

IM⁽¹⁾ AND Q-D RULES: AN ANALYSIS BY FRENCH CLUB MURAT

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ABSTRACT

The potential user of IM (or MURATs) is not only expecting an increase of platforms survivability during war time, but also a reduction of logistic constraints during peace and crisis time.

It's then essential to take into account the improved safety properties of IM when establishing these constraints.

After a recall about the present situation concerning the standardization in the field of IM, or MURAT in France, the different regulations followed by the main Forces are analysed, to better describe the possibilities offered by introduction of IM or MURAT into service.

It comes out of this analysis that reductions of Q-D may be reached by different ways:

- the transition of 1.1 or 1.2 munitions to 1.2 u.r, 1.3, 1.4 or 1.6 munitions, which is not possible in the same terms according to the followed regulation (NATO, US or France),
- or case by case, the analysis of the real effects produced by IM or MURAT in accidental situations.

(1) *IM has a French equivalent acronym, MURAT, which stands for MUnition with Risks ATtenuated*

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1- INTRODUCTION

In 1996 the technologies for acquiring insensitive munitions (IM) exist in countries which have engaged in significant research in this field since 1970-1980. France, one of them, is therefore faced now with the problem of implementing IM, which can be summed up as follows:

- ↳ identify the armed forces that require IM;
- ↳ spell out specifications for the IM;
- ↳ develop IM;
- ↳ decide IM allocations;

all of which must be done in a context of tight budget constraints.

As part of its objective to promote the concept of insensitive munitions, Club MURAT, jointly with the French MOD, has undertaken a number of initiatives [1 & 2] designed to help formulate elements capable of resolving this problem. These initiatives include:

- ↳ cost/benefit type analyses carried out by the Cost/Benefit working group [3];
- ↳ the development of a methodology for evaluating IM in accordance with the French National Doctrine, undertaken by the 'standards & labels working group' [4,5];
- ↳ an analysis of the 'technical' advantages stemming from a reduction of the effects produced by accidental reactions in munitions; this analysis is the result of careful consideration in connection with the above two initiatives and poses the question discussed below:

IM AND Q-D RULES
In which respects do the two converge?

This question reflects in concrete fashion the concern of the armed forces which, as well as a reduction of potential losses from hazards in wartime, want to see an easing of logistical constraints, especially in respect of munition storage.

Club MURAT, which groups the Aerospatiale Missiles Div., Giat Industries, Matra Défense, SNPE and TDA in this particular sphere, makes proposals on this issue.

2 - IM AND MURATs

Standardization in the realm of IM has made significant strides recently, notably following:

- ↳ the publication of a French National Doctrine (Instruction DGA/IPE No.0260 dated August 4,1993);
- ↳ the publication of a draft edition 1 of STANAG 4439 (Policy for introduction, assessment and testing of Insensitive Munitions - MURAT) ratified by six NATO countries.

In the table 1 hereafter, the reaction levels accepted in these two documents are compared with those accepted under MIL-STD-2105B ('Hazard Assessment Tests For Non-Nuclear Munitions - 12.01.94').

**Table 1: MURAT requirements in US, NATO and France
in accordance with the NATO nomenclature for the violence-of-reaction scale**

STIMULI	ACCEPTED MAXIMUM REACTIONS				
	US IM as per MIL-STD- 2105B	NATO ideal GOALS as per STANAG 4439	MURAT FRANCE as per Instruction DGA/IPE n° 0260		
			*	**	***
FIRE	V	V	IV	V	V
BULLET IMPACT	V	V	III	III	V
SYMPATHETIC REACTION	II	III	III	III	IV
SLOW HEATING	V	V	III	V	V
LIGHT FRAGMENT	V	V	/	III	V
HEAVY FRAGMENT	/	/	/	III	IV
SHAPED CHARGE	II	III	/	/	III

I to V: reaction levels (I: complete detonation -> V: combustion only)

An examination of these requirements clearly reveals a significant limitation of the response to accidental stimuli with a MURAT munition. If the analysis is confined to possible stimuli in peacetime or in times of crisis, it emerges that:

- ↳ a MURAT* munition
 - will not detonate in response to any of the associated stimuli (fire, slow heating, bullet impact), nor by sympathetic reaction. This last point ensures that in the event of detonation due to a different stimulus (eg. shaped charge, sabotage by explosives, etc.) only the munition actually involved will detonate;
 - in the event of fire, will lead **only to projection effects limited in number, energy, distance and extent of effectiveness.**

- ↳ a MURAT** munition results in even more limited projection effects in the event of fire. In this respect, it comes close to US requirements and to the ideal goals described in STANAG 4439.

