

# INSENSITIVE MUNITIONS INDUSTRY CONTRIBUTION FOR THE AOP 39 RESPONSE DESCRIPTORS IMPROVMENTS

IMEMG's Expert Working Group on  
Hazard Assessment & Classification

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*[www.imemg.org](http://www.imemg.org)*

# CONTEXT

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**IM Policies** define an “ultimate goal” in term of IM Signature,  
in the aim to promote designing of “safer and safer munitions” ...  
*according to the available technologies ... (and to the costs ...)*

→ logical & pragmatic approach leading safety improvements !

*Unfortunately for authorities which are not involved in IM Community,  
“a munition which is not fully compliant with STANAG 4439 or UN 1.6HD is not  
IM and has to be considered as classical munitions”*

## CONTEXT

Today numerous munitions are partially compliant to STANAG 4439,  
and safety & survivability are really improved

→ Thus, it is very difficult to gain any “IMness benefits” during transportation  
and storage phases ...

→ Lack of IM identification generates ignorance and misinterpretations for  
Forces, IM or not ?!

“we don’t take into account IMness, it is too complicated !”

It is true specific regulations exist:

→ For military storage (according to nations), dedicated rules exist:

- NATO Sub-Storage Division 1.2.3
- French 1.2 Unitary Hazard Division,

bring only some virtual opportunities because often not used and ignored by civilian authorities,

→ *UN 1.6 Hazard Division is a very high objective unless for few exceptions.*

## CONTEXT

Present work has been initiated by:

MSIAC's Questionnaire for Survey on Insensitive Munitions Response Descriptors

→ O-153 MSIAC's report "Survey on Insensitive Munitions Responses Descriptors"

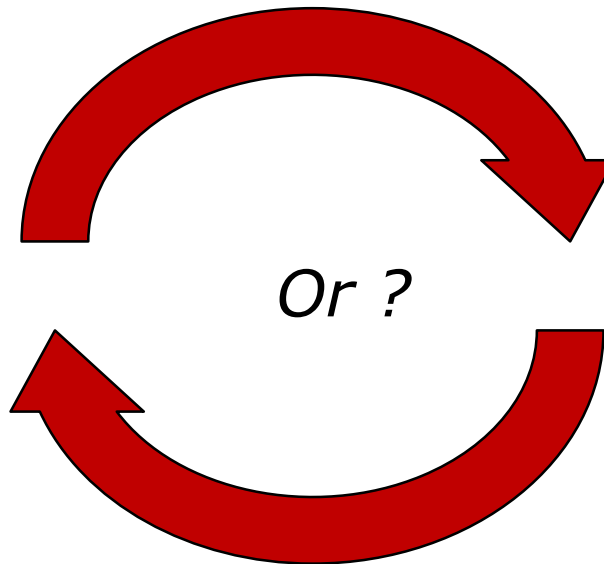
Opportunity to set-up current feed-back coming from the 21 IMEMG companies about the *AOP 39 ed3* implementation:

→ *Do current Responses Descriptors well adapted to assess correctly the IMness for each vulnerability threat and several munitions families?*

# REMARKS ABOUT STANAG 4439 ed3

Question has raised: *Does all Type V Response Descriptors  
Criteria always coherent with threat characteristics?*

*Over specification  
in STANAG 4439?*



*Few Type V response  
criteria too strict or to  
be better defined?*



## STANAG 4439 ed3

Threat	Requirement
Magazine/store fire or aircraft/vehicle fuel fire	No response more severe than Type V (Burning)
Fire in an adjacent magazine, store or vehicle	No response more severe than Type V (Burning)
Small arms attack	No response more severe than Type V (Burning)
Fragmenting munitions attack	No response more severe than Type V (Burning)
Shaped charge weapon attack	No response more severe than Type III (Explosion)
Most severe reaction of same munition in magazine, store, aircraft or vehicle	No propagation of reaction more severe than Type III (Explosion)



## STANAG 4439 ed3

- Slow Heating corresponds to "Fire in an adjacent magazine, store or vehicle",
- if an accidental scenario is able to heat munitions many hours, higher than 150 to 300°C (300 to 500°F),
- this scenario requires a closed space: magazine battleship, storehouse, bunker, igloo...,
- is it really necessary to respect all the Type V requirements ?
  - No-propulsion effect,
  - No-projection (20J @ 15m/50ft).

