Question No. **2020-MSIAC-3000** **02 Sep. 2021**

Requestor Brian Fuchs **Position** Chair of MSIAC Steering Committee

3000th MSIAC Technical Question

Question

In this 3000th Technical Question MSIAC staff are requested to discuss:

- Metrics and topics and trends of questions;
- The value and importance of Technical Questions to the member nations;
- How the questions have influenced and directed MSIAC's work over the last 30 years, including how this has contributed to the technical community;
- What is expected for the next 3000 Technical Questions, and how this might shape MSIAC in the years to come.

Background

One of the most important services that MSIAC provides is the answering of Technical Questions (TQs) posed by our member nations. Anyone from a member nation can submit a TQ[1] and once it has been approved by their MSIAC National Focal Point Officer (NFPO), our staff will do their best to provide a comprehensive answer. Since MSIAC was established as the NATO Insensitive Munitions Information Center (NIMIC) in 1991, over 3,000 TQs have been received from our member nations on a variety of topics related to munitions safety; our answers to these questions have not only proved of use to the requesting nation, but have also helped to shape and influence the wider munitions safety community.

While the distribution of TQ answers is normally limited to the requestor, to mark the occasion of our 3,000th TQ the MSIAC Steering Committee have agreed to make this answer publically releasable.

[1] Via our website: https://www.msiac.nato.int/products-services/msiac-technical-question-form

Metrics, Topics & Trends

"85% of statistics are made up on the spot."

Number of Questions Received

Figure 1 shows the total number of TQs received per year over the period 2010-2020. The maximum number of TQs received over this period was 110 in 2020; the minimum was 60 in 2018. As 3,000 TQs have been received over the last 30 years, MSIAC should on average expect to receive ~100 TQs each year.

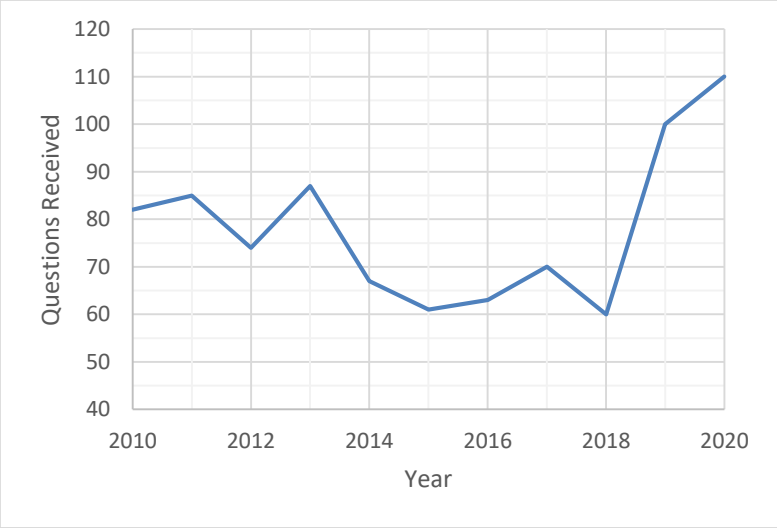

Figure 1: Total number of TQs received per year for period 2010-2020.

Complexity of Questions

The complexity of the TQs received is obviously a very subjective matter: there is a general feeling amongst the MSIAC staff that the TQs are increasing in complexity each year, but this is difficult to quantify. Making the assumption that a more complex question requires a more in-depth answer, and further that an in-depth answer is likely to be longer, we may try and gauge TQ complexity by the length of the answers provided.

Using data from the MSIAC records management system, it has been possible to determine the length of each TQ answer provided as expressed by number of pages. The average number of pages per year was then determined for years 2010-2020 (Figure 2). A general increase in the average number of pages is observed over this time period, which can be inferred to correspond to an increased complexity of questions.

