

History of NIMIC/MSIAC is linked to history of IM

- Need arose from horrific accidents of 1960 and 1970s



HORRIFIC MUNITION ACCIDENTS

NATIONS RECOGNIZE NEED TO REDUCE DANGER TO OUR OWN FORCES

RFA Bedenham accidental
detonation of depth charges
13 killed

1951

1960

USS Forrestal
accidental
ignition of
a Zuni rocket
134 killed,
161 injured

1967

USS Enterprise accid
cook-off of a Zuni ro
28 killed, 344 injured

1969

1970



Technical Information & Analysis Center Focusing on Munitions Safety

- NATO Project Office
- Independently Funded by its Member Nations

MSIAC Strategic Goal:

Eliminate Hazardous Consequences due to Unintended Reactions of Munitions and Energetic Materials Throughout their Lifecycle

- Want to minimise the risk from our own munitions
- Understand and demonstrate benefits of munitions safety throughout the lifecycle
- Improve and standardise munitions safety risk assessment methodologies
 - better understanding of benefits and relative costs of munitions safety measures and methods
- Harmonize munitions safety policies to achieve greater sharing of munitions safety evidence
- Provide world leading scientific and technical analysis, and advice to support decisions on munitions safety and risk management
- Standardise approach to safe storage and use of munitions in operational theatres

- **MSIAC Strategies, Policies, & Work Efforts Defined by a Steering Committee (SC)**
 - 1 SC Representative per Member Nation, 1 Vote per Member Nation
 - 1 Elected Chairman (non-voting) from a Member Nation

