



Bulletin

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NATO ANNOUNCES SECOND RANGE CHARACTERIZATION COOPERATIVE DEMONSTRATION OF TECHNOLOGY

Introduction

The NATO Science and Technology Organization's Cooperation Support Office (CSO) will once again be sponsoring a Cooperative Demonstration of Technology (CDT) on Military Live-Fire Range Characterization at the Defence Academy of the United Kingdom, Cranfield University, Shrivenham, UK. The CDT is an activity within the Applied Vehicle Technology Panel (AVT) of the CSO that is conducted by the members of AVT-249 / RTG-086 Task Group, co-chaired by Mrs. Tracey Temple (GBR) and Dr. Sonia Thiboutot (CAN). The RTG-086 CDT is a comprehensive activity that covers most aspects of the characterization of military live-fire ranges, concentrating on theory, methods, and practices for obtaining robust, reproducible, and defensible data on metals, propellants, and explosives contamination in soils and surface waters.

Who will benefit from attending

Recent range closures and very high environmental liabilities are driving the need to quantify contamination levels on ranges to prevent off-site migration of contaminants.. In the US, one facility has incurred liabilities in an ongoing cleanup effort in excess of €1.5B, with severe restrictions in place limiting training capabilities. The ability to accurately monitor contamination levels on ranges will allow resources to be allocated where needed to ensure that range sustainability is maintained in the most cost-effective manner. Range characterization methods have also been used to determine the impact of new munitions on ranges. Tests of 60-mm mortar rounds containing insensitive high explosives were conducted to determine the mass and composition of energetic residues resulting from high-order detonations. It was found that ammonium perchlorate, a compound in the explosive formulation, reacted inefficiently during detonation, resulting in a mass deposition of perchlorate from each round sufficient to contaminate 7M liters of drinking water above the threshold limits.

The CDT will provide a unique opportunity for staff and communities who have an interest or responsibility in the management, maintenance, and sustainability of live-fire combat training ranges. The aim of the CDT is to engage potential end users in a demonstration of current and emerging technologies, to illustrate the benefits to decision-makers and end-users of that technology, and to promulgate these technologies throughout the NATO nations.

The venue

The CDT is being held and supported at Cranfield University in Shrivenham, UK. Cranfield University has excellent explosives research facilities that include both laboratory and explosives test and evaluation ranges. In addition, there are classrooms with a full array of teaching equipment and knowledgeable teaching and support staff. Cranfield is located in a unique setting at the Defence Academy of the UK, which is a large site and has all the facilities of a modern university. These combined capabilities make Cranfield an ideal location to host the CDT.

October 2017

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What to expect

The **CDT will run for 5 full days**. It will consist of field and laboratory practical lessons combined within classroom lessons. To ensure that participants attending the CDT have a basic understanding of how reproducible range characterization data is obtained, a broad range of topics will be covered. On arrival to the CDT, there will be an evening reception so that participants can be registered and have the opportunity to meet with the instructors before the start of the course. At the reception, briefings will be given on the local area and amenities, the course content, what to expect, and any logistical arrangements. The reception is a great way to start the course as it helps to create a constructive atmosphere between participants and instructors.

The CDT will have a range of instructors, many of whom were instrumental in developing the techniques that will be taught in the course, therefore bringing a wide scope of knowledge. Most of the instructors are also well published in this area and have both practical and academic experience. This experience helps to align the essential theoretical elements with the practical 'real life' scenarios with which the instructors have been involved. As part of the CDT, participants will spend time in the classroom and laboratory, but will also undertake practical application in a military field environment. This blended learning is an excellent approach to understanding all aspects of military live-fire range characterization. To further support this learning, participants will visit the Technology School at the Defence Academy of the United Kingdom, where it is possible to become familiar with the various weapons and ordnance that are used on live-fire ranges. Visiting the School is a valuable and worthwhile opportunity, especially as a full guided tour is given by experienced military staff that are based at the Defence Academy.

CDT structure

Day 1 – In the classroom: A series of lectures, covering topics such as the theory of soil and water sampling; sources of error in sampling, sample processing, subsampling, and sample analysis; and current innovations in field sampling of surface waters and soils will be given. There will be a special emphasis on multi-increment soil sampling throughout the above lectures. In addition, lectures will be given on quality assurance procedures, which determine the robustness of the data.

Day 2 – In the classroom and in the field: Instructors will demonstrate the principals of how to set up decision units (areas to be sampled) and obtain soil samples, how to sample contaminated and complicated soil piles, how to collect surface water samples, and how to do field assessments for metals and energetics. Participants will have the opportunity to help set-up sampling regimes and begin the sampling process.

Day 3 – In the field: Participants will observe a field detonation of a confined explosive on a military range. The detonation residues will be the focus of the field sampling exercises. Participants will have the opportunity to collect actual samples on an active military training range using the knowledge gained from the lectures on Day 1 and the Day 2 field instruction.

Day 4 – In the laboratory: Participants will receive instructions and will learn how to prepare soils for pre-analysis processing; grind samples to improve the homogeneity of the soil, metals, and energetics; subsample the soils; and prepare the subsamples for analysis. Instructors will demonstrate the use of analytical instrumentation to derive estimates of soil contamination.

