

# STANAG 4439 ed3 Mandatory Reactions & AOP 39 ed3 Response Descriptors: Feed-Back & Considerations from Industry

IMEMG's Expert Working Group on  
Hazard Assessment & Classification

*Presented by Yves GUENGANT*

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



# INTRODUCTION

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- European Organisation assembling twenty leading armament groups working with Insensitive Munitions technologies



## INTRODUCTION

Express the armament industry's viewpoint with regards to relevant transnational regulations and requirements.

### Expert Working Groups:

- Computer Models for IM Performance,
- Cost & Benefit Analysis,
- Effects of Ageing,
- Fast Cook-off Test Procedure,
- Hazard Assessment & Classification.

*Hazard Assessment & Classification Expert Working Group  
to present this analysis*

# CONTEXT

- This analysis has been initiated by two events:
  - Questionnaire for Survey on Insensitive Munitions Response Descriptors done by the MSIAC
    - ➔ opportunity to set-up current feed-back coming from the 20 IMEMG companies about the AOP 39 ed3 implementation by Test Centers and National Authorities

## CONTEXT

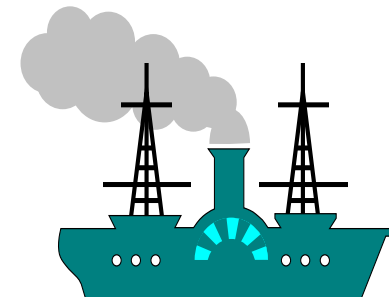
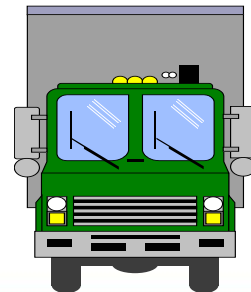
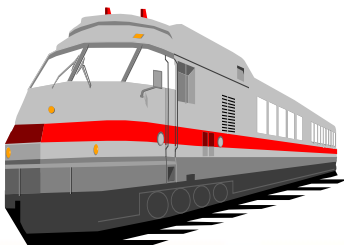
- A remark coming from audience during the last MSIAC Activities Presentation Meeting in Paris, a French Army Officer has said:

*"IM are more expensive, less efficient and in addition there is no-logistic gain"*

- ➔ for IMEMG members and IM community,  
we have to do always many efforts to publicize IM advantages !!!

## CONTEXT

- This problem that we have already been identified:
  - Numerous munitions are partially compliant to STANAG 4439,
  - they fulfill the development program requirements which take into account the Threat Hazard Assessment according to the life cycle,
- ➔ Thus, it is very difficult to gain any IMness benefits during transport and storage phases !!!





## CONTEXT

- dedicated regulations exist:
  - NATO Sub-Storage Division 1.2.3
  - French 1.2 Unitary Risk Division,
- bring only some virtual gains,
- *UN 1.6 Hazard Division is a quite unreachable objective unless for few exceptions.*

## CONTEXT

- AOP 39 Response Descriptors in conjunction with the STANAG 4439 mandatory reactions show distortions :
  - Slow Heating mandatory reaction: Type V
    - ➔ what are reaction effects outside the heated store?
  - Fragment Impact mandatory reaction : Type V
    - ➔ what are the donor detonation effects surrounding the acceptor location ?
  - ...

# REMARKS ABOUT STANAG 4439 ed3

IM Signature assessment is not limited to test STANAGS but,

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)

- *"Introduction of IM/MURAT into service :*
  - ➔ *enhances the survivability of logistical and tactical combat systems, platforms and stockpiles,*
  - ➔ *minimizes the risk of injury to personnel.*

*It accomplishes this significantly reducing:*

- *the potential for the inadvertent reaction of a munition to occur;*
- *the scope and/or violence of a reaction, if it were to occur;*
- *the consequences from such a reaction".*

## 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: store, bunker, ...,
- 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 20J fragment isn't able to go through only 2 mm 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 is a sufficient requirement for such threat !!!