- **14 Members**



- **Soon to be 15**



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- **Soon to be 15**



- **US Contacts**

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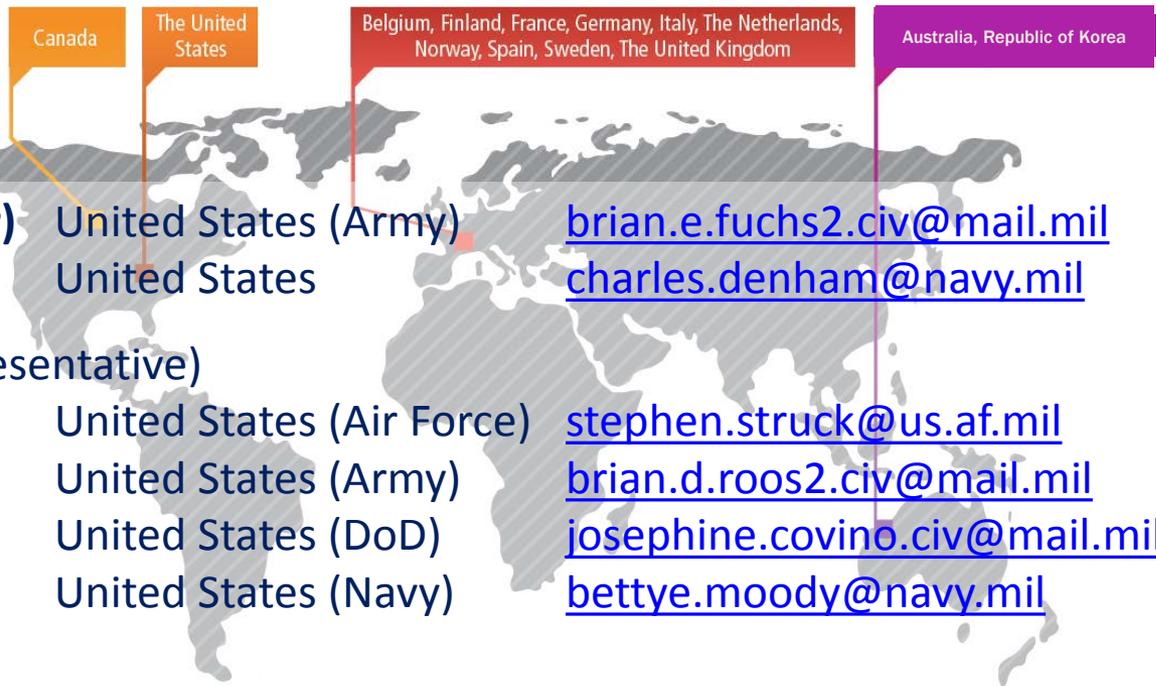
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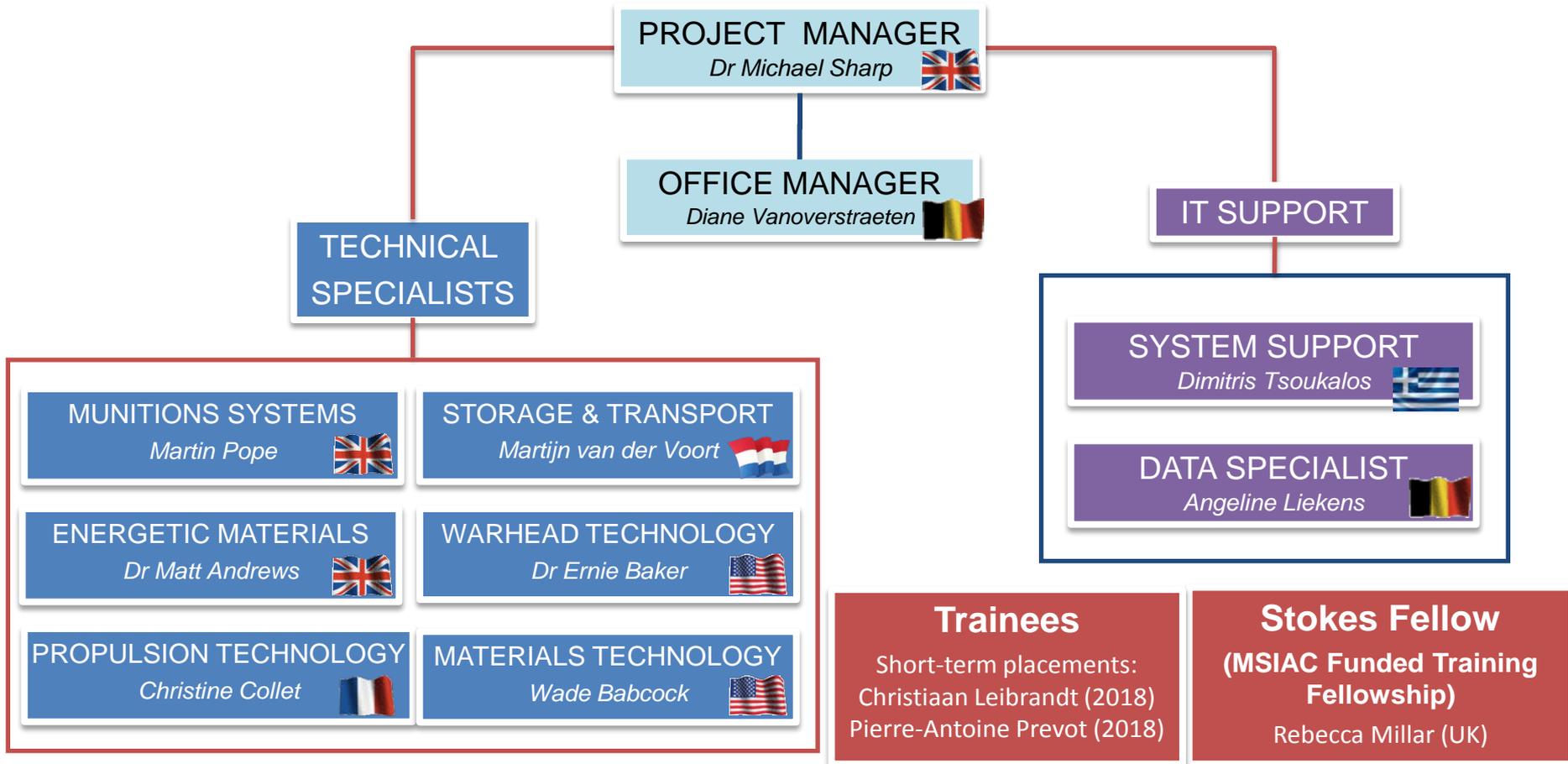
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Knowledge & Access to Community of Technical Experts Across our Member Nations

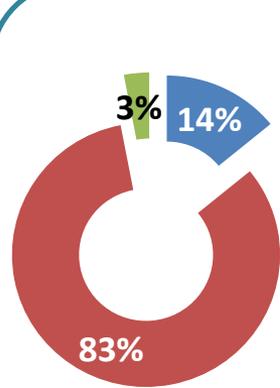
- Grouped into following areas:

Develop, Synthesize, and Maintain **Knowledge** and understanding to enhance Munitions Safety