Day 5 – In the classroom: Instructors will demonstrate how the analytical data is used to derive soil and water concentrations and mass deposition estimates. This data can be used to support risk assessments. Finally, instructors will cover a number of case studies that illustrate how the course material has been applied in the real world, which will give the participants a frame of reference for implementing the knowledge and skills accumulated during the course. The course will end with a short feedback session where participants will discuss their experiences of the 5 days, giving an opportunity for valuable comments to be made on how the CDT can continue to improve and evolve.

Feedback and Testimonials from the CDT in 2016

The CDT was previously run in 2016 at the Defence Academy of the UK, it was rated highly.

Participants stated **'they enjoyed the variety of activities and mix of theory and practical', 'they enjoyed trying out the sampling tools and setting up the multi-increment sampling decision units' and ' they found the laboratory sessions both useful and interesting'**.

Comments like these have led to the request by NATO for an additional CDT. In total there were 30 participants at the 2016 CDT, 24 of whom were students. For many, it was their first exposure to field sampling on training ranges. The comprehensive scope of the CDT is very significant in that no other course affords the participant a complete exposure to all the components necessary in obtaining high-quality data on range conditions.

There is an increase in the tempo and magnitude of training currently being conducted by NATO and NATO partner nations, such as with the Connected Forces Initiative. A better understanding of range characterization and the associated processes to obtain representative samples is necessary to determine the impacts of live-fire training to ensure range sustainability. All the students from the 2016 CDT felt they met their individual requirements.



Photograph of the 2016 CDT attendees and instructors at COTEC



Details of the CDT 2018

The 2018 CDT will run from the afternoon of 30th September through the afternoon of 5th October. The venue is centered at Cranfield University, with related activities conducted at the Defence Academy of the UK and the Cranfield Ordnance Test and Evaluation Centre, COTEC <http://www.cotec.org.uk>

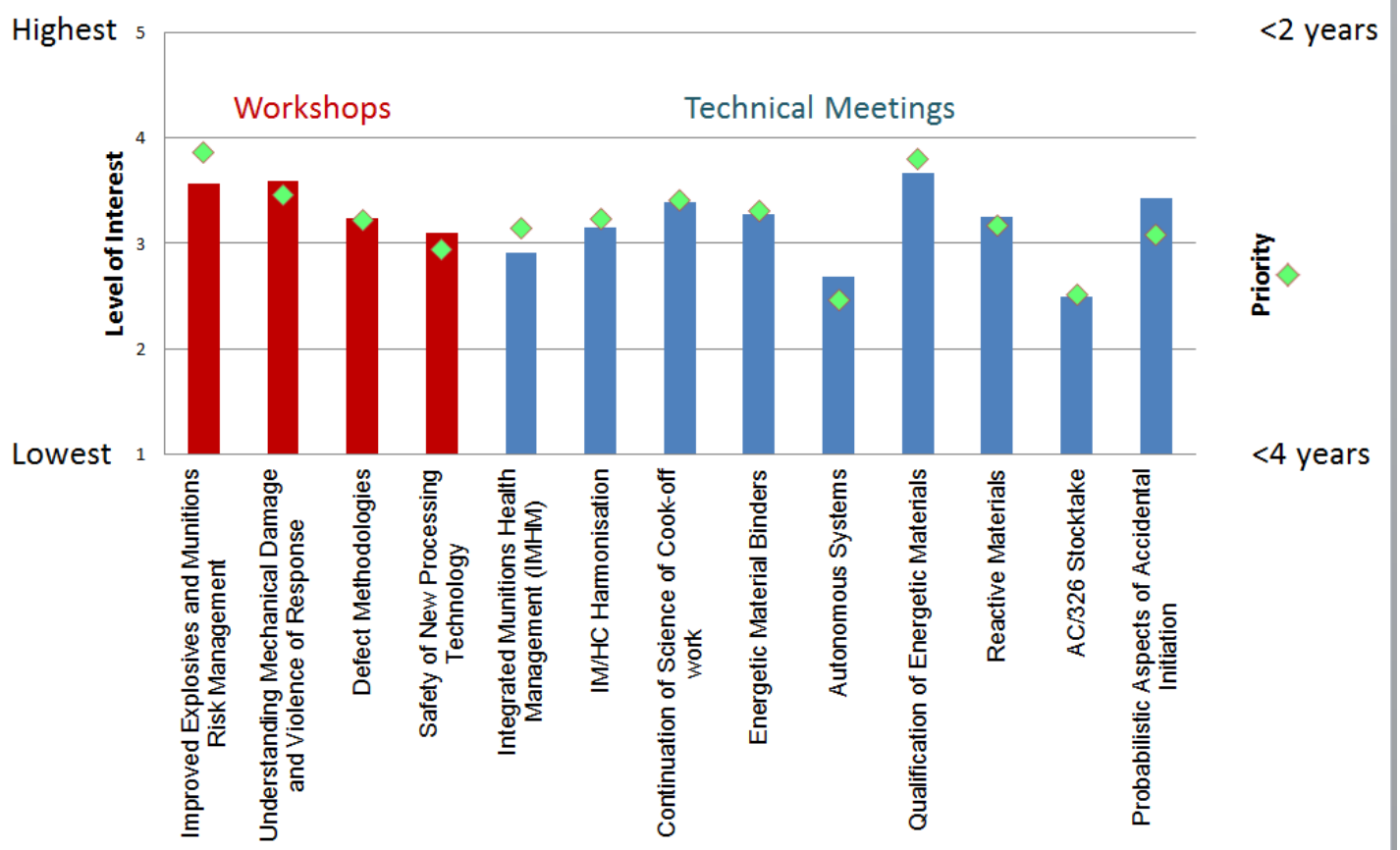
The CDT is offered to all NATO and NATO partner nations. The course includes all instruction, site transportation, and materials needed for instruction and field exercises. Participants will be responsible only for their transportation to and from Shrivenham, their lodging, and some of their meals. For more information on the 2016 CDT, go to: <https://www.youtube.com/watch?v=Tt7fA0XR7bU&t=26s> - <https://www.youtube.com/watch?v=yfQ3nnPkUIg>

