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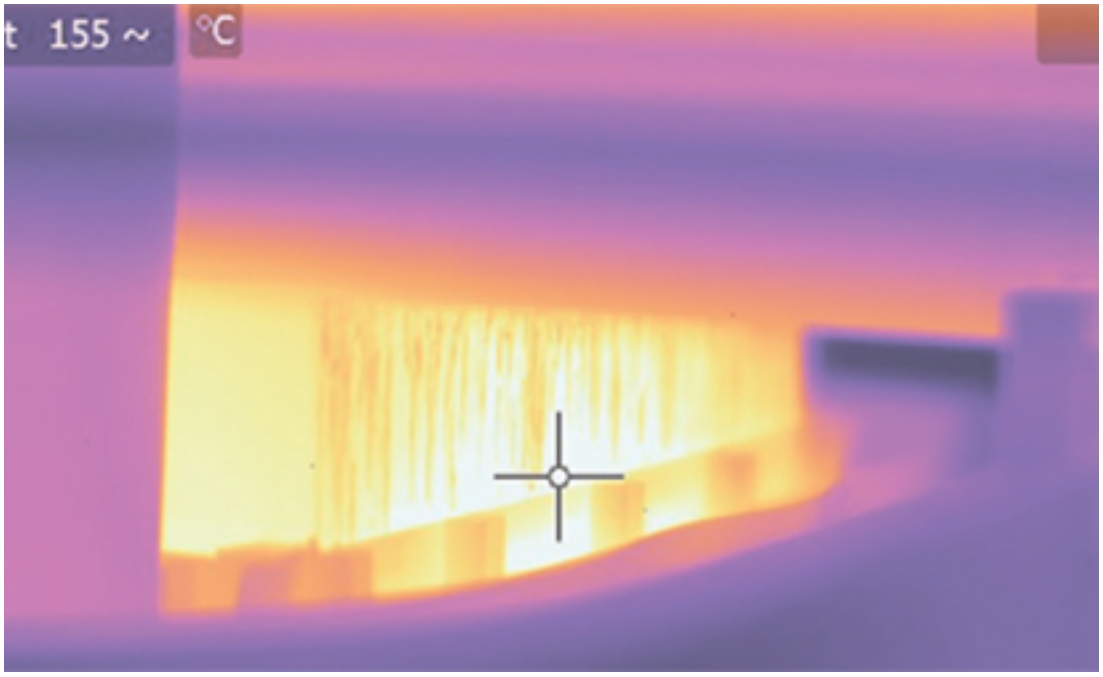

Seeing is believing. So is hearing. And with electrical systems, two predictive/diagnostic technologies can be better than one.

When it comes to complex electrical systems, all components have value. But some, such as transformers, circuit breakers, insulators, switchgear, etc., can take entire systems down— *with disastrous results*. These “high-value” assets are the ones that demand the most scrutiny.

There are myriad things that can and do go wrong with electrical systems, and “fixing” them isn’t possible without first diagnosing them. Interestingly, infrared and ultrasound technologies are often used in tandem to identify potential faults. Since infrared technology doesn’t “see” through enclosed panels unless they’re equipped with infrared windows, ultrasound technology can play a key role in safety and convenience. In fact, this is where ultrasound really proves its value as a predictive and diagnostic tool.

Listening first and looking later

The uses of infrared technology in managing equipment assets are typically well known. Some

maintenance professionals, however, may not be as familiar with the role of ultrasound technology in diagnosing complex system malfunctions. The two technologies work well together because one “sees” and the other “hears” what humans are incapable of sensing.

One of the keys to successful deployment of ultrasound is the ability to identify the sound signatures of electrical emissions, such as arcing, tracking and corona. This becomes easier with experience and practice. (There is also substantial information on sound signatures available via the Internet. One helpful, free resource is a sound-recording library from UE Systems at www.uesystems.com).

Ultrasound is particularly useful in helping avoid potentially lethal events such as arc flash. By first listening with an ultrasound instrument, a user can detect anomalies—*i.e., the tell-tale “bursts” of arcing or the steady, continuous “frying-egg” sound of corona*—that clearly say to him or her, “Don’t open this unit (unless, that is, you’re ready to be exposed to temperatures as hot as the sun itself and an almost-inevitably fatal explosion).” It’s early-warning signs like these that bring us to the example of how ultrasound was instrumental in diagnosing a potentially disastrous failure in a critical-care unit of an Ohio hospital.