Define, harmonize, improve and promote **Policies** for Munitions Safety
(technical support to AC/326)

Capture and Analyse Munitions Safety **Requirements**

Maintain Technical Expertise and Resources to **Deliver** Information and Promote Munitions Safety



■ AC/326 Support

■ MSIAC Member Nations

■ IMHM SMART Defence

Support NATO Policy, Advice and Review

More than 20 Workshops

Open- and Limited-Distribution Reports

Open & Secure Websites with more than 600 users

Answering more than 2600 Technical Questions

Training, Country visits, Fellow and Students

15 Distributable Software Tools and Databases

Develop, Synthesize, and Maintain **Knowledge** and understanding to enhance Munitions Safety

- Answering Technical and non-Technical Questions
 - available free of charge to member nations
 - may be screened by Nation
- Questions can easily be submitted using an online form

Examples:

- What is the effect of endothermic polymer decomposition on thermal ignition of PBXs?
- What is the survivability of Bradley fighting vehicles to an RPG attack?
- What are the infrastructure options for a new High Explosives plant?
- Assist in the developing national IM policy/implementation plans?
- What LOVA propellants options are available?

<https://www.msiac.nato.int/products-services/msiac-technical-question-form>



A goal of MSIAC is to encourage and facilitate the sharing of Munition Safety and Insensitive Munitions related information.

MSIAC DOCUMENT MANAGEMENT SYSTEM

Laserfiche[®]

*16,500 Docs
Directly Accessible via Secure
Web Environment
depending on access rights*

<https://www.msiac.nato.int/Weblink/>



*150,000 Docs (4M pages)
Accessible by MSIAC staff
on behalf of member nations*



Limited Reports (from March 2017 – Available to MSIAC Nations only)

- L-199 Mitigation Technologies for Rocket Motor (Cheneau)
- L-200 Benefits of IM (van der Voort, Keefe)
- L-203 Science of Cook Off Workshop – Final Report (MRA/MWS/ES/WB)
- L-204 Science of Cook Off Workshop Ignition and Growth Focus Area (ES/Bryan Henson)
- L-205 Science of Cook Off Workshop Material Damage Focus Area (MWS/Malcolm Cook)
- L-206 Science of Cook Off Workshop Violence of Reaction Focus Area (WB/G Scholtes)
- L-207 Science of Cook Off Workshop Chemistry & Material Parameters Focus Area (MRA/Lori Nock)
- L-208 Science of Cook Off Workshop Chemistry & Materials Process Focus Area (Andrews/K Clark)
- L-209 Science of Cook Off Workshop Small Scaled Test Focus Area (ES/L Smilowitz)
- L-210 Science of Cook Off Workshop Modelling Focus Area (WB/D Picart)
- L-215 An International Review of Hazard Classification (A Leroy, van der Voort, Pope)
- L-214 Modular Charge Systems (Schultz)
- L-213 Material Parameters needed for Insensitive Munition-Related Modeling and Simulation Efforts (Babcock)
- L-216 An Overview of Shear Initiation and Ignition of High Explosives (Pouliquen, Baker)

Open (from March 2017)

- O-177 An International Review of The Slow Heating Test (Baker)
- O-178 Review of Munitions Safety Processes within MSIAC Nations (Pope)
- O-179 Future development of Quantity Distance standards (van der Voort, Raimbault)
- O-180 Probabilistic Aspects of the Initiation of Explosives and Ammunition (van der Voort ,Sharp)
- O-181 APS SCCM - Gun Testing Ballistics Issues for Insensitive Munitions Fragment Impact Testing (Baker, Schultz)
- O-182 APS SCCM - Ballistics Trajectory and Impact Analysis for Fragment Impact Testing Insensitive
- O-183 ISB - Laboratory Setback Activator Tests for Gun Launch Explosive Suitability (Baker)



WL

WebLink Portal

Securely search, browse and retrieve documents

Forum

Forums

Access point to forums associated with MSIAC, AC/326 and munitions

Security

To securely log out of the portal and the associated applications, you must close your browser and all its tabs with **Alt + F4** on Windows or **⌘ + Q** on Mac.

Welcome Martin Pope, you have access to the following applications:

AIMS

Advanced IM Search

Web-based platform for quick and easy search of Insensitive Munition Test Results

EMC

Energetic Materials Compendium

Database providing information on explosives, propellants and pyrotechnics

MADx

MSIAC Accident Database eXchange

Multi-national accident database with government-lead contributions

MQD

MSIAC Quantity Distance

The MSIAC QD (MQD) tool is currently being developed to perform an experimentally validated consequence analysis of the initiation of various types and quantities of munitions in various types of magazines, and with possible mitigation measures in place.

