Defense Threat Reduction Agency (DTRA)
2027 Small Business Innovation Research (SBIR) BAA
Release 2
Proposal Submission Instructions

INTRODUCTION

The Defense Threat Reduction Agency (DTRA) mission is to enable the Department of War (DoW), the U.S. Government, and International Partners to counter and deter Weapons of Mass Destruction (WMD), Chemical, Biological, Radiological, Nuclear, and Improvised Threat Networks. The DTRA SBIR/STTR program is consistent with the purpose of the Federal SBIR/STTR Program, i.e., to stimulate a partnership of ideas and technologies between innovative small business concerns and through Federal-funded research or research and development (R/R&D).

The approved 2027 topics solicited for the DTRA SBIR/STTR Program are included in these instructions followed by the full topic description. Offerors responding to this Broad Agency Announcement (BAA) solicitation must follow all general instructions provided in the related Department of War Annual Program BAA and submit proposals by the date and time listed in this release. Specific DTRA requirements that add to or deviate from the DoW Annual Program BAA instructions are provided below with references to the appropriate section of the DoW document.

Proposers are encouraged to thoroughly review the DoW Annual Program BAA and register for the DSIP Listserv to remain apprised of important programmatic and contractual changes.

- The full DoW solicitation is available on DSIP at https://www.dodsbirsttr.mil/submissions/solicitation-documents/active-solicitations. Be sure to select the tab for the appropriate solicitation cycle.
- Register for the DSIP Listserv at: https://www.dodsbirsttr.mil/submissions/login.

Specific questions pertaining to the administration of the DTRA SBIR/STTR Program and these proposal preparation instructions should be directed to:

Ms. LaTracia Price
DTRA SBIR/STTR Program Manager
LaTracia.T.Price.civ@mail.mil
Tel: 571-616-6583

Defense Threat Reduction Agency
8725 John J. Kingman Road
Stop 6201
Ft. Belvoir, VA 22060-6201

PHASE I PROPOSAL GUIDELINES

The DoW SBIR/STTR Innovation Portal (DSIP) is the official portal for DoW SBIR/STTR proposal submission. Proposers are required to submit proposals via DSIP; proposals submitted by any other means will be disregarded. Detailed instructions regarding registration and proposal submission via DSIP are provided in the DoW solicitation.

Proposal Coversheet (Volume 1)
The proposal coversheet is prepared on DSIP and in accordance with the DoW solicitation.

Technical Volume (Volume 2)
The technical volume is not to exceed 20 pages and must follow the formatting requirements provided in the DoW solicitation. Only the first 20 pages of the technical volume will be considered in proposal evaluations.

Offerors should follow the DoW SBIR Program BAA guidelines regarding Technical Volume content. A Phase I Proposal Template is available in Appendix A of the DoW SBIR Program BAA.

Cost Volume (Volume 3)
The Phase I Base amount, not including the amount allocated for Technical and Business Assistance (TABA), must not exceed $250.000.00. All costs must be clearly identified on the Proposal Cover Sheet (Volume 1) and in Volume 3. DTRA requires the use of the attached excel spreadsheet for the Cost Volume. The cost template becomes visible to the offeror when the Cost Volume is initiated.

The DTRA Cost Volume template 2027 will be accessible once the Cost Volume is initiated.

IMPORTANT: When completing the cost volume, you must provide enough information to allow the agency to understand how you plan to use the requested funds if a contract is awarded. Itemized costs of any subcontract or consultant should be provided to the same level as for the prime small business. If an unsanitized version of costs cannot be provided with the proposal, the Government may request it during negotiations if selected. Refer to the instruction provided in the DoW Annual SBIR program BAA for additional details on the content of the Cost Volume.

Note 1: Cost for travel funds must be justified and related to the needs of the project.
Note 2: Attachment – DTRA SBIR/SITTR Program Funding Limits

Please review the updated Percentage of Work (POW) calculation details included in the DoW Program BAA.

Note: DTRA normally will not accept any deviation to the POW requirements, however if discovered during review in Contracting, the offeror may be allowed to revise the cost proposal to be in line with **DTRA's requirement limits.**

Page Limit, Cost and Duration:

Project Phase	Technical Vol Page Limit	Cost	Duration
Phase I	20 pages	$250,000.00	7 Months

Company Commercialization Report (CCR) (Volume 4)
Completion of the CCR as Volume 4 of the proposal submission in DSIP is required. Please refer to the DoW SBIR Program BAA solicitation for full details on this requirement. Information contained in the CCR will not be considered by DTRA during proposal evaluations.

Supporting Documents (Volume 5)
Volume 5 is provided for proposing SBCs to submit additional documentation to support the Coversheet (Volume 1), Technical Volume (Volume 2), and the Cost (Volume 3). Please refer to the DoW solicitation for more information.

All proposing small business concerns must submit the following documents to Volume 5:

- Contractor Certification Regarding Provision of Prohibition on Contracting for Certain Telecommunications and Video Surveillance Services or Equipment.

Note: Offerors having any concerns pertaining to mandatory requirement as stated above should provide a mitigation plan addressing the concerns.

Fraud, Waste and Abuse Training (Volume 6)
Fraud, Waste and Abuse training material can be found in the Volume 6 section of the proposal submission module in DSIP and must be thoroughly reviewed once per year to proceed with proposal submission.

Disclosures of Foreign Affiliations or Relationships to Foreign Countries (Volume 7)
Small business concerns must complete the Disclosures of Foreign Affiliations or Relationships to Foreign Countries webform in Volume 7 of the DSIP proposal submission. Please be aware that the Disclosures of Foreign Affiliations or Relationships to Foreign Countries WILL NOT be accepted as a PDF Supporting Document in Volume 5 of the DSIP proposal submission. Do not upload any previous versions of this form to Volume 5. For additional details, please refer to the DoW Program BAA.

PHASE II PROPOSAL GUIDELINES

Phase II proposals may only be submitted by Phase I awardees.
Those small business concerns submitting a Phase II proposal should plan to submit a fully developed proposal into the DSIP proposal system within thirty (30) days after the end of the Phase I period of performance. The small business concern may or may not be notified of the proposal's due date.

The Phase II proposal's Technical Volume should not exceed 20 pages and should generally follow the outline and structure of Phase I to include benefits or lessons learned from the Phase I effort.

DTRA Phase II projects are not to exceed (NTE) a 24-month duration and a ceiling cost of $1,500,000, not including TABA.

DISCRETIONARY TECHNICAL AND BUSINESS ASSISTANCE (TABA)

In accordance with the Small Business Act (15 U.S.C. § 638(q)) and the Small Business Innovation and Economic Security Act of 2026 (P.L. 119-83), the Defense Threat Reduction Agency (DTRA) authorizes recipients of Phase I and Phase II awards to request TABA funding to use for eligible services.

These business-related services are designed to improve the commercialization success of small business concerns. This includes providing access to a network of scientists and engineers across a wide range of technologies or providing access to technical and business databases.

Allowed TABA Focus Areas

- Technical Decision Making
    - Making improved, evidence-based technical decisions concerning the project.
- Technical Problem Solving
    - Addressing and solving technical challenges that arise during project execution.
- Risk Mitigation
    - Minimizing overall technical risks associated with the project.

- Product Commercialization
    - Developing and commercializing new products or processes resulting from the project.
- Cybersecurity Compliance
    - Assistance with meeting federal and agency cybersecurity requirements.

If you are proposing use of Discretionary Technical and Business Assistance (TABA), you must provide a cost breakdown in the Cost Volume under "Other Direct Costs (ODCs)" and provide a one-page description of the vendor you will use and the Technical and Business Assistance you will receive. For the Phase I project, the amount for TABA may not exceed $6,500 per award. For the Phase II project, the TABA amount may be less than, equal to, but not more than $50,000 per project. The description should be included in Volume 5 of the proposal. TABA activity costs are line item portioned into the contract price.

Approval of Discretionary Technical and Business Assistance is not guaranteed and is subject to review of the contracting officer.

For Discretionary Technical and Business Assistance, small business concerns may propose one or more vendors. Additionally, business-related services aimed at improving the commercialization success of a small business concern may be obtained from an entity, such as a public or private organization or an agency or other entity established or funded by a State that facilitates or accelerates the commercialization of technologies or assists in the creation and growth of private enterprises that are commercializing technology.

TECHNICAL EVALUATION AND SELECTION

All proposals will be evaluated in accordance with the evaluation criteria listed in the DoW SBIR Program BAA.

Proposing firms will be notified of selection or non-selection status for a Phase I award within 90 days of the closing date of the BAA. DTRA has a single Evaluation Authority (EA) for all proposals received under this solicitation. The EA either selects or rejects Phase I and Phase II proposals based upon the results of the review and evaluation process plus other considerations including limitation of funds, and investment balance across all the DTRA topics in the solicitation. To provide this balance, a lower rated proposal in one topic could be selected over a higher rated proposal in a different topic. DTRA reserves the right to select all, some, or none of the proposals in a particular topic.

