TEST REPORT FOR THE SPECIAL PURPOSE RIFLE (SPR)

21 MARCH 2015

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EXECUTIVE SUMMARY

Purpose

This Test Report (TR) presents the summarization of the data collected during the exploratory testing into the feasibility and practicality of using the M27 Infantry Automatic Rifle (IAR) as a Special Purpose Rifle (SPR) to fulfill an Urgent Statement of Need. The Test Team (TT) conducted the test in accordance with the Test Plan (TP) for the SPR. The two key areas of exploration were the use of a "*more advanced optic*" than the Squad Day Optic (SDO) and "*suppressing*" the M27 IAR in order to enhance the capabilities of this weapon system in order to fulfill the SPR requirement. Product Manager Infantry Weapon's (PdM IW's) intent was to determine if an enhanced IAR could fill the SPR requirement while minimizing the impact on logistics, maintenance, and training.

Description

The M27 IAR is a lightweight, air-cooled, gas piston operated, shoulder-fired weapon (see Figure I) used primarily as an alternative to heavier belt-fed squad automatic weapons. The M27 IAR uses the standard M16/M4 30-round magazine.

Figure I. M27 IAR with Leupold Mark 4 Scope

The Leupold Mark 4 scope (see Figures I and II) is a 2.5-8 x 36 scope with a 30 mm tube diameter (Part #60150). It has M2 adjustment dials and an illuminated reticle with markings on both axes. The Leupold Mark 4 scope is 11.3 inches long and weighs 16.0 ounces.

Figure II. Leupold Mark 4 Scope

The Leupold Mark 4 scope mounts to the M-27 with the LaRue Tactical Scope Mount, Quick-Detach LT745 with 30mm scope rings (see Figures I and III).

Figure III. LaRue QD LT745 Scope Mount

Knight's Armament Company (KAC) builds the QDSS-NT4 suppressor (see Figure IV) for the M4/M16. The suppressor is a full auto rated quick detachable suppressor made of stainless steel construction. The KAC suppressor is 6.6 inches long and weighs 24 ounces. A special muzzle compensator is required in order to mount the KAC suppressor to the end of the barrel on the M-27. The Ordnance Test Facility (OTF) Armorer applied the muzzle compensator kit to the weapons designated to use the KAC suppressors prior to live-fire testing.

Figure IV. KAC QDSS-NT4 Suppressor

Operator Suppressor Systems (OSS) built the second type of suppressor used during this test. The Back Pressure Regulator (BPR) and a Signature Reduction Module (SRM) are the two components of this suppressor system. The OSS suppressor used during this testing effort was an over the barrel system (see Figure V). The BPR increases the weapon system length by 1.6 inches beyond the end of the barrel and it weighs 14 ounces. The SRM increases the weapon system length by 4.2 inches and it weighs 8.7 ounces. The TT removed the compensators and bayonet studs from the M27s used with the OSS suppressor in order to allow the suppressor system properly mount over the barrel. For purposes of this test, the TT considered the OSS suppressor equipped M27s unsuppressed when fired with the BPR, but without the SRM. The TT considered the OSS suppressor equipped M27s suppressed when fired with both the BPR and the SRM. The OTF Armorer attached the OSS kit to the weapons designated to use the OSS suppressors prior to live-fire testing.

Figure V. OSS Suppressor System (BPR and SRM)

Test Summary

Testing was directed by the Test Manager for PdM-IW with assistance from the Project Officer and Engineer for the SPR effort and the Scout-Sniper Subject Matter Expert (SME) from the OTF. The Test Team (TT) evaluated the Leupold Mark 4 Scope when mounted on the M27 IAR during both suppressed and non-suppressed fire while firing over 2700 rounds per weapon system (9 total). The TT also gathered information on the capabilities of the two different vendor types of suppressors (KAC and OSS) used during this test effort. In this regard, the TT observed and recorded the performance of the SPR while being operated by representative users from the program office and documented opinions as to the extent to which the optic and the suppressors fulfilled established performance attributes stated in the TP. In addition, the Test Team conducted verification testing of measureable attributes at the OTF and at the Electro-Optical Support Facility (EOSF).

During November 2015 through March 2016, the TT conducted the test events in five phases at Marine Corps Base Quantico in Quantico, Virginia. Phase I consisted of receipt and inventory of the equipment (scopes, scope mounts, and suppressors) required to conduct this test. Phase II consisted of the verification testing which was conducted at the OTF and at the EOSF from 14 December 2015 through 8 January 2016. Phase III consisted of the live-fire portion of the SPR testing conducted during 11-14 January 2016 at training ranges aboard Marine Corps Base Quantico using PdM IW personnel. Phase IV consisted of post live-fire verification testing conducted at the OTF and at the EOSF. Phase V consisted of the consolidation of the data collected, analysis of the data, and compilation of this TR.

Test Results

Data collection was both quantitative (verification and live-fire testing) and qualitative (user opinions) in nature. The attributes were resolved in accordance with the Resolution Rules established in Appendix 5 to Annex D of the TP and the results are in Table I. Attributes that met the resolution rules (*MET*) are shaded in light green. Attributes that failed to meet the resolution rules (*NOT MET*) are shaded in light red. Attributes that were *Met with Exception* are shaded in yellow. The attributes not evaluated are shaded in light brown.

Table I. Attribute Resolution

Att #	Attribute	Resolution
Leupold Mark 4 Scope		
A-1	Shock-Unsuppressed	MET 6/6
	Shock-Suppressed with KAC Suppressor	MET 6/6
	Shock-Suppressed with OSS Suppressor	MET 6/6
A-2	Compatibility-	MET 9/9
A-3	Target Engagement-(Heat Signature) Unsuppressed	MET (IAR Testing)
	Target Engagement-(Heat Signature) Suppressed with KAC Suppressor	Met with Exception
	Target Engagement-(Heat Signature) Suppressed with OSS Suppressor	Met with Exception
A-4	Minute of Angle (MOA)-Unsuppressed (2 MOA) Required)	MET (1.56)
	MOA-Suppressed with KAC Suppressor (2 MOA Required)	MET (1.50 Sup/1.63 Uns)
	MOA-Suppressed with OSS Suppressor (2 MOA Required)	MET (1.11 Sup/1.08 Uns)
A-5	Repeatability (EOSF)	MET
KAC Suppressor		
A-6	Suppressor Ease of Installation (KAC Suppressor)	MET (OTF)
A-7	Suppressor Compatibility (KAC Suppressor)	MET (3/3)
A-8	Suppressor Durability (KAC Suppressor)	MET (3/3)(Baffle Strike)
A-9	Suppressor Accuracy (KAC Suppressor) Accuracy/Point of Impact (POI) Shift	(MOA 1.50 Sup/Avg POI 2.49)
A-10	Suppressor Maintainability (KAC Suppressor)	MET (5/6)
A-11	Suppressor Cyclic Rate of Fire (KAC Suppressor)	Not Evaluated
OSS Suppressor		
A-6	Suppressor Ease of Installation (OSS Suppressor)	MET (OTF)
A-7	Suppressor Compatibility (OSS Suppressor)	MET (2/3)
A-8	Suppressor Durability (OSS Suppressor)	MET (2/3)(*Removal Issues*)
A-9	Suppressor Accuracy (OSS Suppressor) Accuracy/POI Shift	(MOA 1.11 Sup/Avg POI 1.23)
A-10	Suppressor Maintainability (OSS Suppressor)	NOT MET (1/6)
A-11	Suppressor Cyclic Rate of Fire (OSS Suppressor)	Not Evaluated

NOTE: *For Attribute A-3, the Test Manager resolved the attribute for both the KAC and OSS suppressors as Met with Exception, because the operator opinions indicated that the heat signature for the KAC suppressor and the OSS suppressor did not degrade the ability of the operator to engage targets, but the heat signature was worse than an unsuppressed M27 IAR. For KAC Suppressor Attribute A-9, the KAC Suppressor met the accuracy requirement but failed the shift of impact requirement of no greater than 2 MOA. For Attribute A-11, the TT had equipment issues that prevented the collection of accurate cyclic rate firing data*.

Conclusions

Leupold Mark 4 Scope

Based on the data collected for shock, compatibility, target engagement, MOA, and repeatability, this optic met all the requirements for use on the M27 IAR when unsuppressed. This optic met all the requirements for use on the M27 IAR when suppressed with either the KAC suppressor or the OSS suppressor. The operators did indicate that the heat signature for both was greater than an unsuppressed IAR, but they also stated that the KAC suppressor and the OSS suppressor did not degrade the ability of the operator to engage targets.

KAC Suppressor

The KAC suppressor met all the attributes as stated in the TP except for the POI Shift of 2 MOA from unsuppressed to suppressed scored groups. The KAC suppressor had an average POI shift for all shooters over the course of fire (18 calculations) of 2.49 MOA. Of the 18 calculations for POI shift, three were over 3 MOA and three were over 4 MOA. Based on the average, the attribute of 2 MOA for POI shift cannot be met on a consistent basis with the KAC suppressor. It is the Test Manager's opinion that POI shift is not as important as it once was. Marine Corps snipers are interested in what the POI shift is for their weapon, but their Tactics, Techniques and Procedures (TTP's) call for them to shoot suppressed rather than unsuppressed. If the TTP for the SPR will require the operator to shoot suppressed rather than unsuppressed, then this attribute should be changed. The TT was not able to determine cyclic rate of fire with the KAC suppressor due to equipment issues during testing.

OSS Suppressor

The OSS suppressor met all the attributes as stated in the TP except for suppressor maintainability. The OSS suppressor used during this effort was an over-the-barrel suppressor that required the OTF armorer to remove the bayonet lug from the M27 prior to mounting the OSS suppressor. The OSS over-the-barrel suppressor prevented the operator from gaining access to the gas piston for cleaning and maintenance, which was a major concern for the operators. The TT also experienced issues in removing the OSS suppressors from the M27 for post live-fire inspections. In hindsight, the TT should have obtained OSS suppressors that were of a flush mount or quick-detach type of mount for this effort. The TT noted that the operators shot appreciably better with the OSS suppressor with an overall average of 1.11 MOA suppressed, which was better than the average MOA suppressed using the KAC suppressor. The average POI shift using the OSS suppressor was 1.26 inches, which met the attribute as stated in the TP. Only one of the 17 validated POI shifts exceeded the 2 MOA requirement at 2.17 MOA. The outstanding results obtained with the OSS suppressor justified the research conducted.

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TABLES

Acronyms, Abbreviations and Definitions

ATT.....Attribute
ATTN.....Attention
BPR.....Back Pressure Regulator
BZO.....Battle Sight Zero
DC.....Data Collector
DCC.....Data Collection Chief
DOD.....Department of Defense
DODIC.....Department of Defense Identification Code
EOSF.....Electro-Optical Support Facility
F.....Fahrenheit
FIPO.....For Informational Purposes Only
FOUO.....For Official Use Only
HK.....Heckler and Koch
IAR.....Infantry Automatic Rifle
KAC.....Knight's Armament Company
LTI.....Limited Technical Inspection
MOA.....Minute of Angle
MCSC.....Marine Corps Systems Command
MUA.....Military User Assessment
NA.....Not Applicable
OIC.....Officer-in-Charge
OIF.....Operation Iraqi Freedom
OSS.....Operators Suppressor Systems
OTF.....Ordnance Test Facility
PdM-IW.....Product Manager-Infantry Weapons
PFI.....Pre-Fire Inspection
PM.....Program Manager
PWS.....Precision Weapons Section
RSO.....Range Safety Officer
SDO.....Squad Day Optic
SME.....Subject Matter Expert
SPR.....Special Purpose Rifle
SRM.....Signature Reduction Module
SUP.....Suppressor
TIR.....Test Incident Report
TP.....Test Plan
TR.....Test Report
TT.....Test Team
UUNS.....Urgent Universal Need Statement
UUT.....Units Under Test

REFERENCES

a. Urgent Statement of Need for Special Purpose Rifle with Change 1 dated 9 April 2007

b. Test Plan (TP-16-PDM-IW-001) for the Special Purpose Rifle of 8 December 2015

c. Quantico Range Regulations, Marine Corps Base Order 3570.1 of 17 May 2010

1. PURPOSE

This Test Report (TR) presents the summarization of the data collected during the exploratory testing into the feasibility and practicality of using the M27 Infantry Automatic Rifle (IAR) as a Special Purpose Rifle (SPR) to fulfill an Urgent Statement of Need (reference (a)). The TT conducted the test in accordance with the Test Plan (TP) (reference (b)) for the SPR. PdM IW's intent was to determine if an enhanced IAR could fill the SPR requirement while minimizing the impact on logistics, maintenance, and training.

2. SCOPE

Product Manager Infantry Weapons (PdM IW) conducted this testing during November 2015 through March 2016. The two key areas of exploration were the use of a "*more advanced optic*" than the Squad Day Optic (SDO) and "*suppressing*" the M27 IAR in order to enhance the capabilities of this weapon system in order to fulfill the SPR requirement. The Test Team (TT) evaluated the Leupold Mark 4 Scope when mounted on the M27 IAR during both suppressed and non-suppressed fire while firing over 2700 rounds per weapon system. The TT also gathered information on the capabilities of two different vendor types of suppressors (Knights Armament Company (KAC) and Operator Suppressor Systems (OSS)). In this regard, the TT observed and recorded the performance of the SPR while being operated by representative users from the program office and documented opinions as to the extent to which the optic and the suppressors fulfilled established performance attributes stated in the TP. In addition, the TT conducted verification testing of measureable attributes at the Ordnance Test Facility (OTF) and at the Electro-Optical Support Facility (EOSF)

3. BACKGROUND

The MK 12 MOD 1 SPR (built by Naval Surface Warfare Center Crane using an M16A1 lower receiver and a *Mark 4 Leupold Scope*) was initially fielded in October 2007 in response to an Urgent Universal Need Statement (UUNS) by units deployed in support of Operation Iraqi Freedom (OIF). The service life of the MK 12 MOD 1 SPR was 24 months, but the service life was extended on 13 March 2009. The Item Exit Date for the MK 12 MOD 1 SPR was 1 February 2014.

The *KAC suppressor* is used as a component of the Close Quarter Battle Weapon (M4A1 with 14.5" barrel) and as a component to the MK 18 Close Quarter Battle Receiver-Carbine with 10.3" barrel. The *OSS Suppressor* was recently used during a Military User Assessment (MUA) at Camp Atterbury, Indiana. Heckler and Koch (HK) and Daniel Defense used the OSS Suppressor on their Suppressed-Upper Receiver Groups during the MUA.

4. SYSTEM DESCRIPTION

The M27 IAR is a lightweight, air-cooled, gas piston operated, shoulder-fired weapon (see Figure 1) used primarily as an alternative to heavier belt-fed squad automatic weapons. The M27 IAR uses the standard M16/M4 30-round magazine.

Figure 1. M27 IAR with Leupold Mark 4 Scope

The Leupold Mark 4 scope (see Figures 1 and 2) is a 2.5-8 x 36 scope with a 30 mm tube diameter (Part #60150). It has M2 adjustment dials and an illuminated reticle with markings on both axes. The Leupold Mark 4 scope is 11.3 inches long and weighs 16.0 ounces.

Figure 2. Leupold Mark 4 Scope

The Leupold Mark 4 scope mounts to the M-27 with the LaRue Tactical Scope Mount, Quick-Detach LT745 with 30mm scope rings (see Figures 1 and 3).

Figure 3. LaRue QD LT745 Scope Mount

KAC builds the QDSS-NT4 suppressor (see Figure 4) for the M4/M16. The suppressor is a full auto rated quick detachable suppressor made of stainless steel construction. The KAC suppressor is 6.6 inches long and weighs 24 ounces. A special muzzle compensator is required in order to mount the KAC suppressor to the end of the barrel on the M-27. The OTF Armorer applied the muzzle compensator kit to the weapons designated to use the KAC suppressors prior to live-fire testing.

Figure 4. KAC QDSS-NT4 Suppressor

OSS built the second type of suppressor used during this test. The Back Pressure Regulator (BPR) and a Signature Reduction Module (SRM) are the two components of this suppressor system. The OSS suppressor used during this testing effort was an over the barrel system (see Figure 5). The BPR increases the weapon system length by 1.6 inches beyond the end of the barrel and it weighs 14 ounces. The SRM increases the weapon system length by 4.2 inches and it weighs 8.7 ounces. The TT removed the compensators and bayonet studs from the M27s used with the OSS suppressor in order to allow the suppressor system properly mount over the barrel. For purposes of this test, the TT considered the OSS suppressor equipped M27s unsuppressed when fired with the BPR, but without the SRM. The TT considered the OSS suppressor equipped M27s suppressed when fired with both the BPR and the SRM. The OTF Armorer attached the OSS kit to the weapons designated to use the OSS suppressors prior to live-fire testing.

Figure 5. OSS Suppressor System (BPR and SRM)

5. TEST ORGANIZATION

The TT was the organization responsible for the execution of the SPR testing and the collection of data. Table 1 lists the personnel requirements and their source. The TT had planned for only three shooters, but Shooter #3 was required elsewhere for the last two cycles of fire. Shooter #4 replaced Shooter #3 during the last two cycles of fire.

Table 1. Test Personnel

Billet	Source	Comments
Team Lead, General Purpose Team	PdM IW	Major Jason Arthaud
Lead Engineer, PdM IW	PdM IW	Salvatore Fanelli
Test Manager	PdM IW	Al Matthews
Project Officer	PdM IW	Guy Callahan
Small Arms Subject Matter Expert (SME)/Data Collector (DC)	PdM IW	Tony Perry
Project Engineer/Data Collection Chief (DCC)	PdM IW	Wes Bird
Officer-in-Charge (OIC)/Sniper SME	PdM IW	Bill Norton
Range Safety Officer (RSO)	PdM IW	Christian Stier
Shooters	PdM IW	1-Bill Norton 2-Major Arthaud 3-GySgt Brian Nelson 4-GySgt Chris O'Shea

Table 2 provides a listing of the Units Under Test (UUTs) and the associated equipment used during the SPR testing.

Table 2. UUTs and Associated Equipment

M27 Serial #	UUT #	Optic Serial #	Suppressor Serial #
USMC-172-000368	A1	346870U	NA
USMC-172-000370	A2	320661U	NA
USMC-172-000371	A3	148629L	NA
USMC-172-000372	B4	184735M	N411911
USMC-172-000373	B5	348380L	N411912
USMC-172-000374	B6	276888U	N411913
USMC-172-000375	C7	320608U	MT1307027
USMC-172-000376	C8	348042K	MT1307028
USMC-172-000391	C9	320669U	MT1307029
USMC-172-000398	Backup	320642U	N411914 and N409938 MT1307030 and MT1307031

Table 3 provides the equipment assignments for each shooter designated to shoot scored groups for dispersion.