MTM

Mitigation Techniques for Munitions

Database providing information on mitigation technologies for munitions

SASO

Safety Assessment Software ★

Aid in standardisation of the S3 assessment made before introducing munitions into service

- Maintenance of Existing IM & MS Databases (POL-MAN-2)
 - Mitigation Technology for Munitions (MTM) database - new web application
 - Energetic Materials Compendium (EMC) version 5.0 developed and deployed
 - Also AIMS, NEWGATES, SASO, MSAS, IMSOA
- MSIAC National Exchange of Information Databases (open to MSIAC & AC326 nations)
 - Both the Hazard Classification and Accident databases continue to be updated.
 - MSIAC has also development of a common accident database MADx which compiles provided national data allowing access through one application
 - Available to Nations contributing data only



Helping to Enhance Technical Expertise in Member Nations

- MSIAC Tools on request
 - Particularly relevant for Temper and SASO

- AASTP1 & 5 Lecture Series
 - Course continues to receive very good feedback from participants
 - Requested 5 times in 2015, 3 times in 2016, 5 times in 2017, 6 times in 2018 (including one in France happening right now)

- Trainees
 - A Stokes Fellow 2017/18 – Pyrotechnic aging
 - Students projects in 2018:
 - 3 short time projects : **Christiaan Leibrandt** from the Military Academy in the NLD, **Anne-Laure Vialette** from ENSMA (1st time!) and **Pierre-Antoine Prevot** from ENSTA Bretagne
 - 1 long time project starting August 2018: **Aurihona Wolff** from ENSTA Bretagne
 - Work covered in 2018: Probabilistic Aspects in EMs initiation, Gathering material properties, Mitigation technologies for warheads and Innovative manufacturing processes



Kineton, UK
2-6 October 2017



Rome, Italy
24-28 October 2016

<https://www.msiac.nato.int/products-services/msiac-interns-trainees>

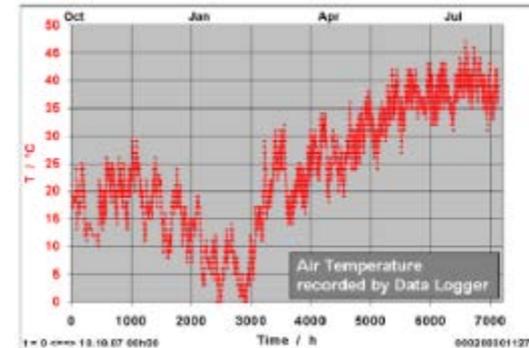
MSIAC efforts on MHM:

- Support NATO STO AVT focused on advances in munition health management : AVT-268 held a 3-day conference in Utrecht, NLD, in October 2017. Currently planning for a technology demonstration in 2019.

- MSIAC Supports NATO Smart Defence Initiative to develop MHM guidance

L-193

- Polled member nations for cumulative experience with dataloggers in munitions service
 - Forms background compilation of National experiences
- MSIAC is facilitating the UK-led SDI
- MSIAC is preparing reviews of MHM efforts across all NATO nations for the past 15 years



MSIAC has continued to support AC326 on the following activities

SG/A (EMT)

- Support to STANAG 4147 - Compatibility (Report due Spring 2018) (KNO-MET-2)
- Setback Assessment of EM – MSIAC will contribute to US-led working group

SG/A (IST)

- Demolition Materiel: Design, Testing and Assessments STANAG 2818 review

SG/B (POL-HAR-2 & POL-HAR-6)

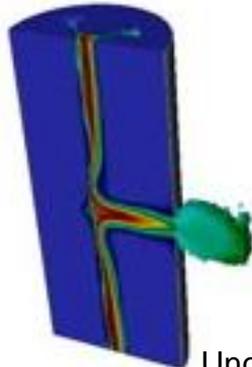
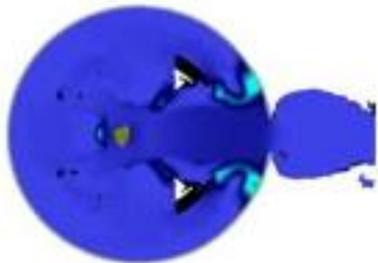
- Supporting the Fragment Impact CWG – Updated and presented MSIAC review paper O-159 “Ed 2 An international review of the fragment impact test”
- Supported Slow cook-off CWG in April 2017
- Work concluding on AOP-39 STANAG and SRD documents
- Support to IM/HC Harmonisation - presentation to follow
- Support to NATO SDI Munitions Health Management