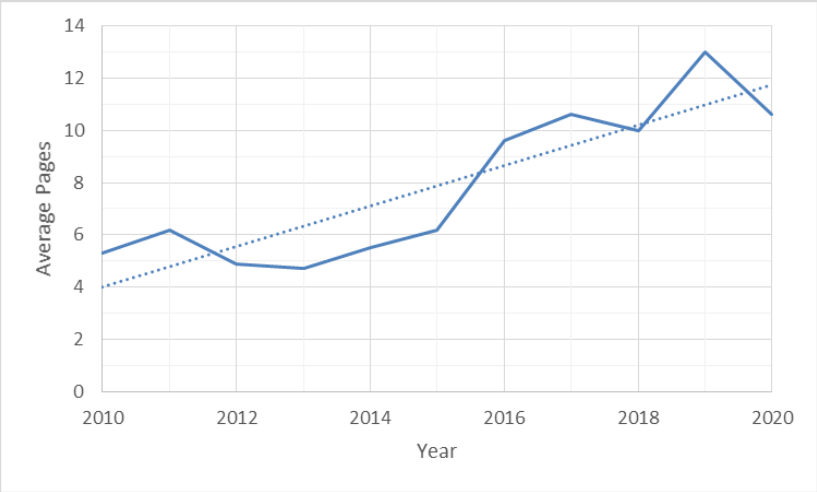

Figure 2: Average number of pages in TQ answers for period 2010-2020.

The apparent increasing complexity of TQs received may be attributable to a corresponding increase in the complexity of energetic material and munition system technologies, including new methods of preparing energetic materials and formulations; equally, it may also be attributable to a requirement for an enhanced understanding of existing technologies in order to increase the fidelity of underlying safety arguments, itself likely a factor of a general downward trend in risk tolerance.

Question Topics

When a TQ is submitted, the requestor is required to identify the topic area to which the question relates. Analysis of the topics of received TQs shows quite significant year-on-year variation; however, some indication of the overall interest in individual topics is provided by considering both the average number of TQs received for a topic each year, and the coefficient of a linear trendline fitted to the data for a given period of time. Table 1 shows this information for the period 2005-2020.

Table 1: Evolution of TQ topics for period 2005-2020.

Topic	Average number of TQs per year	Coefficient A of the trendline	Trend*
Energetic Materials	22.5	-0.7808	↘
Tests & Test Standards	14.9	-1.9315	↘↘
IM Characteristics	10.1	-0.8750	↘
Safety Practices	6.4	-0.0191	→
Policies (e.g. STANAGs, APs, National)	6.1	0.9912	↗
Accidents & Causes	6.0	0.3647	↗
Modelling & Simulation	4.7	0.0103	→
General Munitions Characteristics	4.1	-0.2618	↘
Market Survey	3.6	-0.6118	↘
Aging & Health Monitoring of Munitions	2.8	0.175	↗
Hazard Classification	2.7	-0.0721	→
Production & In Service Support	2.6	-0.1853	↘
Safety & Suitability for Service Use (S3)	2.6	-0.0235	→
Occupational & Environmental Health	1.2	-0.0485	→
Electromagnetic Environmental Effects (E3)	0.7	0.0941	→
Interchangeability	0.2	-0.0338	→

* The criteria for the trend arrows are as follows: ↘↘ when A is below -1, ↘ when A is between -1 and -0.1, → when A is between -0.1 and +0.1 and ↗ when A is above +0.1.

The analysis shows that the topics Energetic Materials, Tests & Test Standards, and IM Characteristics have the highest average number of TQs per year, but also that the interest in these topics appears to be decreasing over time. Conversely, interest in Policies, Accidents & Causes, and Ageing & Health Monitoring appears to be increasing. We believe that MSIAC activities and involvement in these areas has created positive feedback, leading to awareness in the community of the possibility to ask such questions. The increased number of TQs concerning Policies may be explained by the increasing complexity of the technical content in NATO ammunition safety standards.

Importance of TQs to the Member Nations

In January 2020, MSIAC conducted a survey of individuals who had submitted a TQ to MSIAC within the previous 12 months to determine their overall satisfaction with the service received. One of the questions asked respondents how important the MSIAC TQ service was to their nation. All respondents replied that this service was important, with 61% of respondents believing it to be "very important". Selected comments from respondents are presented below:

> *"This is for me an extremely important service which I highly appreciate."*
>
> *"Technical support at MSIAC provides incredible value to NATO and its mission."*
>
> *"It is an essential daily aid to deepen areas related to my* [professional] *activities…"*
>
> *"An invaluable resource."*
>
> *"It is really good to know that there are knowledgeable and experienced people you can ask questions to, in areas as specialised as these, and knowing they will provide an answer."*
>
> *"I have not used this service much, but it is extremely helpful to have when needed. The ability to have technical questions addressed, and discuss relevant topics and scenarios when there is uncertainty/lack of understanding/or looking to get feedback from others in the community with technical expertise is very helpful at times. All of which may help save time, and money."*

When asked if they would use the TQ service again, 100% of those surveyed responded "Yes".

