2017 Infantry Equipping Challenge Phase I Ammunition Test Plan

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Executive Summary

The test plan presented in this document identifies the test procedures, test data, evaluation criteria, and reporting requirements for laboratory testing portion (Phase I) for Marine Corps Systems Command 2017 Infantry Equipping Challenge small caliber ammunition evaluation. The test plan also identifies constraints and limitation of the evaluation. The information gathered during this testing will be used to support safety releases for field evaluation (Phase II) and inform Marine Corps System Command leadership on the readiness of the reviewed technology to move forward in the acquisition process.

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1. Introduction

As a part of the Marine Corps Systems Command (MCSC) 2017 Infantry Equipping Challenge (IEC), the Program Manager for Ammunition (PMM-152, PM-Ammo) has been tasked with providing the Marine Expeditionary Rifle Squad (MERS) lightweight ammunition for evaluation in relevant calibers. PM-Ammo has tasked NSWC Crane to complete baseline safety and performance testing prior to releasing the test ammunition to MERS for Marine performance testing.

2. Background

IEC is MCSC's innovative process to identify and evaluate the best & most relevant equipment for our Infantry Marines and then expedite transition of the associated capabilities as requirements and funding permit. The Challenge will look at equipping opportunities for the Infantry Marine and by primary MOS; specifically 0311 MOS Riflemen, 0313 MOS Light Armor Vehicle Marine, 0331 MOS Machine Gunner, 0341 MOS Mortarman and 0351 MOS Infantry Assault Marine. IEC brings together stakeholders from across the Marine Corps requirements, acquisition, and technology development communities in a dynamic process to quickly evaluate and accelerate fielding of technologies that decrease the Infantry's load, increase operational reach and reduce the reliance on the logistical train. MCSC's metric of success for IEC is the accelerated fielding of material solutions for Infantry Marines.

The IEC is a multi-year, multi-event process. General focus areas to be considered for IEC events include the following:

- Opportunities for equipment that is lighter, more capable, less burdensome, reduced logistical needs, reduced complexity/maintenance, or better tailored for the Infantry's tasks
- Power management, generation, storage, harvesting and scavenging
- Infantry food; weight/bulk repackaging
- Individual and squad level water filtration systems
- Innerwear and outerwear clothing and other worn garments
- Medical and casualty gear
- Lightweight ammo

Focus areas for each individual IEC event will be identified in the respective RFI for that event.

PM-Ammo is focusing on the evaluation of lightweight ammunition. The evaluation will occur in two Phases; Phase I will be used to determine if the candidate ammunition is safe for use by USMC personnel and gather laboratory performance data. Phase II will consist of a field evaluation of the ammunition based on the Marine Expeditionary Rifle Squad (MERS) Marine Corps Load Effects Assessment Program (MCLEAP) obstacle course.

3. Test Objectives

There are two objectives for IEC Phase I testing. The first objective is to determine if the submitted ammunition is safe for live fire and demonstration by USMC personnel. The second objective is to gather independent performance data at a US Government facility to substantiate the performance of the IEC candidate ammunition and offer a comparative baseline against currently fielded capabilities.

4. Constraints and Limitations

The following constraints and limitations have been identified.

4.1. Constraints

- Testing is limited to cartridges provided by the IEC candidate in an as delivered configuration.
    - Ammunition will be tested as is. While potential improvements for the ammunition may be identified, any additional development is outside the scope of this testing.
- Testing is limited to ammunition in calibers currently fielded by the USMC. The following calibers have been identified for investigation during IEC.
    - 9mm (pistol)
    - 5.56mm (rifle)
    - 7.62mm (machine gun)
    - .300 Winchester Magnum (rifle)
    - .50 Caliber (machine gun)
- A limited subset of weapons will be used in testing.
    - Testing will not be conducted on every weapon in the USMC inventory of the submitted caliber.