Notifications

Following the EA decision, the DTRA SBIR/STTR office will release notification e-mails of selection or non-selection status for a Phase I award within 90 days of the closing date of the BAA. The E-mails will be sent to the addresses provided for the Principal Investigator topic and listed Corporate Official.

Offerors may request a debriefing of the evaluation of their not selected proposal and should submit this request via email to: dtra.belvoir.RD.mbx.sbir@mail.mil; the subject line must include **"SBIR or STTR Program the full BAA Proposal number T27BZ-NV00X-0XXX Debriefing Request."** Debriefings are provided to help improve the offeror's potential response to future solicitations. Debriefings do not represent an opportunity to revise or rebut the EA decision.

For selected offers, DTRA Topic Author will build an acquisition package for Finance and the Contract Officer (KO) approval to move to contract execution which is subject to Procurement Acquisition Timeline (PALT) of 120-days to execute the award. DTRA Phase I awards are issued as fixed-price

purchase orders with a maximum period of performance of seven months. DTRA may complete Phase I awards **without additional negotiations** by the contracting officer or without opportunity for revision for proposals that are reasonable and complete.

DTRA Support Contractors

Select DTRA-employed support contractors may have access to contractor information, technical data or computer software that may be marked as proprietary or otherwise marked with restrictive legends. Each DTRA support contractor performs under a contract that contains organizational conflict of interest provisions and/or includes contractual requirements for nondisclosure of proprietary contractor information or data/software marked with restrictive legends. These contractors require access while providing DTRA support such as advisory and assistance services, contract specialist support, and support of the Defense Threat Reduction Information Analysis Center (DTRIAC). The contractor, by submitting a proposal or entering into this contract, is deemed to have consented to the disclosure of its information to DTRA's support contractors.

Offerors are advised that employees of commercial firms under contract to the Government may be utilized to provide administrative, technical, or advisory support during the proposal evaluation process and subsequent contract administration.

These support contractors may require access to proposals, including proprietary and confidential information, solely for the purpose of providing this required support to the Government. Support contractors are strictly prohibited from evaluating proposals or making any source selection decisions.

To protect offeror information, the Government ensures that all such support contractors are bound by strict corporate and individual Non-Disclosure Agreements (NDAs). These NDAs legally prohibit the unauthorized disclosure of offeror proprietary, confidential, and source selection sensitive information. Furthermore, these support contractors are subject to rigorous Organizational Conflict of Interest (OCI) clauses that restrict them from using the information for any competitive advantage or for any purpose other than providing the contracted support to DTRA.

By submitting a proposal, the offeror acknowledges that their proposal information may be disclosed to these authorized support contractors for the limited support purposes stated above. Offerors remain responsible for ensuring that all proprietary information within their proposal is appropriately marked in accordance with the solicitation instructions.

Protests

Refer to the DoW SBIR Program BAA for procedures to protest the Announcement.

As further prescribed in FAR 33.107(b), FAR 52.233-3, Protests after Award should be submitted in accordance with FAR Subpart 33.1 – Protests.

Protests filed with the Government Accountability Office (GAO) must be served on the cognizant Contracting Officer identified in the specific topic instructions or associated award document. A courtesy copy of such protests should also be provided to the SBIR STTR Program Manager, LaTracia Price. (addressed to Don Shires as follows) by obtaining written and dated acknowledgment of receipt from (if mailed letter) Defense Threat Reduction Agency, ATTN: J4CR, Don Shires, 8725 John J Kingman Road, Fort Belvoir, VA 22060-6201. If Federal Express is used for the transmittal, the appropriate address is Defense Threat Reduction Agency, ATTN: J4CR, Don Shires8725 John J Kingman Road, Fort Belvoir, VA 22060-6201.

AWARD AND CONTRACT INFORMATION

On average, DTRA received 350 proposals per topic cycle and awards up to 17 - 20 or .06 percent of the received proposals under a topic cycle. For fiscal year 2027, DTRA plans to utilize its Department of War (DoW) SBIR STTR Program budget proportioned to award a number of firm-fixed-price (FFP) Phase I projects by way of Purchase Order (PO) value not to exceed $250,000.00 for a (7) month period of performance with the six months devoted to the research and the final month for the final report, notwithstanding the TABA maximum of $6,500.00 for the entire project. Additionally, DTRA may use the balance of the budgets' portion to award follow-on Phase II projects, using a definitive cost contract for each award not to exceed $1,500,000 for a duration not to exceed 24-months period of performance, notwithstanding the TABA maximum of $50,000.00 between the combined phase II projects.

ADDITIONAL INFORMATION

The International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 through 130, and the Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, will apply to all projects with military or dual-use applications that develop beyond fundamental research, which is basic and applied research ordinarily published and shared broadly within the scientific community. More information is available at https://www.pmddtc.state.gov/ddtc_public.

The technology within some DTRA topics is restricted under export control regulations including the International Traffic in Arms Regulations (ITAR) and the Export Administration Regulations (EAR). ITAR controls the export and imports of listed defense-related material, technical data and services that provide the United States with a critical military advantage. EAR controls military, dual-use and commercial items not listed on the United States Munitions List or any other export control lists. EAR regulates export-controlled items based on user, country, and purpose. **The offeror must ensure that their firm complies with all applicable export control regulations.**

NOTE: Export control compliance statements found in these proposal instructions are not meant to be all inclusive. They do not remove any liability from the submitter to comply with applicable ITAR or EAR export control restrictions or from informing the Government of any potential export restriction such as fundamental research and development efforts proceed.

DTRA
SBIR DOW 2027 BAA
Topic Index
Release 2

DTR27BZ02-NV001	UAS-based Precision Aim for Device Render Safe in CBRN Environments.
DTR27BZ02-NV002	Remote UAS-based X-Ray for Device Assessment in CBRNE Environments
DTR27BZ02-NV003	Dynamic Sensor-Tasking and Routing System for Subsurface Hazard Detection
DTR27BZ02-NV004	Validation and Verification of Computational Modeling of Human Blast Injury on Battlefield
DTR27BZ02-NV005	Domestic Scalable Growth Of Large-Format Pixelated CZT Crystals For Advanced Radiation Detection
DTR27BZ02-NV006	Domestic Fabrication Of High-Purity Precursor Materials For Advanced Radiation Detection Scintillator Crystals

DTR27BZ02-NV001 TITLE: UAS-based Precision Aim for Device Render Safe in CBRN Environments

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Super Intelligence (ASI)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 1

OBJECTIVE: Develop novel precision-aiming payload capability that can be employed by UAS and operated remotely. Hand-emplaced precision aiming is a common technique used by all militaries and civilian defense forces. Warfighters require the ability to remotely emplace and precisely aim, adjust, and employ disruptor shells against explosive ordnance threats often associated with Chemical or Biological warheads, supporting standoff and remote render-safe operations. The proposed approach should include one or more payloads that can be integrated with one or more Unmanned Aerial Systems (UAS) platforms and be capable of operating in a Chemical, Biological, Radiological, or Nuclear (CBRN) environment.

DESCRIPTION: DTRA is in need of technical innovations associated with warfighting units performing very long range WMD device render-safe missions from a safe distance, outside of potentially CBRN contaminated environments. Explosive Ordinance Disposal (EOD) definitions and terms are commonly used by many nations and exist on the public internet including steps involving EOD detection, identification, field evaluation, render safe, recovery and disposal. Successfully performing stand-off EOD missions with personal positioned away from the contaminated environment requires a payload capable of remotely and accurately aiming via employment of currently fielded EOD disruptors against the explosive ordnance threat with a high degree of precision.

Payload capabilities of the proposed solution should ideally be sized to be compatible with currently fielded Department of War UAS systems. The desired end state is a system weight that is designed for small-unit operations UAS.

DTRA conducts counter WMD science and technology research and testing efforts for Joint Services EOD missions. Ground robotic platforms currently provide the only fielded remote-employment method for EOD disruptors, but these lack terrain-independent access and approach-angle flexibility that an aerial platform would provide. Small unit operations UAS platforms with sufficient flight endurance and payload capacity to carry current EOD-relevant payloads into contested or austere environments. This topic seeks novel approaches to providing precision remote-aiming payloads delivered and emplaced by remote UAS with subsequent operational render safe execution orchestrated from remotely. The capability should be able to be remotely recovered and re-charged to enable system re-use at another location after the render safe mission is completed.

STATE OF TECHNOLOGY:

- Significant technical challenges exist in achieving operational standoff. Standoff is defined as the ability to gather information about, or employ tools against, an explosive ordnance threat at a meaningful physical distance, without the EOD technician or the EOD tool itself needing to be placed directly against or immediately adjacent to the threat.
- The Stand Off objective is a novel precision-aiming render safe capability that can be delivered to a meaningful distance from the threat and still deliver accurate, useful results without requiring direct contact or close-in emplacement against the device itself. In some cases, physically touching or bringing a metal object too close to the device may trigger it’s detonation.

