

INSENSITIVE MUNITIONS INDUSTRY CONTRIBUTION FOR STANAG AND AOP IMPROVEMENTS

IMEMG's Expert Working Group on
Hazard Assessment & Classification

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INTRODUCTION

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- At beginning, this work was initiated by the Survey Questionnaire on Insensitive Munitions Response Descriptors distributed by the MSIAC.
- It has given the opportunity:
 - to elicit feedback from IM designers about current AOP 39 ed3 implementation by test centers and various national authorities,
 - to point out, apparent or real, inconsistencies with others regulations and references.
- Following, continuing work has been fed by:
 - **MSIAC O-153** "Survey on Insensitive Munitions Responses Descriptors", which raised many interesting points;
 - **MSIAC O-167** "Analysis of the IM Type V Response Descriptor" which discusses potential changes to the current 20 Joules fragment energy threshold criterion for AOP39 ed4.

INTRODUCTION

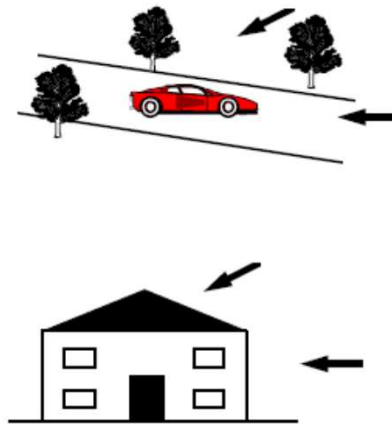
- AOP39 ed4 writing process is in progress, this work is a contribution proposed to NATO AC326 National Experts.
- Main topics detailed in presentation:
 - The **projection criterion** to pass Type V response,
 - The **propulsion effect assessment** to pass Type V response,
 - The mandatory Type V response for the **“Fire in an adjacent magazine, store or vehicle”** threat taking into account STANAG 4382 test conditions,
 - The mandatory Type V response for the **“Fragmenting Munitions Attack”** threat taking into account STANAG 4496 test conditions.



THE PROJECTION CRITERION

THE PROJECTION CRITERION

- In previous AOP 39 ed1 or ed2, for Type V, projection criterion was 79 Joules.
- The 79 Joules energy projection criteria is consistent with current AASTP-1,
 - Value is universally used to define Inhabited Building Distance (IBD)
 - Probability below 1% of being hit by such a hazardous fragment
 - it corresponds to one dangerous projection for 56 m² / 600 ft².



THE PROJECTION CRITERION

- In current **AOP 39 ed3**, for Type V, projection criterion is **20 Joules**.
- The **20 Joules Projection Criterion** for Type V Response, coming from UN Orange Book 6c Test, triggers several concerns:
 - This **20 Joules kinetic energy** is the initial energy and not the energy at the impact on a potential victims as it considered in lethality tables,
 - The **hit probability is not considered**; for example, a fragment, which is able to reach 100 meters, generates only $3 \cdot 10^{-5}$ hit probability.