For further information contact: Tracey Temple - t.temple@cranfield.ac.uk or Sonia Thiboutot - Sonia.Thiboutot@drdc-rddc.gc.ca

Sonia Thiboutot, Tracey Temple, Melissa Ladyman, Nathalie Mai, Michael Walsh

PM'S PERSPECTIVE

Many thanks to those who took the time to answer the MSIAC questionnaire on workshops and technical meetings published in the last news letter. With over 100 responses, it provided us with good insight into the needs of the munition safety communities with respect to the proposed topics. Thank you also to those who provided comments, which was very useful. The results of the survey are best summarised graphically. The chart below, which I hope is self explanatory, gives an indication of the level interest and priority.



Conclusions that we drew from the analysis of this, and other more detailed charts, indicated that all the topics were of interest to different parts of the munition safety community. Those achieving the highest overall ratings included the workshop already planned for 2018 on Improved Explosives and Munitions Risk Management which had highest priority. It is also clear that Qualification of Energetic Materials 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 cookoff follow on and the workshop on understanding material damage were deemed of high importance.

The input will be presented to the MSIAC Steering Committee and following this we will be able to provide more information on our future plans.

Dr Michael Sharp
MSIAC Project Manager



U.S. RDECOM - ATLANTIC VISITED MSIAC

On 26 July 2017, MSIAC was visited by a delegation organized by the U.S. Army Research, Development and Engineering Command (RDECOM) International Technology Center (ITC) Atlantic including COL Steven Ansley, Director; Mr. Bill Ruppert, Deputy; Dr. Jennifer Becker, Basic and Applied Team Lead; Dr. Fredrick Gregory, ARO Human Dimensions Program Manager; and Ms. Sandra Gomez, Technical Director ITC-Southern Europe. The visit was part of an effort by RDECOM-Atlantic to better coordinate and foster international technical cooperation. ITC-Atlantic promotes cooperation between the US Army RDECOM and international researchers as a means to advance science and engineering knowledge and technical capabilities in areas relevant to the overall US Army mission. MSIAC is recognized as a highly productive model for international technical cooperation, data sharing and coordination for the area of munitions safety. COL Ansley presented an overview of the RDECOM-Atlantic organization, mission and work elements. Dr. Sharp presented an overview of MSIAC organization, mission and work elements. Both organizations will continue to coordinate and communicate as required to foster productive cooperation and avoid duplication.

Dr Ernie Baker
MSIAC Warhead Technology Specialist

MSIAC VISITED WTD-91

MSIAC conducted a Germany country visit to the Wehrtechnische Dienststelle für Waffen und Munition (WTD-91) at Meppen, Germany on 28-30 August 2018.

The MSIAC delegation, consisting of Ernie Baker, Martijn van der Voort and summer intern Adrien Leroy, were hosted by the WTD-91 Deputy Directory Dr. Thomas Mályusz. The group was greeted by high level WTD-91 supervisors and was provided an overview of the WTD-91 organizational structure. The MSIAC delegation provided briefs on the MSIAC organization, capabilities, tools and work elements Hazard Classification (HC) and gun launch setback ignition. The MSIAC delegation subsequently met with the WTD-91 Director Wallrich, who described the organizational structure and emphasized issues including REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals), international cooperation, munitions qualification, and HC/IM harmonization. The MSIAC delegation toured the WTD-91 facilities and met with individual groups and SMEs, including experts of energetics chemistry, propellents, explosives, warheads, munitions qualification, surveillance, surety, environmental testing, setback and IM. Highlights of the highly interactive visit included a demonstration of pyrotechnics testing and characterization which included smoke screening from a Leopard II battle tank and the propane fast cook-off burner system. Additionally, significant development in streamlining S3, qualification and IM processes was briefed by WTD-91 personnel.

In all, the MSIAC team was highly impressed by the extremely well organized, comprehensive and efficient layout of capabilities for energetics and munitions characterization, HC/IM testing, as well as the well rounded team of experienced subject matter experts.