- The workshop held in April 2016 achieved its goals:
 - Develop understanding on the role of heating rate (conditions) in determining reaction violence
 - Improve understanding of chemical and physical changes leading to critical ignition and growth conditions
 - Improve understanding of reaction phenomenology
 - Provide guidance on scope of validity of system level tests
 - Improve and update methodologies to predict response
 - Advance methodologies to predict response mechanisms
 - Advance knowledge and tools to assess munition response
 - Hierarchical approach to building response understanding from chemical and physical properties and sub scale testing (identify properties and tests)
 - Assess models, the capabilities and limitations to predict response mechanism

8 limited reports are now available gathering the main outputs from the WGs: L-203 → L-210



- Effect of ageing on materials and munitions safety
 - Will provide MSIAC nations with a state of the art on the effect of ageing on the response of munitions to IM threats.
 - Exploitation of this work for the wider munitions safety ageing issues
- Definition of Material Properties and Data for Modelling
 - Generation of report containing important material properties and the methods to determine them required to support modelling efforts
- Develop Improved Understanding of Ageing Related Mechanical Damage
 - New effort to compile understanding and knowledge on vibration damage mechanisms

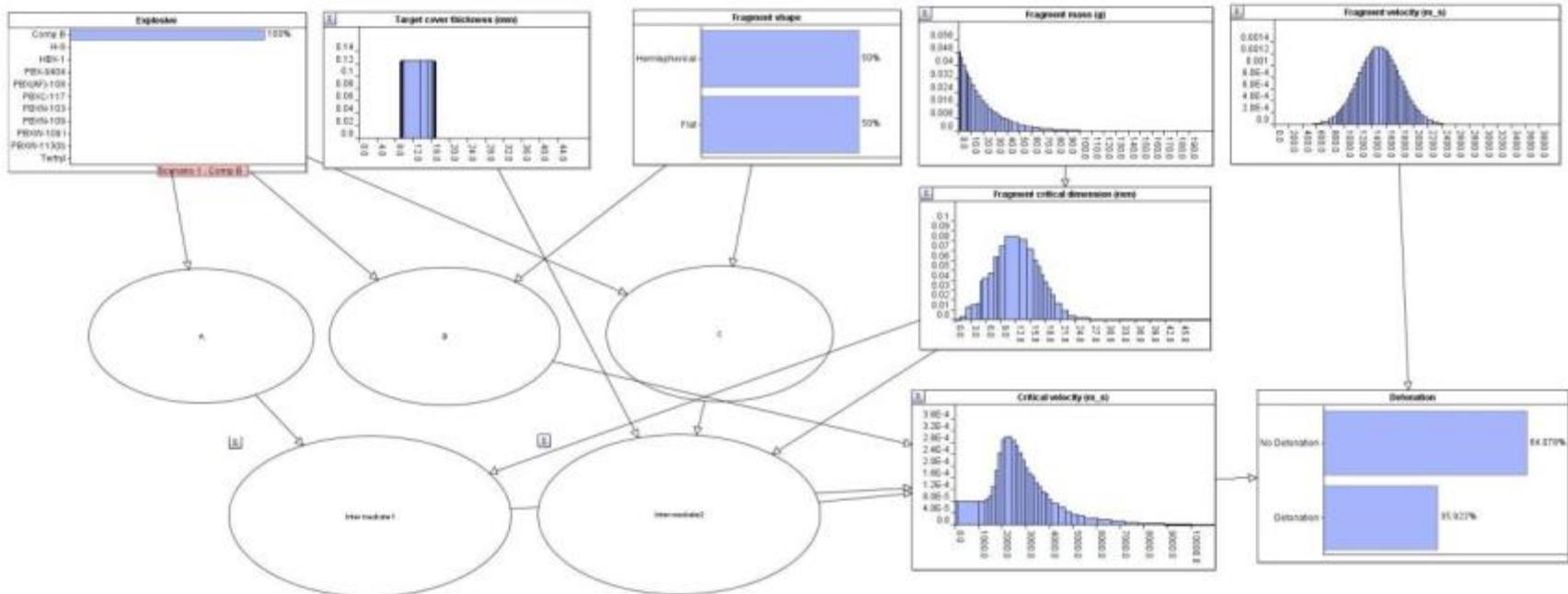


Unclassified / Unlimited Distribution



Case studies investigating benefits and applicability of this approach

- Probabilistic analysis takes into account realistic variations
 - Cover thickness: 9 to 17 mm
 - Threat fragment mass and velocity distribution
 - Flat and hemispherical fragment shapes
 - Explosive set to “Comp B” as an “observation”

