NATO Weapons and Sensors Working Group Panel Discussion

2016 ARMAMENT SYSTEMS FORUM

April 27, 2016

Barton H. Halpern, Ph.D.

Chairman, NATO LCG DSS W&S Sub Group

Agenda

1. NATO Organization
2. W&S Structure/ Terms Of Reference
3. NATO Panel- Participants

Weapon & Sensor Subgroup Structure


Australia**


Belgium


Canada


Czech Republic


Denmark


Estonia


France


Germany


Hungary

Chairman: Dr. Barton Halpern (United States of America)

Vice-Chairman: Ulrich Merkelbach (Germany)

50 Member National Delegates Including PFP* and Contact Countries**

G/3 Team of Experts **Jens Tore Alfei (Norway)**

D/14 Team of Experts **Ulrich Merkelbach (Germany)**

Suppressor Team of Experts **Scott Reeve (UK)**

STANAG 4512 Team of Experts **Per Arvidsson (Sweden)**

Sensor Team of Experts* **Wayde Thomka (USA)**

National Delegates and Supporting Subject Matter Experts


Ireland


Italy


Netherlands


New Zealand


Norway


Poland


United States


United Kingdom


Ukraine*


Turkey


Sweden*


Spain


Singapore**


Portugal

ToR for Weapons & Sensors WG

- The group is responsible for all issues related to dismountable soldier's weapon systems, grenades and shoulder launched and guided anti-tank weapons, as well as dedicated sensors (including, but not limited to day and night sights, laser designators, tactical lights and fire control systems).
- **The group is responsible for training equipment as associated with our ToR equipment**
- The weapon system includes the weapon itself, different types of ammunition and the dedicated accessories.
- The group is also responsible for the interface of the weapons and sensors with the various other parts of the soldier system.

Three Levels of Standardization

AAP-6

Standardization: The development and implementation of concepts, doctrines, procedures and designs in order to achieve and maintain the compatibility, interchangeability or commonality which are necessary to attain the required level of interoperability, or to optimise the use of resources, in the fields of operations, materiel and administration

Three Levels

- **Compatibility**: The suitability of products, processes or services for use together under specific conditions to fulfil relevant requirements without causing unacceptable interactions (04 Oct 2000).
- **Interchangeability:** The ability of one product, process or service to be used in place of another to fulfil the same requirements (04 Oct 2000).
- **Commonality**: The state achieved when the same doctrine, procedures or equipment are used (04 Oct 2000).

Goal

- **Interoperability:** is the ability to act together coherently, effectively and efficiently to achieve Allied tactical, operational and strategic objectives (03 Dec 09)

The Panelists are :

1. **Mr. Michael Tauber, U.S. Army ARDEC**
2. **Mr. Scott Reeve, UK Defence Science and Technology Laboratory**
3. **Mr. Sal Fanelli, U.S. Marine Corps Systems Command**
4. **Mr. David Long, NSWC Crane**
5. **Dr. David Dye, NSWC Crane**
6. **Mr. Adam Jacob, U.S. Army ARDEC**

I have asked each of the panelists to describe their involvement and responsibilities

NATO OTAN

NATO Army Armaments Group

US Support of NATO Weapons & Sensors Working Group

2016 NDIA Armament Systems Forum

April 27, 2016

Fredericksburg, VA

Mike Tauber

US Head of Delegation (HoD)

Office: 973-724-7690

E-mail: michael.j.tauber.civ@mail.mil

Chairman vs US HoD Roles

Chairman

- Plan & manage W&S
  - Establish Teams of Experts (ToEs) and work directives
  - Coordination with 28 nations
  - Conduct bi-annual W&S Meetings
  - Support bi-annual LCGDSS Plenary Meetings

Weapons & Sensors (W&S) Working Group

US HoD

- Support & coordinate W&S US resources
  - Support ToEs and work directives
    - US resources: ARDEC, ARL, ATC, CERDEC, JSSAP, NSWC Crane, PM-IWS (USMC), PM MAS, PM SSL, PM SW
    - US resources includes “permanent” delegates and “temporary” SMEs
  - Support bi-annual W&S Meetings

W&S is Custodian to 10 STANAGs/ STANRECs/ Documents

Document	Title	Status
STANAG 2129	Identification of land forces on the battlefield and in an area of operation	Ratified in 2010 (Action Closed)
STANREC 4498 ED2	Soldier Systems Representative Targets, Helicopters and Unarmored Vehicles	DEU lead. Approved by LCGDSS. Endorsed by NAAG. NSA reports that Promulgation Date 17-10-2013
STANAG 4512	Dismounted Personnel Targets	ToE formed in Feb 2015 led by Sweden. Canada, UK and USA participating. Transition of SET-209 into updated STANAG (Exploitation of Human Signatures for Threat Determination) - Ongoing Effort
STANAG 4513	Incapacitation & Suppression	UK Provided NATO W&S Group a report on their testing. UK will provided draft STANAG at February 2016, W&S Meeting. Forecast to LCGDSS March 2016
STANREC 4536 ED2	Soldier Systems Representative Targets, Unfortified and Fortified Structures	NLD lead. Approved by LCGDSS. Endorsed by NAAG. NSA reports that Promulgation Date 17-10-2013
STANAG 4694 ED1	NATO ACCESSORY RAIL	Ratified: Promulgation Date 16-03-2011
STANAG 4740 /AEP-90Ed.: A	NATO Powered Rail	Submitted for Ratification on 05-01-2015. **12 NATIONS Ratified: Recommend Promulgation**
STANREC 4785 and AEP 4785	SUPPRESSOR TESTING PROTOCOL ON ACOUSTIC SIGNATURE MEASUREMENT FOR SMALL ARMS SUPPRESSORS - AEP-4785 EDITION A	**NSA assigned numbers to the STANREC as a Study on June 4 2015. W&S provided final versions to LCG DSS Dec 2015.**
D/7	INFANTRY SMALL ARMS POST 2025	W&S Subgroup led by SWE updating document to reflect NATO approved Calibers. Document is finished and approved by W&S Group.
D/14	Evaluation procedures for future NATO Small Arms Weapon Systems	Team of experts formed Oct 2012. Ongoing efforts. More details in brief.

