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Industrial Ammunition Stockpile Recovery: Saving Energy and Resources and Protecting the Environment

Erik Lauritzen
NIRAS DEMEX

Mogens Straarup
NIRAS Chemcontrol

Inés García Sánchez
NIRAS DEMEX

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This article presents the opportunities for the disposal of ammunition in an economically and environmentally feasible way, focusing on post-conflict disposal of larger stocks of ammunition with a special view to the ongoing Ammunition Stockpile Destruction Programme in Afghanistan managed by the Afghanistan New Beginning Programme. The contents of the article are based on the experiences gathered under the umbrella of the research and development programmes Western European Armament Group European Cooperation for the Long-Term in Defence and European Union *L'Instrument Financier pour L'Environnement* (EU LIFE), together with a study carried out for NATO's Maintenance and Supply Agency, followed by field studies on ammunition stockpile destruction in mine-action programmes.

by Erik K. Lauritzen, Mogens Straarup and Inés García Sánchez [NIRAS DEMEX & NIRAS Chemcontrol]

Obsolete ammunition is a major problem in many countries, especially in war-torn countries like Afghanistan, Iraq, Sudan and Lebanon. To restore peace, it is imperative to dispose of the ammunition, as this will reduce the capabilities to continue the warfare. Explosive remnants of war are normally destroyed by open burning or open detonation (OB/OD) in suitable amounts according to national regulations or according to *International Mine Action Standards 11.10 and 11.20*.[1] These methods create environmental problems, however, as huge quantities of metal fragments, dust and nitrogen oxides (NOx)[2] are emitted to the environment.

Agenda for ERW and Ammunition Stockpile Disposal

As a result of the end of crises and conflicts around the world, vast quantities of ammunition have been destroyed by OB/OD. They have come from a variety of sources, primarily:

- Excess stocks of military ammunition resulting from the ending of crises/conflicts
- Unexploded ordnance on former military training or gunnery ranges
- Mines and UXO remaining from military and some civil conflicts

The amount of ammunition in abandoned stockpiles in Iraq and Afghanistan comprises several hundred tonnes of various types of munition.

In the wake of the recent conflicts in the Persian and Balkan areas, many questions have been raised about post-war effects, such as the environmental pollution caused by OB/OD of ammunition stockpiles. Kuwait has claimed compensation from the Iraqi government for severe damage of the desert environment caused by chemical pollution of sand and soil because of OB/OD disposal of abandoned Iraqi ammunition after the First Gulf War in 1991.

Today the international market for scrap metal is very favourable, and the prices of scrap iron and especially copper, stainless steel and aluminium are rising.

Recovery and recycling of explosives for industrial use has not proven feasible. Recycled explosives from ammunition are not competitive with industrially manufactured explosives. However, explosive compounds might be incinerated for energy recovery or reclaimed for fertilizing or other chemical purposes.

The clearance of abandoned ammunition stocks in a post-conflict area, necessary logistics management and implementation of appropriate ammunition-disposal procedures require a lot of human resources. The work related to ammunition-stockpile management is highly suitable for demobilisation, demilitarisation and reintegration programmes.

Taking all environmental, economical and social benefits derived from the recovery of ammunition stockpiles into consideration, industrial ammunition stockpile recovery is far preferable to the currently applied, normal practice of OB/OD. However, further investigation and proof of concept is urgently needed.

Principles of Demilitarisation and Ammunition Disposal

Demilitarisation of ammunition can be performed in many ways. Different techniques and methods for demilitarisation of ammunition are presented in IMAS 11.10. Figure 1 illustrates a general methodology for demilitarisation. There are many phases to follow and options that can be chosen. Each phase is composed of a set of processes and many of the stages consist of a number of substages. The most appropriate demilitarisation process to be implemented will be dictated by a number of factors, such as available technology, environmental legislation, contract conditions, commercial issues and safety regulations.

Munitions are inherently dangerous and the demilitarisation process involves considerations about explosive safety and environmental risks. In particular, downsizing and treatment stages are the most critical, during which the explosive components are subjected to processes that can be hazardous depending on the working methods, sensitivity of the explosive components, etc.

In order to save resources and protect the environment, demilitarisation processes must aim for maximal recycling and minimal waste disposal. Furthermore, the processes must be as harmless as possible with respect to workers' health and safety, and emissions into the atmosphere, soil and water.

