From the Directorate of Army Doctrine

The Threat from Blast Weapons

INTRODUCTION

Nations around the world are always working on producing more effective weapons. The speed of such developments will change depending on the situation; the crucible of war often results in rapid advances. During a war or other conflict, a nation is usually more willing to devote extra resources to such Research and Development (R&D). Involvement in a war also has the effect of focussing efforts on any unique threats in that conflict, whether that effect is due to the environment or the opposing forces' capability. As an example, the Americans created or improved many unique and new weapons systems during the Vietnam conflict, including unattended ground sensors, night vision devices, unmanned aerial vehicles and standoff surveillance.

It appears that the Soviet-Afghanistan conflict was the catalyst for the Soviet Army to develop new weapons, as Afghan guerrilla forces stymied its operations. One weapon that was developed to overcome some of the unique problems posed by the mountainous terrain was a hand-held launcher and projectile that used blast as its primary effect. This initial development has apparently led to a sustained development effort to create a class of blast weapons ranging from hand-held to tank chassis-mounted systems. The West has greeted the identification and development of this class of weapons with interest.

BACKGROUND

All explosives create a blast wave, but conventional explosives usually produce a short duration, high-pressure effect. Blast weapons, by contrast, are designed to produce as much blast as possible. To do this, weapon designers will maximize the explosive content and minimize extra weight in the form of shell casing. In addition, extra large burster charges and other mechanisms are used to increase the dispersion of blast-generating energetic materials.

Most of the conventional explosive weapons in the world are designed to use the kinetic energy of projectiles to create their effect. Conventional explosive weapons usually use the energy of the explosion to work on another material, whether it is creating and throwing shrapnel at high speed or forming a shaped charge to punch through armour. The blast effects are normally incidental side effects, which are useful nonetheless. This can be demonstrated by observing artillery shells and hand grenades. Artillery shells use their explosive filling to shatter the shell and then throw the fragments at high speed to create the destruction desired. Modern hand grenades use pre-fragmented liners that are thrown out by the explosive charge. Yes, there are stun grenades, but this is a specialized subset of ordnance. It is only when you look at large aircraft bombs, 250 kg or larger, that you find that the majority of the effect is caused by blast and not shrapnel. It is not clear if this is deliberate or simply a result of the evolution of these weapons (desire for increased bomb weight translates into a greater percentage of explosive filling to case weight?). The only other common weapon that relies on blast is the anti-tank mine, usually in improvised or first generation mines. These mines rely on the blast effect of the explosives to disable or destroy the vehicle. This is inefficient, which is why more modern mines use smaller amounts of explosives and rely on other effects, such as shaped charges, to attack the vehicles.

Due to the reliance on shrapnel, most of our defensive measures have focussed on defeating the shrapnel effects. That is why we wear helmets and body armour and build bunkers and trenches. Shrapnel effects are also the focus of the design efforts of our armoured vehicles. Unfortunately, it is becoming clear that these same protection measures do not always effectively protect us against some of the effects of blast weapons.

The first generation of blast weapons was apparently developed in the late 1960s. Since then, blast weapons have been under continual development, resulting in more portable and effective versions becoming widely available on the world market. It is interesting to note that R&D on fue-air explosive (FAE) blast weapons in the West was largely curtailed or, in cases such as the UK and Canada, entirely terminated in the 1980s because they were considered too dangerous to handle, particularly for naval transport. Technological advances in explosives have since resulted in the development of safer, more effective types of blast weapons referred to as "thermobaric weapons" or "enhanced blast weapons." Because this technology originated from Russia with no Western equivalents for comparison, the English terminology for the various types of blast weapons is very confusing, and many foreign weapon designers use the terms incorrectly. Some of the novel terminology used to identify blast weapons includes vacuum bombs, "FAE-like," high-power blast, and "high-blast." The Russians tend to be fairly consistent with the use of "thermobaric" when referring to the RPO-A hand-held disposable launcher, which is known to have been used in Afghanistan and both of the Chechnyan conflicts.