3 - QUANTITY DISTANCES (Q-D) RULES

3.1. Review of rules observed by the French armed forces

The principal statutory texts for explosive regulations, as applied by the French armed forces, are the following:

- ↳ Interservices Instruction No.1007/DEF/EMA/OL/6 of June 9,1988 relating to munition storage in depots;
- ↳ NATO AC 258 manuals (AASTP1 and AASTP3) during interallied operations.

These texts draw extensive inspiration from two source documents:

- ↳ French Decree No.79-846 and the September 26,1980 Circular relating to Instruction No.1007;
- ↳ UN recommendations concerning the transport of dangerous goods, for NATO manuals.

Under these rules, munitions for military use are divided on the one hand, into hazard divisions and on the other hand into compatibility groups.

◆ Hazard divisions (HD)

Division 1.1 Substances and articles which have a mass explosion hazard

Division 1.2 Substances and articles which have a projection hazard but not a mass explosion hazard

Division 1.3 Substances and articles which have a fire hazard or a minor projection hazard or both, but not a mass explosion hazard

Division 1.4 Substances and articles which present no significant hazard

Division 1.6 Extremely insensitive articles which do not have a mass explosion hazard

◆ Principal compatibility groups

- C: Propellant explosive substance, or other deflagrating explosive substance or article containing such explosive substance
- D: Secondary detonating explosive substance, or article containing such explosive substance, without means of initiation
- E: Article containing a secondary detonating explosive substance, without means of initiation, with a propelling charge
- F: Article containing a secondary detonating explosive substance, with or without a propelling charge
- N: Articles containing only extremely insensitive detonating substances (as per NATO definition)
- S: Substance or article so packed or designed that any hazardous effects arising from accidental functioning are confined within the package or affect only the immediate vicinity of the package

This leads to classification of munitions based on hazard division/compatibility group couplings (eg. 1.3C). In the application of these rules,

- ↪ all such couplings are not feasible; the 1.3D combination, for instance, does not exist;
- ↪ storage and transport requirements are set both by the hazard division (isolation distance between buildings, transport conditions) and the compatibility group (mixing rules);
- ↪ transport requires the relevant munition to come under a designation to which a UN number has been assigned (eg. 'Projectiles containing a detonating substance', 1.2F, No.0324);
- ↪ compatibility group assignments are based on matches with the above definitions (eg. a 155mm propelling charge belongs to Group C by definition);
- ↪ hazard division classification arises out of a technical process (file-based or tests) designed to situate an article with respect to the criteria listed below, except in the case of classification under 1.1 which requires no demonstration other than acceptable reaction to transportability criteria (thermal stability and drop from a height of 12m).

Table 2: Hazard division classification criteria, and comparison with MURAT requirements

STIMULI	(NATO) Hazard Divisions				MURAT France		
	1.2	1.3	1.4	1.6	MURAT*	MURAT**	MURAT***
FIRE	I (5)	V(3)	V(4)	V(4)	IV(1)	V(2)	V(2)
SLOW HEATING	/	/	/	V	III	V	V
BULLET IMPACT	/	/	/	III	III	III	V
LIGHT FRAGMENT	/	/	/	/	/	III	V
HEAVY FRAGMENT	/	/	/	/	/	III	IV(1)
SYMPATHETIC RÉACTION	III	III	III	III	III	III	IV (1)
SHAPED CHARGE	/	/	/	/	/	/	III
DROP	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.	N.R.
ÉLECTRICAL STIMULI	/	/	/	/	N.R.	N.R.	N.R.

