small arms survey

Issue Brief

RASR The Regional Approach to Stockpile Reduction

Number 2 ■ April 2012

Buy and Burn

Factoring Demilitarization into Ammunition Procurement

Introduction

In South-east Europe, states are increasingly aware of the need for the safe and effective demilitarization of their existing surplus small arms and light weapons ammunition stockpiles. Some states participating in the Regional Approach to Stockpile Reduction (RASR) Initiative already have a clear view of their surplus ammunition and its corresponding status, and have made the decision to dispose of parts of it using various demilitarization[1] methods (Gobinet, 2011, pp. 24–31).

Yet states that demilitarize also *procure*: defence reform implies the destruction of surplus ammunition stockpiles, but standardization or modernization requirements simultaneously call for the procurement of modern ordnance. Ammunition, being an expensive commodity that requires lengthy production runs, is often procured in large quantities to anticipate the eventual demands of a state's security apparatus.

In essence, procuring ammunition is similar to subscribing to a national defence insurance policy (Bevan, 2008, p. 56): a large part of what is procured will never be used before its shelf life expires. Newly purchased ammunition is therefore likely to comprise tomorrow's problematic surpluses unless states address their future demilitarization challenges proactively and invest in life cycle stockpile management planning.

This *Issue Brief*, compiled by the Small Arms Survey in support of the RASR Initiative, aims to increase participating states' awareness of the future costs they will incur in disposing of the weapons and ammunition that they acquire today.

It also profiles the options for reducing demilitarization costs in the future—including offsetting disposal costs in the purchase price and 'design for demil' (DfD) technologies—and the impact this is likely to have on states' retention of surpluses in the future.

The *Issue Brief*'s main points are as follows:

- Ammunition generates costs throughout its entire life cycle: from design to purchase, storage, surveillance and proof, handling, and use, and potentially all the way through to the ammunition's disposal. This implies adopting a 'whole-life management' approach to ammunition.
- Policies such as DfD in the United States aim to reduce demilitarization costs 'upstream' by influencing ammunition designers and pro-

High-explosive projectiles being processed using an industrial bandsaw (left), and the resulting opened shells being transported for the removal of energetics (right). © NAMSA

ducers early in the ammunition life cycle, and to make them incorporate demilitarization considerations so that, when the time comes, demilitarization is easier and cheaper.

- Because of the complexity of much modern ammunition and the evolving landscape of the demilitarization industry, with the latter often driven by changing environmental legislation and industrial best practice, anticipating and budgeting for future demilitarization costs in the ammunition's acquisition price largely remains wishful thinking.
- A number of more 'realistic' measures exist, such as ammunition surveillance and modernization, which allow a state to rapidly reduce expenditures throughout the ammunition life cycle by optimizing the point at which any particular batch of ammunition needs to be disposed of.
- Similarly, individual states can take a number of measures to plan, control, and (better still) reduce demilitarization costs at the appropriate stage of the ammunition's life cycle. These measures include issuing tailored requests for proposals to the demilitarization industry, streamlining logistics, and systematically prioritizing surplus items into homogeneous categories throughout the ammunition stockpile life cycle.

