9

Stockpile Management: Disposal and Destruction[1]

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Overview

Understanding the scale of the problem, policy requirements, and technical issues surrounding the disposal, demilitarization, and destruction of ammunition and explosives[2] requires a basic knowledge of the challenges involved. Without this knowledge, it is very difficult to develop effective or relevant domestic and international policies that can effectively address the problem of ammunition disposal.

This chapter is not intended to cover technical solutions to the challenge, or to be a full technical assessment of risks and hazards. Rather, it is designed to explain and clarify the major issues for all stakeholders. The current reality is that there are insufficient resources to make more than a small dent in the global stockpile, and this is unlikely to change in the near future. The education of potential donors, implementing agencies, and other stakeholders regarding the relevant issues, and the development of realistic and safe indigenous capacities, are current priorities.

For the destruction of the large stockpiles of ammunition in non-conflict environments, destruction by demolition (detonation) is often not a practical option. The potential for environmental and noise pollution, and the sheer quantities of ammunition involved, will often suggest that an industrial demilitarization approach is more effective and cost-efficient. This industrial demilitarization of ammunition combines the skills of production, mechanical, chemical, and explosive engineering. It is a highly specialist operation, and appropriate independent technical advice should be taken before planning such an activity.

Reasons for ammunition disposal and destruction

There are often significant security and safety risks posed by the presence of excessive surplus stockpiles of conventional ammunition. The local community and the environment close to ammunition depots are at risk (CHAPTER 18), and sustainable development is hampered due to costs of security and maintenance. There is sometimes a possibility of illicit trafficking and uncontrolled proliferation (CHAPTER 15), especially to terrorists and other criminal groups. This can fuel armed violence within communities and compromise the security of neighbouring states. Therefore the destruction of these stockpiles should be considered as a practical safety requirement, a significant

Table 9.1

Factors influencing support to ammunition destruction programmes

Factor	Example	Remarks
International treaty obligations	Mine Ban Treaty	• Anti-personnel mines • Usually well funded
CSBM initiatives	*Nairobi Declaration;* North Atlantic Treaty Organization (NATO) Partnership for Peace; *OSCE Document* (OSCE, 2003)	
In support of disarmament, demobilization, and reintegration (DDR) initiatives	UN Department of Peacekeeping Operations DDR programmes	• Usually relatively small quantities of ammunition • Frequently, the arms and ammunition surrendered are those that are in the worst state of repair and can present a high risk of accidental detonation.
In support of small arms and light weapons control	Montenegro Demilitarization (MONDEM) Programme	• Although the definition of small arms and light weapons only includes ammunition of 100 mm calibre and below, the systems developed are used for all calibres.
As part of wider security sector reform (SSR)	MONDEM	• The SSR factor is usually complementary to CSBMs initiatives or small arms and light weapons control.

conflict prevention measure, a confidence- and security-building measure (CSBM), and a post-conflict human security issue.

There is a tendency for donors, implementing agencies, and other stakeholders (CHAPTER 17) to regard weapons and ammunition as one task area. Yet the reality is that the destruction of weapons is a relatively straightforward, albeit logistically challenging, task. The destruction of ammunition requires a much more detailed technical response, as the risks and hazards are greater than those for weapons, and the stockpiles are much larger in terms of tonnages and quantities of individual items.

To date, the demilitarization and destruction of ammunition within developing and post-conflict countries has been based on a wide range of factors (see Table 9.1). These factors are often important in determining which part of a donor's budget may be used to support such initiatives.

Small arms ammunition often has priority, as donors have budgets to support the destruction of these particular types of munitions, whereas the larger calibre ammunition and bulk explosives that can present the greater explosive and security risks are afforded a lower priority by donors. While this is understandable from a political perspective due to the range of international and local agreements concerning small arms and light weapons (CHAPTER 1), it may not be the most effective or efficient methodology for approaching the destruction of a national stockpile in a holistic manner. Donor support for the destruction of elements of ammunition stockpiles as part of confidence- and security-building measures is understandable, and should be supported, but there is also an argument to suggest that the impact on: 1) the reduction of risk to the civil population (*human security task area*); or 2) the physical security of small arms and light weapons (*proliferation of small arms and light weapons task area*) should also be considered. One problem is that the term 'small arms and light weapons' means different things to different stakeholders, and there is therefore a lack of consistency when responses are planned or funded.