## STANAG 4439 ed3

- It is reminded that the “20 Joules fragment” isn't able to go through only 2mm thick aluminum sheet (*test 6c UN Orange Book ST-SG-AC10-11 Rev5*).
- 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 !!!



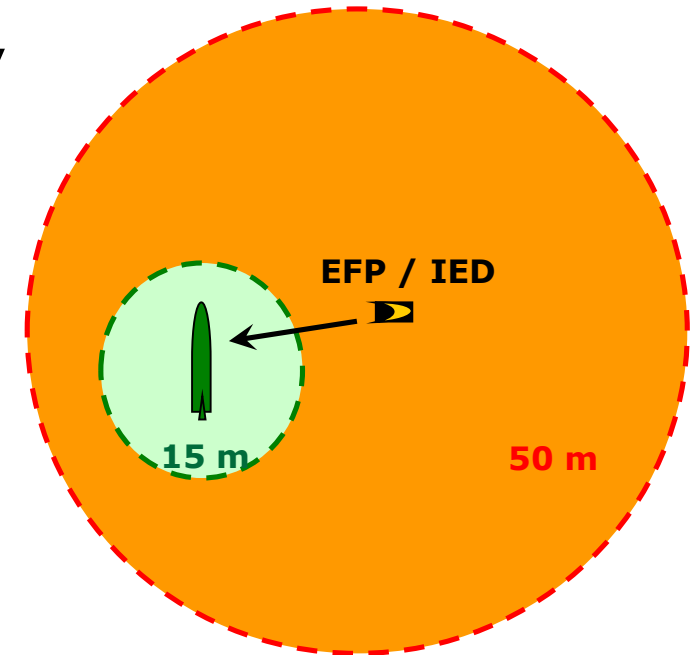
## STANAG 4439 ed3

- Fragment Impact corresponds to "Fragmenting munitions attack",
- Only IED (Improvised Explosive Device) or "few specific missiles" able to propel **18.6g fragment @ 2530 m/s (8300 ft/s)**,



## STANAG 4439 ed3

- Threat generated by the "Donor": blast and fragments to provoke severe damages and injuries to persons up to 50m /160ft,
  - is it really necessary to require Type V Response: no-injuries risk beyond 15m/50ft ?
  - Insensitive Munition as "Acceptor" cannot deliver any 20 Joules projection while STANAG 4496 Fragments delivers 60,000 Joules kinetic energy;
- ➔ *Why Type IV response is not allowed because its hazards are not more severe than the donor detonation effects?*





# COMMENTS ABOUT AOP 39 ed3 RESPONSE DESCRIPTORS

## AOP 39 ed3 Response Descriptors

- **Casing rupture criteria** are defined for steel casings and not at all for composite envelopes or even for forged aluminum casings,
- i.e. the forged aluminum fracture due to an impact can correspond to the type III or IV response descriptors even if the energetic material doesn't react.
  - ➔ *Today, it is desirable, but expensive, to perform preliminary tests on inert items to determine aggression effects ...*

## AOP 39 ed3 Response Descriptors

- Munitions can be tested in **packaged or unpackaged configurations**:
  - if the package is strong, the aggression may be mitigated,
  - if the munition burns (Type V), gases can pressurize the package until it bursts into fragments,
- ➔ *how to consider these packaging projections, is a part of the "munition response" or not?*



## AOP 39 ed3 Response Descriptors

The **Propulsion Effect** is not sufficiently defined:

→ "There is no evidence of thrust capable of propelling the munition beyond 15m/50ft" (in the text)

→ "For rocket motor a significantly longer reaction time than if initiated in its design mode" (in the table)

→ So, information for platform survivability assessment is missing, it is important to identify:

*if propulsion effect is a 20m/65ft shifting or 2 kilometers flight (in comparison with a 40 kilometers range motors).*

→ *Additional remark : missile motors are generally tested separately, it is possible to observe a propulsion effect which is insufficient to move the complete missile.*



# THE 20 JOULE PROJECTION CRITERIA

## THE 20 JOULES PROJECTION CRITERIA

- The 20 Joules Projection Criteria for Type V Response, coming from UN Orange Book 6c Test, triggers several concerns:

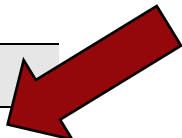
The 20 Joules kinetic energy is the initial energy and not the energy at the impact on potential victims.



