Defense Advanced Research Projects Agency
Advanced Technology Office

Optically Designated Attack Munitions (ODAM)

Technical Requirements Document

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1 Scope - Program Background and Goals

It is the Government's overall objective, as outlined in this Technical Requirement, to contract for the successful design, fabrication, testing, optimization, and demonstration of a replacement fuze/guidance package that effectively converts current, ballistic 60 mm mortar munitions into optically designated 60 mm attack munitions. The intent is to provide a rapid path to an affordable manufacturable end product. The proposal should provide sufficient detail in each of the technical areas to allow adequate evaluation against each of the criteria listed in Section M. Documentation to be delivered under this effort is described in the Contract Data Requirements List (see Section J and Exhibits A and B).

Mortars are one of the most commonly employed weapons in a ground combat unit. The traditional role of mortars has been to provide close and continuous fire support for maneuvering forces. Military history has repeatedly demonstrated the effectiveness of mortars. Their rapid, high-angle, plunging fires are invaluable against dug-in enemy troops and targets in defilade, which are not vulnerable to attack by direct fires. One of the major disadvantages of mortars is their comparatively low accuracy; and as a result mortars are becoming less effective in today's precision combat environment. Equipping a mortar round with a precision guidance package will increase its accuracy, enabling the mortar to be a precision munition that will be significantly more effective in wartime situations. For maximum utility, the guidance package must be an inexpensive retrofit to current munitions, with a cost in production that allows its use in all situations, either as a guided or unguided weapon. The low cost profile is a central component of the program objectives.

The ultimate goal of this program is deployment of a guidance package fuze system for use by US troops as a retrofit for existing 60-mm mortar ammunition.

2 Requirements

2.1 Objective: A replacement for the current fuze of the 60 mm mortar munition that enhances the existing 60 mm mortar system by providing optical guidance and control for precision strikes and first shot kills. The emphasis is on the replacement fuze/guidance unit, seeker system, and optically designating the target.

2.2 Essential Trade-Offs: The Government acknowledges that there is a trade-off between performance features, schedule, program cost, and cost per item in production. The Government valuation of this trade-off is reflected in the Evaluation Criteria.

2.3 System configuration: The system shall be comprised of optical designators and a replacement fuze/guidance unit.

2.3.1 Replacement Fuze/Guidance Unit: The fuze, sensors, actuators, and control systems shall be integrated into a unit that replaces the current multi-function 60 mm mortar

fuze with no additional modifications to the body or tail assembly of the mortar munition.

2.3.2 Optical Designators: The guidance signal for the replacement fuze/guidance unit shall emanate from an optical designator. The optical designator shall be comprised of a standoff illuminator aimed at the desired impact point by a forward observer, or a homing illuminator emplaced at the desired impact point by some remote emplacement means.

2.4 System Performance:

2.4.1 With the new fuze/guidance unit and designator system, the mortar shall be able to engage an optically designated stationary target to a *minimum* accuracy of 4m CEP within a +/- steering range of 100 m from its nominal ballistic trajectory.

2.4.1.1 This performance shall be achieved for short range (1200 m), medium range (2200 m), and long range (3200 m) stationary targets.

2.4.1.2 This performance shall be achieved under both daytime and nighttime conditions.

2.4.1.3 This performance shall be achieved for desert (moderate reflectance brown), arctic (high reflectance white), verdant grassland (moderate reflectance green), and urban (variegated reflectance) environments.

2.4.1.4 This performance shall be achieved over the range of operating conditions called out in this document.

2.4.2 The objective of this effort is a target accuracy of 2m CEP, within a +/- 100m steering range from its nominal ballistic trajectory.

2.4.3 Secondary objectives of this effort are the ability to achieve similar accuracy for optically designated targets within a +/- steering range of 200m from the nominal ballistic trajectory, as well as enabling the mortar to strike, again with similar accuracy, a target moving at 30 kph with constant speed and direction through the accessible impact zone. These secondary objectives are applicable to the medium and long range cases referenced above.

2.5 Optical Designator Subsystem:

2.5.1 The effective range for any standoff designator shall be a minimum of 300 meters.

2.5.2 The objective of this effort is a standoff designator effective range of 1000 meters.

2.5.3 The optical designator wavelengths and power shall be selected to enable the replacement fuze/guidance unit to operate with low cost photo-detector systems, over the range of operating conditions specified in this document.

2.5.4 The optical designator wavelength and power shall be selected to enable the replacement fuze/guidance unit to acquire the designator signal at a slant range of at least 1000 meters.

2.5.5 Designators developed under this effort shall be portable (< 2lbs added soldier weight) and must meet current operating environmental condition specification for current NVG pointer systems.

