IMEMG'snews

INSENSITIVE MUNITIONS EUROPEAN MANUFACTURERS GROUP

## EDITORIAL

**Pierre Olivier Vignaud**
*President*

The first vocation of IMEMG is to gather the Insensitive Munitions stakeholders and make them better connected and aware of each others constraints and expectations for the benefit of all in terms of harmonization. The second IM Day taking place in London in June this year is one of the best illustrations of this goal. Will participate to the event:

- National and international organisations in charge of ammunition safety regulation including NATO, EDA, UN
- Domestic and transnational defence procurement agencies
- Ammunition industry
- Governments and companies test centres
- Armed forces (Army, Navy, Air Force)

IMEMG also aims at promoting the emergence of new IM technologies. The Insensitive Munitions and Energetic Materials Technical Symposium (IMEMTS) is the meeting of reference in the field. As it was the case for Bordeaux in France (2001), Bristol in UK (2006) and Munich in Germany (2010), the 2015 European edition will be organised by IMEMG in Rome, Italy from 18 to 21 May 2015. We trust it will be a big success with participants from all over the world. In the meantime, no need to wait for that date to stay in touch with the latest news in the field of IM: the next IMEMTS conference takes place in October this year in San Diego, Ca. USA.

Now, let us find out the recent incomes of the works of the 20 European armament companies committed to IMEMG.
Have a pleasant reading.

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## ASSIM: A software to Help with IM Specifications

**Pierre-François Péron, *DGA/Munition Safety Office***

The IMEMG Cost & Benefit Analysis Group is designing a software tool, called ASSIM, that aims, as indicated by its acronym, at becoming an Assistant to Specify a Signature for IM/MURAT. ASSIM can help the user to define IM requirements. It takes into account the whole life cycle of the munition, the aggressions the munition may be subjected to, the aggression occurrence probabilities in the different life cycle phases and the consequences of a munition reaction (type I to type V) on the personnel, the assets and the environment. This analysis enables the user to assess the level of hazard or risk that he judges as acceptable for each IM aggression and to define the corresponding reaction types for his requirements.

Although ASSIM main features were developed nearly a decade ago, the process to specify an IM signature is close to that described in the new French MURAT policy **(Ministerial Instruction n°211893)** and implemented in the IPE instruction n°1184: use of a munition life cycle, definition for each IM aggression of a reaction level that is acceptable by the Armed Forces based on the life cycle and hazards.

A beta version of the software has been presented to representatives of the DGA MURAT community in March 2013 to get some feed-back on the software usefulness. The presentation showed that this software offers advantages in data handling to check the consistency of the information used to fill in the hazards and acceptable reaction levels. It also makes it easier to study the influence of certain parameters (hazard severity, aggression occurrence probability, etc.) on the acceptable levels of reaction. It can also be used as a dialogue tool between the participants to the specification of an IM signature.

Improvements have been suggested, especially to take into account the specificities of the MURAT process described in the instruction n°1184:

- signature based on an hazard analysis, the IM state-of-the-art and logistical benefits brought by certain IM signatures;
- consideration of different IM signatures depending on the munition configuration (logistical, tactical, bare, etc.).

It should be noted that the instruction n°1184 enforces the IM signature to be defined by systematically considering all the aggressions whatever the phase of the life cycle.

ASSIM appears as an original tool whose use could provide a better balance between IM requirements and operational needs while pursuing the effort towards increased IMness of the munition stockpiles.

## Shaped charges standard: which one to choose?

Man portable weapons like RPGs equipped with shaped charges are one of the most proliferating threat on today's battlefields. Everyone agrees it is therefore a top priority to find an efficient way to protect our munitions from these threats during logistic and combat phases. However, when it is time to specify an IM international standard for shaped charges so that all new ammunition can be qualified with a mutually accepted level of IM response, IMEMG can testify there is a certain lack of consistency in the test procedure definitions.

The promulgated STANAG 4526 (ed2) cannot be used as a standardized reference for the following reasons:

- it is not ratified by all Nations;
- the 50 mm Rockeye Shaped Charge is not readily available and its performance is not correctly defined for determination of an equivalent Shaped Charge;
- test set-up is not clearly defined (conditioning plate, target nose, ...);
- each Test Center uses their own Shaped Charge and test procedure.

Recent feedback from Afghanistan and Iraq has led to a Threat Hazard Analysis review. Many National Authorities are choosing / designing specific Standard Shaped Charges which would be representative of numerous RPGs types:

- USA MIL-STD-2105(D) specifies a standardized 81 mm Shaped Charge;
- France has selected CCEB 62 Shaped Charge;
- Germany is developing a PG-7 replica.

