SenTech
Systems and Energy Technologies

A) Draft Proposal Framework for EDF-2026-DA-ENERENV-AWC-STEP:Ammunition waste collection and disposal unmanned platform

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Indicative budget: *EUR 10 000 000 for this topic under the EDF-2026-DA call.* • ***Indicative number of proposals to be funded:*** *One proposal may be funded for this topic. However, depending on the quality of the proposals submitted and the budget available, more than one proposal may ultimately be funded for this topic.*

Project Acronym: AWC-ORACLE (Omni-sensor Reconnaissance & Autonomous Clearance for the Environment)
Topic: 2.5.4. Ammunition waste collection and disposal unmanned platform.
Consortium Philosophy: A **multi-sensor, multi-platform** approach using **current UAV technology** as the carrier for a **state-of-the-art, layered sensor suite**, fused by a central AI to guide a sophisticated UGV.

At the heart of our proposal: "Zero-Finding" certification: The ability to reliably release land — what we call "Zero-Finding" certification — is not just a technical metric. It is a high-value KPI that transforms our solution from a capable demining tool into a vital socio-economic enabler. Placing this at the core of our narrative will resonate strongly with the EU's dual focus on technological excellence and tangible civilian impact. 2-strengthen the consortium with powerful UGVs capable of carrying out decommissioning

1. EXECUTIVE SUMMARY

FOR DETECTION

The AWC-ORACLE project delivers an unmanned system capable of addressing the **full spectrum of ammunition waste (AW)**, from surface debris to **buried UXOs and chemical residues**. We deploy a **current, high-capacity VTOL UAV** as a carrier for a **modular, state-of-the-art sensor pod** integrating: **1) EO/IR/LiDAR** for macroscopic mapping and surface object detection; **2) Hyperspectral Imaging** for chemical residue identification (NOT necessary); **3) Magnetometer Arrays** for detecting ferrous masses; and **4) a lightweight GPR** for sub-surface imaging (better installed on UGV) DETECT METAL PLASTIC DOWN TO 30 CM - SKYKORP. LASER INDUCED SPECTROSCOPY?? This **multi-physics data fusion** is processed by a self-learning AI to create a probabilistic 4D hazard map (3D space + hazard type/confidence). This map guides a heavy-duty UGV equipped with a precision manipulator and a suite of tools. The UGV performs **ground-truthing** with its own sensors before executing safe recovery. The system demonstrably handles the entire threat list, including the most challenging items like buried mortar bombs and white phosphorous remnants. PREPARE FOR RECICLING

For UGV (Unmanned Ground Vehicles):

- Experience in **modular UGV platforms** for contaminated or harsh environments
- Integration of **sensors for environmental monitoring** and **material detection**
- Autonomous or semi-autonomous **navigation and manipulation capabilities**

For Recycling:

- **On-site or near-site recycling processes** for composite materials (RINA)
- **Waste-to-resource** technologies for defense-related waste streams (RINA)
- **Circular economy approaches** for end-of-life military equipment (RINA)

2. TABLE OF CONTENTS (Part B, Section 2)

(Standard EDF format)

3. QUALITY AND EFFICIENCY OF THE IMPLEMENTATION - WORK PACKAGES

WP1: Project Management & Coordination

WP2: Multi-Physics Sensor Strategy & System Architecture (Co-led by Sensor Integrator)

- **Objective:** Define the optimal sensor fusion strategy and platform integration for each detection layer.
- **Key Tasks:**
  - **Task 2.1: Threat-to-Sensor Mapping & Payload Definition:**
    - **EO/IR + LiDAR:** Primary for surface geometry, object shape, thermal anomalies (crashed drones, casings).
    - **Hyperspectral (VNIR-SWIR):** Critical for **material identification** – detecting chemical staining from white phosphorous, explosives, or other residues. Maps areas of concern for toxicity.
    - **Magnetometer (Gradiometer Array):** For detecting **ferrous masses** (artillery shells, mortar bombs, large fragments) even when deeply buried. Provides precise location for metallic targets.
    - **Lightweight GPR:** For **sub-surface imaging and volumetric assessment** of buried objects (depth, size, shape). Complements magnetometer data to discriminate UXOs from clutter.
  - Task 2.2: SWaP-Constrained Integration Plan for UAV Pod.
  - Task 2.3: UGV Tooling & Recovery Procedure Design.

WP3: Unified AI for Multi-Physics Data Fusion & Interpretation (**SENTECH**)

- **Objective:** Develop the core self-learning AI that fuses disparate sensor data into a single, actionable intelligence picture. The AI must be designed for **asynchronous, multi-source data fusion**. It becomes a **dynamic mission manager.**
- **Tasks:**
  - **Task 3.1: Multi-Modal Data Fusion Engine:** Develop algorithms to co-register and fuse 5D data (x, y, z, spectral bands, EM/magnetic signals).
  - **Task 3.2: Advanced ATR for Composite Signatures:** Train AI models not on single sensors, but on **fused signatures**. E.g., a target is classified as a "**buried, ferrous, cylindrical object**" by combining GPR hyperbola + magnetic anomaly + slight surface depression in LiDAR.
  - **Task 3.3: Hyperspectral Analysis Module:** Develop algorithms for automated detection of specific chemical/material signatures from hyperspectral libraries.
  - **Task 3.4: Probabilistic Hazard Mapping & Tasking Server:** Outputs a map with layers for object class, confidence, burial depth, and suspected hazard type (explosive, chemical, inert).