Team of Experts (ToE) – US Participation

1. Suppressor ToE – UK Lead

- **Current Scope of ToE:**
  - Produce test methodologies/protocols for evaluating Acoustic, Flash, Visual, and Thermal Signatures of suppressors and suppressed weapons; also investigate Vapor and Particulate by-products and effect on operator in confined space, indoor range training.
  - Started Acoustic effort in Feb 2013. NATO Acoustic Suppressor Testing Methodology STANAG (AEP-4785) was approved in Jun 2015 and finalized in Dec 2015.
  - Flash and Thermal started in Feb 2015. A new STANREC / AEP for measurements in the Visible and Infrared Spectrums for Small Arms will result.
  - US Participants: ARDEC, ARL, ATC, JSSAP, NSWC Crane, PM-IWS (USMC), PM SW

Team of Experts (ToE) – US Participation (cont.)

2. D/14 (T&E Procedures of Future NATO Small Arms Systems) ToE – DEU Lead

- Development of a new structure of D/14; ToE initiated in Oct 2013 ✓
- Divide the team into two sub teams: "weapon system“ responsible for Chapters 2,3 and Annex B "accessories and miscellaneous” responsible for Chapters 1,4,5,6, Annexes A,C ✓
- Definition of work packages ✓
- Development of a draft chapter by the respective custodian(s); US is responsible for:
  - 2.1 Preliminary Inspection Firing and Weapon Characteristics ✓
  - 2.2 Kinematics Analysis ✓
  - 2.3 Safety Recommendations (based on MIL-STD-882E, System Safety) ✓
  - 2.6 Barrel Examination and Reporting Procedures ✓
  - 2.11 Recoil by Ballistic Pendulum
  - Chapter 4: Sighting Devices
- Revision of the drafts by subteams
- Revision of final drafts by ToE
- “Test drive” with the final drafts at test facilities
- Completion of D14-update: 2018
- US Participants: ARDEC, ATC, JSSAP, PM-IWS (USMC), PM SW, PM SSL

Team of Experts (ToE) – US Participation (cont.)

3. STANAG 4512 (Dismounted Personnel Targets) ToE – SWE Lead

- Initiated Feb 2015
- CAN, UK, and USA participation
- The aim of this STANAG update is to define enemy body armor that must be defeated.
- Current activity: Analysis of NIJ 0101.06 (Ballistic Resistance of Body Armor) and NATO AEP-2920 (Procedures for the Evaluation and Classification of Personal Armor).
- US Participants: ARDEC, JSSAP

4. Sensor ToE – USA Lead

- Initiated Feb 2016
- 12 nations will participate
- Weapon centric sensors only.
- Initial efforts will focus on standardizing symbology and display format/layout.
- US Participants: CERDEC, JSSAP, PM SSL

