Field #	Field Name	Population Description
1	REPORT DATE	October 7, 2013
2	REPORT TYPE	Final Report
3	DATES COVERED	May 2010 – September 2013
4	TITLE AND SUBTITLE	Engineering Support for 105mm M119A2 Bottom Carrieage
5a	CONTRACT #	OTA # W15QKN-09-9-1001
5b	GRANT #	N/A
5c	PROGRAM ELEMENT #	N/A
5d	PROJECT #	DOTC-09-01-INIT192
5e	TASK #	N/A
5f	WORK UNIT #	N/A
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8	PERFORMING ORGANIZATION REPORT #	N/A
9	SPONSORING/ MONITORING AGENCY NAME AND ADDRESS	US Army Armament Research Development and Engineering Center, Picatinny Arsenal, NJ
10	SPONSOR/MONITOR ACRONYM	ARDEC
11	SPONSOR/MONITOR REPORT NUMBER(S)	N/A
12	DISTRIBUTION/AVAILABILITY STATEMENT	**DISTRIBUTION STATEMENT A.** Approved for public release; distribution is unlimited.
13	SUPPLEMENTARY NOTES	N/A
14	ABSTRACT	The objective of this initiative is to conduct a parametric study to quantify the improvements that will make smart projectiles compatible with the M119 system. The improvements can be conducted on, but not limited to, the platform, projectile designs and propellant. Projectile prototype metal parts will be fabricated and producibility will be evaluated and improved
15	SUBJECT TERMS	Weapon Design
16	SECURITY CLASSIFICATION OF:	Leave blank
16a	REPORT	Distribution limitation to the report. Enter UU (Unclassified Unlimited)
16b	ABSTRACT	Distribution limitation to the abstract. Enter UU (Unclassified Unlimited)
16c	THIS PAGE	Distribution limitation SF298 form. Enter UU (Unclassified Unlimited)
17	LIMITATION OF ABSTRACT	Distribution limitation to the abstract. Enter UU (Unclassified Unlimited)
18	NUMBER OF PAGES	6
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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
07 OCT 2013		**00-05-2010 to 00-09-2013**

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Engineering Support for 105mm M119A2 Bottom Carrieage	5b. GRANT NUMBER
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a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**8**	

Final Technical Status Report

For

Engineering Support for 105mm M119A2 Bottom Carriage

Initiative No: DOTC-09-01-INIT192

Reporting Period: May 2010 – September 2013

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Submitted: October 7, 2013

1. **Objective:**
   The objective of this initiative is to conduct a parametric study to quantify the improvements that will make smart projectiles compatible with the M119 system. The improvements can be conducted on, but not limited to, the platform, projectile designs and propellant. Projectile prototype metal parts will be fabricated and producibility will be evaluated and improved.

   The 105mm artillery platform M119A2 have shown deficiencies in meeting requirements set forth by various smart munitions design envelopes. The need to achieve improved accuracies by means of guidance systems has added mass to the complementary projectiles. The increased launch mass have increased operational stress levels on the weapon platform.

2. **Comments on Technical/Schedule Performance:**
   SUBSYSTEMs was awarded the initiative to provide support services as described in statement of work. SUBSYSTEMs team includes the contract and program management team, non-traditional contractor, subject matter experts and technical advisors.

   SUBYSTEMs team reviewed various applicable data and conducted a parametric study on the wide range of artillery and mortar systems to define the interoperability of guided munitions and the weapon platforms. The proposed improvements include but not limited to; weapon platforms, lightweight projectile designs, and advanced propulsion systems. Our team reviewed the proposed design and conducted a producibility study for the design and development of all aspects artillery systems. The proposed tasks are on schedule and performing within the budget. The technical data packages were reviewed during technical interchange meetings. SME conducted project schedule and progress meetings with the technical team. Various studies were conducted to provide the scalable effect on different sizes of projectiles.

   ARDEC team performed two separate testings to validate the component design. Team SUBSYSTEMs provided prototypes for scat gun testing which was successfully demonstrated. The cost and schedule performance of this initiative meets the customer's requirements.

   Testing: ARDEC Technical Team performed two tests during this reporting period, the SCat gun test and the Strength of design test.

