APPLICATION OF AIRBAG TECHNOLOGY FOR VEHICLE PROTECTION AND NON-LETHAL APPLICATIONS

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ABSTRACT

The Warheads Group at the U.S. Army ARDEC developed a novel non-energetic RPG protection munition based on automotive airbag technology. This munition dispenses an airbag to impact an RPG causing it to go high order at long standoff causing the shaped charge jet to be ineffective. There are many advantages for this munition, primarily there are no explosions and no high energy fragments dispersed, therefore, no fratricide issues. Dynamic testing has demonstrated that this technology is capable of meeting these requirements.

1. BACKGROUND

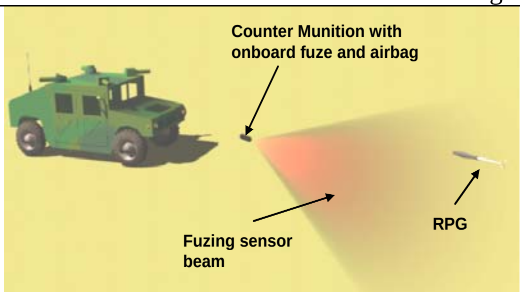
The RPG is the weapon of choice because their availability, ease of deployment and low cost. These factors make them widely proliferated and suitable for ambush attacks. While the RPG has little impact on heavily armored vehicles because thick armor stops the shaped charge jet penetration, they post significant threats to lightly armored vehicles such as Stryker, High Mobility Multipurpose Vehicle(HUMMWV), and other combat vehicles. For this reason, the U.S. Army is pursuing an Active Protection System to provide vehicle survivability against this threat.

Both government and industry are investigating several Active Protection System (APS) initiatives. The vast majority of Active Protection Systems are energetic in nature, deploying a fragmenting explosive warhead or high velocity / high energy projectile. While these energetic solutions are effective against the RPG threat, they can pose problems when used in heavily populated, urban environments.

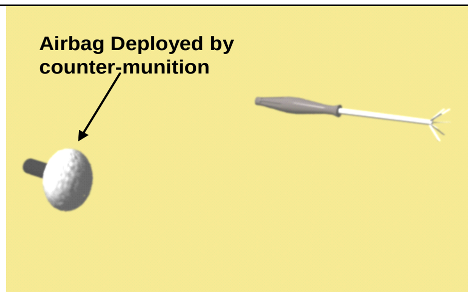
In view of the above, the Warheads Group at the U.S. Army ARDEC developed a novel non-energetic RPG protection munition based on automotive airbag technology. Figure 1 depicts the operation of this munition. The figure shows the munition being launched to intercept the incoming RPG. Upon launch, the munition dispenses an airbag to either deflect the RPG away from the vehicle or crash into the RPG causing it to pre-detonate at a long standoff from the vehicle, rendering it ineffective.

While there are many advantages for this munition, first and foremost, is that there are no explosions and no fragments dispersed, therefore, no fratricide issues. Because this munition contains no explosive, it can be fielded quickly as a first generation Active Protection System that can offer a high level of protection for U.S. troops.

Figure 1.



A) Counter-munition searching for threat



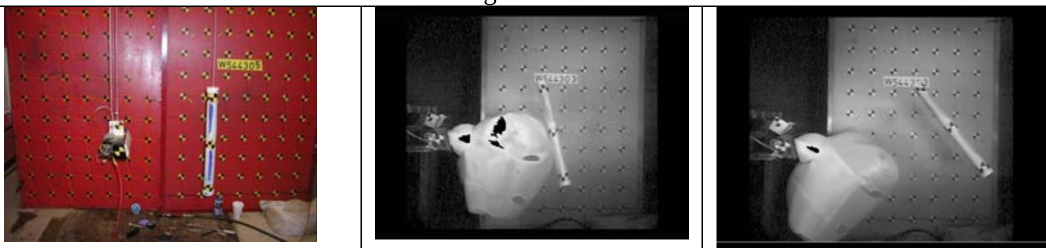
B) Deployment of airbag

2. INTRODUCTION

Initially, the concept was to deflect an incoming RPG away from a vehicle. A series of experiments were conducted using an airbag to characterize this deflection. The purposes are 1) to characterize the airbag deployment, 2) measure the amount and rate of deflection, and 3) provide data to calibrate the computer model for analyzing the deflection. These initial experiments were conducted at the TRW commercial automotive airbag test facility.

A length and mass matched object was created to simulate the RPG-7. A 1995 Ford Taurus passenger side airbag was chosen for this test because it has a very high deployment-force and speed. Figure 2a shows the experiment setup. Both the airbag and RPG simulant are freely suspended. Figure 2b shows the airbag in mid-deployment beginning to impact the simulant. Figure 2c shows the simulant being deflected upward. In fact, the simulant was deflected all the way up to the stop which is 90 degrees from the start position. Table 1 summarizes this test series.