The same lot of ammunition (Lot #: BLH11L194-002) of Special Ball, Long Range, 5.56mm, ammunition (DODIC: AA53) was fired throughout the live-fire events.

Table 3. Shooter Equipment Assignments

Shooter	UUT	M27 Serial #	Optic Serial #	Suppressor Serial #
1	**A1**	USMC-172-000368	346870U	NA
	B4	USMC-172-000372	184735M	N411911 (KAC) N411914 (KAC)
	C7	USMC-172-000375	320608U	MT1307027 (OSS)
2	**A2**	USMC-172-000370	320661U	NA
	B5	USMC-172-000373	348380L	N411912 (KAC)
	C8	USMC-172-000391	348042K	MT1307028 (OSS)
3/4	**A3**	USMC-172-000371	148629L	NA
	B6	USMC-172-000374	276888U	N411913 (KAC)
	C9	USMC-172-000398	320669U	MT1307029 (OSS)

Note: The TT replaced KAC suppressor N411914 for UUT B4 after the 2700 round durability cycle due to baffle strike on N411911.

Table 4 provides User Attributes on the PdM IW personnel who fired the UUTs for scored data.

Table 4. User Attributes

Shooter	Height	Weight	Right or Left Handed	Corrected Vision
1	73”	210	Right	No
2	73”	210	Left	No
3	69”	175	Right	No
4	72”	205	Right	No

6. TEST EXECUTION

This test effort focused on conducting verification testing of measureable attributes at the OTF and the EOSF both prior to and after live-fire. The test effort also focused on recording the performance of the M27 IAR equipped with a Leupold Mark 4 Scope during both suppressed (using two different types of suppressors) and non-suppressed fire. All test events were conducted at Marine Corps Base Quantico in accordance with the TP for the SPR. All range operations were conducted in accordance with the Quantico Range Regulations (reference (c)).

During November 2015 through March 2016, the TT conducted the test events in five phases at Marine Corps Base Quantico in Quantico, Virginia (as per Table 5). Phase I consisted of receipt and inventory of the equipment (scopes, scope mounts, and suppressors) required to conduct this test. Phase II consisted of the verification testing which was conducted at the OTF and at the EOSF from 14 December 2015 through 8 January 2016. Phase III consisted of the live-fire portion of the SPR testing conducted during 11-14 January 2016 at training ranges aboard Marine Corps Base Quantico using PdM IW personnel. Phase IV consisted of post live-fire verification testing conducted at the OTF and at the EOSF. Phase V consisted of the consolidation of the data collected, analysis of the data, and compilation of this TR.

Table 5. Test Schedule

TIMELINE	EVENT
Phase I	
5 Nov 15	Test Manager conducted Acoustic System Pilot Test at Precision Weapons Section (PWS).
6 Nov- 14 Dec 15	Received and inventoried optics and suppressors. OTF personnel configured M27 IARs with assigned optics and suppressors.
Phase II	
15 Dec 15- 8 Jan 16	OTF personnel conducted pre-fire verification testing. EOSF inspected optics for serviceability and baselined optics for repeatability.
Phase III	
11 Jan 16	The TT setup Range 1. Acoustic, Echo and BZO Targets located 100 meters from firing line. Zeroed weapons (unsuppressed) at 100 meters and confirmed zero with acoustic system. The TT fired cycles 1 and 2 semi (600 rounds per weapon) for 9 weapons.
12 Jan 16	The TT setup Range 2 with the targets forward of the 100 yard line, 100 meters from firing line at 200 yard line. Confirmed zero with acoustic system after 600 rounds. The TT fired cycles 3 and 4 semi for 9 weapons (1200 rounds per weapon). Confirmed zero with acoustic system after 1200 rounds.
13 Jan 16	The TT setup Range 2. The TT fired cycles 5 and 6 semi for 9 weapons (1800 rounds on each weapon). Confirmed zero with acoustic system after 1800 rounds.
14 Jan 16	The TT setup Range 2. The TT fired cycle 7 semi and 8 semi/burst for 9 weapons (2400 rounds on each weapon). Confirmed zero with acoustic system after 2400 rounds. The TT fired cycle 9 semi/burst for 9 weapons (2700 rounds on each weapon). The TT fired for cyclic rate of fire with weapons B5 and C7. Confirmed zero with acoustic system after 2700 rounds.
Phase IV	
15 Jan – 12 Feb 16 22 Jan – 9 Mar 16	OTF Post Live-Fire Verifications and User Surveys EOSF-Inspect the Leupold Mark 4 Scopes for serviceability post live-fire and report the results.
Phase V	
12 Feb-11 Mar 16	Data analysis and preparation of Test Report

Phase I

All of the M27 IARs required OTF personnel to mount the Leupold Mark 4 Scope using the Larue mount. UUTs A1-A3 did not require the mounting of any suppressors (see Figure 6).

Figure 6. Baseline UUTs A1-A3 (Not Suppressed)

The KAC suppressor required the current compensator to be replaced with a KAC compensator (see Figure 7) by OTF personnel in order to attach the suppressor to the M27 IAR. The TT used a shim kit and torque applied without Rock Set.

Figure 7. KAC Suppressor with Compensator prior to Configuring the M27

OTF personnel configured UUTs B4-B6 to accept the KAC suppressor and the Leupold Mark 4 Scope (see Figure 8).

Figure 8. UUTs B4-B6 with KAC Suppressor

OTF personnel configured UUTs C7-C9 to accept the OSS suppressor by removing the compensator from the M27 IAR and mounting the OSS suppressor directly to the existing threads. UUTs C7-C9 were configured to accept the Leupold Mark 4 Scope (see Figure 9).

Figure 9. UUTs C7-C9 with OSS Suppressor

Phase II

After the OTF personnel had configured each of the UUTs into the proper configuration, a technical inspection to verify measureable attributes as stated in the TP (see Tables A-1, A-2 and A-3 in Annex A) was conducted. The TT removed the Leupold Mark 4 Scopes from the UUTs and sent them to the EOSF for technical inspections for serviceability (see Figure 10). EOSF personnel inspected the ten scopes and recorded pertinent data for comparison during post live-fire inspections (see Table A-4 in Annex A)

Figure 10. UUTs A1, B6 and C7 without Leupold Mark 4 Scope

Phase III

Range 1 (*11 Jan*)/Range 2 (*12-14 Jan*)

On 11 January 2015, the TT moved to Range 1 to begin the live-fire portion of this effort. An armorer from OSS inspected, upgraded the on-hand OSS suppressors at PWS, which was next to Range 1, and provided a class/special tools to the OTF Armorer for installing the OSS suppressors. The TT setup the acoustic target cube (see Figure 11) and three echo silhouettes at the down range (see Figure 12). The TT moved back 100 meters and setup the acoustic firing point on the left of the firing line and three firing points to the right (see Figure 13).

Figure 11. Acoustic Cube and Target

Figure 12. Range 1 Target Setup

Figure 13. Range 1 Firing Point Setup

The TT started the live-fire event by having the assigned shooters Battle Sight Zero (BZO) from their assigned firing points with their assigned UUTs at a BZO target 100 meters distance. After the initial BZO, the shooters moved over to the acoustic firing point where a *lead sled* was setup to provide shooter support during scored firing (see Figures 14 and 15).

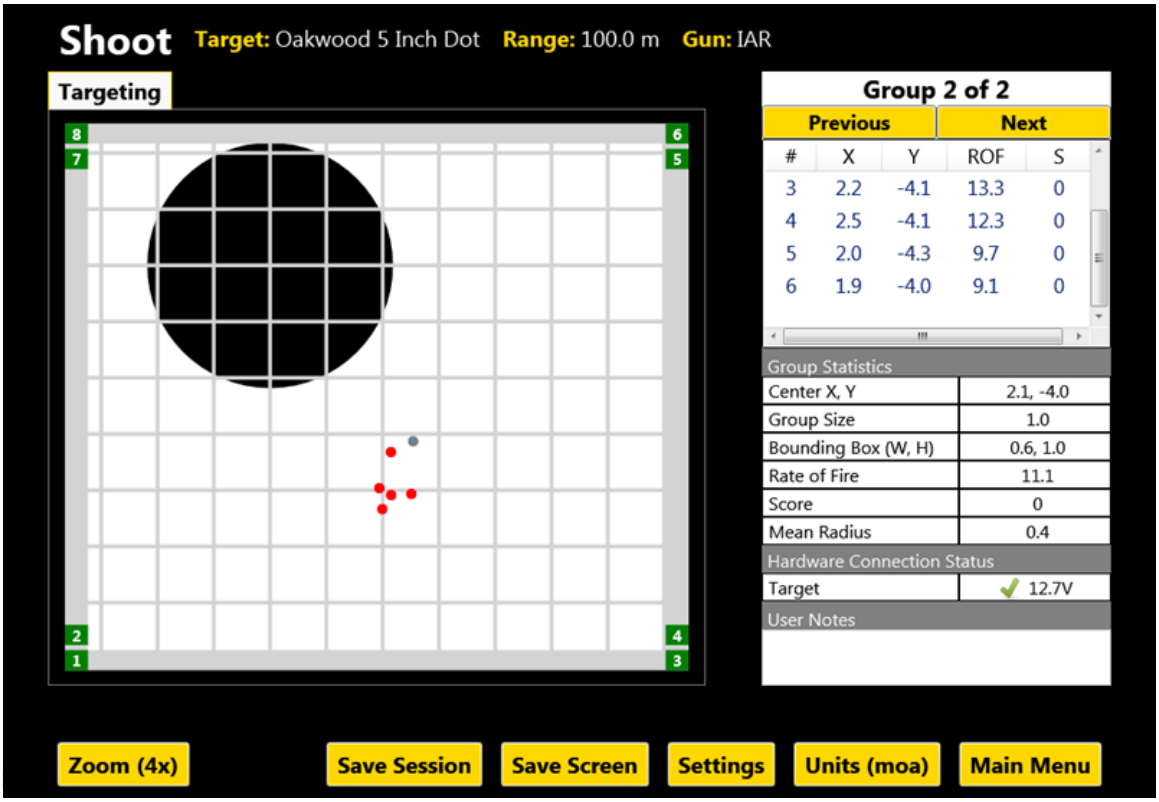
Figure 14. Lead Sled for Firing at Acoustic Target

Figure 15. Lead Sled Oriented towards Acoustic Target

Shooters fired a warmer/spotter round (see Figure 16) through the acoustic cube and then five scored rounds using the BZO target on the echo silhouette as the point of aim. Shooters fired two scored groups with the suppressed UUTs, the first group was suppressed, and the second group was unsuppressed.

Figure 16. Firing at Acoustic Target

The scored round data (see Figure 17) was captured via Wi-Fi from the acoustic target to a Toughbook computer stationed behind the acoustic firing point (see Figure 18) located 100 meters from the target. Captured data displayed the X and Y location of each round fired through the target and the Minute of Angle (MOA-Group Size) of the five valid scored rounds. The warmer/spotter round was shown grayed out but the software was setup for the data on this round to be disregarded for MOA purposes. The shooters were encouraged to keep the same point of aim for each round fired within a group.



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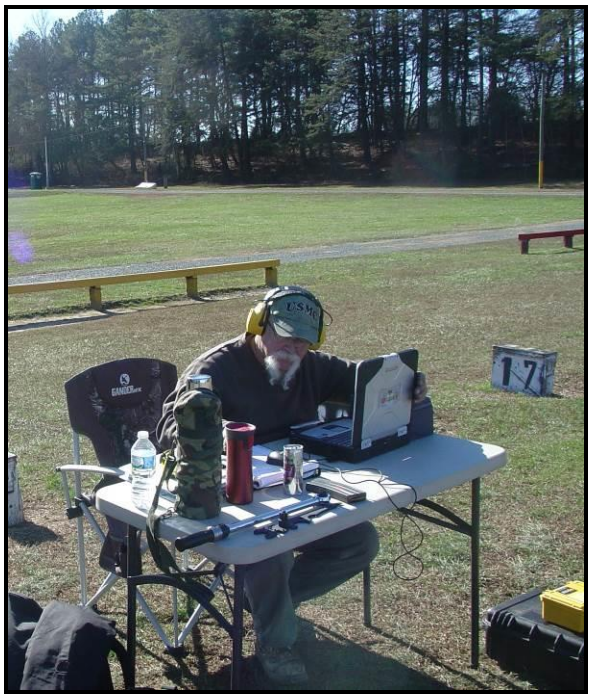


Figure 18. Collecting Acoustic Target Data with Toughbook

Each shooter fired one scored group with the unsuppressed UUTs (A1-A3) and two scored groups with the suppressed UUTs (B4-B6 and C7-C9). The OTF Armorer removed the KAC suppressor (see Figure 19) for UUTs B4-B6 by hand.

Figure 19. OTF Armorer removing KAC Suppressor

For UUTs C7-C9 the OTF Armorer used a tool (see Figures 20 and 21) to remove the SRM leaving only the BPR on the UUT (see Figure 22). Shooter #3 was uncomfortable with the lead sled and fired for score using the bipod for the initial scored rounds and then again for the scored rounds at the 600 round count. Shooter #3 changed to the lead sled at the 1200 round count and continued to use the lead sled through the remainder of the test.

Figure 20. Tool used to remove SRM from UUTs C7-C9

Figure 21. OTF Armorer removing SRM from UUT C9

Figure 22. Shooter 4 Firing UUT C9 for Score (without SRM)

After each shooter had fired scored rounds for the baseline with each of their assigned UUTs (unsuppressed and suppressed), then the shooters moved back to their assigned firing points to begin durability/reliability firing. Each shooter had an assigned DC and a table behind the firing point where 10 magazines for each UUT for that assigned shooter were loaded with 30 rounds each (see Figures 23 and 24) with a speed loader. Magazines were numbered with the UUT number and then a dash, followed by 1 through 10 (i.e. magazines for UUT A1 were numbered A1-1 through A1-10). The TT fired the magazines in sequence and the numbering system on the magazines was used to track stoppages.

Figure 23. Using Speed Loader to Load Magazines

Figure 24. Firing Line with Data Collectors

For the durability/reliability firing, the shooters fired on echo silhouette targets with BZO targets affixed (see Figures 25-27).

Figure 25. Shooter 1's Target for Durability/Reliability

Figure 26. Shooter 2's Target for Durability/Reliability

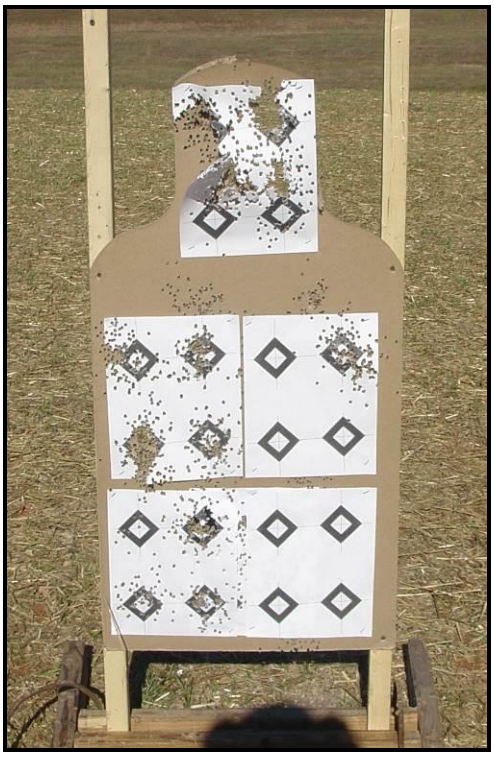


Figure 27. Shooter 3 & 4's Target for Durability/Reliability

Shooters fired magazines 1 through 5 for each assigned UUT in sequence starting with the A's, then the B's and finishing with the C's. The shooters would then start over with A, then B, and finish with C with magazines 6 through 10. The TT was prepared to cool the barrels with an air compressor but the cold temperatures allowed the barrels and suppressors to cool well below the 120^{o} F requirement before firing magazines 6-10. Firing of all ten magazines per UUT was called a cycle of fire of 300 rounds. After every 300 rounds fired, the UUTs were disassembled, cleaned, lubricated, and reassembled. The TT encountered difficulties in fully disassembling the OSS equipped UUTs as they did not want to fully remove the BPR each time. The TT opted to bore brush the barrel and pull a cleaning snake through the weapon. The TT reloaded empty magazines prior to starting a new cycle of fire. Backup magazines were available to replace defective magazines as needed. Cycles 1 through 7 (2100 rounds total per UUT) were all fired in semi-automatic mode. Cycles 8 and 9 (the last 600 rounds per UUT on Day 4) were fired by alternating between semi-automatic mode and burst mode.

Shooter #1 fired UUTs A1, B4, and C7 throughout the test (see Figures 28-31).

Figure 28. Shooter 1 Firing UUT A1

Figure 29. Shooter 1 Firing UUT B4 Suppressed

Figure 30. Shooter 1 Firing UUT C7 Suppressed

Figure 31. Shooter 1 Firing UUT C7 without SRM

Shooter #2 fired UUTs A2, B5, and C8 throughout the test (see Figures 32-36).

Figure 32. Shooter 2 Firing UUT A2

Figure 33. Shooter 2 Firing UUT B5 Suppressed

Figure 34. Shooter 2 Firing UUT B5 Unsuppressed

Figure 35. Shooter 2 Firing UUT C8 Suppressed

Figure 36. Shooter 2 Firing UUT C8 without SRM

Shooter #3 fired A3, B6, and C9 throughout the test until reaching the 1800 round count and then Shooter #4 fired those UUTs through to the final 2700 round count (see Figures 37-38).

Figure 37. Shooter 3 Firing UUT A3

Figure 38. Shooter 4 Shooting UUT B6 Suppressed

On Day 1 of the live-fire (11 Jan) the TT was able to BZO all the UUTs, baseline all the UUTs for score with the acoustic targeting system after BZO, and fire cycles 1 and 2 for a total of 600 rounds for durability/reliability on each UUT. The Commanding Officer for Weapons Training Battalion observed testing for about an hour on Range 1. See Appendix 2 to Annex A for Test Incident Reports (TIRs)/Stoppage reports reported during the live-fire for each day.

On Day 2 of the live-fire (12 Jan), the TT moved to Range 2 to set the range up in the same manner as on Range 1. The TT fired at Range 2 for the remainder of the live-fire. The TT fired the UUTs with the acoustic targeting system for score after 600 rounds, and then fired cycles 3 and 4 for an accumulated 1200 rounds for durability (600 rounds on Day 1 and Day 2). The TT fired the UUTs for score with the acoustic targeting system after 1200 rounds. The TT noted that the magazines for the Bravo UUTs showed a lot of carbon buildup as compared to the Alpha and Charlie UUTs (see Figure 39). The Program Manager (PM) and Deputy PM for IWS arrived to observe testing. The PM fired a magazine of 30 rounds through UUTs B4 and C7 and the Deputy PM fired 30 rounds through UUT A1 during cycle 4 of durability/reliability.