The visit concluded with Dr. Mályusz emphasizing the ongoing need for international cooperation in order to increase safety, reliability, and cost effectiveness.



Dr Ernie Baker
MSIAC Warhead Technology Specialist

ACCIDENT REPORTING AND MADx

The MSIAC Accident Database (MADx) allows easy searching in over 12,400 accident reports from US, UK, France, Australia, Canada, and Germany. Since the start of 2017 MADx is available to all governmental users from those nations. MADx is available through the MSIAC portal.

<https://portal.msiac.nato.int/madx/>

Germany was the sixth nation to share its accident reports through MSIAC. Recently LtCol Sascha Decker made a significant effort to translate and provide a first batch of accident reports. We invite other nations to make future contributions as well and gain access.

MSIAC also regularly updates a series of open accident reports based on information in the media. In conjunction with this newsletter a new update has been added to the website, covering the period between January 2017 and August 2017. (<https://www.msiac.nato.int/news/accident-reportings>)

LtCol Sascha Decker has authored some of these reports, including one about the devastating explosions at the Balaklija ammunition depot, followed by major evacuations.



Explosions at ammunition depot and major evacuations (Balaklija, Ukraine, 23 March 2017)

In the night of 23th of March 2017 a fire occurred in Balaklija Ammunition Depot, which caused several explosions at 3.00h. The explosions ejected ammunition from open stacks throughout the whole ammunition depot and its vicinity. Media reported that altogether 138.000 tonnes of different ammunition was stored in the ammunition depot. Most of the munitions were artillery shells and unguided/guided rockets and missiles which were spread all over the ammunition depot and within the city of Balaklija. The ammunition depot was totally destroyed. The government ordered the evacuation of Balaklija at first within a radius of 5km followed later by a radius of 7km. In total 35.000 residents have been affected by the accident. It is reported that a house collapsed by ammunition debris and killed one woman inside. Another woman was injured on her head.

Pro-Russian separatists published that those responsible for the ammunition depot caused the fire to hide deficiencies in ammunition stocks to an upcoming official inspection suggesting they bought those ammunition illegally.

Ukrainian government stated that the fire and the explosion of the ammunition depot were caused by sabotage conducted by pro-Russian separatists. Drones would have been used



like in a similar event at the ammunition depot in December 2015. A drone carrying a incendiary device was found within the ammunition depot surrounding fences. Two other cases were reported in 2015 and 2016.

Martijn van der Voort

MSIAC Safety of Storage and Transport Specialist



ENERGETIC MATERIALS SUPPLIERS CATALOGUE HELP REQUIRED !

MSIAC has a number of catalogues that it maintains on behalf of the community (L-106 – Directory of IM Testing Facilities, L-196 – Catalogue of Environmental Testing Facilities & O-082 – Energetic Materials for Insensitive Munitions Suppliers Catalogue). These resources allow all its members to quickly find information in one document making their day-to-day job easier. The Energetic Materials Suppliers Catalogue was placed on the 2017 program of work as the current catalogue, O-082, is out of date.

In order to update this catalogue we have been searching our databases and the web for information, but, in order to be accurate and current, we require input from the community. So we have generated a short questionnaire to allow manufacturers of energetic materials to quickly inform us of their current portfolio.

We are interested in capturing primary and secondary energetic materials used for formulations but also please inform us if you are producing energetic plasticisers, energetic polymers or other materials of interest to the

community. If you are able to produce material to a recognised specification, have production capabilities to support the defence community, and/or have had your material checked by a recognised body (European Notified Body, DOT, DoD etc.) then information from you would be valuable.

Part of the exercise will look to the standards that manufacturers are using to produce the materials. There will also be a section to allow manufacturers to highlight which formulations and/or pre-mix materials they currently produce.

This is an opportunity for organisations in MSIAC, NATO and its allied partners to inform the community of their capabilities. The updated catalogue will be an **open report** and will be made available to all approved contributors.

The benefits of this catalogue will allow all manufacturers to highlight their portfolio in one location. This catalogue will be of interest to defence and industry alike involved in the procurement of energetic materials.

Please pass this survey on to your supplier. If you have any concerns or questions please contact either Dr Matt Andrews or your NFPO (MSIAC member).

- ⊕ Replies/Questions to: m.andrews@msiac.nato.int
- ⊕ Important date: Replies by the **10th November 2017**
- ⊕ Click [here](#) to access the questionnaire
- ⊕ POC: Dr Matthew Andrews (Energetic Materials TSO)

Dr Matt Andrews

MSIAC Energetic Materials Specialist

HAZARD CLASSIFICATION TRAINEE PROJECT

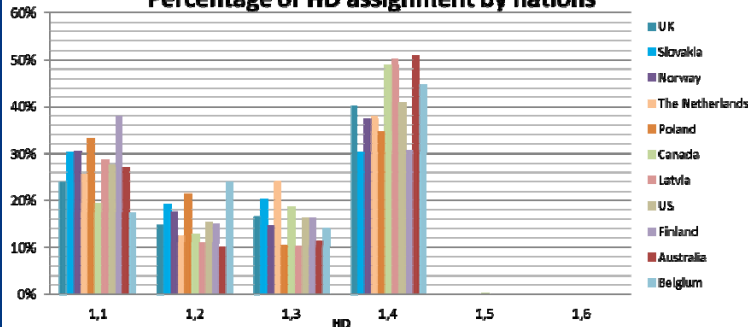
MSIAC maintains a Hazard Classification (HC) database with 14 contributing nations. The database is accessible through the MSIAC weblink. At the present time, the MSIAC HC database contains the nations' data in separate files. Each nation has its own report structure and format that makes searching difficult and time-consuming. MSIAC has plans to develop a database tool for HC that would contain all the nations' data and enhance the work on HC; the **MSIAC HC Database Exchange (MHCDx)**.