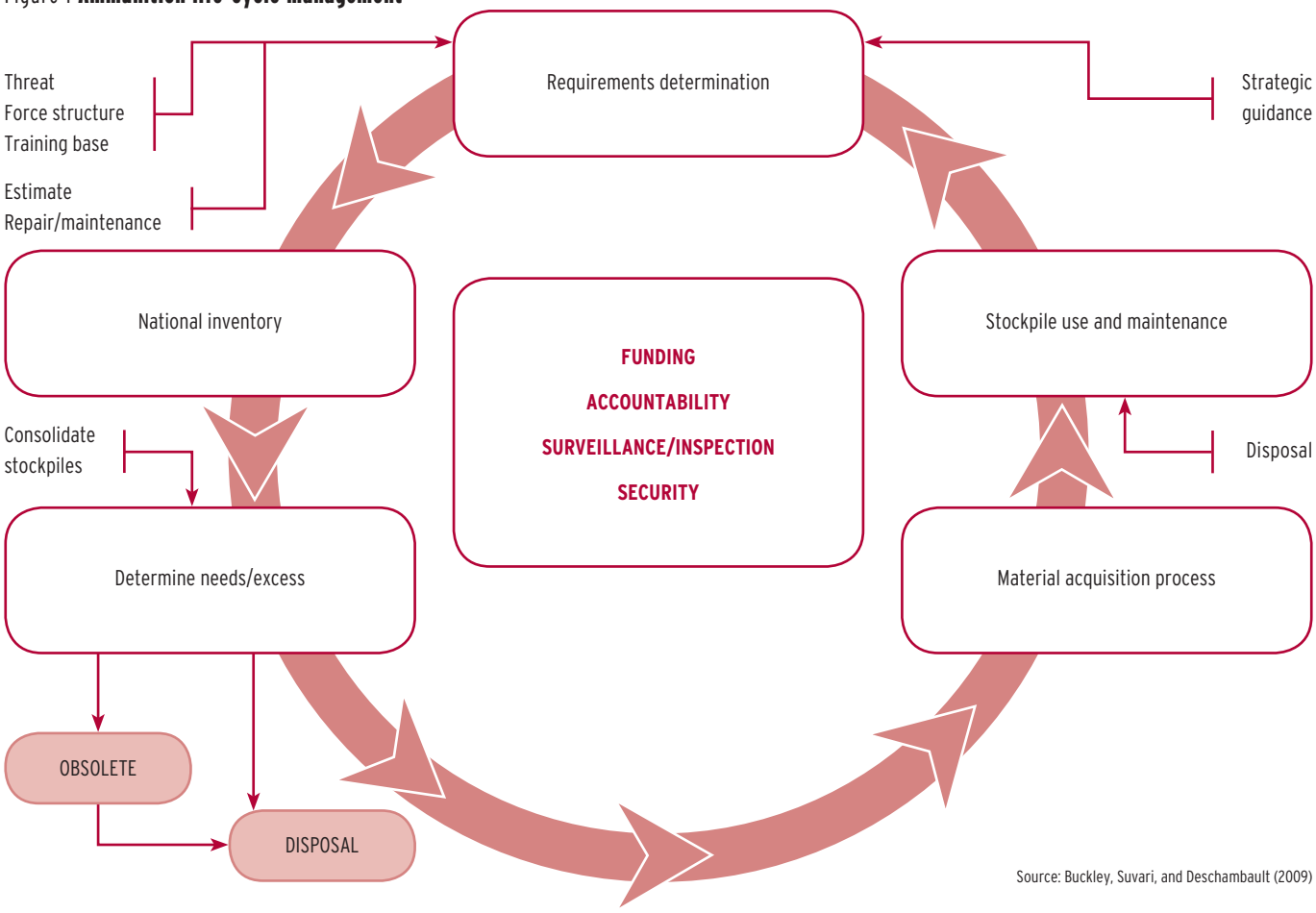
Reducing demilitarization costs at the design stage

Ammunition designers have traditionally focused their product development and design on performance, not on ease of demilitarization at the end of the munitions' life cycle (Mescavage, 2010).

This was not a significant issue when nations used the traditional—and less complex—open burning (OB) or open detonation (OD) disposal techniques, or the wholesale dumping of surplus munitions such as deep-sea dumping, for which ammunition design is not a fundamental factor.

Faced with the international prohibition of deep-sea dumping (IMO, n.d.), an increasingly tight regime of environmental regulations, public pressure on governments for sustainable methods of demilitarization, growing stockpiles of post-cold war surplus munitions, and limited government budgets, demilitarization has over the past two decades progressively moved away from OB/OD as the main disposal method. New techniques have been developed by industry and research agencies that aim to control emissions into the atmosphere and increase recover, recycle, and re-use (R3) methods. R3 methods strip the ammunition down to its basic, recyclable component parts and compounds, which can then be sold to offset processing costs and thus reduce the overall cost of demilitarization. However, not all munitions are suited to R3, and in some cases the quantity required to be demilitarized

Figure 1 **Ammunition life-cycle management**



Source: Buckley, Suvari, and Deschambault (2009)

is insufficient to develop an economically sustainable industrial process line.[2]

The efficiency of these industrial demilitarization operations is, among other factors such as the quantity and rate of demilitarization, significantly influenced by the original *design* of the ammunition. Yet the design of ammunition does not always lend itself to the cost-effective recovery of materials for recycling or re-use. Ammunition designed and purchased today tends to be more complex than that currently being demilitarized. It may incorporate embedded electronics, plastic-bonded (PBX)[3], and insensitive high explosives. These ammunition designs may not efficiently accommodate current demilitarization processes, presenting additional difficulties during disassembly, and ultimately adding time and expense to demilitarization operations. This can contribute to an increased life-cycle cost.