## STANAG 4439 ed3

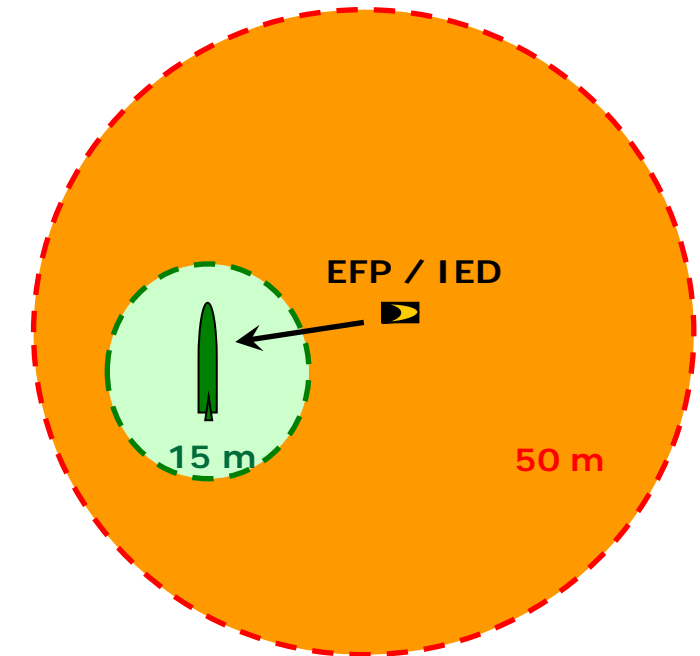
- Fragment Impact corresponds to "Fragmenting munitions attack",
- Only IED (Improvised Explosive Device) or "few specific missile" able to propel 18.6g fragment @ 2530 m/s (8300 ft/s),





## STANAG 4439 ed3

- Donor : Blast and fragments can provoke severe damages and injuries to persons up to 50 m / 165 ft,
- is it really necessary to require Type V and no-injuries farther than 15m/50ft ?
- STANAG Fragment delivers 60,000 Joules kinetic energy, while it is forbidden, for the acceptor, to have only one 20 joules projection;



→ This threat can be compared with Sympathetic Reaction scenario, but for this trial the mandatory response is only Type III.



# COMMENTS ABOUT AOP 39 ed3 RESPONSE DESCRIPTORS

## AOP 39 ed3 Response Descriptors

- IMEMG experts have identified some difficulties for Response Descriptor implementation and they propose some potential improvements :
  - **Casing rupture criteria** are defined for steel casings and not at all for composite envelopes or even for forged aluminum casings,
  - i.e. the sole forged aluminum fracture due to an impact can correspond to type III or IV response descriptor 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,
- ➔ **Packaging projections for large munitions are likely to be projected at distances exceeding 15m/50ft,**
- ➔ *how to consider these packaging projections, is munition response or not?*

## AOP 39 ed3 Response Descriptors

- **Munition size** should be considered :
    - Type V response of large munitions delivers massive combustion energy :
    - it can be more severe for the platform than Type I to III reaction of a hand grenade located inside the ship magazine.
- ➔ *Response Descriptors would consider munitions sizes?*



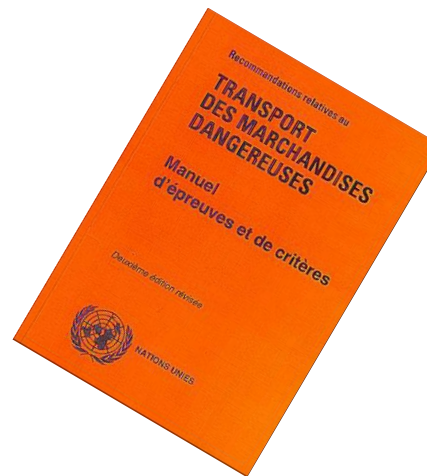
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# THE 20 JOULE PROJECTION CRITERIA

## 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 20J kinetic energy in the initial energy and not the energy at the impact on potential victims.