The hospital’s problem…

Two transformers, manufactured in 2004, were inspected in October 2011. Virtually identical, the units were used to power a critical-care unit at the hospital.

Transformers are crucial to the entire performance of an electrical system and, if properly maintained, should last about 30 years. Regular maintenance is paramount, as transformers are subject to scarcity: The lead-time to obtain one is approximately 10 months.

The hospital had hired its local TEGG Service provider to inspect the transformers annually. The previous year, there had been no maintenance problems noted. Unfortunately, that was not the case with the facility’s October 2011 energized services inspection.

The inspection's findings…

An ultrasound examination of one of the units revealed a suspect sonic signature in the B phase coil. For comparison, an ultrasonic sound recording was taken of the sister unit, which was under similar operating conditions.

— The B phase coil of the suspect unit had a distinctly different and substantially louder sonic signature when compared with that of the “good” unit. This was the first indication of a potential malfunction within the unit. But, ultrasound by itself can’t tell exactly what a problem is, especially when relying on decibel level alone.

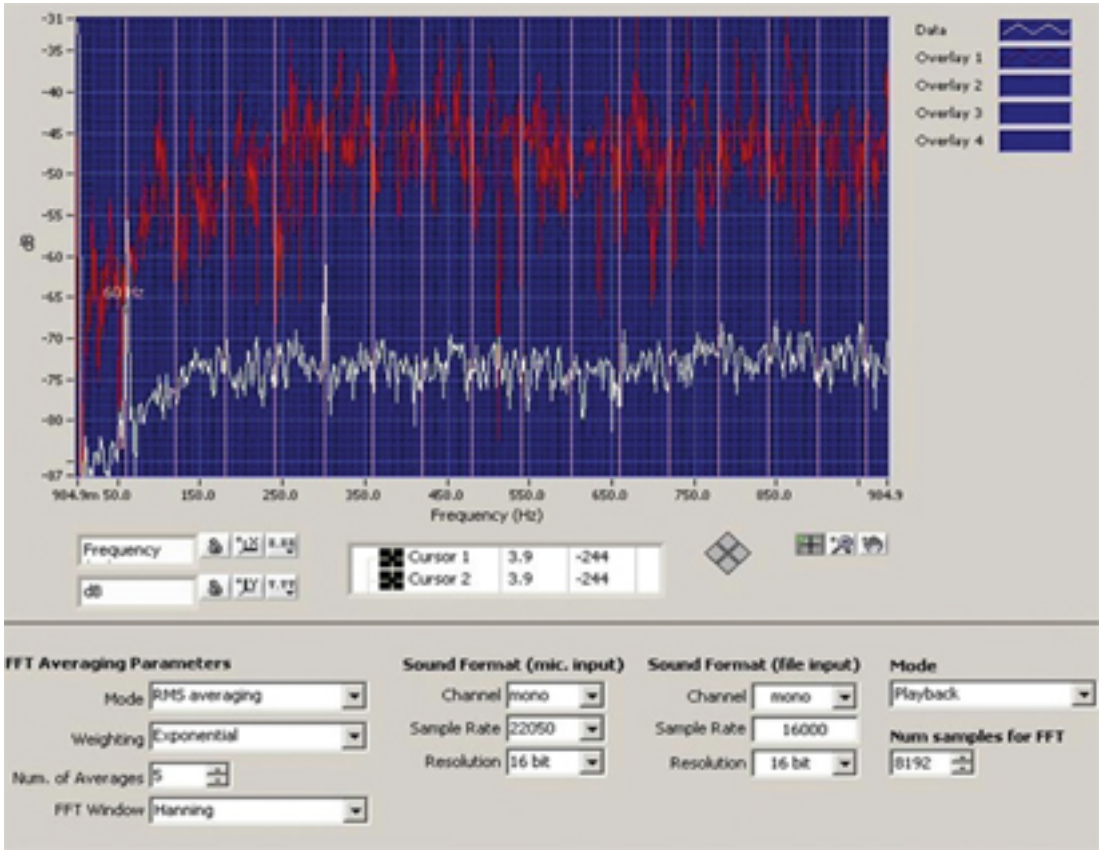

Fig. 1. There’s clearly a qualitative difference in the FFT display comparing the “B” phase coils of the hospital's two transformers.

