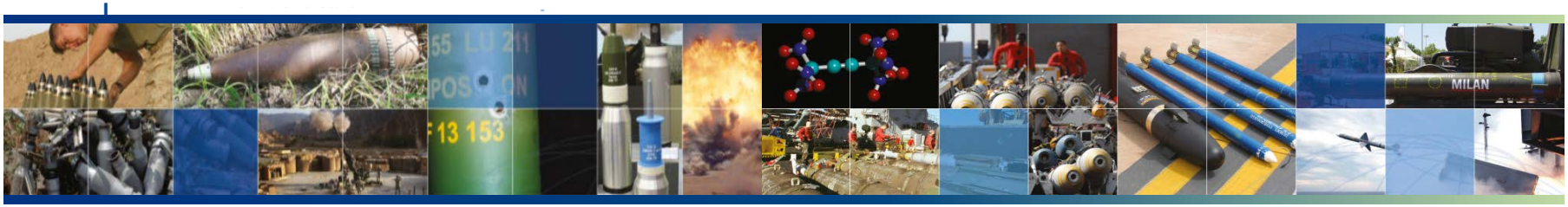
MSIAC

Munitions Safety Information Analysis Center

Supporting Member Nations in the Enhancement of their Munitions Life Cycle Safety



MSIAC Workshop 2018:
Improved Explosives and Munitions Risk Management

IMEMTS, Portland, 23-27 April 2018

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Improved Explosives and Munitions Risk Management
Granada, Spain | 10 - 14 September 2018

IEMRM 2018

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IEMRM 2018

- Unclassified workshop open at no cost to government, industry and academia representatives from all MSIAC member nations

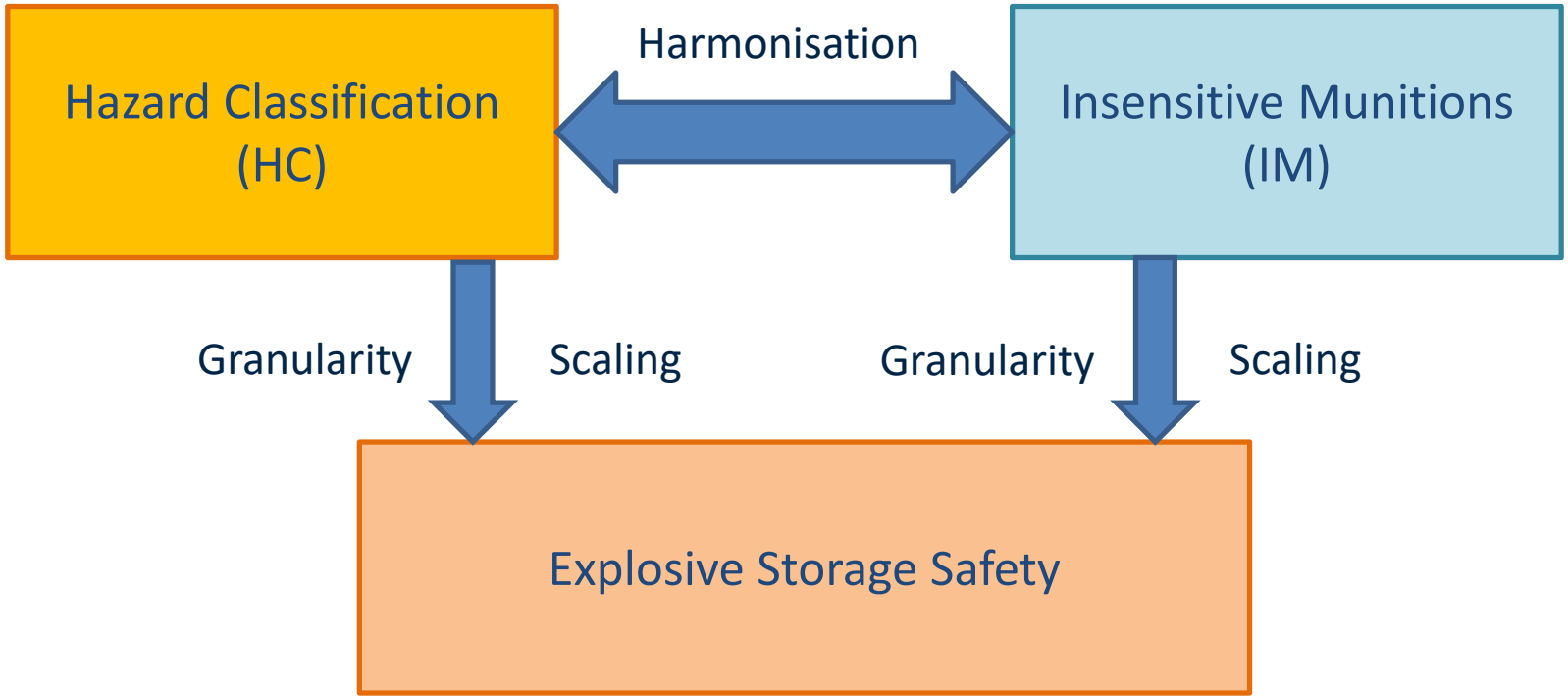
- Limited to 65 participants. In the event of oversubscription, MSIAC will work with the National Focal Point Officer(s) from the nations to balance participation.

