COMPARATIVE STUDY ON DIFFERENT TYPES OF 0.5 BULLETS

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The GEMO (French committee tests procedures) is a working group treating tests standards on defense explosives. It is under the autority of the DGA (French Procurement agency of the French Ministry of Defense) and it regroups experts from the Ministry of Defense and from Armament Industries.

The scopes treated by the GEMO cover the statistics methods and metrology, the explosives properties and the physico-chemical analysis, the security and the vulnerability, and finally the ammunitions performances.

The vulnerability working group of the GEMO convenes program services of the DGA, four tests centers of the DCE (The Systems Evaluation and Test Directorate) and all the armament industries concerned by the vulnerability of the ammunitions. Apart from the fact that the members of this working group cover all the profession, they also cover the whole explosives and french ammunitions (explosive, powder, propellant, bomb, warhead, shell, rocket motor, ...).

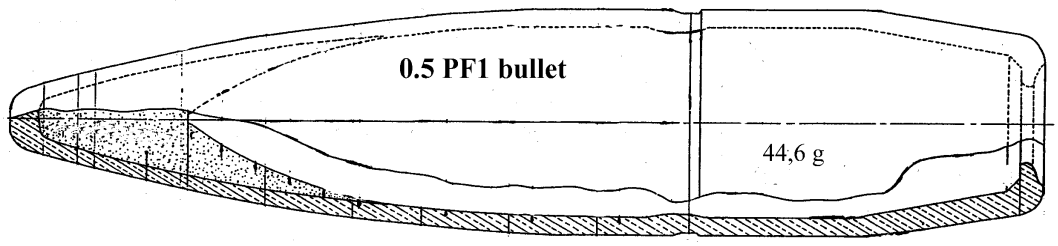
This organisation allows to have the most objective and broad french opinion as possible about the vulnerability standards. After 10 years, this working group writed eight standards to carry out tests on models and seven definition documents of these models.

These works allow France to have, in the vulnerability tests scope, all the necessary documents to study the behaviour of new explosives, confined or not in models. The tests on full scale ammunitions derive also benefit from these works.

These documents are today french standards.

At the time of the standardization of these documents, their subjects matter were revised. When we examined the 0.5 bullet impact standard, it us appeard that it could be restrictive to impose the type PF1 of the 0.5 bullet for these tests, as it was the case in the initial version of this document.

This bullet is equivalent to the APM2 but for the french armies.



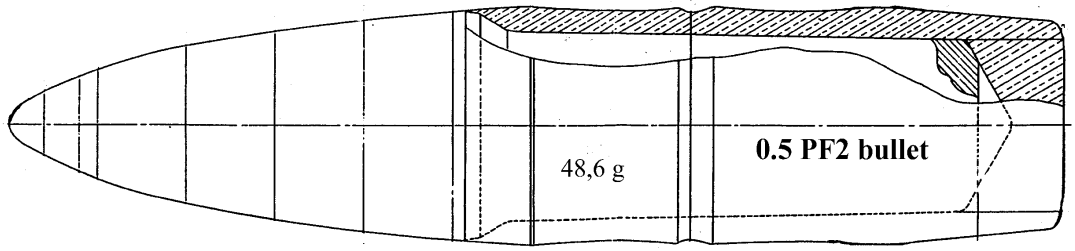
Today, all the tests standards, french ones, american ones or those writed by the NATO working groups, impose to carry out this type of tests with one of these two bullets (APM2 or equivalent as french PF1).

Yet, the french problem is that this 0.5 bullet PF1 is no more manufactured and that the actual stock is relatively reduced.

It won't permit at all events to secure the whole tests of different french tests centers for many years.

The idea was then to think that we could replace the PF1 bullet by the new one, the PF2, which is today in service in french armies.

This PF2 bullet has for US homologue the APM8 bullet. This one is also in service in the US armies today.



Yet, before to face this substitution it was necessary to study differencies between them. More than the differencies of architecture or materials, it was essential to examine the impact behaviour of bullets throughout inert materials and energetic ones.

Indeed, France is in possession of an enough large data bank of tests on many different energetic materials, confined or not.

