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Corona is a serious issue in metal clad switchgear because of its highly destructive nature—it is the cause of most flashovers in the equipment.

The fundamental cause is an electrical breakdown of air brought on mostly by an insulating deficiency within the switchgear. Corona results from the ionizing of gases because of this high electrical stress. The stress is often brought on by contamination and poor insulation values.

If the situation is not rectified, a flashover is imminent, possibly causing enormous damage and personal injury.

Tests have proven that when a flashover occurs, the temperature exceeds 15,000 deg. Most of the damage is caused by explosions from the buildup of unburned gases within the enclosure. Corona discharge is unpredictable and caution must be used at all times.

Applying current technologies

All electrical thermographers brace themselves for possible surprises when entering electrical equipment. They know they should always expect the unexpected. Prior to opening any equipment for a visual inspection, ultrasound detection and sometimes infrared imaging are necessary.

Because of corona byproducts, nitric acid and carbon produced from the corona discharge, a continuous decay of insulation takes place which makes the situation highly unpredictable.

There are various signs that identify corona. Some methods of nondestructive testing show no indication of corona, but closer visual inspection may show that corona discharge had been present, but is not active (see Fig. 1 and Fig. 2).

In both images, flashover was imminent if the problem was not rectified. Even though the corona was dormant at the time of inspection, it would have started discharging again with the appropriate relative air density, temperature, moisture, and lack of air movement. In this case

the deterioration is on the conductor insulation and corrosion on the metal clad switchgear.

In other cases, the corona discharge may be extremely active. Extra caution should be taken as a flashover could occur at any time. Corona also produces airborne ultrasound and ultraviolet light, and, if advanced into arcing, it will sometimes show a thermal signature. This is a perfect opportunity for ultrasonic detection, ultraviolet corona imaging, and infrared thermal imaging to find out where and why the corona is discharging (Fig. 3).

The problem in this case is decay in the horizontal insulators causing electrical stress to initiate the corona. This starts with contamination entering the switchgear, trapping moisture, and then, under the right conditions, producing corona. With nitric acid, ultraviolet light, ozone, and carbon deteriorating the insulation, the corona eventually spreads on its own.

At times the environment changes inside the metal clad compartment when a door is opened or a cover is removed. This on occasion stops the corona discharge which makes it more difficult to verify. Another byproduct of corona is ozone, and the odor can be identified.

Sometimes corona discharge events show up well in a thermal image as shown in Fig. 4 .

Active corona in Fig. 4 shows a 4160 V junction box which is very close to flashover on three phases and had to be rebuilt because the corona damage was too extensive. The activity was temporarily stopped with cleaning which kept it energized until a scheduled shutdown.

Use multiple tools

There is no one tool that will verify all corona problems all the time because corona discharge is erratic and unpredictable, especially in the early stages. An ultrasound detector can verify if airborne ultrasound is present from the corona discharge. An infrared camera is used to verify if there is any temperature rise from corona discharge. The ultraviolet corona camera is the ultimate tool for verifying corona discharge.

If the discharge is dormant, then none of this equipment will indicate or verify anything. A visual inspection may indicate there was discharge previously—an indication that it will return.

There are times when corona is quite obvious without using any test equipment. Fig. 5 shows severe corona in a 15 kV interrupter switch. The green material on the buss bar is corrosion from active corona and the black material on the bakelite insulation is carbon residue from active corona. This particular switch was very close to flashover.

Fig. 6 shows the same location after it was cleaned. Corona activity was stopped temporarily to buy time for a scheduled power outage. The problem was the red bakelite divider was tight against the 15 kV buss and was starting to short out. The problem was resolved by cutting the insulating divider a few inches back from the buss.

Corona does not always leave a thermal signature. It creates little or no heat, but as it progresses into arcing and tracking, a thermal signature can sometimes be found. Corona is most intense in the 300-400 nanometer range in the ultraviolet spectrum. When it exceeds the 400 nm range, corona can be seen in the visual spectrum if there is no interference from background light.

Fig. 7 shows different scenarios of active corona at 5 kV. The left and right columns show three different spectra. At the top in the ultraviolet spectrum using the corona camera, corona is evident. In the middle, nothing can be seen in the visible spectrum. At the bottom in the infrared spectrum using thermal imaging, there is no thermal signature where the corona activity is present.

