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Ultrasonic detection of arcing, tracking, and corona in enclosed electrical cabinets helps reduce the potential for personal injury and equipment outage.

Safety First with Ultrasonic Sensors

Arc flash can be considered a short circuit through the air. It produces tremendous stored-up energy that can travel outward from electrical equipment (see Figure 1). An arc flash produces temperatures as high as 35,000°F, hotter than the sun and exerting a force equivalent to being hit by a hand grenade. The impact can cause hearing and memory loss. If it doesn't kill you, it will severely burn or injure you. In addition, the conditions that produce an arc flash, even when none occurs, can damage electrical equipment and cause unplanned outages and costly downtime. According to one source, 5–10 arc flash explosions occur in electric equipment daily within the United States [1], and those are just the reported events.

The Occupational Safety and Health Administration has become aggressive in its attempts to reduce arc flash incidents, and has begun to use the National Fire Protection Association NFPA 70E Standard for Electrical Safety Requirements for Employee Workplaces, 2000 edition, as the guide for compliance for worker safety. There are standards for arc flash assessment, for various types of personnel protective equipment, for working around energized equipment, and for opening enclosed equipment, to name a few. All are geared for worker safety.

Certain conditions favoring arc flash inside electrical cabinets can be detected before creating flashover or arc flash incidents: arcing, tracking, and corona. These emissions produce ionization, a process by which a neutral atom or molecule loses or gains electrons, thereby acquiring a net charge and becoming an ion. It occurs as the result of the dissociation of the atoms of a molecule in solution or of a gas in an electric field. Its byproducts are ozone and nitrogen oxides. These combine with moisture to produce nitric acid, which is destructive to most dielectric materials and corrosive to certain metallic compositions.

The object of electric condition monitoring is to detect arcing, tracking, and corona before flashover

occurs or before they produce an arc flash when the cabinet is opened. Because these phenomena are characterized by airborne and structure-borne ultrasonic emissions, they can be detected by ultrasonic sensors. The instruments have a sensing range of 20–100 kHz, and use heterodyning to translate ultrasonic emissions into the audible range. They are portable, and provide information via headphones for the audio signal and on a meter that displays intensity readings, usually as decibels. They usually contain two sensing heads incorporating piezoelectric transducers—a scanning module for airborne sounds and a contact probe/waveguide for structure-borne signals.

Typically an operator will scan around the door seams and air vents of enclosed electrical cabinets with the scanning module while lis-

Figure 1. Arc flash has many causes, and can occur in any electrical equipment, whatever the voltage.





Figure 2. Handheld ultrasonic monitors are used to detect ultrasonic emissions produced by arcing, tracking, and coronas in an electric cabinet. The operator first checks door seams and air vents for airborne signals. If there are no air paths, the sensor's waveguide is used to probe around the cabinet wall. For continuous monitoring, an ultrasonic unit can be mounted inside the cabinet.

tening through headphones and observing the display panel (see Figure 2). Arcing, tracking, and corona all have distinct sound qualities that can be detected. If there are no air paths, the inspector will use the waveguide to probe around the cabinet wall. To compensate for a possible change in wave characteristics as the ultrasound moves from airborne to structure borne, the operator will change the frequency from 40 kHz (effective for airborne scans) to 25 kHz. Should there

components. A threshold level for ambient ultrasound is set. Should arcing, tracking or corona occur, the sound level will be above the ambient threshold and therefore detectable.

A 4-20 mA or 0-10 VDC output can be selected to carry the signal to an alarm mechanism or red light alert. These monitors also contain a heterodyned signal to provide recording capability for purposes of record keeping and analysis.

be a need to further analyze these patterns, the sounds can be recorded and played back on spectral analysis software. Voltage will play a role in the diagnosis since corona will occur only at 1000 V and higher

There is also a need for continuous online monitoring to detect events that occur when no one is present. For this purpose, a cabinet monitor can be mounted on the inside of the door or wall facing the electrical

Reference

1. George Gregory, "Preventing Arc Flash Incidents in the Workplace," *EC&M*, June 2003. ■

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