4.2. Limitations

- Test data is not sufficient for qualification.
    - The purpose of testing is to gather sufficient information for a limited safety release and baseline functional performance, additional testing will be required if full qualification is desired.
- Testing will not include extended environmental exposure.
    - Ammunition will be exposed to representative temperatures; however long term exposure to environmental stimulants will not be examined. The ability of the ammunition to withstand extreme temperatures is not being evaluated.
- Testing will not examine the detailed effects of ammunition on weapons dynamics.
    - Testing will only determine if the ammunition will function through the designated weapons systems. Additional testing will be required to define any changes in weapons operating characteristics. Rate of fire data will be captured.

- Terminal ballistic performance testing will only be conducted with candidates that utilize projectiles that are not currently in use by the USG.
    - The terminal ballistic behavior of currently, or previously, fielded projectiles is well understood. Confirmation of muzzle velocity is sufficient to understand whether or not the candidate can meet the performance requirements of a currently fielded design.

5. Test Procedures

The below tests are designed to provide a basic safety and performance assessment of each IEC candidate. Unless otherwise noted, all of the tests detailed will be conducted on each IEC candidate. Detailed test plans and procedures will be produced by the test activity on an as needed basis. Unless otherwise noted, all tests will be conducted at ambient temperature (+70ºF). Extreme temperatures for IEC Phase I testing have been identified at -25ºF and +145ºF. All temperatures will be maintained at ±2ºF unless otherwise noted. All raw and processed data shall be made available electronically after testing.

A generalized test matrix with the test name, quantity, and temperature is show in Table 1.

Test	Quantity	Temperature
Visual and Dimensional Inspection	25*	+70ºF
Leak Testing	5*	+70ºF
Electronic Pressure, Velocity and Action Time	20	+145ºF
	20	+70ºF
	20	-25ºF
Dispersion	100	+70ºF
Function and Casualty	Varies**	+70ºF
	Varies**	+145ºF
	Varies**	-25ºF
Terminal Ballistics	15***	+70ºF

Table 1. General Test Matrix.

*25 cartridges will be inspected, but 5 will be used for leak test

** Function and casualty quantities vary by caliber

*** Terminal ballistic testing is limited to candidates that make use of projectiles that are not fielded by the USG

5.1. Visual and Dimensional Inspection

Visual and Dimensional Inspections shall be conducted on a twenty-fire (25) cartridge sample of each IEC candidate. At a minimum, the following measurements will be taken of each cartridge:

- Cartridge weight
- Cartridge overall length
- Cartridge mouth diameter
- Extractor groove diameter (rifle)/ Rim diameter (pistol)
- Extractor groove thickness (rifle) / Rim thickness (pistol)

- Case diameter
- Cartridge case overall length
- Primer seating depth

Any visual defects shall be recorded and categorized in accordance with MIL-STD-636.

After the test sample has been dimensionally inspected, five cartridges shall be set aside for leak testing (see section 5.2). The remaining twenty (20) cartridges shall have the following measurements taken:

- Bullet extraction force
- Projectile weight
- Projectile diameter
- Propellant charge weight

To compare any potential weight savings with the polymer cased ammunition, brass cased cartridges with the same projectile will have twenty-five (25) cartridges weighed.

5.2. Leak Testing

Leak testing shall be conducted on the five (5) cartridges that were set aside from section 5.1. The cartridges shall undergo leak testing using the method described in MSCAT-P (DTL13038145) Appendix D – Waterproof Test Procedure. Rifle cartridges shall be placed in a pressure tight vessel submerged in 2 inches of water with a vacuum of 7.5 psi applied for 30 seconds. Pistol cartridges shall be placed in a pressure tight vessel submerged in 2 inches of water with a vacuum of 5 psi applied for 15 seconds. The number of bubbles liberated from each case shall be recorded.