Figure 39. Carbon Build-up Magazine Comparison

On Day 3 of the live-fire (13 Jan), the TT fired cycles 5 and 6 (accumulated 1800 rounds for durability). The TT fired the UUTs with the acoustic targeting system for score after 1800 rounds. The TT encountered issues with the lithium batteries for the acoustic targeting system due to the extreme cold. Temperatures started at 22^{o} F and the highest temperature reached during the day was 33^{o} F. The lithium batteries were dead due to the cold, so the TT used the portable generator and chargers to charge the batteries up for use to collect the dispersion data after 1800 rounds.

On Day 4 of the live-fire (14 Jan), the TT fired cycles 7 and 8 for an accumulated 2400 rounds for durability. For cycle 7, the TT continued to fire the entire cycle in semi-automatic mode. For cycle 8, the TT alternated between semi-automatic and automatic fire (bursts). The TT fired magazines 1, 3, and 5 in semi-automatic mode. The TT fired magazines 2 and 4 in automatic fire mode. The TT fired magazine 2 in a 3-5 round burst and magazine 4 fired in a 5-7 round burst. The TT used this same pattern of fire for magazines 6-10, with 6, 8, and 10 fired in semi-automatic and magazines 7 and 9 fired in automatic mode (see Figures 40-42). The TT had the shooters shoot into the berm so that the RSO could observe impacts when firing in automatic mode.

Figure 40. Shooter 1 Firing Burst with UUT A1

Figure 41. Shooter 2 Firing Burst with UUT B5

Figure 42. Shooter 4 Firing Burst with UUT A3

After cycle 8, the TT fired the UUTs with the acoustic targeting system for score after 2400 rounds. The TT cleaned weapons, reloaded magazines and fired cycle 9 in the same manner as cycle 8 (semi-automatic and automatic mode). The TT noted at the end of cycle 9 that UUT B4's KAC suppressor (N411911) had a baffle strike (see Figure 43). The TT replaced this suppressor with the backup KAC suppressor (N411914). Upon completion of cycle 9, the TT attempted to capture the cyclic rate of fire using a shot counter with UUT B5 and UUT C6. The TT was unable to capture valid data with the shot counter. From the data collected, it could only be determined that the B4 weapon had a higher cyclic rate of fire than the C6 weapon, which was to be expected based on the advertised characteristics of the OSS suppressor (lower bolt velocity than baffled suppressors).

Figure 43. KAC Suppressor Baffle Strike on UUT B4

The TT fired the UUTs with the acoustic targeting system for score after 2700 rounds, which completed the live-fire for this effort. The TT cleaned up the range and all serialized gear was returned to the OTF.

Phase IV

OTF/EOSF Post Live-Fire Verification Inspections

The OTF Armorer held several discussions with the vendor on the issue of the SRM and BPR caps for the OSS suppressors loosening during the live-fire. These discussions started on the third day of live-firing (13 Jan) and continued into the post live-fire phase. The vendor hypothesized that the firing schedule did not meet the number of rounds fired at a cyclic rate to self-tighten and maintain a tight fit for the SRM. The vendor did agree with the TT's course of action of applying torque during tightening of the SRM caps. The OTF encountered extreme difficulty in removing the OSS BPR from the weapon even with the "special tools" provided by the vendor due to the heavy carbon build up within the two components. One of the OSS suppressors was broken in the attempt to disassemble (see Figure 44). The remaining OSS suppressors have been soaking in Hoppes Rifle Bore Cleaner to allow for the breakdown of the carbon build-up. See Table A-4 and A-4A in Annex A for EOSF Post Live-Fire results.

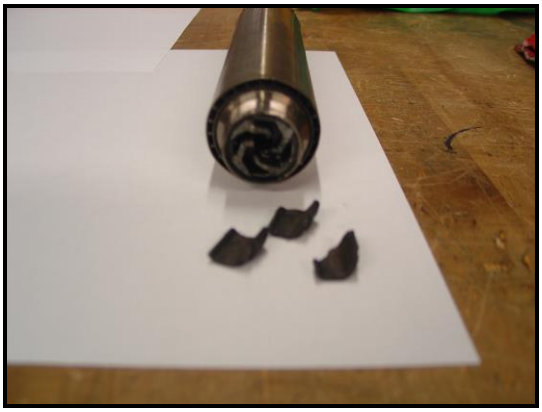


Figure 44. OSS Suppressor with Broken Parts

User Survey

Upon completion of the live-fire event (14 Jan), the Test Manager provided the designated shooters with a User Survey. The shooters completed the User Survey Questionnaire based on their experiences using their assigned UUTs during the live firing effort.

User Survey Results

The shooter was given a User Survey consisting of 17 questions on the SPR. Each shooter was assigned a User ID as per Table 6. The TT used the User ID to track all user survey data collected during the SPR effort.

Table 6. User IDs

Shooter	UUT	User ID
1	A1, B4 and C7	1
2	A2, B5, and C8	2
3	A3, B6 and C9	3

Each question except for questions #15 and #17 in the user survey was associated with a six-point response scale as shown in Table 7. Questions #15 and #17 are For Informational Purposes Only (FIPO) and required the user to rate the suppressor in question on a scale of 1 to 5 with 5 being the best.

Table 7. Response Scale for Survey Questions

Negative Responses			Positive Responses			
Completely Disagree	Substantially Disagree	Slightly Disagree	Slightly Agree	Substantially Agree	Completely Agree	N/A

The User Survey results in Table 8 show the percentage of positive responses for the final answers to the questions. The responses that are 66.6% resolution (2 out of 3 users with positive opinions) or above for the question are shaded in light green and considered MET. The responses that are below 66.6% resolution are shaded in light red. Questions #15 and #17 are FIPO questions and shaded in brown. The User Survey results are provided in detail in Appendix 3 to Annex A

Table 8. User Survey Results

Q #	MOE #	Question	Results
1	M-2	The Mark 4 Scope **easily withstood the shock, vibration, and recoil** of the durability firing of 2700 rounds with the M27 IAR **(Alpha UUTs).**	Met (3/3)
2	M-2	The user did not observe any **physical damage or performance degradation** to the Mark 4 Scope during the durability firing of 2700 rounds with the M27 IAR **(Alpha UUTs).**	Met (3/3)
3	M-2	The Mark 4 Scope **easily withstood the shock, vibration, and recoil** of the durability firing of 2700 rounds with the M27 IAR and the **KAC suppressor (Bravo UUTs)**.	Met (3/3)
4	M-2	The user did not observe any **physical damage or performance degradation** to the Mark 4 Scope during the durability firing of 2700 rounds with the M27 IAR and the **KAC suppressor (Bravo UUTs)**.	Met (3/3)
5	M-2	The Mark 4 Scope **easily withstood the shock, vibration, and recoil** of the durability firing of 2700 rounds with the M27 IAR and the **OSS suppressor (Charlie UUTs)**.	Met (3/3)
6	M-2	The user did not observe any **physical damage or performance degradation** to the Mark 4 Scope during the durability firing of 2700 rounds with the M27 IAR and the **OSS suppressor (Charlie UUTs)**.	Met (3/3)
7	M-4	The Mark 4 Scope is an **improvement over the Squad Day Optic** (SDO).	Met (3/3)
8	M-5	The Mark 4 Scope is **compatible** with the M27 IAR.	Met (3/3)
9	M-6	The user could **easily attach** the Mark 4 Scope to the M27 IAR **without tools**.	Met (3/3)
10	M-6	The **heat signature** from the **KAC suppressor** during firing **did not degrade** the user's ability to **engage targets**.	Met (2/3)
11	M-6	The **KAC suppressor** had **less heat signature effect** on the Mark 4 Scope than the heat signature from the unsuppressed IAR.	Not Met (0/3)
12	M-6	The **heat signature** from the **OSS suppressor** during firing **did not degrade** the user's ability to **engage targets**.	Met (3/3)
13	M-6	The **OSS suppressor** had **less heat signature effect** on the Mark 4 Scope than the heat signature from the unsuppressed IAR.	Not Met (0/3)
14	M-13	The **KAC suppressor** was **compatible** with the M27 IAR.	Met (3/3)
15	M-13	**Rate** the **KAC suppressor** on a scale of 1-5 with **5 being the best**.	3.66 average
16	M-14	The **OSS suppressor** was **compatible** with the M27 IAR.	Met (2/3)
17	M-14	**Rate** the **OSS suppressor** on a scale of 1-5 with **5 being the best**.	3.00 average
18	M-17	The **KAC suppressor** was **durable** throughout the durability firing of 2700 rounds.	Met (3/3)
19	M-18	The **OSS suppressor** was **durable** throughout the durability firing of 2700 rounds.	Met (2/3)
20	M-21	The **KAC suppressor** was **easy to remove** and **reattach** to the M27 IAR for cleaning.	Met (3/3)
21	M-21	The **KAC suppressor** was **easy to clean**.	Met (2/3)
22	M-22	The **OSS suppressor** was **easy to remove** and **reattach** to the M27 IAR for cleaning.	Not Met (0/3)
23	M-22	The **OSS suppressor** was **easy to clean**.	Not Met (1/3)

7. TEST LIMITATIONS

Test limitations are risk characterizations that the decision authority assumed.

(a) **Limitation #1.** The TT did not experience all climates and weather conditions during SPR testing. The conditions were those present during the January timeframe at Quantico, Virginia. The TT did not evaluate the performance of the optic and the suppressors in other climates and weather conditions, especially extremes such as hot-humid, constant high humidity, or severe cold, during this exploratory testing. There is risk that the optic and/or the suppressors may not perform as well or in a similar manner in these climates.

(b) **Limitation #2.** The TT limited the amount of rounds fired to 2700 rounds per weapon based on the successful performance of the Leupold Mark 4 Scope on the MK 12 MOD 1. There is risk that the optic may not perform as well or in the same manner under a higher round count on the M27 IAR.

(c) **Limitation #3.** The bulk of the durability testing with the M27 IAR was done in the semi-auto mode for which the SPR is intended. Limited durability testing was done in the automatic mode to ensure that the Leupold Mark 4 Scope is durable under limited automatic fire. There is risk that the optic and/or suppressor may not perform as well or in a similar manner under extended automatic fire.

(d) **Limitation #4.** The suppressor testing for the IAR consisted of only two types of 5.56mm suppressors (KAC and OSS). This testing was considered research for internal use by PdM IW.

8. DATA COLLECTION AND ANALYSIS

The TT conducted all SPR test events in accordance with the TP. Data collection was both quantitative (verification and live-fire testing) and qualitative (user opinions) in nature. The test results are in Annex A. Test deviations are in Appendix 1 of Annex A. TIRs/Stoppage Reports are listed in Appendix 2 to Annex A. The designated shooters were required to complete user surveys as described in the User Survey Results section of this report. The raw survey results are shown in Appendix 3 to Annex A. Annex B provides the scored data as collected from the acoustic targeting system. Appendix 1 to Annex B provides the X and Y coordinates for the Mean Point of Impact (MPI) of the unsuppressed scored group and the suppressed scored group. Appendix 2 to Annex B shows the MOA data by shooter for each assigned UUT. Appendix 3 to Annex B shows the MOA data by weapon configuration. Appendix 4 to Annex B shows the POI shift as determined by the MPI for both the scored suppressed and scored unsuppressed groups. Annex C provides data on the observed weather conditions during the test. Annex D provides acoustic targeting data through screen captures for each scored group per weapon. Annex E provides the data collected by the EOSF on the Leupold Mark 4 Scopes.

9. ANNEXES AND APPENDICES

Annex A: Test Results

Appendix 1 to Annex A: Test Deviations
Appendix 2 to Annex A: Test Incident Reports/Stoppage Reports
Appendix 3 to Annex A: User Survey Results

Annex B: Scored Group Data

Appendix 1 to Annex B: Scored Data for Shot Locations
Appendix 2 to Annex B. Scored Data by Shooter
Appendix 3 to Annex B. Scored Data by Weapon Configuration
Appendix 4 to Annex B. Scored Data for POI Shift

Annex C. Weather Data during Live-Fire

Annex D. Screen Capture Data
Appendix 1 to Annex D. Alpha UUT Scored Data
Appendix 2 to Annex D. Bravo UUT Suppressed Scored Data
Appendix 3 to Annex D. Bravo UUT Unsuppressed Scored Data
Appendix 4 to Annex D. Charlie UUT Suppressed Scored Data
Appendix 5 to Annex D. Charlie UUT Unsuppressed Scored Data

Annex E. Electro-Optical Support Facility Data

Annex A: Test Results

A Pilot Test was conducted on 5 November 2015 at the Precision Weapon Section to ensure that the scored rounds could be captured using the portable acoustic targeting system. The User Survey Questionnaires provided data that was qualitative in nature. The User Survey Question Resolution used the Resolution Rules from Appendix 5 to annex D of the TP to resolve the MET/NOT MET criteria.

Tables A-1 through A-3 show the results of the OTF Technical Inspections. Table A-4 shows the results of the EOSF Pre-Fire and Table A-4a shows the results of the Post-Fire Inspections conducted on the Mark 4 Leupold Scopes. Additional EOSF data is in Annex E.

Table A-5 shows the results of the User Survey Question Resolution with those areas shaded in light green indicating that the Questions were resolved favorably and light red indicating that the Questions were resolved unfavorably. Questions were resolved as MET if 66.6% or more of the Users responded favorably. Questions that were FIPO are shaded in light brown.

The Measures for each Attribute (taken directly from the Table D-1-1 in Appendix 1 to Annex D of the TP) are listed in the Measure Resolution Tables (see Table A-6 for the Leupold Mark 4 Scope, Table A-7 for the KAC Suppressor, and Table A-8 for the OSS Suppressor. The results were determined from the User Survey Question Resolutions (Table A-5), from the data collected from the Technical Inspections by the OTF/EOSF, and from the acoustic target data for scored groups. Measures that met the resolution rules (*MET*) are shaded in light green. Measures that failed to meet the resolution rules (*NOT MET*) are shaded in light red. Measures that were *Met with Exception* are shaded in yellow.

The resolution determined for each attribute is in Table A-9. The same color-coding used in Table A-8 is in Table A-9.

RESULTS

Leupold Mark 4 Scope

Based on the data collected for shock, compatibility, target engagement, MOA, and repeatability, this optic met all the requirements for use on the M27 IAR when unsuppressed. This optic met all the requirements for use on the M27 IAR when suppressed with either the KAC suppressor or the OSS suppressor. The operators did indicate that the heat signature for both was greater than an unsuppressed IAR, but they also stated that the KAC suppressor and the OSS suppressor did not degrade the ability of the operator to engage targets.

KAC Suppressor

The KAC suppressor met all the attributes as stated in the TP except for the POI Shift of 2 MOA from unsuppressed to suppressed scored groups. The KAC suppressor had an average POI shift for all shooters over the course of fire (18 calculations) of 2.49 MOA. Of the 18 calculations for POI shift, three were over 3 MOA and three were over 4 MOA. Based on the average, the attribute of 2 MOA for POI shift cannot be met on a consistent basis with the KAC suppressor. It is the Test Manager's opinion that POI shift is not as important as it once was. Marine Corps snipers are interested in what the POI shift is for their weapon, but their Tactics, Techniques and Procedures (TTP's) call for them to shoot suppressed rather than unsuppressed. If the TTP for the SPR will require the operator to shoot suppressed rather than unsuppressed, then this attribute should be changed. The TT was not able to determine cyclic rate of fire with the KAC suppressor due to equipment issues during testing.

OSS Suppressor

The OSS suppressor met all the attributes as stated in the TP except for suppressor maintainability. The OSS suppressor used during this effort was an over-the-barrel suppressor that required the OTF armorer to remove the bayonet lug from the M27 prior to mounting the OSS suppressor. The OSS over-the-barrel suppressor prevented the operator from gaining access to the gas piston for cleaning and maintenance, which was a major concern for the operators. The TT also experienced issues in removing the OSS suppressors from the M27 for post live-fire inspections. In hindsight, the TT should have obtained OSS suppressors that were of a flush mount or quick-detach type of mount for this effort. The TT noted that the operators shot appreciably better with the OSS suppressor with an overall average of 1.11 MOA suppressed, which was better than the average MOA suppressed using the KAC suppressor. The average POI shift using the OSS suppressor was 1.26 inches, which met the attribute as stated in the TP. Only one of the 17 validated POI shifts exceeded the 2 MOA requirement at 2.17 MOA. The outstanding results obtained with the OSS suppressor justified the research conducted.

Table A-1. OTF Technical Inspection (Form 1A)

UUT TECHNICAL INSPECTION			
IAR Serial # (List all three)	USMC-172-000368	USMC-172-000370	USMC-172-000371
UUT # for each weapon:	A1	A2	A3
LTI/PFI Passed (circle one):	YES	YES	YES
Mark 4 Serial # (List all three)	346870U	320661U	148629L
Ten magazines marked per UUT	YES	YES	YES
Record the weight of each UUT configured with optic	11.26 lbs.	11.28 lbs.	11.28 lbs.
Photograph each UUT configured with optic with UUT markings visible	YES		
Length with Buttstock extended:	37.25 in (E)		
Length with Buttstock collapsed:	33.50 in (C)		
Photo			

Comments:

Weighed with:
- With Front/Rear Iron Sights
- With Mark 4 Optic
- With sling and bipod
- No Manta rail covers on weapon when weighed (shooters will configure for shooting)
- No forward grips on rails when weighed (shooters will configure for shooting)
- No suppressor for the A's
- Note: UUT A2 was missing the cover for the front of the optic

Length measurement was from top of buttstock in both fully extended and collapsed mode.

Inspector: Robert Perry	Date: 14-15 Dec 15
Verifier: Alan J. Matthews	Date: 14-15 Dec 15

Table A-2. OTF Technical Inspection (Form 1B)

UUT TECHNICAL INSPECTION			
IAR Serial # (List all three)	USMC-172-000372	USMC-172-000373	USMC-172-000374
UUT # for each weapon:	B4	B5	B6
LTI/PFI Passed (circle one):	YES	YES	YES
Leupold Serial # (List all three)	184735M	348380L	276888U
KAC Suppressor Serial #	N411911	N411912	N411913
Ten magazines marked per UUT	YES	YES	YES
Record the weight of each UUT configured with optic and suppressor	12.64 lbs.	12.64 lbs.	12.64 lbs.
Record length of each UUT:	42.00 in (E)/38.25 in (C)		
Mark 4 Scope can be attached to M27 IAR without tools.	YES		
The KAC suppressor can be installed on the M27 by a Unit level armorer.	YES, if Unit Armorer uses crush washers. NO, if Unit Armorer uses KAC shims, as these require a torque wrench, which is held at 3rd echelon maintenance.		
On a scale of 1-5, with 5 being the best, rate the ease of installation for the KAC suppressor.	1		
Photograph UUT fully configured with optic and suppressor.			
Inspect at 600, 1200, 1800, 2400, and 2700 round counts and note any suppressor anomalies during durability firing.	Test Team noted that the suppressor for UUT B4 had a baffle strike after completion of 9th cycle of fire (2700 rounds). Used backup suppressor to conduct final scored rounds for dispersion.		