- Visit MSIAC IEMRM workshop page!
  - Call for papers extended until April 30
  - Registration just opened
  - Take part in IEMRM Webinar, May 24, 15:00 CET

- Workshop will have various plenary sessions and parallel session (focus areas) and will host a dinner (Tuesday evening) and a visit to General Dynamics European Land Systems, GDELS (Wednesday afternoon)

Improved Explosives and Munitions Risk Management

This workshop seeks to exploit an improved understanding of munitions vulnerability and consequences to deliver improvements in munitions risk management



Objectives

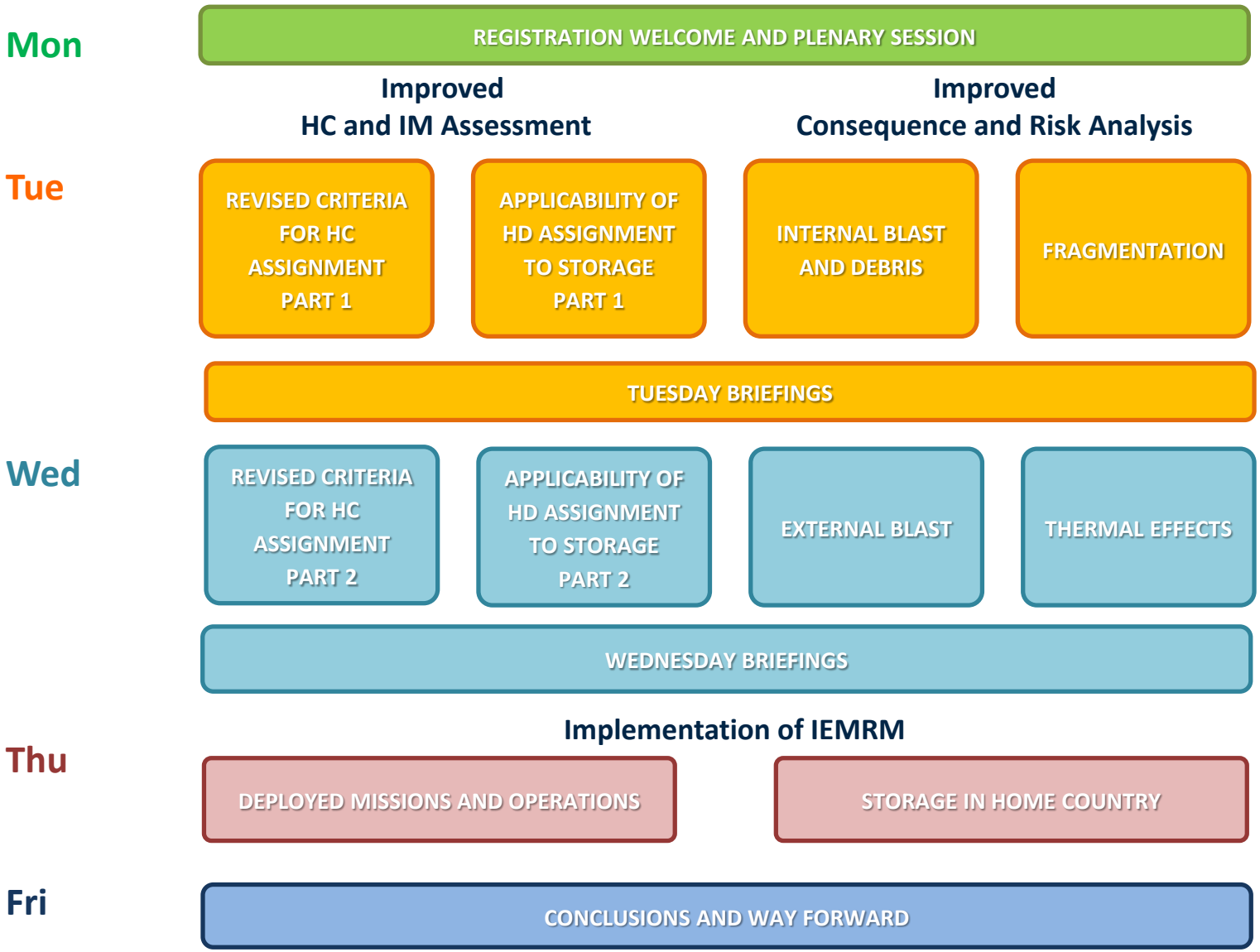
- **Support** the IM and HC harmonization initiative
  - Identify how response descriptors can be introduced in HC testing
  - Identify whether there's a need for revised definition of Hazard Divisions (HD) and Storage sub Divisions (SsD)