Munitions are, with few exceptions, designed with focus on the use phase, and little or no thought is given during the design phase to the end-of-life stage, when demilitarisation is required. Consequently, demilitarisation of munitions is often a more complicated process than initial construction. Modern design of munitions is becoming more and more complex, and therefore demilitarisation has to be more carefully considered at this initial stage. With growing requirements for insensitive munitions,[3] the energetic constituents are evolving and becoming more difficult to deal with compared with traditional explosives, such as TNT. Munitions containing TNT can easily be melted out, since TNT's melting point is lower than that of water; however, new filling compositions tend to be based on nitramines[4] embedded in a cross-linked polymeric matrix[5] with a higher melting point.

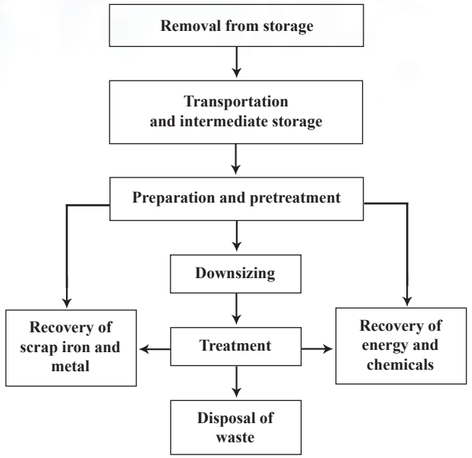


Figure 1: Schematic illustration of the typical sequences of demilitarisation.

Mobile incineration plant for hazardous waste.
PHOTO COURTESY OF MOGENS STRAARUP/NIRAS CHEMCONTROL

Mobile Ammunition Disposal Plant

In May 2000 NIRAS DEMEX published a report, *Research and Development Technologies for Safe Disposal of Explosive Wastes*, which compiled the results of a project carried out under the EU-LIFE programme. The project demonstrates by means of laboratory tests that it is possible to extract the explosive content from the ammunition shells, mix it with water and incinerate the resulting mixture without risk of explosion.

NIRAS Chemcontrol has designed and set up both large incinerators and small-scale, mobile incinerators for disposal of hazardous waste like pesticides, PCB, etc., such as the one shown to the right. NIRAS DEMEX and NIRAS Chemcontrol have further been responsible for the design, construction and setup of a plant for ignition of fired small ammunition at the Danish Ammunition Arsenal, as shown in the photo on the next page. The process ensures any remaining explosive material within the disposed ammunition items is burned out and is done so in a way that guarantees safe handling and eventual recycling of the shells.

During the incineration of explosives, it is possible to recover the generated energy and clean the exhaust gases so the emissions comply with the environmental requirements in the area. This technique is therefore preferable to OB/OD from an environmental perspective. Moreover, mobile incineration units can be established on-site and thus offer the same logistic advantages regarding local disposal of ammunition waste as the currently used OB/OD.

The extraction of the explosives from the ammunition shells and their incineration has only been tested on a laboratory scale, however. A full-scale demonstration test is under preparation.

Proposed Design for Mobile Ammunition Disposal Plant

Overall layout. Due to the safety risks associated with the transport of ammunition, having a relocatable or transportable facility for its safe disposal constitutes an essential advantage. Obsolete ammunition is normally stockpiled at a number of depots, and it is preferable to dispose of the ammunition on premises instead of transporting it to a central facility. For practical reasons, it is also preferable if the disposal unit can be shipped by normal road transport.

Extraction of explosive material and preparation of explosive/water mixture. Explosive content is extracted from the shells by high-pressured water. The shell is then cleaned so the metals can be recycled, constituting a considerable income from the overall process. In regions where armed conflicts are still ongoing, shells should be transported outside the country to prevent them from being retrofitted with explosives. The transport of ammunition shells is not problematic, as they are composed of non-explosive and non-hazardous materials.

The extracted explosive material is mixed with water in such a proportion that the resulting mixture has some specific properties with respect to explosive capability. An important criterion is that the mixture shall not explode by shock or exposure to temperatures below 60 C (140 F). The mixture is not considered explosive material, and can therefore be stored in dedicated vessels until disposal.

Incineration process. The explosive/water mixture is pumped into the primary incineration chamber, where a pilot flame ensures the mixture is ignited and the incineration process is initiated. The incineration speed is an important operation parameter, which is also controlled by the mixture composition. Too fast an incineration speed—e.g., too high a proportion of explosive material—could damage the equipment, or in the worst case, the plant could explode. Too low an incineration speed—e.g., too much water in the mixture—might hinder the ignition of the mixture. The results obtained during the LIFE project have been valuable in estimating the optimal water/explosive proportion.