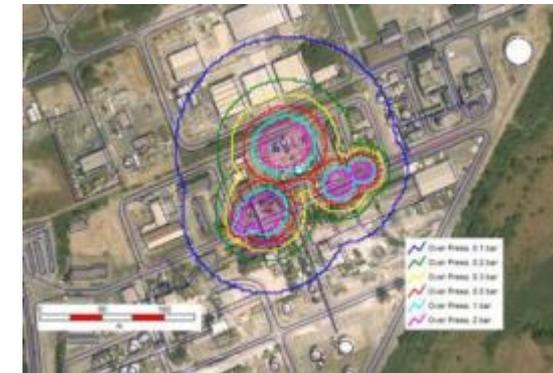
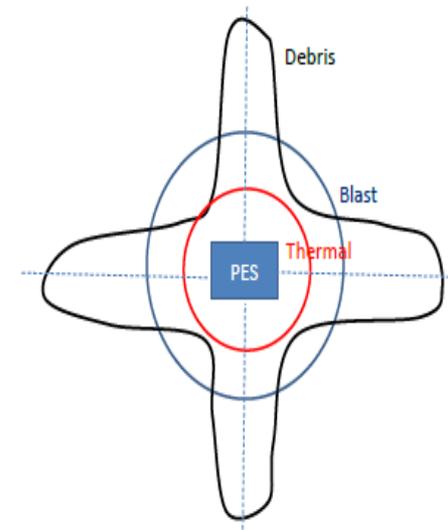


- To provide documents that assess setback activator technology (2016-17) and gun launch ignition (2017-18).
- Inform on the need to develop a NATO standardised approach to proving the suitability of energetic materials for gun launch.
 - Reports discuss the assessment of new energetic materials for which there is little knowledge base and experience
 - **Limited Report: “Use of Laboratory Setback Activator Tests to assess Suitability for Gun Launch”**
 - Aim is to develop supplementary data for complex artillery S3 assessment
 - Allow reducing the reliance on costly all-up-round level tests while maintaining confidence

L-212



- Background
 - QD standards are based on many tests and decades of development
 - Not easy to understand for new people in the field
 - Transparency could be improved
- Tasks:
 - Collect all references with experimental work and analysis that are relevant for AASTP-1 and AASTP-5, including the latest WPs
 - Compile a comprehensive report that gives the experimental and theoretical basis of current QD standards
 - Identify knowledge gaps and advice on areas for further development.
 - Development of MSIAC QD tool (MQD)
 - Implements Analytic Models for QD determination
 - Limited report in 2018 and repository of supporting information