- **Develop** improved methods for explosives and munitions risk management
  - Exploit results from small- and full-scale testing
  - Manage risk with sufficient detail and granularity
  - Realize benefits of IM
  - Efficiently manage munitions presenting the greatest hazard

- **Recommend** improved methods for explosives and munitions safety risk standards
  - Ensuring they reflect the changing nature of the munitions stockpile
  - Balancing complexity versus ease of user application

Preliminary workshop structure

Supporting Munitions Safety



MSIAC Technical Preparation

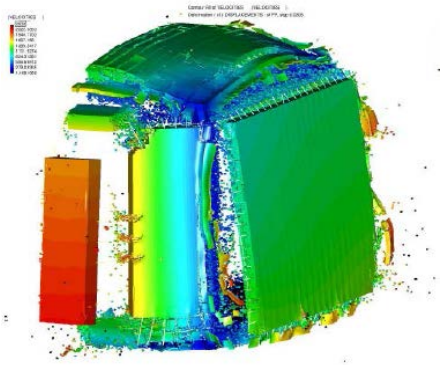
Plenary session presentations:

- Workshop introduction (MV)
- Lessons learned from Cook-Off Workshop & scaling effects (MA, MV)
- Operational aspects and limitations (MP)

Session papers and presentations:

- HC & IM harmonisation (MS, MP)
- Warhead fragmentation (EB, WB, MV, CC)

- Internal blast loads and debris (MV)
- External blast and TNT equivalence (CC)



Input from Nations

Abstracts already received:

- The Detonative Reaction Behaviors of Minimum Signature Rockets Subjected to Fragment Impact (Mark Pfeil, AMRDEC, US)
- Numerical Modeling of Explosively Loaded Concrete Structure Using a Coupled CFD-CSD Methodology (Michael Giltrud, ASI, US)
- Characterization of debris throw from structural components subjected to dynamic loads (Johannes Schneider, EMI, DEU)
- Physics-based injury models for improved explosives and munitions risk management (Dr. Malte von Ramin, EMI, DEU)
- Many more have been discussed

And more….

- Lessons learned from International Explosives Safety Seminar (August 2018) by (Dr. Josephine Covino, DDESB, US)
- Input from the AASTP-4 Custodian Working Group by (Hans Oiom, NDEA, NOR)
- ……..