— An FFT (fast Fourier transform) analysis of the ultrasound recording was conducted that showed a visually qualitative difference between the wave patterns of the two units’ B phase coils (Fig. 1.) Further, a time domain analysis between the two coils showed a distinct difference in the peaks and valleys of the sonic signature.

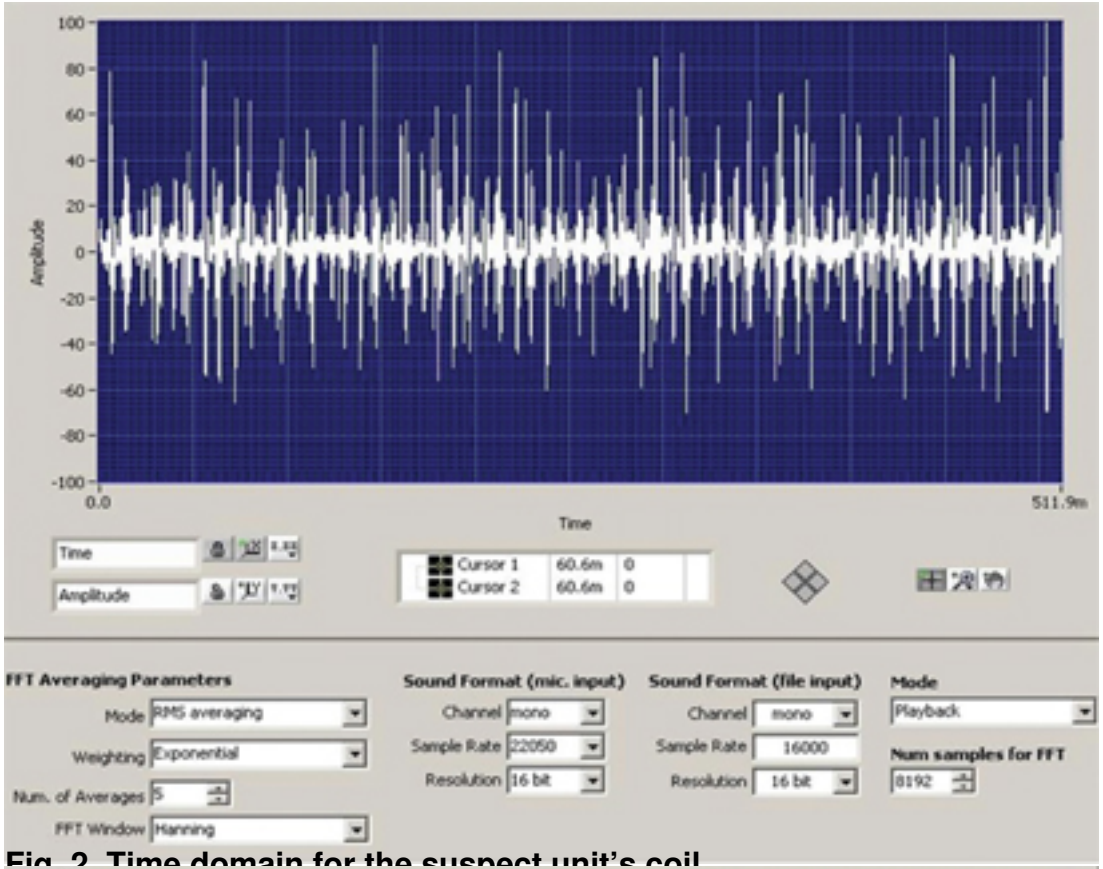

