HVPACE

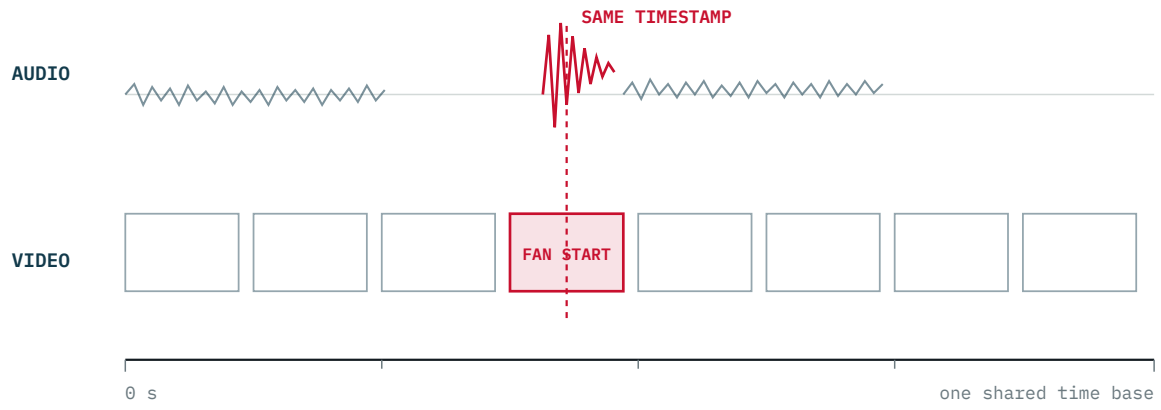
FIELD DIAGNOSTICS · CORE TECHNOLOGY NOTE

What the phone hears first

Mobile video as a first-pass triage tool for live power equipment

On site, the first sign of trouble is rarely a reading — it is a sound, noticed by someone who cannot prove what they heard. A phone recording turns that impression into data that can be analysed, compared and acted on, in minutes, with no specialised equipment.

HVPACE Technical Paper WP-01 · Rev 1.1 · For substation maintenance technicians, field engineers and condition assessment teams



A phone captures two kinds of evidence on one clock. The audio locates the event in time; the video says which component was doing what at that instant.

01

The diagnosis that starts with “I heard that”

Field maintenance runs on a skill that is rarely written down: an experienced technician often hears a problem before any instrument reports it. Thermal overload, abnormal discharge, excessive vibration — all

of them change the sound of a machine well before a sensor threshold is crossed.

So the most common starting point for a real diagnosis is not *"I measured this"* but *"I heard that"*. The difficulty is what happens next. An impression of a sound cannot be attached to a work order, compared against last month, or handed to a colleague. It has to become data before it can become a decision.

> A phone recording is the cheapest available instrument that converts an auditory impression into something structured: a signal that can be measured, plotted, compared and argued about.

02

Two streams, one timestamp

What makes mobile video useful is not the audio alone. It is that a phone records two different kinds of evidence **on a single shared time base**, with no configuration and no synchronisation work.

- **The audio track** is a time-varying pressure signal. It converts directly into waveform data, which opens up time-domain, frequency-domain and time-frequency analysis — spectra, spectrograms, feature extraction.
- **The video track** supplies the reference frame: which equipment is running, in what state, and what is physically moving. Start-up and shutdown events, mechanical looseness, vibrating enclosures, heat sinks and cables are all visible.

Separately, each is weak. Together, they let you test whether an acoustic feature actually belongs to the component you suspect — because both tracks carry the same clock.

03

What the audio track yields

Phone audio is not laboratory-grade. It is band-limited, automatically gain-controlled, and captured through a small microphone in an uncontrolled acoustic environment. What survives all of that is **structure**: equipment anomalies tend to produce consistent spectral patterns, and those patterns remain detectable even when absolute levels are not trustworthy.

