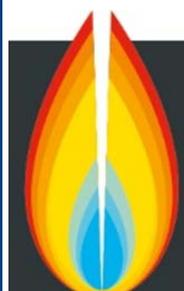




# Bulletin

## WORKSHOP ON THE SCIENCE OF COOK OFF



**SCIENCE OF COOK OFF**  
**ATLANTA**  
25-29 APRIL 2016

**Request for Abstracts - OPEN**  
<http://www.msiac.nato.int/workshop/science-of-cook-off>

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In September 2015 we formally announced the location of the Science of Cook Off workshop, which will be held at the Executive Conference Center (1170 Peachtree St NE, Atlanta, GA 30309) based in the Midtown district of Atlanta, Georgia, USA. The dates for the workshop will be 25<sup>th</sup> – 29<sup>th</sup> April 2016.



The workshop's objectives are to improve understanding of cook off of energetic materials and the role that heating rate and heating conditions play in determining reaction violence from reduced scale up to system level. These objectives will be achieved through discussions and presentations on chemical and physical changes leading to critical ignition and growth conditions, reaction phenomenology and models, and linking these through sub-scale testing to system-level tests.

This Unclassified workshop is open at **no cost** to Government, Industry and Academia representatives from all MSIAC member nations only.

**Limit/Limitation**

The workshop will be limited to 75 participants and we encourage representation from all MSIAC member nations. In the event that the workshop is oversubscribed, MSIAC will work

December 2015

**CONTACT INFORMATION**  
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(Continued on page 2)



with the National Focal Point Officer(s) from the nations so participation is balanced.

We would therefore encourage early registration and for those government personnel requiring approval to start their approvals process simultaneously.

### Program

The program details for the event are currently under development but we envisage that discussions will start on Monday morning and take place over 4.5 days. The plenary discussion on day 1 will allow the problem, current understanding and national interests in the topics to be discussed and to provide anchors for the subsequent days' focus area groups. The final day will be available to provide a wash up and draw together conclusions from the previous days technical discussion. The final day will only be a half day to enable participants to make their return travel.

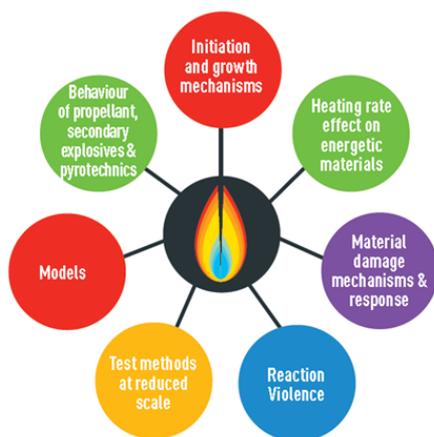
A draft/outlined program is currently available on the website for planning purposes. The full program will be available on the website when registration opens.

### Abstracts

The focus areas will be based around the following topics (Figure 1) and as such we encourage those who are interested in attending to submit abstracts for presentation. Please submit your abstract using the online [abstract form](#) as soon as possible. We would like to receive abstracts prior to the registration process to allow us to populate the plenary and focus area discussion groups.

We are also encouraging participants to think about other technical information they can bring to the workshop, i.e. published papers, technical data, models. A dedicated space, prior to the event, will be made available to workshop participants to share the information.

**Figure 1:**  
Discussion Topics



### Registration

The workshop registration will open in mid-January and participants will be asked to fill in the online form. Registration will stay open for 2 months and close mid-March or until capacity for the event has been reached (see earlier note about potential limitation for the workshop).

Registrants will receive an email informing them that MSIAC has received their application. MSIAC will then send a separate email confirming that you have been granted a place. Please bear the latter point in mind before committing to travel.

### Administration

Further details pertaining to Atlanta, the venue and

reserved hotel rooms can be found on the website.

On behalf of the MSIAC team we are looking forward to welcoming you in Atlanta and providing the right environment to generate focused discussions on the science of cook off.

**Dr Matthew Andrews**  
MSIAC Energetic Material Specialist  
Workshop Lead

[SoCoWorkshop@msiac.nato.int](mailto:SoCoWorkshop@msiac.nato.int)



## PM'S PERSPECTIVE

This quarter I want to remind readers about training and development opportunities here at MSIAC.