IMEMG intends to support current harmonization efforts and wish to highlight the fact that STANAG 4526 should list a very limited number of approved Shaped Charge types and test set-ups:

- Shaped charges diameter would be sufficiently closed generating comparable aggressions, their performances would be precisely defined;
- Conditioning plate thickness and precise quality must be defined;
- Standardized stimulus: $V^2d$ could be ~ 140 $mm^3/\mu s^2$, its tolerance would be +/- 10 % or +/- 14 $mm^3/\mu s^2$;
- An optional standardized $V^2d$ would be defined taking into account THA results and existing IM technologies, it could be around 60 / 70 $mm^3/\mu s^2$, this would help to select less vulnerable compositions.

AC/326 SG B (former SG 3) has issued the MSIAC Work Requests Procedure about Shaped Charge Jet in June 2012; it considers same questions and reviewing ways for next STANAG 4526 edition. IMEMG's HA&C EWG is working to establish Best Practices for Shaped Charge Jet characteristics determination –comprehensive technical data pack including test set-up available for each NATO nation– and to improve test procedure. HA&C EWG will present a paper at the next IMEMTS (October 2013 – San Diego, USA).

**Kerosen used in FCO-test**
*(Courtesy to Saab Bofors Test Center)*

**LPG used in FCO-test**
*(Courtesy to WTD91, Meppen)*

## *IM testing and environmental issues: the case of Fuel Fire*

**Two main issues have been raised with Liquid Fuel Fire:**

- **Negative influence on the environment (smoke, ground pollution), see photo aside;**
- **High sensitivity to wind conditions, difficult to handle.**

### Is it time to change direction?

***"Where environmental concerns dictate, alternative fuel such as propane, or natural gas may be used if testing verifies that the overall test item heating rate, uniformity of spatial heating to the test item and type of radiation heat transfer duplicate those of the hydrocarbon fuel fire."*** **This is a quote from the NATO nations Proceedings of the Fuel Fire Experts II Meeting held in France at the end of September 2012, which also reflects IMEMG concern.**

**Emerging Liquefied Propane Gas (LPG) test facilities in Europe are currently being reviewed and compared. In addition work has started to define an instrumented "test dummy" to collect adequate information for comparing LPG/LFF results, as well as LPG/LPG results from different test facilities: heat fluxes, temperature levels, heating rates, etc.**

**IMEMG is working actively on the subject through a dedicated Expert Working Group on Harmonisation and Improvements of Fast Cook-Off test procedures. It gathers member companies from France, Germany, Great Britain, Norway and Sweden.**

# IM Signature: a "bankable" future?

**COST BENEFIT ANALYSIS (CBA)** and associated tools help assessing the cost linked to IM/MURAT introduction. Depending on the domestic policies, IM introduction is drawn by a regulation or customer requirements. CBA tools were initially developed to calculate the cost to comply with a required IMness level. The methods used consider the cost of ownership. They are balanced between the recurrent/non-recurrent costs (including development/qualification costs) and potential profits. The aim is to provide economic arguments to justify whether the required signature is "bankable" or not!

All those analyses are based on the ammunition ***life cycles:*** they have demonstrated that the earlier (ideally during development phase) the specified signature is taken into account, the more economical the IM/MURAT introduction is.
CBA approach has generated derivative tools not directly linked to cost calculations. Within this scope, IMEMG Expert Working Group on CBA started developing the help-to-decision tool ASSIM.