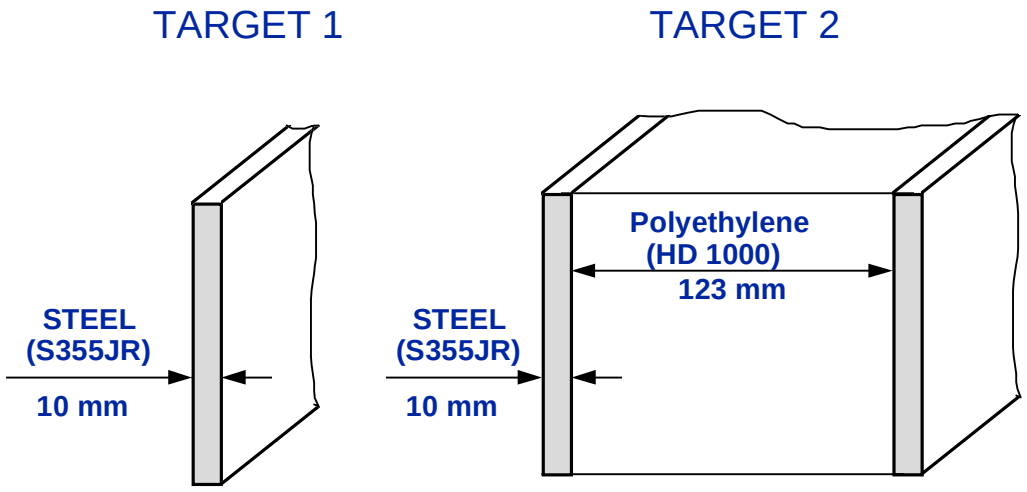
Moreover, on these tests made in models, many results comparisons were made between different nations. Indeed, USA, Canada, GB and Germany, for example, also carry out their study tests on energetic materials with models similar to those defined by the GEMO, making easy in this manner the comparisons.

The best way to compare the effects of these two bullets looked to us as the tests way. Indeed, it seemed to us that by some well defined tests, we could have a first idea on these differencies.

We wished to know if their perforation in inert targets and their effects (caracterized by a reaction type as it was defined by the NATO) on different type of ammunitions were identical.

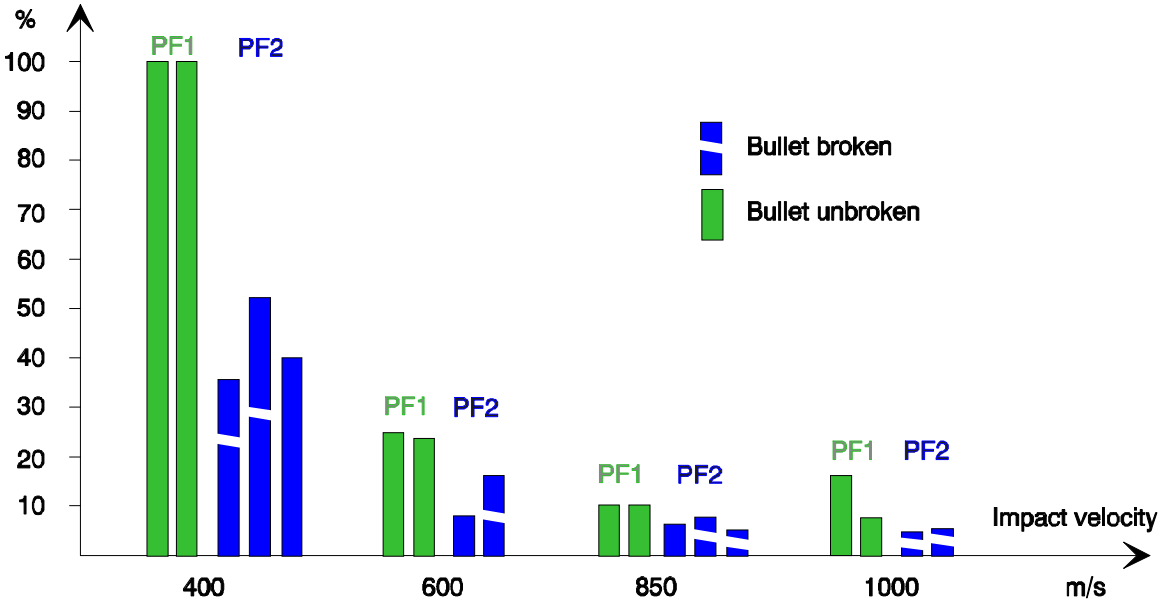
In case of opposite way, it would be first impossible to accept the substitution of the PF1 by the PF2 without a more elaborate study.

