

MSIAC - SUPPORTING THE MUNITIONS SAFETY COMMUNITY

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Abstract

The NATO Munitions Safety Information Analysis Center (MSIAC) is a multinational collaboration that collects, stores, and analyses technical information related to Munitions Safety (MS) with a focus on Insensitive Munitions (IM). MSIAC supports its member nations through a variety of products and services. In addition to a core responsibility of addressing technical questions related to Munitions Safety posed by nations, MSIAC has a diverse programme of work aimed at developing and sharing the related underpinning scientific knowledge. This is then applied to support policy implementation and development related to munition safety. Some examples of current activities are given in this paper.

MSIAC has developed a number of tools to help advise nations on the implementation of national and international munition safety related policy and standards. MSIAC supports the NATO ammunition safety group, AC/326, and current strands of work include: development and support for IM self audit procedure, review of IM response descriptors, and facilitating the review of a number of STANAGs.

The paper also presents a plan of proposed workshops and technical meetings. Using input from the nations, MSIAC has developed the plan to ensure that the member nations' needs are addressed in the coming years. The paper includes brief descriptions of the topics and planned dates over the next six years.

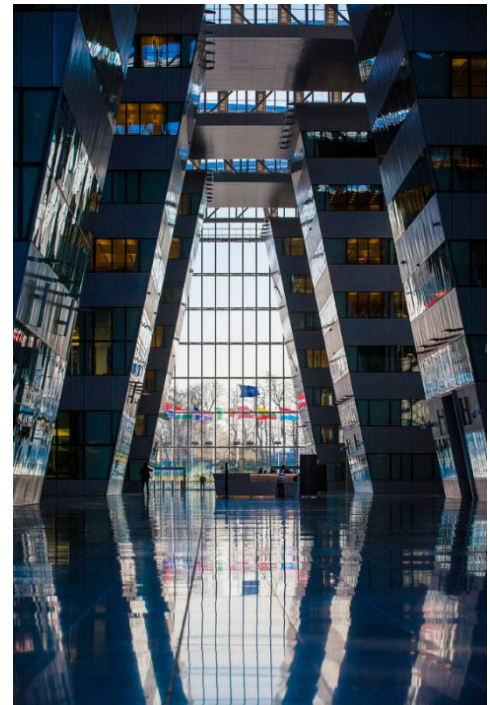
Introduction

MSIAC is a member nations' funded and directed NATO project office, which was established in 1991. Its goal is to help nations reduce, and eliminate, the risk to personnel and materiel from explosive incidents associated with their own munitions.

The overarching goal agreed by MSIAC member nations is to:
“Eliminate Hazardous Consequences due to Unintended Reactions of Munitions and Energetic Materials throughout their Lifecycle”

To help its member nations realise this goal, MSIAC gathers, stores, exchanges, and analyses information and technology related to munition safety and insensitive munitions. Over the years MSIAC has played a central role in facilitating member nation's efforts to design, develop, procure, and use safer munitions.

Recent notable events for MSIAC include in 2016 achieving an important milestone of providing 25 years of support to the munition safety community. We have seen a recent expansion in membership and by the end of 2018 we expect to have added two new member Nations to the growing MSIAC family; ROK joined from the beginning of 2018 and Poland is expected to join shortly. The introduction of new nations is always an exciting time with opportunities to exploit the growing pool of knowledge and to share best practice between national experts. 2018 was also the year of the big NATO move. MSIAC left the basement of Battiment Z to move to its new home in the impressive new NATO Headquarters in Brussels.



About MSIAC

The MSIAC project is directed and administered by the Project Manager (PM) and Steering Committee (SC) who are responsible for the implementation of the MSIAC memorandum of

understanding (MOU). The SC consists of one senior representative from each of the 14 participating nations¹.

The MSIAC team consists of the PM, support staff, and six technical specialist officers (TSOs). Key to the successful operation of the project is the knowledge and experience of the TSOs and the extensive MSIAC database. The TSOs are recruited via a competitive process from MSIAC Member Nations² and each has a focused area of expertise, details of each TSO and the current incumbent are summarised below:

- **Propulsion Technology** – Ms. Christelle Collet (France)
 - *Interest areas:* Design, manufacture, safety testing and evaluation, ignition/initiation systems, and operation and performance. Surveillance and munitions health monitoring.
- **Energetic Materials** – Dr. Matthew Andrews (United Kingdom)
 - *Interest areas:* Synthesis, formulation, production techniques, testing and qualification, chemical and physical properties, and reaction mechanisms.
- **Munitions Systems** – Mr. Martin Pope (United Kingdom)
 - *Interest areas:* Weapon system integration, threat and hazards analysis including: natural, induced and extreme environments. Demilitarization and disposal, weapon platform vulnerability, and safety testing and evaluation.
- **Munitions Safety, Transport and Storage** – Mr. Martijn van der Voort (Netherlands)
 - *Interest areas:* Safety principles, regulations, testing, hazard classification, storage facilities, packaging features, risk analysis, and training.
- **Munition Materials Technology** – Mr. Wade Babcock (United States)
 - *Interest Areas:* material properties (energetic and inert), ageing mechanisms, ageing models for predicting material life and changes in properties, safety design principles and margin of safety.
- **Warhead Technology** – Dr. Ernie Baker (United States)
 - *Interest areas:* Design, manufacture, safety testing and evaluation of warhead systems, fuzing systems, operation (detonics), accidental initiation and reaction mechanisms.

The expertise required by the project has changed over the years with interest areas being determined in consultation with the SC and guided by the strategic plan and work plan. TSOs are on definite duration contracts and can expect to spend up to six years at MSIAC.

Overview of the Programme of Work

The MSIAC project scope of work is to collate, review, and analyse munitions safety-related information across the whole life cycle of munitions. IM is a key focus, with IM technologies

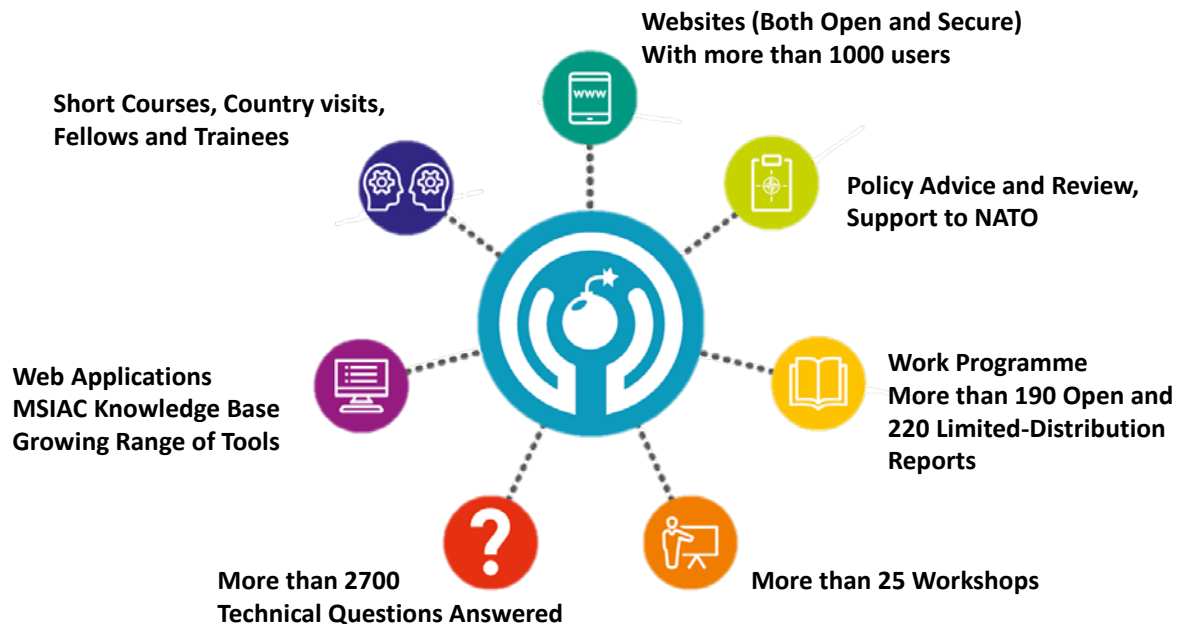
¹ Current members include: Australia, Belgium, Canada, Finland, France, Germany, Italy, The Netherlands, Norway, Republic of Korea, Spain, Sweden, United Kingdom, and United States.

² There is an additional caveat that employment in NATO is limited to nationals from NATO nations.

continuing to be key drivers to enhanced munitions safety. The scope of work of the MSIAC team is organised under four main areas:

- **Requirements.** Capture and analyse MSIAC member nations' and relevant stakeholders' munitions safety requirements;
- **Knowledge.** Develop, synthesize, and maintain knowledge and understanding to enhance munitions safety;
- **Policy.** Define, harmonize, improve, and promote policies for munitions safety;
- **Delivery.** Promote munitions safety and execute MSIAC's mission.

MSIAC's products and services are available in a number of different ways. Some are engaged via national practitioners through the secure web environment, some are collaborative engagements of many experts, and others are focused, targeted engagements at the organisational level. The schematic below provides a summary of these, all centred about the fundamental MSIAC goal to support munitions safety.