- The Remote Objective is defined as the ability to employ Joint Service EOD tools using robotic platforms, hook-and-line techniques, or a combination of tools and techniques without the EOD technician being physically present at the threat site. For example, employing a disruptor via a ground robot so that the technician never approaches the device directly. In an existing CBRNE environment or if the unexploded ordinance is associated with a CBRN warhead, is critical to conduct the mission from a remote location.
- Current EOD disruptor technology is capable of engaging a threat at a distance once it is properly aimed and fired, but current aiming and emplacement methods require the disruptor to be physically positioned and adjusted by hand, meaning an EOD technician must be directly at the tool to set it up correctly. As a result, even though the disruptor's terminal effect has standoff, the technician does not retain standoff during the aiming and emplacement process itself. Existing remote delivery methods can get a disruptor near a threat, but it remains difficult to finely position and aim it once it arrives.
- Current ground robotic platforms are limited by terrain and access. A threat located on a rooftop, upper floor, or otherwise inaccessible position is simply unreachable by a ground platform, regardless of any aiming capability it might have. Novel aerial delivery capabilities are emerging that could resolve this access constraint by providing rapid ingress and egress over obstacles, terrain, rubble, and structures common to austere and urban environments, along with the ability to approach threat devices from angles and approach paths unavailable to ground robots.

PHASE I: Design a system architecture and conduct an Analysis of Alternatives (AoA) to identify and evaluate candidate remote precision-aiming disruptor payloads against Joint Service EOD operational requirements. Assess mechanical, electrical, and software adaptability and versatility of leading candidates from each technology category, and define the specific engineering interfaces (mechanical mounting, power, control/data links, payload release and re-attachment mechanisms) required to integrate the at least one proposed system. Include in the proposed architecture a proposed method to communicate and control from a remote location, outside and upwind of a potential CBRN contaminated area. If feasible, a visual simulation of the proposed architecture executing an example mission would be helpful.

PHASE II: Construct the engineering integration and prototype effort identified in Phase 1. Construct and bench-test the set of key physical and electronic interfaces using the proposed UAS platform and the selected precision-aiming disruptor payload, including pickup/drop-off release mechanisms, remote aiming control integration, and command-and-control software integration. Demonstrate subsystem functionality in a Government identified controlled test environment.

PHASE III: DUAL USE APPLICATIONS: Revise prototype design based on operational feedback and any testing results during Phase 2. Produce two complete sets of proposed system prototype capability including methods to enable remote command and control. Conduct two integrated field employment and demonstrations of the combined system, in representative austere and in an urban operational environment, the government will provide access to government test ranges and assist in test planning. Demonstrate end-to-end mission execution: aerial transit, precision payload emplacement, remote disruptor aiming and adjustment, and (as an objective capability) payload retrieval/repositioning.

REFERENCES:

1. Naval Surface Warfare Center (NSWC) / Indian Head Division. https://www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Indian-Head/

2. Naval Sea Systems Command (NAVSEA) / Indian Head Division. https://www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Indian-Head/What-We-Do/
3. U.S. Army Program Executive Office Aviation / Unmanned Aircraft Systems Project Office. https://www.peoavn.army.mil/ Additional system descriptions and fact sheets are commonly available via Army.mil UAS pages and the official program office releases.
4. Murphy, R. R., Tadokoro, S., & Kleiner, A. (2019). Disaster robotics. In B. Siciliano & O. Khatib (Eds.), Springer Handbook of Robotics (2nd ed., pp. 1577–1604). Springer. https://doi.org/10.1007/978-3-319-32552-1_60
5. Kruijff-Korbayová, I., M., Ögren, P., Svoboda, T., & Worst, R. (2021). Deployment of ground and aerial robots in earthquake-struck Amatrice, Italy: Lessons learned from a multi-robot system for search and rescue. Journal of Field Robotics, 38(1), 5–31.
6. Delmerico, J., Mintchev, S., Giusti, A., Gromov, B., Melo, K., Tørdal, P., Bachmann, B., et al. (2019). The current state and future outlook of rescue robotics. Journal of Field Robotics, 36(7), 1171–1191. https://doi.org/10.1002/rob.21887
7. Lee, J., Hwangbo, J., Wellhausen, L., Koltun, V., & Hutter, M. (2020). Learning quadrupedal locomotion over challenging terrain. Science Robotics, 5(47), eabc5986.
8. Lee, D., Ryan, T., & Kim, H. J. (2019). Autonomous landing of a VTOL UAV on a moving platform using image-based visual servoing. IEEE Robotics and Automation Letters, 4(4), 3401–3408. https://doi.org/10.1109/LRA.2019.2926671
9. Staub, N., Bicego, D., Sablé, Q., & Franchi, A. (2018). Towards a flying assistant paradigm: The OTHex. Proceedings of the IEEE International Conference on Robotics & Automation (ICRA), 6997–7002. https://doi.org/10.1109/ICRA.2018.8460680;

KEYWORDS: Unmanned Aerial System (UAS); Explosive Ordnance Disposal (EOD); Render Safe; Precision Aiming; Remote Operations; Operational Standoff; Disruptor Payload Integration; CBRN / CBRNE Operations; Trusted Autonomy; Remote Command and Control (C2)

DTR27BZ02-NV002 TITLE: Remote UAS-based X-Ray for Device Assessment in CBRNE Environments.

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Applied Super Intelligence (ASI)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 1

OBJECTIVE: Develop a novel stand-off X-ray capability by integrating appropriate x-ray transmitter and x-ray receiver capabilities into multiple cooperating UAS systems to enable remote threat device imaging capabilities from a safe distance away from potential Chemical, Biological, Radiological, or Nuclear (CBRN) environments.

DESCRIPTION: DTRA is in need of technical innovations associated with Warfighters performing long range WMD device assessment and characterization from a safe distance outside of potentially CBRN contaminated environments. Explosive Ordinance Disposal (EOD) definitions and terms are commonly used by many nations and exist on the public internet including steps involving EOD detection, assessment, identification, field evaluation, render safe, recovery and disposal. Current device assessment is manual, requiring personnel to approach closely and manually move x-ray transmitters and x-ray receivers around an unknown device to perform the required assessment mission. Current stand-off capabilities are typically ground robots manually driven a short distance which may be safe for some unexploded ordinance (UXO), but are not safe for suspected WMD warheads. Recent UAS innovations associated with coaxial form factor systems that can perch or land as part of their mission flight profile appear to offer a novel approach to conducting bi-static x-ray image collection.

STATE OF TECHNOLOGY.

- Current Portable digital radiography systems that depend on hand- or robot-emplacement of a source and flat-panel detector near the device are limited in a CBRN environment. There is no current technology solution that can generate diagnostically useful transmission images (sufficient penetration of ordnance casings plus resolution of fine fuse features such as wires, switches, or delay elements) without any ground contact or personnel entry into the contaminated zone.
- Mobile x-ray transmitters and various options for exposing images, and stitching multiple images together to create a 3-D assessment of an unknown device exist, but they are generally hand-carried and emplaced. Complex mathematics and algorithms for capturing and rendering X-ray results from multiple simultaneously moving transmitters and receivers each with potential uncertainties in position and angle are limited.
- Tactical UAS systems are generally small, carry lighter payloads, do not have open architectures for payloads, and payload options are generally difficult and limited to the bottom side to integrate without adversely affecting flight profiles.
- Robotic x-rays exist but are typically fixed, large and devices are brought to them and put on a turntable. This topic is for x-rays done in the field, at 5km distances, without moving the threat device.
- No UAS-based x-ray capability currently exists.

PHASE I: Design a novel stand-off X-ray capability concept that would integrate portable x-ray transmitter and receiver capabilities into multiple cooperating UAS systems. Create an in silico model of

system performance with mathematical assessment of anticipated image quality as a function of time, motion, and navigation uncertainties. A functional transmission X-ray source (high-voltage generation, cooling, radiation shielding) plus a suitable detector must be integrated while preserving flight stability for sharp imaging, supporting open real-time data architectures.

PHASE II: Build one working prototype of proposed system to demonstrate capability to collect data for post-processing at a later date. Prototype design should look to fill persistent and newly heightened technical gaps to include: lightweight, high-flux (preferably pulsed) X-ray sources and detectors suitable for prolonged airborne carriage; robust real-time algorithms for motion-compensated multi-view reconstruction from independently flying platforms; methods to extract fuse-function information from low-signal, limited-angle, or single-pass data; sealed or disposable system architectures that eliminate the need for recovery of contaminated hardware; and practical techniques that achieve usable diagnostic quality at greater effective standoffs while still resolving internal mechanisms without any ground presence.

