

## Biosensing Surveillance Technologies: A Quick Guide to Biological Operations Security



Green Berets with 1st Battalion, 10th Special Forces Group (Airborne) conduct drone surveillance during a support-by-fire event in Grafenwoehr, Germany, May 2, 2025. The exercise provided U.S. Special Operations Forces a realistic training environment, advancing their ability to integrate emerging technologies into future operations. Biological operations security, when embedded in routine Special Operations Forces training, could enhance field readiness by strengthening awareness of physical and biochemical surveillance. (U.S. Army photo by Sergeant Gabriel Rivera)

*To think of the human body merely as present in space is to underestimate its operational footprint. Continuously emitting biological signals across multiple sensory domains, the body projects itself into its environment in ways that the adversary can detect, interpret, and exploit. Understanding, managing, and deliberately deploying these persistent emissions can form the foundation of biological operations security (bio-OPSEC).*

### Changing Surveillance Landscape

Emerging surveillance technologies are becoming increasingly accessible, precise, and sophisticated.<sup>1</sup> Laser beams aimed at hanging light bulbs detect minute vibrations caused by voices in the room, from which algorithms can reconstruct entire conversations.<sup>2</sup> Wi-Fi-based systems monitor how human bodies disrupt wireless patterns, enabling the tracking of movement within

buildings.<sup>3</sup> Millimeter-wave radar detects subtle chest movements from respiration and heartbeat, allowing for discreet presence detection and activity monitoring.<sup>4</sup> Moreover, portable bioaerosol samplers can collect genetic traces from the air and enable post-event attribution—potentially linking operators to a specific nationality, biometric database, or unit.<sup>5</sup>

These four examples illustrate the varied ways in which emerging surveillance technologies can operate.

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*Wearable tech like a smart watch, which transmits heart rate and other physiological parameters wirelessly, can be intercepted or triangulated, exposing individual presence, group composition, and movement patterns. (Image: Adobe Stock)*

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While they target different types of signals—ranging from physical vibrations to genetic emissions—what unites them is their reliance on signal emissions from the human body rather than on signals from carried technology. By cultivating awareness of the body as a source of operational signature, SOF can advance bio-OPSEC as a new layer of protection.

## **A Quick Guide: The Body as Emitter**

### **Physical Signature**

The human body is not neutral in its environment—its presence disrupts energy, interrupts radiation, and displaces air. Develop the ability to see oneself as a signal source in the space occupied. Even seemingly passive activities—such as sitting and standing—can affect environmental sensors that monitor airflow, pressure changes, or electromagnetic disturbance.

### **Biochemical Signature**

High-sensitivity sensors can detect human-derived CO<sub>2</sub>, sweat components, and trace chemicals from skin and breath. Be aware that

diet, nicotine, medication, and stress change emission composition and rates. Air-flow patterns—particularly proximity to intakes and prevailing wind direction—determine how far the plume travels.

### **Electromagnetic Signature**

The significant water content of the human body makes it susceptible to detection technologies that rely on radiofrequency, microwave, and millimeter-wave scanning. Prioritize barriers with known electromagnetic attenuation properties—such as metal and layered shielding—when avoiding exposure to active or passive scanning systems.

### **Thermal Signature**

The body emits infrared radiation that can be detected by thermal imaging devices. Activities such as leaning against a wall, gripping equipment, or lying on vegetation transfer body heat and leave residual “hot spots” that can remain visible for seconds to several minutes, depending on the material, airflow, and ambient temperature. Minimizing contact with surfaces—or cooling them afterward—reduces these tell-tale traces.

## Sound Dynamics

The body affects how sound propagates. Even minimal movement can alter the acoustic profile of a space—shifting reverberation patterns or disrupting ambient noise levels that sensitive surveillance systems may detect. When positioned near walls, corners, or metal surfaces, a body can reflect and redirect sound waves, potentially boosting them in unpredictable ways. Cultivate awareness of acoustic environments.

## DNA Release

While traditional DNA collection focuses on sources like body fluids, DNA can also be aerosolized and emitted through less apparent routes. Microscopic particles containing genetic residue, such as those found in saliva droplets or shed skin cells, can become airborne and remain suspended, especially indoors. In outdoor settings, DNA-containing particles disperse much more rapidly. Operators should be aware that any action increasing particle expulsion—including coughing, shouting, sneezing, and vigorous breathing—can release DNA into the air that emerging

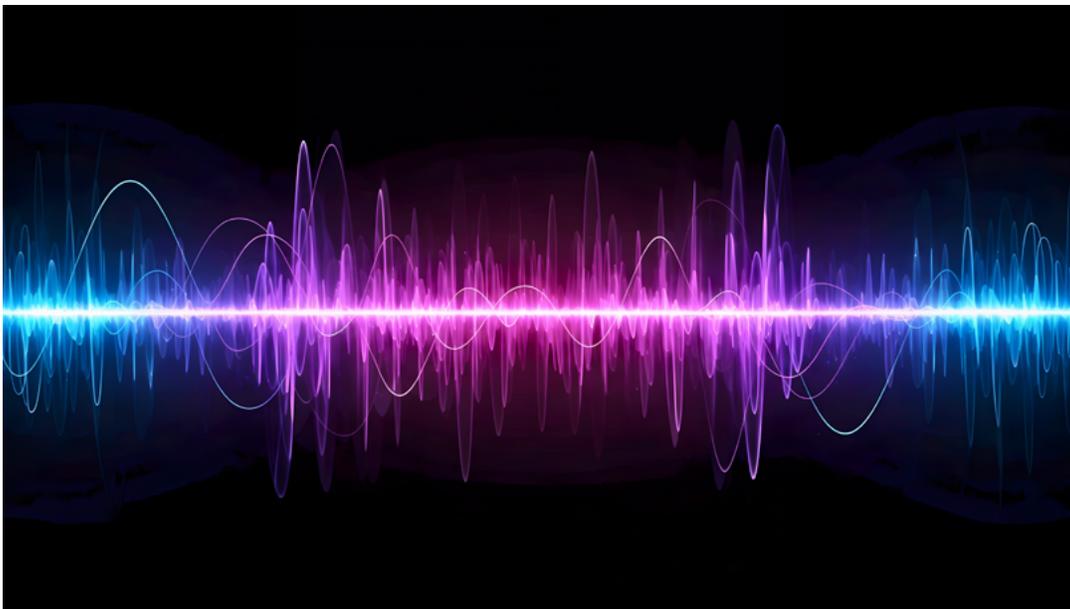
high-sensitivity bioaerosol samplers may detect.