2.5.6 Different designators are allowed for daytime and nighttime operations.

2.5.7 The system shall be operable at nighttime with currently fielded man-portable laser designators.

2.5.8 Daytime designators shall use up to 3 preset visible colors for improved signal discrimination from the required operating background environments.

2.5.9 Designators shall employ temporal signal encoding to improve daytime and nighttime signal discrimination, acquisition, and lock. The signal encoding shall provide for at least sixteen different temporal codes that allow multiple rounds to independently track multiple respective designators in the same tracking area with no coding interference.

2.5.10 Designators shall be designed in such a way that no personnel operating designators shall suffer any harm or injury from designator use through particulate scattering, or reflectance. Additionally, designators shall not cause harm or injury to enemy personnel per OSD policy.

2.5.11 Contractors shall evaluate and may consider alternatives to laser designators including LEDs and ballistic projectile means for their emplacement.

2.6 Fuze/Guidance Subsystem:

2.6.1 The fuze/guidance unit shall have a 90% probability of acquiring, discriminating, and locking on to the designator signal at a slant range of at least 1000 meters when

2.6.1.1 The background is solar illuminated at 100 kLux (solar noon at the equator, clear sky) and for the following reflectance characteristics of the background

a) Desert (moderate reflectance brown): 5% reflectance over 400-500nm, 30% reflectance from 500-700nm.

b) Arctic (high reflectance white): 90% reflectance from 400-700nm

c) Verdant grassland (moderate reflectance green): 5% reflectance from 400-500nm and from 600-700nm, 25% reflectance from 500-600nm.

d) Urban (variegated reflectance): 20% reflectance from 400-700nm.

2.6.1.2 These same backgrounds are illuminated by a full moon.

2.6.2 The fuze/guidance unit shall incorporate design features that allow selection of different wavelength designators, consistent with the selected designator wavelengths.

2.6.3 The fuze/guidance unit shall incorporate design features to take advantage of the selected temporal encoding features of the optical designator. The temporal code setting of a particular unit shall be manually selectable at the time of firing.

2.6.4 The fuze/guidance unit shall include a contact fuze detonator. The fuze shall function in super-quick and impact delay modes.

2.6.5 If the fuze/guidance unit fails to acquire the optical designator, it shall perform as a nominal ballistic mortar round.

2.6.6 The fuze/guidance unit shall be capable of meeting all the requirements of the current fuze with respect to detonation and safety requirements.

2.6.7 The assembled munition including the fuze/guidance unit shall retain aerodynamic stability in cross winds of at least 50 kph.

2.6.8 The fuze/guidance unit shall function properly in all respects after a drop of the assembled munition from 2 meters onto firm, dry, soil. Any packaging or protective material designed to prevent damage to aerodynamic structures during these tests must be an integral part of the unit during storage and shipment/handling, but may be removed immediately prior to launch.

2.6.9 The fuze/guidance unit shall withstand axial G-loads during launch of at least 4,500 G.

2.6.10 The objective of this effort is a fuze/guidance unit that withstands axial G-loads during launch of at least 10,000 G.

2.7 Operating Environments: The minimum required system performance characteristics shall be met under the full range of the following operating conditions

2.7.1 Temperature: -40 to +60 C.

2.7.2 Humidity: 0 – 100% relative humidity, non-condensing.

2.7.3 0.1 inch per hour light rainfall

2.7.4 Cloud cover at 1000 m altitude or greater

2.7.5 Altitude: sea level to 4,000 m at launch

2.7.6 Surface winds: 0 to 50 kph.

2.7.7 Winds aloft: 0 to 50 kph.

2.8 Storage and Non-Operating Environments: The replacement fuze/guidance unit and any proposed designators in their normal shipping and transport configuration shall retain their full operating characteristics following exposure to the following conditions:

2.8.1 Storage life: 20 years

2.8.2 Temperature: -40 to +85C

2.8.3 Humidity: 0 to 100% relative humidity, non-condensing.

2.8.4 Immersion in salt or freshwater up to a depth of 5 meters for a period of 90 minutes.

2.9 Cost per unit in low rate production:

2.9.1 The maximum allowable per-unit-cost for production of the new fuze/guidance units is $500 per unit, for an initial purchase lot of 30,000 units.

2.9.2 The target per-unit-cost for production of the new fuze/guidance units is $30 per unit, for an initial purchase lot of 30,000 units.

2.10 Schedule of Development and Demonstration:

2.10.1 The schedule for the program, not inclusive of the Final Report, shall be no less than 24 months, and shall not exceed 30 months, assuming all options are exercised.