## THE 20 JOULES PROJECTION CRITERIA

UN 6c test / AOP39 ed3		IMEMG Calculation		
Mass	20J Projection Distance	20J Initial Velocity	Projection Distance	Impact Energy
(g)	(m)	(m/s)	(m)	(J)
25	83.6	40.0	85	7
50	58.4	28.3	58	11
75	44.4	23.0	44	13.5
100	35.6	20.0	35	15
125	29.8	17.9	29	16
150	25.6	16.3	25	17
175	22.43	15.1	22	17
200	20	14.1	19	17,5
277 <sup>(*)</sup>	15	12.0	14	18
300	13.9	11.5	13	18.5
400	10.9	10.0	10	19
500	8.9	8.9	8	19

(\*) Calculated value for projection at 15 meters.



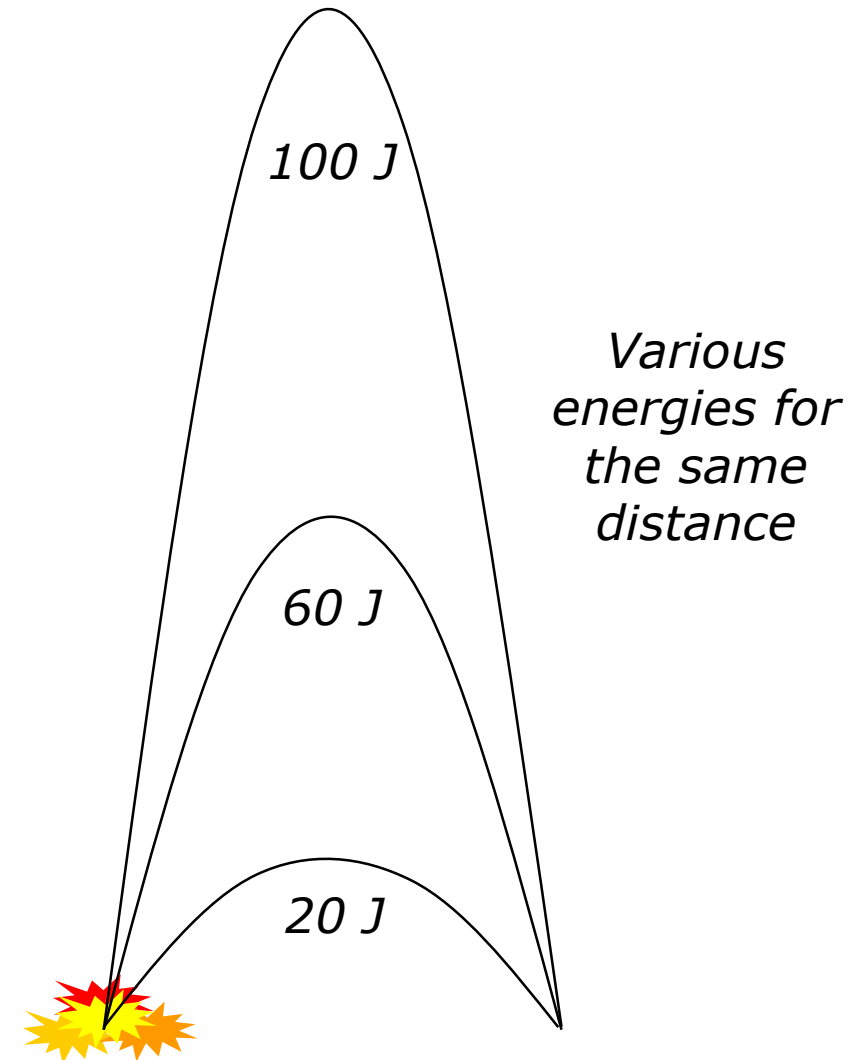
## THE 20 JOULES PROJECTION CRITERIA


➤ But i.e. a 100g projection can respect the AOP39 maximum distances (35m/115ft) with an impact energy reaching 100J,