Revised Criteria for HD assignment

Current HC system loosely defines explosive effects

Differences in Hazard Divisions (HD) between nations possible

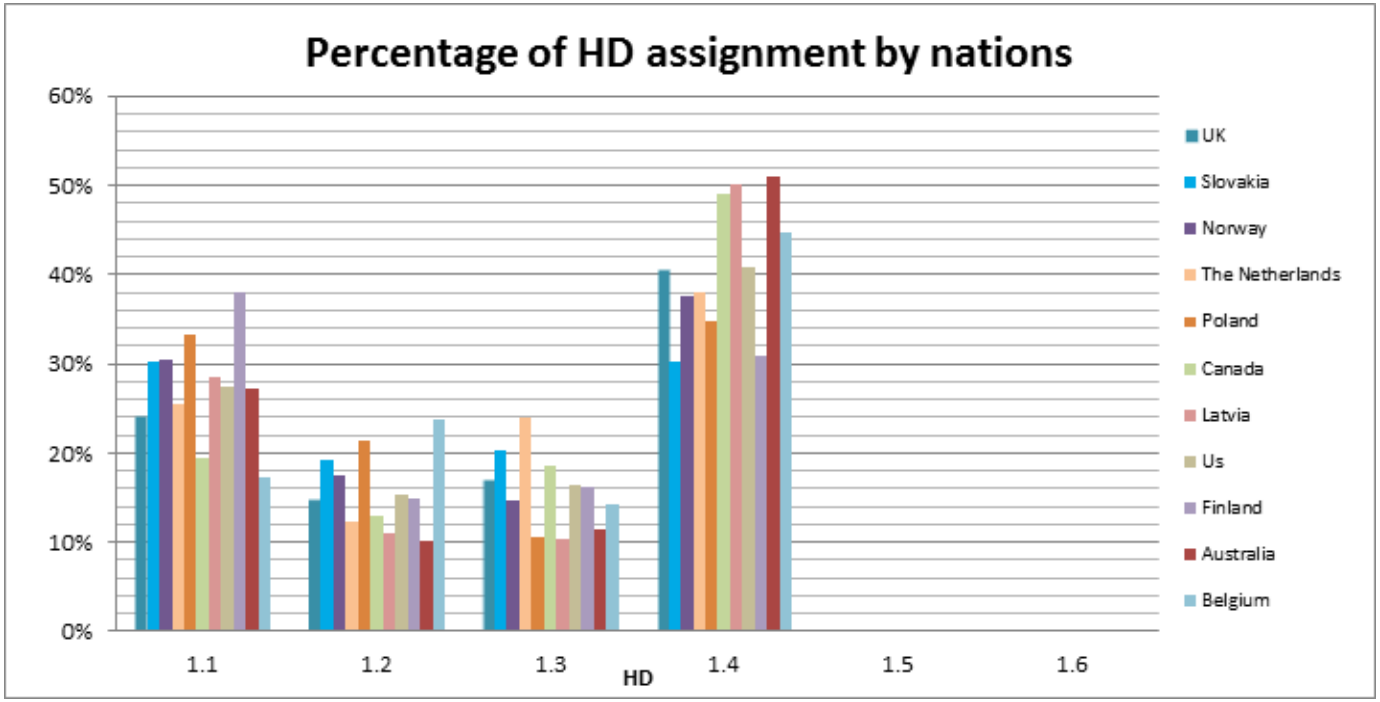
	Munitions Response
I	Detonation
II	Partial Detonation
III	Explosion
IV	Deflagration
V	Burn
VI	No Reaction

- Can IM response descriptors be introduced in HC testing* and what would be the implications?

**this was already done for test series 7 used to classify HD1.6*

Revised Criteria for HD assignment

Current HD & SsD may not be ideally representing the current and future munitions stockpile

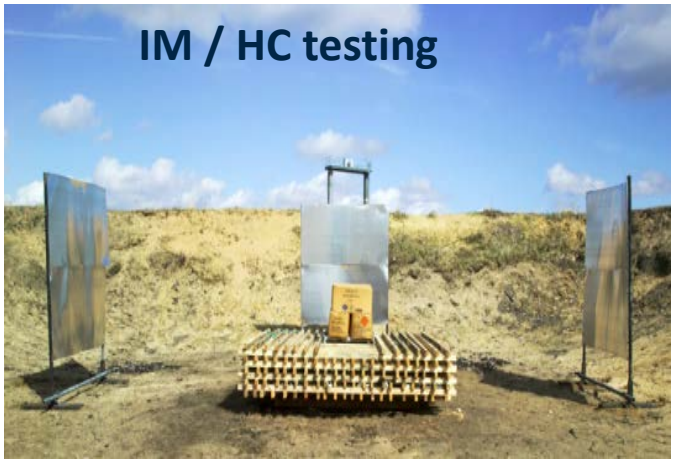


Study of International Hazard Classification, Leroy (2017)

- Is it necessary to revise the definitions of HD & SsD and what would be the implications?