Firstly, the Benjamin Stokes' Fellowship programme is available for junior to senior scientists and engineers to gain and share knowledge and experience on munition safety. Normally, fellows are expected to spend from 6 to 24 months working as a member of the MSIAC team whilst on secondment from their host nation. Subsistence expenses are funded by MSIAC but salary must be paid by the seconding nation. This position is available for the second half of the year. If you or someone you know are interested, and are a national from a MSIAC member nation, we would be happy to hear from you together with proposals for area of study.

We also have opportunities for student nationals of MSIAC nations. Each year we can accept a limited number who have completed or are completing a technical degree related to munitions science/engineering and safety. Typically this would involve a placement of 2-3 months but can be tailored to suit needs. Benefits of working at MSIAC include: learning from staff that have a deep interest and knowledge in munition safety issues, furthering munition safety related efforts, and working with the international community and developing contacts. Students maybe eligible for a small stipend to cover accommodation expenses. Applications will be considered throughout the year but please bear in mind that it can take up to 6 months to make the necessary arrangements. Hence, the closing date is **end of January** for summer 2016 placements. Feel free to contact us or your NFPO directly for more information (<https://www.msiac.nato.int/>).

The last year has been a time of change in the MSIAC offices: two Technical Specialist Officers left the team, Tom Taylor and Fred Becker, and we welcomed Martijn van der Voort and Wade Babcock. We currently still have one vacant post, on warhead technology, but have identified a suitable candidate who should join the team early in 2016. All the technical posts at MSIAC are definite duration and although it's hard to lose experienced colleagues, changing staff brings new ideas and new focus areas.

These ideas can transition into new work elements and in 2016 these include:

- ⊕ **Develop Improved Understanding of Ageing Related Mechanical Damage** (POC Wade Babcock)
  - Response of munitions, and the materials that they contain, to mechanical stresses is a complex problem and one which often limits the life of munitions. This new effort seeks to develop understanding of



mechanisms such as cracking, delamination, fibre breakage and fibre matrix debonding by exploiting knowledge from the wider materials community.

⊕ **Benefits of IM** (Stokes Fellow project, POC Martijn van der Voort) - For the introduction of IM it is important to explore the impact over all phases of the ammunition life cycle. This work element will study the consequences of munition reaction during the storage phase, and will seek to quantify break-up of storage structures by hazard divisions using engineering models. We are grateful to the Klotz Group for allowing use of their Engineering Tool in the study.

⊕ **Integrated Munition Health Management – support to NATO Smart Defence Initiative** (POCs Emmanuel Schultz, Wade Babcock) – A proposed output of this NATO initiative is development of a STANREC with the aim to standardise the use of health monitoring amongst NATO nations. MSIAC will assist in the drafting of discussion documents to address common issues with implementation of a health management system, including: the level of sensor integration, recommend data to measure as a function of the failure modes, recommend measurement characteristics, use of data, interoperability of data, and modelling data (determination, use and predictive capability).

Our biggest single undertaking next year will be the Science of Cook-Off workshop. As discussed elsewhere in this Newsletter, it only remains for me to encourage the community to make the most of this opportunity to share knowledge and experience in this area.

As always we encourage you to get involved in the programme of work for 2016. Please feel free to contact us on any of the items mentioned herein or in the wider newsletter.

Best wishes for 2016

Dr Michael Sharp, Project Manager

MSIAC is what you make of it!



## PROCUREMENTS, SCIENCE AND TECHNOLOGY

*If you have information that you consider of relevance to this section, contact MSIAC at [info@msiac.nato.int](mailto:info@msiac.nato.int).*

In this issue of Science, Technology and Procurement the news items have been divided in the following sections: Manufacturing, Systems, New Technology and Contracts.

As you can read in the System's section, the US Navy confirmed that a Raytheon made Standard Missile-2 (SM-2) test missile exploded after suffering a malfunction after it was fired from the guided-missile destroyer USS The Sullivans during a planned missile exercise off the coast of Virginia.

The New Technology section begins with the news that the Excalibur N5 155mm Projectile was test fired successfully. The Contracts section is certainly also worth a look with Rheinmetall winning a new order for tank ammunition worth around €20 million. The section ends with the US Army and Navy awarding Lockheed

Martin \$66 Million Contract for Joint Air-to-Ground Missile.