   SCat gun test: This test provides the best and most cost effective method for analyzing the critical components in their representative, unmodified structure by subjecting them to the actual launch environment and then allowing for their recovery without damaging the projectile or payload at a low cost. The ARDEC Team successfully demonstrated the two warhead designs using the prototype fabricated by Team SUBSYSTEMs.

   Strength of Design test: The ARDEC Team successfully demonstrated the warhead design using inert fire. The components were recovered after the fire and evaluated for joint survivability.

3. Technical Achievements:

The following sections summarize the technical achievements and project progress. All the scheduled milestones and deliverables are on schedule and have met the requirements stated in the statement of work.

Task 1: Parametric Study

SME performed the design constraints and studied the ranges for parametric dimensions. SME conducted meetings with ARDEC personnel and reviewed the deficiencies for various smart munitions. During meetings, the requirements were discussed and reviewed to launch smart projectiles from 105mm platform.

Task 2: Proposed system producibility improvements

SME attended the design review meetings and technical interchange meeting. The technical data package was discussed and performance specifications were reviewed. The drawings were redlined for manufacturability. SME reviewed and commented on new technology approach for smart munition. SME updated the project schedule and attended the progress meetings with the Technical Team. Various studies were conducted to provide the scalable effect on different sizes of projectiles.

Task 3: Prototype Hardware: We completed the design and fabrication of 50 sets igniter housing hardware. The drawing was reviewed for completeness; the parts were fabricated, inspected and delivered to POC.

Task 4: Parametric study and prototype support for STAR

During the months of October through December of 2011, the Subsystems assisted in the fabrication, testing, and evaluation of STAR hardware components. Parts were fabricated that will be used in upcoming pre-demonstration engineering tests as well as assets that will be used for the STAR live fire demonstration. Parts were also fabricated and used for two major flight tests. The program conducted an aero-ballistic test at Yuma Proving Ground in Arizona, to determine the dispersion of a number of STAR rounds down range. These parts were mass mocks of the tactical assembly so as to match the physical properties of the system as accurately as possible. A follow-up aero test was then conducted to determine the capability to effectively capture a telemetry data stream from a round in flight. This round includes both mass mock hardware and hardware that will be used in the upcoming demonstrations. Finally, mass mock parts were fabricated to conduct strength of design tests using STAR warheads. These parts will help to validate the designed interfaces for a particular warhead concept. Currently, parts are being fabricated to support pre-demo engineering tests as well as for the live fire demonstration testing.

Testing: ARDEC Technical Team performed live test at YPG. The total of nine rounds were fabricated, assembled and tested for the performance and target accuracy. The STAR ATO program conducted live-fire testing at Yuma Proving Ground on December 15, 2011. The purpose of this test was to demonstrate the STAR 105mm technologies in a system to a TRL 6. Three warhead concepts were fired: Compartmentalized Deflagration (LEI), and

Composite Pre-Formed Fragment (CPFF). The test also demonstrated the functionality of the STAR fuzing and power systems which include the prox sensor, the thermal battery power module, the custom built GNC unit, and the ESAD. The EPIAFS setter was used in conjunction with a new interface box in order to set each round at the gun site. STAR also developed new propellants which were used in this test. All of the integration designs and assembly of these rounds were done in-house within ARDEC including the development of the six-fin base kit.

In total, nine live HE round were fired. Four of those nine functioned and detonated fully as intended. All four rounds detonated at a 3 meter height of burst. The four rounds verified the full functionality of the integrated STAR technology packages. All rounds demonstrated the structural survivability of the airframe design, which includes the fin kits. The CPFF round successfully fired the rear point initiator through a high voltage strip line from the ESAD. The Compartmentalized and LEI rounds demonstrated front point initiation.

The STAR ATO is a four year program to develop and demonstrate scalable technologies for adaptive response in three separate project demonstrations; a 30mm HE cartridge, a 105mm artillery projectile and a 250mm GMLRS unitary warhead. Scalable and adaptive response enables enhanced effectiveness, reduced logistics burden and reduced collateral damage. The NLOS Canon Artillery group at ARDEC is responsible for managing the integration and demonstration of the STAR artillery system.

Task 6: Parametric Study and Prototype support Base Kit Guided Projectile.