5.3. Electronic Pressure, Velocity, and Action Time

Seventy (70) cartridges from each IEC candidate shall be used for Electronic Pressure, Velocity, and Action Time (EPVAT) testing in the quantities show in Table 1. Ten (10) reference cartridges will be used for warm/foul/ correction prior to testing each sample. EPVAT testing for rifle cartridges shall be conducted in accordance with MSCAT-P (DTL13038145) Appendix A – EPVAT test procedure. EPVAT testing for pistol cartridges shall be conducted in accordance with SCATP-9mm Chapter 4 – EPVAT Procedure. Pressure, velocity and action time data will be recorded for each fired cartridge.

The cartridges that undergo leak testing will be tested at 70°F with the pressure, velocity, and action time being recorded, as well as port pressure if it is a rifle cartridge.

EPVAT testing of a specific IEC candidate shall proceed all other ballistic testing of that candidate.

Data reporting will be in accordance with proper reference with any values from the reference cartridges being reported.

5.4. Dispersion

One-hundred and ten (110) cartridges will be used for dispersion testing. Five (5) cartridges will be used to warm, foul and sight each accuracy barrel before firing five (5) groups of ten (10) cartridges each.

Rifle cartridges shall be tested in accordance with MSCAT-P (DTL13038145) Appendix C – Accuracy (Dispersion) Test Procedure. Targets shall be setup at a range of 300 yards from the muzzle of the test weapon. The x and y coordinate of each shot shall be recorded with the Mean Radius and Extreme Spread of each group being reported.

Pistol cartridges shall be tested in accordance with SCATP-9mm Chapter 3 – Accuracy Test Procedures. Targets shall be setup at a range of 50 yards from the muzzle of the test weapon. The x and y coordinate of each shot shall be recorded with the Mean Radius and Extreme Spread of each group being reported.

5.5. Function and Casualty

Function and Casualty testing will be conducted with the quantities and at the temperatures listed in Table 2.

Caliber	Weapon	Cartridge Quantity	Temperature
9mm	M9 Pistol	45 (3 magazines)	+70ºF
		45 (3 magazines)	+145ºF
		45 (3 magazines)	-25ºF
5.56mm	M4A1 Carbine, M27 Infantry Automatic Rifle	60 (2 magazines, ea)	+70ºF
		60 (2 magazines, ea)	+145ºF
		60 (2 magazines, ea)	-25ºF
7.62mm	M240B	100 (1 belt)	+70ºF
		100 (1 belt)	+145ºF
		100 (1 belt)	-25ºF
.300 Winchester Magnum	Mk13 Mod7 (USMC mod)	30 (3 magazines)	+70ºF
		30 (3 magazines)	+145ºF
		30 (3 magazines)	-25ºF
.50 Caliber	M2HB	100 (1 belt)	+70ºF
		100 (1 belt)	+145ºF
		100 (1 belt)	-25ºF

Table 2. Function and Casualty Test Quantities and Temperatures.

Pistol cartridges shall be tested in accordance with MSCAT-P (DTL13038145) Chapter 6 – Function and Casualty Test Procedure using the weapon and quantities listed in Table 2. After firing, the cartridge cases shall be examined for any defects. The quantity, type, and test conditions of a defect shall be recorded and reported.

Rifle cartridges shall be tested in accordance with MSCAT-P (DTL13038145) Appendix B – Function and Casualty Test Procedure using the weapons and quantities listed in Table 2. Ammunition tested in select fire weapons will be fired half in fully automatic, half in semi-automatic. When firing the M4A1 and the M27, in the fully automatic mode, fire a 3-5 round

bursts with at least 2-5 seconds between each burst. The 5.56 weapons will be allowed to cool between magazine changes and after firing one-hundred and twenty (120) rounds. When firing the M240B, fire in 3-5 round bursts with no more than one-hundred (100) rounds being fired in a minute. The weapon will be allowed time to cool after firing one-hundred (100) rounds.

The rate of fire for all fully automatic fire shall be recorded. After firing, the cartridge cases shall be examined for any defects. The quantity, type, and test conditions of a defect shall be recorded and reported.