Additionally, in some commercial cases, ammunition has been selected purely for ease of destruction or the potential financial return on scrap recovery or reuse of explosives,[3] and minimal consideration has been given to the selection of ammunition for destruction on security or humanitarian grounds.

Ammunition disposal options

International security concerns, international legislation, and practical considerations indicate that the most effective option is the physical destruction of ammunition. Table 9.2 summarizes the current options.

Table 9.2
Ammunition disposal options

Disposal option	Comment
Sale or gift	• The most cost-effective means of disposal, **BUT**: • Any sale or gift should comply with international export control and transfer best practices. • The quality of the ammunition at the end of its useful shelf life will not be as high as newly manufactured ammunition. This makes it unattractive to reputable end users, as it is highly unlikely to meet their performance standards. Therefore diversion risks are high. • Much of the surplus ammunition will require inspection and classification before it can be transported in accordance with international transport regulations. • This option merely transfers the problem somewhere else.
Increased use during training	• Creates additional wear on equipment (such as gun barrels and vehicle automotive systems). This will inevitably reduce the life of the parent equipment and will result in additional maintenance costs. • May also negate CSBMs with neighbouring states. • Only limited stocks can be disposed of in this manner, as the costs of training and the time taken would be unrealistic as a means of destroying a large stockpile. • The disposal of larger calibre ammunition requires large military training areas, which may not be available.
Deep sea dumping	• Subject to international agreements that ban dumping at sea of hazardous or industrial waste.[4] • International donor support unlikely. • Remains an option for non-signatories of international agreements.
Destruction	• Physical destruction by a range of technical options. • The most realistic and practical solution.

Ammunition destruction factors

The physical destruction techniques available range from relatively simple open burning and open detonation (OBOD) techniques to highly sophisticated industrial processes. The detailed arguments for and against each process are outside the scope of this chapter,[5] but it is important to note that the selection

Table 9.3
Factors affecting ammunition disposal techniques

Factor	Comment
Physical condition of the ammunition	• This influences the safety aspects of the destruction programme, which may mean open detonation as the destruction technique rather than industrial demilitarization. • This may impact on whether the ammunition is safe to move to a destruction facility, or whether it must be destroyed as close to storage as possible.
Quantity of ammunition	• Economies of scale will improve destruction efficiency. Such economies of scale mean that a wider range of affordable and efficient technologies is available for consideration.
Indigenous capacity and available resources	• Few countries with large ammunition destruction requirements outside NATO have an indigenous demilitarization capacity that is safe, environmentally benign, effective, and efficient, although they may be capable of achieving one or two of those requirements.
National legislation	• National environmental and explosive safety legislation will influence the technique(s) to be used.
Technology options	• Industrial-scale demilitarization can be carried out by mechanical disassembly and incineration in environmentally controlled systems, and has the advantage of being able to operate 24 hours a day, 365 days a year. • A major disadvantage is the high capital set-up costs of design, project management, construction, and commissioning; but the operating costs are generally lower than OBOD (once amortization of the development capital is discounted).

of the most appropriate destruction technique will depend on a range of factors (see Table 9.3).

The problem is not the lack of technical guidance, but rather the global shortage of qualified technical staff experienced in best international technical practices in demilitarization project development and operations. Very few people have the experience of establishing a demilitarization capability or facility from scratch; technical standards of staff in those countries with large ammunition stockpiles are often not in accordance with international best practice; commercial industry experience is often limited to its own techniques; and the military are generally untrained in demilitarization. Consequently, programmes in post-conflict or developing countries are often not designed in the most safe, effective, and efficient manner (there are, of course, exceptions). As no UN department has overall responsibility for the coordination of ammunition destruction, and regional organizations are often competing for the limited donor funding available, there is no international strategy or policy to deal with the issue.