WP4: UAV-Based Multi-Layer Discovery Platform

- **Task 4.1: Modular Sensor Payload Development:** Develop **specialized, optimized sensor modules** for different UAV types.
  - **Payload A (High-Resolution Mapper):** EO/IR + LiDAR on a stable gimbal. For general topography and surface object detection.
  - **Payload B (Chemical & Material Analyst):** Compact Hyperspectral Imager (e.g., snapshot or pushbroom VNIR-SWIR). For chemical residue mapping.

    - **Payload C (Sub-Surface & Metallic Scout):** UAV-towed or bird-mounted **Magnetometer Array** and a **lightweight GPR** system. This is the most specialized payload, likely requiring a dedicated platform.
- **Task 4.2: Onboard Processing & Communication Modules:** Develop a standard data link and pre-processing unit for each payload to communicate with the central AI server.
- **Task 4.3: Specialized UAV Platform Selection & Fleet Coordination Protocols (CRITICAL REVISION)**

Task 4.3 Detailed Description:

- **Objective:** To select and adapt a fleet of complementary, current UAV platforms, each best suited to carry a specific sensor payload, and to develop the protocols for their coordinated operation.
- **Sub-Tasks:**
    1. **Platform Selection & Justification:**
        - **UAV-1 (Mapper):** A **medium endurance, fixed-wing VTOL** for area coverage (e.g., **Quantum Systems Trinity, WingtraOne**). Carries **Payload A**. Chosen for its long flight time, stability, and high-quality gimbal integration.
        - **UAV-2 (Chemical Scout):** A **high-payload multirotor or VTOL** with precise hovering and slow flight capability (e.g., **DJI Matrice 350, AeroVironment Quantix Recon**). Carries **Payload B**. Chosen for its ability to fly low-and-slow for detailed hyperspectral analysis of flagged areas.
        - **UAV-3 (Geophysics Scout):** A **heavy-lift multirotor or adapted geophysical survey platform** (e.g., **Harris H6HEX, Acecore Neo** or a custom heavy-lift octocopter). Carries **Payload C**. Chosen for its ability to lift the magnetometer/GPR payload and fly precise, low-altitude grid patterns.
    2. **Platform Adaptation & Safety Certification:** Minimal adaptation of mounting points and data/power interfaces for each payload. Focus on maintaining platform integrity and airworthiness.
    3. **Fleet Coordination Protocol Development:** Define the operational doctrine. For example:
        - **Phase 1 - Broad Scan:** UAV-1 performs a fast, wide-area LiDAR/EO scan.
        - **Phase 2 - Targeted Analysis:** The AI analyzes Phase 1 data, flags areas of interest (AOIs). UAV-2 is deployed to specific AOIs for hyperspectral analysis. Concurrently, UAV-3 performs a systematic magnetic survey over the entire site or focused on grid-like anomalies.
        - **Data Synergy:** The central AI server (WP3) ingests data from all platforms in near-real-time, using early results (e.g., a magnetic anomaly) to re-task other platforms (e.g., "UAV-1, image this coordinate with LiDAR at highest resolution").
- **Outputs:** A fleet of 3 operational, sensor-equipped UAVs; Fleet Coordination SOPs; Safety case for concurrent operations.

WP5: UGV for Ground-Truthing, Manipulation & Secure Transport (Led by UGV Partner)

- **Objective:** Build the ground recovery unit with integrated verification sensors.
- **Tasks:**
    - Task 5.1: UGV Platform with Segmented, Protected Container.
    - Task 5.2: Multi-Tool Robotic Manipulator System.
    - **Task 5.3: UGV Verification Sensor Suite (Sentech Contribution):** Equip the UGV with **close-range verification sensors**:
        - Manipulator-mounted micro-hyperspectral sensor for final chemical ID.
        - Hand-held GPR/magnetometer probe for final burial confirmation.
        - High-resolution 3D camera for grasping guidance.
    - Task 5.4: Recovery Autonomy & AI-Guided Manipulation.

WP6: Integrated System Demonstration & Validation

- **Objective:** Prove the complete operational chain in a realistic environment. The scenario shows:
    1. UAV-1 maps the area, detects surface debris and ground disturbances.

2. AI correlates a ground disturbance with a magnetic anomaly from UAV-3, flagging a "high-probability buried metallic object."
3. UAV-2 is tasked to overfly that spot, collecting hyperspectral data to rule out surface chemical hazards before the UGV approaches.
4. The UGV is then sent to the precisely located, multi-sensor-confirmed target.

- **Key Demonstration Tasks:**
  - **Task 6.1: **Buried UXO Scenario:** UAV detects a **magnetic anomaly** and a **shallow GPR signature**. AI fuses data, classifies it as a "probable buried mortar bomb," and tasks the UGV. UGV navigates to the GPS mark, uses its probe to confirm, and marks the location for EOD or carefully excavates.
  - **Task 6.2: Chemical Residue Scenario:** UAV **hyperspectral sensor** detects a spectral signature consistent with white phosphorous residue on soil. AI highlights the contaminated area on the map. UGV is tasked to navigate to the perimeter, use its micro-hyperspectral sensor to confirm, and then scoop the contaminated soil into a sealed container compartment.
  - **Task 6.3: Mixed Debris Field Scenario:** UAV maps a field with surface metallic debris (LiDAR/EO), explosive residues (hyperspectral), and a buried casing (magnetometer). The system prioritizes tasks and guides the UGV through efficient recovery of multiple item types.