Because of the potential prevalence of these weapons worldwide, blast weapons are an increasing threat to the Canadian Forces (CF) as it

conducts operations around the world. Much of the information about these weapons has been classified until recently. However, the proliferation of blast weapons demands that Canadian soldiers be informed of their capabilities and the means to defend against them or reduce their potential effects.

AIM

The aim of this primer is to provide general information on the threat posed by blast weapons and what the Canadian Army is doing to develop countermeasures. This primer will lead the reader through a sequence of information to ensure a basic understanding of blast weapons, followed by an overview of the threat, known countermeasures and, lastly, some information on how the Army is tackling the problem. More detailed information on threat weapons and countermeasures can be found in *The Bulletin* on "The Threat from Blast Weapons" produced by the Army Lessons Learned Centre.[1]

BLAST WEAPONS

The two common types of blast weapons are FAE and thermobaric. The terminal effects of these two types are quite different at close ranges but are basically the same at locations well outside the fireball. The blast effect can be produced in two ways: the traditional two-stage event or the more recent development of a single-stage weapon.

In general, a two-stage blast weapon creates its effect by an initial explosion of the carrier shell, which disperses fuel into the air as vapour, droplets or dust—a "finely dispersed cloud." This cloud of liquid fuel or dust is subsequently detonated, creating a blast wave that produces high levels of overpressure. In the case of FAE, some systems have produced overpressure levels that are well in excess of 3-4 times that of TNT, on a pound per pound basis. Latest Russian designs claim to have improved on this performance by another 1.5 to 2 times by enhancing blast dispersion. The duration of an FAE blast wave is typically also of much longer duration (relatively) than a conventional explosion.

By contrast, a single-stage weapon uses one explosive to burst open and disperse the fuel. The composition of this fuel allows it to ignite and progressively propagate a shock and blast wave. These are sometimes referred to as "thermobaric" weapons, as they have an intense fireball due to the considerable amount of afterburning that occurs (the term originates from the fact that it involves thermally generated blast or baric).

Blast weapons act differently than shrapnel-based weapons, which essentially travel in straight lines. The intense heat of the fireball of the thermobaric weapons must also be considered. Waves, whether water, sound or blast, have the same characteristics and properties: waves reflect off surfaces, travel through openings and can be magnified anywhere two or more waves intersect. Most importantly, however, waves can also refract around corners, and reflecting or refracting waves can superimpose upon each other to greatly increase their intensity over localized regions. Therefore, blast weapons can penetrate buildings, bunkers or trenches through windows, doors, firing ports, observation slits or other openings. This destructive blast can also enter vehicles through open hatches, firing ports and air intakes. Once inside confined spaces, the destructive effects of the blast wave are magnified significantly as it reflects off hard surfaces.

The overpressure from blast waves can kill or injure personnel by crushing internal organs, causing damage to the lungs and intestines. Another source of injury is simply the effect of the blast wave literally throwing objects and personnel around. Inside a confined space such as a room, a blast weapon can blow out all of the walls, with the potential effect of collapsing the structure. Often, an internally-activated blast weapon will literally lift the roof off of the load-bearing walls thereby rendering the entire structure unstable so that it collapses easily. The heat effects, as mentioned, can cause additional burn injuries or fires, although this is considered a secondary kill effect and some blast weapons are designed to almost exclusively deliver blast kill. As with all explosives, secondary fragments are a concern even if the design is not intended to maximize fragment delivery.

Blast weapons are not the perfect weapons for all circumstances. The destructive effects of blast waves are magnified in confined spaces, but they dissipate quickly in the open. This characteristic could be used to the advantage of any force confronted with these weapons. At the same time, the relatively short range of the blast effect, coupled with the low quantity of shrapnel produced by blast weapons, allows them to be used to for close support. Assaulting troops can manoeuvre more closely to their supporting fire than they can with conventional, fragment-producing weapons.