Furthermore, there are no international standards for the planning and conduct of ammunition destruction, although very good national and regional guidelines do exist, which could easily be adopted with little amendment to reflect global needs.

The ammunition demilitarization cycle

The process of physically destroying ammunition is only one part of the complete demilitarization cycle. This operational cycle is complex, comprehensive, and wide-ranging, and includes activities such as transportation and storage, processing operations, equipment maintenance, staff training, and accounting.

The development of a safe, effective, and efficient industrial demilitarization capability within a state that also reflects the safety and environmental concerns of donors inevitably takes time, but this should not prevent the initial steps being taken to support the development of such facilities. In many regions, this sort of capacity has to be developed from the semi-dormant and under-resourced state ammunition production facilities, which require infrastructure investment, staff training, and demilitarization equipment procurement. Perhaps the solution is a balance, whereby OBOD should be used to destroy potentially unstable stocks in the short term, while facilities are developed for those nations with large stockpiles. For those countries with insignificant stockpiles, OBOD will remain the only economically practical option.

Regional ammunition demilitarization facilities?

A solution that is often proposed at international conferences is that of the development of a regional demilitarization facility. While this seems an attractive concept for donors and the recipient country, the political and technical realities are very different for the remainder of the countries in the region. The very large stockpiles often present in many countries of a region[6] mean that national economies of scale can usually justify a national demilitarization capacity anyway. Many states within the region will support a regional facility, so long as it is in their country, because it represents a major economic investment and potential source of income. They are unlikely to commit funds for destruction at a regional facility 'next door'.

The most efficient means of transporting ammunition and explosives is usually by rail; therefore, the effectiveness of the rail infrastructure and the distance to be travelled will have a significant effect on the location of any regional demilitarization facility. Furthermore, the international donor community is unlikely to have the resources to pay for the destruction of the total surplus stockpile, therefore it would also become an economic issue between countries.

Costs of ammunition destruction

It is difficult to estimate the destruction costs for ammunition, as there are so many factors to consider, as Table 9.4 illustrates.

The numerous factors listed in Table 9.4 make estimating the costs of an intervention to support the destruction of ammunition very difficult when large stockpiles are involved, particularly when there is not an effective ammunition management system in place. Experience in Eastern Europe has indicated that assessments by properly qualified and experienced technical personnel are a valuable pre-requirement for demilitarization planning, and donors must be prepared to accept the costs of these assessments. It is also important that donors recognize that the costs associated with structural development, technical training, and equipment procurement means that the initial costs per ton can be high, but subsequent destruction is a lot cheaper, as economies of scale take effect and national capacity has been built.

Progress to date[7]

Specific reference to the management and destruction of stockpiles of ammunition in the framework of international legislation or agreements is less than comprehensive (see Table 9.5). Relevant instruments either do not mention ammunition explicitly, or the instrument is limited in scope to small arms and light weapons only, with the emphasis being on weapons. Ammunition is generally regarded very much as a secondary consideration.

