

EVALUATION OF KINETIC-ENERGY NON-LETHAL WEAPONS

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The recent operations conducted by American and European armies have always included a peacekeeping or peace-enforcement part. For these types of operations, the classical small-caliber weapons are less effective because too lethal. That's why a few kinetic-energy non-lethal weapons are now present, not only for law enforcement associations but also for military task-forces.

The efficiency of small-caliber weapons is measured by using human "simulants" (ballistic soap or gelatin) for the terminal effects.

This paper applies these techniques to two different kinetic-energy non-lethal weapons. The first one is the 17.3 mm air-launched FN303, the second one is the 56 mm pyrotechnically launched COUGAR.

The difference between the calibers and velocities, and therefore between the way these weapons try to incapacitate, shows the difficulty to evaluate and compare these weapons. The classical mediums show here their limitation and have been modified to allow a comparison of "non-penetrating" projectiles.

This paper presents results for the two weapons in gelatin and soap. The tests are then extended by using skin simulants in front of the surrogate materials. Finally a new simulant which combines the advantages of both gelatin and soap is described.

INTRODUCTION

The NATO definition of a Non-Lethal Weapon (NLW) is the following: ***Non-Lethal Weapons are weapons which are explicitly designed and developed to incapacitate or repel personnel, with a low probability of fatality or permanent injury, or to disable equipment, with minimal undesired damage or impact on the environment.***

This definition points out that the denomination “less-lethal weapons” is more appropriate than “non-lethal weapons” since the risk of permanent injury always exists. That’s why when we speak about NLW, we are meaning: “less-lethal weapons”.

This general definition is quite wide and can be applied to any NLW such as mechanic, electrical, chemical, optical, microwave, ... systems.

In this article we would like to focus on and evaluate two systems that are characteristic of the kinetic-energy (KE) NLW: the FN303 (FN Herstal, Belgium [1]) and the Cougar (SAE ALSETEX [2]).

As is further developed in the following sections, these two weapons are actually representative of the possible approaches of pure kinetic energy NLW (propulsion system, projectile types ...).

The ballistic dispersion aspect is also studied in order to emphasize not only the need of efficient but also of consistent NLW.

EFFICIENCY OF WEAPONS

Introduction

To study the efficiency of weapons, some human body simulants are commonly used: gelatin, soap and clay. The wounding effect is related to the energy deposit in the simulant. Gelatin is usually a good simulant for soft tissues but is expensive and requires a sophisticated instrumentation system. Soap is quite appreciated to act as a plastic material but raises the question of the calibration (energy/volume). Finally modeling clay is used to measure behind armor blunt traumas.

The department ABAL of the Royal Military Academy of Belgium [3] has a well-established know-how in terminal ballistics for lethal weapons and would like to apply these methods for the evaluation of KE non-lethal rounds.

The Non-Lethal Weapons

The two selected “NLW” that we intend to study are FN303 and Cougar.

FN303 (figure 1) is a 17.3 mm (.68 inch) caliber air-weapon. Its 200 bar air-filled tank produces a velocity between 85 and 91 m/s for the 8.5g projectile.



Figure 1. FN303 non-lethal weapon

Figure 2 shows the available projectiles that can be placed in the 15 rounds cartridge clip. Most of them have a payload to mark a target (paint) or to enhance the incapacitation (OC). In our tests we will focus on the kinetic-energy (impact) incapacitation of the projectile.

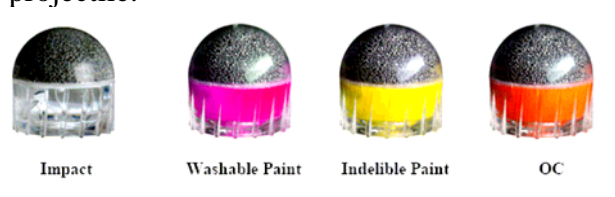


Figure 2. FN303 available projectiles

The COUGAR (figure 3) is a 56 mm one-shot weapon. It has two positions: one with sighting elements and one without (French police requirement for indirect firings). The 82g pyrotechnically-launched projectile is accelerated to 56 m/s and is called “bliniz”.



