

# **TECHNICAL REPORT: THE DIRECT IMPACT**

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## **INTRODUCTION:**

Specialty Impact Munitions (SIM) continue to be important tools for the law enforcement professional that provide favorable alternatives to the use of lethal force to control aggressive subjects or deter unwanted behavior. They are useful in crowd management situations, as well as in targeting specific aggressive individuals. The munitions allow the user to elicit compliance from the subject without coming into physical contact, which improves the safety of all involved. While all impact munitions have the potential for causing injury, careful control of the design, materials, and performance of the munition and the impact projectile minimizes the probability of serious injury.

Impact munitions fire a projectile at the body, which delivers blunt trauma and the associated pain of the impact. For maximum effectiveness, the pain inflicted by the projectile impact must be sufficient to elicit compliance, yet the delivered energy must be low enough to prevent serious injury. Equally important is the projectile accuracy, to allow precise shot placement over a wide range of engagement distances to maximize standoff from the target. By carefully controlling the velocity of the projectile, a high degree of accuracy can be maintained while delivering consistent kinetic energy levels at various operational distances. In addition to the mass and velocity of the projectile, the physical design and materials of construction significantly influence the projectile's potential to cause injury.

Other useful tools for the law enforcement professional involve delivery of a chemical irritant, such as Oleoresin Capsicum (OC), to incapacitate or produce pain compliance in an aggressive subject; or delivery of a marking compound, for later identification of the subject in a crowd. Munitions currently available in the industry to deliver a chemical irritant cannot be directly fired at the body, and existing marking rounds do not have the required range and accuracy to be effective. Combining the blunt trauma of a direct-fired impact munition with the dispersion of a chemical irritant or marking compound will produce a multi-sensory response in the subject, producing optimal pain compliance and increased effectiveness. This report describes the development and testing of the Direct Impact, a 40mm projectile that is designed to be direct-fired at the body to deliver both blunt trauma and an irritant or marking payload.

## **DESIGN:**

The Direct Impact components include a specially engineered projectile combined with a proven smokeless propulsion system. The resulting munition produces consistent performance over a wide operational range, as well as unmatched accuracy and less-lethal impact characteristics.

The projectile utilizes the 40mm spin-stabilized base developed by the US Army Research Laboratory, which is currently produced by Defense Technology for the eXact iMPact 1006, under an exclusive licensing agreement with the Department of Defense. The projectile base incorporates a rifling band to spin the projectile in-bore, to produce optimum stabilization in flight. The design of the overall projectile (base and nose) was optimized using computer simulation software to model the projectile mass properties and aerodynamic shape, stability, and flight dynamics.

The key design feature of the Direct Impact projectile is a rigid, crushable foam nose that incorporates an aerodynamic external contour and a hollow internal cavity to carry a 5-gram payload. The available payload options include an inert powder, an OC irritant powder, or a fluorescent green marking compound. The foam density is controlled to produce a projectile nose with good structural properties for rough handling and launch shock. The rigid foam nose, while strong, will deform and crush when it impacts the target. The deformation increases the surface area of impact, and the crushing action ejects the payload laterally, dispersing a two-foot diameter cloud of irritant or marking compound. The combination of the deformation and dispersion of the payload dissipates significant energy, which decreases the kinetic energy that is transferred to the target and reduces the potential for injury over the entire operational range.

The Defense Technology propulsion system incorporates a modified high-low pressure design, which results in very efficient burning of the smokeless powder propellant and consistent shot to shot velocities. Other advantages of the smokeless powder system include minimal smoke that can obscure vision, reduced fouling of the barrel, and a lower report and recoil compared to conventional black powder systems.

## **RESEARCH AND TESTING:**

During the development of the Direct Impact, extensive testing was done to characterize the performance and less-lethal properties of the round. Specific tests assessed the velocity and accuracy over the range of operation, demonstrating the stable flight characteristics of the projectile, and the consistent performance produced by the propulsion system. The velocity was adjusted to deliver approximately the same kinetic energy as the XM 1006 round, accounting for the slightly heavier projectile. The impact energy shows only minor degradation at the longer ranges due to the aerodynamic design and the flight stability of the projectile (Table I). Figure 1 compares the velocity and kinetic energy data of the Direct Impact inert and marking rounds with other specialty impact munitions. The optimized flight characteristics are further verified by the typically tight shot patterns observed at the longer range (see accuracy data).

Numerous tests were also done to assess the relative lethality of the round by measuring impact deformations into ballistic clay, which were based on the standard for body armor testing (NIJ Standard 0101.03). In this test, the projectile is fired into temperature-conditioned Roma Plastilina No. 1 Modeling Clay, and the resulting deformation cavity is measured. To be considered non-lethal, the depth of the impact cannot exceed 44mm. Other parameters can be derived from these measurements, including the force and pressure exerted by the projectile. The Direct Impact had excellent impact characteristics over the range of operation, due to the unique energy-dissipating properties of the crushable foam nose. The impact deformations for the Direct Impact were compared to the large database that exists for the XM1006, showing significantly improved penetration depth (Table II).