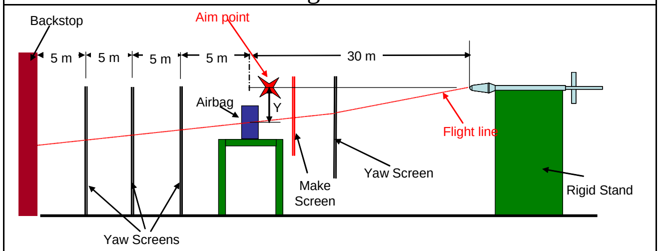
Figure 2.



A) Setup photo | B) Mid airbag deployment | C) Full airbag deployment

As the table shows, the experiments demonstrated the airbag's ability to deflect a statically suspended RPG, in this case, an RPG simulant. The next experiment, conducted at ARDEC, would determine whether the airbag has the capability of deflecting an RPG in flight. Figure 3 shows the experiment setup.

Figure 3



Static airbag vs. dynamic RPG

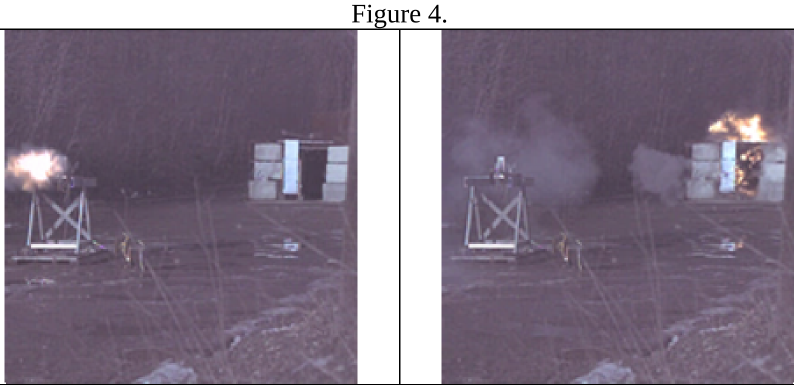
Table 1.		
Test Configuration	**Test Objective**	**Test Result**
Airbag only	Bag deployment characterization	Determined bag deployment time and size
Hard mounted airbag vs. simulant @ 0" standoff	Measure amount of simulant deflection	Simulant deflected more than 90 degrees
Hard mounted airbag vs. simulant @ 18" standoff	Measure amount of simulant deflection	Simulant deflected more than 90 degrees
Suspended airbag vs. simulant @ 0" standoff	Measure amount of simulant deflection	Simulant deflected more than 90 degrees
Suspended airbag vs. simulant @ 18" standoff	Measure amount of simulant deflection	Simulant deflected more than 90 degrees

In this experiment the airbag, a 1995 Ford Taurus passenger side airbag, is mounted to a rigid stand to intercept the dynamically fired RPG. The RPG is located 34 meters from the airbag. This distance was chosen to maximize the probability of intercept. A witness plate was placed 20 meters from the airbag to collect post intercept data. The test involves launching the RPG towards the witness plate. When the RPG passes through a make screen, it triggers the airbag to deploy deflecting the RPG as is passes the side of the bag.

After three attempts, it was apparent that, due to the uncertainty of the RPG fly out, it would be extremely difficult to time the bag deployment to strike the RPG as it flew by. The experiment was modified to have the bag partially deployed as the RPG flew by. This ensured that there would be some interaction of the airbag with the RPG.

Figure 4a shows the RPG being launched towards the witness plate. Please note that the witness plate is inside the structure shown at the right side of the picture. Figure 4b shows the RPG detonating where the airbag was deployed. It turned out that the crush fuze of the RPG requires little force to generate the voltage required to detonate the warhead. When the RPG detonated, the shaped charge jet becomes ineffective because of the long standoff before impacting the witness plate. Due to the standoff only a splattering of the shaped charge jet particles was seen. This significantly reduced the effectiveness of the jet enough to protect a vehicle at that distance.

Figure 4.



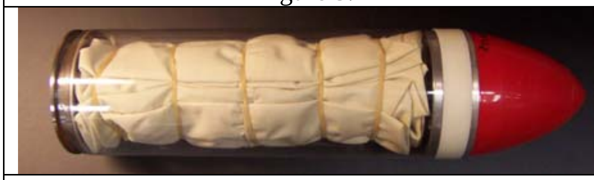
A) RPG’s main motor ignited | B) RPG detonates on Taurus airbag

3. TACTICAL MUNITION

The tactical interceptor now contains a driver side airbag assembly plus inflator. This bag was chosen because 1) it can be packaged into a four inch round, and 2) it opens radially into a spherical shape, an important feature for aerodynamic stability in flight. The steel inflator doubles as the interceptor’s structural member helping to drive the fully inflated bag forward in flight and maintaining course. A plastic shell houses the airbag assembly and provides an aerodynamic profile for the interceptor. When the airbag deploys, it will fracture the shell and scatter the pieces. A nose cone assembly is attached that contains the electronic timing circuit that initiates the bag inflator after time out.