➔ This introduces uncertainties between trials, due to projection distance criteria: a munition response can be declared :

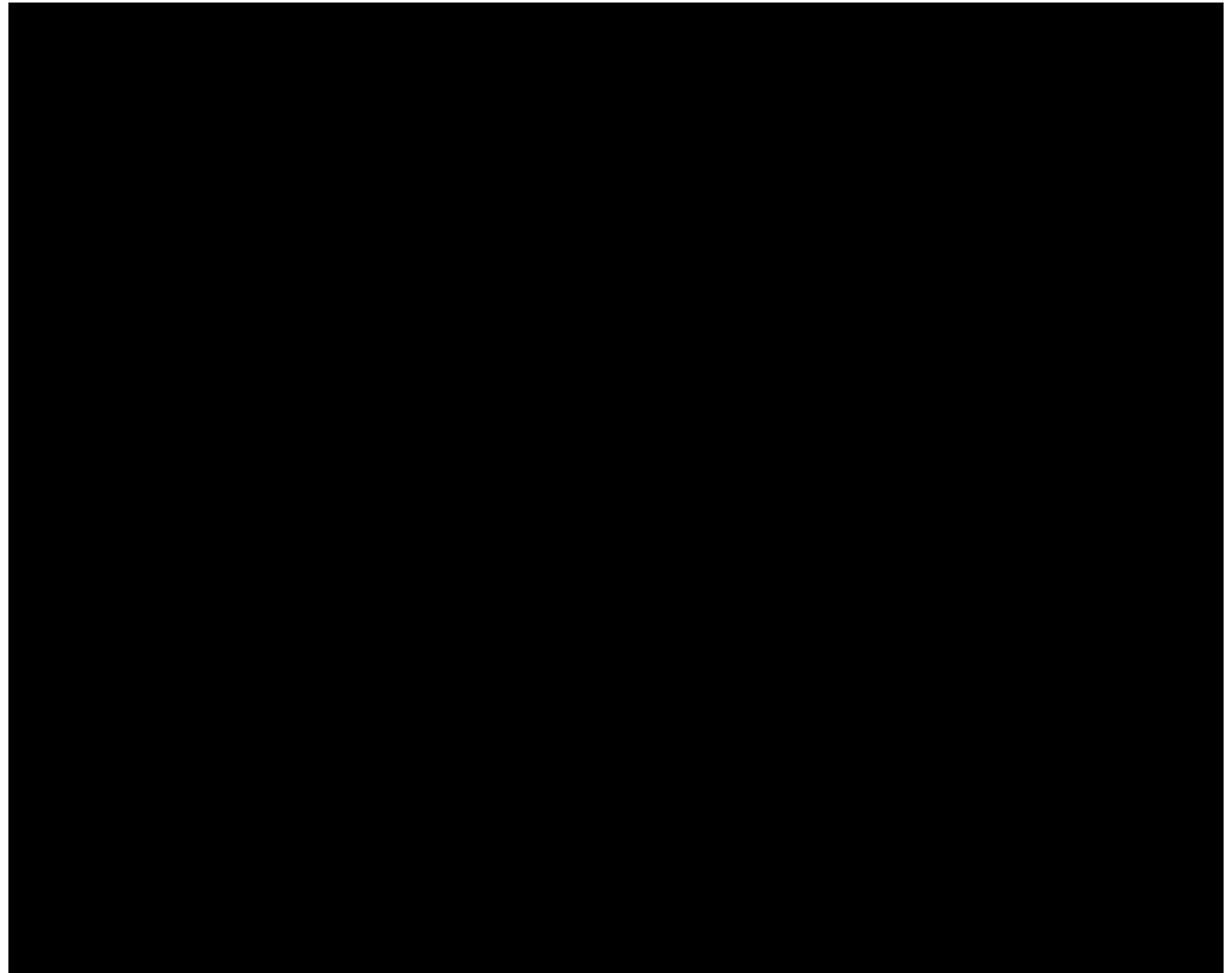

Type IV or V

without taking into account the real physical effects.