How the TQs Have Directed the Work of MSIAC

By receiving TQs from across our member nations, MSIAC is in the unique position to identify areas of interest to the munitions safety community that would not otherwise be obvious: it is not unusual for MSIAC to independently receive a question on the exact same topic from two different nations within a short space of time. Through analysis of such trends, MSIAC can focus our technical efforts so as to provide the most benefit to the community. The following paragraphs describe how this is done.

Work Elements & Technical Reports

As part of the annual MSIAC strategic planning process, a number of work elements are defined. These work elements represent discrete packages of work, carried out by the MSIAC Technical Specialist Officers (TSOs), which support our strategic goals and objectives. In defining these work elements, observed trends in TQs from the preceding year are often used as a starting point to identify technical areas of interest to the community. Examples in the recent past include:

- Between 2015 and 2018 a total of 18 technical questions were received regarding the basis of Quantity Distances (QD) in NATO ammunition storage policy; this led to a new work element investigating the experimental and theoretical basis of QD. This in turn contributed to the development of a major update to the NATO policy for ammunition storage, for which

MSIAC worked closely with the technical community in AC/326 CNAD Ammunition Safety Group.

- In 2019 and 2020 an increased number of TQs were received on the topic of Electromagnetic Environmental Effects (E3); this led to two new work elements and three technical reports involving this topic: L-263, L-264 and L-265.
- In 2020 and 2021, several TQs were received on the topic of novel national approaches to S3 assessment. A work element was subsequently established to allow further investigation of this area.

There are other circumstances where the establishment of a new work element is not warranted, but the answer to a TQ is still considered to be of interest to the entire community. In such cases, the TQ response may be transposed into a technical presentation at an international symposium and/or into an MSIAC Technical Report (Limited or Open distribution). The development of a TQ into a Technical Report usually involves an expansion of the discussion and inclusion of additional references; in some cases, a number of TQ responses on similar topics may be combined to form a Technical Report. The full list of the 450+ MSIAC Technical Reports is available on our website.[2]

Workshops and Technical Meetings

There may be occasions where the topic raised by a TQ is too great in scope to be addressed by MSIAC staff directly, but is considered to be of interest to the community at large. In such circumstances, the TQ may form the basis of an MSIAC-hosted workshop or technical meeting, wherein subject matter experts from across the member nations can come together to collaborate on a solution to the problem.

For example:

- The topic for the 2021 MSIAC workshop “Defects – Causes, Classification & Criticality” originated from a TQ received in 2017;
- The upcoming 2021 MSIAC technical meeting on explosive substances and articles belonging to Hazard Division 1.3 is based on a number of TQs received in recent years on this topic.
- The upcoming 2021 MSIAC technical meeting on Hazards of Electromagnetic Radiation to Ordnance (HERO) is based on a number of technical questions received in the last few years related to the derivation of safe separation distances and HERO risk mitigation for wireless devices and the general philosophy and methodology behind HERO certification testing of munitions.

Looking Forward

“It is difficult to make predictions, especially about the future.”

As well as directing the immediate work of MSIAC technical staff, the technical questions we receive give us a valuable insight into emerging technological trends and other areas of concern driven by strategic factors. While it is challenging to predict with any certainty the exact concerns of the munition safety community 30 years from now, we can at least make general predictions as to the potential topics of interest in the immediate future.

Legislation

As has already been seen with the introduction of the REACH regulations in the EU, the use of many substances commonly found in energetic materials and munition systems has been effectively banned

[2] https://www.msiac.nato.int/products-services/publications-technical-reports

due to concern about their impact on human health and the environment. There have already been challenges associated with identifying suitable replacement materials which offer equivalent levels of safety and performance, and with mitigating second-order effects (e.g. increased barrel wear with different materials). As more substances of concern are identified, MSIAC can expect an increased interest from the community in identifying alternative materials, as well as alternative methods of achieving the same effect.