NATO OTAN

NATO Army Armaments Group

LCGDSS – W&SWG
Suppressor Test Methodologies Team of Experts

April, 2016

NDIA, Fredericksburg, USA

Scott Reeve

ToE Chairman

Dstl/DOC95303

Direct: +44 30 6770 5610, Mobile: +447769 966 966

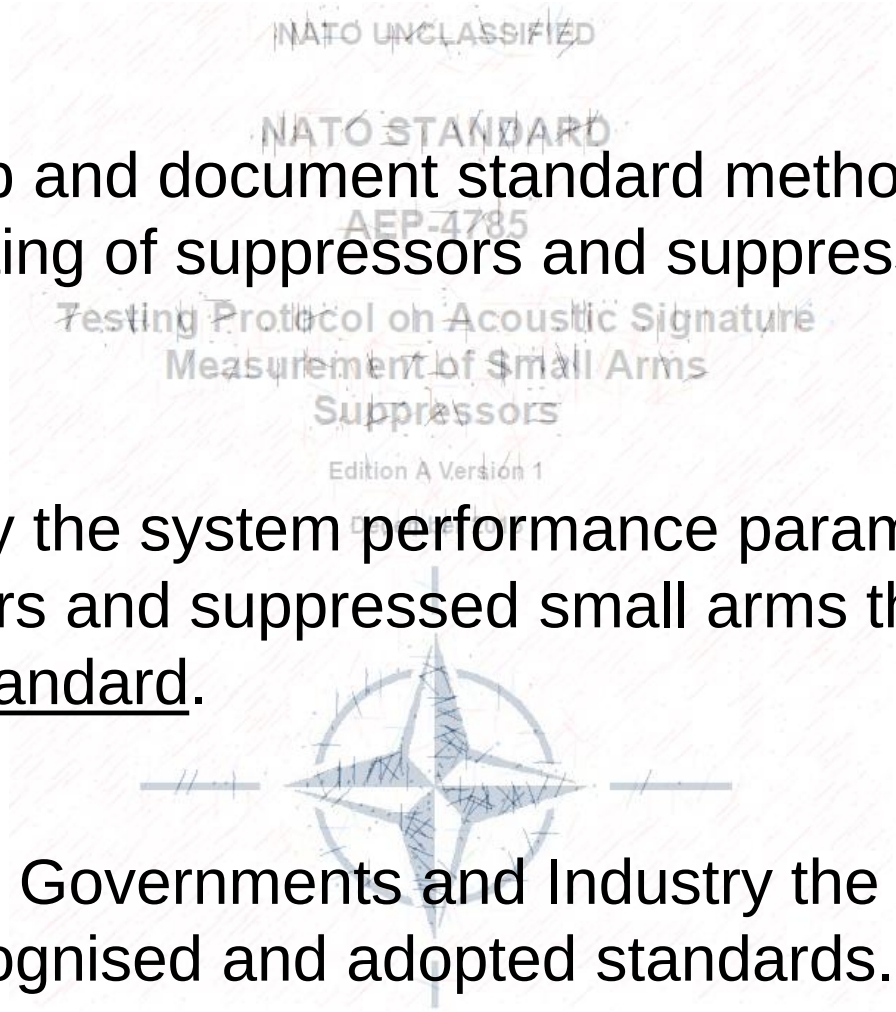
E-mail: sreeve@dstl.gov.uk

Why a Suppressor ToE?

- There is an interest across NATO.
  - Not just for specialist users
  - Move away from bespoke/qualitative testing
  - Move away from solutionising the requirement
- Lack of standards
- Decision made in October 2012 to form:

  Suppressor Test Methodologies Team of Experts
- The ToE:
  - Experienced members of LCGDSS W&S WG
  - Active Suppressor programmes (funding to support)
  - Access to SMEs in Government or Industry.

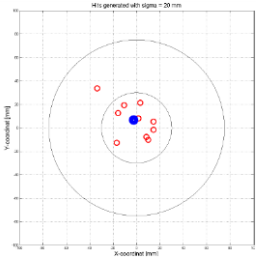
The A S P of the Suppressor ToE

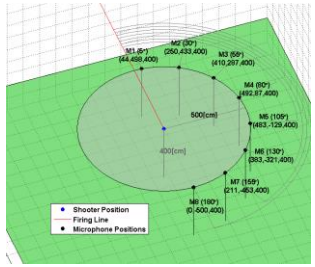


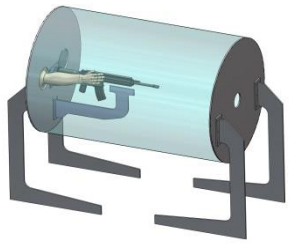
- Aim:
  - To develop and document standard methodologies for the testing of suppressors and suppressed small arms.
- Scope:
  - To quantify the system performance parameters of suppressors and suppressed small arms that warrant a useful standard.
- Purpose:
  - To provide Governments and Industry the opportunity to use recognised and adopted standards.

The Scope of the Suppressor ToE

- Safety
  - Proofing
- Signature
  - Acoustic, Vis and IR signature, Blast
- A&C
  - MRD and POA/POI shift
  - Mirage
- System degradation
  - Cyclic rates (back pressure)
  - Vapour and Particulate by-products (Toxicity)







What have we done?

NATO UNCLASSIFIED

NATO STANDARD

AEP-4785

Testing Protocol on Acoustic Signature Measurement of Small Arms Suppressors

Edition A Version 1

December 2015

NATO UNCLASSIFIED

NATO STANDARD

AEP-yy

Testing Protocol for Intensity Measurements in the Visible and Infra-red spectrum of Small Arms

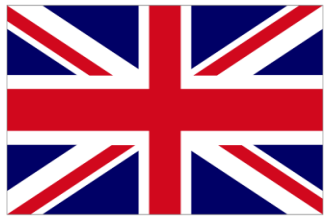
Edition Z Version 1

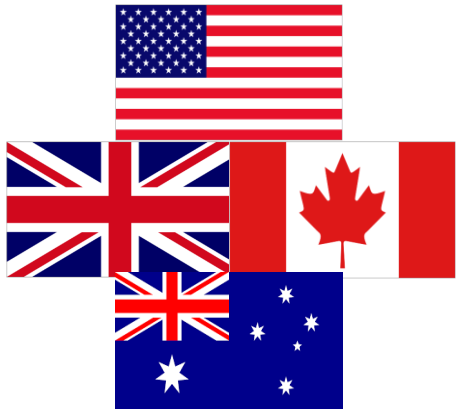
xxx 2016

- A&C in D14, Mirage being planned, toxicity…

Why am I supporting this?

