless there is a separately derived system, the only neutral-to-ground bond should be at the service entrance. The neutral-to-ground should be kept separate at all panel boards and junction boxes. Downline neutral-to-ground bonds result in parallel paths for the load return current where one of the paths becomes the ground circuit. This can cause misoperation of protective devices. Also, during a fault condition, the fault current will split between the ground and the neutral, which could prevent proper operation of protective devices, directly violating the NEC.

(4) **Ungrounded Equipment:**

Isolated grounds are sometimes used due to the perceived notion of obtaining a "clean" ground. The proper procedure for using an isolated ground must be followed. Procedures that involve having an illegal insulating bushing in the power source conduit and replacing the prescribed equipment grounding conductor with one to an "isolated dedicated computer ground" are dangerous, violate code, and are unlikely to solve noise problems.

(5) **Additional Ground Rods:**

Ground rods should be part of a facility grounding system and connected where all the building grounding electrodes are bonded together. Multiple ground rods can be bused together at the service entrance to reduce the overall ground resistance. Isolated grounds can be used for sensitive equipment but these should not include isolated ground rods to establish a new ground reference for the equipment. One very important power quality problem with additional ground rods is that they create additional paths for lightning stroke currents to flow, which goes to the ground at the service entrance and the ground potential of the whole facility rises together.

(6) **Ground Loops:**

Ground loops are one of the most important grounding problems in many commercial and industrial environments that include data processing and communication equipment. If two devices are grounded via different paths and a communication cable between the devices provides another ground connection between them, a ground loop results. Slightly different potentials in the two power system paths can cause circulating currents in this ground loop if there is indeed a complete path. Even if there is not a complete path, the insulation that is preventing the current flow may flash over because the communication circuit insulation levels are quite low.

Very low magnitudes of circulating currents can cause serious noise problems.

(7) Insufficient Neutral conductor:

Switch-mode power supplies and fluorescent lighting with electronic ballasts are widely used in commercial environments. The high third-harmonic content present in these loads ~~to~~ currents can have a very important impact on the required neutral conductor rating for the supply circuits. Third-harmonic currents in a balanced system appear in the zero sequence circuit. This means that third-harmonic currents from three single-phase loads will add in the neutral, rather than cancel as is the case for the 60-Hz current. Thus, the neutral current rises to 140% to 170% of the fundamental frequency phase current magnitude.

Solutions to Wiring and Grounding Problems:

(1) Proper Grounding Practices:

(a) Ground Electrode (Rod):

The ground rod provides the electrical connection from the power system ground to earth. The item of primary interest in evaluating the adequacy of the ground rod is the resistance of this connection. The resistance of the ground rod connection is important because it influences transient voltage levels during switching events and lightning transients, that result in a voltage across the resistance, raising the ground reference for the entire facility. The voltage between the ground reference and the true earth ground will appear at grounded equipment within the facility, resulting in dangerous touch potentials.

(b) **Service Entrance Connections:**

The primary components of a properly grounded system are found at the service entrance. The neutral point of the supply power system is connected to the grounded conductor at this point. This is also the one location in the system where the grounded conductor is connected to the ground conductor (green wire) via the bonding jumper. For most effective grounding, the ground-electrode conductor should be exothermically welded at both ends. Throughout, the system, a safety ground must be maintained to ensure that all exposed conductors that may be touched are kept at an equal potential.

(c) **Panel Board:**

The panel board is the point in the system where the various branch circuits are supplied by a feeder from the service entrance. The panel board provides breakers in series with the phase conductors; connects the neutral of the branch circuit to that of the feeder circuit; and connects the ground conductor to the feeder ground conductor, conduit and enclosure. There should not be a neutral-to-ground connection at the panel board, as it would result in load return currents flowing in the ground path between the panel board and the service entran Also, the fault currents will split between the two paths. Protection is based on the fault curre flowing in the ground path.

(d) Isolated Ground:

The noise performance of the supply to sensitive loads can sometimes be improved by provided by providing an isolated ground to the load. This is done using isolated ground receptacles, which are orange in color. If an isolated ground is being used downline from the panel board, the isolated ground conductor is not connected with the conduit or enclosure in the panel board, but only to the ground conductor of the supply feeder. The conduit is the safety ground in this case and is connected to the enclosure.

12) Separately Derived Systems:

A separately Derived system has a ground referenc that is independent from other systems, such as a delta-wye isolation transformer. These syste are used to provide a local ground reference for sensitive loads. The local ground reference can have significantly reduced noise levels as compared to the system ground in case of using an isolation transformer. An additional benefit is that neutral currents are localized to the load side of the separately derived system. This can help reduce the neutral current magni-tudes in the overall system when there are large numbers of single-phase nonlinear loads.

Ques 4. Discuss the reasons of grounding in aspects of:
(1) Personnel safety
(2) Ensuring protective device operation
(3) Noise control.

Ans 4. (1) Personnel Safety:
Personnel safety is the primary reason that all equipments must have a safety equipment ground. This is designed to prevent the possibility of high touch voltages when there is a fault in the place of equipment. The touch voltage exists between any two conducting surfaces which may be simultaneously touched by an individual. The earth may be one of these surfaces.
There should be no "floating" panels and enclosures in the vicinity of electric circuits. In the event of insulation failure or inadvertent application of moisture, any electric charge which appears on a panel, enclosure, or raceway must be drained to "ground" or to an object which is reliably grounded.

(2) Ensuring Protective Device Operation:
A ground fault return path to the point where the power source neutral conductor is grounded is an essential safety feature. An insulation failure or other fault that allows a phase wire to make contact with an enclosure will find a low impedance path back to the power source neutral. The resulting overcurrent will cause circuit breaker to fuse to disconnect the failed circuit promptly.

An effective grounding path shall:

(a) Be permanent and continuous

(b) Have a capacity to conduct safely any fault current likely to be imposed on it.

(c) Have sufficiently low impedance to limit the voltage to ground to facilitate the operation of the circuit protective devices in the circuit.

(d) Not have the earth as the sole equipment ground conductor.

(3) Noise Control:

Noise control includes transients from all sources. This is where grounding relates to power quality. Grounding for safety reasons defines the minimum requirements for a grounding system. The primary objective of grounding is for noise control is to create an equi-potential system. Potential differences between different ground locations can stress insulations, create circulating ground currents in low-voltage cables, and interfere with sensitive equipment that may be grounded in multiple locations. Ground voltage equilization of voltage differences between automated data parts in processing (ADP) grounding system is accomplished in parts when the equipment grounding conductors are connected to the grounding point of a single power source. For long conductors, it is difficult to achieve constant potential throughout the grounding system.