Technology of Improvised Explosive Devices

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THE IMPROVISED EXPLOSIVE DEVICE OR IED IS INCREASINGLY BECOMING THE weapon of choice by insurgents. In Iraq and Afghanistan, insurgents soon learned that conventional infantry assaults would incur very high loss rates, and the increasing use of IEDs reflects an increasingly smarter insurgent force.

Emphasizing the term, improvised IED's are made from a wide variety of sources which might include this Italian made VS 1.6 anti tank blast mine, artillery and mortar shells, and unexploded aircraft ordinance.

Historically, there is nothing new about IEDs. Explosive booby traps, now termed Victim-Operated IEDs, were used extensively in the latter part of World War II, usually put in place by retreating troops. In the early years of the occupation of Germany, booby traps used extensively by former SS and paramilitaries opposing the occupation caused significant Allied personnel losses resulting from tactics such as suspending piano wire or steel cable across a road to decapitate personnel in open jeeps, staff cars or on motorcycles.

In South Vietnam, the VC and NVA used IEDs extensively, often making use of UXO (unexploded ordnance) after bombing raids. One available statistic credits around one third of US casualties in Vietnam to the use of Warsaw Pact supplied land mines and VC/NVA IEDs.

Arguably, the most refined users of the IED prior to the post Cold War Middle Eastern users were the IRA in Northern Ireland who used a range of devices, primarily remotely initiated to attack Royal Ulster Constabulary and British forces. Roadside or buried bombs used against vehicles – remotely initiated and later initiated by the interruption of an infrared beam – were a favourite tactic and accounted for serious losses. The unfortunate historical reality is that the conflict between the IRA and Britain brought about significant evolution in IED technique, a tradecraft that has since contributed to turmoil globally.

Conflict in the Islamic world is where the IED rose to major significance, used in Afghanistan against the Soviets and more recently by the Taliban, in Lebanon by the Hezbollah, in Iraq by Al Qaeda, local insurgents and militias, and in Chechnya by fundamentalist separatists. The IED has displaced most other weapons, and its effect dominates casualty statistics.

The attraction of the IED is that it allows an opponent to be attacked, often remotely, not exposing the operator to the superior firepower and tactical skills of a modern infantry force.

IEDs can be divided into several categories, including roadside or buried bombs, effectively improvised land mines, suicide bomber vests worn by 'martyrs' who provide a 'not so smart bomb' delivery system, vehicular car bombs, static or driven by a suicide bomber, and a variety of directional or shaped charge IEDs. In principle, any explosive weapon not originated from an industrial production line may be classified as an IED.

Unarmoured and lightly armoured vehicles often stand little chance against the explosive effects of IEDs. The US armed forces are currently involved with the Mine Resistant Vehicle Program MRAP seeking over 20,000 vehicles to provide better protection for its troops against IED's.

IED Explosives and Construction

There is considerable diversity therefore in the configuration and size of IEDs, which can be further expanded if explosive types employed and techniques used to trigger the IED are considered. The type of explosive used in IEDs varies widely. For instance, in Iraq a very common style of IED used against vehicles and personnel is based on a buried single round or cluster of 155 mm artillery shells, buried landmines, or aerial bomb casings. The explosive filler used in these will vary with the origin of the ammunition used.

Common explosive fillers for such munitions include RDX (1,3,5-hexahydro-1,3,5-trinitrotriazine), TNT (2,4,6-trinitrotoluene), Composition A (RDX plus wax), Composition B / Cyclotol (63% RDX and 36% TNT plus wax), HMX (Octogen or Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine), and HBX-1 / HBX-3 / H-6 Compositions (RDX, TNT, Aluminium powder, calcium chloride and wax), and a wide range of equivalent SovBloc compositions. Older fillers such as Amatol (RDX and ammonium nitrate compositions) were used during Cold War conflicts, but have been since displaced by newer compositions.

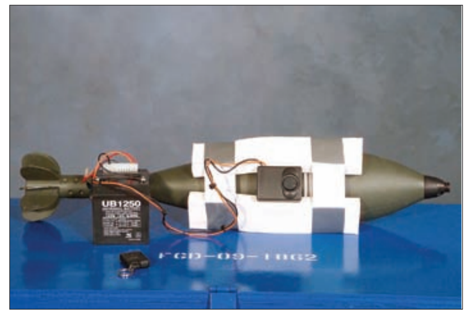
The use of military explosives and munitions in IEDs reflects availability, and is typical for theatres of operations where a withdrawing or defeated force has left large quantities of unsecured munitions. Iraq is a good case study insofar as Saddam's regime cached vast quantities of its munitions, stockpiled across the country. Much of the difficulty seen now is a result of a failure early in the occupation to secure and dispose of the majority of this stockpile. By the time the largest caches and dumps were disposed of, insurgent groups managed to acquire and disperse a considerable volume of such materiel.