N.R. No reaction

(1) No propelling effect

(2) Only after a certain time lapse

(3) No screen perforation or over-150g projections beyond 15m

(4) As per (3) above, plus no fireball at over 4m or jet of flame beyond 3m

(5) Detonations accepted, but not simultaneously

3.2 Examples of application of the present regulations (NATO)

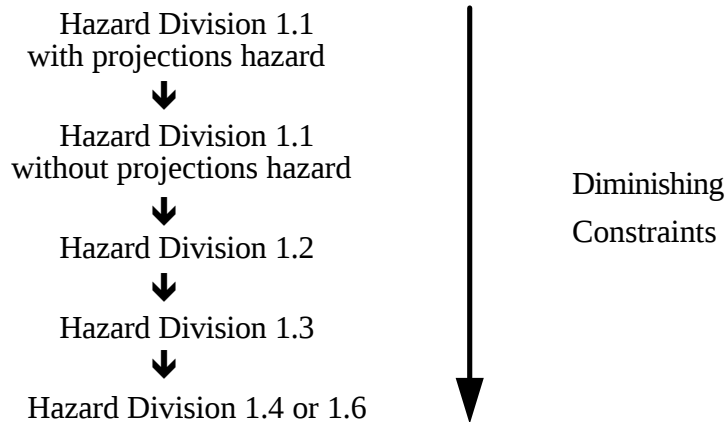
Most munitions in service, whether warheads or all-up rounds, come under one of the following three classifications:

↪ Classification 1.1, with solely a mass explosion hazard

↪ Classification 1.1, with a mass explosion hazard and high-speed projections, with consequent application of isolation rules 1.1 and 1.2

↪ Classification 1.2, with a hazard of projections but no mass explosion hazard

An initial analysis would therefore suggest that an easing of logistical constraints must entail changes in hazard division, *a priori* in the following order:



An example of application of these isolation rules is given in Table 3 below.

NATO's AASTP1 manual was used for the purpose.

In this example, the potential explosion site is a non-barricaded site (as in the case of stacks in the open air or under light shelter).

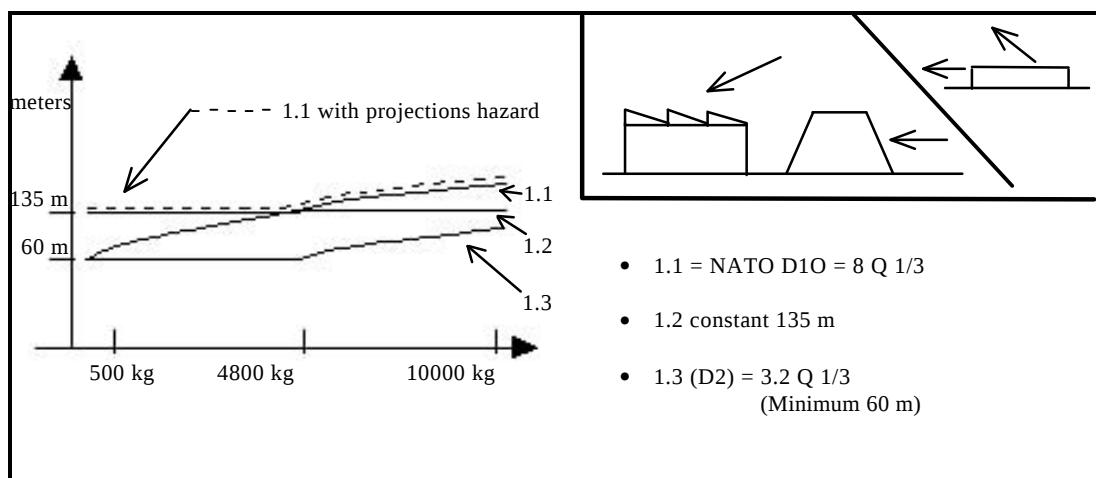
The exposed site is a munitions workshop devoid of a barricaded protective roof.

Isolation distances are those given by the manual for 1,1, 1,2 and 1,3 HD munitions. A special note states that in the case of 1.1 HD munitions, a serious projections hazard remains.

In the case of 1.1 munitions having an intrinsic projections hazard, it can be assumed that the dotted curve applies.

No curves between 0 and 500kg are plotted because the NATO manual does not cover small quantities such as these.

Table 3: Comparison of NATO 1.1/1.2/1.3 Q-D (AASTP1)



4 - LOGISTICAL BENEFITS TOO MUCH LIMITED FOR MURATs AND IM

Transition to IM primarily concern munitions presently assigned to 1.1 or 1.2 Hazard Divisions.

IM are munitions which, of course, no longer come under hazard division 1.1 but are still mainly 1.2 types, according to present rules.

Unfortunately, as the previous isolation-distance table showed, the safety distances stipulated for 1.2 are often the same as those for 1.1 coupled with a projections hazard, when the weight is less than about 5000kg. Thus, little benefit is accorded to IM in this weight range, which are in fact frequently encountered in the French Air Force.

