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Recycling and Reuse of military explosives for the blasting industry

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The collapse of the Soviet Union in 1991 revealed enormous quantities of military material stored in magazines and ready for use both in the Soviet Union, USA and other countries. For example tanks, airplanes, guns and other non explosive materials where easily taken care of by the existing recycling industry. Metals have been recycled for thousands of years but Explosive wastes cannot be handled like ordinary wastes from society. Due to their ability to explode or detonate, and additionally often also being toxic to both man and the environment, they constitute a very dangerous type of waste. If not adequately handled they have a high potential to cause severe and fatal accidents.

The use of explosives started with the Black Powder era which lasted 1,500 years and left very small environmental problems since the ingredients ─ charcoal, nitrates and sulphur ─ easily lost their explosive properties when exposed to water. About 150 years ago high explosives (HE) were introduced, starting with nitro-glycerine, picric acid and TNT[1]. The two latter explosives were very stable in storage, had low sensitivity and quickly became very popular for military purposes. They are equally stable in ambient conditions.

Today explosives are fundamental tools for building our modern society. They are used for blasting in construction, mining and oil exploitation, airbags in cars, in medicine, in fuels and devices for space rockets and satellites, for pyrotechnics such as emergency rockets/signals, and for defence materiel.

Modern military explosives are synthetic, have very stable properties and are often toxic. They must therefore be recycled, detonated, burned or chemically decomposed as normally they will not lose their explosive properties with time.

Sweden has recycled military explosives since 1970 at the Nammo Vingåkersverken facility.

Recycled TNT was delivered in flaked form to the Iron ore area in the north of Sweden. Other explosive materials was as propellant and composite explosives was burnt

Today, year 2010, recovered military explosives are widely used in commercial blasting mainly for production of boosters which transfers the initiation from the blasting cap to the main charge which is made of low sensitive ammonium nitrate based pump able explosives.

The production of boosters in the world today is exceeding 100 ton per day and the prize for recycled explosives are increasing.

Recovered propellants are often added to the to the commercial explosives in order to increase the gas volume

New commercial products based on recovered military explosives are ready to be introduced on the market.

Our conclusion is that all new military explosive products must be designed so that the explosives materials can be recycled and used in order to replace virgin products.

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[1] TriNitroToluene

Recycling and reuse of all excessive Energetic materials is an important marker on the way to build a sustainable society on our planet. Open burning and open detonation must be reduced to a minimum.

Modern warheads, mines and other explosive articles spread out and remaining uncontrolled in the environment present a serious risk for accidents and death to all living!

The necessity to preserve our world from ecological disasters has induced a strong ecological trend among inhabitants of our world. Large efforts are made to create a long-term sustainable society based on renewable energy, recycling and reuse of resources. To litter the world with mines, AXO[2], UXO[3] and other explosive remnants of war (ERW) then seems to be a very counterproductive and unintelligent action.

The world of today must react quicker to the fact that almost all post-conflict environments from the last 100 years contain a substantial risk for unexpected detonations from explosive residues; these threaten public safety. More resources for remediation are now urgently required.

It is now acknowledged that in many countries a physical risk exists to individuals and communities from the presence of abandoned munitions and explosives. In 2006 5,751 casualties from mines, ERW[4] or victim-activated IED[5]s were recorded (1). The true number may be considerably larger since the quality of recording varies much. By August 2007 it was estimated that there were 473,000 survivors from such explosive events (1). Also this number is likely to be much too low. The numbers are increasing!

2 Abandoned Explosive Ordnance
3 Unexploded Explosive Ordnance
4 Explosive Remnants of War
5 Improvised Explosive Device

Explosive wastes cannot be handled like ordinary wastes from society. Due to their ability to explode or detonate, and additionally often also being toxic to both man and the environment, they constitute a very dangerous type of waste. If not adequately handled they have a high potential to cause severe and fatal accidents.

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The most obvious threats are mines and UXO that kill and hurt many thousand people each year but also other types of "lost" explosives, such as AXO, turn up as dangerous pollutants in the environment.

Most of the victims are children or young males, and ─ if they survive ─ in many countries they will become and remain expelled from normal life in society.

In order to give a first coarse introduction to the challenge we present this first article.

1. Pollution of land

The cleaning of battlefields, even those from World War I nearly 100 years ago, will continue for many years ahead. Even if all deployment of UXO and mines stopped today clean-up processes will need to continue for hundreds of years.

2. Pollution of water

A quick and easy way to get rid of old ammunition was to dump it at sea, in lakes, disused quarries or ore mines. This method was used by many countries as recently as 15 years ago. Normally such dumps are not considered serious sources of pollution if they are left undisturbed. However, pollutants may leak out into sea or ground water and cause serious contamination, and if the explosives must then be removed serious problems will arise.

Hundreds of thousands (2) of abandoned naval mines in many seas of the world, mostly laid in relatively shallow waters, will add to this problem. Many can remain effective for a hundred years or more, some can break loose and float away while remaining dangerous. Modern, advanced mines are very difficult to find and may in practice be impossible to clear, unless this can be done by the laying party, knowing its exact location.

Explosively contaminated process water must be cleaned before being returned to nature, but that has not always been the case!

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[6] TriNitroToluene

It is essential that groundwater is well protected from explosive contamination as it is impossible to clean with available techniques.