Using infrared imaging, corona imaging, and airborne ultrasound detection, problem areas can be found before they become a health and safety risk and a serious financial burden. Cleaning and maintaining electrical equipment under live conditions has proven to be beneficial for everyone. **MT**

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Fig. 1 Triad 2 ma activity on a 4160 V conductor (5 kV) feeder line (left) and air flow in the

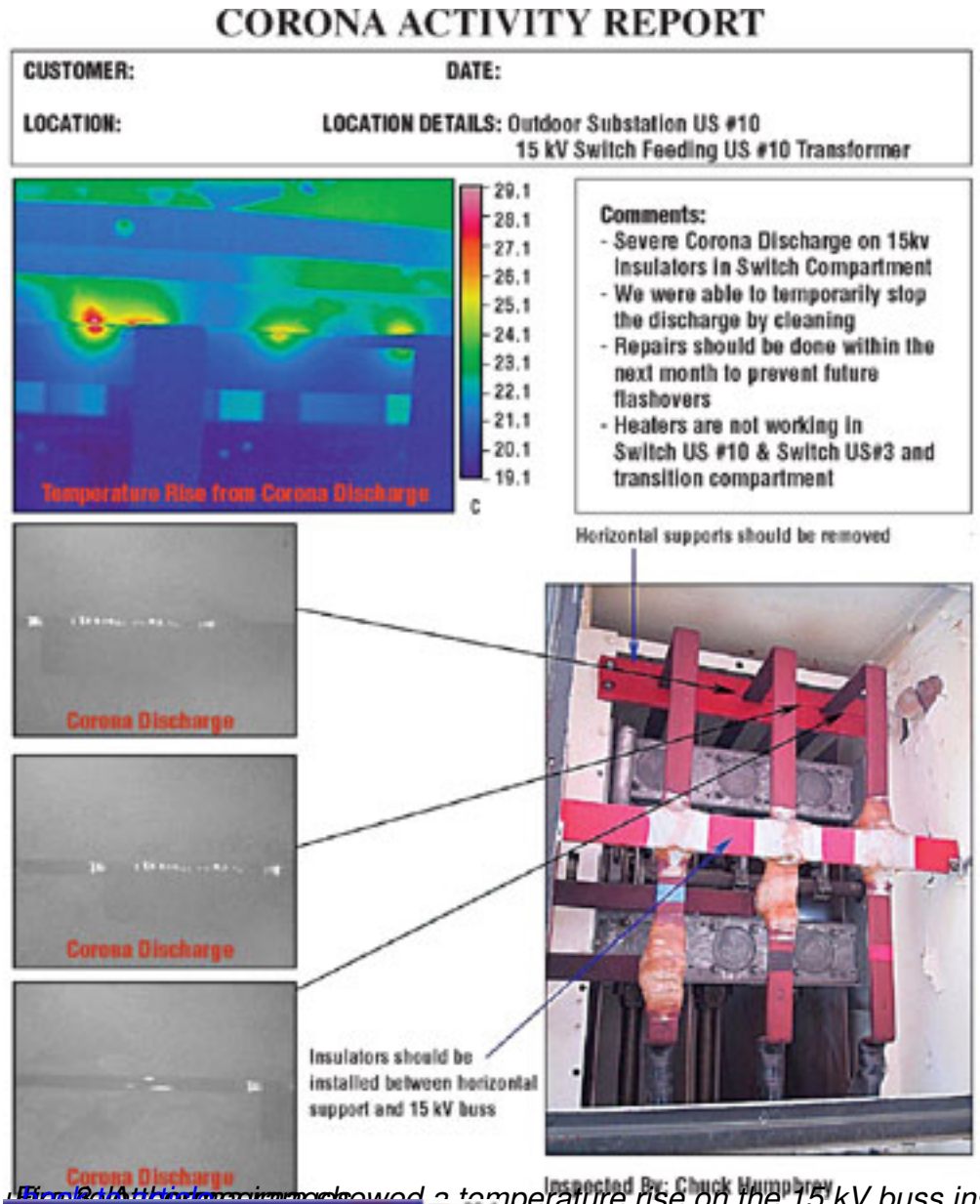

Figure 3. A thermogram showed a temperature rise on the 15 kV buss insulators, verified by the corona activity report.

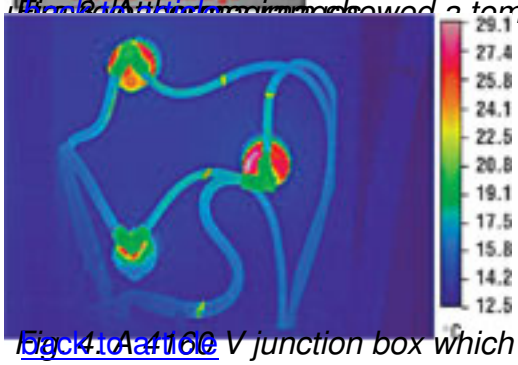

Figure 4. A 4160 V junction box which is very close to flashover on three phases.