Two inert targets were defined. The first one was only contituted by a 10 mm thickness of S355JR steel plate. The second one intended to represente bomb or sheel type of ammunition and it was constitued by two 10 mm thickness of S355JR steel plates divided by 123 mm of high density polyethylene (HD 1000).



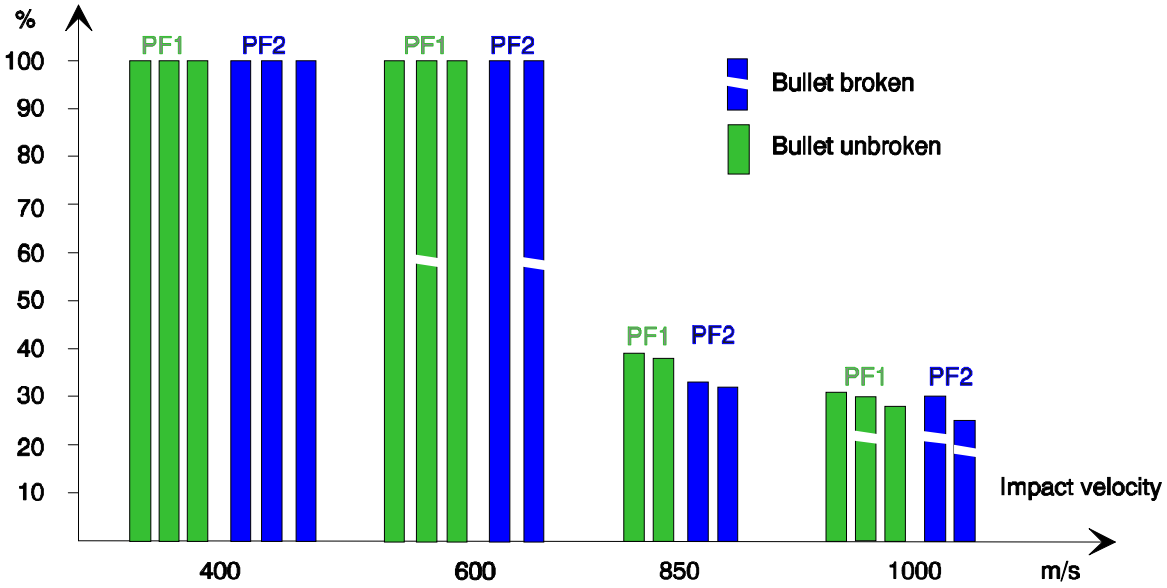
The results of these tests are given hereunder. With respect to carried out tests speeds, they represente the pourcentage of speed loses by the bullet during the target perforation. A 100 % loss squares with a stop of the bullet in the target.

VELOCITY LOSS IN TARGET 1



We can observe, on these results, that the PF2 loses more speed than the PF1 going through the target 1 and at any speeds.

VELOCITY LOSS IN TARGET 2



At the target 2 crossing, on the other hand, the speed losses are similar.

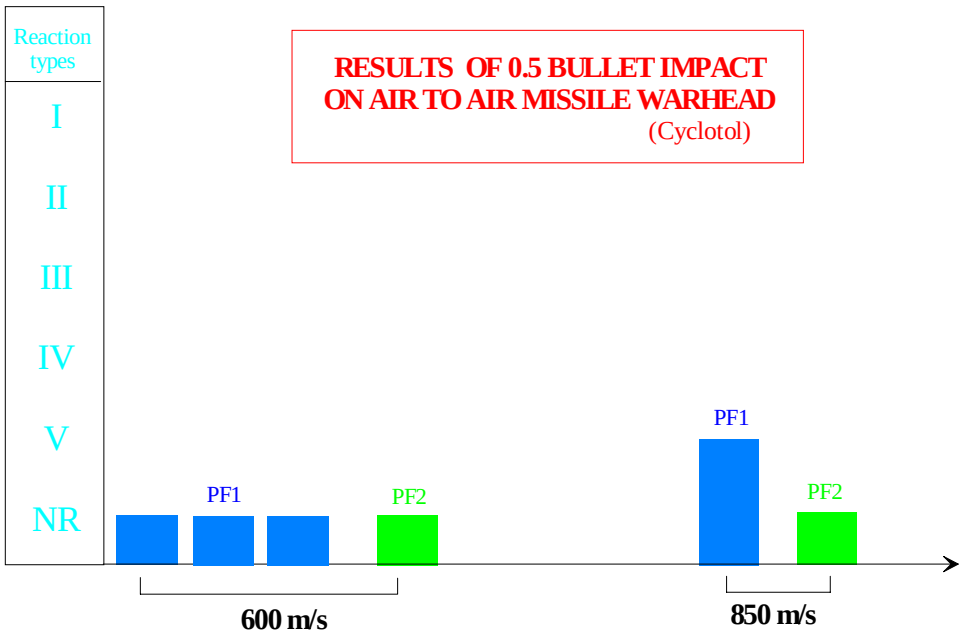
But what is sure, there are the bullet behaviour differencies. Even when the PF1 nether brakes in the target 1 and two times out of eleven in the target 2, the PF2 brakes almost every time : eight times out of ten in the target 1 and three times out of nine in the target 2.