Fig. 2. Time domain for the suspect unit's coil

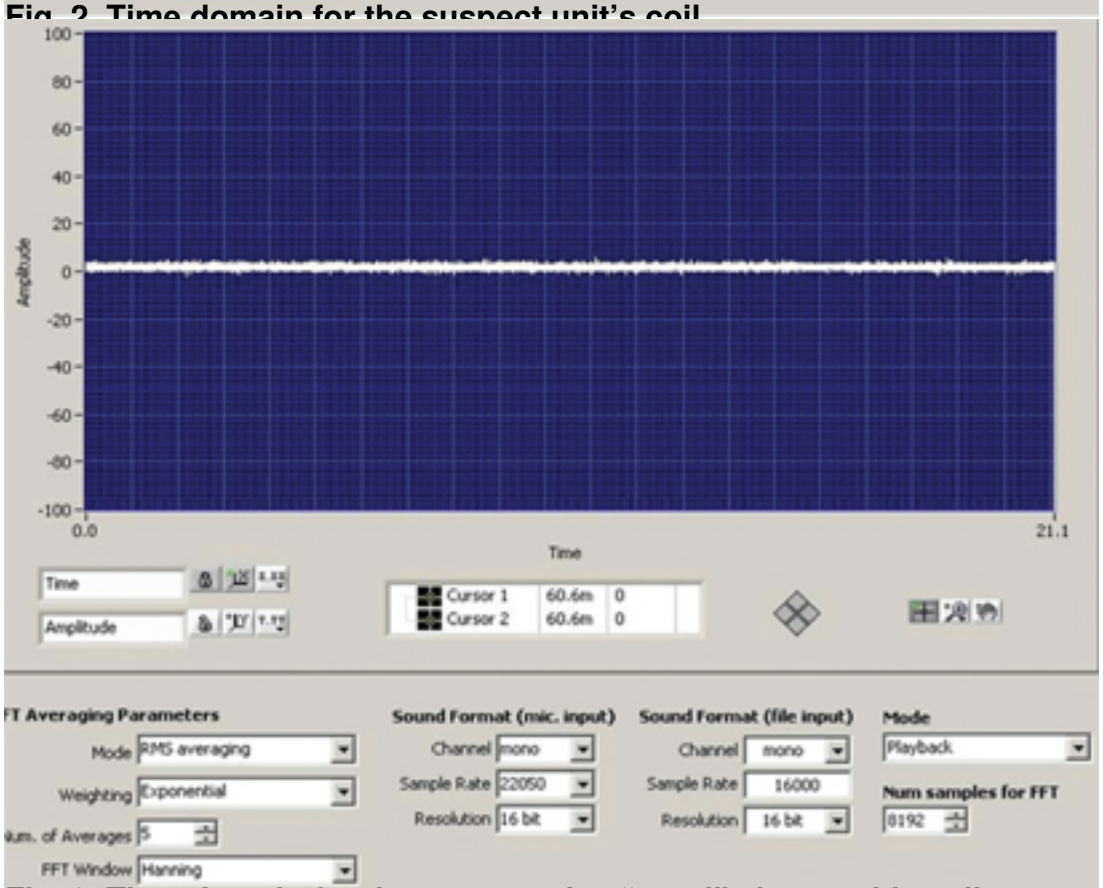

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Fig. 4. These comparative infrared images were another indication that problems were occurring. Note the heat saturation on the suspect unit's winding that exceeded the infrared camera's dynamic range of 150 C.