## THE 20 JOULES PROJECTION CRITERIA

- In leisure world, Paintball or Airsoft gamers are playing with gas guns able to propel 0.68" projectiles with 10, 20 or even 40 Joules launching energies. Of course, players wear face protections, but injuries aren't frequent.
- ➔ This allows comparison in terms of projection energy especially for non metallic fragments.

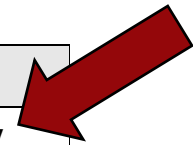




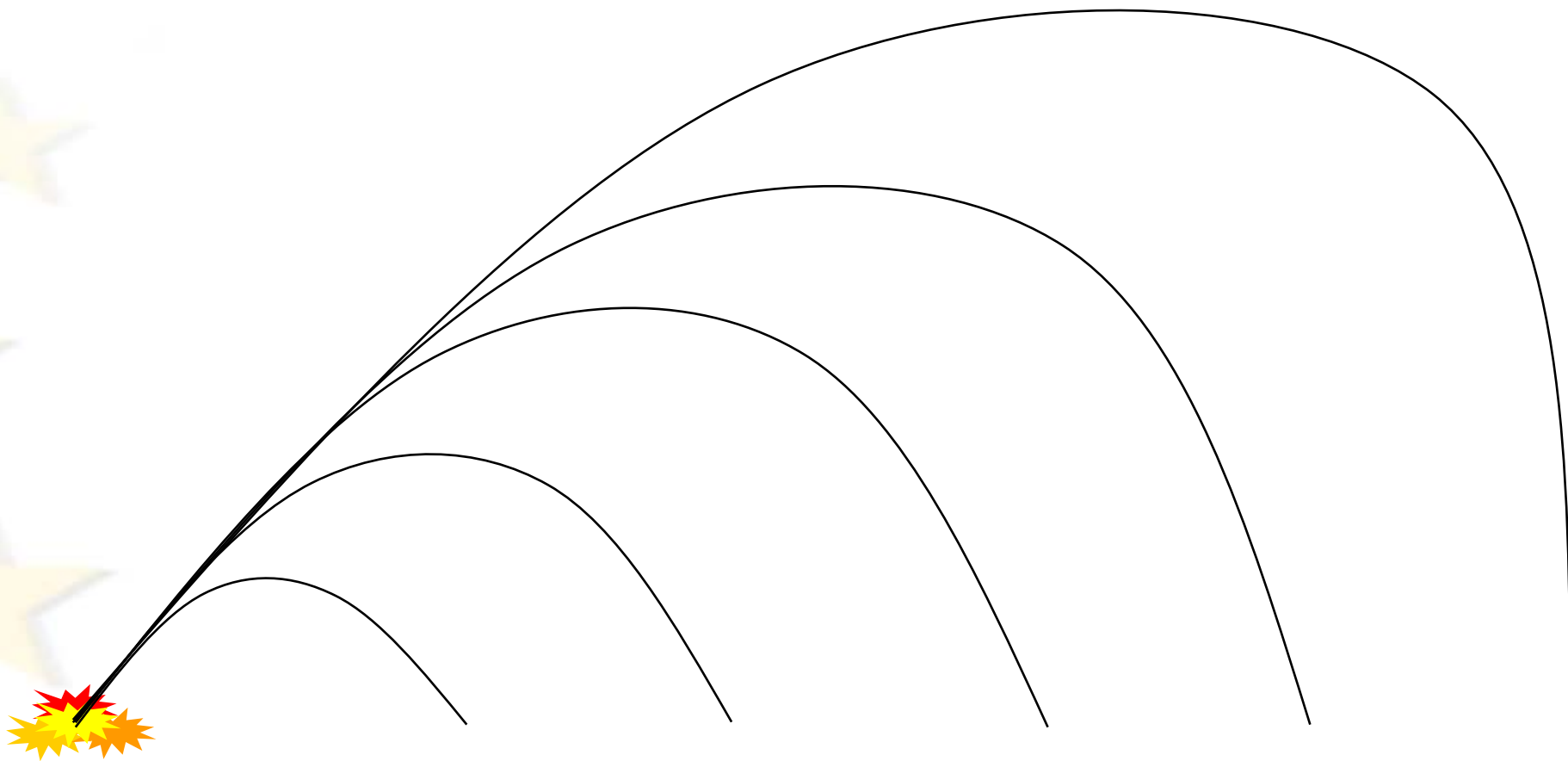
## THE 20 JOULES PROJECTION CRITERIA

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