PHASE III: DUAL USE APPLICATIONS: Extend Phase 2 capabilities to scale performance of missions at multiple sites, allowing for multiple swarming transmitters and/or receivers spread over time and space. Demonstrate ability to generate integrated X-Ray image results rapidly, on location in near-real-time during or soon after completion of swarming activities.

REFERENCES:

1. Naval Surface Warfare Center (NSWC) / Indian Head Division. https://www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Indian-Head/
2. Naval Sea Systems Command (NAVSEA) / Indian Head Division. https://www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Indian-Head/What-We-Do/
3. RAND study “Army Explosive Ordnance Disposal in Large Scale Combat Operations”, Jennifer Lamping Lewis, et. al. 2024. Download at ttp://www.rand.org/t/RRA2078-2
4. Chandra, R., Kaczmarek, J., & Neumann, M. (2025). X-ray image generation for robotic radiography: A case study on motion blur in drone-based wind turbine inspections. Journal of Nondestructive Evaluation, 44(1), Article 12. researchgate.net
5. University of California - Santa Barbara. "X-ray eyes in the sky: Drones and WiFi for 3-D through-wall imaging." ScienceDaily. ScienceDaily, 19 June 2017. <www.sciencedaily.com/releases/2017/06/170619144830.htm>.
6. Example UAS with modular architecture - Coaxial Spartan NX-30 Ascent UAS, https://www.robinsonheli.com/unmanned/uas/spartan
7. Lee, H., et al. (2024). “A Drone-Driven X-Ray Image-Based Diagnosis of Wind Turbine Blades for Reliable Operation of Wind Turbine.” IEEE Access, 12, 56141–56158. DOI: 10.1109/ACCESS.2024.3388494.
8. Lee, J., et al. (2023). “X-ray image-based flight path planning model of UAVs for non-destructive inspection of wind blades.” ITC-CSCC 2023. DOI: 10.1109/ITC-CSCC58803.2023.10212472.
9. Lee, H., et al. (2025). “Autonomous Drone Flight Using Object Detection in X-Ray Images for Wind Turbine Blade Internal Inspection.” ECAI 2025, pp. 5319–5326. DOI: 10.3233/FAIA251469
10. Meere, B., et al. (2025). “X-ray Image Generation for Robotic Radiography: A Case Study on Motion Blur in Drone-Based Wind Turbine Inspections.” Journal of Nondestructive Evaluation, 44, 139. DOI: 10.1007/s10921-025-01279-6

11. University of North Carolina at Chapel Hill (2020). Mobile and Free-Form X-Ray Imaging Systems and Methods, U.S. Patent 10,539,708.
12. Novel Coaxial UAS, Ascent AeroSystems. Spartan Unmanned Aircraft System (UAS) – System Description and Specifications. Website: https://ascentaerosystems.com/ (product/system pages for the Spartan UAS)

KEYWORDS: Unmanned Aerial System (UAS): Explosive Ordnance Disposal (EOD): Remote Render Safe: Precision Aiming: Operational Standoff: Disruptor Payload: CBRN Environments: Remote Command and Control: Trusted Autonomy: Small-Unit UAS

DTR27BZ02-NV003 Title: Dynamic Sensor-Tasking and Routing System for Subsurface Hazard Detection

COMPONENT TECHNOLOGY PRIORITY AREA(S): Trusted AI and Autonomy

PROJECTED CMMC LEVEL REQUIREMENT: Level 1

OBJECTIVE: Develop an explainable, adaptive machine learning architecture using Super Intelligence (SI) that dynamically schedules, sequences, and gates geophysical sensor modalities based on real-time environmental physics, learned sensor operational envelopes, and predictive target response models. The system will enable autonomous platforms to perform in-stride characterization and clearance of subsurface hazards, including potential WMD devices or components, in high-tempo, contested tactical environments.

DESCRIPTION: Current field-deployable capabilities for WMD device and component defeat, route reconnaissance, and sensitive site exploitation have made significant strides in rapid surface-level mapping and visual threat triage using unmanned aerial and ground platforms. However, these operational systems encounter a critical bottleneck when confronting subsurface hazards. Visual, optical, and topographic sensors are fundamentally blind to threats that are partially buried, completely subsurface, or obscured beneath soil, blast debris, or disturbed earth. When subsurface geophysical instruments are integrated onto these unmanned platforms to address this blind spot, current field architecture suffers from a severe "collect everything" bottleneck. Lacking localized intelligence, platforms typically execute static, pre-programmed survey scripts which force sensors to operate continuously and indiscriminately across an entire area. This floods constrained tactical communication networks with massive volumes of raw sensor data, overwhelms field computing devices, drastically slows operational tempo, and results in sensor operational blindness when local soil physics degrade or invalidate specific sensor modalities. When conducting standoff reconnaissance of suspected hazard areas—which may contain buried chemical or biological munitions, radiological dispersal device (RDD) components, bulk precursor storage vessels, or associated explosive triggers and conventional ordnance—these bottlenecks force operators into dangerous, prolonged exposure on target. Furthermore, relying on rigid, static classical logic to manage these complex sensor suites in real time introduces a critical limitation, as traditional rule-based programs cannot adapt to highly dynamic, uncharacterized environments where the boundary conditions are not known beforehand.

A proactive system is required to answer:

"Given this specific environment and mission profile, which sensor should be deployed first, what detection threshold triggers the next modality, and which sensors may be inhibited due to the environment or other physical boundary conditions?"

This topic seeks an adaptive, machine-learning-driven sensor-tasking and routing decision engine capable of scheduling sensor deployment and routing platform payloads in real time using probabilistic, data-driven optimization methods. The primary need is an intelligent edge capability that continuously monitors changing site conditions and dynamically queues, activates, or inhibits physical sensor payloads on an autonomous platform. Rather than streaming raw data or running all sensors simultaneously, the system must govern sensor execution through learned decision policies (utilizing techniques such as reinforcement learning, contextual bandits, or partially observable Markov decision processes) that optimize performance based on sensor-inferred environmental physics (such as electrical conductivity and dielectric permittivity), immediate mission constraints (such as required advance speed, standoff distance requirements, and target priority), and real-time sensor performance signatures. When an initial screening modality detects an anomaly, the engine must evaluate the environmental context to dynamically determine if a secondary, higher-fidelity sensor is required to verify and classify the threat, or if the platform should continue its

route. By automating this sensor-queuing and routing logic at the edge through explainable and efficient AI, the system will overcome the subsurface bottlenecks of current field suites, eliminate tactical network saturation, minimize time on target, and ensure reliable detection and defeat of subsurface WMD devices and associated hazards across diverse, uncharacterized operational environments.

State of Technology: Currently deployed military and commercial technologies have reached a high level of maturity in distinct, stove-piped domains, but they do not integrate these capabilities into a single, closed-loop, in-stride subsurface decision engine. The current technical landscape is characterized by the following:

- *Standoff Aerial and Surface Visual Mapping Systems*: Existing fielded systems utilize unmanned aerial vehicles (UAVs) and ground platforms to perform rapid photogrammetric, optical (EO/IR), and LiDAR mapping of surface terrains. These systems feature mature edge-computing architectures that run real-time automated target recognition (ATR) to classify surface munitions, craters, and obstacles on tactical hand-held tablets in under 30 minutes. However, these systems lack subsurface sensing capability, limiting their ability to detect and characterize hazards that are partially buried, covered by debris, or below the ground surface.

- *Geophysical Post-Processing Classification Suites*: For subsurface detection, advanced electromagnetic induction (EMI) and ground-penetrating radar (GPR) systems are highly mature and accredited for DoW munitions response. These systems utilize sophisticated physics-based inversion models to extract target polarizability tensors and classify anomalies against standard munitions libraries. However, these software suites are strictly designed for post-processing desktop environments. They are not integrated into real-time, in-stride robotic platforms, and they cannot make autonomous decisions in the field regarding active sensor scheduling.

- *Uncoordinated "Collect-Everything" Sensor Payloads*: Current multi-sensor ground platforms operate in a fixed, concurrent acquisition mode where all integrated sensors (such as magnetometers, GPR, and EMI) run continuously regardless of whether the local terrain and environment is physically compatible with the sensor. For example, when a platform transitions into wet, highly conductive clay, a ground-penetrating radar (GPR) antenna suffers from severe signal attenuation, rendering the collected data ineffective for its intended detection purpose. Current systems lack the real-time feedback loops to recognize these environmental changes and limitations then automatically adjust, disable, or redirect sensor payloads. This lack of dynamic management creates a major operational inefficiency, resulting in the collection of highly degraded data that requires excessive post-processing, while unnecessarily consuming onboard battery power, communication bandwidth, and valuable mission time.

