Insensitive RDX
(I-RDX)

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1 – INTRODUCTION

Many countries and especially most of NATO countries have now adopted IM (Insensitive Munitions) policies for their armament in order to save lives and material ~~and~~ plus enhance military capabilities.

Standards, labels (STANAG, MIL Std, MURAT*, **, *** …) have been issued and are defining what are IM Standards & objectives and what is necessary ~~to verify to be compliant~~ for compliance verification with IM objectives.

Fulfilling IM specifications is a system approach and requires to take into account the entire armament system ~~up to~~ to include the packaging. ~~and~~ ~~m~~ Many different types of IM improvements can be considered ~~and~~ that are potentially workable on each subpart of a munition.

Nevertheless ~~try to act on~~ trying to alter the energetic materials involved is of course, if possible, the best way to reduce and master both reactivity (or sensitivity) and violence of reaction.

Among the energetic material characteristics to be improved, reduction of shock sensitivity is probably one of the most difficult to achieve.

2 – STATE OF THE ART

The shock sensitivity of an energetic material is mainly due to two parameters : shock sensitivity of energetic ingredients and some physical properties of the composition (residual porosity, flaws …).

Reduction of the shock sensitivity of energetic ingredients ~~shock sensitivity~~ has been a constant goal of the world armament community during the past decades, two main methods have been pursued :

- either, find and use less shock sensitive ingredients, such as « NTO » or « TATB » for instance, and replace partially or totally the conventional ingredients like RDX or HMX in the corresponding composition,
- or, try to reduce the inherent shock sensitivity of these conventional ingredients.

It has been shown that the first method is working well with some degree of success ; this means that new energetic compositions using NTO or TATB with low shock sensitivity levels ~~has~~ have been successfully developed and applied for some programs (CBEMS 125, multipurpose bomb, using NTO based cast PBX and produced for the French Navy, is the first IM penetrator in service according to STANAG 4439 and MURAT** specifications). But these solutions have the disadvantage to give an increase of cost that is frequently unaffordable especially in the field of conventional munitions (shells, GP bombs ...).

SNPE has discovered that it is possible for us to produce industrially an insensitive quality of RDX,
so-called I-RDX, which permits us to reduce the shock sensitivity of energetic materials without the previous disadvantage of much greater costs.

3 – WHAT IS I-RDX AND WHAT ARE THE EVIDENCES OF ITS EXISTENCE ?

SNPE is producing industrially two qualities of RDX which have been recently named I-RDX for the insensitive RDX and ~~(moderate)~~ MI-RDX (moderate insensitive RDX) for the quality which seems to be produced elsewhere.

- I-RDX and MI-RDX cannot be differentiated through chemical, physical, safety characterization and even through shock sensitivity tests that are usually performed on raw materials (Card Gap Test for instance).
- I-RDX and MI-RDX can be produced with the same ranges of particle size distribution.
- I-RDX can be obtained from both Type I (WOOLWICH process) and Type II (BACHMAN process) RDX.
- The actual acknowledgement of the shock sensitivity differences between I and MI-RDX is particularly evident through shock sensitivity characteristics of cast PBX's~~;~~. This considerable IM difference is noted clearly when strictly controlled comparisons are made on cast PBX formulations using either I-RDX or MI-RDX such as illustrated in the following diagrams which show~~ing~~ shock pressure thresholds issued from LSGT or ELSGT tests.

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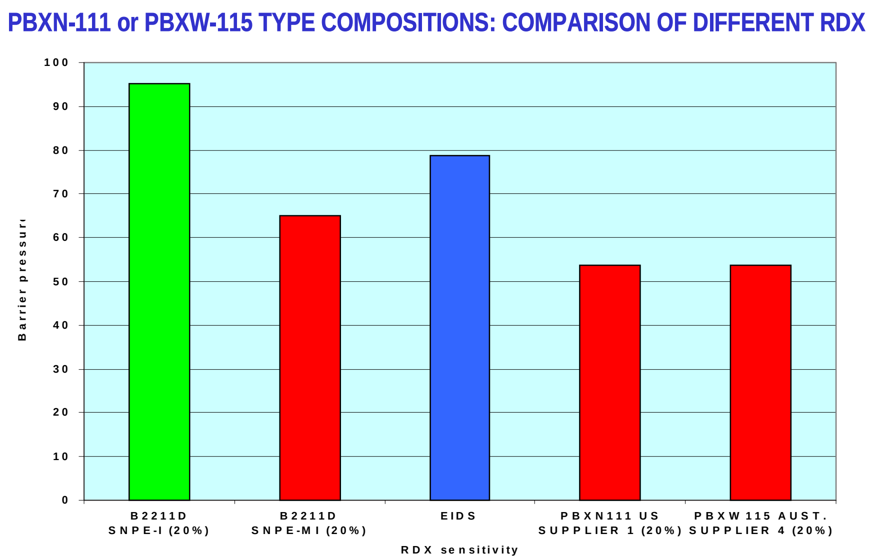