A secondary combustion chamber could be installed to guarantee the destruction of organic compounds. In this way, European criteria for incineration of hazardous waste—e.g., more than two seconds at 1,100 C (2,012 F)—would also be met.

Energy recovery. A boiler is installed to recover the energy generated during the incineration of the water/explosive mixture and reuse it for, among others, heating purposes. The energy recovery supplies added income for the project.

Flue-gas cleaning. A full flue-gas cleaning system is installed to minimise the emissions and ensure they comply with the legal requirements. It is expected the emissions will comply with the rigorous EU emission requirements for incineration of hazardous waste. The main focus of the flue-gas cleaning system will be removal of dust and nitrogen oxides.

An emission-monitoring system will continuously ensure air emissions comply with the established legal requirement for the flue gases.

Control system. The incineration process is carefully controlled by a computer system to ensure safe and environmentally sound operation. In case of abnormal operation, the process will be stopped in a controlled manner.

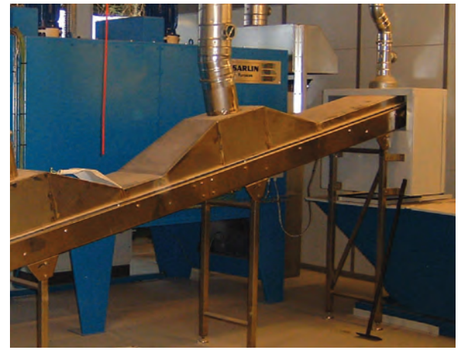
Mechanical safety measures are incorporated to protect the equipment from damage in case of improper operation or unexpected events. A tentative sketch of the overall process is shown in Figure 2 below.

Ammunition Stockpile Destruction Programme of Afghanistan

The Afghanistan New Beginning Programme launched the ammunition destruction project in December 2005, based on the Anti-Personnel Mines and Ammunition Stockpile Destruction Project.[6]

Coalition Forces and the International Security Assistance Force in Afghanistan have conducted and continue to conduct the destruction of ammunition stockpiles in Afghanistan. However, this work is not coordinated with the United Nations Mine Action Centre for Afghanistan or ANBP and has sometimes resulted in failed bulk demolitions and the accidental displacement of ammunition, requiring time-consuming explosive-ordnance-disposal cleanup operations.

The ammunition destruction project is a continuation of the Afghan Disarmament, Demobilisation and Reintegration Programme managed by ANBP. During the DDR activities, a large amount of stockpiled ammunition was found and ANBP became aware of the need for ammunition stockpiles to be destroyed. Parallel to the ammunition destruction project, ANBP is also running the Disbandment of Irregular Armed Groups



Treatment of disposed small-calibre ammunition.
PHOTO COURTESY OF MOGENS STRAARUP/NIRAS CHEMCONTROL

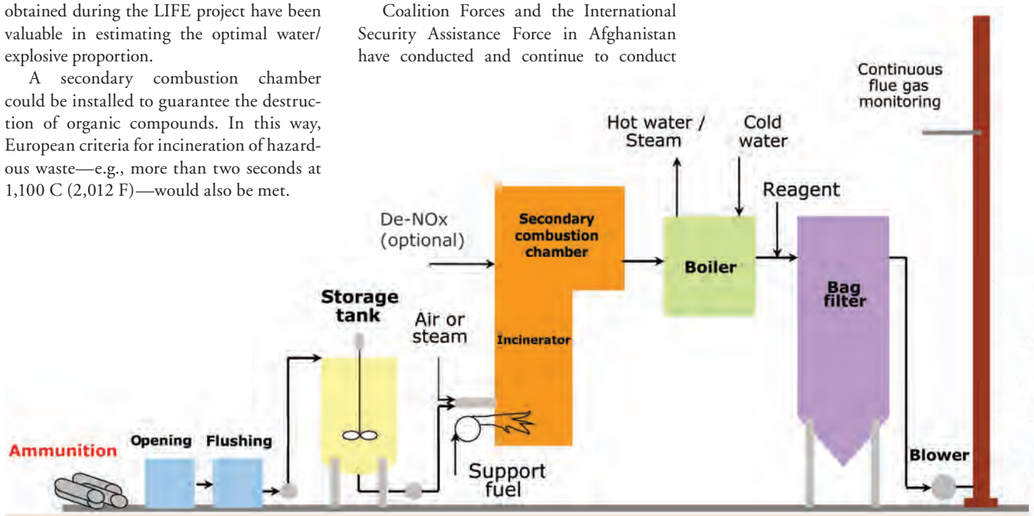


Figure 2: DEMEX / Chemcontrol facility for mobile ammunition disposal plant. Ref. ANBP Anti-Personnel Mine and Ammunition Stockpile Destruction Project Document, Annex 2.