Trajectories for 20J fragments according to their mass

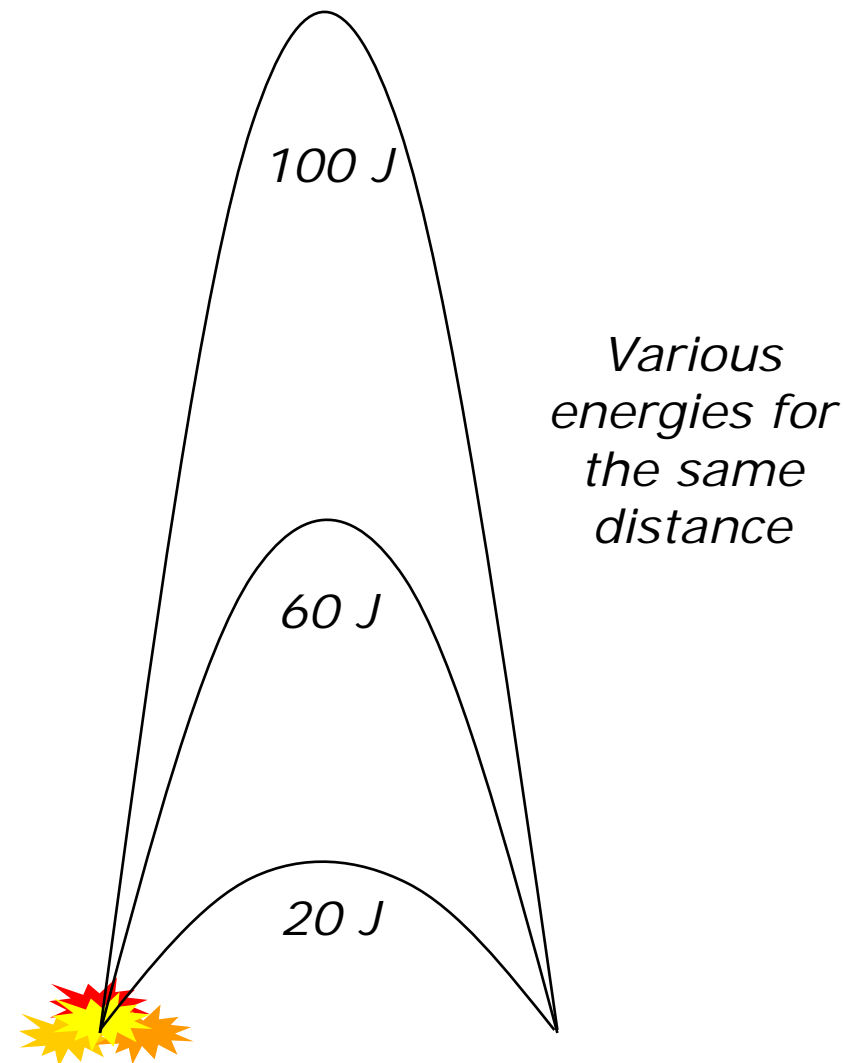
## THE 20 JOULES PROJECTION CRITERIA

➤ 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

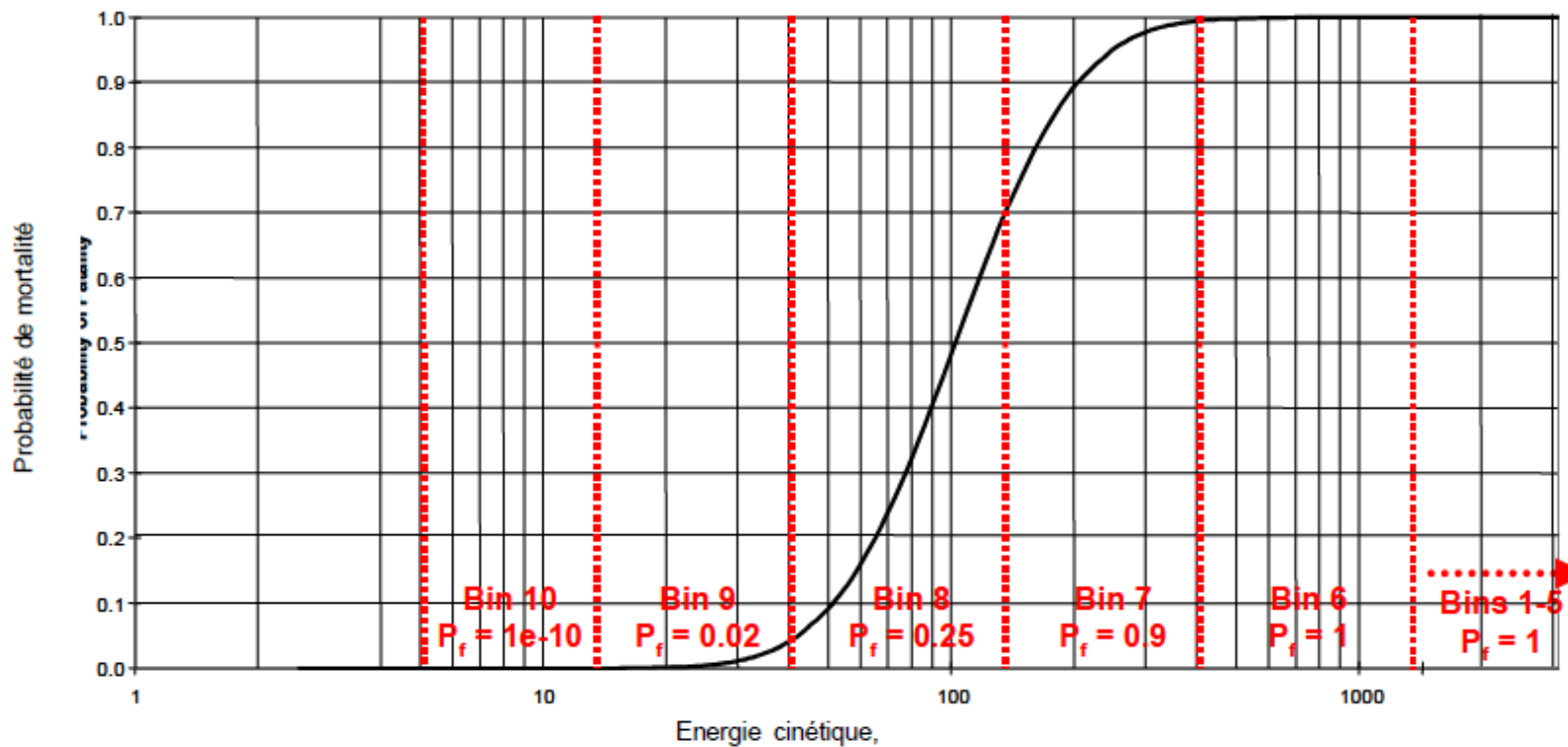
without taking into account the real physical effects.