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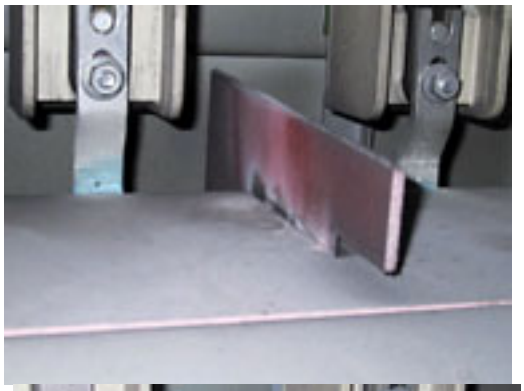

Figure 5 and 6. Interrupter switch before (left) and after (right) cleaning to temporarily stop degradation.

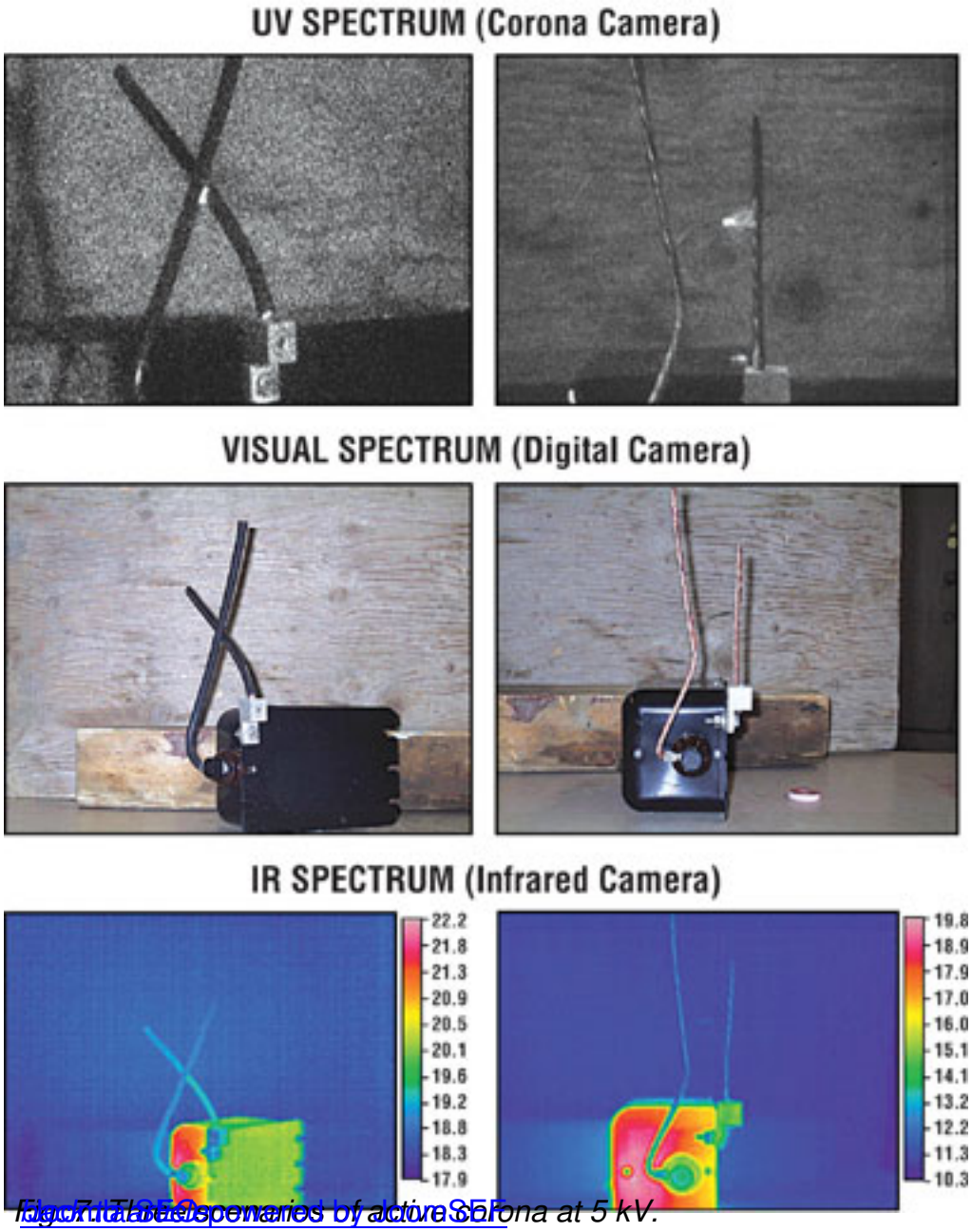

Fig. 7. Three scenarios of active corona at 5 kV.