Project. The DIAG project has Weapon Collection Teams that perform similar work to that of the previous DDR Mobile Disarmament Units. The ammunition the WCTs find will be handled within the ammunition destruction project. The project has been running since December 2004. The organisation of the ammunition destruction project is shown to the right in Figure 3.[7]

The Anti-Personnel and Ammunition Stockpile Destruction Programme under the supervision of the Ministries of Defence and Interior and the National Department of Security are being surveyed, and the ammunition is classified into three categories:

1. Ammunition required by the Afghan National Army for service
2. Ammunition that might be required for service of the ANA
3. Ammunition to be destroyed, including APMs

During the transfer of the ammunition from the cache, ANA transports the first two categories of ammunition together, and there is no registration of the specific types of ammunition belonging to each of the two categories.

ANBP transfers serviceable ammunition to temporary and permanent ammunition storage points called Temporary Ammunition Consolidation Points and Permanent Ammunition Supply Points, respectively. Two Ammunition Supply Points are planned in the Kabul area and another five elsewhere. The ASPs are mainly existing storage sites that have to be repaired and secured. They need to be cleared of UXO and the ammunition already stored has to be sorted. Some of the ASPs are ready, and ANA has started transporting ammunition to some of the prepared Ammunition Survey Teams.

Each of the eight Ammunition Survey Teams simultaneously undertakes the ammunition survey in multiple locations on a nationwide basis. ANBP conducts the transportation of serviceable ammunition to regional ammunition supply points with assistance from the U.S. company UXB International and ANA. ANA handles storage of the ammunition without support. Destruction of unserviceable ammunition (unsafe, unpacked and non-required) and APMs is conducted by implementing partners, The HALO Trust and UXB International, by means of open-air burning and bulk demolition.

The Ammunition Survey Teams are surveying ammunition caches. The ASTs also empty the ones not considered usable for future storage. Unsafe, unwanted and illegal ammunition, including anti-personnel mines, are destroyed by implementing partners. The rest is moved to Temporary Ammunition Consolidation Points. The survey teams consist of one ANA Team Leader, one ANA Deputy Team Leader, one International Adviser, one Translator/Associate and four drivers. Each team has two trucks and two cars. Technical assistance is provided by HALO Trust personnel.

The actual destruction of ammunition is conducted by implementing partners including The HALO Trust, RONCO Consulting Corporation and UXB International.

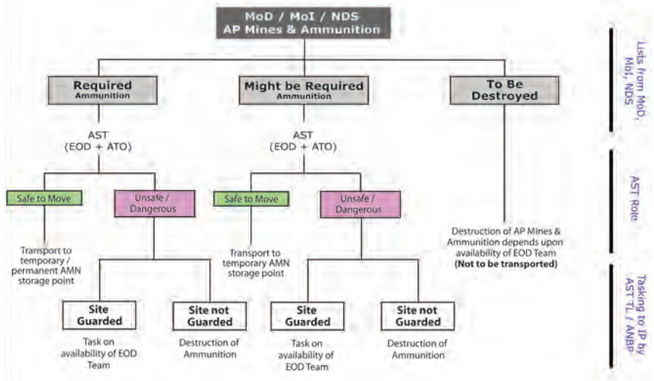


Figure 3: The ammunition destruction project. *(*ATO=Ammunition Technical Officer)*

Demilitarisation process by OB/OD of tank ammunition and rockets in Afghanistan.
PHOTO GROUP COURTESY OF ERIK K. LAURTIZEN, NIRAS DEMEX

Proposed Industrial Ammunition Disposal Programme for Afghanistan

By the end of 2005 it was estimated that total stocks of abandoned ammunition in Afghanistan amounted to 50,000–100,000 tonnes (55,000–110,000 U.S. tons). Some of the ammunition was deemed serviceable by the Afghan Army and had to be recovered, while the remaining stocks had to be demilitarised.