Difficulties to mitigate  
responses of pressurized  
volumes about  
projections



## THE 20 JOULES PROJECTION CRITERIA

- IMEMG paper has been presented during a previous IMEMTS :
- ➔ 3 liters of water in 220 liters barrels, submitted to the UN 6c test wood fire, has to be assigned to a Type IV response, *the cover plate (2.5 kg / 5.5 lb) has been propelled too far (22 m / 72 ft) !!!*
- This explains difficulties to mitigate responses of pressurized volumes about projections



## THE 20 JOULES PROJECTION CRITERIA

In leisure world, Airsoft gamers are playing with gas guns able to propel 0.68" projectiles with up to 40 Joules launching energies.

➔ This allows comparison in terms of projection energy especially for non metallic fragments.





## THE 20 JOULES PROJECTION CRITERIA

French Police Forces currently deploy Flash Guns which propel 44mm rubber balls with a 200 Joules residual energy up to 7 meters.

Of course, due to the ball diameter and its crushing at impact, the resulting energy density being around  $6 \text{ J/cm}^2$ .

People can be injured by this weapon, often broken ribs.

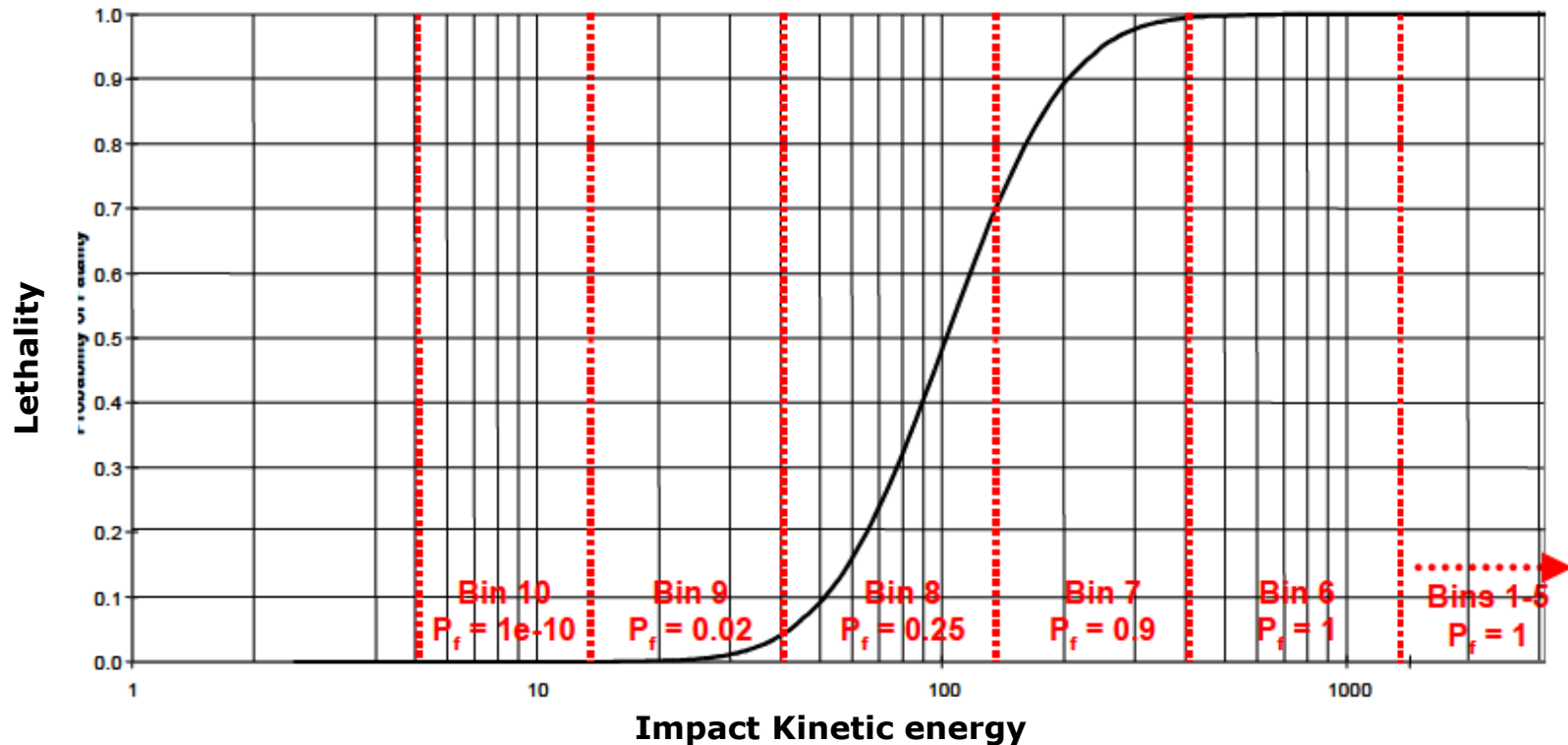


→ This allows comparison in terms of projection energy especially for non-metallic fragments.

## THE 20 JOULES PROJECTION CRITERIA

References for impact kinetic energy lethality:

→ DDESB SAFER Software (AASTP-4 extract)



## THE 20 JOULES PROJECTION CRITERIA

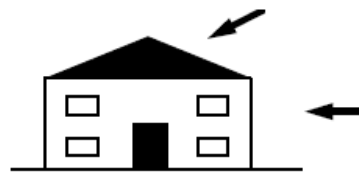
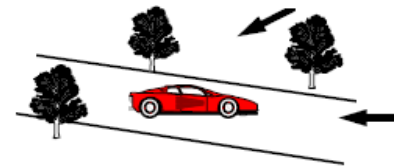
Impact energy & probability as to be considered ...

→ ASSTP-1 ed1 change 3 April 2010, table [5-15]

<b>LETHALITY DUE TO IMPACT ENERGY</b>				
<b>LETHALITY (p in %)</b>	<b>IMPACT ENERGY / KINETIC ENERGY (Joule)</b>			
	<b>HEAD</b>	<b>CHEST</b>	<b>ABDOMEN</b>	<b>LIMBS</b>
<b>1</b>	<b>55</b>	<b>58</b>	<b>105</b>	<b>155</b>
<b>5</b>	<b>65</b>	<b>90</b>	<b>140</b>	<b>240</b>
<b>20</b>	<b>79</b>	<b>140</b>	<b>200</b>	<b>380</b>
<b>50</b>	<b>100</b>	<b>230</b>	<b>280</b>	<b>620</b>
<b>99</b>	<b>200</b>	<b>850</b>	<b>850</b>	<b>2500</b>