Comments:

Weighed in same configuration as A's with addition of KAC compensator and KAC suppressor.
Note: UUT B5 was missing the cover for the front of the optic.

Length measurement was from top of buttstock in both fully extended and collapsed mode.

Inspector: Robert Perry	Date: 14-15 Dec 15
Verifier: Alan J. Matthews	Date: 14-15 Dec 15

Table A-3. OTF Technical Inspection (Form 1C)

UUT TECHNICAL INSPECTION			
IAR Serial # (List all three)	USMC-172-000375	USMC-172-000376	USMC-172-000391
UUT # for each weapon:	C7	C8	C9
LTI/PFI Passed (circle one):	YES	YES	YES
Leupold Serial # (List all three)	320608U	348042K	320669U
OSS Suppressor Serial # (List all three)	MT1307027	MT1307028	MT1307029
Ten magazines marked per UUT	YES	YES	YES
Record the weight of each UUT configured with optic	12.66 lbs.	12.74 lbs.	12.68 lbs.
Record length of each UUT:	42.0 inches with BPR & SMR 38.5 inches with just BPR		
Mark 4 Scope can be attached to M27 IAR without tools.	YES		
The OSS suppressor can be installed on the M27 by a Unit level armorer.	YES		
On a scale of 1-5, with 5 being the best, rate the ease of installation for the OSS suppressor.	5		
Photograph UUT fully configured with optic and suppressor.			
Inspect at 600, 1200, 1800, 2400, and 2700 round counts and note any suppressor anomalies during durability firing.	Noted issues with cap for SRM. Noted cleaning issues.		

Comments:

Weighed in same configuration as A's with additional removal of bayonet stud, addition of OSS BPR & SRM.
Note: UUT C7 was missing the cover for the front of the optic.

Length measurement was from top of buttstock in both fully extended and collapsed mode.
Length measured with SMR and without SMR.

Inspector: Robert Perry	Date: 14-15 Dec 15
Verifier: Alan J. Matthews	Date: 14-15 Dec 15

Table A-4. EOSF Baseline Technical Inspection

SUMMARY												
UUT		A1	A2	A3	B4	B5	B6	C7	C8	C9	BU	AVERAGE
(S/N)		346870U	320661U	148629L	184735M	348380K	276888U	320608U	348042K	320669U	320642U	
Actual Magnification	Set at 2.5X	2.12	2.69	2.50	2.50	2.58	2.50	2.31	2.50	2.31	2.58	2.45
	Set at 4X	2.81	3.59	3.18	3.19	3.20	3.31	3.05	3.10	2.92	3.38	3.15
	Set at 6X	4.70	4.72	4.20	4.50	4.72	4.77	4.54	4.31	4.52	4.82	4.55
	Set at 8X	6.87	7.14	6.72	6.65	6.75	6.84	6.47	6.51	6.49	6.75	6.72
Angular Δ After Unit Repositioned on Rail (MoA)	Trial 1	0.27	0.20	0.21	0.04	0.06	0.22	0.08	0.03	0.12	0.12	0.14
	Trial 2	0.47	0.25	0.20	0.08	0.13	0.07	0.06	0.16	0.09	0.04	NA
	Trial 3	0.52	0.24	0.20	0.10	0.16	0.05	0.10	0.15	0.11	0.18	NA
	Average	0.42	0.23	0.20	0.07	0.12	0.11	0.08	0.11	0.10	0.12	0.16
Alignment Δ after Field Use (MoA)	Trial 1	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	NA
	Trial 2	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	NA
	Average	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Ave Angular Δ per Increment/click (MoA)	Left/Right											
	Up/Down											
Number of Increments/clicks	Left/Right	56	56	56	57	56	57	56	56	56	56	56.22222
	Up/Down	192	194	191	193	185	190	192	185	192	194	190.4444
Total Angular Movement (MoA)	Left/Right											
	Up/Down											

Note: The Optics Engineer noted (yellow highlight) the higher average angular deviation for the optics mounted on UUTs A1-A3 as compared to the other UUTs.

Table A-4a. EOSF Post Live-Fire Technical Inspection

Post Live-Fire Summary											
UUT		A1	A2	A3	B4	B5	B6	C7	C8	C9	AVERAGE
(S/N)		346870U	320661U	148629L	184735M	348380K	276888U	320608U	348042K	320669U	
Actual Magnification	Set at 2.5X	2.57	2.75	2.62	2.74	2.74	2.74	2.61	2.63	2.75	2.68
	Set at 4X	3.94	3.63	3.76	3.87	3.75	3.98	3.86	3.75	3.89	3.82
	Set at 6X	5.75	5.56	5.64	5.61	5.61	5.77	5.64	5.73	5.63	5.66
	Set at 8X	8.14	8.45	8.34	8.09	8.11	8.11	8.24	8.13	8.08	8.19
Angular Δ After Unit Repositioned on Rail (MoA)	Trial 1	0.07	0.06	0.14	0.05	0.12	0.11	0.08	0.09	0.11	NA
	Trial 2	0.03	0.12	0.11	0.08	0.14	0.11	0.12	0.02	0.11	NA
	Trial 3	0.04	0.06	0.07	0.11	0.26	0.11	0.13	0.10	0.06	NA
	Average	0.05	0.08	0.11	0.08	0.17	0.11	0.11	0.07	0.09	0.10
Alignment Δ after Life-fire Test (MoA)	Trial 1	2.78	3.78	3.37	3.64	3.14	6.08	5.42	4.75	3.63	NA
	Trial 2	2.78	4.18	3.69	3.33	3.24	6.16	6.02	4.94	3.62	NA
	Average	2.78	3.98	3.53	3.48	3.19	6.12	5.72	4.85	3.62	4.14
Angular Δ per Increment/click (MoA)	Elevation	0.53	0.53	0.54	0.51	0.53	0.52	0.52	0.52	0.52	0.52
	Windage	0.53	0.53	0.53	0.52	0.54	0.53	0.53	0.53	0.52	0.53
Number of Increments/clicks	Elevation	56.00	56.00	56.00	57.00	56.00	57.00	56.00	56.00	56.00	56.22
	Windage	192.00	194.00	191.00	193.00	185.00	190.00	192.00	185.00	192.00	190.44
Total Angular Movement (MoA)	Elevation	29.68	29.68	30.24	29.07	29.68	29.64	29.12	29.12	29.12	29.49
	Windage	101.76	102.82	101.23	99.40	98.98	99.75	100.80	98.05	99.84	100.30

Note: The high angular delta noted for the UUTs A1-A3 during the Baseline was not observed during the Post Live-Fire technical inspections. It is the Test Manager's Opinion, that this was learning curve during the Baselining of the initial systems (A1-A3) or that there was a small error in the initial setup for those systems. The high values in alignment delta during the Post Live-Fire technical inspections are attributed to the shooters applying their BZO data to the scopes for their Length of Pull and sight picture.

Table A-5. User Survey Question Resolution

Q #	MOE #	Question	Results
1	M-2	The Mark 4 Scope **easily withstood the shock, vibration, and recoil** of the durability firing of 2700 rounds with the M27 IAR **(Alpha UUTs).**	Met (3/3)
2	M-2	The user did not observe any **physical damage or performance degradation** to the Mark 4 Scope during the durability firing of 2700 rounds with the M27 IAR **(Alpha UUTs).**	Met (3/3)
3	M-2	The Mark 4 Scope **easily withstood the shock, vibration, and recoil** of the durability firing of 2700 rounds with the M27 IAR and the **KAC suppressor (Bravo UUTs)**.	Met (3/3)
4	M-2	The user did not observe any **physical damage or performance degradation** to the Mark 4 Scope during the durability firing of 2700 rounds with the M27 IAR and the **KAC suppressor (Bravo UUTs)**.	Met (3/3)
5	M-2	The Mark 4 Scope **easily withstood the shock, vibration, and recoil** of the durability firing of 2700 rounds with the M27 IAR and the **OSS suppressor (Charlie UUTs)**.	Met (3/3)
6	M-2	The user did not observe any **physical damage or performance degradation** to the Mark 4 Scope during the durability firing of 2700 rounds with the M27 IAR and the **OSS suppressor (Charlie UUTs)**.	Met (3/3)
7	M-4	The Mark 4 Scope is an **improvement over the Squad Day Optic** (SDO).	Met (3/3)
8	M-5	The Mark 4 Scope is **compatible** with the M27 IAR.	Met (3/3)
9	M-6	The user could **easily attach** the Mark 4 Scope to the M27 IAR **without tools**.	Met (3/3)
10	M-6	The **heat signature** from the **KAC suppressor** during firing **did not degrade** the user's ability to **engage targets**.	Met (2/3)
11	M-6	The **KAC suppressor** had **less heat signature effect** on the Mark 4 Scope than the heat signature from the unsuppressed IAR.	Not Met (0/3)
12	M-6	The **heat signature** from the **OSS suppressor** during firing **did not degrade** the user's ability to **engage targets**.	Met (3/3)
13	M-6	The **OSS suppressor** had **less heat signature effect** on the Mark 4 Scope than the heat signature from the unsuppressed IAR.	Not Met (0/3)
14	M-13	The **KAC suppressor** was **compatible** with the M27 IAR.	Met (3/3)
15	M-13	**Rate** the **KAC suppressor** on a scale of 1-5 with **5 being the best**.	3.66 average
16	M-14	The **OSS suppressor** was **compatible** with the M27 IAR.	Met (2/3)
17	M-14	**Rate** the **OSS suppressor** on a scale of 1-5 with **5 being the best**.	3.00 average
18	M-17	The **KAC suppressor** was **durable** throughout the durability firing of 2700 rounds.	Met (3/3)
19	M-18	The **OSS suppressor** was **durable** throughout the durability firing of 2700 rounds.	Met (2/3)
20	M-21	The **KAC suppressor** was **easy to remove** and **reattach** to the M27 IAR for cleaning.	Met (3/3)
21	M-21	The **KAC suppressor** was **easy to clean**.	Met (2/3)
22	M-22	The **OSS suppressor** was **easy to remove** and **reattach** to the M27 IAR for cleaning.	Not Met (0/3)
23	M-22	The **OSS suppressor** was **easy to clean**.	Not Met (1/3)

Table A-6. Measure Resolution for Leupold Mark 4 Scope

Att #	MOE #	Task	Result
A-1	Attribute. **Shock.** The Leupold Mark 4 Scope shall withstand the shock, vibration, and recoil of repeated M27 IAR firing with no physical damage or performance degradation		
	M-1	Measure. EOSF will inspect the Leupold Mark 4 Scopes prior to the start of and upon completion of durability firing.	**MET**
	M-2	Measure. Operator opinion on the ability of the Leupold Mark 4 Scope to withstand the shock, vibration, and recoil of repeated M27 IAR firing with no physical damage or performance degradation.	**MET (3/3)**
A-2	Attribute. **Compatibility.** The Leupold Mark 4 Scope shall be compatible with and attachable to the M27 IAR via the Mil-Std-1913 rail system with no tools required.		
	M-3	Measure. OTF Armorer SME will verify that the Leupold Mark 4 Scope can be attached to the M27 IAR without tools.	**MET**
	M-4	Measure. Operator opinion on the compatibility of the Leupold Mark 4 Scope with the M27 IAR.	**MET (3/3)**
	M-5	Measure. Operator opinion on the ability to attach the Leupold Scope Mark 4 to the M27 IAR via the Mil-Std-1913 rail system without tools.	**MET (3/3)**
A-3	Attribute. **Target Engagement.** The firing of the M27 IAR and resulting heat signature shall not cause degradation in the ability of the operator to engage targets.		
	M-6	Measure. Operator opinion on the ability of the operator to engage targets without degradation from the heat signature resulting from the firing of the M27 IAR.	**MET (Unsuppressed)** **KAC (Met with Exception)** **OSS (Met with Exception)**
A-4	Attribute. **MOA.** The Leupold Mark 4 Scope will maintain a two Minute of Angle (MOA) to enable precise engagements from 300 to 600 meters.		
	M-7	Measure. The Test Team will capture the MOA for the 5 round scored groups fired during Zero and Confirmation of Zero (suppressed and unsuppressed).	**MET (1.56 MOA Uns)** **KAC MET (MOA 1.50 Sup/1.63 Uns)** **OSS MET (MOA 1.11 Sup/1.08 Uns)**
A-5	Attribute. **Repeatability.** The Leupold Mark 4 Scope will be capable of retaining zero during removal and re-attachment of the scope from/to the M27 IAR Mil-Std-1913 rail system.		
	M-8	Measure. The EOSF will conduct an optics repeatability test to ensure that the Leupold Mark 4 Scope retains zero when removed and re-attached from/to the M27 IAR Mil-Std-1913 rail system.	**MET**

Note: For Attribute A-3, the Test Manager resolved the attribute for both the KAC and OSS suppressors as Met with Exception, because the operator opinions indicated that the heat signature for the KAC suppressor and the OSS suppressor did not degrade the ability of the operator to engage targets, but the heat signature was worse than an unsuppressed M27 IAR. The Optics Engineer noted that the optics for UUTs A1-A3 had a higher angular deviation after repositioning on the rail, but this did not appear to have any visible negative effect during live-fire.

Table A-7. Measure Resolution for KAC Suppressor

Att #	MOE #	Task	Result
A-6	Attribute.	**Suppressor Ease of Installation.** The suppressor shall be installed by a unit level armorer.	
	M-9	Measure. OTF Armorer SME will verify that the KAC suppressor can be installed on the M27 IAR by a unit level armorer.	**MET**
A-7	Attribute.	**Suppressor Compatibility.** The suppressor shall be compatible with and attachable to the M27 IAR.	
	M-11	Measure. The OTF Armorer SME will install three KAC suppressors on three M27 IARs and provide comments on any issues that occur during installation.	**MET**
	M-13	Measure. Operator opinion on the compatibility of the KAC suppressor with the M27 IAR.	**MET (3/3)** **Rated 3.67 out of 5**
A-8	Attribute.	**Suppressor Durability.** The suppressor shall be durable when attached to the M27 IAR.	
	M-15	Measure. The KAC suppressor will be inspected at round counts of 600, 1200, 1800, 2400 and 2700 rounds during the durability firing by the OTF Armorer SME and any anomalies will be noted.	**MET**
	M-17	Measure. Operator Opinion on the durability of the KAC suppressor when used with the M27 IAR.	**MET (3/3)**
A-9	Attribute.	**Suppressor Accuracy.** The suppressor shall be interchangeable with other suppressors and able to be placed on and off the weapon with no greater than two MOA shift in impact and with no degradation in accuracy.	
	M-19	Measure. The Test Team will capture the MOA for the 5 round scored groups fired during Zero and Confirmation of Zero for both suppressed and unsuppressed modes of fire for the KAC suppressor (POI Shift).	**MET (1.50 Sup/1.63 Uns)** **POI Shift (2.49 MOA)**
A-10	Attribute.	**Suppressor Maintainability.** The suppressor shall be easy to remove, clean, and reattach to the M27 IAR.	
	M-21	Measure. Operator Opinion on the ability to remove, clean and reattach the KAC suppressor to the M27 IAR.	**MET(5/6)**
A-11	Attribute.	**Suppressed Cyclic Rate of Fire.** The suppressor shall not increase the cyclic rate of fire to the point that more stoppages occur.	
	M-23	Measure. The TT will capture stoppages throughout durability firing for the KAC equipped UUTs. Rate of fire captured during Cycle 9.	**Not Evaluated**

For Attribute A-9, the Test Manager resolved the attribute as Met with Exception due to passing the MOA requirement, but failing to pass the POI Shift of no greater than 2 MOA. For Attribute A-10, the Test Manager resolved the attribute as Met with Exception, because the operator opinions indicated that the heat signature for the KAC suppressor did not degrade the ability of the operator to engage targets, but the heat signature was worse than an unsuppressed M27 IAR.

Table A-8. Measure Resolution for OSS Suppressor

Att #	MOE #	Task	Result
A-6	Attribute.	**Suppressor Ease of Installation.** The suppressor shall be installed by a unit level armorer.	
	M-10	Measure. OTF Armorer SME will verify that the OSS suppressor can be installed on the M27 IAR by a unit level armorer.	**MET**
A-7	Attribute.	**Suppressor Compatibility.** The suppressor shall be compatible with and attachable to the M27 IAR.	
	M-12	Measure. The OTF Armorer SME will install three OSS suppressors on three M27 IARs and provide comments on any issues that occur during installation.	**MET**
	M-14	Measure. Operator opinion on the compatibility of the OSS suppressor with the M27 IAR.	**MET (2/3)** **Rated 3.00 out of 5**
A-8	Attribute.	**Suppressor Durability.** The suppressor shall be durable when attached to the M27 IAR.	
	M-16	Measure. The OSS suppressor will be inspected at round counts of 600, 1200, 1800, 2400 and 2700 rounds during the durability firing by the OTF Armorer SME and any anomalies will be noted.	**MET**
	M-18	Measure. Operator Opinion on the durability of the OSS suppressor when used with the M27 IAR.	**MET (3/3)**
A-9	Attribute.	**Suppressor Accuracy.** The suppressor shall be interchangeable with other suppressors and able to be placed on and off the weapon with no greater than two MOA shift in impact and with no degradation in accuracy.	
	M-20	Measure. The Test Team will capture the MOA for the 5 round scored groups fired during Zero and Confirmation of Zero for both suppressed and unsuppressed modes of fire for the OSS suppressor (POI Shift).	**MET (1.11 Sup/1.08 Uns)** **POI Shift (1.23 MOA)**
A-10	Attribute.	**Suppressor Maintainability.** The suppressor shall be easy to remove, clean, and reattach to the M27 IAR.	
	M-22	Measure. Operator Opinion on the ability to remove, clean and reattach the OSS suppressor to the M27 IAR.	**NOT MET (1/6)**
A-11	Attribute.	**Suppressed Cyclic Rate of Fire.** The suppressor shall not increase the cyclic rate of fire to the point that more stoppages occur.	
	M-24	Measure. The TT will capture stoppages throughout durability firing for the OSS equipped UUTs. Rate of fire captured during Cycle 9.	**Not Evaluated**

For Attribute A-10, the operators had a poor opinion of the ability to remove, clean, and reattach the OSS suppressor.