Risk Tolerance

Societal opinion on the tolerability of risk has changed considerably over the last 60 years; at the same time, several high profile accidents have shown how operational capability can be quickly compromised through a combination of inadequate planning, unsuitable materiel, and ineffective precautions. These issues are exacerbated by the ever increasing constraints on defence budgets, and the removal of the immunities to prosecution under health and safety legislation that have traditionally been afforded to government agencies and employees.

From a materiel perspective, it is already apparent that a greater degree of rigour is being applied to the judgment of initial and ongoing safety and suitability for service, both from the robustness of the safety arguments that are made, as well as the fidelity with which environmental exposure and remaining safe life are assessed. Activities such as Munitions Health Management (MHM) are an indicator of the direction of travel, and although the benefits of this approach are clear, a key barrier to adoption is likely to be the requirement to prove that benefits such as increased useful life outweigh the cost of collecting the required data. MSIAC TSO's expect to receive more questions in this area.

From an operational safety perspective, MSIAC is already contributing to the international effort to review the basis of NATO ammunition storage policy, some of which was based on data collected over 70 years ago. Changing opinions on risk tolerability will necessarily lead to nations applying greater scrutiny to the technical basis of their own national ammunition storage policies, and will likely turn to MSIAC for guidance on this topic.

Emerging Technologies

The next 30 years will surely see the widespread adoption of new high-performance weapon systems – such as hypersonic missiles – that will subject energetic materials to challenging new shock, vibration and temperature environments which are not associated with contemporary weapon systems. MSIAC should expect to receive an increasing number of TQs concerning the continued safety of energetic materials when subject to these environments.

The next 30 years will also see the gradual introduction of weapon systems that do not rely solely on energetic materials: directed energy weapons and railguns are currently being researched, both of which operate on the direct application of electrical energy. While such technologies are unlikely to completely supplant the need for energetic materials, in the future consideration must be given to the threat posed by these new technologies to traditional munition systems. MSIAC have already answered two TQs concerning the direct effects of electromagnetic radiation on energetic materials; the answers to these question resulted in the publication of an MSIAC Technical Report, and delivery of an award winning presentation at the IMEMTS conference in 2019.

While it is difficult to predict the likelihood of discovery of useful new energetic molecules, we are already starting to see disruptions to traditional manufacturing processes which will result in reduced costs, enhanced performance and increased safety. As an illustration, a number of technical questions have been recently asked by the MSIAC community on flow chemistry, additive manufacturing, Resonant Acoustic Mixing (RAM), machine learning and quantum chemistry. As the research related to these techniques is currently rapidly evolving, MSIAC TSO's expect to receive many more TQs on these topics.

Disposal and End-of-Life Concerns

Historic munition disposal practices (e.g. sea-dumping, burial, open burning and open detonation) as well as the generation of duds during training exercises have both led to TQs concerning the safety of munitions and energetic materials exposed to adverse environments for extended periods of time. While we should expect to continue to receive such questions, changes in legislation and heightened environmental awareness of the population will likely lead to an increased interest in safe and environmentally sound methods of munition disposal, as well as best-practices in considering disposal during initial munition design activities.

Conclusion

Over the last 30 years, MSIAC has answered 3,000 technical questions posed by our member nations on a wide range of topics. Our responses have contributed towards the development of national and international munition safety policy, as well as supporting the ongoing munition safety efforts of our member nations.

As a member nation funded and directed initiative, MSIAC is in the fortunate position to be able to rapidly respond to the changing technical interests of the community; to this end, the technical questions we receive give us a valuable insight into technological trends, as well as other emerging areas of concern driven by strategic factors.

We look forward to the challenges that the next 3,000 technical questions will bring, and continuing to support munition safety.

Matt Ferran
TSO Munition Systems

Ernie Baker
TSO Warheads Technology

Chris Hollands
TSO Energetic Materials

Chuck Denham
MSIAC Project Manager

Martijn van der Voort
TSO Munitions Transport & Storage Safety

Christelle Collet
TSO Propulsion Technology

Kevin Jaansalu
TSO Materials Technology

The MSIAC TSOs would like to acknowledge the incredible support of the office staff who make our work possible.

Angeline Liekens
Information Specialist

Dimitris Tsoukalos
IT Manager

Diane Vanoverstraeten
Office Manager

For contact details, or more information on a wide range of topics related to munitions safety visit our website:

www.msiac.nato.int