To decrease the life-cycle cost of conventional ammunition (Figure 1), it is understood that demilitarization considerations must be included at its design stage. At a global, policy-relevant level, UNODA's International Ammunition Technical Guidelines (UNODA, 2011a, p. v) state that ammunition must be demilitarized or destroyed at the appropriate stage of its life cycle, but also stress the importance of adopting a 'whole-life management' approach endorsed by the 2008 UN Group of Governmental Experts report (UNGA, 2008, Summary). At a more regional—and technical—level, Standardization Agreement (STANAG) 4315 and *Allied Ordnance Publication* (AOP) 46 provide the basis of NATO's approach to the whole-life assessment of munitions (Sharp, n.d.).

This approach is not new to Ministries of Defence (MoDs) either. Ammunition specialists introduced the DfD concept in the demilitarization community in the mid-1990s, yet governments have often been reluctant to make allowance for its costs in their budgeting cycles.[4] Moreover, only mature MoDs, staffed with ammunition experts and capable of advanced stockpile management, have been receptive to DfD considerations. In transitioning countries, MoDs have traditionally not enjoyed such control over the design of the ammunition they purchase. Still, many MoDs now implicitly recognize the benefits of DfD and increasingly apply disposal considerations during procurement.[5]

Going a step further, the US Department of Defense has made DfD a policy. On 4 August 2008 the US undersecretary of defense for acquisition, technology, and logistics signed a policy memorandum requiring DfD to be implemented throughout the Joint Services. The memorandum states that '[g]ood systems engineering addresses all aspects of the life cycle, including systems' demilitarization and disposal'; delineates specific requirements; and requests that all services 'include in their acquisition documentation for all [pending and future] conventional ammunition programs how they intend to address demilitarization design requirements throughout system design' (Young, 2008). The policy's goal is to influence ammunition designers early in the ammunition life cycle and to make them incorporate demilitarization considerations with 'low cost changes that do not impact performance' (Mescavage, 2010). Ideally, the acquisition documentation for conventional ammunition should incorporate demilitarization design requirements and a demilitarization plan describing the procedures, processes, and technologies to be used. DfD is a key strategic goal of the Demilitarization Enterprise Strategic Plan (PM Demilitarization, 2009, p. 4), while the Joint Services programme director is currently finalizing a DfD handbook that includes a section on design considerations and best practices (Mescavage, 2010).

DfD is not a once-stop solution to address future demilitarization challenges and not every ammunition item can benefit from it. Some items in an inventory are purchased in very small quantities and require simple disposal techniques. Others may never need a formal disposal process because they are all used in training or operations. Disposal planning needs to be taken in context and DfD used proportionately. The DfD process itself absorbs time and resources, and must not be applied indiscriminately for fear of developing techniques for which there are no viable quantities of munitions to process—or, worse, of compromising the design or cost of new munitions unnecessarily.[6]

Yet DfD may have repercussions for all demilitarization stakeholders and procurement officers, including in South-east Europe. For instance, it is considered to be a driver of the development of environmentally responsible munitions systems that involve the removal of potentially environmentally hazardous materials to reduce or avoid the need for firing range remediation (Towndrow, 2009). It is conceivable that in the near future a new NATO STANAG will incorporate DfD considerations in the planning and decision-making processes for all new or modified ammunition items (including insensitive munitions and future energetics) from conception to final acceptance of the end item. Indirectly, it should encourage procurement officials to reconsider or reorient their procurement policies accordingly.

Incorporating the costs of demilitarization at the procurement stage

When purchasing ammunition, procurement personnel must take into account a range of expenditures incurred, such as delivery costs, in addition to the initial cost of the ammunition itself. Once purchased, the ammunition will trigger additional, 'indirect' costs throughout its total life cycle, such as storage, proof, surveillance, maintenance, repair, and security costs, that will add to the initial procurement

costs. If the ammunition is not used after a few years, analysis may conclude that disposal is a cheaper option than continued storage once the ammunition has reached the end of its useful life. If the state chooses to destroy or demilitarize the ammunition, then this will represent yet another 'indirect' expenditure, which is not usually considered by the original purchasers of the ammunition.