Table 9.4
Ammunition destruction cost factors

Factor	Comment/examples
Ammunition type	• The technology requirements for each type of ammunition means that costs vary for different generic ammunition types. • Small arms ammunition destruction costs are low, as relatively cheap technology is available with high production rates (transportable explosive waste incinerators will destroy 0.5 tonnes/hour). • Destruction costs for high explosive (TNT)-filled medium and heavy calibre shells are much higher, as steam-out equipment is needed, and production rates are fixed according to the equipment used. • High explosive (RDX/Octagen)-filled shells are very expensive, as steam-out is not possible and more complex technology is required. • Guided missiles are possibly the most expensive due to the manual (or robotic) disassembly costs.
Economies of scale	• This determines the technology options, and hence capital equipment costs. Economies of scale must apply to each generic ammunition type, however, and not necessarily the total stockpile.
Capacity development requirements	• Many indigenous demilitarization facilities require significant infrastructure improvements in terms of security and safe storage before safe demilitarization operations can commence. • Equipment procurement is also a significant capital cost.
Legislative issues	• Conformity to different states' environmental and ammunition disposal legislation creates variations in the cost of destruction.
Economic level of host nation	• This will impact on personnel costs, and to a degree, infrastructure improvement costs.
Fixed cost contracts	• Some demilitarization programmes include weapons and ammunition at an overall fixed cost, as opposed to costs per generic weapon and ammunition type.
Donor funding cycles	• Costs of destruction may initially seem high in the first year due to capital equipment and infrastructure development costs. This is sometimes a problem when the donor single-year funding cycle is applied, as the decreasing cost of destruction in subsequent years is often difficult to specify.
Decaying military-industrial capacity	• Some countries are very reluctant to discuss detailed destruction costs and ask for unrealistic donor funding for their ammunition destruction, as they really want the funds to 'prop up' their decaying military-industrial capacity. They will try and use defence conversion as a justification. • The reality is that defence conversion is primarily a socio-economic issue, and nations should deal with it from that perspective. The market will decide the cost-effectiveness and realistic prospects of any conversion of defence production to civilian production, not an ammunition demilitarization programme.

Table 9.5
International frameworks

Instrument/ agreement	Comment
International	
Programme of Action (UNGA, 2001)	• Although there is no specific provision for ammunition under this, the most comprehensive instrument at the global level, it could be argued that ammunition can be inferred to fall under the same umbrella as weapons, as the UN definition of small arms and light weapons includes their ammunition. • This includes destruction of stockpiles, as articulated in Article 29 of the instrument.* • Yet the scope of this instrument and others at the global and regional levels is limited to *illicit* trade, and fails to address national surpluses of ammunition in detail.
Firearms Protocol (UNGA, 2005)	• This includes an obligation to destroy illicitly manufactured and trafficked firearms that extends explicitly beyond small arms and light weapons to include other firearms and their ammunition (Article 6), yet by implication this cannot cover the medium and large calibre ammunition that accounts for over 70 per cent of national stockpiles.
Regional	
EU Joint Action (EU, 2002)	• This explicitly identifies small arms and light weapons ammunition as a cause for concern and recognizes the importance of the safe storage as well as quick and effective destruction of small arms and light weapons ammunition (Preamble and Article 4).
OAS Convention (OAS, 1997)	• This explicitly incorporates ammunition and explosives within its scope.
OSCE Document (OSCE, 2003)	• This outlines in detail procedures for assistance from other Organization for Security and Co-operation in Europe (OSCE) participating states in the destruction of ammunition.
SADC Protocol (SADC, 2001)	• This stresses the need to maintain effective control over ammunition (and not just that related to small arms and light weapons), especially during peace processes and in post-conflict situations, and to establish and implement procedures for ensuring that firearms ammunition is securely stored, destroyed, or disposed of in a way that prevents it from being used in illicit conflict.

* In this respect, it should be noted that the 1997 report of the UN Panel of Governmental Experts defined the scope of categories of small arms and lights weapons as including ammunition and explosives (UNGA, 1997, Annex, para. 26).

The UN Secretary-General reported in 1999 that the UN, supported by donors, had been involved in the safe storage, disposal, and destruction of weapons, but stated that 'the number and scale of such programmes remains small compared with apparent requirements'. Despite some limited progress, there is a huge disparity even between known needs and international donor support.

Despite growing political awareness of the issue, to date the international response has been limited in terms of financial support to surplus ammunition stockpile destruction as a global issue. Significant support has been provided for the destruction of anti-personnel mines in support of Article 7 of the Mine Ban Treaty, and it is likely that this support will continue. The United States has funded the destruction of significant quantities of man-portable air defence systems (CHAPTER 12), primarily as part of its counter-proliferation programme.