Other military explosives used widely in IEDs are the Composition C-4 (primarily RDX) or Warpac (Czechoslovakian) Semtex, both used as demolition explosives, and a favourite ingredient in suicide bomber jackets used across the Middle East. Semtex comes in two variants, and typically is a composition of RDX and PETN (pentaerythritol tetranitrate) with plasticisers and other additives.

Where military explosives are scarce, insurgents or terrorists will turn to industrial explosives. The most common of these are the dynamite compositions, where the primary explosive is nitroglycerine


Example IED manufacturing kit.


MRAP Vehicle being introduced in Iraq.


Example IED configuration based on mortar round.

often mixed with nitrocellulose (blasting cotton). Dynamite type compositions have been more recently displaced in the market by aqueous gel slurries, where an explosive like ammonium nitrate is suspended in a water solution with a gelling agent and a fuel added.

Ammonium nitrate has been a favourite of urban terrorists as the basic material, an oxidiser, is widely used as an agricultural fertiliser. Once the ammonium nitrate is mixed with a fuel such as diesel fuel or kerosene, with a suitable booster charge and detonator, it can be used as a bulk explosive. Many truck or car bomb attacks have involved the use of ammonium nitrate based explosives, including the Oklahoma City bombing by domestic terrorists in the US. An ammonium nitrate derivative, which remains in use in former Warpac nations and Soviet client states, is Ammonite, an industrial grade derivative of Amatol, with 20 per cent RDX content.

Ammonium nitrate based explosives present a major problem, especially with urban terrorists, as until recently the agricultural grade material was not tightly controlled.

Where access to industrial grade explosives or agricultural ammonium nitrate is limited, the resourceful insurgent or terrorist has other options including the manufacture of explosives.

Potassium chlorate is one option, and can be manufactured from sodium hypochlorite bleach and potassium chloride (lite salt) available in supermarkets, using a simple process available on the Internet. Mixing the potassium chlorate with wax and Vaseline, and adding aluminium powder as an additional fuel can produce an improvised plastic explosive.

Swimming pool cleaner or calcium hypochlorite can also be used to manufacture potassium or sodium perchlorate, using potassium or sodium chloride salt. Boiling these ingredients will cause the formation of calcium chloride and potassium or sodium perchlorate, which can be used to make improvised plastique.

RDX is another explosive that can be manufactured in a garage but it requires difficult-to-source red nitric acid, in addition to more common ingredients such as hexamine fuel bars (sold for camping stoves). The process is very simple but requires careful control of temperature and removal of the acid once the RDX crystals have formed in the solution. Once the RDX is manufactured an improvised C-4 composition can be made.

Recipes are also easily available for the manufacture of nitroglycerine or nitroglycol explosives, but as with RDX manufacture the sourcing of nitric acid can present difficulties. HMX recipes are also available, based on acetic acid (an active component of vinegar), hexamine, nitric acid and ammonium nitrate.

A favourite of urban terrorists is acetone peroxide, also known as triacetone triperoxide, peroxyacetone, TATP, or TCAP. The popularity of TATP in part derives from easy access to ingredients (concentrated hydrogen peroxide bleach and acetone paint solvent) and in part due to the absence of nitrogen compounds (which defeats many bomb detection technologies). Unlike most nitrogen-based explosives, which involve the burning of an oxidiser and fuel to release heat and gas, the unstable TATP molecule produces a large volume of gas during its explosive decomposition. So unstable is TATP that many urban terrorists have self destructed during the manufacture or attempted deployment of the explosive. TATP degrades relatively quickly and its short shelf life has confined its use to terrorists.

Publicly documented incidents involving TATP include the London bombings in 2005, the shoe bomb attack on an airliner, and a number of bomb plots by Islamist terrorists in the EU.

The recent ban on a number of liquid household products in airliner cabin luggage is the result of an attempted plot to use ‘liquid explosives’, with considerable public speculation that this involved the use of a TATP derivative or nitroglycerine derivative.

More recently, larger IEDs have been enhanced in effect by adding LPG tanks, which once ruptured by the explosive deliver additional gaseous fuel. Depending on the available oxidiser in the explosive, this may or may not produce a thermobaric effect like a fuel air explosive bomb. For instance, where a thermobaric effect is sought excess fuel would

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be added to an oxidiser such as a perchlorate or ammonium nitrate. Alternately, a non-oxidising explosive may be used.