- *Static Autonomous Path Planning*: Existing autonomous ground and aerial navigation algorithms plan paths based on surface traversability, geometric obstacle avoidance, and pre-mapped terrain features. They do not ingest real-time subsurface hazard maps or dynamically adjust their routing, payload dwell times, or sensor modalities based on changing subsurface soil electromagnetic properties or detected anomalies.

- *Adaptive AI/ML for Sequential Decision-Making and Path Planning*: In adjacent fields such as autonomous warehouse robotics, dynamic network routing, and space domain awareness, machine learning is highly mature for solving complex, real-time sensor scheduling and path-planning

challenges. State-of-the-art approaches utilize Deep Reinforcement Learning (DRL) and Contextual Multi-Armed Bandits to train autonomous agents that make optimal sequential decisions under extreme uncertainty. These AI models observe dynamic environmental contexts (e.g., localized obstacle density or changing wireless signal-to-noise ratios), weigh the trade-offs between exploring unknown areas and exploiting known paths, and automatically adjust sensor power cycles or update the platform's route on-the-fly. However, these advanced decision-making frameworks have not yet been integrated with or trained on subsurface geophysical physics, leaving a critical gap where current autonomous AI agents remain incapable of managing multi-modal subsurface sensor suites.

PHASE I:

Feasibility & Concept Architecture

Demonstrate the technical and operational feasibility of an adaptive, machine-learning-Super Intelligence (SI) driven decision engine for dynamic sensor-tasking and routing. Efforts will focus on identifying the theoretical machine learning models, policy optimization frameworks, and reward structures (e.g., reinforcement learning, contextual bandits, or other decision-making algorithms) governing a representative sensor suite, which may include multiple sensor phenomenology's to identify representative subsurface and surface hazards, including potential WMD devices or components.

The investigator will develop an Super Intelligence (SI)-based software emulator or conceptual model to evaluate the feasibility of the learned sensor-gating policies and decision rules under varying environmental and mission constraints. Phase I will conclude with a demonstration showing that the adaptive, machine-learning-driven system can successfully execute sensor-gating, anomaly escalation, or vehicle routing to prove a reduction in survey time and data overhead compared to static multi-sensor acquisition.

PHASE II:

Prototype Design & System Integration

Transition the theoretical machine learning models, policy optimization frameworks, and adaptive sensor-gating logic developed in Phase I into a functional software prototype of the decision engine. The investigator will design and program an edge-deployable software package optimized to execute real-time model inference on embedded processors without requiring cloud reachback or high-performance computing resources during operations.

The prototype design and engineering effort will focus on converting Phase I's learned decision models and policy algorithms into robust, real-time software capable of ingesting in-stride environmental feeds and continuously calculating the optimal sensor-tasking sequence at the tactical edge. The investigator will conduct demonstrations using real physical sensor data to verify that the machine-learning-driven decision engine successfully executes the correct sensor-sequencing commands (activating, disabling, or swapping sensor modalities based on physical environmental transitions) and adapts simulated platform routing based on learned, unclassified target-detection thresholds.

PHASE III: DUAL USE APPLICATIONS:

Expanded Testing, Scaling, & Technology Transition

Phase III will scale the testing and validation of the machine-learning-driven software prototype developed in Phase II through larger-scale field demonstrations and expanded evaluations across highly diverse,

uncharacterized environments. This phase will focus on scaling the system's capabilities by validating the generalization of the trained decision policies against significantly larger, multi-site real-world environmental datasets and conducting testing across larger geographical search areas to ensure the model adapts to novel terrain without requiring real-time retraining. Testing and evaluations should focus on demonstrating the software's execution on representative unmanned ground vehicle (UGV) and unmanned aerial system (UAS) platforms configured with the sensor payloads identified in the previous phases.

The expanded demonstrations will evaluate the SI decision engine's ability to repeatably execute sensor-gating commands and adapt platform routing when encountering a wider array of subsurface hazards and simulated WMD-relevant components under diverse, live-field terrain and soil conditions. This expanded validation will provide the necessary performance data to support future technology transition pathways into DTRA C-WMD technology suites, Joint Service EOD robotic systems, and automated route-reconnaissance and breaching suites to support future engineering requirements. For commercial dual-use, the scaled software will transition to geophysics and environmental remediation contractors conducting UXO clean-up at Formerly Used Defense Sites (FUDS), as well as subsurface utility engineering (SUE) platforms to enable more efficient, rapid subsurface mapping in complex civil environments.

REFERENCES:

1. F. Samadzadegan, F. Qaderi, T. L. Haghighi, A. Toosi, and S. M. Mousavi, “Unmanned Aerial Remote Sensing for Unexploded Ordnance Detection: Concepts, Methods, Current Status and Trends,” *Sens Imaging*, vol. 26, no. 1, p. 137, Oct. 2025, doi: 10.1007/s11220-025-00668-5.
2. D. R. Glaser, F. Shubitidze, and B. E. Barrowes, “Standoff High-Frequency Electromagnetic Induction Response of Unsaturated Sands: A Tank-Scale Feasibility Study,” *Journal of Environmental and Engineering Geophysics*, vol. 27, no. 1, pp. 45–51, Mar. 2022, doi: 10.32389/JEEG21-030.
3. M. D. Richardson and M. T. Tuley, “SERDP/ESTCP Munitions Response Program: A Summary of Progress and a Way Forward for Underwater Remediation of Unexploded Ordnance (UXO),” in *OCEANS 2022, Hampton Roads*, Hampton Roads, VA, USA: IEEE, Oct. 2022, pp. 1–6. doi: 10.1109/OCEANS47191.2022.9977115.
4. D. K. Butler, J. E. Simms, J. S. Furey, and H. H. Bennett, “Review of Magnetic Modeling for UXO and Applications to Small Items and Close Distances,” *Journal of Environmental and Engineering Geophysics*, vol. 17, no. 2, pp. 53–73, Jun. 2012, doi: 10.2113/JEEG17.2.53.
5. L. Zhou, J. Wu, Q. Wei, W. Shi, and Y. Jin, “Multi-Sensor Scheduling Method Based on Joint Risk Assessment with Variable Weight,” *Entropy*, vol. 24, no. 9, p. 1315, Sep. 2022, doi: 10.3390/e24091315.
6. S. P. Bragdon, V. H. Truong, M. I. Bishop, and J. L. Clausen, “Leveraging environmental conditions to inform a two-step ATR for buried objects,” in *Automatic Target Recognition XXXIII*, T. L. Overman, R. I. Hammoud, and A. Mahalanobis, Eds., Orlando, United States: SPIE, Jun. 2023, p. 23. doi: 10.1117/12.2663970.
7. F. Accomando *et al.*, “Advances in Magnetic UAV Sensing: A Comparative Study of the MagNimbus and MagArrow Magnetometers,” *Sensors*, vol. 25, no. 19, p. 6076, Oct. 2025, doi: 10.3390/s25196076.
8. N. AbuJabal, M. Baziyad, R. Fareh, B. Brahmi, T. Rabie, and M. Bettayeb, “A Comprehensive Study of Recent Path-Planning Techniques in Dynamic Environments for Autonomous Robots,” *Sensors*, vol. 24, no. 24, p. 8089, Dec. 2024, doi: 0.3390/s24248089.

KEYWORDS: Unmanned Aerial System (UAS): Explosive Ordnance Disposal (EOD): Remote Render Safe: Precision Aiming: Operational Standoff: Disruptor Payload: CBRN Environments: Remote Command and Control: Trusted Autonomy: Small-Unit UAS

DTR27BZ02-NV004 Title: Validation and Verification of Computational Modeling of Human Blast Injury on Battlefield

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Computing and Software

PROJECTED CMMC LEVEL REQUIREMENT: Level 1

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with section 3.5 of the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Computational modeling and simulation of human blast injury on the battlefield has been a gap for the Department of War (DoW). DTRA Technical Reachback is tasked with supporting operational decision-making by providing advanced analytics, modeling, and simulation. The Command Surgeon General Office has submitted numerous requests to estimate human blast injuries on the battlefield to inform medical planning purposes—specifically to forecast requirements for medical supplies, medical staff, and personal protective equipment (PPE). Furthermore, Combatant Commanders require assessment of casualty tolerance thresholds for specific operation environments.

To address these analytics requirements, Technical Reachback initiated and continued a human blast injury modeling effort in the past three years. As development is ongoing, it is crucial to integrate the verification and validation effort early during the data collection and model development stage to ensure sound technical approaches, data application, and expected outputs.

DESCRIPTION: Blast events accounted for over 70% of casualties among service members engaged in ground combat events. The energy generated by an explosion can cause devastating physical trauma, affect multiple body systems and result in severe injuries or even fatalities (1.2). Although there has been extensive research into injury mechanisms of blast trauma, including primary overpressure effects, secondary fragmentation wounds, tertiary blunt trauma, and quaternary thermal or chemical injuries, there are no modeling & simulation (M&S) tools currently available which can provide a comprehensive view of the types and severity of injuries in the context of the uncertainties and complexities of realistic battlefield scenarios.