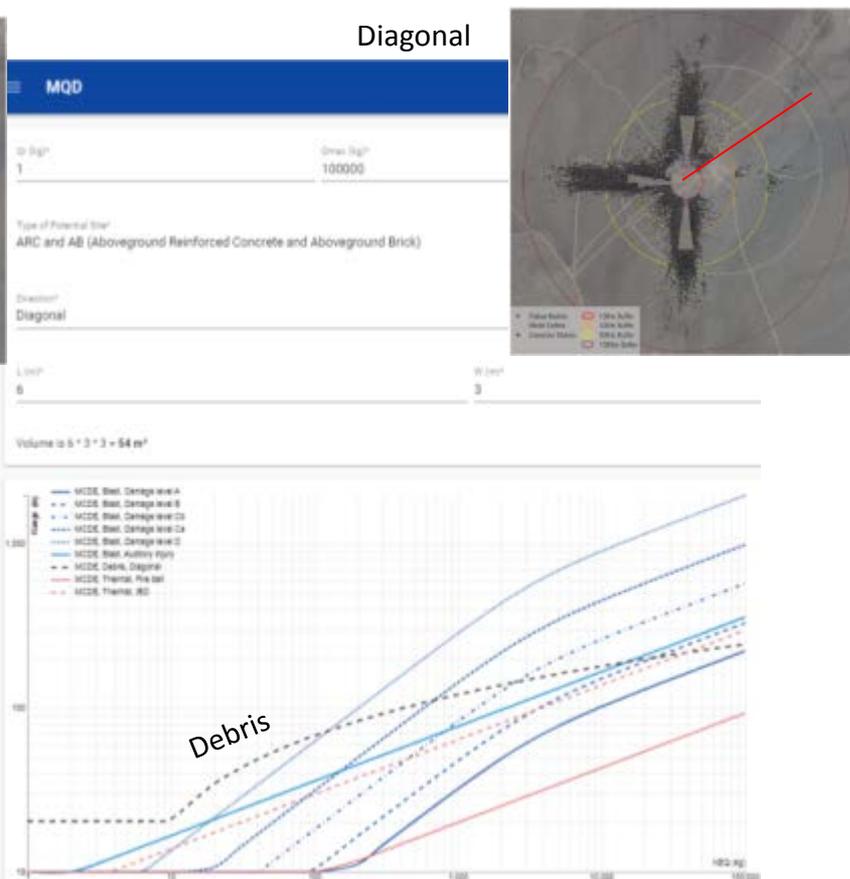


- Example:
 - Reinforced concrete structures (6*3*3 m)
 - Consequence distances in two directions
 - Reduced debris in diagonal direction

Normal



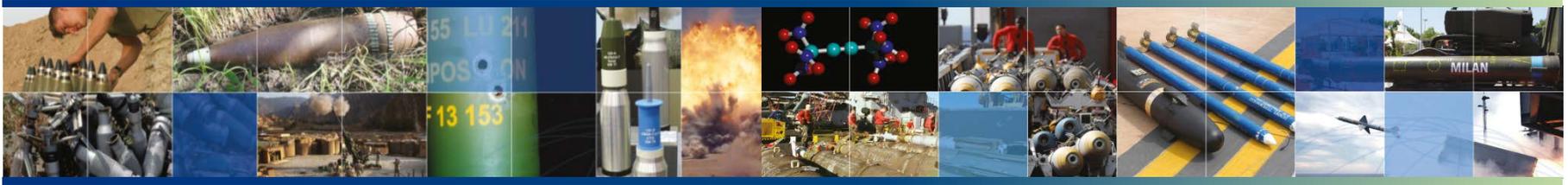
Diagonal



Distance (m)

Debris

Debris



2018 Workplan



- New Work Elements

- [KNO-UND-12] Ageing and Degradation of Pyrotechnic Compositions
(Stokes Fellow)
- [KNO-CAP-7] Emerging Technologies for Gun Propelling Charges.
- [KNO-CAP-8] Material Defects – Definitions, Tests and Principles.
- [KNO-CAP-9] Emerging Minimum Smoke Propellants.
- [POL-MAN-3] Database of Electromagnetic Radiation Hazards to Munitions.
- [POL-HAR-7] MSIAC 2018 workshop: Improved Explosives and Munitions Risk Management (IEMRM).

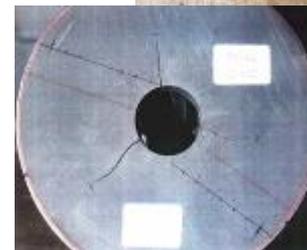
- **Title:** Ageing and Degradation of Pyrotechnic Compositions (Stokes Fellow project)
- **Description:** review R&D activities in this area:
 - Types of flares and pyrotechnic compositions
 - Process
 - Safety data
 - Ageing and degradation processes
 - Related standards and tests
- **Input:** data from a survey sent late 2017 to industry and research center
- **Duration:** 8 months (Nov 2017 – July 2018)
- **Deliverables:**
 - Progress brief
 - Limited report
- **Classification:** MSIAC member nations only



- **Title:** Emerging technologies for gun propellant
- **Description:** review R&D activities in this area:
 - New formulation (with CAN, GUDN, DNDA, ...)
 - New process: SSE, co-extrusion, coating
 - New shape: cubic, 3D printing
 - Ignition technologies: micro wave, miniature laser,...
 - Mitigation technologies for cartridge case
- **Input:** publication and direct approach to industry and research center
- **Duration:** 2 years
- **Deliverables:**
 - Progress brief
 - Limited report
- **Classification:** MSIAC member nations only