Demilitarization can thus be considered as a service for which national authorities and international organizations are willing to pay if they are to maintain the safety of their ammunition stockpiles. Therefore, one could theoretically envisage a system by which the costs incurred by the demilitarization of ammunition are anticipated upstream and budgeted for during the ammunition's initial acquisition. One could argue that the defence companies that sell the ammunition to governments could include this service in the ammunition's purchase price, in effect creating a trust fund to cover future demilitarization costs downstream.

This ideal scenario is, in reality, difficult to achieve, for a number of reasons:

- The budgets and/or departments responsible for initial procurement, support, and disposal are separate in many MoDs, making a coherent approach difficult. In recent years, this has become less of an issue as mature MoDs adopt a whole-life approach.[7]
- Ammunition is increasingly purchased off the shelf, leaving no opportunity for a customer to incorporate specific DfD requirements into its design without significant delay and cost. Similarly, nations that accept munitions as gifts or transfers have limited influence over their design[8].
- Ammunition is purchased to be used in conflict or training. It is not deliberately bought by governments to be stored for a 20–30-year life cycle and then ultimately demilitarized—even though this may be what happens to much of the stockpile. Adding future demilitarization costs to the initial procurement costs of ammunition is asking the purchaser to pay for a service that may never be needed, because some of the purchased ammunition will be expended and will have ultimately cost the buyer more (i.e. by paying for demilitarization that never happens). In order to convince a customer to buy the demilitarization upstream, e.g. during the initial purchase of the ammunition, defence companies need to propose a number of complex contract options.
- The time frame between ammunition manufacture and its disposal is often between 20 and 30 years. Defence companies can change drastically over this period of time. A government that purchases ammunition from a company and simultaneously contracts the company for the future demilitarization of this ammunition in 20 or 30 years faces the prospect of dealing with a company that is very different from the one that signed the initial contract. If the company or its demilitarization division no longer exists, then the buyer will not be able to use a service that was paid for long in advance. In this case, a new demilitarization company must be contracted via costly tenders. This ultimately increases the life-cycle costs of the ammunition.
- The price of the demilitarization service itself is difficult to determine 20 or 30 years ahead of time because of the role played by logistics. The costs involved in securing, storing, and transporting ammunition—with the latter often across several countries—can represent up to 50 per cent of the total amount of a demilitarization contract. Logistics is not the core business of industrial demilitarization companies and this makes it difficult for them to estimate fixed prices for this service. Moreover, neither the manufacturer nor the customer can anticipate where the ammunition earmarked for demilitarization will need to be collected in 20 or 30 years' time, nor can they certify the physical state of the ammunition and its packaging this far ahead.
- Not all ammunition manufacturers manage the whole life cycle of ammunition. Those that do not, often partner with subcontractors to fulfil their demilitarization needs. The complexity of their contractual agreement and the simple fact that it adds intermediaries between the buyer and the service provider will ultimately increase the price of demilitarization.
- In order to win tenders, demilitarization companies need to standardize their services according to international agreements and according to the national legislations of the countries with which they do business. To comply with environmental regulations and meet customers' demand for an increased use of R3 methods, the demilitarization industry has been progressively required to use expensive pollution control equipment, e.g. to reduce emissions into the atmosphere from incineration. These methods are complex and costly to set up, develop, and operate. The ammunition itself often becomes more complex to demilitarize as years go by. Increased complexity

Theoretically, defence companies could envisage an ammunition procurement system that anticipates their products' future demilitarization costs.

results in increased costs and diminished 'marginal returns' (Raftery, 2008, p. 40). This implies that tomorrow's demilitarization euro or dollar will give less in terms of the number of items demilitarized.