- Benefits to the UK MOD
  - Active programmes need suitable test methods
  - Active participation with Allied Partners
  - Support UK industry with test capabilities
- Benefits to the SOF 4 EYES community
  - Active participation in cutting edge development
  - Drive their requirements for test methods
  - Will lead to better Suppressor technology
  - Supports requirement definition
- Benefits to Dstl
  - A forefront of development
  - Ensure the test and evaluation capability is developed
  - Development of staff





[dstl]

USMC IWS Participation

- Why do we support these efforts?
  - International Collaboration efforts
  - Lessons Learned
  - Technical input to all STANAG updates
  - Technical input to new STANAGs
  - Nations status of small arms
  - Corroboration with Team of Experts
  - Support from SYSCOM

CAPT JT Elder, USN
Commanding Officer
NSWC Crane

Ms. Trisha Herndon, SSTM
Acting Technical Director
NSWC Crane

NDIA Armaments Conference

NATO Panel

Presented By: David Long, Small Arms Weapons Division

Date: 27-April-2016

Why participate in the ToE

CAPABILITY PRODUCTION DOCUMENT

For

Family of Muzzle Brakes and Suppressors (FMBS)

Increment II, III (III A, III B), IV, and V Version 1.0

ACAT: 3

Validation Authority: USSOCOM J8

S&T Opportunity

Personal Defense Weapon Upper Receiver Group $XXK

FY 2014 NSWC Crane Division Internal Rapid Experimentation Funding

Project Description: This concept is to develop an integrally suppressed drop-in, short barreled, between 7 to 8.5 inch, Upper Receiver Group (URG) for the M4A1 Carbine that would use a 30 caliber bullet in a cut-down 5.56 cartridge to improve accuracy and penetration capability at shorter ranges in a more compact system than is currently available to the Warfighter. In addition, the suppressor includes novel material to improve heat transfer and sound dampening. Revolutionary manufacturing methods will also be explored.

Project Justification: This project needs to be conducted at NSWC Crane based on its Small Arms expertise and established programs of record that would permit easy insertion of the proposed technological capability. This project would provide a game-changing capability at short ranges.

PIs: Jason M. Davis (JXNR) & Dr. Steve Seghi (WXT)

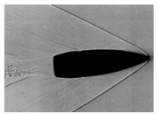
Team: JXN, JXQ, JXT, WXT

S&T Opportunity

Relevant Weapon Signature Evaluations

$: XXXK
PI: Owen Cramer
NISE Category:
Basic/Applied Research

Project Description:
Developing effective sound and flash suppression for small arms weapons is critical for warfighter survivability. Often, however, visual and acoustic weapon signatures are evaluated subjectively or using potentially irrelevant parameters. Even when quantitative measurements are obtained, well-defined comparison measurements and standardized techniques are lacking. This leads to difficulty in comparing suppression systems. In this project, we'll methodically develop a set of relevant and quantitative parameters and testing procedures to evaluate the efficacy of visual and/or acoustic suppressors in small arms weapons.



Shadowgraph of bullet above Mach 1

A subjective flash measurement technique

= ??

= 148.6 dB

What do we gain

- Collaboration with doctoral level expertise across NATO


Australia


Canada


Netherlands


Norway

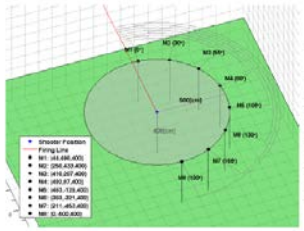

Sweden


United Kingdom


United States (Army, Marine Corps, Navy)

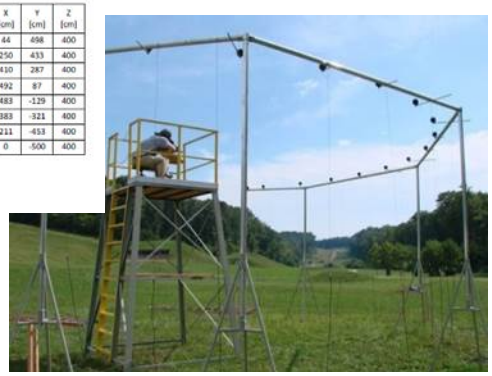
What do we gain

Repeatable, quantitative methods



Microphone number	Angle [deg]	X [cm]	Y [cm]	Z [cm]
M1	5	44	498	400
M2	30	250	433	400
M3	55	410	287	400
M4	80	492	87	400
M5	105	483	-129	400
M6	130	383	-321	400
M7	155	211	-453	400
M8	180	0	-500	400

Figure 4 Transducer placement specification.



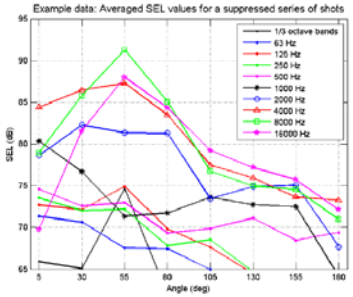


Figure A.2 A selection of averaged 1/3 octave band SEL values for a suppressed series of shots as a function of the angle.

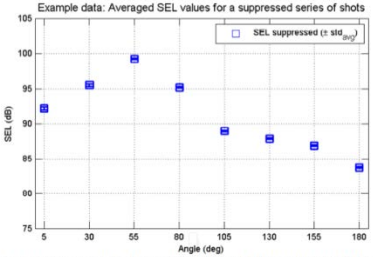
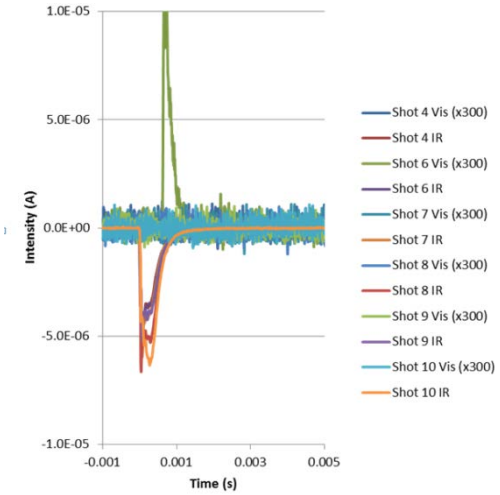


Figure A.1. Averaged SEL values for a suppressed series of shots as a function of the angle (for 8 microphones). Error bars are also given (± the standard deviation of the average based on 20 shots).