THE PROJECTION CRITERION

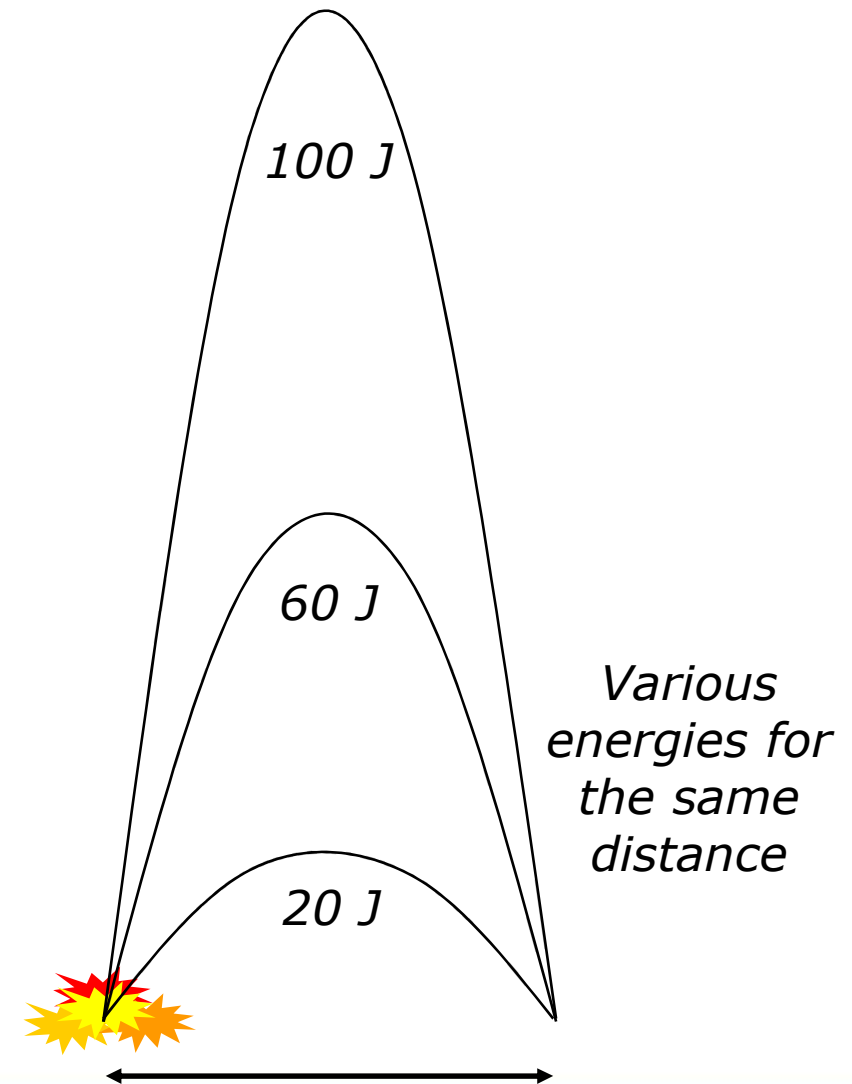
- The MSIAC O-167 "Analysis of the IM Type V Response Descriptor"
- IMEMG experts agree with the technical analysis and take the view that this report constitutes common technical reference for discussions.
- *Four possibilities for a way forward have been defined by MSIAC staff:*
 1. *Maintain distance-mass relation based on 20 J launch energy criterion,*
 2. *Change to distance-mass relation based on 20 J impact energy criterion at 15 m,*
 3. *Change to distance-mass relation based on 79 J impact energy criterion at 15 m,*
 4. *Change to distance-mass relation based on 79 J impact energy criterion at 15 m, combined with a 1% hit probability criterion at 15 m.*
- The MSIAC staff recommendation is to choose option 2.

THE PROJECTION CRITERION

- The IMEMG preference is to choose option 4 “Change to distance-mass relation based on 79 J impact energy criterion at 15 m, combined with a 1% hit probability criterion at 15 m”, for the following reasons:
- MSIAC’s TSO, Martijn van der Voort, has calculated that a 1% hit probability criterion at 15 meters corresponds to 25 projections.
 - Feedback shows that number of projection is generally below this value for burning reaction.
- For Dangerous Goods Transportation in civilian environment (UN Orange Book concern), in case of truck fire, it is desirable to protect civilian fire fighters at 15 meters, if they are not aware of potential explosive hazards, it is not the same for munitions environment.
- IBD allows civilians to be hit by 79 Joules fragment with 1% probability in case of event, which makes sense for acceptable risks.

THE PROJECTION CRITERION

- IMEMG experts are available to exchange about these considerations,
- *and also to define accurate methods to assess real impact energy :*
 - *mapping appears insufficient,*
 - *recording of trajectories seems strongly necessary.*





THE PROPULSION EFFECT CRITERION

THE PROPULSION EFFECT CRITERION

The Propulsion Effect is not sufficiently defined for Type V response:

- **in the text:** "There is no evidence of thrust capable of propelling the munition beyond 15m/50ft",
- **in the table:** "For rocket motor a significantly longer reaction time than if initiated in its design mode",
- The text indicates in fact a **moving effect** and the table a possible **real propulsion effect**.