BLAST WEAPON SYSTEMS

Since the initial development of blast weapons, a variety of weapon systems have been developed or modified to use them. Generally, in order for a weapon system to be chosen, it must support the use of thin-walled carrier shells to maximize the amount of the fuel and minimize the amount of metal that does not contribute to the blast effect. It is obvious that rocket systems lend themselves to this feature, whereas conventional tube artillery shells do not. Another concern with tube artillery is that the set back forces cause problems for the liquid fills common to most blast munitions. Stability and accuracy of the airborne projectile is another consideration for those blast-fill formulations that are pastes or liquids.

The current blast weapons threat ranges from artillery to hand-held weapon systems. Artillery systems include the large diameter, multiple-barreled rocket launchers such as the widely available 122mm GRAD (BM-21), 220mm URAGAN and 300mm SMERCH. The most widespread threat—therefore, potentially the most dangerous—comes from the wide variety of shoulder launched weapons that are now available on the open market. Examples of these types of weapons are the Russian RPO-A (SHMEL) and the TBG-7V (TANIN). These infantry weapons are used against defensive positions, whether bunkers, defended buildings or other field fortifications. Assault troops are able to manoeuvre within 40 metres of the objective when RPO-A is employed. However, because they cannot penetrate a protective barrier, more sophisticated blast weapons have been developed. These have a double (often incorrectly referred to as "tandem") warhead arrangement, which uses a precursor high-explosive anti-tank charge to create a hole through the target to allow a secondary, enhanced-blast warhead to pass through. This double warhead arrangement affords an anti-armour and fortification penetration capability and allows the enhanced-blast charge to be detonated when completely inside the target.

COUNTERMEASURES

Some countermeasures are known today, which require the application of common sense with knowledge of the weapon effects. Some of the countermeasures are procedures that are already taught: camouflage and concealment, dispersion and deception are all valid measures that will reduce our vulnerability to any weapon system. Other measures are more specifically targeted against blast weapons.

As with many other activities in the military, the first step relies on intelligence. Identification of the presence or absence of blast weapons is important as it allows commanders at all levels to consider the appropriate countermeasures. Defences, as an example, could be sited in depth with early warning systems in place. Offensive measures could be designed to target the destruction of blast weapons systems or their crews. Personnel carrying or about to employ blast weapons could be engaged as priority targets, rules of engagement permitting. The ability of blast weapons to defeat standard field fortifications reinforces the requirement for such fortifications to be mutually supporting within the defensive framework. This concept is not new, as any stand-alone defensive position is more easily taken than a properly supported position.

Current personal protective equipment (helmets, ballistic vests and eye protection) can be used to reduce the effects of flying debris and the thermal effects of the fireball. Armoured fighting vehicle crew suits and gloves will also provide a degree of protection against flash burns, as will almost any skin covering. The difficulty is providing adequate protection against the overpressure created by a blast weapon. R&D is working on this, with initial research concentrating on getting a much better understanding of the effects on the body. This research is a necessary first step leading to possible protective measures or equipment.

Research conducted at Defence Research Establishments Valcartier and Suffield regarding mine blast effects has demonstrated that the best means to protect the occupants of field fortifications from the effects of blast weapons is to prevent the blast wave from entering the structure. Openings such as observation ports need to be covered with materials that will not shatter and become lethal projectiles. Screens should also be used so that the weapons detonate away from the building. The construction of a building must be carefully considered before using it for defence (this is also nothing new in urban warfare). Masonry or brick buildings with concrete floors and roofs are liable to collapse if the walls are blown out or damaged by a blast weapon. By contrast, most modern high rise buildings with curtain walls won't collapse, although the walls normally offer scant protection.

Trenches are designed to protect troops from fragments and blast from conventional weapons. The effects of blast weapons reduce, but do not negate, the overall effectiveness of trenches. Shelter bays can be protected to a certain extent by hanging a heavy curtain across the bay entrance. Notwithstanding the reduced effectiveness of trenches against blast weapons, they can still provide protection against debris and the other conventional weapons systems that will continue to be the overwhelming threat.