Contact Information

David Long
Naval Surface Warfare Centers
Crane Division
300 Highway 361
Crane, IN 47522
812.854.3542
david.r.long@navy.mil

CAPT JT Elder, USN
Commanding Officer
NSWC Crane

Development of Standardized Test Methods for Quantitative Small Arms Flash Measurements

Dr. David F. Dye (david.f.dye@navy.mil) and Jason M. Davis

April, 2016, NDIA Armament Systems Forum

NAVSEA
WARFARE CENTERS
CRANE

CAPT JT Elder, USN
Commanding Officer
NSWC Crane

Development of Standardized Test Methods for Quantitative Small Arms Flash Measurements

Dr. David F. Dye (david.f.dye@navy.mil) and Jason M. Davis

April, 2016, NDIA Armament Systems Forum

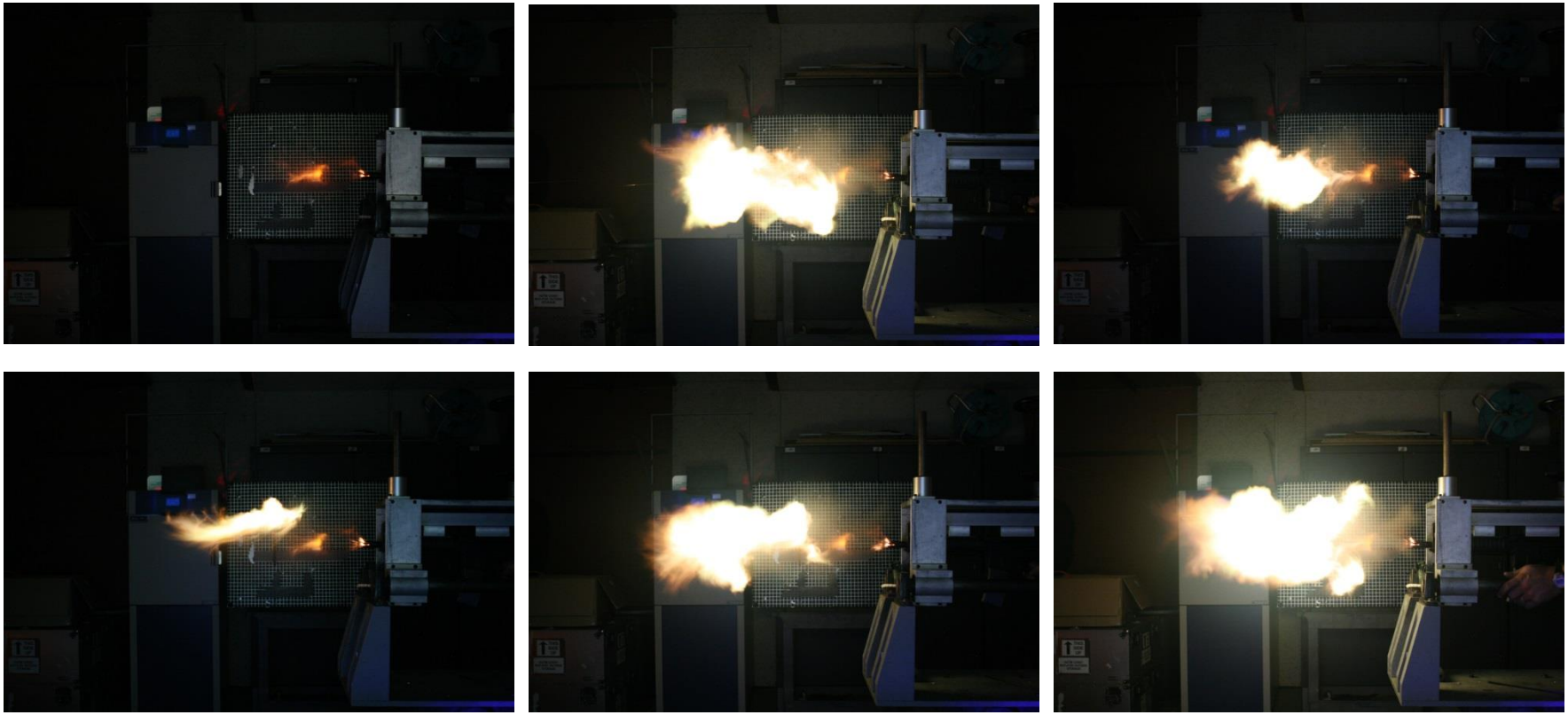
Project Objective

- Current flash measurement methods rely on still (long exposure) photography
  - Qualitative assessment of performance
  - Poor calibration/standardization

- Objective: Develop and evaluate quantitative small arms muzzle flash measurement methods—emphasis on suppressed weapons
  - Effort part of NATO Army Armaments Group (NAAG), Land Capability Group Dismounted Soldier Systems, Suppressor Team of Experts