Applicability of HD to storage

HC (UN orange book) for transport also adopted for storage

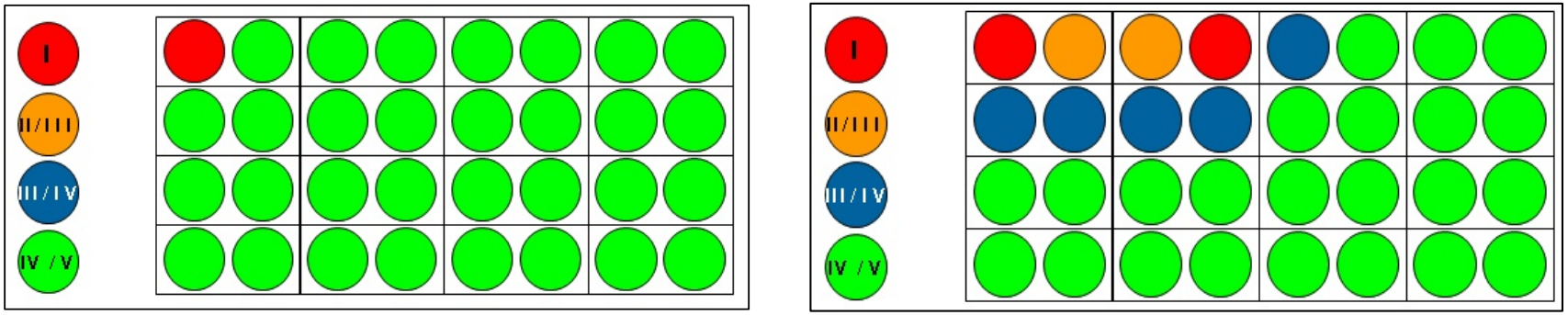


Scaling
Confinement

US propellant testing in concrete magazines, Farmer, et al. 2015

Applicability of HD to storage

Supporting Munitions Safety



105 mm HE IM shells, Edwards (2011), single shell detonation (left), two shell detonation (right)

- Can we develop improved guidance to clarify the applicability of HC assessments?
- What complementary information (related to scale and confinement) is needed to make a reliable estimate of munitions response in storage conditions?
- What information from the explosive (storage) safety community is needed?
- What is a sufficient number of test repetitions?
- Are there best practices?

Current risk management

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Hazard Classification

AASTP-3

Guidelines for safe storage of ammunition

Simple

Complicated

AASTP-1

Home country:
Quantity Distances (QD)

AASTP-5

Deployed operations:
Field Distances (FD)

If these cannot be met:

Explosives Safety Risk Analysis

AASTP-4

Detailed models

AASTP-5

Practical method

Explosives Safety and Munitions Risk Management (ESMRM)

ALP-16

Continuous process
To be conducted by ESO
As Low As Reasonably Practicable (ALARP)
Level of authority for risk approval

Current consequence and risk analysis

- Models primarily available for (mass) detonations
- Benefits of less violent munitions can't always be exploited

Munitions response descriptors (AOP-39)		Models available for consequence and risk analysis, e.g. AASTP-4?
I	Detonation	Yes
II	Partial Detonation	Yes/No (fraction that will detonate uncertain)
III	Explosion	No
IV	Deflagration	No
V	Burn	Yes
VI	No Reaction	NA

- What experimental data and models is required to quantify consequences and risks based on the response descriptors, in particular for Deflagration (type IV) and Explosion (type III)

Fragmentation

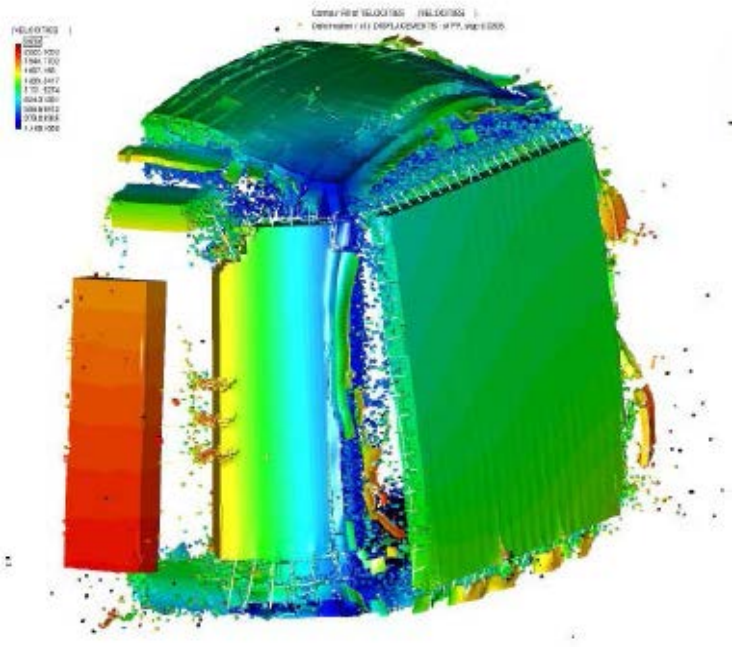
- What models need to be developed in order to quantify fragmentation effects for less violent munitions responses?
- What experimental data is needed to develop and validate these models?
- Is the concept of Maximum & Hazardous Fragment Distance (MFD and HFD) still valid as a basis for safe separation distances?
- What information is needed from the HC/IM community?