[Click here to read more.](#)

**Martin Pope & Dr Michael Sharp**  
MSIAC Munitions Systems Specialist and PM

## MTM - LOOKING FOR BETA-TESTERS !

Mitigation Techniques for Munitions (MTM) is a web based application including a database of mitigation techniques and a powerful search engine. It is currently in development within MSIAC with the aim of being deployed on its server in early 2016. It will allow users to find mitigation techniques against IM threats.

In the past, MSIAC developed a software tool named M<sup>3</sup> (Mitigation Methods for Munitions) which is a compendium of mitigation methods. This software has several limitations, including limited search capability and the fact that every update requires the user to install a new version on their computer.

MTM will improve the user experience by adding several features. The product will be updated online by the administrator, which will allow an increase in the number of techniques available. The search feature will be improved, allowing the user to make complex queries and to search for more data than currently possible. This product will be accessible via the MSIAC portal.

The application displays the information as a list (Figure 1) within a table that provides a short description of the mitigation as well as its attribute.

ID	Description	Threat	Component	Category	Technique	Configuration	Permanent modification	Ref.
31	Using ammunition as buffers for stacks of MK 82 Bombs.	SR	Warhead	Bomb	Arrangement	Storage	No	35
32	Noise-to-noise orientation of MK 84 Bombs.	SR	Warhead	Bomb	Arrangement	Storage	No	35
33	Using ammunition as buffers for stacks of MK 84 Bombs.	SR	Warhead	Bomb	Arrangement	Storage	No	35
41	Head-to-tail arrangement between the 2 rounds packed in the same container.	SR	Warhead	Direct fire, Mortar	Arrangement	Storage	No	27
18	Use of barrier and spacing to enhance the pallet design of mortar shell	SR	Propelling Charge, Warhead	Mortar	Arrangement, Barrier	Packed, Storage	No	20, 21, 22
38	Pallet design or artillery shells with plywood barrier to avoid detonation en masse.	SR	Warhead	Artillery	Arrangement, Barrier	Packed	No	44
50	Water barrier to prevent SR between stack of munitions.	Bl, Fl, SR	Warhead	Artillery, Direct fire, Mortar	Barrier	Storage	No	45
49	Water barrier to prevent SR.	Bl, Fl, SR	Warhead	Bomb	Barrier	Bare, Storage	No	44, 45
51	Modular Reusable Protection (MRP) Water Barrier.	Bl, Fl, SR	Warhead	Bomb, Missile, Torpedo	Barrier	Storage	No	46, 47
27	Aluminum plates were added to the AMRAAM container in order ...	Fl, SR	Warhead	Missile, Rocket	Barrier	Packed	No	19

Figure 1: MTM - view list

All the attributes can be searched thanks to the search engine. The attributes are as follow:

⊕ **Technique:** active venting device, passive venting device, thermal protection, case, diverter, liner,



- container, arrangement, barrier
- ⊕ **Component:** warhead, motor, propelling charge
- ⊕ **Category:** mortar, artillery, medium calibre, tank, missile, torpedo, bomb, grenade, mine, rocket, bulk explosive
- ⊕ **Threat:** SCO, FCO, BI, FI, SCJ, SR.
- ⊕ **Configuration:** bare, packed, storage, launcher
- ⊕ **Permanent modification:** yes, no
- ⊕ **Reference:** title, author, country

Each mitigation is further described in its detailed view (Figure 2). This detailed view contains a longer text to explain the characteristics of the mitigation as well as pictures extracted from publications. All the information provided is based on data available in the MSIAC document database.

Example 51 ✎ Edit   🖨 Print   📄 Export

Commercial off the shelf barriers made of polyurethane containers (each block 75cm X 50cm) filled with water have been proven effective for unitizing event. They are significantly lower cost when compared to other barriers or structures, portable & easy to reconfigure & maintain and unofficially endorse by the DDESB in 2007. They are used in Afghanistan by USAF and UK MOD to limit event to one aircraft only. They are also used on barges transporting large ammo and in many storage configurations. Test results of the Commercial off the shelf barriers made of polyurethane showed that replacing water by sand does not bring a significant improvement. Using water as filler provides suitable ballistic protection from one off munitions detonations and in some cases single shot direct small arms fire. But, unsurprisingly, once the water is leaking out of a single hole or a fracture in the barrier then the protection is lost. Adding sand as filler takes longer, requires mechanical assistance with handling and lifting. The sand provides additional longer term protection from sustained small arms fire. The performance of the sand filled barriers in protecting against fragments and blast from explosions would seem to be similar to that of water filled barriers.