Table A-9. Attribute Resolution

A #	Attribute	Resolution
Leupold Mark 4 Scope		
A-1	Shock-Unsuppressed	MET 6/6
	Shock-Suppressed with KAC Suppressor	MET 6/6
	Shock-Suppressed with OSS Suppressor	MET 6/6
A-2	Compatibility-	MET 9/9
A-3	Target Engagement-(Heat Signature) Unsuppressed	MET (IAR Testing)
	Target Engagement-(Heat Signature) Suppressed with KAC Suppressor	Met with Exception 2/6
	Target Engagement-(Heat Signature) Suppressed with OSS Suppressor	Met with Exception 3/6
A-4	MOA-Unsuppressed (2 MOA Required)	MET (1.56)
	MOA-Suppressed with KAC Suppressor (2 MOA Required)	MET (1.50 Sup/1.63 Uns)
	MOA-Suppressed with OSS Suppressor (2 MOA Required)	MET (1.11 Sup/1.08 Uns)
A-5	Repeatability (EOSF)	MET
KAC Suppressor		
A-6	Suppressor Ease of Installation (KAC Suppressor)	MET (OTF)
A-7	Suppressor Compatibility (KAC Suppressor)	MET (3/3)
A-8	Suppressor Durability (KAC Suppressor)	MET (3/3)(Baffle Strike)
A-9	Suppressor Accuracy (KAC Suppressor) Accuracy/POI Shift	(MOA 1.50 Sup/Avg POI 2.49)
A-10	Suppressor Maintainability (KAC Suppressor)	MET (5/6)
A-11	Suppressor Cyclic Rate of Fire (KAC Suppressor)	Not Evaluated
OSS Suppressor		
A-6	Suppressor Ease of Installation (OSS Suppressor)	MET (OTF)
A-7	Suppressor Compatibility (OSS Suppressor)	MET (3/3)
A-8	Suppressor Durability (OSS Suppressor)	MET (2/3)(Removal Issues)
A-9	Suppressor Accuracy (OSS Suppressor) Accuracy/POI Shift	(MOA 1.11 Sup/Avg POI 1.23)
A-10	Suppressor Maintainability (OSS Suppressor)	NOT MET (1/6)
A-11	Suppressor Cyclic Rate of Fire (OSS Suppressor)	Not Evaluated

NOTE: *For Attribute A-3, the Test Manager resolved the attribute for both the KAC and OSS suppressors as Met with Exception, because the operator opinions were based on heat signature after high volumes of fire. For KAC Suppressor Attribute A-9, the KAC Suppressor, met the accuracy requirement but failed the shift of impact requirement of no greater than 2 MOA. For Attribute A-11, the TT had equipment issues that prevented the collection of accurate cyclic rate firing data*.

Appendix 1 to Annex A: Test Deviations

The following deviations to the TP were made during the SPR testing:

Deviation #1

The TP called for the shooters to fire unsuppressed and then suppressed for score using the acoustic targeting system. The Test Manager changed the sequence to firing for score suppressed and then unsuppressed, which saved time. The shooters fired for BZO and durability/reliability in the suppressed mode.

Deviation #2

The TT pushed the schedule on Day 4 (Thursday, 14 Jan) to shoot three cycles of durability/reliability (900 rounds) vice the two cycles of fire (600 rounds) as planned. Military personnel were given a 96-hour liberty for that weekend, so the TT combined cycle 9, which was scheduled for Day 5 (Friday, 15 Jan) into the schedule for Day 4.

Deviation #3

The TT was unable to capture cyclic rate of fire for either of the suppressed weapons. The TT attempted to do so with UUT B5 and C7, but the shot counter was not reliably.

Appendix 2 to Annex A: Test Incident Reports/Stoppage Reports

The TT collected TIRs for any SPR issues (parts not working, broken parts, etc.) as per Table A-2-1 for UUTs A1-A3, Table A2-2 for UUTs B4-B6 and Table A2-3 for UUTs C7-C9.

The Alpha UUTs had only a single TIR (not attributed to the optic or the suppressor). The Bravo UUTs had a single TIR for a baffle strike on UUT B4. The TT discovered the baffle strike at the 2670 round count out of 2700 rounds. The TT used a backup suppressor on UUT B4 to complete the last magazine for the final cycle of fire for durability/reliability. There were several TIRs for the Charlie UUTs, but most centered around the issue of the caps on the SRM and the BPR being loose, which caused the zero of the weapon to appear to change, which could have been attributed to the optic. Once the TT determined the need to apply more torque to the tightening of the caps, the issue of the zero moving disappeared. Based on the lack of any further zero issues after the early morning of 12 January, when the TT applied more torque to the tightening of the caps, the Test Manager attributes the Zero issue for UUT C7 and C8 to the suppressor and not to the optic.

Table A-2-1. SPR TIRs for Alpha UUTs

TIR #	UUT	Weapon	Event	Date	Start	Stop
A1-1	A1	Unsuppressed	Cycle 3	12 Jan 16	0900	0905
What Happened: Group is 1.5 mils high. Shooter had obtained a good zero on Monday, but group has moved. **What did it prevent the operator from doing**: Retaining zero. **Corrective Action:** Operator noted that it was most likely operator error and not the fault of the scope.						

Table A-2-2. SPR TIRs for Bravo UUTs

TIR #	UUT	Weapon	Event	Date	Start	Stop
B4-1	B4	KAC suppressed	Cycle 9	14 Jan 16	1255	1256
What Happened: At end of B4-9 magazine on Cycle 9 (semi and burst) a baffle strike on the KAC suppressor (N411911) was noticed. See picture below. **What did it prevent the operator from doing**: Nothing. Backup suppressor was used. **Corrective Action:** Backup suppressor (N411914) was used to finish firing. 						

Table A-2-3. SPR TIRs for Charlie UUTs

TIR #	UUT	Weapon	Event	Date	Start	Stop
C7-1	C7	OSS Suppressed	Cycle 1	11 Jan 16	1150	1151
What Happened: After the first 300 rounds of Durability/Reliability firing, the shooter noted that the groups were walking. The TT thought that the Leupold Mark 4 scope might be loose. **What did it prevent the operator from doing**: Lacking precision. **Corrective Action:** Used a Larue wrench to ensure tightness to tighten the sight mount.						
C7-2	C7	OSS Suppressed	Cycle 2	11 Jan 16	1156	1157
What Happened: At the 450 round count the armorer noted that the BPR cap was loose after taking SRM cap off. Checked again at the 600 round count and the armorer noted that the cap was loose. **What did it prevent the operator from doing**: Noted that this may have caused the groups to walk as noted in TIR# C7-1. **Corrective Action:** Armor tightened. After 600 rounds, the Armorer pulled the entire suppressor off and put it back on as per vendor specifications with lock tight. TT will continue to monitor.						
C8-1	C8	OSS Suppressed	Cycle 2	11 Jan 16	1332	1333
What Happened: After 450 rounds fired the TT noted that the paint on the OSS suppressor for UUT C8 was bubbling. See pictures below. **What did it prevent the operator from doing**: Nothing, cosmetic in nature. **Corrective Action:** A lower rate of fire would probably not cause the bubbling.  						
C7, C8, C9	C7, C8, C9	OSS Suppressed	Cycle 2	11-12 Jan 16	NA	NA
What Happened: Due to issues with C7 (caps on SRM and BPR loosening) the armorer checked all the OSS suppressors and all SRM caps were starting to loosen. **What did it prevent the operator from doing**: C7 had noted the group moving high for his weapon. **Corrective Action:** Armorer used a tool to tighten both the BPR and the SRM caps on all C weapons as per vendor instructions. On 12 Jan, the TT decided to apply a torque of 25 ftlbs to the SRM when tightening. Adaptors and tools were temp-loaned from PWS to assist with the mounting of the SRM to the system. The TT removed the SRM for unsuppressed firing at scheduled cycles and put back using the same torque. The TT did not experience any SRMs loosening throughout the rest of the live-fire after applying torque.						
C8-2	C8	OSS Suppressed	Cycle 3	12 Jan 16	0942	0943
What Happened: Shooter noted that the weapon was shooting 6" high as compared to original zero. **What did it prevent the operator from doing**: Retain Zero. **Corrective Action:** Shooter fired for zero again. The TT noted that the SRM cap was loose.						

The TT collected Stoppage Reports in the case of any stoppages. The Alpha and Charlie UUTs did not incur any stoppages during the test, only the Bravo UUTs had stoppages as per Table A-2-4. The magazine column in Table A-2-4 is color coded with a different color for each magazine that had multiple stoppages for that UUT.

Table A-2-4. SPR Stoppages for Bravo UUTs

UUT	Mag	Stoppage	Cause	Comment
B4	B4-1	FTL	Mag/Weapon	Dirty weapon/Magazine caused three failure to locks during the 3rd Cycle of Fire. Cleaned weapon and magazine. No further issues.
B5	B5-10	FTFd	Mag/Sup	Bolt over brass 30th round of magazine during 5-7 round burst. Caused by higher cyclic rate.
	B5-3	FTFd	Mag/Sup	Bolt over brass 27th round of magazine during 5-7 round burst. Caused by higher cyclic rate.
	B5-7	FTFd	Weapon/Sup	Bolt over brass 30th round of magazine during 5-7 round burst. Caused by higher cyclic rate.
	B5-9	FTFd	Weapon/Sup	Bolt over brass on 28th round of magazine during 5-7 round burst. Caused by higher cyclic rate.
	B5-10	FTFd	Weapon/Sup	Bolt over brass on 27th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B-5-10	FTFd	Weapon/Sup	Bolt over brass on 30th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B-5-3	FTFd	Weapon/Sup	Bolt over brass on 26th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B-5-3	FTFd	Weapon/Sup	Bolt over brass on 25th round of magazine during semi-auto fire. Caused by higher cyclic rate.
B6	B6-6	FTL	Weapon/Sup	Failure to Lock on 29th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B6-10	FTFd	Weapon/Sup	Bolt over brass on 29th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B6-10	FTFd	Weapon/Sup	Bolt over brass on 28th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B6-1	FTFd	Weapon/Sup	Bolt over brass on 25th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B6-10	FTFd	Weapon/Sup	Bolt over brass on 28th round of magazine during semi-auto fire. Caused by higher cyclic rate. Replaced B6-10 magazine with backup B6-10A.
	B6-1	FTFd	Weapon/Sup	Failure to Lock on 29th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B6-3	FTFd	Weapon/Sup	Bolt over brass on 28th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B6-6	FTFd	Weapon/Sup	Bolt over brass on 28th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B6-8	FTFd	Weapon/Sup	Bolt over brass on 28th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B6-1	FTFd	Weapon/Sup	Bolt over brass on 26th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B6-3	FTFd	Weapon/Sup	Bolt over brass on 28th round of magazine during semi-auto fire. Caused by higher cyclic rate.

Table A-2-4. SPR Stoppages for Bravo UUTs (continued)

UUT	Mag	Stoppage	Cause	Comment
B6	B6-5	FTFd	Weapon/Sup	Failure to Lock on 29th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B6-6	FTFd	Weapon/Sup	Bolt over brass on 28th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B6-7	FTFd	Weapon/Sup	Bolt over brass on 28th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B6-9	FTFd	Weapon/Sup	Bolt over brass on 25th round of magazine during semi-auto fire. Caused by higher cyclic rate.
	B6-9	FTFd	Weapon/Sup	Bolt over brass 26th round of magazine during 5-7 round burst. Caused by higher cyclic rate.
	B6-9	FTFd	Weapon/Sup	Bolt over brass 28th round of magazine during 5-7 round burst. Caused by higher cyclic rate.
	B6-10A	FTFd	Weapon/Sup	Failure to Lock on 26th round of magazine during semi-auto fire. Caused by higher cyclic rate
	B6-10A	FTFd	Weapon/Sup	Failure to Lock on 27th round of magazine during semi-auto fire. Caused by higher cyclic rate
	B6-10A	FTFd	Weapon/Sup	Failure to Lock on 29th round of magazine during semi-auto fire. Caused by higher cyclic rate
	B6-10A	FTFd	Weapon/Sup	Failure to Lock on 30th round of magazine during semi-auto fire. Caused by higher cyclic rate

The TT noted that most of the stoppages were Failure To Feed (FTFd), also known as Bolt over Base or Bolt over Brass (BOB).

UUT B5 had eight FTFds, with six of those eight happening with the same two magazines. Four of those eight stoppages for UUT B5 occurred during burst fire and four occurred during semi-automatic fire during the semi/auto burst cycle. The TT attributed the stoppages for UUT B5 to the higher cyclic rate of fire caused by the baffled suppressor, which also caused for more carbon buildup throughout the weapon and the magazines (see Figure 39).

UUT B6 had 20 FTFds, with the first five of those 20 occurring during standard semi-automatic fire cycles of fire, but of those five, three were with magazine B6-10. The TT replaced that magazine after the third occurrence with a backup magazine that was marked B6-10A. The remaining 15 FTFds for UUT B6 occurred during the semi/auto burst cycle of fire, with only two of those FTFds occurring during an actual auto burst magazine. The TT noted that of those 15 FTFds, three FTFDs occurred during a single firing of 30 rounds from magazine B6-9 and four FTFDs occurred during a single firing of magazine B6-10A.

All of the FTFds occurred during the last five rounds of the magazine. This is an indicator of possible issues with the magazine follower. The TT noted that the amount of carbon being blown back into the magazines (see Figure 39) or the higher cyclic rate of fire than with an unsuppressed M27 IAR might have caused these issues.

Appendix 3 to Annex A: User Survey Results

The User Survey responses are provided for the 23 Questions that were asked of the shooters in Table A-3-1.

Table A-3-1. User Survey Results for the SPR

Question 1. The Mark 4 Scope **easily withstood the shock, vibration, and recoil** of the durability firing of 2700 rounds with the M27 IAR (**Alpha UUTs**).

Completely Disagree	Substantially Disagree	Slightly Disagree	Slightly Agree	Substantially Agree	Completely Agree	NA
0	0	0	0	0	3	0
0/3= 0%			3/3 = 100 %			

User ID	Response	Remarks
1	Completely Agree	No loss of Zero. Zero moved once. Operator error.
2	Completely Agree	
3	Completely Agree	There were zero effects noticed. Scope maintained zero throughout the test.

Question 2. The user did not observe any **physical damage or performance degradation** to the Mark 4 Scope during the durability firing of 2700 rounds with the M27 IAR (**Alpha UUTs**).

Extremely Difficult	Moderately Difficult	Somewhat Difficult	Somewhat Easy	Moderately Easy	Extremely Easy	NA
0	0	0	0	0	3	0
0/3= 0%			3/3= 100 %			

User ID	Response	Remarks
1	Completely Agree	Scope performance was good.
2	Completely Agree	
3	Completely Agree	No damage at all. Zero was maintained throughout the test.

Table A-3-1. User Survey Results for the SPR (continued)

Question 3. The Mark 4 Scope **easily withstood the shock, vibration, and recoil** of the durability firing of 2700 rounds with the M27 IAR and the **KAC suppressor (Bravo UUTs)**.

Completely Disagree	Substantially Disagree	Slightly Disagree	Slightly Agree	Substantially Agree	Completely Agree	NA
0	0	0	0	0	3	0
0/3= 0%			3/3= 100 %			

User ID	Response	Remarks
1	Completely Agree	No loss of zero.
2	Completely Agree	
3	Completely Agree	No negative effects were noticed.

Question 4. The user did not observe any **physical damage or performance degradation** to the Mark 4 Scope during the durability firing of 2700 rounds with the M27 IAR and the **KAC suppressor (Bravo UUTs)**.

Completely Disagree	Substantially Disagree	Slightly Disagree	Slightly Agree	Substantially Agree	Completely Agree	NA
0	0	0	0	0	3	0
0/3= 0%			3/3= 100 %			

User ID	Response	Remarks
1	Completely Agree	No damage. Performance was good.
2	Completely Agree	
3	Completely Agree	No damage noticed. Zero was maintained throughout the tes.t

Table A-3-1. User Survey Results for the SPR (continued)

Question 5. The Mark 4 Scope **easily withstood the shock, vibration, and recoil** of the durability firing of 2700 rounds with the M27 IAR and the **OSS suppressor (Charlie UUTs)**.

Completely Disagree	Substantially Disagree	Slightly Disagree	Slightly Agree	Substantially Agree	Completely Agree	NA
0	0	0	0	0	3	0
0/3= 0%			3/3= 100 %			

User ID	Response	Remarks
1	Completely Agree	No loss of zero.
2	Completely Agree	
3	Completely Agree	No negative effects noticed.

Question 6. The user did not observe any **physical damage or performance degradation** to the Mark 4 Scope during the durability firing of 2700 rounds with the M27 IAR and the **OSS suppressor (Charlie UUTs)**.

Completely Disagree	Substantially Disagree	Slightly Disagree	Slightly Agree	Substantially Agree	Completely Agree	NA
0	0	0	0	0	3	0
0/3= 0%			3/3= 100 %			

User ID	Response	Remarks
1	Completely Agree	No damage. Performance was good.
2	Completely Agree	
3	Completely Agree	No damage noticed. Zero was maintained throughout the test.

Table A-3-1. User Survey Results for the SPR (continued)

Question 7. The Mark 4 Scope is an **improvement over the Squad Day Optic** (SDO).						
Completely Disagree	**Substantially Disagree**	**Slightly Disagree**	**Slightly Agree**	**Substantially Agree**	**Completely Agree**	**NA**
0	**0**	**0**	**0**	**0**	**3**	**0**
0/3= 0%			**3/3= 100 %**			

User ID	**Response**	**Remarks**
1	**Completely Agree**	
2	**Completely Agree**	**With respect to this role, the Mark 4 provides higher magnification, which allows for more positive target identification.**
3	**Completely Agree**	**For use as a SPR, the MK4 optic is a better fit than the SDO. The SDO would still work better when the M27 is used as an IAR.**

Question 8. The Mark 4 Scope is **compatible** with the M27 IAR.						
Completely Disagree	**Substantially Disagree**	**Slightly Disagree**	**Slightly Agree**	**Substantially Agree**	**Completely Agree**	**NA**
0	**0**	**0**	**0**	**0**	**3**	**0**
0/3= 0%			**3/3= 100 %**			

User ID	**Response**	**Remarks**
1	**Completely Agree**	**The M27 IAR with the Mark 4 scope and good ammo can fulfill the mission of the SPR.**
2	**Completely Agree**	
3	**Completely Agree**	**There were no issues with the MK4 scope on the M27 and it improved target identification.**

Table A-3-1. User Survey Results for the SPR (continued)

Question 9. The user could **easily attach** the Mark 4 Scope to the M27 IAR **without tools**.

Completely Disagree	Substantially Disagree	Slightly Disagree	Slightly Agree	Substantially Agree	Completely Agree	NA
0	0	0	2	0	1	0
0/3= 0%			3/3= 100 %			

User ID	Response	Remarks
1	Slightly Agree	A tool is required to ensure that the mount is tight enough.
2	Completely Agree	
3	Slightly Agree	Mk 4 needs to be tightened into the rings and again on the mount to the rifle. This is an easy process.