THE PROPULSION EFFECT CRITERIA

- Distinction between **Type IV & V responses** consists to detect if a **moving effect** provokes a risk of fire propagation beyond 15 meters or not
- It could be pertinent to extent the maximum distance to **30 meters** like for energetic materials projections,
- For better understanding, it is desirable to indicate **Type IV "m"** in case of moving effect (limited to few ten meters) in the aim to explain the feared effect and keep **Type IV "p"** in case of thrust capable to propel the munition beyond few hundred meters or crosses magazine walls (*if this case was already observed*).

THE PROPULSION EFFECT CRITERIA

- *The most important concern for IMEMG is the **thrust measurement**:*
- Thrust transducers can run with axial propulsion effect but nothing is indicated in STANAG/AOP for lateral thrusts,
- Sole flames recording seems insufficient to quantify accurately propulsion effect (especially if only sub-system is tested)
- That introduces uncertainties between trials which are performed by various tests centers, and can cause distortion in IM Signatures.



THE TYPE V RESPONSE TO SLOW HEATING

SLOW HEATING

- Slow Heating Threat corresponds to "Fire in an adjacent magazine, store or vehicle" with heating rate from 1°C to 30°C per hour
- if an accidental scenario is able to heat munitions:
some hours, higher than 150 to 300°C (300 to 500°F),
- this scenario requires a **closed space**: magazine battleship, vehicle, storehouse, bunker, igloo...



SLOW HEATING

- is it pertinent to require Type V response ?
 - No-hazardous effects beyond 15 meters.
- i.e. it is reminded that the “20 Joules fragment” isn't able to go through only 2 mm thick aluminum sheet (*test 6c UN Orange Book ST-SG-AC10-11 Rev6*).
- i.e. Typical walls of warships ammunition stores are some 8 mm thick steel sheets ...
 - ➔ **Type IV seems be a sufficient requirement for such a threat !!!.**

SLOW HEATING

- *Principal idea to be studied :*
- An alternative option consists to perform the **Slow Cook Off test** in a “**standardized oven**” which reproduces confined space where the slow heating event can occur.
- This “standardized oven” would be : enough large and have few millimeters thick walls, typically it can be an **ISO container**, but also have an opening for combustion gases release.
- The Type V response descriptors can be assessed by effects which are observed outside of this “standardized oven”.
- Of course, the requirement is still Type V: No-hazardous effects beyond 15meters from the confined space.

THE TYPE V RESPONSE TO FRAGMENT IMPACT

FRAGMENT IMPACT

- Fragment Impact corresponds to "Fragmenting munitions attack",
 - Threat generated by the "Donor attack": **blast and fragments** to provoke severe damages and injuries to persons surroundings → **some dozens of meters or more ...**
 - is it really necessary to require Type V Response: no-injuries risk beyond 15m/50ft ?
- *Why Type III (or IV) response is not allowed as for the **Sympathetic Reaction Threat** and because its hazards are not more severe than the donor detonation effects?*

CONCLUSIONS AND PERSPECTIVES

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➤ **Projection criterion for the Type V response**

- prefer the option 4 proposed by MSIAC : "Change to distance-mass relation based on 79 J impact energy criterion at 15 m, combined with a 1% hit probability criterion at 15 m"
- also necessary to define accurate methods to assess real impact energy of various projections.

➤ **Propulsion effect criterion for the Type V response**

- could be "Munitions movement would be limited to around 30 meters to respect Type V response as for energetic material projections".
- in the case of a possible movement resulting in a Type IV reaction, it is preferable to indicate Type IV "m" (moving).
- strongly necessary to indicate how to evaluate accurately thrust effect / propulsion distance in future AOP or SRD.

CONCLUSIONS AND PERSPECTIVES

➤ **Slow Heating Threat :**

- Change the maximum response from Type V to Type IV, because the Type V effects are contained inside the confined space (magazine, store, vehicle ...),
- *Or define, for the Slow Cook off Test, a "standardized oven" reproducing such confined space and consider external hazardous effects for Type V response descriptors, this principal idea could be studied.*

➤ **Fragment Impact :**

- Change the maximum response from Type V to Type III (or IV), because hazardous effects of the threat itself largely overpass all tolerated effects of Type V response, it seems as pertinent to require similar response than for sympathetic reaction.

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For PowerPoint presentation :

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