Modular Resuable Protection  
Blocks available  
& Walls mounted in Afghanistan.  
Can be filled with Water or Sand.

Technique	Barrier
Component	Warhead
Category	Bomb, Missile, Torpedo
Threat	BI, FI, SR
Configuration	Storage
Permanent modification	no
Reference	46, 47

⏪ Previous   ✖ Remove from results   Next ⏩

20/51

Figure 2: MTM - Detailed view

MSIAC is looking for beta testers to provide feedback on the tools. These comments will help us to finalize the development of the application before its final deployment on our server.

Should you like to test the application, please contact Emmanuel via [e.schultz@msiac.nato.int](mailto:e.schultz@msiac.nato.int).



**Emmanuel Schultz**  
MSIAC Propulsion Specialist

**FAREWELL ...**  
**FROM THOMAS TAYLOR**

Tom left in June 2015, after spending 7 years with MSIAC and then retiring from the US Army in September.

Over this period of time, Tom made many and varied contributions to the output of MSIAC. He was the originator of a number of the team's new initiatives e.g.: creating and running a very successful AASTP training on safe storage principles for the MSIAC member



nations, and developing a common accident database, MADx.

On this last item Tom continued to provide support even after leaving the team while he was working at the US delegation in NATO.

Tom also played an important role in helping to facilitate the work of AC326 SG-C, providing technical advice and input into a number of its papers during his tenure.

We will miss Tom's broad practical knowledge, his professionalism, and quality of his work. We will also

miss his humor which was guaranteed to brighten your day.

We wish Tom the very best for his retirement.

## AND WELCOME TO MARTIJN VAN DER VOORT

Martijn (NL) joined MSIAC on 1 October 2015 as the TSO for Munitions Safety, Transport and Storage.



After he obtained his MSc in Applied Physics at the University of Technology Delft in 2001, Martijn started his professional career as a scientist and project manager at TNO. He managed a broad range of projects related to explosives safety, risk analysis, counter IED, and forensic analysis, for the Dutch Ministry of Defence and the European Union.

Martijn was responsible for the development of Risk-NL, the Dutch software code for Quantitative Risk Analysis (QRA) of ammunition storage. Also he was a key player in the development of the Klotz Group Engineering Tool (KG-ET) for the prediction of debris thrown from storage structures and the risk assessment method described in the NATO field storage manual AASTP-5. Martijn participates in a number of international expert groups on explosives safety and risk modelling, e.g. NATO AC/326 SGC and the AASTP-4 Custodian Working Group. Martijn has published 6 reviewed articles and over 30 research papers at various symposia.

## ACCIDENT REPORTING

Reporting accidents with ammunition and explosives is very important to generate lessons learned. Sharing the information with other nations and organizations helps to prevent similar events in the future. MSIAC has a number of ongoing activities to contribute to these goals.

### 1. Accident reports on the public MSIAC website

An overview of recent accidents is given on the public MSIAC website: <https://www.msiac.nato.int/news/accident-reportings>

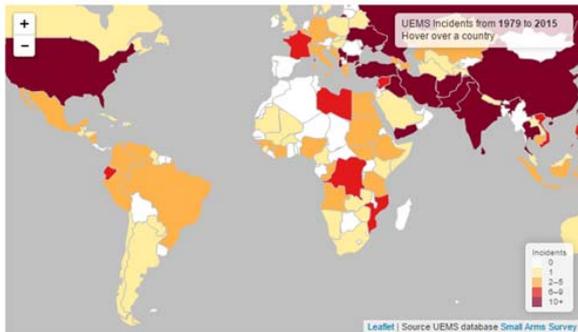
Over the last year no updates were made, but a new report for the year 2015 is now available. The future



intent is to provide updates each quarter in conjunction with the newsletter. The main focus is on accidents with ammunition, but accidents in industry (e.g. with fertilizer) and explosive attacks (e.g. IED) may also provide relevant information in terms of the damage effects.