840 g steel fragment from a M107 155 mm artillery shell that reached 1824 m after a sub-detonative response.

Internal blast and debris

- What models need to be developed in order to quantify internal blast and debris effects for less violent munitions responses?
- What experimental data is needed to develop and validate these models?
- What information is needed from the HC/IM community?

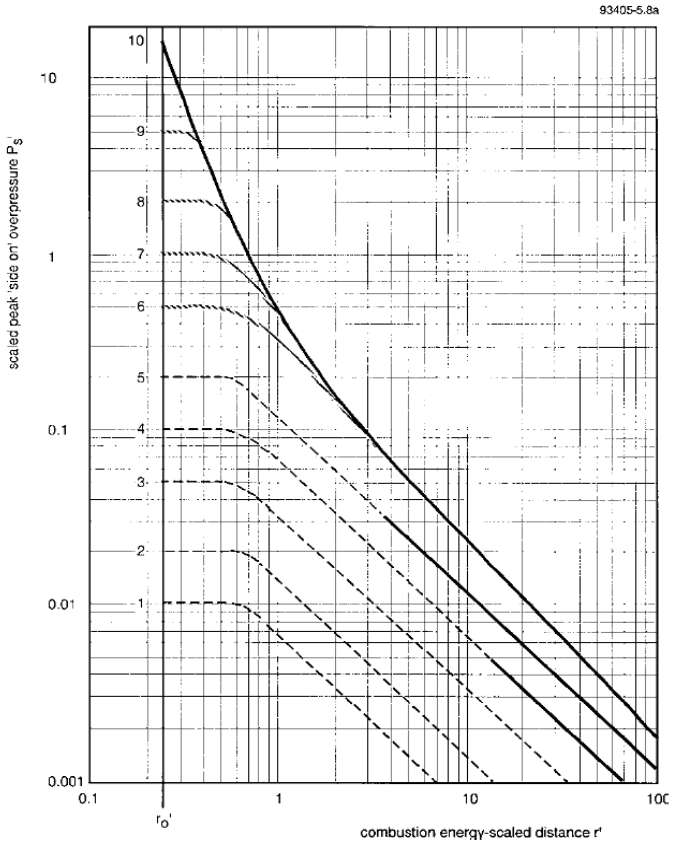
*High speed frame from Kasun test (*Grønsten)



Detonation in ammunition magazine (right) by Applied Simulations, Inc (ASI)