Question 10. The **heat signature** from the **KAC suppressor** during firing **did not degrade** the user's ability to **engage targets**.

Completely Disagree	Substantially Disagree	Slightly Disagree	Slightly Agree	Substantially Agree	Completely Agree	NA
0	0	1	1	1	0	0
1/3= 33%			2/3= 67 %			

User ID	Response	Remarks
1	Slightly Agree	Heat signature can degrade sight picture if the suppressor gets too hot.
2	Slightly Disagree	By the third magazine, fumes and heat waves were noticeable and slightly interfered with aiming.
3	Substantially Agree	If firing at a rapid rate for an extended period of time, the user will notice mirage from the suppressor. It dissipated quickly.

Table A-3-1. User Survey Results for the SPR (continued)

Question 11. The **KAC suppressor** had **less heat signature effect** on the Mark 4 Scope than the heat signature from the unsuppressed IAR.

Completely Disagree	Substantially Disagree	Slightly Disagree	Slightly Agree	Substantially Agree	Completely Agree	NA
2	1	0	0	0	0	0
3/3 = 100%			0/3 = 0 %			

User ID	Response	Remarks
1	Completely Disagree	Heat Signature can degrade sight picture if the suppressor gets too hot.
2	Completely Disagree	
3	Substantially Disagree	There was little to no effect from an unsuppressed M27, so the KAC definitely caused more.

Question 12. The **heat signature** from the **OSS suppressor** during firing **did not degrade** the user's ability to **engage targets**.

Completely Disagree	Substantially Disagree	Slightly Disagree	Slightly Agree	Substantially Agree	Completely Agree	NA
0	0	0	1	2	0	0
0/3= 0%			3/3= 100 %			

User ID	Response	Remarks
1	Slightly Agree	Heat Signature can degrade sight picture if the suppressor gets too hot.
2	Substantially Agree	Fumes were not as dramatic. Mirage was present, but it did not interfere with aiming as much as with the KAC suppressor.
3	Substantially Agree	When firing at a rapid rate for an extended period of time, the user will notice much more of a mirage than that of the KAC suppressor. Mirage dissipates rather quickly.

Table A-3-1. User Survey Results for the SPR (continued)

Question 13. The **OSS suppressor** had **less heat signature effect** on the Mark 4 Scope than the heat signature from the unsuppressed IAR.						
Completely Disagree	**Substantially Disagree**	**Slightly Disagree**	**Slightly Agree**	**Substantially Agree**	**Completely Agree**	**NA**
1	**1**	**1**	**0**	**0**	**0**	**0**
3/3= 100%			**3/3= 0 %**			

User ID	**Response**	**Remarks**
1	**Completely Disagree**	**Heat Signature can degrade sight picture if the suppressor gets too hot.**
2	**Slightly Disagree**	
3	**Substantially Disagree**	**The OSS had more of a heat signature than both the unsuppressed and the KAC suppressor.**

Question 14. The **KAC suppressor** was **compatible** with the M27 IAR.						
Completely Disagree	**Substantially Disagree**	**Slightly Disagree**	**Slightly Agree**	**Substantially Agree**	**Completely Agree**	**NA**
0	**0**	**0**	**0**	**0**	**3**	**0**
0/3= 0%			**3/3= 100 %**			

User ID	**Response**	**Remarks**
1	**Completely Agree**	**No stoppages or malfunctions.**
2	**Completely Agree**	
3	**Completely Agree**	**Functionally, the KAC is compatible, but it just runs dirty.**

Table A-3-1. User Survey Results for the SPR (continued)

Question 15. Rate the **KAC suppressor** on a scale of 1-5 with **5 being the best**. Circle a number below. Justify your rating in the remarks. .					
1	**2**	**3**	**4**	**5**	**N/A**
		x	**xx**		
AVERAGE: 3.67					

User ID	**Response**	**Remarks**
1	**4**	**Suppressor works fine on M27. Weapon will get dirty faster.**
2	**3**	
3	**4**	**Performance was a 4. Maintenance was a 3.**

Question 16. The **OSS suppressor** was **compatible** with the M27 IAR.						
Completely Disagree	**Substantially Disagree**	**Slightly Disagree**	**Slightly Agree**	**Substantially Agree**	**Completely Agree**	**NA**
0	**1**	**0**	**1**	**2**	**0**	**0**
0/3 = 0%			**3/3 = 100 %**			

User ID	**Response**	**Remarks**
1	**Substantially Disagree**	**M27 cannot be field stripped by the operator for maintenance.**
2	**Substantially Agree**	**More complex design may complicate maintenance as design traps the handguard and requires tools to remove and install.**
3	**Substantially Agree**	**Functionally, the OSS suppressor worked extremely well with the M27. As far as maintaining the OSS, that is a different story.**

Table A-3-1. User Survey Results for the SPR (continued)

Question 17. Rate the **OSS suppressor** on a scale of 1-5 with **5 being the best**. Circle a number below. Justify your rating in the remarks.					
1	**2**	**3**	**4**	**5**	**N/A**
	x	**x**	**x**		
AVERAGE: 3.00					

User ID	Response	Remarks
1	**2**	**Feels really good while shooting. The operator cannot field strip the weapon for maintenance.**
2	**4**	
3	**3**	**Performance was a 5. Maintenance was a 1.**

Question 18. The **KAC suppressor** was **durable** throughout the durability firing of 2700 rounds.						
Completely Disagree	**Substantially Disagree**	**Slightly Disagree**	**Slightly Agree**	**Substantially Agree**	**Completely Agree**	**NA**
0	**0**	**0**	**0**	**2**	**1**	**0**
0/3= 0%			**3/3 = 100 %**			

User ID	Response	Remarks
1	**Substantially Agree**	**Weapon gets dirty faster. No stoppages or malfunctions with weapon. One suppressor strike at the end of durability firing.**
2	**Substantially Agree**	
3	**Completely Agree**	**There were zero issues with the KAC during the test.**

Table A-3-1. User Survey Results for the SPR (continued)

Question 19. The **OSS suppressor** was **durable** throughout the durability firing of 2700 rounds.

Completely Disagree	Substantially Disagree	Slightly Disagree	Slightly Agree	Substantially Agree	Completely Agree	NA
0	0	1	0	2	0	0
1/3= 33%			2/3 = 67 %			

User ID	Response	Remarks
1	Slightly Disagree	Suppressor (SRM Cap) comes loose while firing rounds, which causes them to string across the target. Zero was greatly affected. Armorer eventually was able to torque the caps on so that they did not loosen.
2	Substantially Agree	Exhibited some blistering on surface coating. Appeared to be cosmetic.
3	Substantially Agree	The OSS would occasionally unscrew from the barrel due to the slow rate of fire.

Question 20. The **KAC suppressor** was **easy to remove** and **reattach** to the M27 IAR for cleaning.

Completely Disagree	Substantially Disagree	Slightly Disagree	Slightly Agree	Substantially Agree	Completely Agree	NA
0	0	0	2	1	0	0
0/3= 0%			3/3 = 100 %			

User ID	Response	Remarks
1	Slightly Agree	Can be difficult to remove if dirty carbon is built up.
2	Substantially Agree	Carbon builds up; some resistance was present requiring significant force to remove.
3	Slightly Agree	After extended firing, fouling would make it difficult to remove from the flash hider.

Table A-3-1. User Survey Results for the SPR (continued)

Question 21. The **KAC suppressor** was **easy to clean**.

Completely Disagree	Substantially Disagree	Slightly Disagree	Slightly Agree	Substantially Agree	Completely Agree	NA
0	0	1	1	1	0	0
1/3= 33%			2/3 = 67 %			

User ID	Response	Remarks
1	Slightly Agree	Suppressor becomes filthy after heavy shooting.
2	Substantially Agree	Cleaning limited to brushing attachment points and brushing bore.
3	Slightly Disagree	Can only be cleaned with a "bore" brush and it cannot be opened.

Question 22. The **OSS suppressor** was **easy to remove** and **reattach** to the M27 IAR for cleaning.

Completely Disagree	Substantially Disagree	Slightly Disagree	Slightly Agree	Substantially Agree	Completely Agree	NA
2	0	1	0	0	0	0
3/3= 100%			0/3 = 0 %			

User ID	Response	Remarks
1	Completely Disagree	The operator cannot remove the suppressor. Do not like the over-the-barrel concept for the M27. It must be Quick Detach.
2	Slightly Disagree	Tools were required to install and remove the OSS suppressor.
3	Completely Disagree	Fouling will almost seal the suppressor (SRM to BPR) together and to the barrel.

Table A-3-1. User Survey Results for the SPR (continued)

Question 23. The **OSS suppressor** was **easy to clean**.						
Completely Disagree	**Substantially Disagree**	**Slightly Disagree**	**Slightly Agree**	**Substantially Agree**	**Completely Agree**	**NA**
0	**1**	**1**	**0**	**1**	**0**	**0**
2/3= 67%			**1/3 = 33 %**			

User ID	**Response**	**Remarks**
1	**Completely Disagree**	**The operator cannot remove the suppressor. Do not like the over-the-barrel concept for the M27. It must be Quick Detach.**
2	**Substantially Agree**	**Cleaning was limited to brush through bore and external surfaces.**
3	**Substantially Disagree**	**Fouling basically seals the suppressor parts together and it is very difficult to take apart to clean.**

Annex B: Scored Group Data

This annex contains the scored group data captured using the acoustic targeting system and used to determine MOAs and POI shift.

Appendix 1 to Annex B: Scored Data for Shot Locations

Table B-1-1. X and Y Data for Midpoints of Scored Shot Groups

Weapon	Day Fired	Interval	X	Y	MOA	Sup X	Sup Y	Sup MOA	POI Shift	Shooter	Diff X	Diff Y	Avg Diff X	Avg Diff Y	
		Initial	0.71	-0.67	0.84	NA	NA	NA	NA	1					
		600 Rounds	3.42	1.36	1.18	NA	NA	NA	NA	1					
A1		1200 Rounds	3.25	-3.13	1.27	NA	NA	NA	NA	1					Note: Shooter noted on A1 that he lost zero on Mark 4 Scope (1.5 mil high) and had to rezero.
		1800 Rounds	2.42	-3.63	1.57	NA	NA	NA	NA	1					
		2400 Rounds	3.71	-2.55	1.22	NA	NA	NA	NA	1					
		2700 Rounds	2.86	-3.29	0.77	NA	NA	NA	NA	1					
		Initial	0.92	-1.76	0.72	NA	NA	NA	NA	2					
		600 Rounds	1.61	-3.69	1.00	NA	NA	NA	NA	2					
A2		1200 Rounds	2.33	-4.84	1.42	NA	NA	NA	NA	2					
		1800 Rounds	0.74	-4.58	1.47	NA	NA	NA	NA	2					
		2400 Rounds	1.72	-3.79	1.64	NA	NA	NA	NA	2					
		2700 Rounds	2.15	-3.95	1.02	NA	NA	NA	NA	2					
		Initial	0.88	-0.38	2.13	NA	NA	NA	NA	3					
		600 Rounds	3.60	-3.78	2.96	NA	NA	NA	NA	3					
A3		1200 Rounds	2.92	-2.61	2.69	NA	NA	NA	NA	3					
		1800 Rounds	2.66	-4.25	1.55	NA	NA	NA	NA	3					
		2400 Rounds	2.24	-2.37	2.04	NA	NA	NA	NA	4					Note: Changed shooter out for A3, B6, and C9 for last two confirmation cycles.
		2700 Rounds	2.31	-2.02	2.63	NA	NA	NA	NA	4	Diff X	Diff Y	Avg Diff X	Avg Diff Y	
		Initial	-0.89	-1.03	0.69	1.51	-2.00	0.57	2.59	1	2.40	-0.97	1.45	-1.34	
		600 Rounds	0.57	-2.81	1.44	1.80	-5.29	1.56	2.77	1	1.23	-2.48			
B4		1200 Rounds	0.62	-3.44	1.81	3.24	-4.74	1.69	2.92	1	2.62	-1.30			
		1800 Rounds	0.40	-3.04	1.57	2.56	-4.91	2.66	2.86	1	2.16	-1.87			
		2400 Rounds	2.11	-3.02	1.53	2.94	-3.84	1.95	1.17	1	0.83	-0.82			
		2700 Rounds	1.75	-3.67	1.86	1.22	-4.29	1.67	0.82	1	-0.53	-0.62			Note: Noted Baffle stike at end of B4-9 magazine on cycle 9 (semi/burst), replaced with backup Sup.
		Initial	-0.79	-0.01	1.63	0.29	-3.06	1.13	3.24	2	1.08	-3.05	0.92	-1.35	
		600 Rounds	0.61	-3.06	2.40	1.89	-4.54	1.69	1.96	2	1.28	-1.48			
B5		1200 Rounds	0.88	-3.77	1.59	2.59	-5.37	1.03	2.34	2	1.71	-1.60			
		1800 Rounds	0.68	-4.98	1.55	1.22	-5.52	2.09	0.76	2	0.54	-0.54			
		2400 Rounds	2.15	-3.52	1.28	2.35	-4.10	2.08	0.61	2	0.20	-0.58			
		2700 Rounds	2.96	-4.06	1.26	3.64	-4.93	1.35	1.10	2	0.68	-0.87			
		Initial	1.80	-0.98	1.46	0.99	-1.78	1.08	1.14	3	-0.81	-0.80	-1.20	-3.35	
		600 Rounds	3.85	-2.64	1.43	2.85	-5.92	1.29	3.43	3	-1.00	-3.28			
B6		1200 Rounds	4.37	-3.91	1.52	2.65	-6.46	1.14	3.08	3	-1.72	-2.55			
		1800 Rounds	3.09	-2.63	2.33	2.12	-7.24	1.40	4.71	3	-0.97	-4.61			
		2400 Rounds	2.65	1.87	1.88	1.75	-2.52	1.84	4.48	4	-0.90	-4.39			Note: Changed shooter out for A3, B6, and C9 for last two confirmation cycles.
		2700 Rounds	5.24	4.49	2.05	3.46	0.00	0.83	4.83	4	-1.78	-4.49			Note: Threw out one round as a flyer, so B6 Sup data is for a 4 round group.
		Initial	4.01	-3.68	1.02	1.22	-1.80	3.58	3.36	1	-2.79	1.88	-0.95	-0.63	Note: Issue with loose cap on C7 SRM for Suppressed, which was discovered
		600 Rounds	3.60	-1.11	0.43	3.48	-2.34	0.84	1.24	1	-0.12	-1.23			after the fact while shooting for Reliability/Durability.
C7		1200 Rounds	3.83	-3.33	2.06	3.25	-4.22	1.20	1.06	1	-0.58	-0.89			
		1800 Rounds	2.19	-4.17	1.30	1.05	-5.03	0.83	1.43	1	-1.14	-0.86	-0.59	-1.13	Avg Diff without Initial C7
		2400 Rounds	3.55	-2.43	0.90	2.55	-3.96	1.15	1.83	1	-1.00	-1.53			
		2700 Rounds	1.98	-2.68	1.05	1.89	-3.80	1.53	1.12	1	-0.09	-1.12			
		Initial	1.41	0.62	0.92	1.32	-0.77	1.37	1.39	2	-0.09	-1.39	-0.02	-1.02	Note: After issues with C7, the Armorer checked caps on all C's and they
		600 Rounds	3.40	2.66	0.88	3.14	1.88	1.21	0.82	2	-0.26	-0.78			were loose. Armorer hand tightened as best as possible
C8		1200 Rounds	3.34	-3.63	1.15	2.73	-4.42	1.05	1.00	2	-0.61	-0.79			Note: Shooter lost zero on C8 Mark 4 Scope (6" high) and had to rezero at 720 round count.
		1800 Rounds	0.02	-4.21	1.40	0.54	-5.14	0.96	1.07	2	0.52	-0.93			
		2400 Rounds	2.12	-2.84	0.94	2.52	-3.75	1.18	0.99	2	0.40	-0.91			
		2700 Rounds	5.66	2.59	0.97	5.60	1.25	0.61	1.34	2	-0.06	-1.34			
		Initial	0.48	-0.31	1.17	0.61	-0.70	0.90	0.41	3	0.13	-0.39	0.25	-1.21	Note: After issues with C7, the Armorer checked caps on all C's and they
		600 Rounds	3.42	-1.95	0.49	3.76	-3.38	0.74	1.47	3	0.34	-1.43			were loose. Armorer hand tightened as best as possible
C9		1200 Rounds	2.58	-2.84	1.12	3.31	-4.88	2.73	2.17	3	0.73	-2.04			
		1800 Rounds	0.41	-2.85	1.23	0.87	-4.08	0.39	1.31	3	0.46	-1.23			
		2400 Rounds	3.27	-2.61	1.22	3.27	-4.10	1.19	1.49	4	0.00	-1.49			Note: Changed shooter out for A3, B6, and C9 for last two confirmation cycles.
		2700 Rounds	4.71	-1.61	1.17	4.57	-2.30	1.04	0.70	4	-0.14	-0.69			

NOTE: The data above provides the X and Y locations for the midpoint of the scored groups for Unsuppressed (all UUTs) and for Suppressed (B4-B6 and C7-C9). The MOA for those scored groups are also provided.

The POI shift is computed from the midpoint of the Unsuppressed group to the midpoint of the Suppressed groups for UUTs B4-B6 and C7-C9. POI Shifts of greater than 2 MOA are highlighted in light orange and in light green for POI Shifts of less than 1 MOA.

The TT noted that the #3 shooter was replaced by the #4 shooter for the scored groups for the 2400 and 2700 round counts on UUTs A3, B6, and C9.

The TT also noted that the MOA for the Initial suppressed group for UUT C7 was attributed to a loose SRM cap.