Adrien Leroy from ENSTA started June 12 a 3 month trainee project at MSIAC, under the guidance of TSOs Martijn van der Voort and Martin Pope. The project aimed to bring an analysis of current MSIAC HC database, and to focus on HC differences. This analysis will be used to make recommendations for the future automated MHCDx. In the project visits were made to the WTD 91 in Meppen (hosted by Dr. Thomas Malyusz), and Paris (hosted by Yannick Le Sciellour). Their Hazard Classification process was discussed and test facilities visited.

A general overview of the nations' data shows that some reports are outdated. The overview also pointed out that there isn't a single article classified as HD1.6, and only a few articles are classified as SsD1.2.3 (61 in total). The figure below gives the distribution of HC data for the various nations.



Percentage of HD assignment by nations



Nevertheless, the trend concerning the development of SsD1.2.3 and IM in general is encouraging. For most nations, HD1.4 has more articles than any other Hazard Division (HD) (about 1/3 of total number of articles). Then, a correlation has been made between HDs and Compatibility Groups (CG). Most HD1.1 articles are CG D, while most HD1.3 articles are CG C (e.g. rocket motors) and G (e.g. flares). For HD1.4, CG S occurs the most, but also C and G. For HD1.2 there's not a clear trend. A more precise study of the data brought to light examples of differences in HD, CG and Net Explosive Weight (NEW). These differences impact QD calculation and mixing rules for the storage of A&E.

MHCDx could be a great support to enhance safety and develop work on HC. This tool would be useful to warn countries concerning munitions related to accidents. With a further exchange of information like test reports, MHCDx could potentially save time and money.

Adrien Leroy, MSIAc Trainee

SLOW HEATING CUSTODIAL WG MEETING

The STANAG 4382 Slow Heating Custodial Working Group, SH CWG Meeting was held on 18-19 September 2017 at the Belgian government Prince Albert facility in Brussels, Belgium. The USA is the custodian, with Stephen Struck overseeing the process. This was the second meeting of the group held in order to review STANAG 4382, make recommendations and provide a draft STANAG update for review by the NATO AC326 CNAD Ammunition Safety Group.

The meeting was attended by subject matter experts representing USA, UK, Norway, Sweden, France, Turkey, Canada and Germany. Ernie Baker has been providing technical support to the group, and he provided a presentation of a historical review of heating rates and durations from actual fire events. A similar analysis which included significant associate fire modeling was presented by Dr. David Hubble of the US Naval Surface Warfare Center Dahlgren Division. Based on the previous working group meeting discussions and updated information, national positions were presented and discussed. Lively technical discussions resulted in significant consensus, as well as a requirement for gathering of further information. It was agreed that dialog among nations present & others interested in this subject matter must continue. It was recognized that there was a need for a future meeting to resolve all technical issues associated with slow heating testing described in

STANAG 4382 and AOP-4382 for IM and HC assessments.

The follow-up meeting for this Working Group is planned for early April 2018.

Dr Ernie Baker
MSIAc Warhead Technology Specialist

MSIAc ANNOUNCES THE IM DESIGN TOOLS WEBINAR



MSIAc's **Dr. Ernie Baker** will be hosting a web-based seminar demonstrating the IM design tools available to our member nations. The interactive session will not only allow participants to see how the tools can provide answers, accelerate munitions design, and solve problems, but the session will also provide *hands-on demonstrations* of how the tools work.

The session will be held 7 December at 15:00 CET and will be accessible via a web-based virtual meeting connection.

For more information, visit: <https://www.msiac.nato.int/webinars>.

ENERGETIC MATERIALS ROUND UP

INTRODUCTION

As in previous year's we have attended and presented information at a number of energetics related meetings, these included 48th ICT in Germany, the 8th KISHEM in South Korea and the Pyrotechnics workshop in Germany. We were unable to attend or be present at all meetings, such as the annual seminar NTREM held in the Czech Republic.

Both ICT and KISHEM were well attended with an increase in the number of participants from previous years and a good quality in the presented work. ICT had 296 people registered to attend the meeting with 27 countries were represented, and of those 12 were MSIAc member nations. KISHEM had 17 countries represented (7 MSIAc nations) and over 100 submitted abstracts; 52 oral papers were delivered and 56 posters were presented over the 3 days.

PYROTECHNIC WORKSHOP (26-JUN-17)

The pyrotechnic workshop was held in conjunction with ICT and was entitled Combustion Mechanisms: Thermites – Versatile Energetic Materials. This workshop is usually held in association with the International Pyrotechnic Symposium.