Photographic Flash Characterization

- Currently preferred method for flash characterization
  - Quantification is difficult using uncalibrated cameras
  - Limited to visible flash (using consumer cameras)



Comparison of Available Methods

Critical Requirements:

- Reliable calibration
- High sensitivity
- Temporal resolution
- Multiple spectral bands

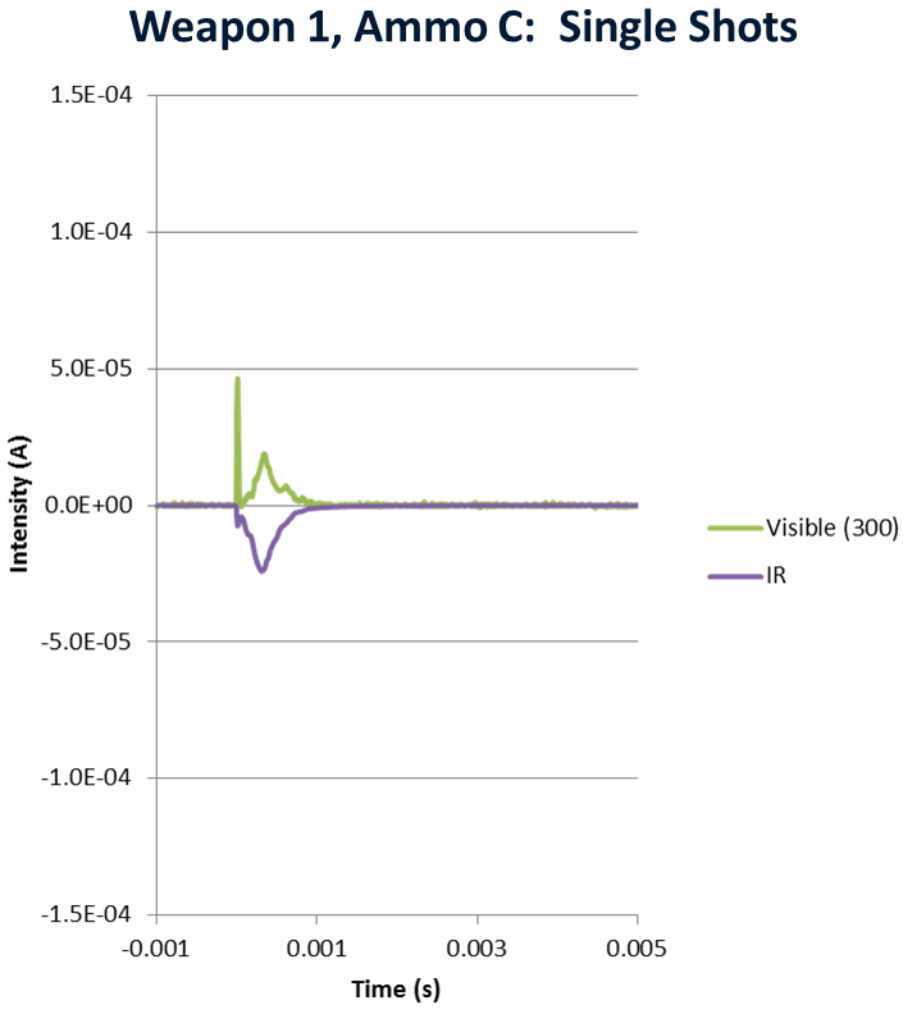
Secondary Concerns:

- Shape/size images
- Low cost (relative)
- Easy to use

	Still Photography	H.S. Photography	Radiometry	H.S. Spectrometers
Reliable intensity measurement	✓	?	✓	✓
High sensitivity	✓	X	✓	X
Large dynamic range	✓	✓	✓	✓
Temporal resolution	X	✓	✓	?
Multiple spectral bands	X	X	✓	✓
Shape/Size measurement	✓	✓	X	X
(Relatively) Low Cost	✓	X	✓	?
Ease of operation/maintenance	✓	?	✓	X