Appendix 2 to Annex B: Scored Data by Shooter

Table B-2-1. Scored Data by Shooter

		MOA	A1	B4 Uns	B4 Sup	C7 Uns	C7 Sup						
Shooter	1	Initial	0.84	0.69	0.57	1.02	3.58	Loose SRM cap on C7 for initial Confirmation					
		600 Rounds	1.18	1.44	1.56	0.43	0.84						
		1200 Rounds	1.27	1.81	1.69	2.06	1.20						
		1800 Rounds	1.57	1.57	2.66	1.30	0.83						
		2400 Rounds	1.22	1.53	1.95	0.90	1.15						
		2700 Rounds	0.77	1.86	1.67	1.05	1.53		Shooter 1				
		Average	1.14	1.48	1.68	1.13	1.52	1.39	Avg A	Avg B	Avg C		
			1.14	1.48	1.68	1.13	1.11	1.31	1.14	1.58	1.12	Average without C7 Suppressed due to issue with loose cap on SRM.	
		MOA	A2	B5 Uns	B5 Sup	C8 Uns	C8 Sup						
Shooter	2	Initial	0.72	1.63	1.13	0.92	1.37						
		600 Rounds	1.00	2.40	1.69	0.88	1.21						
		1200 Rounds	1.42	1.59	1.03	1.15	1.05						
		1800 Rounds	1.47	1.55	2.09	1.40	0.96						
		2400 Rounds	1.64	1.28	2.08	0.94	1.18		Shooter 2				
		2700 Rounds	1.02	1.26	1.35	0.97	0.61		Avg A	Avg B	Avg C		
		Average	1.21	1.62	1.56	1.04	1.06	1.30	1.21	1.59	1.05		
		MOA	A3	B6 Uns	B6 Sup	C9 Uns	C9 Sup						
Shooter	3	Initial	2.13	1.46	1.08	1.17	0.90						
		600 Rounds	2.96	1.43	1.29	0.49	0.74						
		1200 Rounds	2.69	1.52	1.14	1.12	2.73		Shooter 3				
		1800 Rounds	1.55	2.33	1.40	1.23	0.39		Avg A	Avg B	Avg C		
		Average	2.33	1.69	1.23	1.00	1.19	1.49	2.33	1.46	1.10		
		MOA	A3	B6 Uns	B6 Sup	C9 Uns	C9 Sup						
Shooter	4	2400 Rounds	2.04	1.88	1.84	1.22	1.19		Shooter 4				
		2700 Rounds	2.63	2.05	0.83	1.17	1.04		Avg A	Avg B	Avg C		
		Average	2.34	1.97	1.34	1.20	1.12	1.59	2.34	1.65	1.16		

Note: Yellow highlights values over 2.00 MOA and green highlights values under 1.00 MOA. Shooter #1's initial value for C7 Suppressed (highlighted in orange was attributed to a loose SRM cap. Average values are computed both with and without this MOA. The second set of average values are without. The TT used the average values computed without the initial value for C7 suppressed to show overall averages for Shooter #1.

Appendix 3 to Annex B: Scored Data by Weapon Configuration

Table B-3-1. Scored Data by Weapon configuration

IAR Unsuppressed	MOA	A1	A2	A3		
	Initial	0.84	0.72	2.13		
	600 Rounds	1.18	1.00	2.96		
	1200 Rounds	1.27	1.42	2.69		
	1800 Rounds	1.57	1.47	1.55		
	2400 Rounds	1.22	1.64	2.04		
	2700 Rounds	0.77	1.02	2.63		
	Average	1.14	1.21	2.33	1.56	Overall Average

IAR w/KAC	MOA	B4 Uns	B5 Uns	B6 Uns	B4 Sup	B5 Sup	B6 Sup		
	Initial	0.69	1.63	1.46	0.57	1.13	1.08		
	600 Rounds	1.44	2.40	1.43	1.56	1.69	1.29		
	1200 Rounds	1.81	1.59	1.52	1.69	1.03	1.14		
	1800 Rounds	1.57	1.55	2.33	2.66	2.09	1.40		
	2400 Rounds	1.53	1.28	1.88	1.95	2.08	1.84		
	2700 Rounds	1.86	1.26	2.05	1.67	1.35	0.83		
	Average	1.48	1.62	1.78	1.68	1.56	1.26	1.56	Overall Average
				1.63	Uns		1.50	Sup	

IAR w/OSS	MOA	C7 Uns	C8 Uns	C9 Uns	C7 Sup	C8 Sup	C9 Sup		
	Initial	1.02	0.92	1.17	3.58	1.37	0.90		
	600 Rounds	0.43	0.88	0.49	0.84	1.21	0.74		
	1200 Rounds	2.06	1.15	1.12	1.20	1.05	2.73		
	1800 Rounds	1.30	1.40	1.23	0.83	0.96	0.39		
	2400 Rounds	0.90	0.94	1.22	1.15	1.18	1.19		
	2700 Rounds	1.05	0.97	1.17	1.53	0.61	1.04		
	Average	1.13	1.04	1.07	1.52	1.06	1.17	1.16	Overall Average with C7 Suppressed Initial
		1.13	1.04	1.07	1.11	1.06	1.17	1.10	Overall Average without C7 Suppressed Initial due to loose SRM cap.
				1.08	Uns		1.11	Sup	

Note: The value for C7 Initial suppressed highlighted in orange is attributed to a loose SRM cap. Average values are computed with and without this value. The second row of averages is without this value. Values highlighted in yellow are values that exceeded 2.0 MOA.

Appendix 4 to Annex B: Scored Data for POI Shift

Table B-4-1. Scored Data for POI Shift

POI Shift		POI Shift	B4	B5	B6	C7	C8	C9
		Initial	2.59	3.24	1.14	3.36	1.39	0.41
		600 Rounds	2.77	1.96	3.43	1.24	0.82	1.47
		1200 Rounds	2.92	2.34	3.08	1.06	1.00	2.17
		1800 Rounds	2.86	0.76	4.71	1.43	1.07	1.31
		2400 Rounds	1.17	0.61	4.48	1.83	0.99	1.49
		2700 Rounds	0.82	1.10	4.83	1.12	1.34	0.70
		Average	2.19	1.67	3.61	1.67	1.10	1.26
						1.34	1.10	1.26
	Average POI Shift		B's=	2.49		C's=	1.23	

Note: The value for C7 Initial suppressed (highlighted in orange) is attributed to a loose SRM cap. Average values are computed with and without this value. The second row of averages is without this value. The final Average POI Shift is computed without this value.

The POI Shifts that were over 2 MOA are highlighted in yellow.

Annex C: Weather Data during Live-Fire

This annex contains the weather data recorded during the live-fire conducted on Range 1 and Range 2 aboard Marine Corps Base Quantico, Virginia during 11-14 January 2016.

Table C-1. Weather Data during Live-Fire

Date	Time	Temp (F)	Wnd Spd	Wnd Dir	Comments
11-Jan-16	9:15:00	38	0 mph		Prior to BZO at Range 1.
12-Jan-16	8:29:00	35	2 mph	SSW	600 Round Interval Dispersion at Range 2.
12-Jan-16	13:25:00	44	6 mph	S	1200 Round interval Dispersion at Range 2.
13-Jan-16	12:03:00	33	5-7 mph	NW	1800 Round Interval Dispersion at Range 2.
14-Jan-16	11:17:00	Unk	Unk	Unk	2400 Round Interval Dispersion at Range 2
14-Jan-16	13:42:00	55	3-5 mph	SW	2700 Round Interval Dispersion at Range 2.

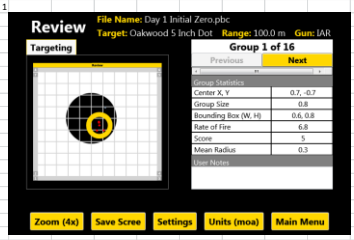
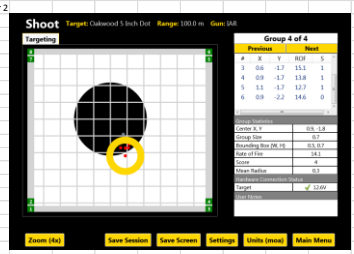
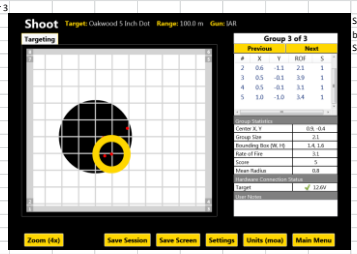
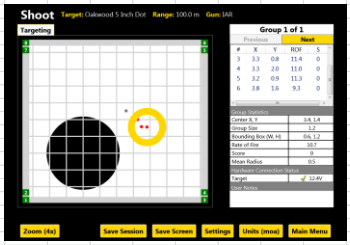
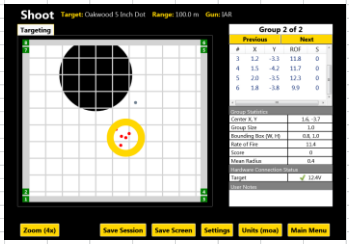
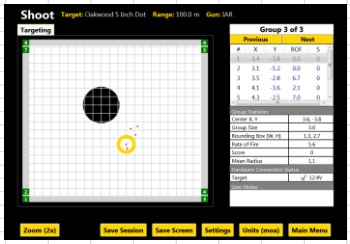
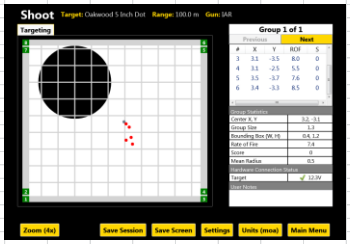
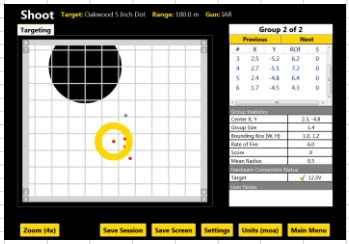
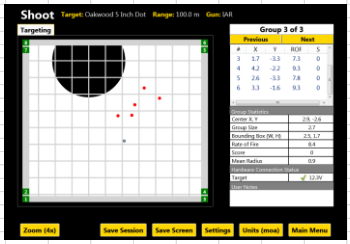
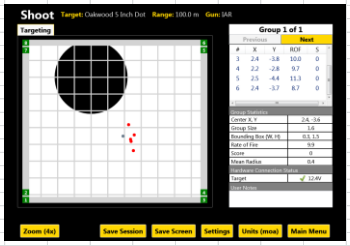
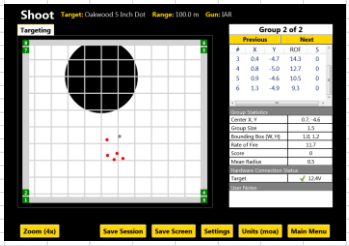
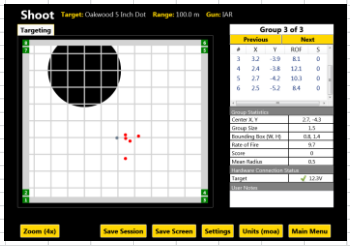
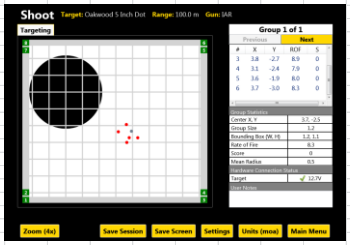
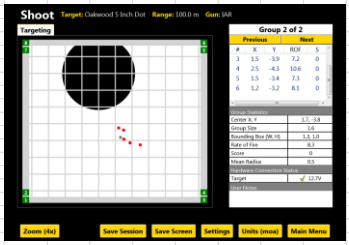
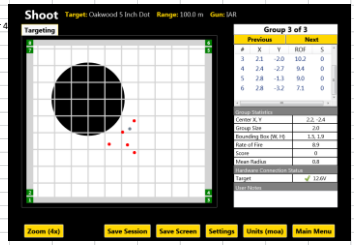
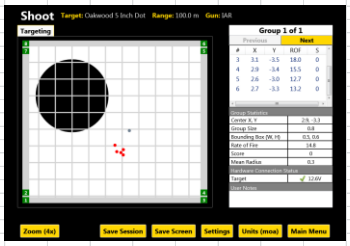
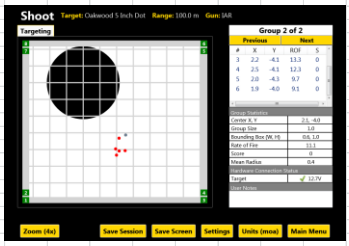
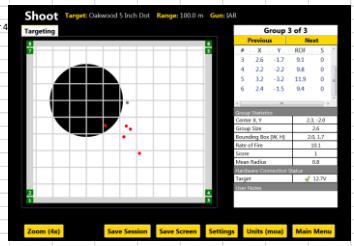
Note: Weather data was not recorded for the 2400 round dispersion.

Annex D: Screen Capture Data

This annex contains the screen capture data recorded via the acoustic targeting system during the firing of scored groups conducted on Range 1 and Range 2 aboard Marine Corps Base Quantico, Virginia during 11-14 January 2016.

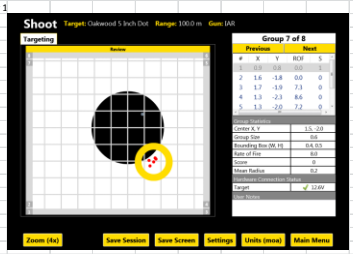
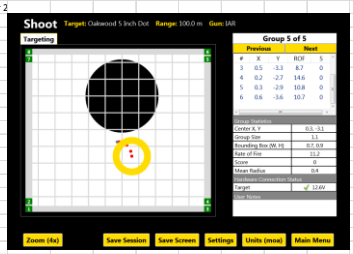
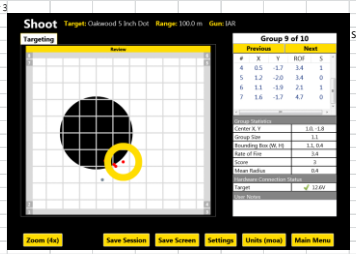
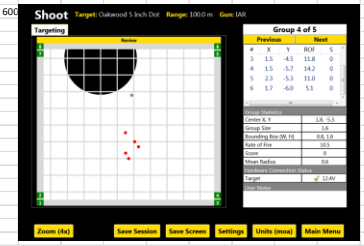
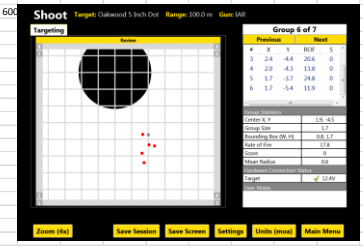
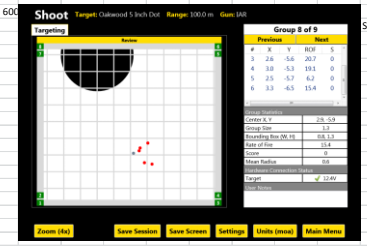
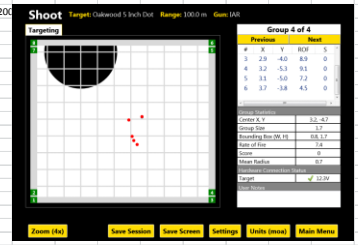
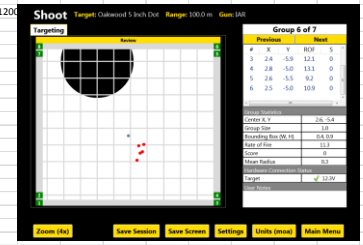
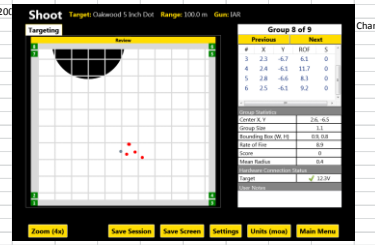
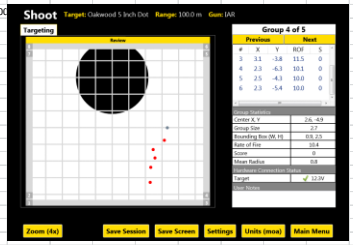
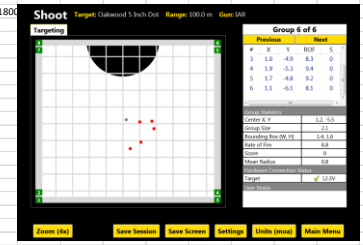
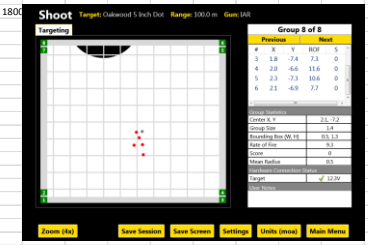
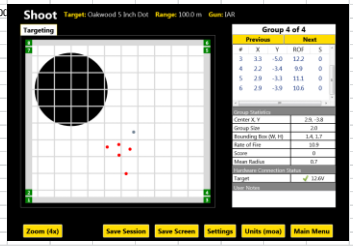
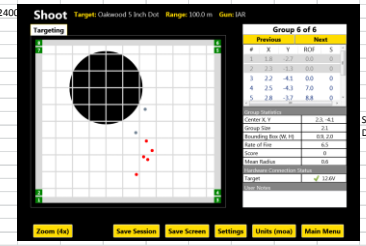
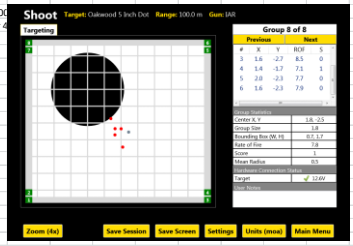
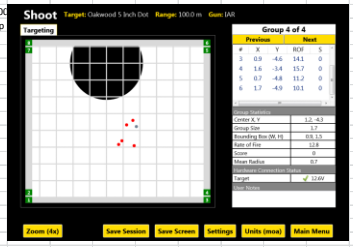
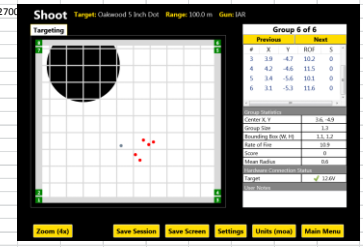
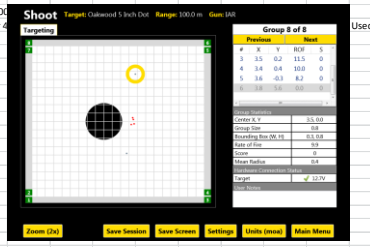
Appendix 1 to Annex D: Alpha UUT Scored Data

Table D-1-1. Alpha UUT Scored Data

A1 Groups	A2 Groups	A3 Groups	
Shooter 1	Shooter 2	Shooter 3	
Init	Init	Init	Shot Lead Sled for Group 2, but not comfortable. Shot Group 3 with bipod.
			