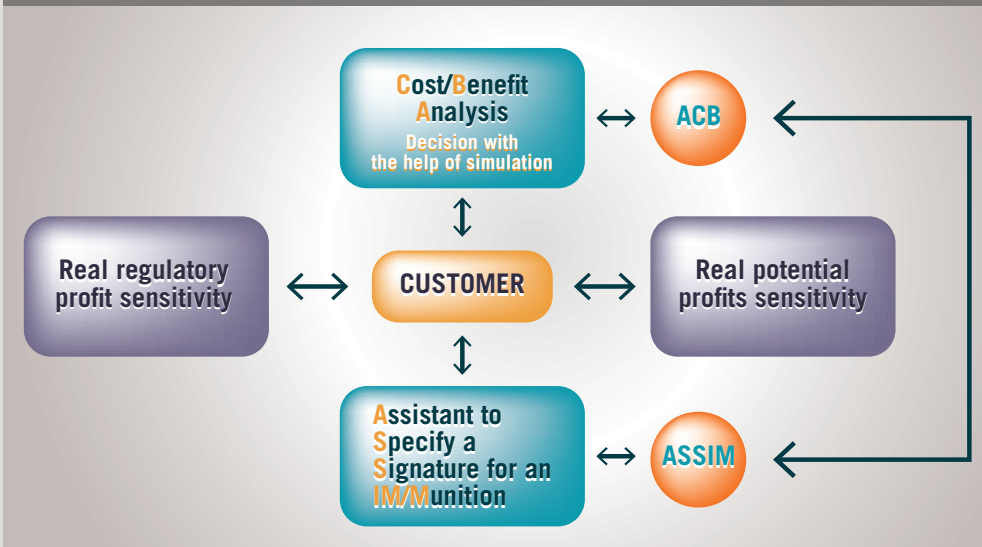
***For each elementary situation*** and for each STANAG 4439 threat, a reaction level is required, either by civilian or military regulations. The reaction level runs from I to VI for each threat. There may be different reaction levels requested for a given threat when considering the various elementary situations. At the end of this work, analysis starts: it consists in selecting only one reaction level for one threat (logically the most difficult to reach, e.g. the weakest reaction level for each threat).

Then, the signature requirement has to be compared to the technological responses provided by products with an IM signature supplied by manufacturers.
Analyzing the existing gaps will help take decisions. For example, let's consider a munition, which will encounter only one situation requiring a Type V reaction level for a FCO and three situations requiring a Type III during its whole life cycle. The technological solution proposed by the manufacturer only allows a Type III reaction level, the question is: do we need to go for an important development to obtain the difficult signature level to satisfy this hazard situation? Is it acceptable or not to risk encountering this isolated situation, thus specifying only a Type III instead of the desired Type V reaction level? Or, what steps could be undertaken to decrease the threat probability?
The easiest way to specify an IM signature is obviously to stick to STANAG 4439 compliance. It may thus involve unessential and costly requirements which ASSIM will allow to identify. Without any cost calculations, ASSIM is a useful tool promoting exchanges between manufacturers and customers/end users in order to justify the best compromise in terms of IM requirements. Different technological solutions could be assessed by this analysis. A true economic analysis is then facilitated via the work performed when building the ammunition life cycle. It can be valued again through the "conventional" CBA tool used as the last step of the argumentation.

***Example of a 120 mm HE mortar munition: life cycle phases***

| Life cycle phase | | Environment | Configuration |
|---|---|---|---|
| **Storage** | National | Peacetime (P) | Palette |
| | Logistical Storage | Operations (O) | Palette |
| | Tactical Storage | O | Tactical |
| **Transport** | Road | P | Box |
| | Road | P | Palette |
| | Road | O | Tactical |
| | Rail | P | Palette |
| | Sea | P | Palette |
| | Air (Aircraft) | O | Palette |
| | Air (Helicopter) | O | Box |
| **Fire** | Training | P | Tactical |
| | Combat Operation (vehicle) | O | Tactical |

## APPROACH



## IM Signature for Life?

The importance of IM properties being maintained throughout the service life of a munition has long since been recognised by IMEMG. Age-related changes to the intrinsic safety properties of energetic materials could affect the IM response of munitions in service. To address this issue, an Expert Working Group was created to study "The effects of ageing on the properties of energetic materials which could affect IM response". This group has members from AWE, BAe Systems, MBDA, Nexter Munitions, Roxel, Eurenco, DIEHL-BGT, Rheinmetall and SAAB Dynamics.

The Terms of Reference for the group are to:

- Analyse how energetic materials degradation can affect IM response
- Establish state-of-the-art with respect to ageing of energetic materials
- Identify data with which to validate the proposed failure modes
- Identify gaps in empirical evidence and knowledge
- Write a final report and make recommendations for further work

The group recognised that a wide range of energetic materials are used in IM applications (cast-cure PBXs, composite propellants, melt-cast IM formulations and gun propellants). However, the group have initially focussed on cast-cure PBXs while striving to develop a generic approach that could be applied when considering other energetic material types.