The workshop was chaired by Dr Knapp (ICT) and Dr Koch (Lutradyn) and the day allowed for several presentations and discussion surrounding thermite processes. The first presentation touched upon the potential explanation as to why, after high temperature reactions, low concentrations of elements not present in reactants are present (Prof Gromov; Tomsk University, RUS). These reactions were described as Kervran-Bolotov transmutation reactions whereby elements such as Ca, K and Na can be found after thermite reaction of Al with Fe₂O₃. Discussion within the group stated that similar 'impurities' have been seen in detonations and



explosive bridge wires reactions but that the impurity answer has always been the easy explanation. This will no doubt be a topic for further and future discussions. Doorenbos (LLC; USA) provided an overview of Fe-based solid state combustion emitters with the addition of multiwall carbon nano tubes. Resodyn Acoustic Mixing (RAM) was used for manufacture of the Fe-MWNT with a range of oxidisers. Good results were observed using Al_2SiO_5 but the project remained at the research level. Comet (ISL; FRA) described their work on nanothermites and the ability to use them as initiators. DDT reactions were possible using mixtures of $\text{Bi}_2\text{O}_3/\text{nAl}/\text{nRDX}$ giving reaction velocities of 2700 m s^{-1} in 6-8 mm. Tests were able to shock initiate secondary explosives within $50 \mu\text{s}$.

A good understanding of density effects and sensitiveness could lead to these materials being used in detonators.

Catoire (ENSTA Paris Tech; FRA) provided detailed chemical kinetic models for nanothermite combustion and highlighted the detailed work required to capture the experimental parameters such as elementary kinetics for these reactions.

Weinhold (Schott, DEU) gave an interesting presentation on the variety of glass based thermites from bullet-proof glass to shaped charge jet (SCJ) liners. Fabrication of the SCJ liners required multiple steps, selection of three powdered materials at the correct particle size distribution; addition of polymer matrix and the use of a LabRAM to mix high viscosity material. Subsequent step included sintered and/or passivation in inert atmosphere to produce the final product.

Weiser (ICT; DEU) provided a systematic comparison of theoretical and performance data for thermite systems. Of these reactions, a matrix of 6 (metals) by 18 (oxides) were tested for burn rate, particle release, temperature of reaction (in N_2 & air) and compared against the EVKI adiabatic temperature code. The correlation between actual temperature measurements against models was lower than expected. The sources of errors or understanding of the thermite materials would improve the correlation.

Finally Proud (ISP; GBR) provided an overview of shock and ignition properties of thermites that Cavendish and ISP had performed over the last 40-50 on the topic. One of the take away points was thermites were more sensitive to shock impact when in pressed disc form compared to loose powder.

48TH ICT (27 – 30-JUN-17)

The topic of this year's conference was energetic materials: reactivity and modelling, which attracted 39 oral presentations and 125 posters. The opening address was given by Dr. Stella Oldenbürger (German MoD) in which she referred to the development of a toolbox to aid the German government to make responsible decisions. Responsibility means choosing the right option, options are needed and that is where scientists come in to provide the options/advice.

Some of the highlights of the meeting are included plus the winners of the poster competition.

Poster winners

- 1st - P80, Wenchao Zhang, PRC. Template-directed construction of three dimensionally ordered macroporous materials for nanothermites
- 2nd - P59, A. Mitchell, GB. The development of a time resolved initiation characterization test
- 3rd - P108, A. Provatat, AUS. Development,

characterization and ageing of an alternative plastic explosive

- 1st (ICT) - P126, S. Hafner, ICT-Poster Award. Synthesis of copolyethers for energetic binder systems



Synthesis

Of main interest was the high output of ammonium dinitramide (ADN) based research. Heil (ICT; DEU) provide some information on stabilising ADN, whilst Heintz (ICT, DEU) showed the effect of prilled particle properties on sensitivity. A number of propellant papers also provided results of combustion behaviour (Imiolek, ICT; DEU), ballistic modifiers (Tagliaue, ICT; DEU) and decomposition behaviour (Freudenmann, DLR; DEU).

Processing and Formulations

Doorenbos (LLC; USA) provided characterisation of a DBX-1 based composite energetic material for percussion primer applications. This work was looking to replace lead styphnate in primers.

Provatat (DST Group; AUS) provided an excellent review on the hazard and performance properties of ARX-2045. This material was investigated as a replacement for PE-4, and used RS-RDX, polydimethylsiloxane (PDMS) binder and taggant. ARX-2045's performance matched that of PE-4, had a larger critical diameter and showed promising ageing characteristics.

Propellants & Pyrotechnics

An interesting 3-D printed propellant grain using a helical grain geometry showed an increase in performance properties (Zhou, National University of Defense Technology; PRC). Griffiths (Qinetiq; GBR) gave a presentation on pyrotechnic delay formulations containing 1,2,4-trihydroxyanthraquinone; a naturally occurring dye from the madder plant. Both the method of manufacture and ingredient particle size were found to influence the burning rates of the compositions.