Figure 3. the COUGAR non-lethal weapon

The “bliniz” (figure 4) is a soft projectile containing powder in a latex frame. The cartridge case contains the propellant and the projectile and is guided by 4 sabots in the barrel.



Figure 4. BLINIZ : the COUGAR projectile

Table 1 shows a summary of the characteristics of the two selected weapons. The two are widely different (caliber, energy level ...) even if the final goal is the same.

Table 1. Summary of the characteristics of the selected NLW

	FN303	COUGAR
Operation mode	Pneumatic	Pyrotechnic
Launcher mass	2.3 kg	3.7 kg
Projectile mass	8.5g	82g
Caliber	17.3 mm	56 mm
Muzzle energy	35 J	130 J

The evaluation – energy considerations

If we enter these data in a trauma data correlation system [4], both weapons appear to be in the low-lethality zone for regular targets (80kg human targets).

Tests have been carried out to compare the weapons [5]. Other values have been collected to correlate the data with other weapons/systems (tennis ball, squash ball, shotgun rubber ball and shotgun 15 flexible rubber ball).

Figure 5 and 6 show the KE and KE density values for each system. “Medical” criteria are also shown on the graphs for the contusion and bone fracture limit (60 J) and for the skin and cornea perforation (0.06J/mm²). Both systems respectively fail for one of the two criteria (and succeed for the other).

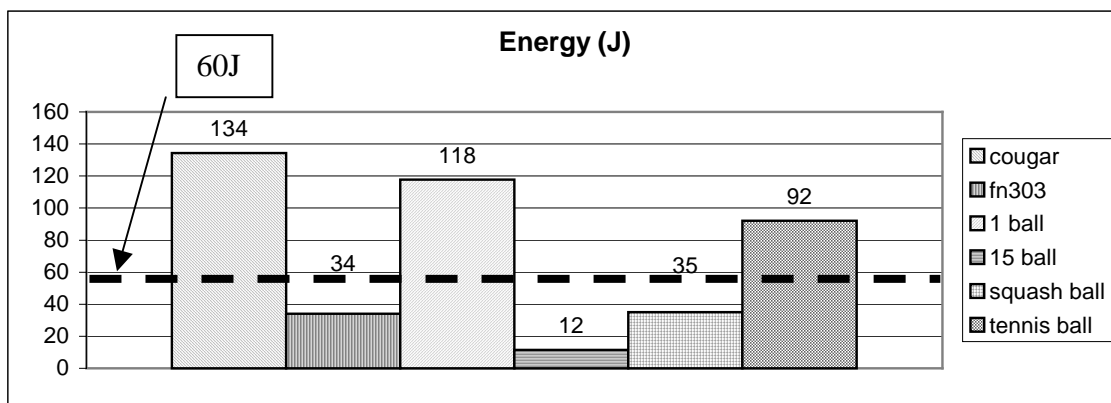


Figure 5. KE values for resp. the COUGAR, FN303, shotgun, 15-shotgun, squash and tennis balls vs. the 60J fracture level

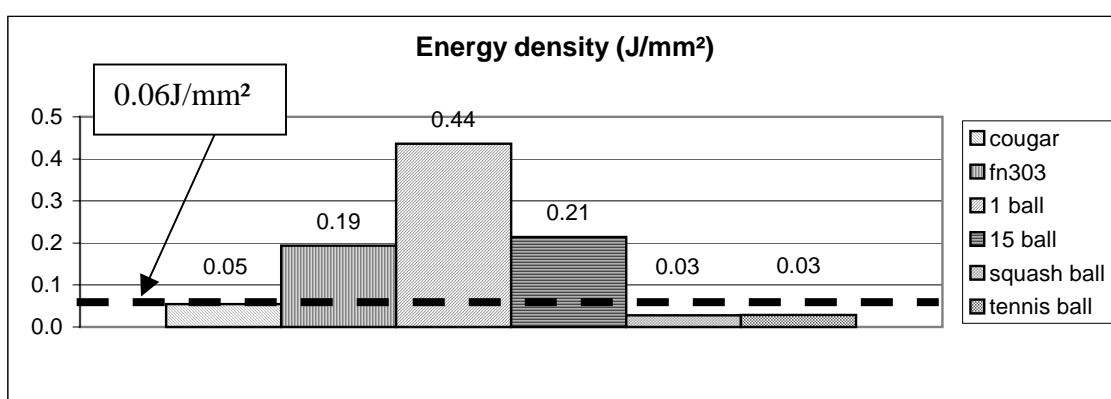


Figure 6. KE density values for resp. the COUGAR, FN303, shotgun, 15-shotgun, squash and tennis balls vs. the 0.06J/mm² skin perforation level