## THE 20 JOULES PROJECTION CRITERIA

- In previous **AOP 39 ed1 or ed2**, for Type V, projection limit was **79 Joules** (or 150 gram beyond 15 m / 50 ft).
- The 79 Joules energy projection criteria is consistent with **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 m<sup>2</sup> / 600 ft<sup>2</sup>**.



## THE 20 JOULES PROJECTION CRITERIA

- So, in order to launch the debate, it is proposed to make the Type V projection criterion evolve to the following statement:

"Only few projections farther than 15 m  
with a moderate mass are accepted for the Type V Response."

- ➔ It is consistent with other AOP 39 qualitative criteria and National Authorities to take into account consideration both the influence of the munition architecture on the response and the type of material which is propelled (steel, aluminum, composite, plastic ...).



# CONCLUSIONS AND PERSPECTIVES

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- IMEMG experts offer as topic of discussion to AC326 SGB National Experts the following proposals:
  - Move from Type V to Type IV, the maximum response allowed to slow heating "*Fire in an adjacent magazine, store or vehicle*", because munitions effects are contained inside such a magazine, store or vehicle and because nobody can survive to the aggression itself.
  - Move from Type V to Type III or IV, the maximum response to fragment impact, because hazardous effects of the threat itself largely overpass all tolerated effects of Type V response, similar to sympathetic detonation.
  - Review the projection criterion for the Type V response,
  - Review the propulsion effect assessment for the Type V response

## CONCLUSIONS AND PERSPECTIVES

→ Through that way, IM criteria would be more consistent, and

→ more munitions can be awarded IM, allowing logistic gains and bringing real cost benefits to customers,

→ more munitions will be introduced in-service and, IM use will increase the personnel safety and the platform survivability.



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