## High-Exertion Biosignatures

Intense physical activity amplifies nearly all human signatures. Elevated respiration, sweating, and muscle activity can trigger sensors otherwise evaded. Anticipate that violence of action, speed, and exertion may come with a trade-off in stealth. Consider tactical pauses to reduce elevated biosignatures, which are the types of signals that most sensors are currently optimized to detect. However, state-of-the-art systems are beginning to reach down to resting levels.

## Note on Wearable Physiological Monitors

Many SOF personnel make regular use of physiological-monitoring wearables for fitness tracking, health monitoring, or personalized health insights. Worn on the body, these devices transmit heart rate, oxygen saturation, and other physiological data via Bluetooth, Wi-Fi, or other wireless protocols. In doing so, they generate an RF footprint. RF, or radio frequency, refers to the electromagnetic waves used to



*The body subtly but significantly impacts sound propagation. Silent movement alone can alter a space's acoustic profile, shifting reverberation or disrupting ambient noise, which sensitive surveillance systems can detect. Spatial awareness of the acoustic environment is crucial, as proximity to surfaces like walls or metal can unpredictably amplify sound reflections. (Image: Adobe Stock)*

wirelessly transmit data. These RF signals can serve as unintended beacons in sensitive environments. If radio frequency silence is required, either the device must be powered down, placed inside a Faraday sleeve, or its battery removed. Otherwise, it could emit signals that allow conclusions about location and movement patterns.

## Opportunity

SOF could aim to use bio-surveillance to distort the adversary's situational awareness. By deliberately shaping bio-emissions—through decoys, environmental interference, or tactical movement—operators can inject doubt into sensor-driven assessments. Bio-signals are generally interpreted by automated systems. Actively distorting these signals could be sufficient to reduce the confidence of system outputs or trigger false negatives, potentially prompting adversaries to delay action pending further verification. In environments with increasingly AI-driven surveillance, even such momentary delay can create a tactical advantage.

## Historical Lessons

There may be valuable lessons in historical approaches to managing biosignatures. It is useful to examine how both groups and individuals addressed this challenge since they offer complementary perspectives. Groups reveal patterns of systematic training and doctrine, while individuals highlight unique experience and improvisation under pressure. Groups reveal patterns of systematic training and doctrine, while individuals highlight unique experience and improvisation under pressure. For example, during World War II, members of European resistance movements trained to suppress natural reflexes and involuntary actions when under observation. In a different operational context, Simo Häyhä, the Finnish sniper, deliberately regulated his breathing to reduce visible vapor in the cold air and placed snow in his mouth to prevent steam from revealing his position. Historical examples such as these underscore a timeless truth: The human body is not a mere source of risk in stealth operations—it can be a deliberate instrument for confusing adversary perception.

## Potential Steps

Some technologies that exploit human biosignatures can already bypass the need for line-of-sight and



*A historical example of effective biosignature management: Simo Häyhä, the Finnish sniper, camouflaged himself in the snow during the Winter War. Dressing in many layers and keeping bread and sugar in his pockets to consume for energy to stay warm, he would set up position before dawn and remain there until sunset, even keeping snow in his mouth so his breath would not identify his location. Source: War History Online (Photo: Unknown/Wikimedia Commons/Public Domain)*

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*At the SOF enterprise level, more formally defining and embedding bio-OPSEC across individual training pipelines could further accelerate capability development.*

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physical contact, underlining the diminishing returns of conventional concealment strategies. Steps can be taken to mitigate this challenge. At the SOF team level, embedding bio-OPSEC into routine training can enhance field readiness by strengthening operator awareness of advanced surveillance systems. For instance, teams could incorporate scenario-based training focused on evading simulated thermal, acoustic, and radar detection. Teams could practice elements such as posture adjustment, breath and movement control, and thermal management. To support rapid recall under pressure, they could also develop acronym-based guides or concise checklists tailored to their specific environments and mission profiles. At the SOF-enterprise level, more formally defining and embedding bio-OPSEC across individual training pipelines could further accelerate capability development.

## Bio-Operational Security

Traditional operations security (OPSEC) doctrine tends to frame surveillance primarily as a challenge of technological exposure. However, as surveillance capabilities expand into biological domains, bio-OPSEC emerges as an additional layer of protection. It is based on the recognition that the human body itself can become a vector of compromise. Bio-OPSEC, therefore, is the proactive management of SOF's biological signatures during operations: It involves not only minimizing unwanted biosignatures but also actively manipulating them. In doing so, bio-OPSEC reframes the human body not as a potential liability—but as a dynamic operational asset capable of being leveraged for signature-based deception, environmental control, and, ultimately, the temporary disruption of adversary decision-making. 📌

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Anna M. Gielas holds a PhD in the history of science from the University of St. Andrews (United Kingdom). After earning fellowships at Harvard University and, most recently, the University of Cambridge, she is currently pursuing a second PhD focusing on SOF and emerging technologies.

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## NOTES

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