New strategy. The EU prepared a new strategy for ammunition management for the Afghanistan government.[8] Current demilitarisation practice by OB/OD may only be used up to 2007. Starting in 2007 demilitarisation of ammunition shall be performed in an environmentally friendly way. By 2012 all unserviceable and unwanted ammunition currently stored shall be destroyed.

It is proposed that the demilitarisation should be performed in accordance with the European Commission principles of best available technologies not entailing excessive cost, the EC directives of waste management[9] and the International Mine Action Standards.[10]

Most likely a large proportion of the ammunition that has been consolidated will turn out to be obsolete or unserviceable stockpiles that must be destroyed. However, ammunition stockpiles contain valuable materials that can be recovered. If innovative, environmentally friendly demilitarisation techniques are proven to be cost-effective, then scrap metal and explosives could be recycled for commercial use. Energy and nitrogen-based compounds can be recovered from explosives to be used in fertilisers and scrap metal can be recovered from the casing materials. The present world prices for scrap steel are relatively high and it is therefore recommended that an industrial demilitarisation system should be analysed in detail, with the indirect objectives of improving business activities and creating employment for the local Afghan population. An industrial demilitarisation system could be established in connection with the Temporary Ammunition Consolidation Points, for example a mobile demilitarisation plant based on closed incineration or similar technologies.

It is strongly recommended that open burning/open detonation of ammunition should not continue as a demilitarisation technique, due to the proven environmental damage and inefficient use of resources.

Furthermore, it is mentioned that UNDP South Eastern and Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons has considerable experience with demilitarisation technologies, and the publication *Briefing 18—Biting the Bullet*[11] gives practical guidelines for the ammunition stockpile management.

Capacity building. It is a priority for EC projects to build up local capacity. After one year of ammunition stockpile destruction, an appropriate national capacity has been established. A capacity-building plan is supposed to be prepared with special focus on local ammunition technicians and leaders of Ammunition Survey Teams. Furthermore, the capacity-building plan must be accompanied by a plan for transfer of ownership from ANBP to a local organisation and by a specific exit plan for ANBP, the international implementing partners and Technical Advisors.

It is assumed that the initial phase of the ammunition destruction programme will be implemented via cooperation between U.N. humanitarian organisations, international NGOs and other civil implementing partners on one side and the military society (including the Coalition Forces/International Security Assistance Forces), ANA, police, and security forces on the other side.

It has been proposed that industrial ammunition recovery might be transferred to commercial companies—possibly international companies in cooperation with local companies—in accordance with specific international procedures stipulated by the donor organisations. The contract must be based on industrial demilitarisation practices in compliance with the above-mentioned requirements for health, safety and environmental protection.

For additional references for this article, please visit http://snipurl.com/15i4j.
See Endnotes, page 109

Erik Lauritzen is the founder of DEMEX Consulting Engineers and has worked within the field of ammunition and explosives technologies for more than 25 years. Lauritzen holds a Master of Science in civil engineering, is a Lieutenant Colonel (Reserve, retired), and member of the International Mine Action Review Board, representing the Danish Ministry of Foreign Affairs and donors.

Erik K. Lauritzen
Managing Director
NIRAS DEMEX
Sortemosevej 2
DK - 3450 Alleroed / Denmark
Tel: +45 4810 4218
Fax: +45 4810 4300
E-mail: ekl@niras.dk

Mogens Straarup holds a Bachelor of Science in civil engineering and business administration and has worked in several manufacturing, contracting and consulting engineering companies with projects in Europe and Asia for 25 years. Straarup has worked with the thermal treatment of waste and hazardous waste and been responsible for manufacturing and setting up facilities, including a facility for treatment of discharged small-scale munitions.

Mogens Straarup
Managing Director
NIRAS Chemcontrol
Buchwaldsgade 35, 3rd floor
DK - 5000 Odense / Denmark
Tel: +45 6312 5050
Fax: +45 6312 1481
E-mail: mos@niras.dk

Inés García Sánchez has a Master of Science in chemical and environmental engineering and has been involved during recent years in international demilitarisation projects. García specializes in environmental management aspects of ammunition-clearance projects.

Inés García Sánchez
Project Manager
NIRAS DEMEX
Sortemosevej 2
DK - 3450 Alleroed / Denmark
Tel: +45 4810 4397
Fax: +45 4810 4300
E-mail: igs@niras.dk