A question remains open: what is the reliability of these limit values. For example, if we look at figure 6, one might say that FN303 will surely penetrate in human skin (0.19J/mm² vs. 0.06J/mm²). Reports from FN303 real users showed that it is not the case. An investigation work must be carried out to better understand the interaction between a non-lethal projectile and a human target in order to “fine-tune” these values.

The evaluation – gelatin firings

For this part of the study we will focus on FN303 results because the FN projectile is more likely to be sensible at this test (smaller caliber and higher velocity).

Results of firings in gelatin (NATO preparation) [6], show indeed a penetration (same results on soap but with a more limited penetration). This is not compatible with results of real firings. That's why a skin simulant has to be placed in front of the gelatin. At first, synthetic wet chamois leather was used in front of the simulant, then chamois leather with paraffin wax (instead of water) and finally wet pure chamois leather as it is sometimes used for automotive crash simulations [7]. The first two skin simulants still showed a penetration. That's not the case anymore for the last one. Figure 7 summarizes the tests results.

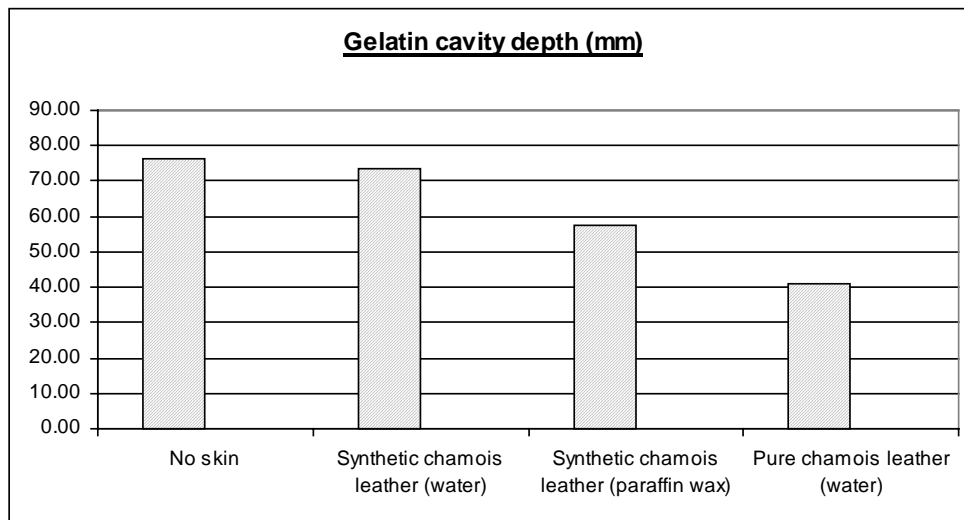


Figure 7. KE Gelatin cavity depth for the FN303

Further investigation must however be carried out because the FN303 projectile should break at impact and it's not the case. We think that the softness of gelatin is responsible for this particular point.

Because of that and because of some of the disadvantages of gelatin (not very transparent, difficult to conserve, rather long to prepare ...) we also tried to find an alternative simulant.

The evaluation – “candle gel” firings

A “soft” simulant like gelatin is more appropriate for NLW tests than a “hard simulant” like soap. It is more representative of human tissues and can also be used in conjunction with other material like bone simulants for example [8].

A new candidate has consequently been tried: candle gel (13% Kraton, 85% paraffin oil) [9]. This simulant has advantages in comparison to gelatin: more transparent, brief preparation, can be conserved, reusable ...).