Testing

A redesign and evaluation for the method to determine the erosivity of gun propellant led to a standard model that was independent of experimental conditions and propellant type (Langlotz, Diehl; DEU)

Hobbs (Sandia; USA) presented working using their SITI test apparatus to understand the binder effects during cookoff of HMX formulations. 12 HMX-based explosives were tested with different binders. The employed model was able to describe the cookoff process using either HMX kinetics or HMX and a binder kinetics irrespective of the binder type. This, along with the experimental data, highlighted when the binder was involved in the reaction which was related to density-dependent thermal conductivity.

4TH KISHEM (29-AUG – 01-SEP-17)

This was the 4th iteration of the Republic of Korea's symposium on energetic materials. It was, however, the first time that it was held jointly with the Chinese



International Autumn Seminar on Propellants, Explosives and Pyrotechnics (IASPEP). The topics covered in the plenary sessions included synthesis, mechanical behaviour of binders, modelling of SDT/DDT, environmental aspects, propellants, and pyrotechnics. Similar topics, including storage, were covered in the parallel sessions.

Synthesis

Plugged flow microfluidics for the synthesis of primary explosives, lead styphnate, was presented by Shen, R (Nanjing; CHN). This is one of many recent papers now referring to this technique for energetic materials manufacture. The continued work on the synthesis of nitroazapropellanes was reported by Lee, B (Seoul National University; ROK). The target compound of 2,4,6,8,9,11-hexanitro-2,4,6,8,9,11-hexaaza[3.3.3]propellane has still not been achieved, but results were however presented on the formation of 2,6-dinitro-3,7,9,11-tetraoxo--2,4,6,8,10-pentaaza[3.3.3]propellane (DNTOPAP).

A number of papers, but mainly posters, presented work on azoles (pyrazoles, triazole, tetrazoles, bis-compounds....) and their derivatives. By example two bis (dinitropyrazole)methane compounds, bis(3,4-dinitropyrazole)methane & bis(3,5-dinitropyrazole)methane, were synthesised by Kim, N (Seoul National University; ROK) and co-workers. Both materials exhibited properties similar to RDX but, due to their lower densities, did not achieve high performance characteristics.

Processing and Formulations

Large scale manufacture of VI-RDX was reported by Eurenco [Eck, G. (Eurenco; FRA)], which has commercialised the work carried out by ISL. Formulations of VI-RDX have shown an increase in the threshold for shock initiation. A novel plastic explosive based on *cis*-1,3,4,6-tetranitrooctahydroimidazo-[4,5-d]imidazole (bicyclo-HMX; BCHMX), FOX-7 and polydimethylsiloxane (PDMS) binder (44, 44, 12 wt %) was presented by Hussein, A. K. (University of Pardubice, CZE). Detonation velocity and pressure was quoted as being higher than SEMTEX-10 and this is the second formulation reported this year using PDMS as a binder system.

Propellants

Interesting monopropellants work investigating replacements for hydrazine focused on 4-amino-1-methyl-1,2,4-triazolium nitrate; C1N [Schaller, U. (ICT; DEU)]. Synthesis of C1N used microfluidics to produce kg quantities for research; this highlights the flexibility of this technology to the research community. Mixtures of C1N with nitromethane exhibited desirable properties for sensitiveness, shock and I_{sp} . Rocket research by ADD has focused on non-isocyanate curing reaction mechanisms for the polymeric binder systems [Min, B. S. (ADD; ROK)] such as the 3+2 cycloaddition chemistry of azide moieties (N_3) reacting with alkynes to generate triazoles.

Pyrotechnics

Flare igniters and their ignition process, under temperature & pressure extremes, was presented by Woodley, C (Qinteq, GBR). Critical material parameters were collated and used in a number of models to aid simulation of the burning processes. Presentation on lithium-based red light emitting, chlorine-free pyrotechnics [Glück, J; LMU, DEU] as Sr has to be withdrawn from use (US EPA) due to adsorption into the human body; can replace Ca in bone calcification, affect children bone growth. The work used a high nitrogen-Li

salt (bis-lithium 5,5'-diamino-4,4'-dinitramino-3,3'-bi-1,2,4-triazolate) that produced the correct frequency, and high spectral purity as Sr/PVC composition but the intensity was low. 5-Aminotetrazole was employed as an additional gas generator for improved efficiency coloured smokes [Glück, J. (LMU, DEU)].

Dr Matt Andrews

MSIAC Energetic Materials Specialist



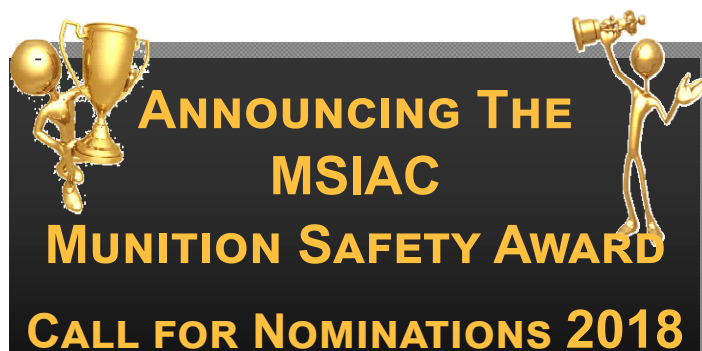
The previous newsletter announced the MSIAC 2018 workshop "Improved Explosives and Munitions Risk Management". The goal of the workshop is to exploit our improved understanding of munitions vulnerability and consequences to deliver improvements in munitions risk management. We are looking forward to interesting discussions between about 65 experts in the field of Hazard Classification, Insensitive Munitions and Explosives Storage Safety.