5.6. Terminal Ballistics

A sample from each IEC candidate that utilizes a projectile that is not in use by the USG sample shall be fired into 10% ballistic gelatin. Fifteen (15) cartridges per sample will be shot out of the appropriate accuracy barrel in a sliding V-block into the ballistic gelatin. The fifteen (15) cartridges will be split evenly among the following target configurations: bare, car door steel and auto-glass.

The gelatin shall be calibrated using the steel BB method according to the Gelatin Block Standard (GBS) (Guidelines for Gelatin Block Testing: The 2004 Joint Service Wound Ballistics Integrated Product Team [IPT] Gelatin Testing Standard (Draft) of 2 SEP 2004). Test set up will be done IAW the FBI Penetration Testing guidelines.

A photo of each gelatin shot and the barrier (as applicable) with a ruled scale shall be taken after each shot.

5.6.1. Bare Gelatin

The bare gelatin block will be set at a distance of 10 feet from the muzzle.

5.6.2. Car Door Steel

Two pieces of 20 gauge steel plates will be separated 3 inches apart and placed 10 feet from the muzzle. The gelatin block will be placed 18 inches behind the car door steel.

5.6.3. Auto-Glass

One piece of auto-glass will be placed 10 feet from the muzzle. The glass will be at a compound angle with a horizontal angle of 45° and a vertical angle of 15°. The gelatin block will be placed 18 inches behind the auto glass.

6. Evaluation Criteria

Phase I evaluation of IEC candidates will be limited to a basic operation safety criteria. A pass/fail value will be assessed each type of ammunition based on the data in Table 3. Each cartridge will be assessed to determine that it does not exceed the allowable chamber pressure and action times in the table. Other information from the test series may be included for

information on the function of the cartridge, but the safety determination will be made on the information in Table 3.

Caliber	Maximum Average Chamber Pressure	Max Individual Chamber Pressure	Maximum Action Time	Chamber Gage	Function and Casualty
9mm	238 MPa (34,500 psi)	273 MPa (39,500 psi)	N/A	Pass/Fail	# of stoppages
5.56mm	58,700 psi	64,700 psi	3 ms	Pass/Fail	# of stoppages
7.62mm	57,000 psi	62,000 psi	4 ms	Pass/Fail	# of stoppages
300 WM	N/A	64,000 psi	4 ms	Pass/Fail	# of stoppages
.50	65,000 psi	N/A	4 ms	Pass/Fail	# of stoppages

Table 3. Ballistic Safety Criteria

7. Test Reporting

Test reports shall be provided electronically to PM-Ammo. While testing is ongoing, a weekly report summarizing the week's activity shall be provided. At the end of each phase of testing a quick look report shall be provided with summary data within two weeks of conclusion of testing. If the data gathered during a phase of testing supports identified evaluation criteria, the quick look report will clearly identify if the IEC candidate passed or failed that criteria. At the conclusion of testing a final test report with all supporting data shall be provided within four weeks. If the determination is made that any of the data gathered during the course of this evaluation is classified, PM-Ammo will be immediately contacted and alternative arrangements made.

8. References

1. MIL-STD-636 Visual Inspection Standards for Small Arms Ammunition through Caliber .50. US Army Armament Research, Development and Engineering Center, ATTN: AMSTA-AR-QAC-C, Dover, NJ 07806-5000.
2. DTL1338145.Detail Specification, Item Specification for the Multi-Small Caliber Ammunition Test Procedures (M-SCATP). Project Manager for Maneuver Ammunition Systems, Picatinny Arsenal, NJ 07806-5000.
3. SCATP-9mm. Department of Defense Small Caliber Ammunition Test Procedures 9mm Cartridges. US Army Armament Research, Development and Engineering Center, ATTN: AMSTA-AR-QAC-C, Dover, NJ 07806-5000.
4. Guidelines for Gelatin Block Testing: The 2004 Joint Service Wound Ballistics Integrated Product Team [IPT] Gelatin Testing Standard (Draft) of 2 SEP 2004.