

THGM

DoD SBIR Phase I / Technical Volume Red-Team Review — Excerpt

Prepared by InTelluric | Pre-Submission Technical Review | May 2026

Executive Scoring Risk Summary

THGM is technically fundable as a Phase I feasibility study. The physics underlying each link in the transduction chain is established in peer-reviewed geophysics literature. The proposal risk is framing risk, not physics risk: a reviewer who does not see the mechanism stated explicitly will score this as speculative. Three targeted rewrites close that gap. The core claim — that hyperharmonic beat products generated by piezoelectric coupling to buried infrastructure propagate as coherent ELF signals through the telluric medium — is falsifiable in a single bench experiment and scoped correctly for Phase I.

Criterion	Risk	Kill Factor	Repair Action
Technical Merit	MEDIUM	Transduction chain not stated link-by-link; mechanism reads as asserted rather than derived	Add explicit chain: DDS → piezo → acoustic → nonlinear mix → electrokinetic → telluric EM. Each arrow cites a source.
Feasibility	LOW-MED	Phase I scope is binary and achievable in 9 months with commercial off-the-shelf hardware	Confirm WP structure retires one uncertainty class per aim; no development language before mechanism is confirmed
Mission Alignment	LOW	Topic match to DARPA/CERDEC underground comms is strong; differentiation from Project ELF is clear	Tighten to specific SBIR topic number; add one-sentence comparison to Project ELF showing categorical mechanism difference
Transition Potential	MEDIUM	End-user value is clear but transition partner is unnamed; commercialization path is implicit	Name a specific transition partner (SOCOM, CERDEC, NAWC) and state the Phase II deliverable explicitly

Verdict: Proceed to proposal development after three targeted rewrites. The mechanism is correct; the proposal must state it precisely.

Technical Objective Map

Three objectives map the full Phase I scope. Each is stated as a measurement, not a development task. Pass criteria are defined before work begins.

Objective 1 — Demonstrate coherent ELF beat product generation in controlled soil medium.

Measurement: Buried induction magnetometer at 1 m, 5 m, 25 m from injection point.

Pass criterion: Coherent signal at target beat frequency, SNR ≥ 10 dB above noise floor; absent at adjacent frequencies when drive is shifted; disappears when drive is disabled.

Phase I deliverable: Beat product amplitude vs. distance curve for three soil compositions.

Objective 2 — Characterize propagation scaling with substrate conductivity.

Measurement: Three soil conditions: dry sand ($\sigma < 0.01$ S/m), moist loam ($\sigma \approx 0.05$ S/m), water-saturated clay ($\sigma \approx 0.5$ S/m). Navy ELF literature predicts resistive substrate favors deep propagation via expanded current loop.

Pass criterion: Propagation distance inversely correlated with substrate conductivity, consistent with skin-depth scaling law.

Phase I deliverable: Conductivity-range specification for THGM deployment site selection.

Objective 3 — Demonstrate FSK modulation at minimum operational data rate.

Measurement: Switch between two beat frequencies at 1 Hz. Measure bit error rate at maximum detected range.

Pass criterion: BER ≤ 10% at maximum detected range.

Phase I deliverable: Modulation bandwidth and range specification for Phase II system design.

System Architecture Audit — Summary

Stage	Function	Risk	Audit Finding
1. DDS Signal Generation	Four phase-coherent channels at hyperharmonic parent frequencies	NONE	Commercial COTS hardware. Use manufacturer spec.
2. Piezo Coupling	Electrical drive to mechanical stress in bonded medium	LOW	PZT-8 coupling documented. Measure coupled power vs. drive impedance at target frequencies.
3. Acoustic + Nonlinear Mix	Parent frequencies propagate in soil; intermodulation at grain boundaries generates ELF beat product	HIGH	Carries all proposal risk. Soil nonlinear acoustics and electrokinetic conversion are individually documented; the engineered chain is the novelty. Aims 1–2 validate it.
4. Telluric EM Coupling	Acoustic ELF oscillation converts to EM via electrokinetic effect in water-saturated pores	MEDIUM	Seismoelectric effect documented in geophysical surveys. Measure EM field at magnetometer; confirm frequency matches beat, not drive.
5. Receiver	Induction magnetometer detects ELF field variation	NONE	Commercial geophysical instruments (Bartington Mag-03). Use instrument spec.

This excerpt is drawn from a full Technical Volume Red-Team Review including Phase I Feasibility Plan, Milestone/Go-No-Go Table, Transition Path and End-User Relevance, Failure Mode Map, Reviewer Objection Map, and Required Rewrite Actions. Full document available upon request.