In terms of wider ammunition stockpile destruction, the donor and international response has been limited due to: 1) the amount of finance required; 2) the fact that it is not a major issue for some donors; 3) other donor mandates not allowing for it; and 4) only a limited number of major donors being engaged in the issue. The most extensive engagements at the operational level have probably been through the UN Development Programme (UNDP) Mine Action and Small Arms Unit[8] and the NATO Partnership for Peace Trust Fund, while the OSCE has primarily been engaged in liquid-propellant disposal, but is looking to engage in wider ammunition destruction. The reality is that, within their region, all of these organizations are in effect 'competing' for projects, and little effective coordination takes place. Each has different implementation mechanisms, which makes such coordination difficult.

Conclusion

The scale of the global ammunition destruction requirements is difficult to quantify due to the lack of available data. Until states demonstrate more transparency and an international organization takes a coordination lead on the issue, this situation will remain. This lack of transparency makes it difficult to identify proliferation when it has happened, or even to fully assess the proliferation risks.

Technical solutions are available, and although the pool of qualified specialists is small, the knowledge necessary to develop safe, effective, environmentally benign, and efficient ammunition demilitarization programmes is available.

Current levels of donor assistance and funding will need to be dramatically increased if the full extent of the problem is to be seriously addressed. This presents serious challenges in terms of donor (and wider) awareness, understanding of the complexities of the issues involved, and commitment (in terms of both financial and technical resources).

Notes

1 This chapter is a synopsis of information in Wilkinson (2006). It has been comprehensively revised and updated by the author in light of recent developments.

2 From this point on, the term ammunition will be used generically in this chapter to include ammunition, explosives, and propellants.

3 The Alliant Techsystems programme in Ukraine during the early 1990s is one example of this.

4 Oslo Convention (1972) and subsequent amendments; London Convention (1972) and subsequent amendments; OSPAR Convention (1998).

5 A summary of these processes can be found in Annexe A.

6 For example, Central and Eastern Europe and South-Eastern Europe.

7 Summarized from Greene, Holt, and Wilkinson (2005).

8 Ammunition destruction projects have been conducted in Central and Latin America, Africa, the Commonwealth of Independent States, and South-Eastern Europe through UNDP country office projects.

9 Other technologies such as molten salt oxidation, biodegradation, etc. are developing, but production facilities are very limited and the technology has still to be universally proven.

10 A PCS that meets European Union environmental emission limits requires a combination of the technologies shown.

Further reading

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Annexe A:

Summary of ammunition demilitarization technologies[9]

Process operation	Technology	Advantages	Disadvantages	Remarks
Pre-processing operations				
Manual disassembly	• Simple hand tools	• Low capital investment	• Labour-intensive • Low production rates	The use of human resources to physically dismantle ammunition by manual labour using simple hand tools.
Mechanical disassembly	• Pulling apart • Defusing • Depriming	• High production rates • Lower staff requirements	• Medium capital investment	The use of mechanically operated systems to dismantle ammunition. Some of the available technologies are shown in the table, but systems tend to be specifically designed to deal with each different type of munition.
Robotic disassembly	• Ammunition dependent	• High production rates • Lower staff requirements	• High capital investment • Reliability	A fully automated disassembly system. This system would only be economically efficient for very large production runs due to the high start-up costs.
Mechanical breakdown	• Bandsaw • Guillotine • Cracker mill • Rock crusher • Punch	• Lower staff requirements • Medium production rates • No secondary waste stream at this phase of the demilitarization cycle	• Explosive safety risks of initiation • Medium capital investment • Wide range of equipment required to deal with all ammunition types	This process is mainly concerned with techniques required to expose the explosive fillings of ammunition prior to the destruction phase.

Process operation	Technology	Advantages	Disadvantages	Remarks
Cryofracture	• Liquid nitrogen cooling	• Environmentally benign • High production rates • Can be used for virtually all ammunition types • Low capital investment for equipment • No secondary waste stream at this phase of the demilitarization cycle	• Large process area requirements • Costs of liquid nitrogen • Health and safety issues for staff • Unpredictable results for necessary fracture forces	This process is used to break down ammunition into pieces small enough to be processed through an incineration destruction method. The liquid nitrogen changes the mechanical properties of the munition casing to a more brittle phase by cooling it to -130°C. The munition can then be easily shattered using simple mechanical shear or press techniques.
Hydro-abrasive cutting	• Entrainment systems • Direct injection systems	• Lower staff requirements • Can be used for virtually all ammunition types • Safety	• High capital investment • Complex filtration systems for waste water required • Grit sensitivity of explosive after cutting	Water and abrasives are used at pressures from 240 to 1,000 BAR to cut open ammunition by an erosive process.