The funding construct of MSIAC means that individuals in the member nations can access these services at no charge once approved by their National Focal Point Officer (NFPO)³.

The following sections provide more details on the programme of work.

? Answering Technical Queries

Answering technical questions continues to be of high importance to the member nations. Over the years MSIAC staff have answered more than 2700 questions which range in

³ Details of NFPOs can be found at: <https://www.msiac.nato.int/contact-access/msiac-staff-members>
Access to specific products and services requires approval which is easily requested through filling out the appropriate forms:

Questions: <https://www.msiac.nato.int/products-services/msiac-technical-question-form>
Access to the secure web environment : <https://www.msiac.nato.int/contact-access/access-request-form-for-members-of-msiac-nations>

subject and complexity. The technical specialists at MSIAC have use of the following resources:

- Combined knowledge and experience of the MSIAC staff;
- 157,000 references held in the MSIAC databases;
- Online databases and libraries;
- MSIAC network of points of contact throughout the world.

The scope of questions answered by MSIAC is wide but there needs to be sufficient focus on Munition Safety. Examples include the following:

- 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?

It is often the case that issues highlighted in questions are of interest to other nations and it is not uncommon for multiple nations to ask the same question in a similar time frame. This can signify a common problem which may then form the basis of a future work element, workshop, and or identified need for standardisation activity.



Publication of Technical Reviews

MSIAC prepares technical reports on issues of interest to the munitions safety community. These reviews can help to define future areas of effort and highlight areas where data is lacking. Reports are often an output of a work element which is part of the yearly programme of work but technical questions can also result in technical reports. Over the years MSIAC has prepared 220 reports limited to member nations as well as 190 open ones. In just over one year, MSIAC has published the following reports limited in distribution to member nations:

- 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 (MSIAC Staff)
- L-204 Science of Cook Off Workshop Ignition and Growth Focus Area (Schultz/ Henson)
- L-205 Science of Cook Off Workshop Material Damage Focus Area (Sharp/ Cook)
- L-206 Science of Cook Off Workshop Violence of Reaction Focus Area (Babcock/ Scholtes)
- L-207 Science of Cook Off Workshop Chemistry & Material Parameters
Focus Area (Andrews/ Nock)
- L-208 Science of Cook Off Workshop Chemistry & Materials Process Focus Area (Andrews/
Clark)
- L-209 Science of Cook Off Workshop Small Scaled Test Focus Area (Schultz/ Smilowitz)
- L-210 Science of Cook Off Workshop Modelling Focus Area (Babcock/ Picart)
- L-215 An International Review of Hazard Classification (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)
- L-222 Life Assessment of Nitrocellulose-Based Energetic Materials: LOVA, Flare and CCC (Andrews, Collet, Millar, Schultz)
- L-223 Physical effects and consequences from detonations and less violent munition responses (van der Voort, Baker, Collet)



Technical Databases

One of the objectives of MSIAC is to gather and share knowledge that supports nations in achieving their munition safety goals. MSIAC's electronic document management system (DMS), Laserfiche, is at the backbone of delivering this objective. Those familiar with MSIAC's secure web environment, should be familiar with Weblink which is the public Web portal for Laserfiche. MSIAC has used this DMS very successfully over the last decade and it continues to be state-of-the-art with respect to functionality and document security (meets DOD standard 5015.2).



The document database has been a major MSIAC asset from the beginning when it started as a paper- (and Microfiche-) based records system. The current systems allow full text search and retrieval of a staggering 157,000 (unclassified) documents, or more than four million pages. Mostly this is available for MSIAC staff to search on your behalf, however, some 21,000 documents are now available to secure web environment users from MSIAC nations (though this depends on what you have been authorised to see).

Over the years MSIAC staffs have identified a need to develop more specific databases, adding value to the information held by the MSIAC project. A number of these support efforts by nations in developing and introducing IM. Most of the databases are now available via the MSIAC secure web environment as web applications:

- **AIMs - Advanced IM Search.** Web-based platform for quick and easy search of IM test results. This started as separate databases detailing the result of testing to the IM threat stimuli. The huge number of results for the IM threats reflects the work that has been done in the nations as part of development efforts or final system tests. It also serves as a powerful tool to gain an understanding of what can be attained with respect to reducing the violence of response to IM threats.
- **EMC – Energetic Materials Compendium.** A database on explosives, propellants and pyrotechnics, which contains formulation and application, physicochemical, mechanical, sensitivity, and explosive performance information. Since its first release in 1994, EMC has been continually updated and improved. Latest improvements include the addition of toxicity data on ingredients and a comparison function. With referenced data on over 1300 formulations and 600 ingredients it's probably the most comprehensive database of its type available.