Existing injury modeling tools, such as Operational Requirements-based Casualty Assessment model (ORCA) developed by US Army DEVCOM, the INJURY code developed by the Medical Research and Development Command, and the AUDITORY model developed by the Joint Intermediate Force Capabilities Office (JIFCO), each model individual injuries occurring to a single person in the absence of PPE. They are not designed to address multiple, multi-modal injuries that may occur in ground combat, and they model wounds from the “skin in,” rather than accounting for the effects of clothing or PPE. These tools can only be used for research purposes and are not designed to support battlefield operation.

In contrast, the Human Injury Prediction (HIP) tool, developed by Defense Science and Technology Laboratory (DSTL) of United Kingdom, predicts injuries to multiple people from a terrorist attack. Unfortunately, this tool is limited to modeling the effects of only a single blast event caused by a terrorist

weapon detonated in an urban environment. And, again, HIP models isolated injuries and cannot address multiple, multi-modal injuries.

Finally, a major challenge of leveraging these tools in DTRA Technical Reachback mission is that injuries are predicted based upon biomechanical effects, and do not address human physiology. This shortcoming becomes particularly critical with multiple injuries, where the human body response to injuries is intact and synergetic among organs/tissues.

Apart from the specific challenges of modeling injuries and the associated changes in physiology, a comprehensive battlefield blast injury M&S tool is a multidisciplinary endeavor, requiring expertise in diverse domains, to include medicine, military operations, weaponeering, synthetic population modeling, epidemiology, structures, machine learning, computational modeling, and PPE.

ASME V&V 40 serves as the gold standard for computational model credibility in biomedical applications, and DoD Instruction 5000.61 (Modeling and Simulation Verification, Validation, and Accreditation) requires human injury models to be validated before moving to support military operation (3,4,5). The modeling effort should align with the Blast Injury Research Coordinating Office (BIRCO) and the Blast Injury Prevention Standards Recommendation (BIPSR) process. The access to sensitive battle databases must be tightly controlled and limited to need-to-know personnel (6). Based on the regulation and scientific merit, the current request for proposal (RFP) will focus on validation of the on-going approach by using independent groups.

PHASE I: Phase I will focus on establishing standards to validate the current technical approach, data source, computational codes, medical definition, injury codes, environmental conditions (topography), generic weapon information and synthetic population. The offeror should thoroughly study all available injury modeling tools and provide detailed pros and cons summary for the existing methodologies (1.7,8). The contractor shall conduct a comprehensive review of pathophysiology of blast injuries and the established injury codes. Key validation methods shall be established. Due to complexity of the effort, machine learning is highly encouraged. A key requirement in this phase is delineation of where existing or synthetic data (based upon first principles modeling) may suffice, as compared to where laboratory or field testing will be required. By the end of Phase I, the offeror should deliver a preliminary approach and document all technical challenges for phase II work.

PHASE II: The validation methods proposed in Phase I should be applied in Phase II. Data sources from historical shock tube experiments, postmortem human surrogates (PMHS) testing, anthropomorphic test devices (ATDs) and computational models must be clearly identified and studied. Key challenges, such as material data gaps, incomplete injury criteria, military operational requirements and emerging weapons should be addressed in Phase II. The focus of this phase will be aggregating existing data and generating synthetic data. Test plans developed to fill in remaining gaps will be executed in Phase III.

Key deliverables include but are not limited to:

1. A structured database of pre-existing data used in validation, and associated data cards.
2. A list of common data elements (CDEs) associated with the database of pre-existing data. This list should be forward-looking in that if many CDEs were not collected in the historical data, they would be recommended for inclusion in future data collection efforts.
3. A structured database of synthetic data and associated data cards used in validation, along with detailed documentation of assumptions to include (1) loading conditions; (2) material properties; (3) tissue/human body models; and (4) first principal codes. This information should be sufficient for a third party to replicate analyses.

4. Detailed test plans with test protocols suitable for submission to IACUC/IRB authorities.

PHASE III: DUAL USE APPLICATIONS: In Phase III, the offeror will focus on the continued refinement and execution of the validation approach. This will primarily include execution of one or more test plans prepared in Phase II. In addition, the performer will have a strategy for ensuring that databases developed in Phase II are accessible to the broader DoW community, with mechanisms for integrating the latest research findings. The performer will work closely with the Blast Injury M&S team to recommend and evaluate changes to the models based upon validation findings. Finally, because new weapons or operational conditions may expand the ranges over which validation data is needed, ongoing collaboration with military medical professionals and other stakeholders is required.

REFERENCES:

1. Alberto Morena, Lorenzo Peroni, Martina Scapin: Numerical Investigation of the Blast- Induced Injuries Using an Open- Source Detailed Human Model. International Journal for Numerical Methods in Biomedical Engineering. https://doi.org/10.1002/cnm.3879 2024
2. X. G. Tan, A. J. Przekwas, R. K. Gupta: Computational modeling of blast wave interaction with a human body and assessment of traumatic brain injury. Shock Waves (2017) 27:889–904, DOI 10.1007/s00193-017-0740-x
3. ASME V&V 40 Standard Alignment: Built the core Technical Requirements (Task 3.1 & 3.2) around risk-risk mapping, Context of Use (COU), and quantitative credibility goals, which are critical for medical modeling applications.
4. DoDI 5000.61 & MIL-STD-3022 Compliance: Incorporated the Department's mandatory modeling and simulation verification, validation, and accreditation procedures into the Statement of Work (Task 3.5) and the delivery schedule (CDRL A007).
5. Multi-Injury Modality Scope: Outlined specific tasks for validation of three key high-risk military blast injuries: Traumatic Brain Injury (TBI), Primary Blast Lung, and Auditory damage.
6. Acquisition Controls: Integrated necessary DoW acquisition requirements including Human Research Protection Office (HRPO) approvals, data rights structures (Section H), security clearances (to access sensitive battle databases such as JTAPIC), and ITAR restrictions.
7. Rui Liang, Hong Wang, Junhong Gao, Jianmin Wang, Wenjuan Zhang, and Airong Qian. Assessment model of blast injury: A narrative review. iScience 28, 112830, July 18, 2025
8. J.C. Roberts, T.P. Harrigan, E.E. Ward, T.M. Taylor, M.S. Annett, A.C. Merkle. Human head–neck computational model for assessing blast injury. Journal of Biomechanics 45 (2012) 2899–2906

KEYWORDS: Human blast injury; Model verification and validation (V&V); Computational modeling; Battlefield blast injury; Modeling and simulation (M&S); Medical planning; Blast biomechanics; Injury prediction; Casualty estimation; Biomedical computational models; Traumatic Brain Injury (TBI), Primary Blast Lung Injury (PBLI), Auditory Damage, Overpressure, Finite Element Analysis (FEA), Computational Fluid Dynamics (CFD), Human Body Models (HBM);

DTR27BZ02-NV005 TITLE: Domestic Fabrication Of High-Purity Precursor Materials For Advanced Radiation Detection Scintillator Crystals

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Contested Logistics Technologies (LOG)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials

PROJECTED CMMC LEVEL REQUIREMENT: Level 1

OBJECTIVE: DTRA seeks to establish reliable, scalable, and secure domestic sources and fabrication processes for high-purity precursor materials or pre-reacted mixes required for the growth of advanced inorganic scintillator crystals, such as $LaBr_3$:Ce, GGAG:Ce (GGAG), Cs_2LiYCl_6:Ce (CLYC), $Cs_2LiLaBr_6$:Ce (CLLB), and other materials. These materials are essential for high-resolution gamma spectroscopy and dual gamma/neutron pulse-shape discrimination (PSD) detectors used in Radiation Isotope Identification Devices (RIIDs), handheld identifiers, and other Department of War (DoW) radiation detection systems.

DESCRIPTION: High-purity precursor materials are the foundational input for all high-performance inorganic scintillator crystals used in the DoW radiation detection and nuclear forensics missions. Current supply chains for key halides (e.g., $LaCl_3$, $LaBr_3$, YCl_3, LiCl, CsCl, $CeCl_3$ etc.) and rare earth oxides (e.g., Gd_2O_3, CeO_2, etc.) are heavily dependent on foreign sources. Several of the materials used for inorganic scintillator crystal growth are included in the U.S. Geological Survey (USGS) 2025 List of Critical Minerals. This need is further reinforced by Executive Order 14415, "Securing America's Defense Supply Chains and Ensuring Domestic Acquisition of Critical Materials" (July 20, 2026), which directs the DoW to prioritize domestic sources for critical materials, restrict routine waivers for adversarial foreign suppliers effective January 1, 2027, and require supply chain mapping and mitigation plans from contractors and subcontractors.
Scaling crystal growth of these scintillators and maintaining consistent performance requires precursor materials with stringent control of purity, stoichiometry, moisture, and trace radioactive contaminants. Poor quality precursor materials often introduce variability that degrades crystal quality, light yield, energy resolution, and PSD figure-of-merit.