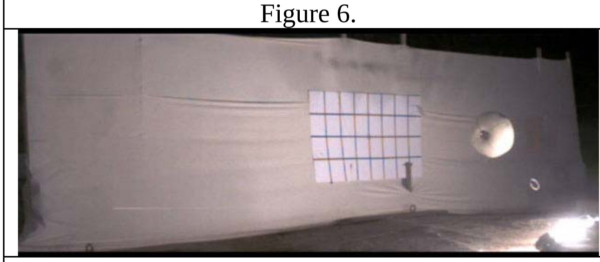
Upon launch, the timing circuit starts the time out sequence. When the preset time is reached, the circuit sends an electric current to ignite the propellant in the inflator. Once ignited, the burning propellant produces enough pressure to force the pressurized inert gas to rupture the containment disk. This allows the pressurized inert gases to escape through the exhaust and inflate the airbag. Figure 5 shows the actual airbag interceptor, and Figure 6 shows the airbag deployed and in flight.

Figure 5.



Repackaged airbag

Figure 6.



Flight test of inflated airbag

The tests showed a tactical interceptor could fly with the airbag fully deployed over long distances in a relatively straight line. This is important because the interceptor can be counted on to fly and remain stable to the intercept location with the incoming threat.

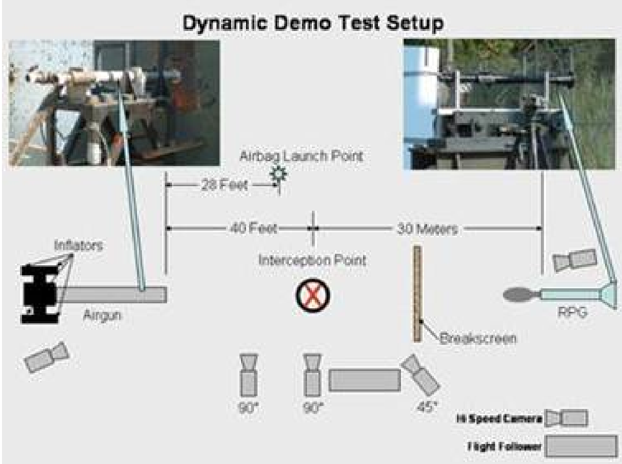
4. DEMONSTRATION

Parallel to the development of the interceptor, a series of static airbag versus dynamically launched RPG tests were conducted. The objective of this test series is to determine if the driver side airbag would be able to defeat the RPG like the Taurus airbag did. This test series was conducted at Aberdeen Test Center (ATC).

The next series of tests would verify the effectiveness in a dynamic / dynamic environment. Figure 7 shows the setup of this test. The picture at top right shows the RPG launcher, while the picture at top left shows the air gun used to launch the airbag interceptor. When the RPG is launched, it flies through a break-screen to trigger the launch of the airbag interceptor.

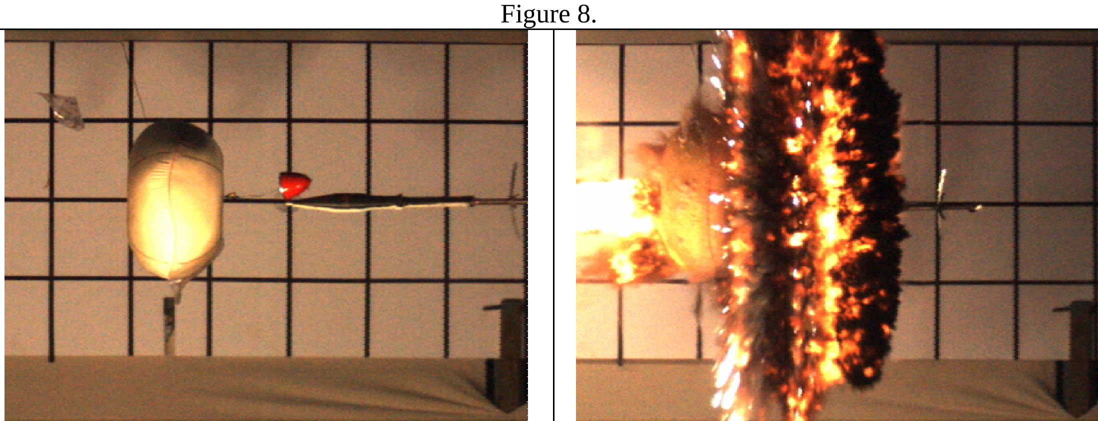
Figure 8 shows the result of one of these tests. A still from the high speed video shows the alignment of the RPG to the airbag just prior to impact. Figure 8b shows that the RPG clearly detonated on impact with the airbag.

Figure 7.



Dynamic / dynamic test setup

Figure 8.



A) RPG just prior to impact with airbag

B) RPG detonates on impact with airbag

4. SUMMARY

Experiments clearly show the potential of automotive airbag technology as a defense against RPG attacks, either by deflecting the RPG away from its flight path or pre-functioning the RPG far from the protection zone. They also showed it is possible to package an airbag into a tacticle interceptor that will fly straight even with the airbag deployed. Further, these experiments demonstrate the potential of the airbag interceptor as a viable means of protecting our soldiers against RPG attacks while minimizing collateral damage.