Another great source of information is the Small Arms Survey based in Geneva, Switzerland. They collect statistics about Unplanned Explosions at Munitions Sites (UEMS) that take place around the world. The information can be browsed by country or by year. The number of fatalities and injuries are given, as well as the cause if available. The 2014 UEMS Handbook gives a 35-year global review of UEMS incidents.

<http://www.smallarmssurvey.org/weapons-and-markets/stockpiles/unplanned-explosions-at-munitions-sites.html>



UEMS Incidents 2015 (a) :

ID	Month	Day	Country	Location	Fatalities	Injuries	Cause
1	February	1	Ukraine	Krasny Chaban	5	11	4
2	March	28	Yemen	Aden	14	9	5
3	April	13	Russian Federation	Chita			4
4	April	21	Afghanistan	Kandahar	2	21	6
5	April	28	Russian Federation	Golovinka	0	0	2
6	September	16	Turkey	Diyarbakir	0	0	6
7	September	28	El Salvador	San Juan Opico	0	13	3
8	October	29	Ukraine	Svatove	4	8	5
<b>Total</b>					<b>26</b>	<b>62</b>	

Meaning of cause codes: 1. lack of surveillance leading to ammunition deterioration, 2. inappropriate storage infrastructure and systems, 3. handling errors and inappropriate working practices, 4. Failure to take into account external, environmental influences and events, 5. Poor security, 6. Cause currently undetermined or unrecorded.

## 2. National accidents database exchange and MADX

More detailed accidents information can be found in the "MSIAC Accident Database Exchange (MADX)" on the MSIAC portal. This database is accessible to contributing nations only; currently Australia, Canada, France, UK, and US. MSIAC and AC/326 SG-C encourage other nations to join.

Tom Taylor, the former TSO Ammunition Safety, Storage and Transport, was responsible for the development of the MSIAC Accident Database Exchange (MADX). This tool allows easy searching and analysis of the accident reports. Searching for weapon type, explosive substance, location, time frame, or part of the life cycle phase in which the accident took place, yields a list with relevant results. Tom's successor, Martijn van der Voort, continues the development of MADX. After a testing period, the aim is to add MADX to the MSIAC suite of tools towards the end of 2016.

MSIAC is looking for beta testers to provide feedback on

MADX. Should you like to test the application, please contact Martijn van der Voort via his email ([m.vandervoort@msiac.nato.int](mailto:m.vandervoort@msiac.nato.int)). Note you must be an individual from one of the five contributing nations listed above.

## 3. Forensic analysis of ammunition accidents

An important part of the accident investigation is to obtain information on the amount and type of ammunition or explosives involved in the event. This can be done based on damage observed to the surroundings such as crater size, structural damage, window breakage, and debris and fragment throw. In 2012 MSIAC analysed the Cyprus accident based on available information.

<https://www.msiac.nato.int/products-services/o-150-rev-1-ammunition-accident-at-the-evangelos-florakis-naval-base-zygi-cyprus>

MSIAC encourages the use of quantitative methods for forensic analysis of explosions. Martijn van der Voort, in his previous job at TNO (Rijswijk, the Netherlands), was responsible for the development of the Inverse Explosion Analysis (IEA) tool. This tool enables inverse calculation of the explosive charge mass based on various types of damage at and around the accident location. The tool was applied in a number of case studies; the Khobar tower attack (1996), the Enschede firework disaster (2000), and the Oslo bombing (2011).

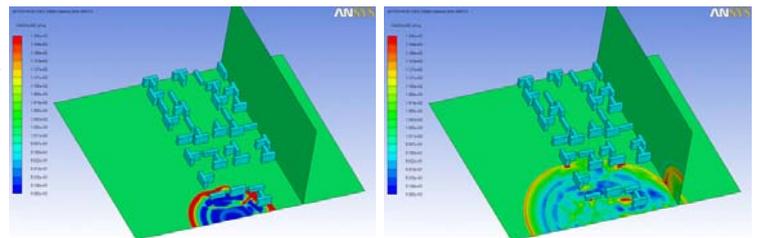
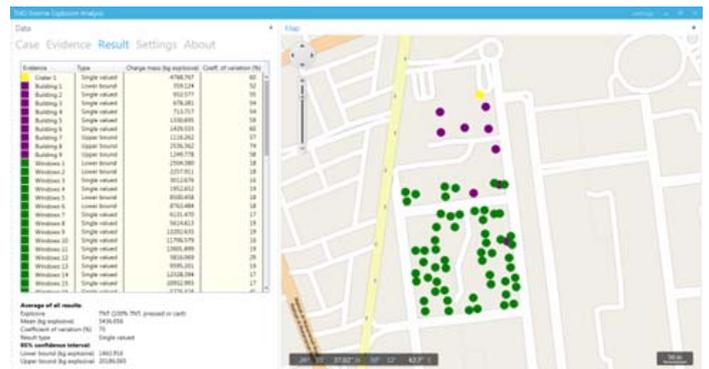