Because the projectile foam nose can fragment as it is crushed, additional testing was done to assess the potential for laceration by the rough surface of the crushed foam. The ballistic clay tests were repeated with simulated and real animal skin stretched over the clay target. Moist chamois cloth and the skin of a freshly butchered hog were used to simulate live skin over a compliant substrate, and the hog skin was stretched over a barrel to simulate live skin stretched over a rigid substrate. No evidence of laceration to the skin was observed for any of the tests, and the impact deformations were reduced.

Finally, testing was done to characterize the dispersion of the cloud formed by ejection of the payload when the projectile foam nose is crushed. Using video footage, measurements were made of the particle spread as well as the residual powder on the target (in the case of the

marking round). Rough handling and 2-meter drop testing were also done to verify the structural integrity of the round.

#### **DEPLOYMENT AND TACTICS:**

The Direct Impact Munition provides the law enforcement professional with the maximum flexibility to address multiple operational scenarios with a single munition. The accuracy and consistent performance of the round make it an ideal choice for deployment ranges from 20 – 100 feet, in variable environmental conditions, with a high degree of confidence in the aim point. This allows the round to be equally effective when used against a lone aggressive subject, or when targeting a specific individual in a crowd. The unique impact characteristics of the Direct Impact make it the safest choice for direct firing at the body with the lowest probability of serious injury. Because the Direct Impact and the XM1006 have similar flight characteristics, familiarity with the XM will help the officer to quickly gain proficiency with the Direct Impact.

The Direct Impact can be used as an accurate way to deliver an irritant or marking payload in close proximity to a group of subjects, without the risk of impact injury inherent with barricade penetrating projectiles. Due to the efficient payload dispersion pattern, multiple subjects can be affected by targeting only a few individuals.

The Direct Impact provides a multi-sensory stimulus to the subject, involving pain from both blunt trauma impact and contact with the OC irritant. The shock induced by the impact from the projectile will often cause increased inhalation or ingestion of the irritant powder, increasing its effectiveness. The combined effect of these two stimuli will incapacitate and elicit compliance from the subject more quickly and with fewer rounds deployed.

#### **CONCLUSION:**

The Direct Impact has been developed to provide the safest, most accurate, and versatile Specialty Impact Munition available on the market today. Its unique design provides significantly improved impact performance that allows precise targeting of the body with minimal probability of serious injury. The ability to deliver multiple stimuli and payloads makes the Direct Impact the best choice for diverse operational scenarios requiring maximum effectiveness. No other available product can provide the law enforcement professional with the consistent less-lethal performance, level of effectiveness, operational flexibility, and confidence backed by the most extensive performance and lethality testing in the industry.

# THE DIRECT IMPACT

## Technical Specifications

Caliber: 40mm (1.6 in.)  
 Length: 4.30 in.

Propellant: Smokeless  
 Average Muzzle Velocity: 302 fps

<u>Payload</u>	<u>Nose Color</u>	<u>Payload Weight</u>	<u>Projectile Mass</u>	<u>Average Kinetic Energy</u>
Inert	Black	5 g	37.8 g	118.0 ft-lbs
OC Irritant	Orange	5 g	37.4 g	116.8 ft-lbs
Marking	Green	3.8 g	36.2 g	113.0 ft-lbs

## Aerodynamic Properties

Drag Coefficient: 0.29  
 Gyroscopic Stability Factor: 1.22

## Accuracy (Measured at 100 ft)

Typical 7-shot spread: 5 in. (horizontal) by 5 in. (vertical)  
 Deviation from aim point: 3 in. (horizontal) by 21 in. (vertical)

**Table I: Impact Energies** (Direct Impact, Inert)

	Muzzle	15 feet	30 feet	45 feet	60 feet	75 feet
Velocity, fps	310	289	294	301	296	283
KE, ft-lbs	123.0	106.9	110.7	116.0	112.2	102.5
Momentum, lbft/s	25.8	24.0	24.5	25.0	24.6	23.6

**Table II: Blunt Trauma** (Measured at 20 ft)

Impact Media	Velocity fps	KE ft-lbs (J)	Impact Depth, mm	Ave. Force lbs	Impact Area, mm <sup>2</sup>	Pressure psi
Ballistic Clay	308	122.7 (166.4)	28.4	1266.5	2419.2	337.8
Hog Skin/Ballistic Clay	302	118.0 (160)	14.8	2428.0	3238.0	483.8
Ballistic Clay (XM)	336	115.9 (157.2)	35.5	994.9	3318.3	193.4

**Figure 1: Impact Energies**