Then, at similar speeds, the behaviours of these two bullets in the two inert targets are obviously not the same.

Can this difference lead different types of reaction on impacted ammunitions ?

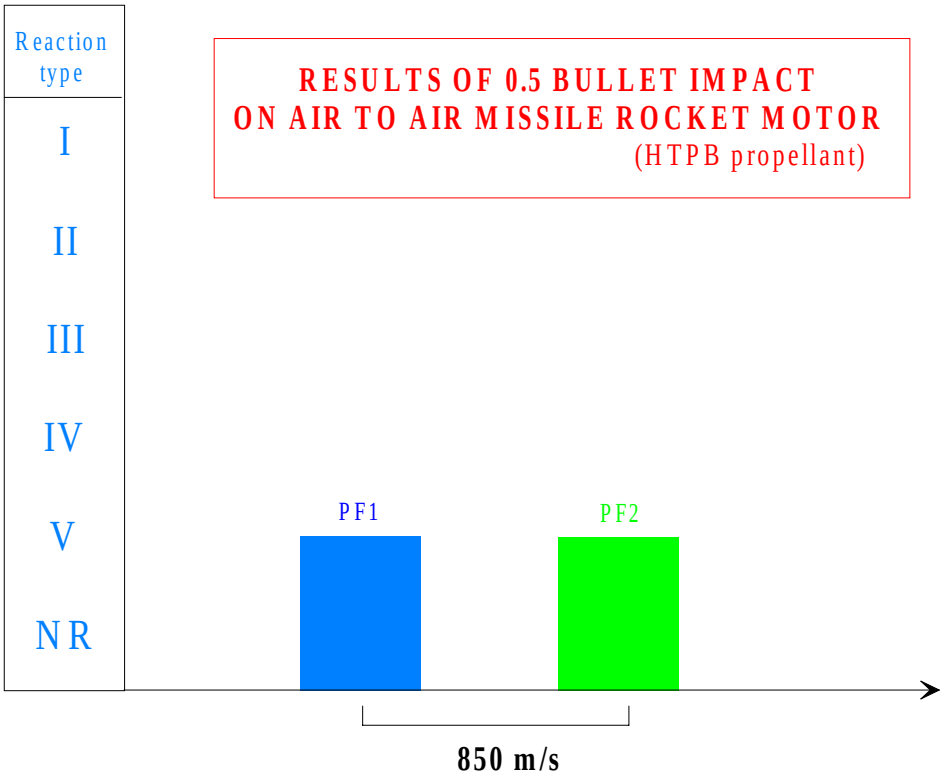
That's what we wanted to see as we carry out tests on three different types of ammunitions : a warhead of an air to air missile (containing cyclotol), a rocket motor of an air to air missile (containing HTPB propellant) and a 155 mm sheel (containing also cyclotol).

Most certainly, the total number of these tests is reduced (tests on sheel are nevertheless quite numerous), but we can get some conclusions from them.