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As it can be seen, there is a very significant difference in shock sensitivity. ~~;~~ ~~w~~We can expect the same level of influence for solid rocket propellants containing RDX ~~;~~. ~~o~~On the other hand the potential effect on shock sensitivity of melt-cast explosives or pressed PBX using RDX, even if it goes in the right direction, seems to be much less ~~important~~ significant, probably by reason of the remaining influence of other parameters (residual porosity for instance).

4 – INTEREST OF I-RDX

The replacement of the conventionally produced MI-RDX by I-RDX with the same particle size distribution, in a cast PBX formulation, does not modify any property other than properties linked to shock sensitivity ; that is to say that :

- chemical, physical, mechanical, safety, aging properties,
- sensitivity to thermal threats (FCO, SCO), bullet or light fragment impacts,
- manufacturing process,

will not be modified.

On the other hand, the significant reduction of shock sensitivity will permit us to improve the behaviour of munitions against heavy fragment impacts or SD (sympathetic detonation) as it is illustrated in the following tables with PBXN 109 composition taken as an example.

FRENCH HEAVY FRAGMENT IMPACT YIELD ESTIMATION

Impact velocity	PBXN109 M.I-RDX	PBXN109 I-RDX
$V < 1400$ m/s	Pass	Pass
1400 m/s $< V \leq$ 1900 m/s	Fail	Pass
$1900 < V \leq 2000$ m/s	Fail	Pass/Fail
2000 m/s $< V$	Fail	Fail

HEAVY FRAGMENT : STEEL BALL Φ 40 mm (1.57'') M= 250 g (0.5 lb)
PBXN109 in Mk82

SYMPATHETIC DETONATION YIELD ESTIMATION

TEST UNITS	PBXN109 M.I-RDX	PBXN109 I-RDX
$\Phi \leq 3''$	Pass	Pass
$3 < \Phi \leq 5''$	Fail	Pass
$5'' < \Phi \leq 6''$	Fail	Pass/Fail
$6'' < \Phi$	Fail	Fail

TEST UNITS :
Φ : External Diameter
Wall Thickness : 0.5''
Donor/Acceptor in the worst situation (distance = 0.5 to 1 Φ)

Besides, the existence of I-RDX will give the possibility to find ~~out~~ additional new ~~compromises~~ improvements between performances, ~~(besides~~ low vulnerability and cost~~)~~ which are not reachable with MI-RDX.

5 – CONCLUSIONS AND FUTURE PROSPECTS

SNPE has discovered that it is possible to produce industrially a more insensitive quality of RDX (I-RDX) than the one which is currently available elsewhere.

This I-RDX has been produced by SNPE for many years and is already used in several mass production munitions and warheads using SNPE cast PBX charges.

SNPE industrial process for I-RDX production is ~~working~~ valid for whatever synthesis process is used (BACHMAN or WOOLWICH process).

Considering that all the characteristics , other than those linked to the shock sensitivity are unchanged ; thus replace conventionally produced RDX by I-RDX in the existing compositions for munitions is easily feasable on a substitute basis for widespread application. This I-RDX permits an affordable major increment~~ed~~al step, towards the ultimate insensitive munitions levels.

US DOD has started (May 2000) an evaluation programm~~me~~ of SNPE I-RDX that is funded under a Foreign Comparative Testing (FCT) program~~me fundings~~. This programme is managed by US ARMY/ARDEC.

In connection, discussions have begun between ~~OSD~~ DOD, RONA and SNPE in order to transfer SNPE's manufacturing technology for the I-RDX at HOLSTON Army Ammunition Plant (HSAAP) for the US market.