Tech Tip #7 - July 2022

Transient Voltage

IEC defines voltage dips, swells, and interruptions as a variation in RMS voltage (root mean square) below 90%, above 110%, and below 10% of the nominal or a sliding reference voltage, respectively.

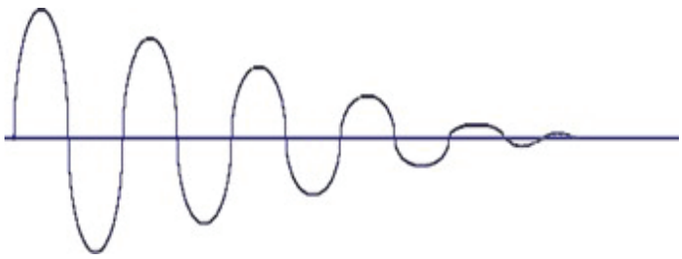
Nominal Voltage: The word **"nominal"** means "named". The actual voltage at which a circuit operates can vary from the nominal voltage within a range that permits satisfactory operation of equipment

Voltage Dips: or sags are a temporary reduction in the RMS voltage of 10% or more below the nominal voltage. The decrease lasts from half a cycle to several seconds. Whereas undervoltage is a dip that lasts for more than 1 minute and can be caused by overloaded circuits or undersized conductors.

Voltage Swells: are the opposite of dips and they are defined as a momentary increase in RMS voltage of 10% or more above equipment recommended voltage range for a period of 1/2 cycle to 1 min, as defined in the IEC 61000-4-30 standard.

Voltage Transients: are defined as short duration surges of electrical energy and are the result of the sudden release of energy into a circuit of energy previously stored in the electrical circuit or induced into the circuit by other means. Transients differ from swells by being larger in magnitude and shorter in duration.

Transients can range from a few volts to several thousand volts and last microseconds up to a few milliseconds. Transients may be of either polarity and may be additive or subtractive energy to the original waveform. Transients are divided into two categories which are easy to identify: oscillatory and impulsive.



The "oscillatory transient" is the most common transient and is sometimes described as a "ringing transient". This type of transients is characterized by deviations above and below the normal line voltage.

The other type "impulse transient" is more easily explained as a "single pulse" event, and it is characterized by having more than 77% of the one pulse above the line voltage. A lightning strike can be composed of multiple transients of this type.

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Transients can be generated internally, or they can come into a facility from external sources. The least common of the two are externally generated transients.

Externally Generated sources: Lightning is the most familiar externally generated voltage transient. These transients may not come directly from lightning striking the power line, but they are normally induced into the power system when lightning strikes near a power line. Other externally generated transients may come from normal utility operations such as switching facility loads, cycling disconnects on energized circuits, switching on or off capacitor banks, reclosure operations or tap changing on transformers. Poor or loose connections in the distribution system can also transients.

Internally Generated sources: The majority of transients are created within you own facility caused by cycling devices on & off, discharge and arcing. Cycling inductive loads such as motors on or off a transient voltage will be produced. Even low horsepower motors (5 HP) can produce transients in excess of 1000V. Static electricity referred to as electrostatic discharge (ESD) can generate more than 20,000 V transients.

Arcing caused by faulty contacts in breakers, switches and contactors can produce an arc when voltage jumps a gap created by the faulty connection.

Effects of voltage variations:

Electronic devices: electrical and electronic equipment may operate erratically and are continually stressed by hundreds of transients that occur every day on the power supply network through switching operations of inductive loads such as air-conditioning units, lift motors and transformers. Switching transients may also occur as a result of interrupting short-circuit currents (such as fuses blowing). Although switching transients are of a lower magnitude than lightning transients, they occur more frequently, and equipment failures unexpectedly occur often after a time delay; degradation of electronic components within the equipment is accelerated due to the continual stress caused by these switching transients.

Motors: will run at elevated temperatures when transient voltages are present, which lead to rapid degradation of the winding insulation and eventual catastrophic failure.