Process operation	Technology	Advantages	Disadvantages	Remarks
Destruction operations				
Explosive removal	• Hot steam melt-out	• Simplicity	• Low capital investment • Restricted to certain explosive types	
	• Microwave melt-out	• Efficiency • Low secondary waste stream	• High capital investment • Developing technology	
Incineration	• Rotary kiln furnace	• Efficiency • Low staff requirements • High production rates	• Limited to small calibre ammunition, propellant, and pyrotechnics • Significant pre-processing required for larger calibres • Small arms ammunition lead residue and pyrotechnic effluent can pose consider-able environmental problems	The kiln is made up of four 1.6 metre long, 1 metre outer diameter retort sections bolted together. The 6–8 cm thick walls of the kiln are designed to withstand small detonations. The kiln contains internal spiral flights, which move the waste in an auger-like fashion through the retort as the kiln rotates.
	• Car bottom furnace	• Ideal for explosive residue • Low staff requirements	• Medium capital investment • Cannot destroy most ammunition types • A system to support destruction, and not a system in its own right	Used to destroy small amounts of explosive or explosive residue left after flush-out pre-processing techniques. It can also be used to destroy explosively contaminated packing material, etc.

Process operation	Technology	Advantages	Disadvantages	Remarks
Incineration	• Hearth kiln furnace	• Low staff requirements • Medium production rates	• Effective only with limited ammunition types	A static high temperature kiln.
	• Plasma arc furnace	• Low staff requirements • High production rates	• High capital investment • High power requirement • Developing technology • Pre-processing still required	A plasma torch, at temperatures in the region of 4,000–7,000°C, is used to heat a container into which waste products are fed. The plasma is an ionised gas at extremely high temperature, which is used to initiate rapid chemical decomposition by the action of this extreme heat. The material is currently fed in a slurry form, although research is ongoing for the destruction of entire munitions.
Contained detonation		• Limited pre-processing requirements • Can deal with many ammunition types • Medium production rates	• Medium staff requirements • High donor explosive requirements • Medium capital investment • Explosive content limited	The destruction of ammunition and explosives by detonation in an enclosed chamber. The evolving gases are then processed by an integral pollution control system.

Process operation	Technology	Advantages	Disadvantages	Remarks
Pollution control systems (PCS)[10]				
Volatile organic compound (VOC) destruction	• Afterburner	• Proven technology • Very low staff requirements	• High fuel requirements	This oxidizes entrained organic compounds, ash, and metal fragments. In order to do this, it must operate above 850°C for over two seconds to destroy VOCs; the VOCs then burn to CO_2, H_2O, and acid gas. All organic particulate is destroyed.
Acid gas neutralization	• Addition of sodium bicarbonate	• Operates over wide temperature range • Produces safe and inert solid waste • Reacts well with nitrogen oxides • Readily available	• Large supplies necessary	Produces safe and inert solids for disposal such as sodium chloride (common salt), sodium sulphate, and sodium nitrate
Particulate removal	• Baghouse	• Simple and cheap technology	• Prone to baghouse fires • Filtration efficiency • Medium capital investment	
	• Dry ceramic filtration	• Fire resistant • Filters down to one micron • Supports a bed of sorbent for improved gas absorption	• Medium capital investment	Dry ceramic filtration is now regarded as one of the most efficient filtration systems available. It has the capability to remove particulate matter down to one micron.
	• Liquid filtration	• Filtration efficiency	• High capital investment • Liquid waste stream requires further processing	

Process operation	Technology	Advantages	Disadvantages	Remarks
Scrap processing operations				
Scrap processing	• Crusher • Shredder • Compacter/ cracker			System requirements depend on the waste stream from the destruction process. Many systems are available.