CAMPAIGN PLAN

To this point, this article has discussed the threat and current countermeasures. To coordinate the work to improve our countermeasures, the Army has been developing a campaign plan. Lines of operation have been identified with specific goals and criteria for success. This plan is under revision, but the basic outline remains valid. The centre of gravity for the Army on the use of blast weapons is assessed to be the capability to protect our soldiers against blast munitions. This has focused the campaign plan's main effort on defensive issues, which range from individual protection, field fortifications and medical countermeasures. These lines of operation are being developed to lead the Army through decisive points to protect our centre of gravity. They include education, intelligence, doctrine, tactics, R&D, weapon system procurement and public relations.

The soldiers in our Army are well educated, which aids in one of the best defences against this new threat: giving our soldiers the information they need to deal with blast weapons. Knowledge dispels fear and will allow our soldiers to better use the tools they have been given. There have been some concerns raised about the potential morale problems of soldiers faced with casualties caused by blast weapons. While there are many aspects to morale, the morale of our soldiers can only be helped by increasing their knowledge, providing them with the best protection that can be devised, good equipment and the knowledge that the health care system can help them.

As already mentioned, an effective intelligence organization will be a key building block in ensuring we are properly protected against blast weapons. This is not new, and history is replete with examples of the importance of effective intelligence, with as many examples of failure when intelligence was not available or used. Intelligence allows the commander to decide on changes to the operation or protective measures to meet the threat, and it allows national resources to properly develop countermeasures.

Potentially, one of the simplest countermeasures could be doctrinal. The Army might be able to change some of the ways it conducts its operations. This change is already underway, with some recent war games and operational research considering different ways to deploy and act in the face of blast weapons. There are no conclusive results at this time, but the Directorate of Army Doctrine is taking care to include the threat and known countermeasures in its work.

R&D is working on countermeasures in a variety of areas, from individual and vehicle protection through to field fortifications. This is a slow but necessary process to ensure that we develop effective countermeasures and don't waste time or resources.

The Army has made no decision on procuring blast weapons; such procurement is a lower priority in the campaign plan. It is also a lower priority for the procurement staff, who are busy managing the large projects currently underway. There is currently no identified capability gap—the first step in any acquisition—that generates the need to procure blast weapons.

Lastly, the campaign plan identifies public affairs as a line of operation. There are two components of this line: internal and external communications. Internally, we need to inform our soldiers of the threat and what we are doing. The Bulletin and this primer are part of this internal communications activity, but they are only the start. Externally, the Army must be prepared to explain the threat from blast weapons and what we will be doing to protect our soldiers and our missions.

SUMMARY

Although blast weapons represent a new and increasing threat to Canadian troops, the effects that they produce are not a mystery. The Army will examine its doctrine, tactics and equipment in order to ensure that it is well prepared to face blast weapons. The intent of this primer has been to increase the awareness of the Army to the threat from blast weapons. Research on countermeasures to blast weapons and their effects is happening now, and results will be incorporated in our doctrine and equipment once it is available.

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ENDNOTES

Other sources of information:

- Grau, Lester W. and Timothy Smith. "A 'Crushing' Victory: Fuel-Air Explosives and Grozny 2000." Fort Leavenworth, KS: Foreign Military Studies Office, 16-09-2000. A US military article re the use of FAE in Grozny, which first appeared in the August 2000 issue (Vol. 84, No. 8) of the *Marine Corps Gazette*, pages 30-33.
- Leaf, Tim. "Thermobaric Weapons: A Weapon of Choice for Urban Warfare." Marine Corps Activity Note (MCIA 1142-001-99), August 1999.

1. The Army Lessons Learned Centre, "The Threat from Blast Weapons," *The Bulletin*, Vol. 7, No. 3 (January 2001).