Desired materials typically have the following attributes, confirmed by analytical means and demonstrated by crystal growth results:

- High Chemical Purity: At least ≥4N (99.99%) anhydrous metal halides or pre-reacted mixes; sub-ppm levels of contaminants that interfere with the selected scintillator's performance, such as transition metals (e.g., Fe, Cr, Ni, Cu) and alkali contaminants (e.g., K, Rb).
- Low Moisture / Oxygen Content: < 50 ppm (minimum) for hygroscopic materials.
- Precise Stoichiometry Control (for pre-reacted elpasolites): Precise control of multi-cation ratios to enable growth of phase-pure crystals with minimal secondary phases or compositional gradients
- Radioactive Impurity Control: Minimized ^{40}K, ^{87}Rb, ^{138}La, ^{176}Lu, and U/Th series contaminants to levels supporting low-background detector applications

This topic specifically targets the development of domestic synthesis, purification and quality-assurance processes capable of producing scintillator-grade precursor materials at laboratory, pilot, and eventually production scales. The goal is to reduce or eliminate reliance on foreign sources while enabling the next

generation of compact, high-performance, ruggedized detectors for WMD detection and nuclear security applications.

The solution must meet the following minimum specifications:

- Analytical Characterization: Comprehensive analytical characterization confirming chemical purity, low moisture/oxygen content (if applicable) and stochiometric control. Appropriate methods should be used for trace-metal purity or trace moisture measurement.
- Domestic Feedstock Utilization: Primary use of U.S. or allied-nation sourced precursor materials (e.g. carbonates, oxides, chlorides) and any specialized equipment with documented traceability.
- Validation Method: Rapid feasibility screening of material performance, which may include small-scale crystal growth and measurements such as powder radioluminescence or optical transmittance.
- Production Scale: Reliable and reproducible laboratory-scale batches (e.g., 50-100 g) in Phase I; pilot-scale (e.g., 1–5 kg) in Phase II with batch-to-batch consistency. Ultimately, the focus is on material quality and potential for process scale up.
- Open market commercialization: Process development must lead to high-purity precursor materials made commercially available to the broader U.S. industrial base, rather than exclusive licenses, proprietary arrangements, or other restrictions.

Objective specifications (desired but not required for basic consideration):

- Advanced Validation Method: Produced batches must be validated through single crystal growth and complete radiation detection performance benchmarking against commercially available crystals, to include absolute light yield (photons/MeV), energy resolution at 662 keV, and PSD where applicable.
- Production Scale: Demonstration of multi-kilogram batch yields achieving or with a roadmap to achieve cost competitiveness with foreign-sourced material.
- Radiopurity: Identification of means to mitigate or minimize naturally occurring radioactive isotopes that impact detector background.
- Extensibility: Tailoring materials to be directly compatible with transparent ceramic scintillator fabrication processes (e.g. desirable particle size distribution and particle morphology).

This effort shall develop reliable domestic manufacturing processes for high-purity scintillator precursor materials while meeting the performance parameters above. Proposed work must include validation. The developed processes and materials will also be tested and validated in Phase II by delivery to DTRA or a designated partner for independent evaluation.

PHASE I:Phase I focuses on conceptualizing the approach and proof-of-principle for the fabrication process, with an emphasis on material synthesis and purity.

In Phase I, offerors shall perform a thorough assessment of current domestic and allied precursor supply chains for a select scintillator composition(s) of interest to DTRA (e.g., $LaBr_3$:Ce, CLYC, CLLB, GGAG, or related materials). This assessment shall consist of market research, identification of viable U.S. and/or allied material sources (including secondary chemicals and any specialized equipment), and technical risk analysis of purification and/or synthesis routes.

Following the assessment, a specific technical approach and one primary scintillator material system shall be selected for proof-of-principle. A laboratory-scale fabrication process shall be designed and demonstrated, producing at least one batch (e.g., 50-100 g total) of high-purity material. The process must demonstrate control of chemical purity, moisture, and stoichiometry. At a minimum, validation shall include rapid feasibility screening of the produced material, such as small-scale crystal growth and basic

scintillation or optical properties characterization, and benchmarking against commercially-available material and/or crystals.

The Phase I final report shall include:

- Detailed supply-chain and market assessment with identified domestic precursor material sources, to include secondary chemicals and equipment used during synthesis and/or purification procedures, and any identified gaps
- Technical rationale for chosen precursor approach and compositions, supported by modeling and/or literature where applicable
- Detailed description of the developed laboratory-scale fabrication/purification process
- Analytical characterization results (e.g. chemical purity, moisture content if applicable, stoichiometry verification)
- Validation results, including test sample fabrication and characterization results.
- Yield assessment: Percentage of fabricated batches meeting target specifications and lessons learned for scale-up.
- Assessment of methods for achieving and/or improving radiopurity.

PHASE II: Phase II focuses on validating crystal growth and scintillation performance, process refinement, and scaling up the process from the laboratory-scale. The goal is a manufacturing process achieving TRL 5, with consistent batch-to-batch performance that supports reliable crystal growth yields and scintillation properties.

Validation shall include growing and characterizing test crystals (≥1 cm^3). Key scintillator metrics to be characterized include but are not limited to energy resolution at 662 keV, absolute light yield (photons/MeV), and PSD if applicable. This validation may be done in-house, if the offer is capable. Offers are also encouraged to engage with a partner if this validation is outside their primary area of expertise, such as sending material to a crystal growth collaborator or sending crystals to a radiation detection characterization collaborator. Performance should be benchmarked against commercially-available crystals or crystals grown using commercially available feedstock. Crystals grown from at least one batch shall undergo independent detector fabrication/evaluation in a representative radiation detection system, which will be facilitated by DTRA.

Year 1: Focus on process optimization, reproducibility, and consistency of small batches (e.g., hundreds of grams), culminating in single crystal growth and scintillator performance validation.

Year 2: Refine the process from validation findings and scale the process to larger batch sizes (e.g., several kilograms). Perform independent evaluation of scintillation crystals produced via this process in a representative detector system, facilitated by DTRA.

The final report shall document the refined process, throughput, analytical quality control procedures, cost model, validation results, and percentage of output meeting all specifications. Grown crystals shall be delivered to DTRA. A clear pathway to Phase III commercial transition and DoW supply integration shall be provided.

PHASE III: DUAL USE APPLICATIONS: Optional phase to continue scale-up, establish pilot production capability, and transition the domestic precursor materials manufacturing process to commercial or DoW-qualified production. The objective is to achieve cost-competitive, on-shore supply of scintillator-grade precursor materials that can support multiple DoW programs and commercial radiation detection markets. This phase may include qualification of the material in full-scale radiation

detector systems, establishment of quality management systems (e.g., ISO or equivalent), and exploration of dual-use applications in medical imaging or homeland security.

REFERENCES:

1. EO 14415, “Securing America’s Defense Supply Chains and Ensuring Domestic Acquisition of Critical Materials,” July 20, 2026. Sets domestic sourcing and supply-chain mapping for defense rare earths and critical minerals; restricts waivers effective 2027.
2. U.S. Geological Survey (USGS). "Final 2025 List of Critical Minerals." *Federal Register*, Vol. 90, No. 216, November 7, 2025.
3. DTRA communications and technical exchanges (2025) documenting precursor supply disruptions for radiation detection materials and the resulting impact on crystal growth programs.

KEYWORDS: Scintillators; precursor materials; precursors; halide materials; rare earth elements; LaBr3; CLYC; CLLB; GGAG; elpasolite; crystal growth; radiation detection; domestic supply chain; high-purity chemicals; anhydrous halides; pulse shape discrimination; RIID; WMD detection; advanced materials manufacturing; purification; chemical synthesis; trace metal analysis; inorganic synthesis; material science

DTR27BZ02-NV006 TITLE: Domestic Scalable Growth Of Large-Format Pixelated CZT Crystals For Advanced Radiation Detection

OUSW (R&E) CRITICAL TECHNOLOGY AREA(S): Contested Logistics Technologies (LOG)

COMPONENT TECHNOLOGY PRIORITY AREA(S): Advanced Materials

PROJECTED CMMC LEVEL REQUIREMENT: Level 1

OBJECTIVE: DTRA seeks to establish reliable, scalable, and secure domestic sources and fabrication processes for large-format monolithic cadmium zinc telluride (CZT) single crystals in the 44 × 44 × 15 mm form factor, optimized for pixelated electrode structures that enable high-performance room-temperature 3D position-sensitive gamma-ray imaging and spectroscopy. These crystals are essential for next-generation compact radiation detection systems supporting WMD detection, nuclear forensics, and other radiation detection efforts within the Department of War (DoW).