The practical consequence is that you should read relationships and patterns, not absolute sound pressure levels. Four feature families do most of the work:

TABLE 1

Acoustic feature families and what they indicate

FEATURE FAMILY	WHAT TO LOOK AT	WHAT IT POINTS TO
Frequency structure	Whether 50 Hz and its harmonics dominate or are persistently elevated; harmonic ratios; amplitude modulation	Electromagnetic imbalance, mechanical resonance, or load-driven amplification of an existing response
Band energy distribution	Energy concentration within bands rather than isolated peaks; sustained increases in a range	Structural resonance, enclosure radiation, or rising noise from auxiliary machinery such as fans and pumps — highly directional for field troubleshooting
Time-varying behaviour	Periodic fluctuation and rhythmic patterns in a time-frequency plot	Rotating components, attachment vibration, or load cycling
Impacts and transients	Short-duration impacts, sudden energy release, non-stationary events	Event-driven faults — arcing, collision, discharge — as distinct from continuous operating noise

The distinction in the last row matters most in practice. Continuous noise tells you about a *state*; a transient tells you about an *event*. Confusing the two is the most common way a field acoustic assessment goes wrong.

04

What the video anchors

Audio analysis can establish that something is abnormal. It cannot, on its own, establish *what* is abnormal. That is the video track's job, and it does it in three ways:

- **Object correspondence.** Identify precisely which equipment or part is in frame and running — motor, enclosure, heat sink, cable. This defines the scope of the acoustic analysis and stops you attributing a sound to the wrong asset.
- **Operational context.** Timestamp the events visible in the frame — start-up, load change, cooling system cutting in — so that changes in the audio can be aligned to a known operating state rather than guessed at.
- **Spatial comparison.** Take short clips from several angles. Comparing intensity and localisation between them narrows down where the source physically is.

05

Triage, not instrumentation

Mobile video does not replace a vibration analyser, an acoustic camera or an electrical test. Framing it as a cheap substitute for instruments is the fastest way to discredit it. Its value is upstream of all of them: it answers, in minutes, the three questions that determine what happens next.

TABLE 2

The three triage questions

QUESTION	WHAT THE RECORDING PROVIDES	WHERE IT LEADS
Is there an anomaly?	Spectral features compared against normal operation, instead of a subjective impression	Either close the item out, or continue
What is the likely cause?	Audio-visual correlation separating electromagnetic imbalance, structural resonance and electrical discharge	A hypothesis specific enough to test
How should we proceed?	Enough evidence to rank the options: temporary reinforcement, sensor validation, or escalation	Targeted vibration, acoustic or electrical diagnostics — on the right asset

None of these is a definitive conclusion, and it would be wrong to present them as one. They are actionable insights that let a frontline decision be made now, with the reasoning recorded.

06

Why low-barrier data works

Effective maintenance technology does not have to rest on complex algorithms or expensive hardware. It has to extract **stable, verifiable features** from data that can actually be obtained, and turn them into interpretable judgements and defined next steps. Mobile video does that unusually well:

- **Low barrier.** No specialised tool, no setup, no training beyond how to hold a phone steady and record for long enough.
- **Reproducible.** Audio and video are captured together, so a second engineer can review exactly the evidence the first one had.
- **Fast closure.** Validation on site takes minutes, not the days it takes to mobilise instrumentation.

It bridges the gap between an experienced engineer's intuition in the field and the deeper diagnostic work that follows — providing evidence for the investigation while narrowing down where that investigation should point.

07

Boundaries

Stated plainly, so the method is not oversold:

- Phone audio is band-limited and gain-controlled. Absolute sound pressure levels from it are not trustworthy; relationships, ratios and patterns are.
- Substation background noise, wind and handling noise all contaminate the recording. Record long enough to capture the steady state, and record a quiet reference clip when possible.
- Comparison against the same asset's own earlier recordings is far more informative than comparison against any absolute criterion.
- Nothing here confirms an internal defect. It directs the confirmation work; it does not replace it.

> **Never compromise safe working distance or approach limits to get a better recording. If the equipment cannot be recorded safely from an approved position, it does not get recorded.**

About HVPACE

HVPACE is the trading name of Power Asset Condition Engineering Limited, a New Zealand-based supplier of test and diagnostic instruments and selected specialty equipment — such as cable sheath voltage limiters and other low-volume, mission-critical components — for high-voltage power systems. Backed by hands-on engineering expertise, including field-tested condition assessment techniques and AI-based signal analysis, we support customers with diagnostic guidance, methodology development and fault investigation, so they get the most value from the equipment they buy.

Areas of expertise

- **Specialty test instruments** and selected critical components for HV/MV power equipment
- **Acoustic and vibration diagnostics**
- **GIS / GIL condition assessment** and fault location
- **AI-based signal analysis** and pattern recognition
- **HV/MV circuit breaker, disconnector and earthing switchgear** diagnosis and consultation
- **Equipment commissioning** and field testing result analysis

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