Reducing demilitarization costs: extending the shelf life of ammunition through surveillance

The chemical, physical, electrical, and mechanical properties of ammunition degrade throughout its life cycle. Environmental factors will also accelerate the ageing process. Ammunition is designed for use between specific climatic limits, otherwise its service life will be significantly reduced. The effects of weather, direct solar radiation, daily temperature changes, and humidity can rapidly degrade the performance and safety of explosives. In some cases the ammunition may rapidly become unserviceable and dangerous to use. Explosives exposed to elevated temperatures may exudate[9] and propellants[10] may decompose. Non-explosive fillings of some ammunition, such as white phosphorus,[11] will melt when subjected to sufficiently high temperatures, thereby changing the centre of gravity of the projectile upon solidification, and thus its ballistics too. If unmonitored, ammunition degradation will therefore ultimately make the ammunition unreliable—and even dangerous—to fire, handle, store, or transport.

Ammunition surveillance[12] is described as

> *a systematic method of evaluating the properties, characteristics and performance capabilities of ammunition throughout its life cycle in order to assess the reliability, safety and operational effectiveness of stocks, and to provide data in support of life reassessment* (UNODA, 2011b, p. 30).

The process involves a battery of functional tests designed to identify the ammunition stockpile's reliability, ensure wartime readiness, and segregate failing hardware. Visual inspections verify the degree of physical damage or deterioration of the ammunition sample and its logistic packaging. Chemical stability tests (e.g. for propellant and propelling charges[13]) and radiographic (X-ray) inspection tests (e.g. for high-explosive filling) are performed in laboratories on randomly chosen samples to determine their components' status. By evaluating the functional and non-functional characteristics of representative samples of stockpiled ammunition, ammunition surveillance allows timely decisions to be made as to whether the shelf life can be extended, or whether the ammunition and its components require maintenance, retrograde, or disposal. If appropriate measures are taken, maintenance operations can be carried out in the depots,[14] which reduces logistics costs significantly. If performed appropriately, ammunition surveillance improves safety towards the end of the life of the ammunition and can reduce its overall life-cycle cost (UNODA, 2011c, p. 2).

The age of the ammunition should be a concern, but does not mean that old ammunition is unserviceable. Ammunition surveillance, which allows specialists to keep track of the age of a stockpile, also benefits older stocks that are stored under optimum conditions. Proper ammunition surveillance may therefore delay a government's need to procure new ammunition. Authorities can set up a 'rotation' policy by which older—yet perfectly serviceable—ammunition stocks are made accessible to soldiers in the field and do not remain in storage indefinitely (US GAO, 1996, p. 28).

Finally, the modernization of ammunition is a cost-effective alternative to the procurement of new ammunition. By replacing certain components, the performance, safety, and reliability of the existing ammunition can be re-established or even improved. By replacing explosives with inert fill or special pyrotechnics (flash, 'bang', and smoke effects), combat ammunition can be successfully converted into training ammunition.

Reducing costs during demilitarization

At the far end of the spectrum of the ammunition life cycle, the decision to demilitarize should encompass a number of considerations that can affect the cost—and efficiency—of the process.

Planning the right demilitarization method

As mentioned above, ammunition undergoes chemical and mechanical degradation throughout its life, making it potentially unsafe to handle or store. When the time comes for the ammunition to be destroyed, it is already too late to start thinking about a disposal plan—the risks of accidents increase while authorities try to decide on a way forward. Even though it may be many years before disposal occurs and technologies may have changed in the meantime, having a ready-made plan will help reduce the time and money needed for disposal action. It is easier to amend an existing plan than to draw one up from scratch, especially when items are time expired and can create a safety hazard during transportation or storage. Planning a demilitarization process in advance implies that the state can:

- prioritize the ammunition in terms of quantity, type, condition, and difficulty to process; and
- make a number of decisions in advance regarding its in-house demilitarization capacity and its willingness to outsource part of the process.[15]

Demilitarization processes use two main methods: OB/OD and industrial

demilitarization. Most physical security and stockpile management programmes will involve a combination of both, and each method has its pros and cons (see King and Diaz, 2011, pp. 37–42). The decision to choose any particular technique will be based on cost, safety, environmental considerations, contractor availability, logistics, the type of ammunition being destroyed, the physical or chemical condition of the ammunition, and the value of recovered materials.