- **Mitigation Technologies for Munitions (MTM).** This is a web based database of mitigation techniques applicable for a particular threat and application; they can be applied to the munition, its packaging, and or as deployable barriers.
- **MSIAC's IM state-of-the-art (SOA).** This provides a review of munition systems with reported significantly improved IM performance. Technology trends are also identified.
- **MSIAC Quantity Distance (MQD) tool.** This is currently being developed to perform an experimentally validated consequence analysis for the initiation of various types and quantities of munitions in different structures, with or without mitigation. The tool implements analytical models derived from trials data and is useful to help understand the basis of the current quantity distance relationship in NATO standards. It is thought that this type of tool will become increasingly used and may eventually replace the tables based approach.
- **TEMPER / Analytical Response Models (ARM).** MSIAC's Toolbox of Engineering Models to Predict Explosive Reactions (TEMPER) contains a library of initiation models. We are currently working to transition the more useful models to a new web application called ARM, which is currently at the prototype phase.

Ammunition safety related databases have also been developed since the broadening of the scope to cover munition lifecycle safety. The Munitions Safety and Standardisation Database (MSAS) contains an up-to-date listing of munition related policy and standards: STANAGs, APs, US DOD Stds, US Nat Stds, European Standards, UK Def Stds, French GAM, UN, and others. The database structure has been updated earlier this year to allow more logical searching of the information. The Safety Assessment software (SASO) tool is an Intelligent database which filters or points the user to relevant requirements and standards based on following input: munition type, Standards to be applied (national and/or international), and the AOP-15 type environmental lifecycle profile. We endeavour to keep both of the databases up-to-date so that the community has one location that they can consult, and rely on, to access all the latest standards.

Two further databases have also been developed in conjunction with AC/326 and are available to those nations prepared to contribute their data:

- **National Hazard Classification (HC) Database.** Contains national HC data provided by the participating nations. Participants have provided six core elements of their respective stockpile, i.e., Nomenclature, NSN, Hazard Classification, Compatibility Group, NEQ and Packaging Details. This is being developed into a more readily accessible software database.
- **MSIAC Accident Database Exchange (MADx).** This contains national accident databases provided by six participating Nations (soon to be seven). Recently, the data has been compiled into one database web application, MADx, to allow searching of all the data. A further benefit of this approach is that trends can be identified, which can help inform on munition safety priorities.



MSIAC Sponsored Meetings, Workshops and Seminars

Over the years, MSIAC has facilitated the advancement of knowledge and policy through organising meetings, workshops, and seminars on IM and munition safety related issues. Workshops constitute a major effort for MSIAC as, in addition to organizing the venue and logistics, the MSIAC technical team prepares much of the technical background on which to base the discussions before the event, as well as through documentation and analysis afterward.

There have been more than 25 workshops or major technical meetings over the years in areas which include: IM reaction mechanisms and testing, IM technology and insertion, and general safety related topics. In particular, the earlier meetings served to increase our understanding of the reaction mechanisms so that nations could design munitions with reduced vulnerability to threats giving lower levels of reaction violence. More recently, a number of workshops on topics relevant to IM implementation were held linked to the increasing availability of IM technology.

The most recent workshop in May 2016⁴ investigated the Science of Cook Off, revisiting IM reaction mechanisms area mentioned earlier. The workshop's objectives were to improve the understanding of cook off of energetic materials and their systems (revisiting the theme of earlier workshops). These objectives were achieved through discussions and presentations on chemical and physical changes, heating rate and heating conditions, critical ignition and growth conditions, reaction phenomenology, models and modelling, and sub-scale testing to system-level tests. MSIAC staff provided a comprehensive write up of the findings which are available in a series of limited reports⁵.



A plan for future workshops, and technical meetings, has been developed recently with input from the community to cover the next 5-6 years effort. MSIAC staff spent time identifying issues which we are either currently actively supporting or are safety related topics that we believe would benefit from a workshop type approach. These topics were presented to the international community via the MSIAC newsletter in 2017 and a questionnaire was released to determine level of interest and priority. With over 100 responses, it provided good insight into the needs of the munition safety community. It was clear from the results that all topics were of priority and interest to one or more areas of the community. The input received was collated, analysed and presented to the MSIAC SC who have subsequently agreed the proposed plan for future events.

Those topics achieving the highest overall ratings (interest and priority) included the workshop already planned for September this year on Improved Explosives and Munitions Risk Management (had highest priority overall). It is also clear that Qualification of Energetic

⁴ Turning Up the Heat: "Science of Cookoff Workshop Findings" M.Andrews. NDIA IMEMTS 2016, Gaylord Opryland Hotel – Nashville, TN.