Recent reports from Iraq also claim the use of bottled chlorine gas to increase the lethality of car and truck bombs. Chlorine is a choking agent and if sufficient concentration is used, bomb victims and rescuers could suffer pulmonary effects.

Other measures used to increase the lethality of IEDs, especially suicide vests, include the addition of metallic components such as ball bearings, scrap metal or wire. This is not unlike the design of a number of air delivered anti-personnel bombs used in earlier conflicts.

Shaped charge and Explosively Formed Penetrator or EFP IEDs are the latest addition to the insurgents’ arsenal. A shaped charge IED uses a cast explosive with a conical cavity, which is intended to produce a jet of high velocity superheated gas that can burn through many types of armour.

Explosively formed penetrators use typically a concave copper disc in front of the explosive charge. The explosive forms the copper into a high velocity projectile to penetrate up to eight inches of armour, according to Israeli sources. The EFP was first widely used in the US Sensor Fused Weapon Skeet anti-armour bomblet introduced during the 1990s. Its use in insurgent and terrorist IEDs is remarkably sophisticated, although US sources claim the technology was developed by Iran’s munitions industry and then proliferated to client terrorist organisations. A variation on this theme is the platter charge, where a disc of steel has a slab of explosive layered on one side – when initiated the steel plate travels at high velocity as a projectile.

There have been no reports as yet of Claymore mine style IEDs, but given the availability of a plastic explosive it is only a matter of time before an enterprising insurgent attempts such a design. A design could employ a sheetmetal base to support the explosive, which would be molded in place and a jacket of ball bearings added for shrapnel effect.

Other ‘innovations’ speculated upon and which will no doubt emerge in time are the addition of toxic solid materials to produce poisoned shrapnel injuries, and the oft discussed ‘dirty bomb’ in which a radioactive material is added to contaminate a target footprint. To date, the creativity of insurgents in bomb making has been limited only by the availability of construction materials and toxic ingredients.

Techniques for triggering IEDs vary widely. The simplest devices may include a landmine as a trigger, or another type of pressure sensitive switch. A car bomb may use a timer or a mercury switch to trigger the explosive when disturbed. A common technique is to electrically trigger the IED using a simple switch and battery, which is the usual method employed by suicide bombers. Remotely detonated IEDs of this ilk present the problem of how to conceal wires between the weapon and the operator.

An ‘innovation’ that emerged during terrorist attacks on Israel was the use of a mobile phone as a remote trigger device. The simplest arrangement is to remove the speaker and wire the signal output to a detonating device of suitable sensitivity. When the phone rings, the current sets off the bomb. The design is so simple that a child with reasonable dexterity could construct one. So serious has the use of mobile phones as IED triggers become that an industry has emerged manufacturing 'cellphone jammers' intended to deny use of mobile phones within some bounded distance from the jammer.

A technique introduced by the IRA and now popular in Islamic nations has been the use of infrared beams to trigger IEDs. This is the technology used by your local Deli owner to ring a bell when a customer enters a shop. Microwave door openers used in shopping centres and public buildings can also be expected to appear in such applications in time.

MRAPs about to be loaded on a C-5 for Iraq.

Dealing With the IED

IEDs remain a leading cause of injuries and deaths of armed forces personnel in Afghanistan and especially Iraq. The most common regime of attack is the roadside or buried remotely-operated IEDs intended to ambush a passing vehicle. Less common has been the use of suicide bomber vests and vehicular bombs but the latter have usually produced far greater damage effects against 'soft' civilian targets.

The US strategy for dealing with the IED has been three pronged. The first of these involves up-armouring many vehicles, especially the Humvee, which became a favourite target for IED attacks. More recently, the US has deployed the MRAP V-hulled truck, conceptually not unlike the South African truck designs built for the counter-insurgency campaign in Namibia. The relatively slow deployment of these measures has been the cause of considerable controversy in the US.

A second prong has been the use of ISR and HUMINT to support interdiction of IED placements and the location of IED caches and factories. This effort has yielded varying degrees of success. One of the problems that remain unsolved is the absence of a sensor technology capable of remotely detecting buried or concealed explosives.

The third and most radical prong has been the development of a range of technologies intended to cripple or prematurely detonate IEDs. These include High Power Microwave (HPM) devices and the Ionatron Laser Induced Plasma Channel (LIPC) electromagnetic beam weapon. An issue remaining with both techniques is the very high power demand of these systems to achieve credible operating ranges at typical road speeds, and the resulting fleet cost even if only deployed on lead vehicles in convoys.

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A future analysis will cover technologies for the defeat of IEDs in more detail.

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