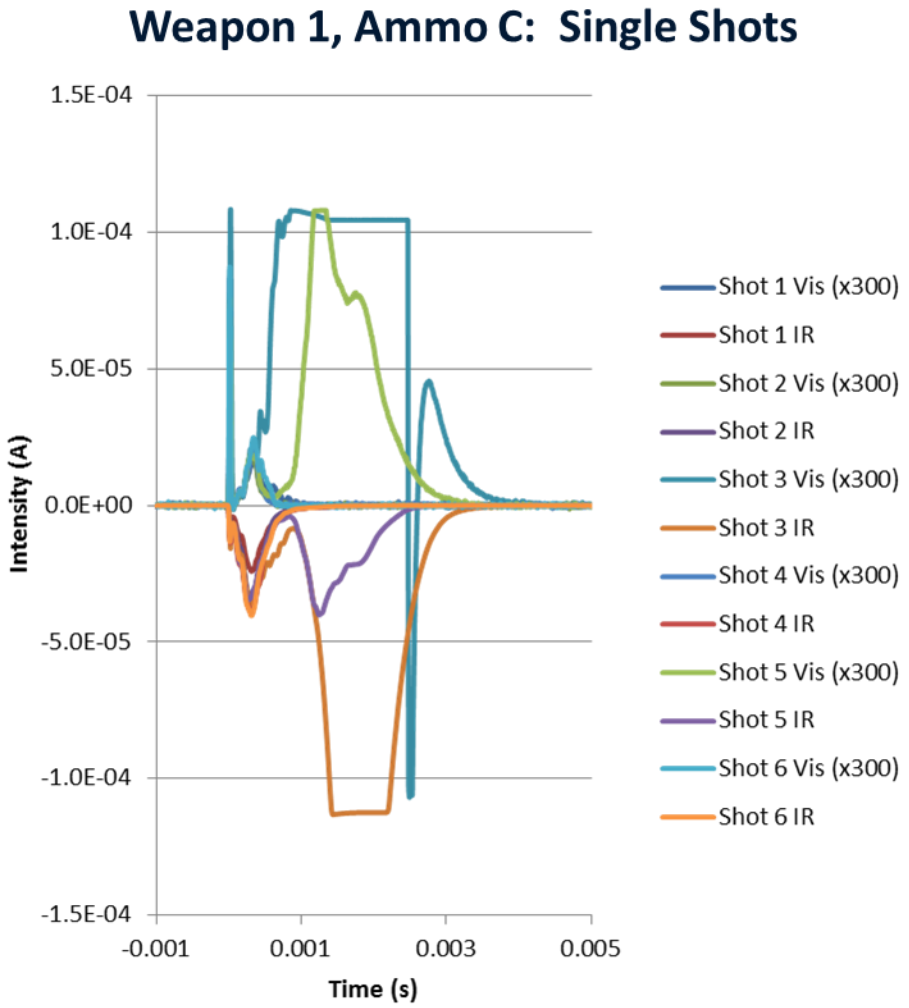
Temporal Flash Characterization

- Test Objectives:
  - Can instrumentation resolve fast features of the flash profile?
  - Can instrumentation quantitatively and repeatably measure intensity of flash profile?
    - Integration yields W/sr
- Notes:
  - Intensities plotted in amps to minimize apparent intensity differences due to amplifier gain settings



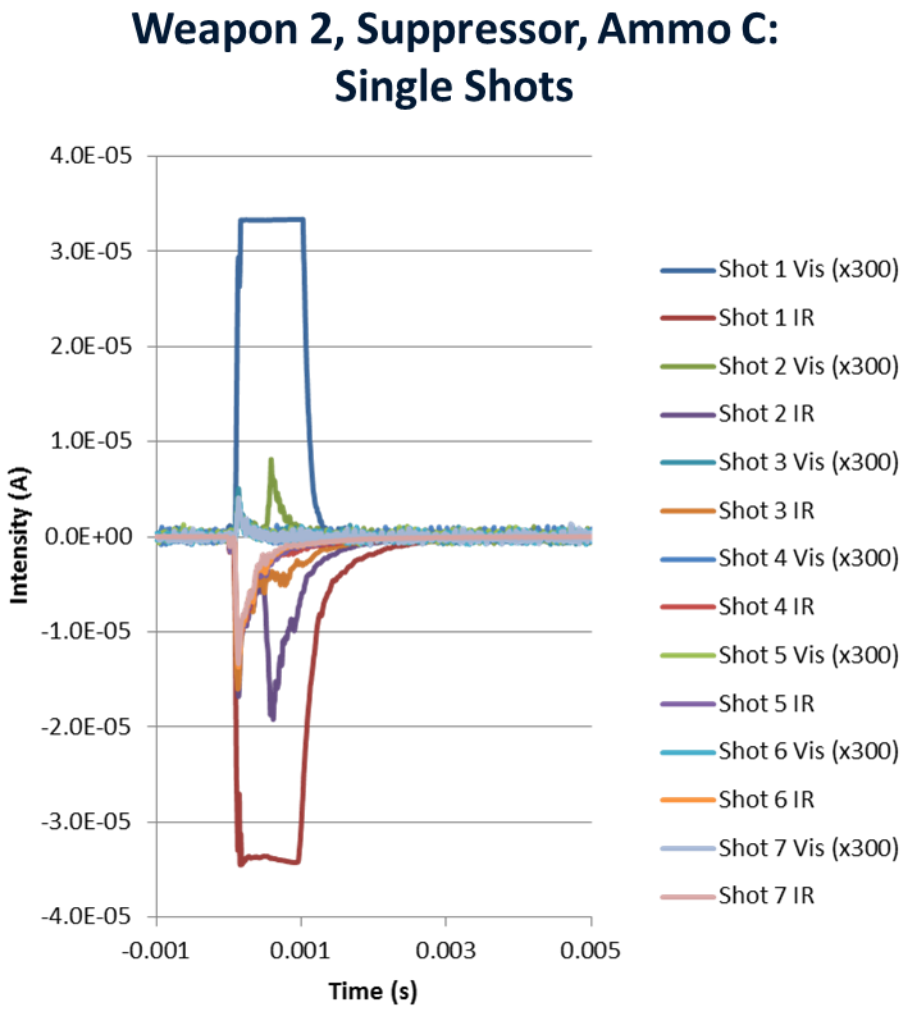
Temporal Flash Characterization

- Expected features observed
  - **Early: Pre-Flash**
    - Consistent profile
    - Bandwidth limiting feature
    - Small total energy emission
  - **Mid: Primary Flash**
    - Consistent duration & intensity
  - **Late: Secondary Flash**
    - Highly variable duration & intensity
- Large variability observed in flash intensities
  - Secondary flash is inconsistent
  - *Visible light level triggering is not reliable*
    - Recommend triggering from either IR or acoustic signal
    - IR triggering used successfully in these tests