⁵ For Workshop output see MSIAC limited report numbers: L-203 to L-210 by Andrews, M., Babcock, W., Schultz, E., Sharp, M., Henson, B., Cook, M., Scholtes, G., Nock, L., Clark, K., Smilowitz, L., Picart, D.

Material is a topic of considerable importance to the community, with the highest level of interest and a high priority. There was also a strong level of interest for continuation of work on Insensitive Munition threats; the science of cook off follow on and the workshop on understanding material damage were also deemed of high importance.

Figure 1, summarises the workshops and technical meetings plan for the next 5 years. The larger rings represent the workshops whilst the smaller circles indicate the technical meetings. Just a note on the difference between workshops and technical meetings; workshops tend to have higher participation levels (60-70 people) and involve much more preparation for MSIAC (technical preparation, write up, and venue organisation). Although we can expect the plan to evolve in the next few years, it will allow us all throughout the international community to better prepare and deliver what the community needs.

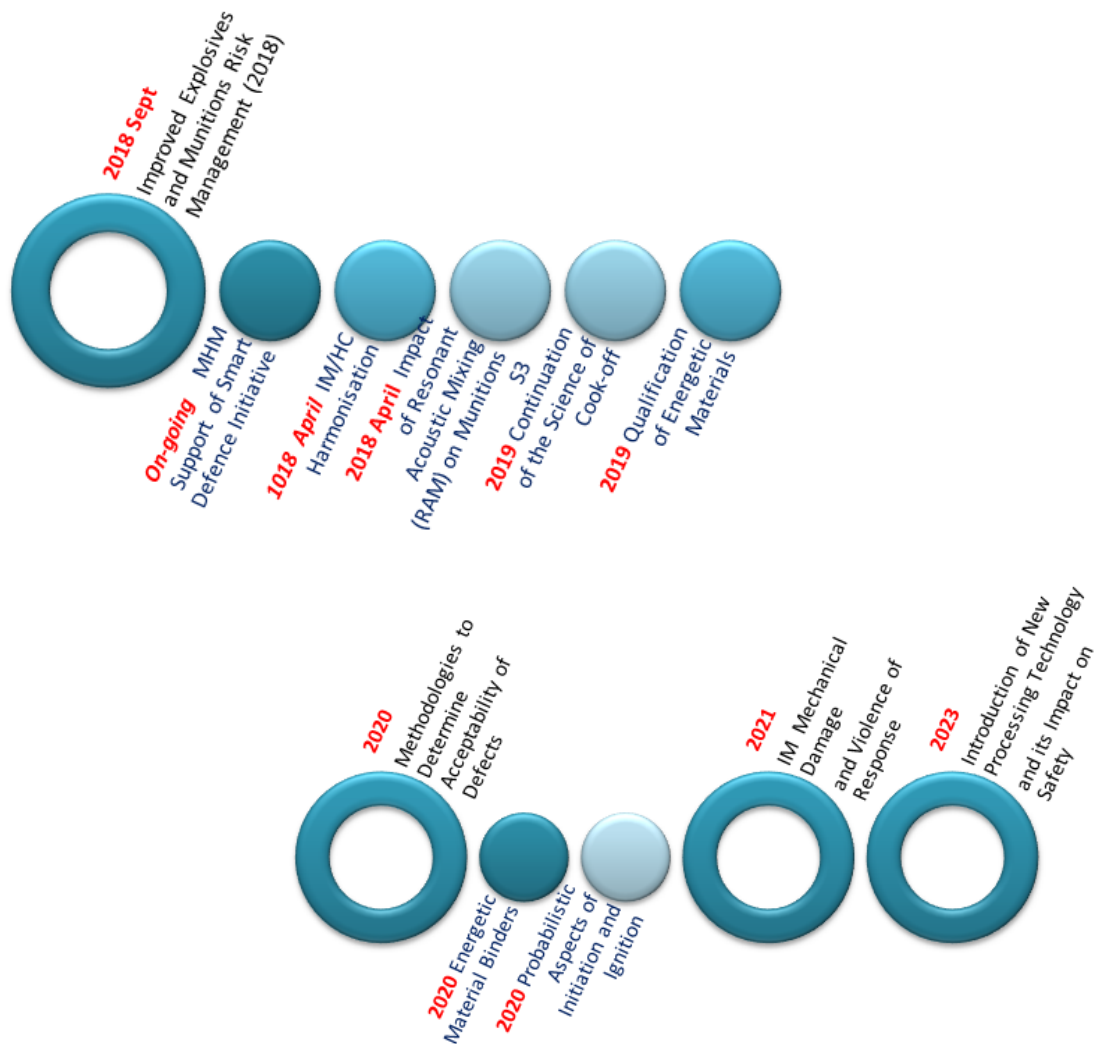


Figure 1. Workshop and Technical Meetings Plan

If you are interested in learning more details on this proposal see Annex A or contact MSIAC staff. The Improved Explosives and Munitions Risk Management workshop will be presented in more detail at the IESS meeting and a paper is available in the proceedings⁶.