The government continues to evaluate options for low cost guided projectile to engage high value targets while minimizing the potential for collateral damage. Our team completes investigating the initial concept of a base guidance kit to be adaptable to the provided interface. This effort investigates integration of a base mounted fin actuated guidance kit designed to attach to the base thread to achieve 10m (T) 20m (O) miss distance while considering its interface with the weapon platform. The increased mass associated with the guidance package will be constrained by the strength of the M119 weapon platform.

- Preliminary Baseline Aero Model
  The team established a preliminary baseline aerodynamic model in order to perform 6DOF simulation based performance analyses. We derived a preliminary set of linearized aerodynamic coefficients based on experience and aerodynamic design tools.
- Preliminary Autopilot Design
  We established a preliminary autopilot design for the baseline preliminary baseline aero model. This preliminary autopilot will be used to perform preliminary performance and subsystem trade studies
- Subsystem Requirements and Performance Analyses
  During this period we performed preliminary subsystem analyses to establish the feasibility of the BKGP. Preliminary requirements were established in order to determine the quality and hence cost of the required subsystems in order to achieve precision GPS guided accuracy
- CAS Mechanical Subsystem Design and Development

We developed and designed a Base Guidance Kit CAS with deployable control fins and conducted initial investigation of the impact of the associated increase projectile launch mass.

Task 7: Parametric Study and Evaluation of Designs of newer extended range Artillery Munitions.

The government continuously evaluates the current family of munitions in the field and in testing. These munitions and their related systems are evaluated based on their performance, reliability, producibility, and how they interface with other weapon components and gun systems. While they function well for today's use in the field, these rounds now have limited capabilities compared to what will be needed in the future artillery systems. The future of artillery munitions is also being evaluated. The next generation family of munitions and gun systems will need to be equipped with precision guidance systems, be more effective in their performance and cost, and reach extended ranges past current projectile requirements, among other factors. Precision guidance packages may include the use of fin base kits, canard systems, PGK systems, and rocket motor designs. All of these improvements will put more stress on the current gun systems used in the field as additions in weight and components make rounds heavier to fire. As a result of these ongoing evaluations, the SME provides technical guidance and design evaluations related to how current and future munitions can be maintained and improved while utilizing the current and future weapon platforms.

Current Projectile and Weapon Systems Designs

The SME reviewed projectile designs and weapon platforms currently used in field operations and provide technical support in order to mitigate risk and correct failures in performance. This work was fed into lessons learned for new projectile design.

Testing and Evaluation Support

The SME provided support in the development of procedures and specifications for testing and evaluation of artillery projectiles and their related gun platforms currently in fielded use. This support included the parameters such as, the performance of the projectile in relation to range, reliability, and production maturity. In addition, SME provided the structural and technical support on corrective actions.

The SME continue to support the design review meetings and technical interchange meeting. The technical data packages ware discussed and performance specifications were reviewed. The drawings were redlined for manufacturability. SME reviewed and commented on new technology approach for smart munitions. SME updated the project schedule and attended the progress meetings with the Technical Team. Various studies were conducted to provide the scalable effect on different sizes of projectiles.

4. Problems Encountered and Action Taken

SUBSYSTEMs Team did not encountered any problems during this reporting period.

- Changes to the initiative objective or schedule:
  No changes to the initiative objective or schedule encountered.

- Technical problems and approach to correct:
  There were no technical problems encountered during this reporting period.
- Schedule problems and approach to correct:
  There was no schedule problems reported.
- Risks identified and mitigation plans:
  There were no identified risks during this reporting period.

Technical Readiness Level Status: Not applicable

3.2 Problems Encountered and Action Taken

- *Changes to the initiative objective or schedule:*
  No changes to the initiative objective or schedule were encountered. The period of performance was extended until September 2013 to meet the additional task requirements.
- *Technical problems and approach to correct:*
  There were no technical problems encountered during this reporting period.
- *Schedule problems and approach to correct:*
  There were no schedule problems reported.
- *Risks identified and mitigation plans:*
  There were no identified risks during this reporting period.

3.3 Technology Transfer

- No technology transfer identified other than the successful completion of flight testing and aero-ballistic testing.

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