2.10.2 The program shall be comprised of three phases, including a base effort and two sequential option efforts.

2.10.3 Phase I, Preliminary and Critical Design (Base Period), shall be no less than 6 months and shall not exceed 9 months. Phase I shall culminate in a Critical Design Review (CDR).

2.10.3.1 The contractor shall hold a Preliminary Design Review (PDR) not later than 3 months prior to the end of Phase I.

2.10.3.2 A test matrix shall be developed which when completed addresses each of the program requirements and provides data indicating the degree of success or failure. This test matrix and associated test schedule must be approved by the Government prior to any Government or contractor field testing of live ordnance.

2.10.3.3 The contractor shall hold a CDR prior to the end of Phase I.

2.10.3.4 A successful CDR shall consist of:

a) a detailed presentation to the Government of the contractors' system and subsystem designs,

b) performance projections that meet or exceed those set forth in the contractor's Statement of Work,

c) detailed substantiation of the performance projections through analysis, simulation, and initial testing,

d) a detailed presentation of a preliminary test plan for Phase III field testing including contractor and government field testing, test range scheduling, GFE requirements, costs, and scheduling, and including any proposed contractor preliminary testing to be executed in Phase II, and

e) a detailed schedule and WBS for the subsequent Phase clearly indicating any deviations from those originally proposed and reasons for same.

2.10.3.5 The results of the CDR and the contractor's performance to that point will be the basis for a decision whether to proceed to Phase II.

2.10.4 Phase II, Brassboard Fabrication and Optimization (Option 1), shall be no less than 12 months and shall not exceed 15 months. Phase II shall culminate in a Test Readiness Review (TRR).

2.10.4.1 The Government shall provide up to twenty inert 60 mm mortar munitions for form, fit, and function demonstrations and evaluations. These munitions shall be provided to the contractor within 60 days of the exercise of Option 1. Test rounds in excess of this number shall be borne at the contractor's expense.

2.10.4.2 The contractor shall prepare and deliver to the Government all documentation required for a fuze, explosive, and flight safety review for limited testing of the developed precision guided munition at least 60 days prior to the Test Readiness Review or any contractor proposed preliminary flight testing in this phase.

2.10.4.3 A successful TRR shall consist of:

a) a detailed presentation to the Government of the contractors' system and subsystem designs,

b) system level performance assessments that meet or exceed those set forth in the contractor's Statement of Work,

c) subsystem level performance characterizations of brassboard fuze/guidance units and designator units that substantiate the subsystem performance characteristics required to achieve the proposed system level performance, including but not limited to

i hardware-in-the-loop characterization of the fuze/guidance unit subsequent to exposing the unit to simulated launch conditions,

ii comprehensive validation of all components and subsystems through the full range of required operating and storage conditions,

iii field validation of designator performance characteristics, minimum standoff range characteristics, and seeker acquisition of the designator signal at the required minimum slant range and representative flight angle from (as, for instance, from a tethered aerostat).

d) preparation and delivery of the level II drawing and schematic package, or equivalent,

e) a detailed cost model for limited rate production that substantiates the proposed per-unit production cost , and

f) a detailed schedule and WBS for the subsequent phase clearly indicating any deviations from those originally proposed and reasons for same.

2.10.4.4 The results of the TRR and the contractor's performance to that point will be the basis for a decision whether to proceed to Phase III.

2.10.5 Phase III, Field Test and Demonstration (Option 2), shall be no less than 6 months and will culminate in the Government Field Test.

2.10.5.1 Field testing shall be carried out by the contractor using government provided facilities at one or more of the following government test ranges (this list represents test ranges under consideration, and should be used for bid, scheduling,

and cost purposes): Testing shall be performed with live munitions under the supervision of range and USMC personnel.

a) Yuma Proving Ground, Yuma, AZ

b) Idaho National Engineering Laboratory, Idaho Falls, ID

c) Aberdeen Proving Ground, Aberdeen MD

d) Camp Lejeune, Jacksonville, NC

2.10.5.2 Successful contractor-executed field field-testing shall be followed by a contractor supported Government Field Test at one of the designated government test ranges. The Government Field Test shall be conducted by a selected USMC unit.

2.10.5.3 Sufficient test articles shall be fabricated to allow for sufficient contractor testing to validate the full performance characteristics of the resulting system, and further allow for the successful firing of at least 1000 rounds during the Government Field Test.

2.10.5.4 The Government shall provide up to 5000 rounds of 60 mm mortar ammunition and at least two 60 mm launch tubes to support the above contractor and Government test activities.

2.11 Training and maintenance documentation.

2.11.1 Preliminary operation and maintenance documentation shall be provided 30 days prior to the Government Field Test in Phase III.