External blast

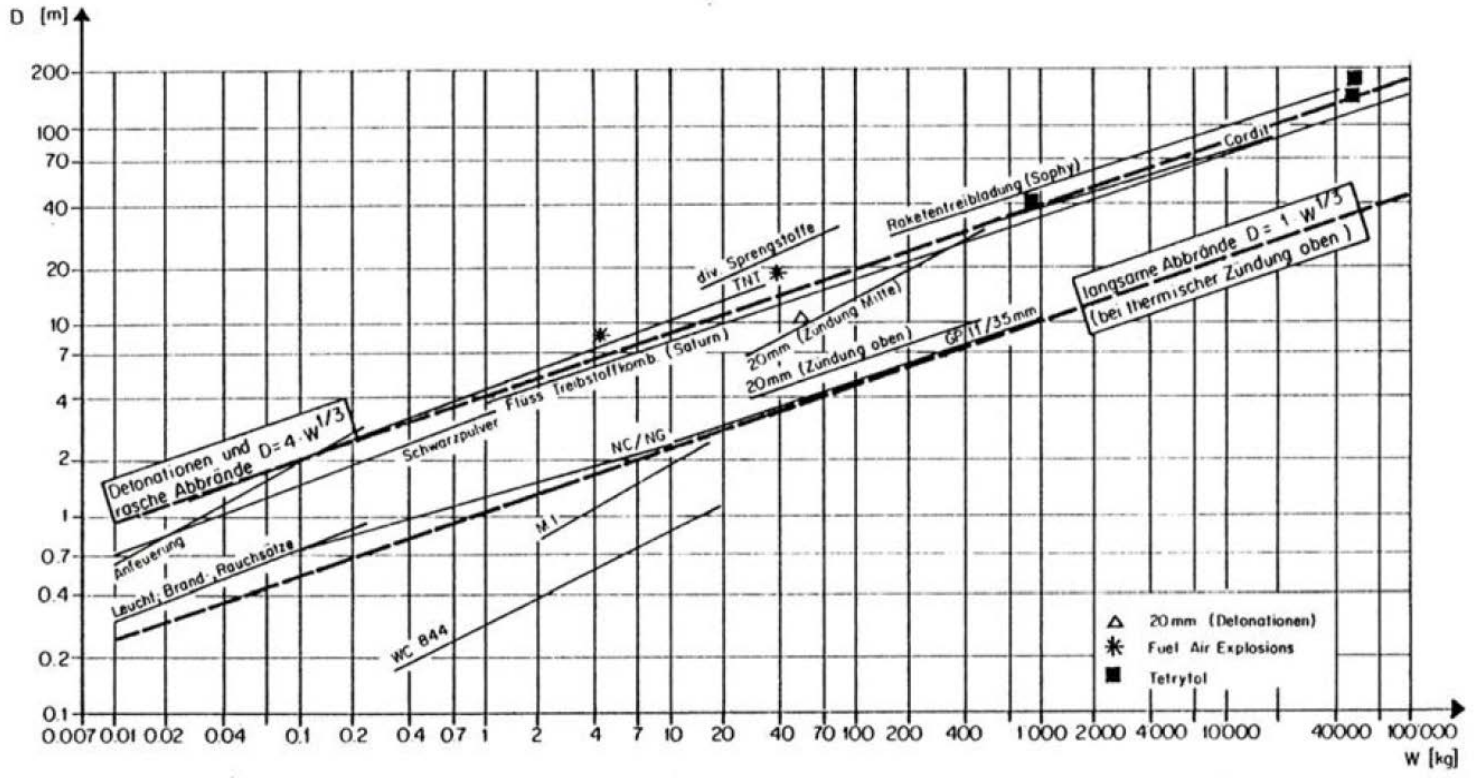
- What models need to be developed in order to quantify internal blast and debris effects for less violent munitions responses?
- Can TNT equivalency be used to model less violent responses?
- What experimental data is needed to develop and validate these models?
- What information is needed from the HC/IM community?



Multi-Energy blast charts [PGS2, van den Berg, 2004]. Curve 1 is a weak deflagration, curve 10 a detonation. Curves 6 to 9 (fast deflagrations) coincide with curve 10 in the far field.

Thermal

- What models need to be developed in order to quantify thermal effects?
- What experimental data is needed to develop and validate these models?
- What information is needed from the HC/IM community?



Fireball diameters for various propellants and explosives [AASTP-4, 2016]

Implementation of IEMRM

- Areas to be addressed:

- An increased granularity and detail could lead to more complex QD tables as well as consequence and risk analysis methods. As an alternative the introduction of **computer-based tools** into the standards could be considered. This will make application easier, and less prone to error, but also leads to a dependency on IT equipment which may be an issue e.g. during missions.

- More detailed methods could also lead to **munition specific** consequence and risk analysis. This will improve the reliability of the results, but on the other hand also limits the range of applicability.

Implementation of IEMRM

- In some cases assumptions made in standards prohibit progress. Currently AASTP-5 requires that all munitions are to be aggregated as HD1.1 in order to keep its application simple. This assumption should be challenged to **enable recognition of the benefits of IM** and **focus efforts on munitions which present the greatest hazard**.

- An **holistic approach** could be developed considering the cost and benefits of using **simplistic and conservative assessment** methods versus **more detailed quantitative assessment** methods. Dependent on the lifecycle phase and situation the most suitable approach could be selected.

Conclusions

The envisaged results of the workshop are:

- Revised approach to munitions hazards and risks in light of development and introduction of IM
- Improved methods for consequence and risk analysis
- Improved understanding of the true nature of hazards and risks and how this can improve ownership and associated costs

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