DESCRIPTION: Compact, high-resolution, room-temperature gamma imaging and spectroscopy systems are critical for a number of government agency applications (DoW, DTRA, DOE/NNSA, IAEA, DHS), in addition to a number of commercial applications (nuclear power, medical community). CZT-based 3D position-sensitive detectors provide these capabilities without cryogenic cooling, leveraging the small-pixel effect and depth-of-interaction (DOI) sensing via pixelated anodes and timing readout.

Current advanced systems rely on high-quality pixelated CZT, but most commercial modules use smaller crystals (~20–22 mm lateral dimensions). Furthermore, finished crystals with a thickness of around 5 mm are readily available for medical imaging; however, thicker crystals are often available from manufacturers by long-lead, custom order. Scaling to monolithic 44 × 44 × 15 mm crystals would significantly increase intrinsic efficiency (particularly for higher-energy gamma rays), reduce the number of crystals and interfaces per imager, improve geometrical coverage, simplify module assembly, and lower overall system complexity while maintaining or exceeding energy resolution targets of <1% FWHM at 662 keV.

High-performance spectrometer-grade CZT at this scale is currently supplied primarily by a limited number of foreign or foreign-owned sources, creating recognized supply-chain vulnerabilities for critical national security radiation detection hardware. Tellurium feedstock is heavily concentrated overseas, and domestic high-end crystal growth capacity remains limited. Zinc and Tellurium are identified in the U.S. Geological Survey (USGS) 2025 List of Critical Minerals. Additionally, Executive Order 14415 "Securing America's Defense Supply Chains and Ensuring Domestic Acquisition of Critical Materials" (July 20, 2026), and related DoW supply chain initiatives, emphasize the need to strengthen domestic reliance on critical materials and components.

This topic directly addresses that gap by focusing on domestic crystal growth and machining innovation—including process improvements to the Traveling Heater Method (THM), Accelerated Crucible Rotation Technique (ACRT)-enhanced methods, alternative or hybrid growth techniques, in-situ monitoring, and stoichiometry/defect control—capable of delivering the required size, uniformity, and spectroscopic performance at scalable yield and cost. Successful development will strengthen U.S. supply chain resilience while accelerating technology transition to operational systems. A successful development under this topic should result in CZT material freely available on the commercial market rather than for exclusive or limited use by license or other restrictions. Furthermore, it is not the intent of this topic to develop detector systems utilizing CZT.

The solution must meet the following minimum specifications:

- Crystal Form Factor: Monolithic single-crystal CZT, nominal dimensions up to 44 × 44 × 15 mm (or equivalent large-format), suitable for pixelation with approximately 22 × 22 pixel anode contact matrix at ~2 mm pitch, a single cathode contact, and a guard ring contact around the edge of each.
- Material Quality: High spatial uniformity of carrier transport properties (electron $\mu\tau$ and adequate hole properties) across the full crystal volume; low defect density (e.g., Tellurium inclusions, grain boundaries, twins, etc.) sufficient to support high-performance spectroscopic operation; and low current leakage.
- Performance Target: Demonstrated or projected capability to achieve < 1% FWHM energy resolution at 662 keV when configured with pixelated readout and DOI sensing in a representative detector geometry.
- Domestic Production: U.S.-based growth process with clear, documented path to scalable yield, lot-to-lot reproducibility, and cost reduction; primary use of U.S. or allied-nation sourced raw materials with traceability.
- Validation: Precursor and crystal lots must be validated through non-destructive characterization (e.g., IR transmission, X-ray topography, $\mu\tau$ mapping) and, where feasible, proxy electrode testing or delivery to a qualified detector fabricator for performance assessment.
- Cost: Demonstrate that under high volume production cost per crystal volume is competitive with CZT commercially available from other commercial vendors.

Objective specifications (desired but not required for basic consideration):

- Larger or thicker monolithic crystals (e.g., approaching 50 × 50 × 20 mm) with maintained uniformity.
- Demonstrated full pixelated detector performance meeting or exceeding < 0.8% FWHM at 662 keV in 3D configuration.
- Production-scale batches (multiple crystals per run) with ≥ 70% single-crystal yield meeting all quality metrics.
- Cost-competitive pathway versus current foreign-sourced material at equivalent performance.
- Extensibility to related materials or detector architectures (e.g., array tiling, alternative electrode designs).

PHASE I: Conceptualizing approach and proof-of-principle fabrication process. In Phase I, offerors shall perform a thorough assessment of current domestic and allied CZT crystal growth capabilities relevant to large-format detector-grade material. This assessment shall include market research on raw material (tellurium, cadmium, zinc) sourcing, identification of viable U.S. and/or allied feedstock pathways, and an analysis of alternative growth methods capable of achieving the target 44 × 44 × 15 mm form factor with required uniformity, including a technical risk analysis for each.

Following the assessment, a specific technical approach and growth process shall be selected. A crystal growth and machining process shall be designed and demonstrated, producing at least one crystal (or multiple smaller proxy crystals demonstrating scalability) approaching the target dimensions with acceptable uniformity and performance. The process must demonstrate control of stoichiometry, defect density, and carrier transport properties.

Offerors are encouraged to seek collaborations in areas outside of their expertise if needed to reach specifications; for example, crystals may be shipped to a partner for properties characterization and validation.

The Phase I final report shall include:

- Detailed supply-chain and market assessment with identified domestic raw material sources, gaps, and risk mitigation strategies.
- Technical rationale for chosen growth method(s), supported by modeling, simulation, or literature where applicable.
- Detailed description of the developed growth and process control methodology.
- Non-destructive characterization results (e.g., IR transmission mapping, X-ray topography or equivalent, μτ property mapping) demonstrating spatial uniformity across the crystal volume.
- Proxy electrode or small-pixel test results (where feasible) or clear pathway to spectroscopic performance validation.
- Percentage of fabricated crystals (production yield) meeting target specifications, key process parameters identified for Phase II scale-up, and lessons learned.
- Analysis of potential product commercialization focusing on a commercial market at full scale production upon successful completion of the development. This should emphasis the technical and business need to reach full potential.

PHASE II: Scaling up output of crystal growth process. In Phase II, the laboratory process developed in Phase I shall be refined, optimized, and scaled to reliably produce multiple 44 × 44 × 15 mm (or equivalent) crystals with high reproducibility and yield. The goal is a manufacturing process achieving TRL 5, with consistent lot-to-lot performance that supports reliable detector fabrication and spectroscopic performance.

At least one lot of crystals (minimum three to five crystals meeting all quality metrics, or equivalent total output across validated runs) shall undergo independent characterization and, where feasible, delivery to a qualified U.S. detector fabricator, end-user partner, or academic investigator (with DTRA approval) for pixelated electrode processing and performance evaluation in a representative radiation detection configuration. The final report shall document the optimized process, throughput, analytical quality control procedures, cost model, and percentage of output meeting all specifications. A clear pathway to Phase III commercial transition and DoW supply integration shall be provided.

Phase II deliverables shall include: delivery of validated crystals to DTRA or a designated partner for independent evaluation; comprehensive process documentation suitable for technology transfer; and a detailed Phase III transition plan including potential commercial or DoW program insertion points.

PHASE III DUAL USE APPLICATIONS: Optional phase to continue scale-up, establish pilot production capability, and transition the domestic large-format CZT crystal growth process to commercial production. The objective is to achieve cost-competitive, on-shore supply of spectrometer-grade 44 × 44 × 15 mm (and larger) pixelated CZT crystals that can support multiple DoW programs and commercial radiation detection markets. This phase may include qualification of crystals in full-scale detector systems, establishment of quality management systems (e.g., ISO or equivalent), exploration of dual-use applications (medical imaging, industrial), and sustained production capacity demonstration.

REFERENCES:

1. EO 14415, “Securing America’s Defense Supply Chains and Ensuring Domestic Acquisition of Critical Materials,” July 20, 2026. Sets domestic sourcing and supply-chain mapping for defense rare earths and critical minerals; restricts waivers effective 2027.
2. DTRA and DOE technical exchanges (2024–2026) documenting CZT supply chain constraints and the impact on advanced radiation detection system development for nonproliferation and WMD detection missions.
3. Open literature on THM and ACRT enhancements for CZT growth, small-pixel effects, and 3D position-sensitive CZT detector architectures, including IEEE NSS/MIC/RTSD proceedings and related journals.
4. U.S. Geological Survey (USGS). "Final 2025 List of Critical Minerals." *Federal Register*, Vol. 90, No. 216, November 7, 2025.

KEYWORDS: cadmium zinc telluride (CZT); crystal growth; large-format CZT; pixelated CZT; 3D position-sensitive detector; room-temperature gamma spectroscopy; domestic supply chain; Traveling Heater Method (THM); Accelerated Crucible Rotation Technique (ACRT); radiation detection; WMD detection; nonproliferation; advanced materials manufacturing; spectrometer-grade CZT