## THE 20 JOULES PROJECTION CRITERIA

- The 20J impact kinetic energy seems to be the safety limit, is it right ?

➔ DDESB SAFER Software (AASTP-4 extract)



## THE 20 JOULES PROJECTION CRITERIA

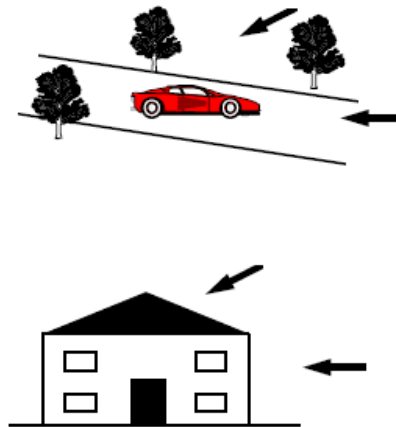
→ ASSTP-1 ed1 change 3 April 2010, table [5-15]

<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 20J launching energy can not be considered as a reference.

## 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 79J 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."

- i.e. it seems as tolerable to observe 12 projections (around 100 g) at 40m/130ft or 8 projections (around 300 g) at 20m/65ft or only one projection (about 3kg) at 25m/80ft.
- ➔ 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 ...).



# THE PROPULSION EFFECT ASSESSMENT



## THE PROPULSION EFFECT ASSESSMENT

- Propulsion effect is not sufficiently defined in AOP 39 ed3:
  - ➔ 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".
  - ➔ So, information for platform survivability assessment is missing, it is important to do identify :

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



## THE PROPULSION EFFECT ASSESSMENT

- On an aircraft carrier deck, if we consider the **Forrestal disaster** example,
- it appears that the main factor of damages were **kerosene leakages on the deck and following, the bomb detonations,**
- **rocket propulsion effect has not been noted in scenario description.**



## THE PROPULSION EFFECT ASSESSMENT

- Clarify which is feared consequences about **propulsion effects**:
  - traumatic effects against personnel,
  - platform survivability concerns,
  - fire propagation,
- **"Shifting distance"** should be similar to Energetic Materials projection distance = 30 m / 100 ft, item mass is balanced the number = 1,
- **"Real propulsion effect"** : long distance projection or possible exit from the storage location, to be considered in the Quantitative Risk Assessment,
- *Additional remark : Cruise motor are generally tested separately, it is possible to observe a propulsion effect which is insufficient to move the complete missile,*

## THE PROPULSION EFFECT ASSESSMENT

- So, in the aim to launch debate, it is proposed to change for the following statement:

"Munitions shifting should be limited to around 30 meters to respect Type V as for energetic material projections".

and

"Munitions response generating strong propulsion effect with a potential flight farther than few hundred meters would be identified to feed quantitative risk assessment and be assigned to type IV or III

or

""Munitions response generating strong propulsion effect with a potential flight farther than few hundred meters would be identified to feed quantitative risk assessment and be assigned to a New Type VII or "V + Propulsion"



# CONCLUSIONS AND PERSPECTIVES

## CONCLUSIONS AND PERSPECTIVES

- 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, 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.

## AUTHORS

- CEA – DAM **FRANCE**  
Frank DAVID-QUILLOT
- EURENCO  
Yves GUENGANT
- MBDA-F  
Michel VIVES
- NEXTER Munitions  
Frederic NOZERES
- ROXEL  
Raymond COLENO
- TDA Armements  
Carole FOURNIER

- RWM Italia SpA **ITALY**  
Massimo CASTIGLIA

- MBDA TDW **GERMANY**  
Dr Werner ARNOLD
- RHEINMETALL WM GmbH  
Dr Gerhard HUBRICHT

- AWE Plc. **UK**  
Helen FLOWER
- BAE Systems GCSM  
Charles MARSHALL
- CHEMRING ENERGETICS  
John HAND
- MBDA-UK  
Sean RANDALL