- **Title:** Material Defects – Definitions, Tests and Principles
- **Description:** Request by TTCP for support on Defects, which fits well with MSIAC plans for workshop in this area, hence would assist preparation.
 - Provide a draft of rocket motor, warhead, bomb and gun launch defect lexicon (characteristics)
 - Review determine current pass/fail criteria development and knowledge
 - Review methods/principles OEMs use to rate defects particularly for rocket motors (minor/major/critical)
 - Information to be gathered using a survey approach
- **Input:** Information from government, industry and research centers required
- **Duration:** 2 years
- **Deliverables:**
 - Progress brief
 - Limited reports
- **Classification:** MSIAC government only



- **Title:** Emerging minimum smoke formulations
- **Description:** review R&D activities in this area. New min smoke have been introduced in service recently (Brimstone II, LMM). New ingredients used: GAP, ADN, FOX-7, AN,...



IMEMTS 2016

A New Generation of Minimum Smoke Propellants for Tactical Missile Propulsion

Eirik A. Løkke, Thomas Deschner Tor E. Kristensen, Tomas L. Jensen, Erik Unneberg

- **Input:** publication and direct approach to industry and research center
- **Duration:** 2 years
- **Deliverables:**
 - Progress brief
 - Limited report
- **Classification:** MSIAC member nations only

- **Title:** Database of Electromagnetic Radiation Hazards to Munitions
- **Description:** To assist nations in their efforts to apply correct procedures and precautions in support of NATO operations and exercise to prevent functioning of electrically initiated devices (EID's) in ordnance from electromagnetic radiation (EMR).
 - Develop needs statement in discussion with the HERO community
 - Determine nations intent to share relevant information
 - Develop specification for the software tool (functionality and data requirements)
 - Instruct software developer to produce prototype for testing purposes
 - Populate the tool with SRAD & TRAD codes and complete testing
- **Input:** nations must be prepared to exchange HERO data on transmitters and munition susceptibility. National expertise required to guide effort.
- **Duration:** 2 years (15K development cost in year 1)
- **Deliverables:** *Web application*
- **Classification:** Contributing MSIAC members only

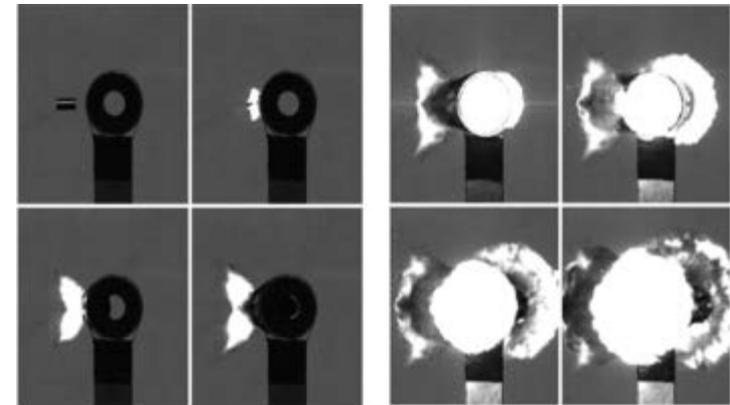
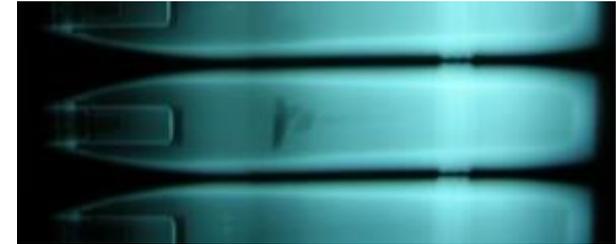


MSIAC Workshop in 2018:

- Improved Explosives and Munitions Risk Management, 10-14 Sept., Granada, Spain

Proposals for years 2019-2023:

- Methodologies to Determine Acceptability of Defects and Design Tolerance on Safety
- Introduction of New Processing Technology and its Impact on Safety
- IM – Understanding Mechanical Damage and Violence of Response



IMEMTS 2016 DE&S, UK Ministry of Defence THALES
Small Scale Fragment Attack Testing on the LMM Missile Boost Motor and the Influence of the Conduit Form on XDT Threshold
Authors: Stephen Holden, et al.

- MSIAC continues to provide support on **Insensitive Munitions and Munitions Safety**
- Policy remains an active area for MSIAC with **support provided to AC 326** to facilitate review of standards
- **Workshops** continue to be an important means to help advance munitions safety efforts
- **Training courses and opportunities** exist and can be exploited by members