In the mean time we have fixed the date; this 5 day event will take place from 10 to 14 September 2018. Please make a note in your agenda's!

The MSIAC Steering Committee will soon make a decision between a number of possible European venues. We will keep you updated with information about the workshop contents and logistics.

Martijn van der Voort

MSIAC Safety of Storage and Transport Specialist



To acknowledge and encourage progress and achievements in munitions safety and insensitive munitions technology, MSIAC will present awards for Munition Safety excellence at the upcoming 2018 IM/EM Technology Symposium.

The call for nominations is open now through **January 2018**.

Submission guidelines may be found at <https://www.msiac.nato.int/news/ms-awards/>



EUROPEAN INSENSITIVE MUNITIONS DAY CONFERENCE

The European Inensitive Munitions (IM) Day Conference was held on 18-19 May 2017 at The Rosarium in Amsterdam, The Netherlands. This was the 3rd European IM Day held to date. The conference is held about every 5 years, with the 2nd European IM Day being held on 13-14 June 2013 in London, UK. The conference is organized by the Inensitive Munitions European Manufacturers Group (IMEMG) and was hosted by the IMEMG President, Dr. Ronald E. Hollands from BAE Systems. The conference is centered around European IM industry, focusing this year on "Priorities for IM". The conference addressed pragmatic approaches and effective solution, threat analysis and risk reduction and delivering benefits through the lifecycle. The conference was well attended by the European IM industrial community, with representatives and presentations from all of the MSIAC European member nations. The Deputy Assistant to the NATO Secretary General, Ernest J. Herolds, presented an overview of NATO and NATO IM related activities, including a significant outline of MSIAC functions, capabilities and history. Presentation sessions included Viewpoint of the User; IM Policies and Implementations; European Industry Contributions, and Current IM Challenges. MSIAC provided a number supporting presentations including: "Improved explosives and munitions risk management based on an updated understanding of vulnerability and consequences" by Dr. M. Sharp and Martijn van der Voort, and "Insensitive Munitions Design: MSIAC Tools" by Dr. E. Baker. A lively debate focused on industry requirements and impacts followed the presentation sessions.

Dr Ernie Baker
MSIAC Warhead Technology Specialist

FAREWELL ... FROM EMMANUEL SCHULTZ

Those 6 years within MSIAC passed so quickly that I almost didn't notice the Belgium weather and the taste of the beers.

Some highlights of my time include:

- ⊕ The development of the Integrated Munitions Health Management activity with the coordination of the cooperative demonstration of technology in NATO HQ, and the launch of the related SMART Defence Initiative
- ⊕ Databases: the finalization of Advanced Inensitive Munitions Search (AIMS) that was developed by Pierre-François Péron, and the development of Mitigation Techniques for Munitions (MTM)
- ⊕ Country visits including Australia, Belgium, France, Sweden, Norway, the Netherlands, Spain, and the USA
- ⊕ Review of IM Tests STANAGs with AC/326
- ⊕ Training, including the Eurosae IM course and Shrivenham, and the supervision of trainees
- ⊕ Beating Matt at tennis on a regular basis

Most important was the good times spent with the team, the munitions safety community and the AVT members.

I really enjoyed my time in Brussels and I wish the best of luck to my successor.



AND NOT TO FORGET...

16TH INTERNATIONAL DETONATION SYMPOSIUM



15 — 20 JULY 2018

HYATT REGENCY CHESAPEAKE BAY
CAMBRIDGE, MARYLAND, USA

Visit the website [here](#) for the list of Topical areas, Submission Guidelines and link to the Abstract Submission Website.

ABSTRACTS ARE DUE ON OR BEFORE 13 OCTOBER 2017. Abstracts will be competitively evaluated for their application to the science of explosives and detonation. Questions? Email info@intdetsymp.org.

8TH INTERNATIONAL NITROCELLULOSE SYMPOSIUM

05 — 07 JUNE 2018, BERGERAC, FRANCE

You are invited to attend, submit a paper or poster, and participate in this symposium. Herein below, you can find important details and deadlines for you to submit your documentation and/or registration online.

Call for Abstracts

Participation via presentations and posters are welcomed. Please submit an abstract with the exact title, names and affiliations of author(s). Abstracts of presentations and posters will be evaluated by the scientific committee and will be distributed at the symposium.

Deadlines:

- ⊕ Reception of Abstracts: max November 30, 2017
- ⊕ Reply to the authors: January 15, 2018
- ⊕ End registration: April 30, 2018
- ⊕ Paper/presentations for symposium: April 30, 2018
- ⊕ NC Symposium: June 5, 6, 7 2018

Online registration is now open!

For more details, visit the registration website:
<http://ncsymposium2018bergerac.fr/> .



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