600	600	600	
			
1200	1200	1200	
			
1800	1800	1800	
			
2400	2400	2400	
		Shooter 4 	
2700	2700	2700	
		Shooter 4 	

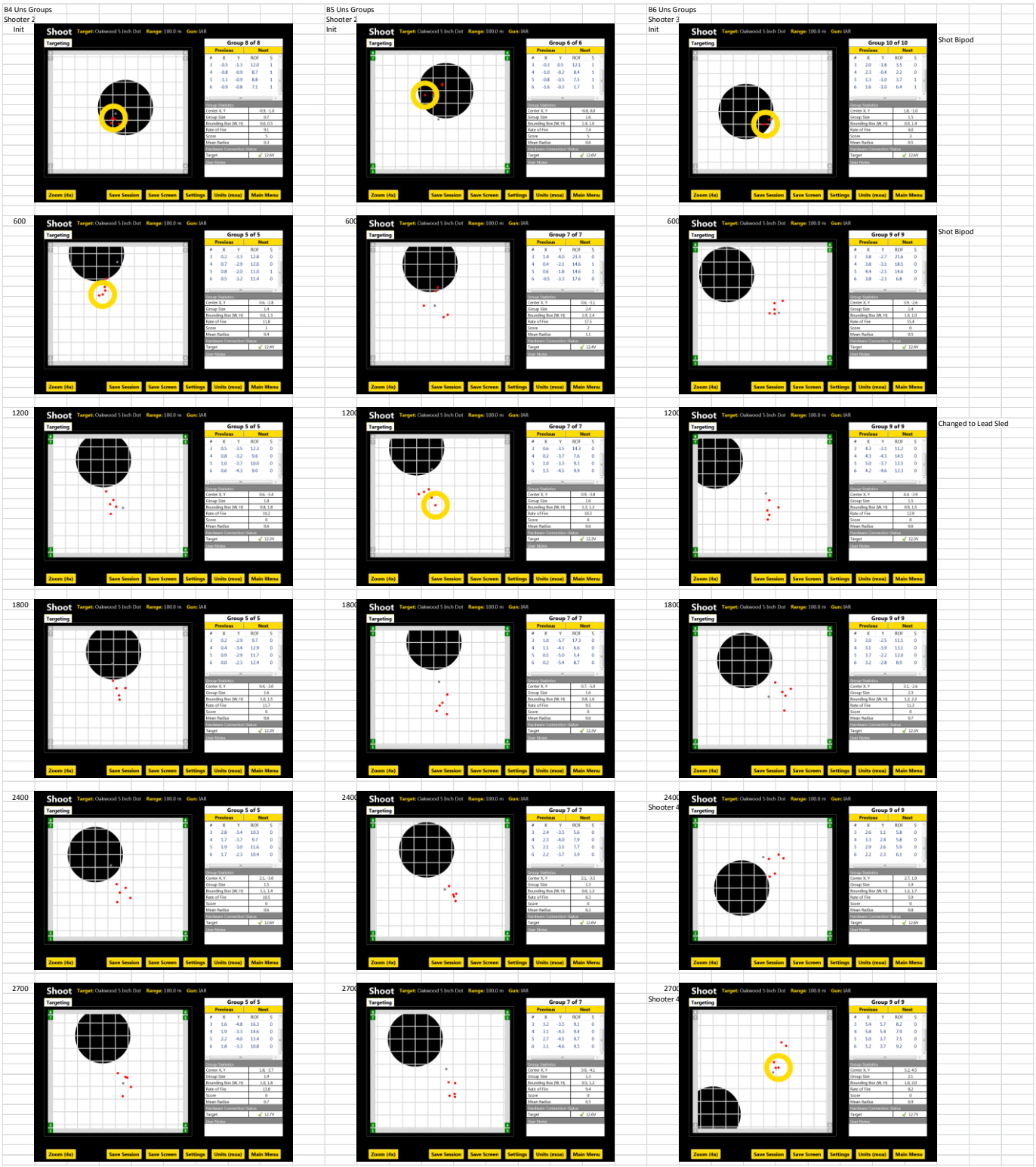
Appendix 2 to Annex D: Bravo UUT Suppressed Scored Data

Table D-2-1. Bravo UUT Suppressed Scored Data

B4 Uns Groups Shooter 1 Init		B5 Sup Groups Shooter 2 Init	
B6 Sup Groups Shooter 3 Init		Shot Bipod	
600		600	
600		Shot Bipod	
1200		1200	
1200		Changed to Lead Sled	
1800		1800	
1800			
2400		2400	
2400 Shooter 4		Shot extra round. Dismissed #2.	
2700 New Sup		2700	
2700 Shooter 4		Used only 4 rounds.	

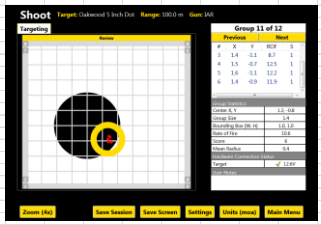
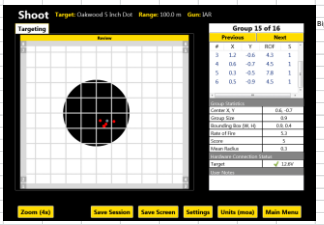
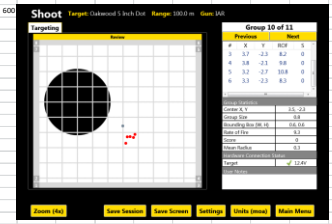
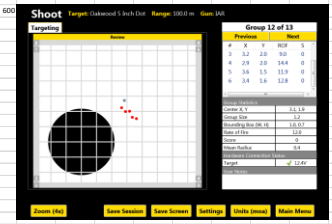
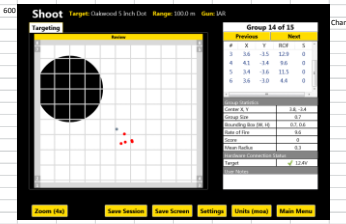
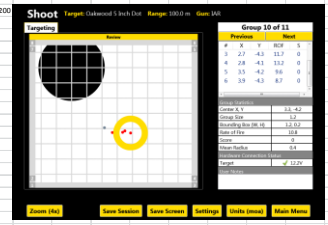
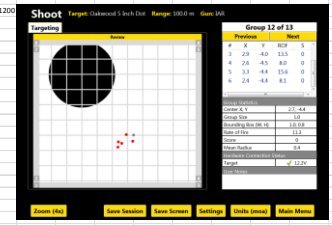
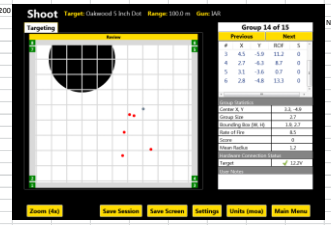
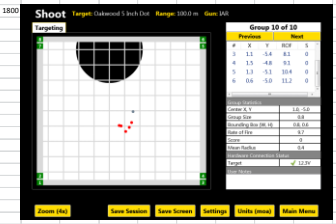
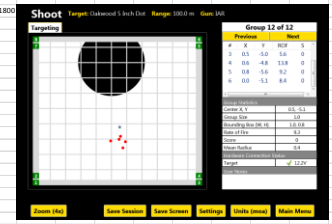
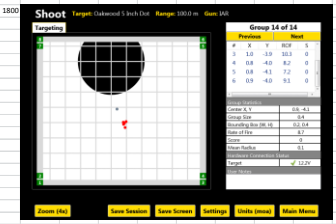
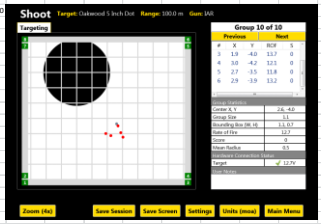
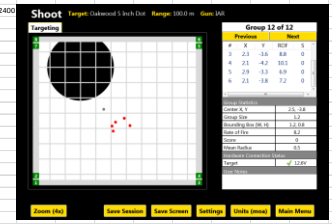
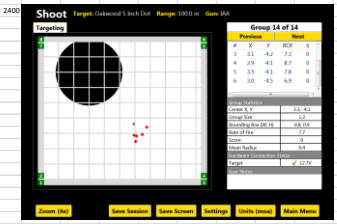
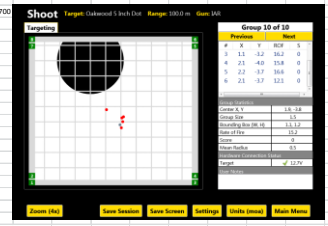
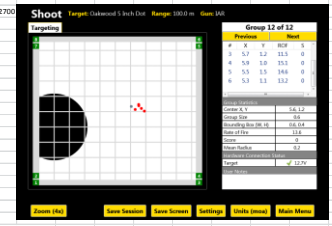
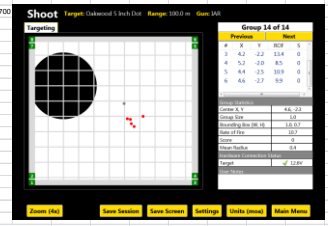
Appendix 3 to Annex D: Bravo UUT Unsuppressed Scored Data

Table D-3-1. Bravo UUT Unsuppressed Scored Data



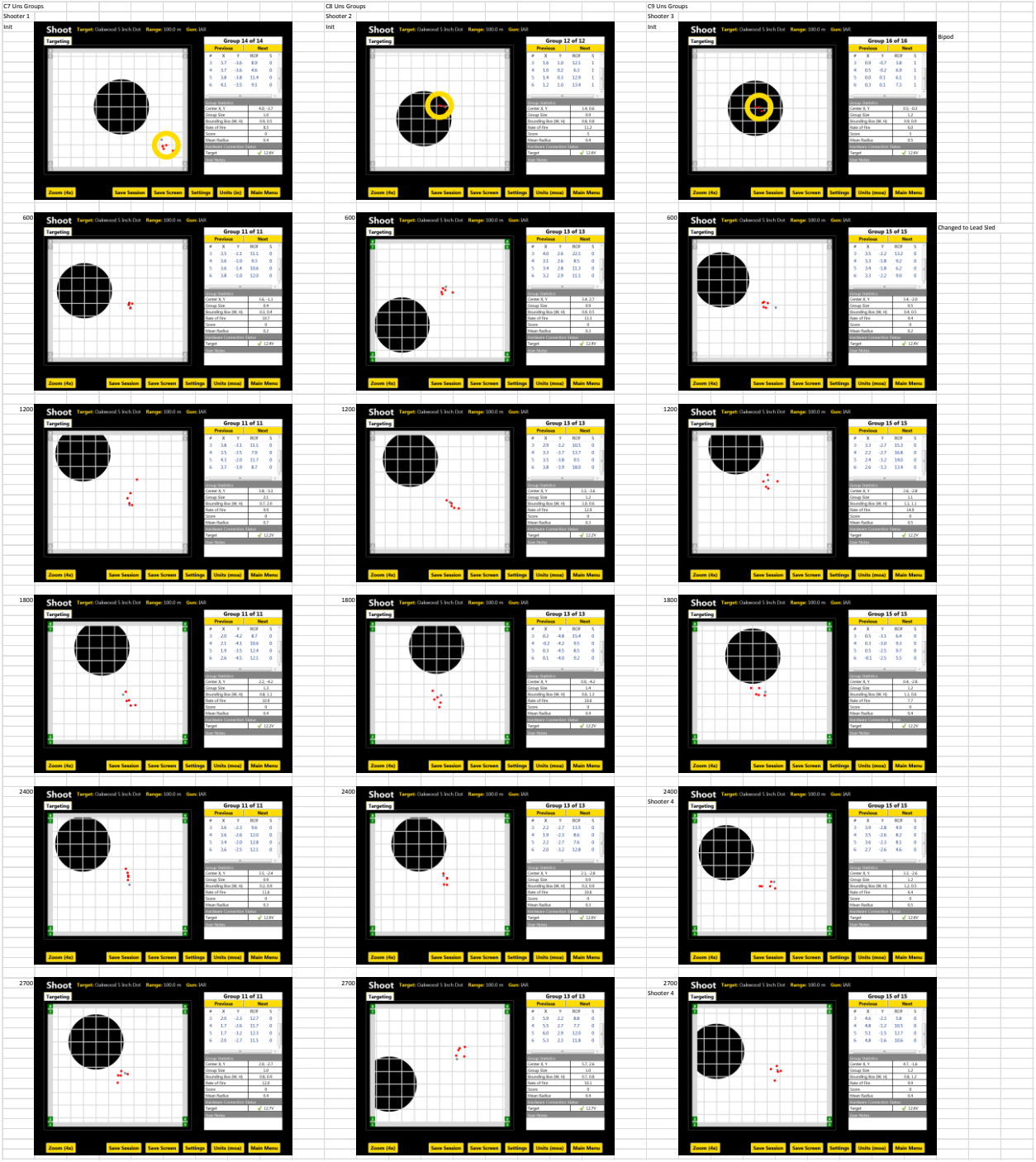
Appendix 4 to Annex D: Charlie UUT Suppressed Scored Data

Table D-4-1. Charlie UUT Suppressed Scored Data

C7 Sup Groups	C8 Sup Groups	C9 Sup Groups	
Init			 Bipod
600			 Changed to Lead Sled
1200			 Noted that cap was loose on SRM.
1800			
2400			
2700			

Appendix 5 to Annex D: Charlie UUT Unsuppressed Scored Data

Table D-5-1. Charlie UUT Unsuppressed Scored Data



Annex E: EOSF Zero Alignment Check Procedures

The EOSF used the following procedures for the Zero Alignment Check:

1. Set up the camera in front of a long MIL STD 1913 rail (see Figure E-1).

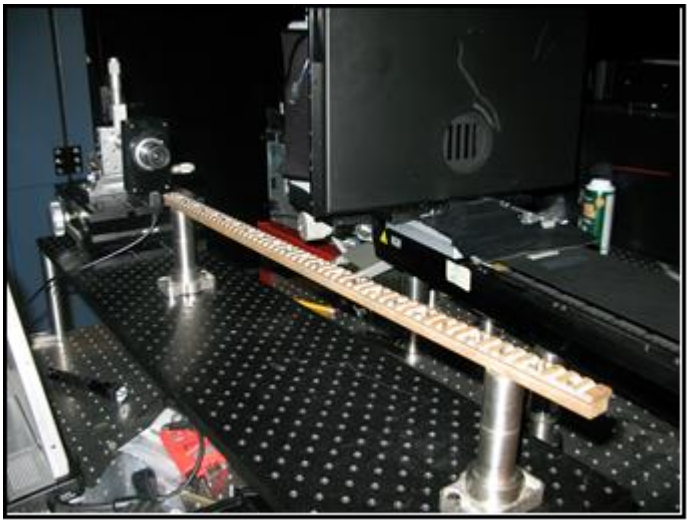


Figure E-1. Camera and Mil-Std 1913 Rail Setup in EOSF Lab

2. Mount the UUT and a Squad Day Optic (SDO) on the rail, in line with the camera (See Figure E-2).

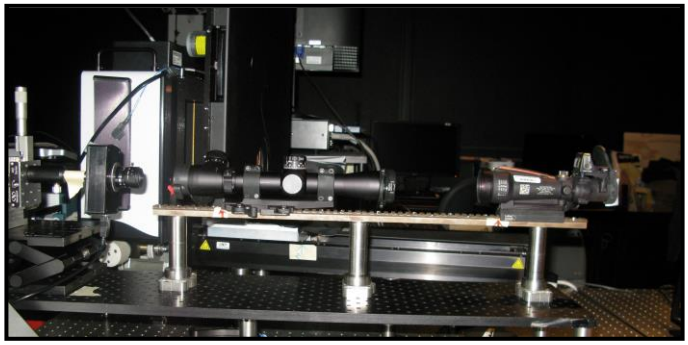


Figure E-2. Camera with UUT and SDO on Mil Std 1913 Rail

3. Focus the camera on the center dot of the SDO.
4. Use masking tape to mark the position of the camera, UUT and SDO. These three items must be placed in the same position when collecting data both pre and post live-fire event.
5. Capture images of the UUT's FOV both before and after the live-fire event.
6. Capture an image of a USAF 1951 resolution target to be use in calibration
7. Upload the USAF-1951 image on a graphic editor (Canvas X); calibrate the editor according to the chart layout product specification. The measurement unit should be in subtended minute of angle.
8. For each UUT, superimpose a Pre-Live-Fire image on a Post-Live-Fire image and determine the subtended angle of the two center dots (or alternatively, one can measure the subtended angle of the cross hairs). See Figures E3 and E4 for an example of the measurements made on UUT A1. The results of these inspections are in Tables A4 and A4a.

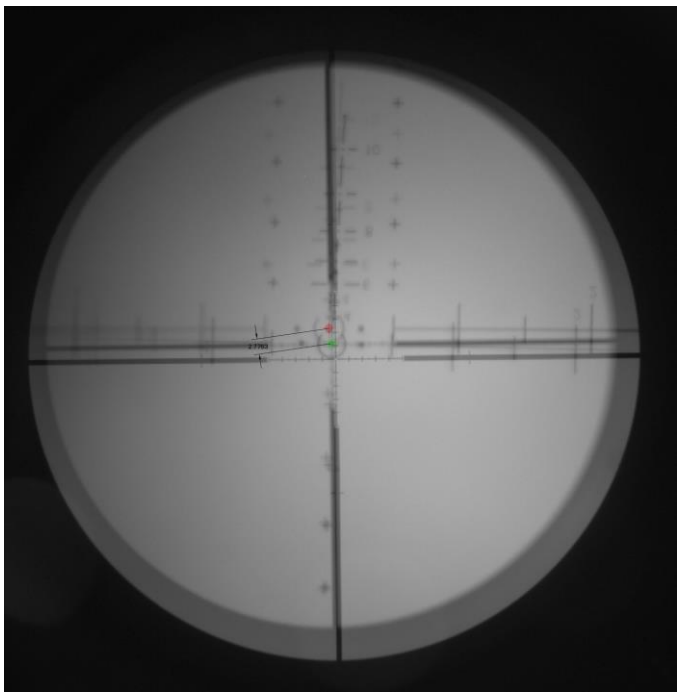


Figure E-3. Pre and Post Live-Fire Images (Trial 1)

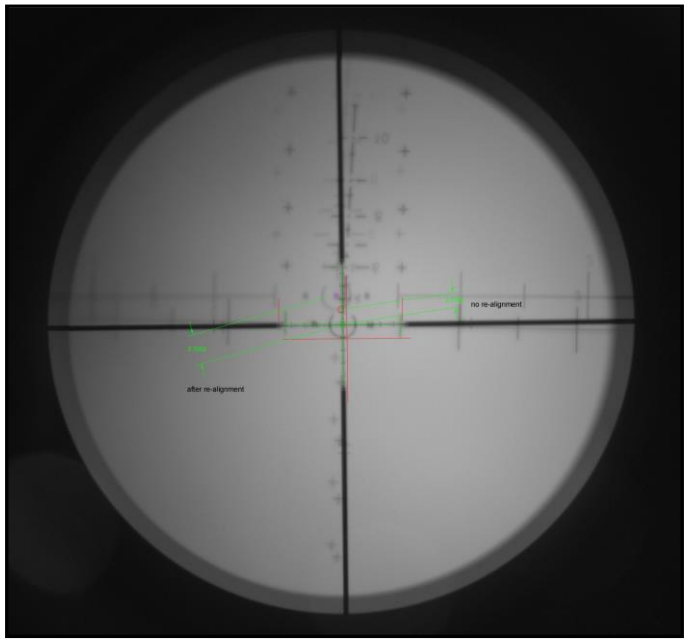


Figure E-4. Pre and Post Live-Fire Images (Trial 2)