Temporal Flash Characterization

- Addition of suppressors has a major impact on measured intensity
  - Infrared and visible signals both greatly reduced
  - “Cold” shots were much more intense than “warm” shots



Conclusions

- Photometers provide reliable muzzle flash measurement
  - Spectral radiant intensity measurements:
    - Visible, NIR, SWIR, and MWIR detectors available
    - Clearly defines measured intensity (W/sr)
  - Secondary flash creates dynamic range issues
    - “Bright” flashes saturate high-gain detectors/amplifiers
    - Possible solution is multiple detector/amplifiers
    - High sensitivity COTS solutions are being explored
  - Suppressed measurements pose sensitivity issues
    - Evaluation of alternate detectors is ongoing
  - Combination of photometry and photography is current path forward

- Documentation and validation of standards is ongoing
  - Final procedures established by Fall, 2016

Purpose

Develop a Method to Measure and Quantify Blowback From Small Arms Systems

- Blowback – Refers to the tendency of a small arms system to blow gases back through the chamber and toward the Operator after the bolt opens
- Although there has been work done in the area, there is no standard or accepted method to measure this phenomena with respect to the gases experienced by the Operator in a repeatable manner

Unsuppressed M249

Suppressed M249

*Photos courtesy of AAI/Textron.

Background

Unsuppressed M249

Suppressed M249

- Many Operators report increased blowback when a suppressor is added to a small arms system – we also have some qualitative laboratory evidence of this
- Different suppressor designs result in different amounts of blowback
- Why is this a problem?
  - Operational impact
- How is it currently measured and assessed?
- Why do we need to measure it?
  - Comparison of suppressors
  - Predict operational impact
  - Generation of requirements

*Photos courtesy of AAI/Textron.

Malcolm Baldrige National Quality Award 2007 Award Recipient

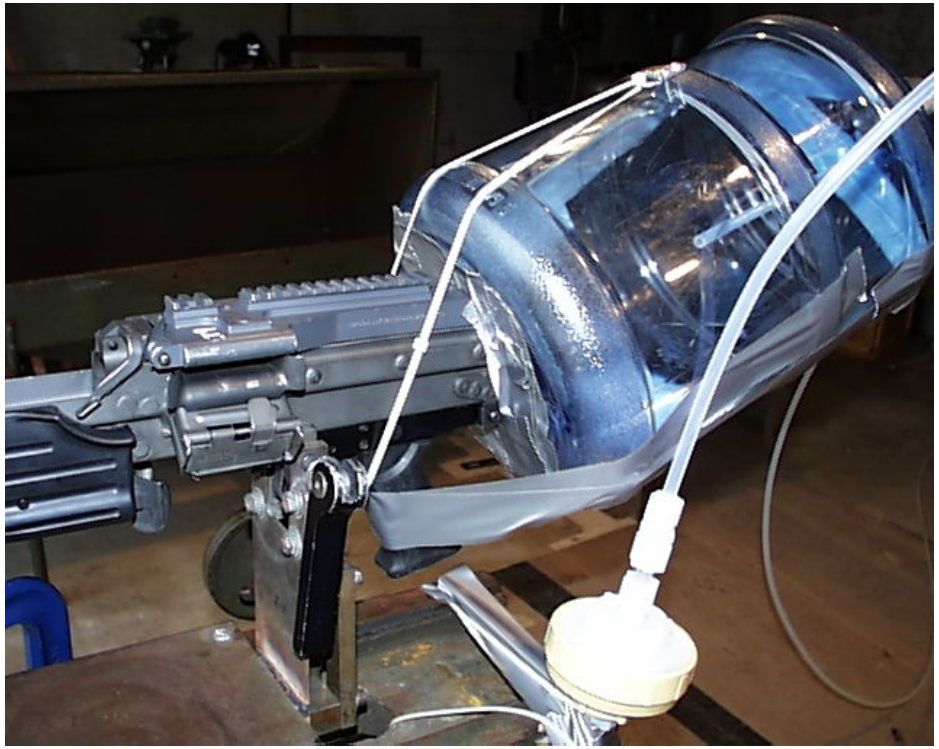
Small Arms Toxic Gas Testing – Toxins

Toxins in Small Arms Exhaust Gases

- Ammonia (NH_3)
- Carbon Dioxide (CO_2)
- Carbon Monoxide (CO)
- Hydrogen Cyanide (HCN)
- Methane (CH_4)
- Nitric Oxide (NO)
- Nitrogen Dioxide (NO_2)
- Sulfur Dioxide (SO_2)

US ARMY RDECOM

2005 U.S. Army Blowback Test



*Photos from 2005 ATC report, “Comparison of Toxic Gas Results for the M249 SAW, (Squad Automatic Weapon) Weapons Firing Testing Using Various Suppressors”.

Path Forward

1. Preliminary proof of concept test at Army Research Lab (ARL) Aerodynamics Range (18-22 April, 2016)
   - Test blowback using a wide variety of different methods
   - Multiple weapons and suppressors from high blowback, to low

2. Analyze data
   - Assess the ability of each method to measure blowback differences at the Operator's location
   - Determine which methods have the best results, both in ability to measure differences from system to system, as well as repeatability of measurements
   - Overall cost of method will also be considered

3. Write standardized test method

4. Validate standardized method in live fire test

Questions/Discussion