Furthermore, when a munition is already assigned to 1.2 HD before IM processing, there is strictly no benefit accruing, irrespective of weight or configuration.

This situation could lead users to become less open to transition to IM, particularly if this transition is perceived as being no more than evolving from 1.1 to 1.2 HD.

And yet MURAT* or IM stand out clearly among 1.2 munitions, especially in respect of reaction to fire:

- ↳ No detonation, hence no high-speed fragment
- ↳ No propulsive reaction, hence no munitions blown off
- ↳ Limited projections without significant damage
- ↳ Limited overpressure

Such reactions warrant applying to MURAT* and IM isolation rules intermediate between those for hazard division 1.2 and those of hazard division 1.3.

5 - CONCEIVABLE WAYS TO REDUCE Q-D THROUGH IM

Three ways are conceivable today:

- Way A: to use specific Q-D for such and such IM
- Way B: to apply Q-D rules for 1.3, 1.4 and 1.6 HD
- Way C: to create a 'IM 1.2' subdivision

5.1.Way A: to use specific Q-D for such and such IM

This solution is quite legal and authorized in French Q-D rules (which are almost the same for companies and forces).

Even if it is used by French companies on workshops dedicated to a specific product, this solution is not adapted to multiproducts military compounds.

Way A, a short-term way, seems to be a dead-end for military compounds.

5.2.Way B: to apply Q-D rules for 1.3, 1.4 and 1.6 HD

- 1.3 HD is accessible for propulsive munitions (compatibility group C) without difficulty as soon as they pass the technical criteria. Some are presently in 1.2, which so could be assigned to 1.3 HD (for example arrow munitions could enter this process).

As for munitions of compatibility groups D, E and F, which could be technically IM, it is not the same process. Access to 1.3 HD seems impossible, on 'administrative grounds' since 1.3 HD is not administratively accessible for munitions having an intentionally detonating part (bombs, shells, torpedoes, missiles, ..):

- neither 1.3 D nor 1.3 E do exist in NATO manuals; only 1.3 F exist
- no 'description' of article for 1.3 D or 1.3 E , and even for 1.3 F item do exist in the NATO manuals.

However, comparative analysis of requirements for MURAT** and***, and for 1.3 HD (as per NATO manual AASTP-3) shows similarities, relating to stack test and fire test.

And assimilation rules have elsewhere been introduced in the French doctrine: MURAT** is assimilated to 1.2 or 1.3 HD according to detailed results of tests; MURAT*** is assimilated to 1.3 HD.

- 1.4 Q-D are quite moderate. However, 1.4 HD definition is restrictive:
"This division comprises substances and articles which present only a small hazard in the event of ignition or initiation during transport. The effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected ..." (from UN orange book).
According to the definition, 1.4 HD can accept only small detonating items : it is clear that when they are initiated, bombs, shells and torpedoes don't present effects limited to the package.
So, 1.4 HD is not accessible for the quasi totality of IM.
- Q-D rules for 1.6 HD have been adopted by NATO and are beneficial - but the number of 1.6 articles will remain limited within the next 10 years - 1.6 is a long term option.

5.3.Way C: to create an IM 1.2 subdivision

It would be a subdivision of 1.2 HD, Q-D of which should be intermediate between those of 1.2 HD, which are designed for the most hazardous 1.2, detonating in a fire, and those of 1.3 HD.

It is worth noting that in this situation, US DOD took an initiative. It has, in some way, made official the light projection hazard of IM, by creating a special subdivision, unit risk 1.2 HD, with isolation distances intermediate between 1.2 Q-D and 1.3 Q-D. It is also worth noting that NATO is presently exploring projections hazard of 1.2 items, through a testing campaign performed in different countries [Ref: 7,8,9]. It would be interesting that IM be included in this campaign.

6 - CONCLUSIONS

Here above analysis shows that access to IM which is technically possible today, could lead to a significant reduction of logistical constraints in peace and crisis times, in addition to a survivability gain on combat platforms in wartime.

Indeed, this answers to a claim from IM potential users, which could so obtain very practically economic gains in compensation of IM acquisition effort.

Convergence points do exist between transition to IM and Q-D rules; they must be written down.

Our analysis of different ways leads us to the conclusion that, for the years to come, way C (IM 1.2 subdivision) is the most promising way to take into account improved safety of IM.

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