Support to NATO AC/326

MSIAC also supports requests for technical assistance from NATO AC/326 and its three Sub-Groups on matters of common interest with MSIAC member nations, and with approval by the MSIAC SC. As all MSIAC member nations are active participants in AC/326, the support provided furthers the objectives of member nations and hence requests are generally approved. Typically, about 15% of MSIAC's technical output goes to supporting the work of NATO standardisation activities. Currently MSIAC is supporting the following reviews:

- Support to AC/326 SG/A(IST) Working group in the review and update of: STANAG 2818 - Demolition Materiel: Design, Testing And Assessments.
- STANAG 4147 – review of compatibility of energetic materials.
- STANAG 4496 – review of the fragment Impact STANAG. MSIAC produced a paper reviewing issues associated with the test based on input from the nations.
- STANAG 4382 - MSIAC is supporting a review of the slow cook off tests standard. A major outcome of this effort will be a revision of the heating rate.
- Support to NATO Smart Defence Initiative on Munitions Health Management. This effort is aimed at developing guidance on use of technology to improve our management of munition life.
- Technical support for the development of AASTP-1 Part I, including development of a new QD table format.
- Support to AASTP-1 Part 4 through assisting with the development of a new airfield criteria chapter.
- IM/HC Harmonisation activities, which are described in a paper at the IESS in more detail.



MSIAC Interns, Trainees and Stokes Fellows

MSIAC has opportunities for individuals from member nations' to undertake a placement with MSIAC and work on a project of mutual value and interest. This is open to anyone who has completed or are completing a technical degree related to munitions engineering and safety and the intention to enter government or industry. For people between years at university or engineering school, placements can be eight weeks or longer after completing a technical degree or Masters level degree.

⁶ "MSIAC workshop 2018: Improved Explosives and Munitions Risk Management." Martijn van der Voort, Matthew Andrews, Wade Babcock, Christelle Collet, Martin Pope, Michael Sharp. 2018 International Explosives Safety Symposium and Exhibition, San Diego, USA.

In addition, the Benjamin B. Stokes Fellowship program provides opportunities for young and senior scientists and engineers alike to gain or share knowledge and experience from technical and personal interactions within the MSIAC network. The post is jointly funded by the nation seconding the individual and by MSIAC. It is normally for a period of 6 to 12 months but can be for up to a maximum of two years depending on individual circumstances, sponsoring Nation desires, and/or MSIAC needs.

This year we have had trainees and a Stokes Fellow working as part of the MSIAC team. The Stokes Fellow, Rebecca Millar, seconded from the UK MOD, studied the ageing and degradation of pyrotechnic compositions⁷. This work focused on aircraft pyrotechnic counter measures and will result in three limited reports. One of the conclusions of this work is the need to standardise safety testing of the ignition systems typical for this type of device. Discussion has already been initiated under NATO AC/326 to address this matter.



Online Services to Support the Munitions Safety Community

MSIAC provides access to products and services through its website at www.msiac.nato.int. The open section contains general information about MSIAC, such as organisation and staffing, steering committee members, national focal point officers, information on products and services, latest related news, and the MSIAC quarterly news letter.

MSIAC also provides a secure web environment, which allows authorised users to: download complete copies of MSIAC reports, access software, directly search approximately 21,000 munition safety related conference papers and documents mentioned above. Access to the Web applications described earlier is also enabled through this website. Access privileges are controlled at the individual level and are granted by your National Focal Point Officer, an application can be made by completing the online form⁸.

Future

MSIAC staff have an extensive and challenging work plan which is updated annually or more frequently if necessary. Each year we add new work elements at the request of the MSIAC SC or on topics proposed by the MSIAC staff and agreed by the SC. For 2018, we added a further seven work elements, in addition to the pyrotechnics ageing Stoke's Fellowship and Improved Explosives and Munitions Risk Management (IEMRM) workshop. A list of these is provided below:

- **Blast Equivalency Characterisation of Energetic Materials.** Methodologies and applicability of energetic materials blast equivalencies are not well understood. This is particularly true for propellant and pyrotechnic compositions. The aim of this

⁷ "Life Cycle of Flare Countermeasures" Rebecca M. Millar, Dr. Matthew Andrews, Wade Babcock IPS 20168 Gaylord Opryland Hotel – Nashville, TN.