OB/OD techniques have traditionally been used for the disposal of unserviceable, obsolete, and surplus munitions. In the past few years they have fallen out of favour with many demilitarization practitioners, for whom OB/OD are a potential source of uncontrolled soil, groundwater, and air pollution. Detractors of OB/OD also point to the dangers caused by shockwaves, projected fragments, and kick-outs[16] ejected by the explosions over a wide area. OB/OD are also considered more wasteful of resources, since very little resulting material can be recycled. The overall process is labour intensive and can be slow in heavily populated regions such as much of Europe, where explosive limits are low (Courtney-Green, 2009).

Above a certain quantity, OB/OD may not be as cost effective as industrial demilitarization for some ammunition types. At the Berlin Conference on the Destruction of Cluster Munitions, a Canadian representative noted that, based on the country's experience in supporting destruction projects for anti-personnel mines, if approximately one million mines had to be destroyed, it became less expensive to use other technologies (MacBride, 2009, p. 42). Finally, where OB/OD might be a feasible solution for high-explosive rounds, it is a less suitable technique for munitions with less energetic material content, e.g. countermeasure ammunition or low-vulnerability ammunition (the latter being filled with insensitive high explosives).

Yet the environmental argument currently divides the demilitarization community, with proponents advocating professionally conducted OB/OD operations as a highly efficient process with negligible environmental impact. OB/OD remain the only practical and pragmatic solutions if stocks are too dangerous to move or if there are low economies of scale to be achieved within the national stockpile. Most armed forces, including within NATO, are keen to retain OB/OD as a valid, 'institutional' ammunition and explosives disposal method. The environmental impact can be managed by carefully selecting the location and the materials to be destroyed, and by continually monitoring the destruction

Discharge of TNT-filled projectiles. © Expal Bulgaria

sites' releases into the air, ground, and water. Releases to the local ground area from OD can often be reduced or stopped by sealing the ground to stop water run-off or by using propellant burn trays to stop material spitting out during the burns. In Canada, for instance, soil and hydrogeological sampling studies are carried out at the Canadian Forces Ammunition Depot Dundurn Destruction Site to monitor the concentrations of energetic materials and heavy metals in the water and soil samples (Park, Eng, and Garrard, 2011, para. 5.5).

Industrial demilitarization involves the use of various technologies to burn, melt, cut, crush, or disassemble ammunition down to its component parts and compounds. To reduce demilitarization costs and offset the price of transport and processing, most contractors maximize the recovery of commercially viable materials (Towndrow, 2009, para. 26). Sophisticated R3 industrial processes involve the effective recycling of these components and materials. Industrial demilitarization requires substantial initial investment, but once the plant is established and the machinery is installed, the processes can be operated around the clock by relatively few people. The state can control the implementation of the work during all the phases of the destruction process: most countries delegate this task to the government quality assurance representative of the host nation where demilitarization is performed. Sensitive elements of the ammunition, e.g. the deformed guidance part of a MANPADS[17] missile, can be kept apart to testify that the demilitarization was correctly executed. It must also be noted that certain industrial demilitarization techniques result in the production of hazardous waste that itself requires destruction or disposal in an environmentally benign manner. In addition, many items are either too small, too complex, or not profitable enough to be effectively recycled (Association of the US Army, 2008, p. 4). National authorities should be aware that the development of even relatively simple demilitarization or destruction processes can be time consuming. This time requirement should be incorporated into the demilitarization planning and preparation process.

States rarely have the indigenous capacity to demilitarize their entire security forces' surplus stockpiles.

Contracting private demilitarization companies

States rarely have the indigenous capacity to demilitarize their entire security forces' surplus stockpiles. Instead, they have the option of issuing requests for proposals (RfP) to the private demilitarization industry to address the dismantling and demolition of ammunition and explosives.

Following the prohibition of deep-sea dumping as a disposal technique by the 1972 London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (IMO, n.d.), Europe developed a modern, well-regulated munitions demilitarization industry to dispose of surplus stockpiles. Since then, private companies have demilitarized substantial stocks of all types of ammunition—small arms, pyrotechnics, propellants, mortars, artillery, aircraft bombs, missiles, rockets and countermeasures—under normal competitive tendering rules.

Private demilitarization companies have considerable experience in applying and navigating dangerous goods or hazardous waste regulations[18] that apply to the transportation of ammunition and explosives earmarked for demilitarization. Contracting a qualified private demilitarization company may save time and administrative costs if the demilitarization plan involves substantial transportation and foreign logistics.