Fig 1: Screenshot of the Inverse Explosion Analysis tool and its application to the Khobar tower attack (1996). Foto 2: crater and heavily damaged buildings. Bottom 3-4: Detailed analysis (CFD) of the blast propagation with Ansys AutoDyn.



The scientific background of the various models and the first two case studies are described in a recent publication in Forensic Science International.

[Click here to read the full article.](#)

Results have also been presented at various symposia and conferences; the most recent one was the ISIEMS conference in Florida, 9-13 November 2015.

The work was conducted under the EU FP7 project HYPERION. Consortium leader FOI of Sweden organized a demonstration on 23 and 24 September at the Grindsjon test site near Stockholm. Three trials were performed involving an outside detonation near facades with glazing, a buried explosive and an explosion inside a building. The IEA tool gave predictions that are in close agreement with the actual amount of explosives used, which was also confirmed with overpressure measurements. A movie summarizing the results is available on:

[Click here to view the movie.](#)

The current Point of Contact at TNO for (forensic) analysis of explosions is: Ms. Ans van Doormaal ([ans.vandoormaal@tno.nl](mailto:ans.vandoormaal@tno.nl)).

**Martijn van der Voort**  
**MSIAC Munitions Safety, Transport and Storage.**

## WTD-91 OPEN DAY !

On 11 September Michael Sharp and Martin Pope were the guests of WTD-91 at Meppen as part of their VIP visitors day. This was immediately prior to their public open day on the 12 September. We were hosted by Peter Ubbenjans and Thomas Malysz, currently handing over Steering Committee duties. The day was intended to demonstrate WTD-91 capabilities to a wide range of German defence related personnel. The day consisted of a welcome address from the Director where we were made to feel very welcome followed by a tour of a number of static displays followed by a range of mobility and firing demonstrations.

Thomas escorted through the static displays, where an impressive range of equipment and resources were on display. We were very impressed by the



Weasel armoured support vehicle fitted with either a 20mm cannon or a 120mm mortar which gives it an enviable degree of protection and mobility and not a concept adopted by many other nations. Also on display were the MARDER Infantry armoured fighting vehicle



and the newer PUMA. Whilst the MARDER is still an effective vehicle the PUMA looks to offer improved levels of protection and

comfort as well as firepower. During the tour there was an opportunity to meet, and hold well informed discussions, with many of the staff involved with the systems and munition testing. We also had a chance to

see the WTD-91 IM fragment gun and discuss its details with David Bracke, who supports AC/326 and is well know to the MISAC staff and IM community.

We were hosted by Peter Ubbenjans for the live demonstration which started with an excellent commentary drive past by all vehicles under test and evaluation at WTD-91 or used as systems to support User and munitions testing. The live firing phase was

particularly interesting with an impressive display from the PzH 2000 with its 5 round of Multiple Rounds Simultaneous Impact capability. The LEOPARD A2 gave an impressive display of its mobility and firepower as well as car crushing ability. This may be an



addition to the office car pool for when the Brussels Ring is busy! Also equally impressive was the KEILE R land mine flail which is a different approach to land minefield breaching by contrast with explosive systems.

The day concluded with an opportunity to meet and discuss various matters of interest with a wide range of WTD-91 staff. In all we found the day to be very informative with an interesting range of different design and technology approaches to similar threats faced by other MSIAC and NATO nations. The actual open day had just over 50,000 visitors and was reported to be a great success. We would like to thank all staff at WTD-91 for their hospitality and openness throughout the day which made the visit a very pleasant and memorable experience.

**Martin Pope & Dr Michael Sharp**  
**MSIAC Munitions Systems Specialist and PM**

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 **ALL PATENTS** on can be found in the **News** section on our **Secure Web-environment** via this [hyperlink](#) .