⁸ Access to the MSIAC secure website can be requested via filling out the web form at: <https://www.msiac.nato.int/contact-access/access-request-form-for-members-of-msiac-nations>

project is to gather information on blast equivalency testing and calculation methods; assess their applicability; and provide guidance and recommended values for a broad range of explosives, propellants and pyrotechnic materials.

- **Emerging Technologies for Gun Propelling Charges.** This programme of work will review research and development activities in the area of gun propelling charges.
- **Material Defects – Definitions, Tests and Principles.** MSIAC has been requested to provide assistance with defining defects for rocket motor, warhead, bomb and gun launch munitions. The work will review current pass/fail criteria development and methods/principles used to rate defects. It will also be preparing for the workshop planned in 2020 on methodologies to determine acceptability of defects and design tolerance on safety.
- **Emerging Minimum Smoke Propellants.** This effort will involve review of open research and development activities in the area of minimum smoke formulations for tactical rocket motors.
- **Database of Electromagnetic Radiation Hazards to Munitions.** To assist the community, a common database will be developed to share information to calculate safe separation distances between transmitters and susceptible munitions.

Summary

Over the last 25 years significant progress has been made with respect to munitions safety, particularly with IM development and fielding. MSIAC's role in assisting nations with their munition safety requirements and goals has given rise to a diverse range of products and services which continue to be developed and exploited.

Every year we add to the knowledge contained within MSIAC, which has resulted in a valuable repository which can be utilised to support technical questions and ad hoc enquiries. We encourage the community to continue to use this service⁹.

It is important to realise that MSIAC facilitates munition safety improvements and this works because of a successful partnership with our member nations who have a strong culture and requirements to sustain and continually improve their munition safety.


The efforts of the munitions safety community are ultimately directed towards keeping the warfighter and those handling explosives and munitions safe. For MSIAC member nations this equates to almost five million uniformed service members throughout our 14 member nations. That is no small challenge, and unfortunately accidents and incidents still occur which serve to remind us why the community takes this responsibility seriously.

⁹ Questions related to munition safety can easily be submitted using our electronic form accessible via our website:

<https://www.msiac.nato.int/questions/click-here-to-ask-a-technical-question>

This service is offered without charge to MSIAC member nations

Annex A.

Year	Topic	Goals
Workshops		
2018	<p>Improved Explosives and Munitions Risk Management. This workshop seeks to exploit an improved understanding of munitions vulnerability and consequences to deliver improvements in explosives and munitions risk management.</p> <p>A secondary aim of the workshop is to initiate changes that will help realise the benefits of IM, particularly during transportation and storage to improve safety and help safeguard military capability in hazardous operating environments.</p>  <p>Improved Explosives and Munitions Risk Management Granada, Spain 10 - 14 September 2018</p>	<ul style="list-style-type: none"> • Support the IM and HC harmonization initiative <ul style="list-style-type: none"> ○ Identify how response descriptors can be introduced in HC testing ○ Identify whether there's a need for revised definition of Hazard Divisions (HD) and Storage sub Divisions (SsD) • Develop improved methods for explosives and munitions risk management <ul style="list-style-type: none"> ○ Exploit results from small- and full-scale testing ○ Manage risk with sufficient detail and granularity ○ Realize benefits of IM ○ Efficiently manage munitions presenting the greatest hazard • Recommend improved methods for explosives and munitions safety risk standards <ul style="list-style-type: none"> ○ Ensuring they reflect the changing nature of the munitions stockpile ○ Balancing complexity versus ease of user application
2020	<p>Develop methodologies to determine acceptability of defects and design tolerance on safety. It is often the case that munitions are found to contain defects which deviate from the agreed specification and are not representative of qualified rounds. This presents a challenge for the national safety authority on how to deal with affected rounds. The range of defects which will be included in the discussions includes:</p> <ul style="list-style-type: none"> • Physical Defects <ul style="list-style-type: none"> ○ Manufacturing defects ○ Gun Launch Defects – ignition hazard • Chemical Defects • Ageing – Role of environmental stresses <ul style="list-style-type: none"> ○ Thermal Damage mechanisms ○ Mechanical Damage Mechanisms • Simulation of Defect Effects 	<ul style="list-style-type: none"> • Identification of methodology to determine criteria for 'critical' defects • Updated understanding of critical failure modes. • Identify best practice: application of chemical and physical analysis methods, non-destructive testing and evaluation. • Setting of sentencing or acceptance criteria. <p>Will provide underpinning support for the Munitions Health Management effort.</p>