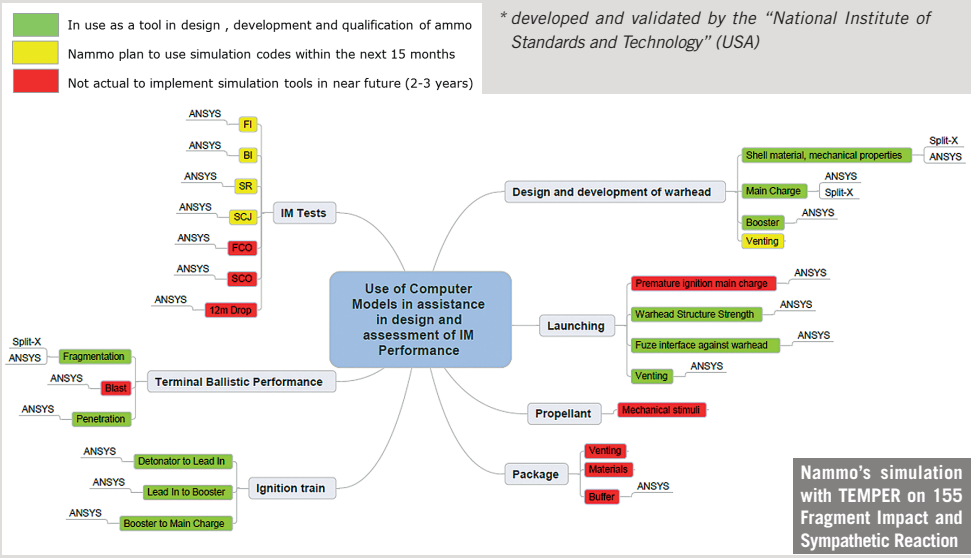
The group are utilising well-established techniques, including Fault Tree Analysis (FTA) and Failure Modes and Effects Analysis (FMEA), to establish the links between energetic materials properties and IM response.

Cast-cure PBXs were developed with the intention of being chemically and physically resistant to ageing under representative conditions. A preliminary conclusion of the work so far is that the properties of a cast-cure PBX are unlikely to change in a way that affects IM response.

# A review of computer models to aid the design and assessment of IM performance

**After establishing a map of the areas where Computer Models would be of assistance in the design and assessment of IM performance, a précis of the applicability & capability of each available computer model is set up together with a gap analysis of the available computer models against this map.**

Participating companies presented their simulation software tools which are developed by themselves or are based on commercial software. Several members of the group had evaluated TEMPER, developed by MSIAC, which is a powerful tool to simulate scenarios of impact, sympathetic reaction and cook off events. "TEMPER is a valuable tool especially for the initial tests of development" said those who studied it. The group members exchange their experience with respect to simulation activities but also with respect to their IM testing capabilities. Procedures to deal with FCO scenarios by using empirical laws, FEA and combining both methods were also reported. "Fire Dynamics Simulation" (FDS), a public domain software* is a tool to simulate fundamental fire dynamics and combustion. FDS is also an option selected when simulating reactive processes to check how fire spreads after ignition by an explosion. There are plans to compare fuel fires with gas fires to proof whether the heat transfer is comparable. The objective of IM simulation is to reduce tests to a minimum by understanding better the effects and reactions of IM threats. All of the participating companies want to extend their IM simulation capabilities. A gap with respect to model IM behaviour of propellants has been stated. In the near future some companies will therefore develop ignition and growth models for propellants.




* *developed and validated by the "National Institute of Standards and Technology" (USA)*

**Nammo's simulation with TEMPER on 155 Fragment Impact and Sympathetic Reaction**

## In your diary

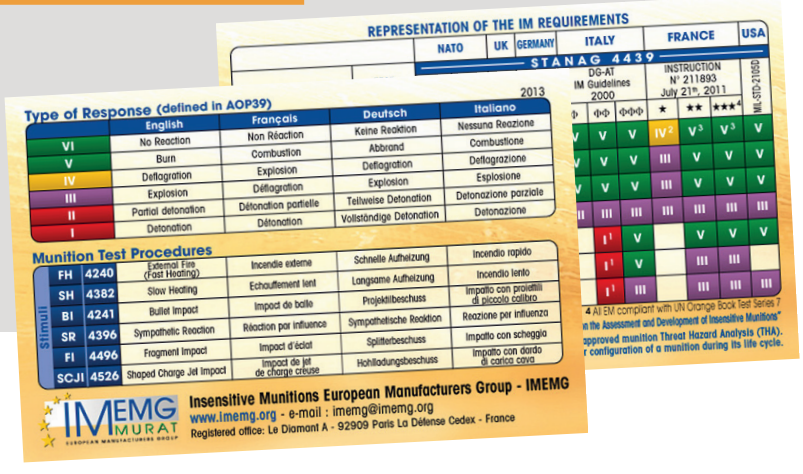
NEWS

The 2015 IM&EM Technical Symposium will be held in Rome, Italy on 18-21 May 2015.

NDIA IMEMG MURAT MSIAC

## IM Card: latest version

IMEMG presents its IM card which compares the different national regulations of the member companies and the test requirements for the IM.





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