Lighting: Transient voltages cause early failure of all types of lights including premature ballast or bulb failure in in fluorescent systems.

Distribution Equipment: transient activity degrades the contacting surfaces of switches, disconnects and circuit breakers. Severe transient activity can produce “nuisance tripping” and overheating of transformers.

Locating Transient voltages: Transient voltages are not easy to locate. Transient voltages are normally intermittent, whereby random events trigger the situation. Weather, other rotating equipment operating intermittently or simultaneously can trigger transient voltages along with benign support accessorial items such as lights, office equipment, HVAC, may create onsite transient voltages that affect your operations.

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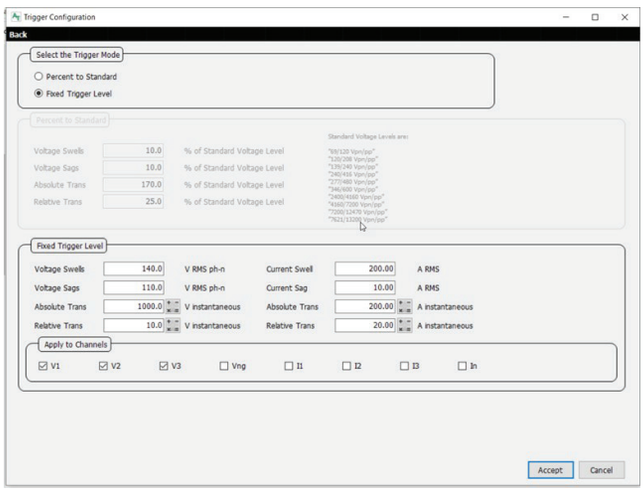
The ATPOL III™ is the most powerful handheld energized motor analyzer available that can also be used to quickly and easily locate and assess voltage, dips, swells and transients using the power monitoring features of the tool.

ATPOL III™ helps in locating these transients by recording the event so that it can isolated and eliminated before it can adversely affect the process or damage the equipment being controlled. Transient events are captured using programmed trigger levels of either absolute or relative values. The ATPOL III™ continually monitors events while a process is under load, it samples every input channel at 8µsec intervals and will capture and store any event exceeding the trigger level. Any anomaly is captured as the voltage and current are being monitored. It will continue to capture the waveform event for 50 msecs starting 1 cycle before the transient event occurs. The ATPOL III™ captures data during the run cycle and finds sag & swell, transient detection plus energy consumption.

Each transient event is a record and includes time, signal, duration, and worst measurement of the event as well as one cycle prior to and one cycle after the peak swell or sag.

It also creates a transient event log that details all the pertinent information of the transient. The event log allows these events to quickly and easily located and evaluated. The captured data can then be uploaded to the accompanying PSM software for graphing display and printing. This feature is extremely value for locating non-repetitive periodic events that are not easily identifiable using Electrical Signature Analysis (ESA). If preferred live time analysis be achieved while the test is being performed, the instrument can connected remotely to a laptop for viewing of the waveform or events.



Since transient events are not related to the process, they will not be recognized using ESA, but each transient event analysis will identify and record when transients occur and they can then be related to external factors inside the plant.

Transients can be proven by restarting a suspect system (lights, larger office equipment, HVAC, etc.) while monitoring for transient events that is affecting your process. This testing helps avoid chronic degradation, latent failures and catastrophic failures of equipment and ensures you know that your rotating equipment is performing as intended.

External events caused by weather or other surges or drops such as power consumption at a nearby facility, lack of available power provided by a utility, or other events, need also to be addressed. These are usually intermittent interruptions and need to be logged so that they can be discussed with your power provider. The ATPOL III™'s power quality mode that will log and analyze incoming power, making the discussion easier with facts: number of occurrences, time of issue, affected assts and their working requirements.

View CBM webinar on ESA here. **Case studies on ESA here.**