2018 International Explosives Safety Symposium and Exhibition

Year	Topic	Goals
2021	<p>IM – Understanding Mechanical Damage and Violence of Response. A further IM workshop is planned on mechanical damage. Understanding the role of mechanical damage on munition response remains a significant challenging for the IM community. It is proposed to bring international experts together to consolidate understanding and identify where to direct future research efforts. Key areas to share knowledge and understanding include:</p> <ul style="list-style-type: none"> • High strain rate properties and prediction • BVR and DDT • Improved understanding of XDT (mainly for rocket motors) 	<ul style="list-style-type: none"> • Improved understanding of reaction growth and violence of response as a function of mechanical damage • Improved assessment of IM response to mechanical threats, primarily for bullet and fragment impact. <ul style="list-style-type: none"> ○ Rocket Motor XDT assessment methodology
2023	<p>Introduction of New Processing Technology and the Potential Impact on Safety. Recent developments in Resonant Acoustic Mixing (RAM) and additive manufacture will likely lead to application of these processing technologies for energetic materials and munitions manufacture. MSIAC areas to address would include:</p> <ul style="list-style-type: none"> • Introducing new processing technologies safely • Understanding impact on qualification and assessment • Develop recommendations for safe use and assessment <p>Note: see also technical meetings on this topic below, which have initiated discussion in this area.</p>	<p>Improved understanding of the impact that new processing technologies have on safety</p> <p>Shared best practice on how to safely use the new EM processing techniques.</p>
Technical Meetings Currently Being Supported		
	<p>Munitions Health Management (MHM). MSIAC continue to support the NATO Smart Defence Initiative to develop policy and standards to facilitate the implementation of technologies to improve life assessment and management. A series of mini workshop are planned to progress this work on behalf of NATO AC/326.</p>	<p>Develop guidance on intelligent management of munitions health To explain how technologies (logging, sensing, age modelling, etc.) and existing techniques of life assessment, will couple with basic/applied research into better understanding of how exposure to environmental surroundings affects both current and future condition.</p>
	<p>IM/HC Harmonisation MSIAC is facilitating this activity on behalf of the NATO ammunition safety group AC/326 MSIAC. The aim is to standardize, harmonize and streamline IM and HC policy on requirements and assessment and enshrine this in UN international policy (legislated). A number of experts working groups will be organised to progress this effort.</p>	<p>The goals of this effort are to:</p> <ul style="list-style-type: none"> • Reaffirming and clarifying the purposes of the IM and HC policy; • Building on IM and HC methodology to improve munition risk assessment for unplanned stimuli; • Developing documents to deliver these.
	<p>Resonant Acoustic Mixing Technical Meetings MSIAC organised two meetings in 2018 to provide an opportunity for national experts in member nations to exchange experience on the safe use of, and</p>	<p>To exchange best practice with respect to:</p> <ul style="list-style-type: none"> • Current practices for RAM manufacturing • Requirements for quality assurance

2018 International Explosives Safety Symposium and Exhibition

Year	Topic	Goals
	possible affect on safety of energetic materials and munitions manufactured using this technique.	<ul style="list-style-type: none"> • Suitability of current energetic material tests in qualification • Baseline materials for comparison - RAM vs planetary or other mixing platforms • Suitability of S3 testing for RAM produced munitions • Generation of confidence in RAM produced munitions
Proposed Technical Meetings for 2018-2023		
	<p>Optimising the introduction of new EM into service. The technical meeting will review:</p> <ul style="list-style-type: none"> • What makes a useable EM • How the Qualification process (AOP-7) can be optimised. • What data should we develop during qualification 	Revised Qualification requirements (including modelling and simulation parameters)
	<p>Continuation of Science of Cook off work. This effort will assess a hierarchy based methodology to predict cook off response using current tools and a shared data set. The intent is to provide an opportunity for participants in this exercise to present and discuss results.</p>	<p>(This work is dependent on the availability of the information pack to support this effort)</p> <p>Review of capabilities to predict cook off response.</p>
	<p>Impact of Reactive Materials (RM) on Performance/Safety Trade Space. This technical meeting/workshop will review current efforts amongst the MSIAC nations to develop and field reactive materials.</p>	<ul style="list-style-type: none"> • Assess RM change to scope of munition design parameters • Available materials (enhance blast effects and/or effects on target) • Effect on qualification procedure • Effect on quantity distance and Storage safety
	<p>Energetic Material Binders. An opportunity to take stock of progress on energetic material binders:</p> <ul style="list-style-type: none"> • Exploit developments in the wider polymer community • Review application of new technology (Group Interaction Modelling) 	Improved tool set for polymer development (especially Energetic Binders)