3. Pollution of air

Gases and dust from open burning or open detonation (OBOD) often contain minute metal particles. Explosive dust and explosive in gas form plus many combustion products are also released to the air. Detonation or combustion in a closed vessel with exhaust cleaning are among the best methods to dispose of explosives when considering air pollution. They are also logistically more effective than OBOD.

4. Factory sites, storages, dumps

Places where explosives have been produced and stored often create very complex environmental problems, especially if the sites have been in operation for a long time. Normally no one would know what has happened at a factory or ammunition dump 50 years ago or more! Therefore keeping and preserving accurate records will be exceptionally important.

Figure: A deteriorating open-air AXO dump. Since these munitions were temperature-cycled over long time, typically they cannot be cleared by moving, but should be detonated *in situ*. (*Photo courtesy OSSE*)

5. Civilian use of explosives

Civilian use of explosives affects many areas of society. Expected normal streams of explosive materials can be exposed to deviations that may result in dangerous situations and explosives accumulation in the unprepared society. For instance, an airbag removed from its normal position in a vehicle will constitute a serious risk for harming people. Surplus explosives must be collected and neutralized in a safe and controlled manner and this will require economic resources. In addition explosives can be stolen and used for criminal or terrorism purposes, which necessitates good control of the materials and secure storages.

6. Economical consequences

Explosive contamination in the territory of a nation will also cause serious economical damage. Even a few uncleared mines or UXO may obstruct large areas from normal use such as agriculture. Also communications, such as roads, rivers, harbours and railways may be non-functional for long periods of time. It will also prevent the population from returning to their former residential areas and then resuming normal life. In addition the cost and personnel resources required for clearance may be very high! Most nations gravely affected are developing nations, which will have difficulty finding the necessary resources within their countries. The funding offered by the International Community is still much too small to suffice, and the attention of developed nations seems to subside very quickly.

7. Clearance and destruction of explosives

This is definitely a task for well trained and equipped professionals, not for amateurs. The general population should only participate in ‘mine risk education’ (MRE), essentially comprising the knowledge how to avoid exposure to the hazards of mines and UXO. MRE is especially important for children who will often become victims of explosive remnants of war

when playing, scavenging for water, food or valuable materials such as metals that can be sold.

At demining operations it is often preferred to destroy the cleared munitions by open-air detonation, either *in situ* or collected close to the area of work. The reasons are that it would be dangerous to move them, and that, if left over-night, there might be a serious risk that they would be stolen and re-used.

Under normal societal conditions the method of choice should be to recycle explosives industrially. Typical military explosives can be melted or cleaned out and then used for instance for production of civilian booster charges or for addition to bulk explosives for rock blasting in order to improve their detonation properties. Recycling plants can be made mobile and be located close to the place where they will be needed.

8. Cleaning of waste soil and water

The increased interest in a clean and sustainable environment raises a demand for remediation of old mistakes. The problems are often a mixture of different pollutants that threaten the environment.

Resources for research and development of new techniques are urgently needed.

We must learn from the mistakes from earlier generations in order to avoid continuing to destroy our world.

9. International efforts

There are limited international legislation, agreements or instruments that refer to or require the mandatory clearance and destruction of ammunition, explosive articles and explosives.

However the Anti-Personnel Mine Ban Treaty (Ottawa Convention), 1997 and the Cluster Munitions Ban of Oslo in 2008, where governments from around the world have pledged to abstain from the use, production, transfer and stockpiling of anti-personnel mines and cluster munitions, do so to some extent. The Convention on Cluster Munitions sets the highest standard to date in International Law for assistance to survivors and their communities. That convention also obliges nations to destroy all stockpiles within eight years and to clear contaminated land within ten. In many cases the latter task will not be possible to fulfil. As with the treaty banning anti-personnel land mines, this treaty will make it difficult also for countries which have not signed it ever to use these weapons again. With time these conventions will also become customary law, binding all! However there will still be non-state belligerents that may see themselves unhindered to use them.

Some good news for the future is that the international community is at last beginning to accept that the problems arising from the accumulation of conventional ammunition stockpiles deserve greater international interest, developmental commitment and political will. This is demonstrated by the Report of a UN Group of Government Experts (GGE) (3) in pursuance of a Resolution (4) of the UN General Assembly that recommends;

1. the education and training of national stockpile management staff;
2. the development of a set of international technical guidelines in order to assist States in improving their national stockpile management capacities; and
3. the improvement of knowledge resource management on ammunition technical issues within the United Nations system to ensure that States have ready access to appropriate technical expertise and guidance for the safe and secure storage of ammunition and the disposal of surplus stockpiles.

The UN General Assembly (5) welcomed the report and strongly encouraged States to implement its recommendations. The very welcome diplomatic engagement of Germany and France on this issue has at last raised the international profile of this threat to an appropriate level, and work on the development of international ammunition guidelines (UN ATG) has commenced in 2009.

10. Actions for the future

The explosives community (i.e. everyone who professionally handles explosives) must develop ethical rules which call for professional workmanship and prohibit explosive contamination of the environment. The explosive community must also preserve general knowledge from the past, and foster new generations of responsible explosives specialists. Regrettably this seldom happens! Additional research in the field is also needed!

The authors of this short introduction to an existing severe problem hope that the International Explosives Community and SAFEX will contribute with actions and suggestions aiming to reduce explosive pollution of our environment.

We hope that this article will start a process that will engage SAFEX members in actions that will serve to reduce and minimize the pollution of the environment with explosive remnents of war, abandoned explosive ordnance and surplus ammunition and explosives.