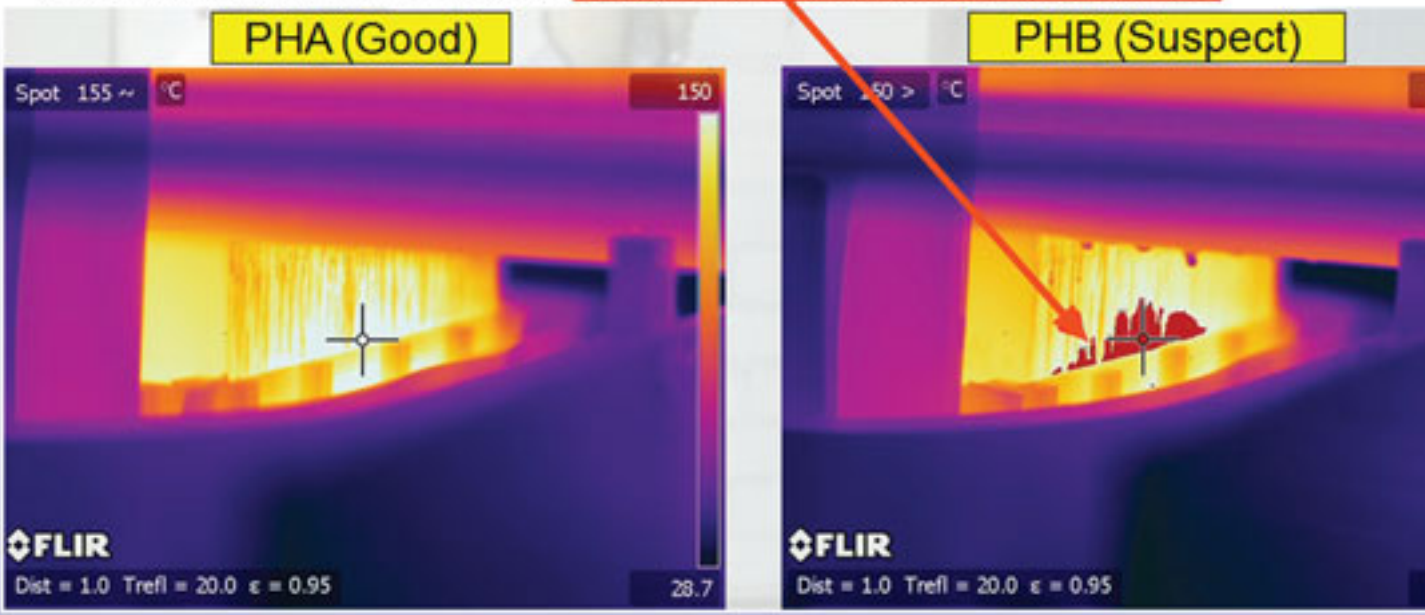
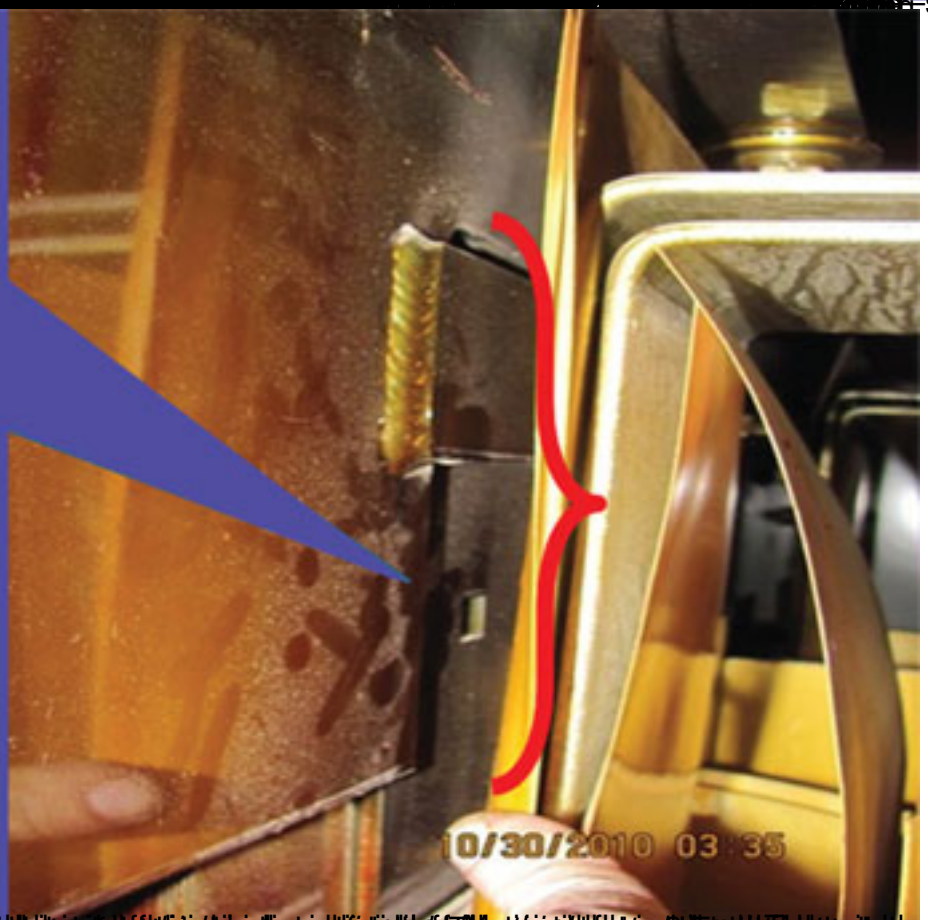


Fig. 5. These steel pieces are clearly not flush, which indicates a distortion of the top horizontal section bowing out on the low-voltage side of the B phase coil winding.



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