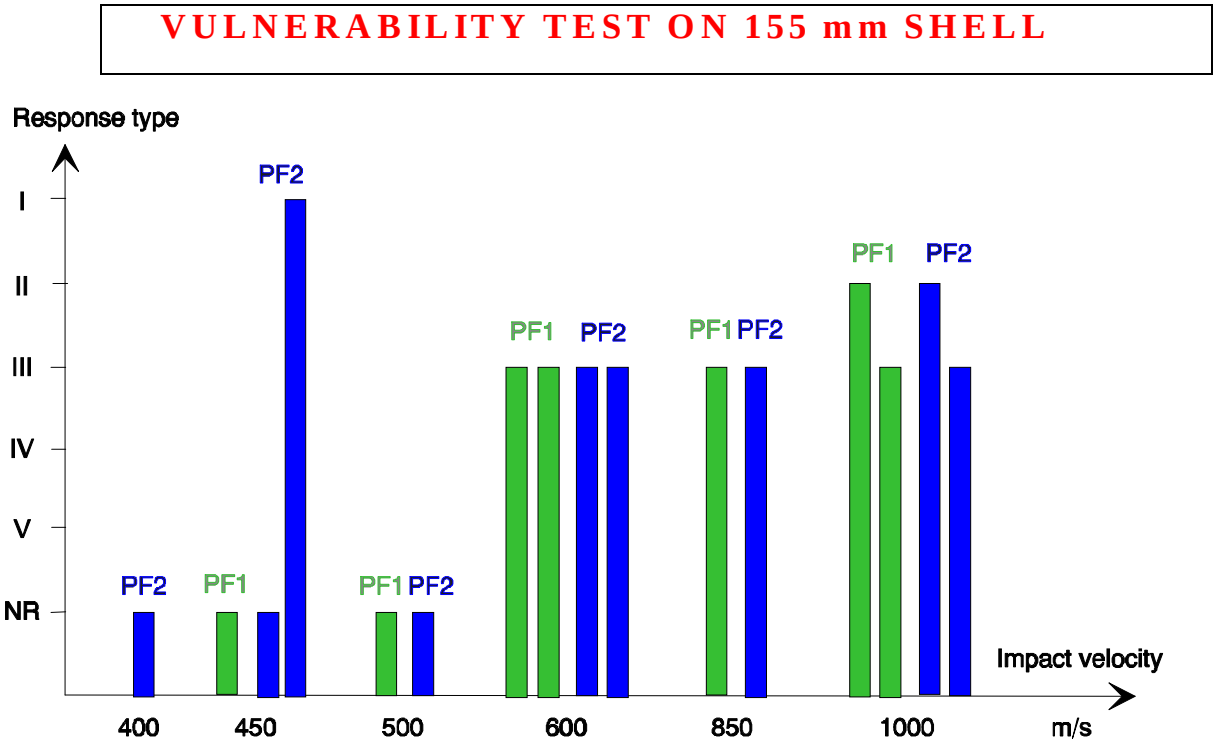


For tests on the warheads and on the rocket motors (carried out by the French MOD/DGA/DCE/CAEPE), only one difference can be noted : at 850 m/s, a type V and a No Reaction were measured.

In conclusion, the effects of both bullets seem to be similar on these two ammunitions.



For tests on the sheel (carried out by the French MOD/DGA/DCE/ETBS) nor do the differences seem significant.



On the sixteen tests, only one differs greatly from the others.

If then this anormal result doesn't compulsorily oppose both bullets. At 450 m/s, we obtained a No Reaction with PF1 and PF2 and a strange type I with the PF2.

This last result is not also coherent with the results obtained with the PF2 at 400 m/s and at 500 m/s.

This could be the fact of anormal mechanical characteristics of the bullet or degradations of the energetic material containing in the sheel.

For the other results, they seem to be in the variability of this kind of tests.

Some numerical computations are under way in France to try to reproduce the behaviour differences encountered on inert targets with the two bullets.

But if these differences seem to not affect the ammunitions reactions, it was impossible to conclude without a more elaborate study.

The later should include a large number of tests to be able to do statistics, to have a larger confidence into the results and also to test new energetic materials : only cyclotol and HTPB propellant have been tested today.

And this is what it's not easy to justify in time of budget reduction.

However one day all the countries will have this problem, then it would be necessary to continue to prepare its resolution.

For the vulnerability working group of the GEMO, it is especially necessary that on this kind of tests the used bullet must be the same during few years and used by all the french tests centers.

It is also to be desired that, through the NATO working groups, all its countries use the same bullet which will facilitate the possible tests comparisons.