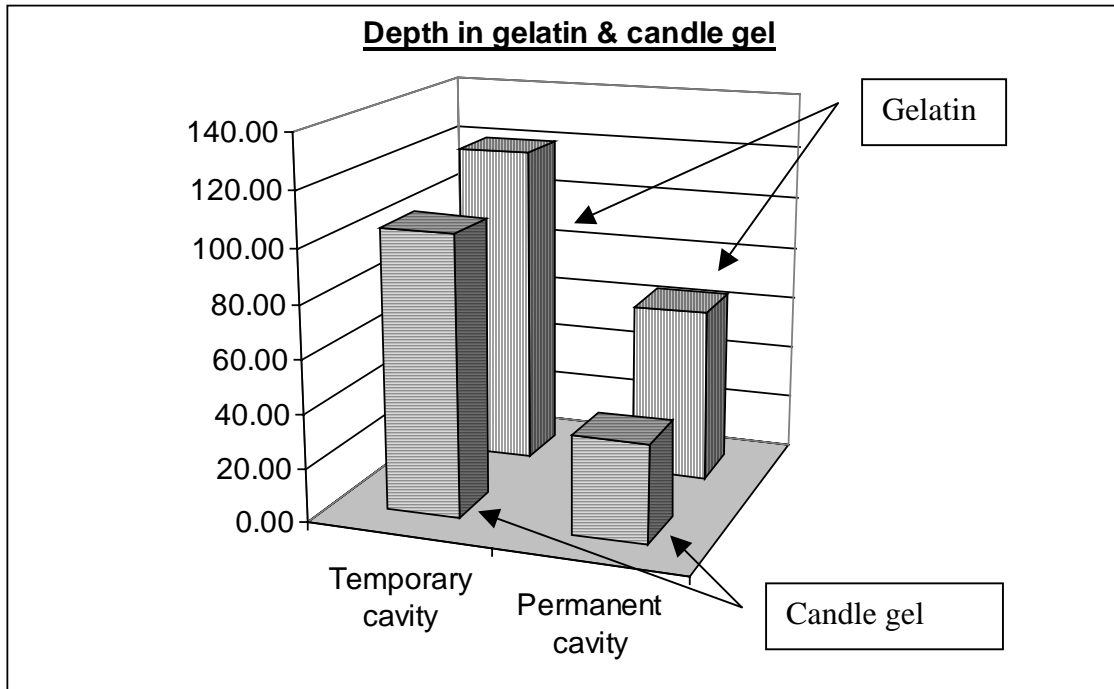


Figure 8. Gelatin and candle gel cavity depths for the FN303

Figure 8 shows that neither the permanent, nor the temporary cavities are the same but there is a relation between the two simulants. Further tests have also been carried out with a P90 5.7x28 mm weapon to ensure that results in this simulant are relevant, which is the case [6]. More NLW tests have to confirm this choice.

The evaluation – ballistic data

Some external ballistic data have also been studied. One of them is dispersion. It is a key parameter for the use of NLW. Some tests were undertaken in order to find out the CEP and R90 values of both weapons. Table 2 summarizes the results. These results show the lack of precision of the COUGAR which is really a point to improve regarding the results of the FN303 given for a longer distance.

Table 2. Summary of the dispersion results

	DISTANCE	CEP	R90
COUGAR	15m	27.0 cm	49.2 cm
FN303	25m	8.2 cm	15.0 cm

CONCLUSION

The evaluation of kinetic-energy NLW is not easy. Energetic criteria exist but they are not sufficient, and their ability to reflect a real situation is not guaranteed.

However, they have been applied to two different kinetic-energy NLW: the FN303 and the Cougar.

The well-established solutions that work for lethal systems (firings on gelatin and soap) must also be adapted to the new weapons. The projectiles fired by these weapons are not meant to penetrate a human target. Consequently, human skin elasticity and muscular tone simulants are both required to model the body response behavior.

One proposition has been made to use wet pure chamois leather in front of gelatin or candle gel. This approach gives better results but further tests have to be carried out on this last simulant in order to ensure its ability as human simulant (projectile performance, reproducibility ...).

Finally the final conclusion of this paper is that the much smaller energy levels obtained in NLW implies a deep revision of the method used for the evaluation of such weapons.

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