RfPs are published by national authorities or coordinated by various international organizations such as the NATO Maintenance and Supply Agency (NAMSA) and the United Nations Development Programme on behalf of a given country or group of countries.[19] The requesting party will then evaluate the various proposals and award the tender(s) to selected demilitarization company(ies) whose solution in terms of value best addresses the requirements defined in the RfP. During the process, cost considerations come into play in a number of areas.

Tailoring the tenders

Demilitarization firms compete for market share. They attempt to optimize their profits, to invest in new demilitarization technology, and to maintain their customer base. This is a powerful incentive to reduce the costs of demilitarization, and choosing the right type of tender is critical. There are three basic types of tender and each assigns various degrees of importance to the cost criteria.

1. The first type combines the technical and financial aspects, but evaluates tender proposals according to a ranking list of criteria. Each predefined criterion is assigned a certain 'weight' of importance, thereby awarding a number of points to each proposal. For instance, the Swedish Defence Materiel Administration evaluates tenders on this basis. The criterion with the highest weight of importance (60 per cent) is explosives recycling; the price criterion has a weight of importance of only 40 per cent. For equally valid offers, the criteria will be weighed and evaluated in the following order:

material recycling, energy recycling with flue-gas cleaning, and dumping (Swedish Defence Materiel Administration, 2010, p. 6).

2. The second type of tender involves a 'two-envelope' system in which the technical proposal is evaluated first (first envelope). The bids are ranked before the financial offer is opened (second envelope). This ensures that the price does not influence the technical evaluation of the proposal. If the technical proposal is assessed as non-compliant, the price envelope will be returned to the bidder unopened (NAMSA, 2009, para. 5.2.1). This allows authorities to select a tender and ensure that it is technically, economically, and contractually compliant with the proposal. When evaluating proposals with the objective of selecting the most economical, due consideration is given to price, delivery schedules, and technical capability.
3. A third option is that price is made the sole award criterion, i.e. the contract will be awarded to the lowest compliant tender.

It is important to frame this competition qualitatively. International organizations such as NAMSA and the European Union (EU) ensure this quality in their statements of work for the tenders by demanding that contractors operate certified quality and environmental management systems or meet specific requirements with regard to the capability of the pollution control system associated with an incinerator. Such standards may include, for instance:

- quality management standards ISO 9001;
- environmental management standards ISO 14001;
- AQAP 2130[20]; and
- one or more regulations, e.g. the EU Directive on the Incineration of Waste 2000/76/EC (EU, 2000).

NAMSA facilitates the process by coordinating the offers from NATO member states' demilitarization industries under normal competitive tendering rules. This bidding process is open to qualified bidders whose sealed bids are opened in public and awarded on the basis of technical compliance and lowest price. National administrations do not have to bother to shortlist suppliers who responded to advertisements expressing an interest in tendering and completed a prequalification questionnaire to show that they have sufficient experience and resources to meet the needs of the procurement opportunity.

In any case, the government or international organization should reject

120 mm mortar tails at ULP Mjekës in Albania. © NAMSA

a tender if the tenderer substantially fails to submit requested information regarding the elemental conditions, such as the security or technical description of the processes.

Ownership of the recycled material

Demilitarization companies will not own the ammunition until they deliver a certificate of destruction. The NAMSA statement of work stipulates, for instance, that in accordance with the country's regulations, the country's armed forces remain the owner of the ammunition. The original owner of the ordnance can monitor its destruction, or delegate the verification to a government quality assurance representative (GQAR).

After demilitarization, ownership of the remaining material passes to the contractor. The certificate of demilitarization, duly signed by the nominated GQAR, will be considered as effective proof of transfer of property from the country's armed forces to the contractor.

However, this transfer of property is not systematic. National authorities may request ownership of any recyclable material such as metallic scrap and explosive residues, and decide whether to destroy them or sell them to fund future demilitarization programmes. Some explosive fillings of ammunition may be useful to the commercial explosives industry; scrap steel is always in demand.

Government measures to reduce demilitarization costs

Once a demilitarization plan is devised or a company is contracted, a government can take a number of measures to reduce the costs of demilitarization.

- As stated above, logistics and transportation can cost up to 50 per cent of a demilitarization contract. This service is almost always subcontracted to a professional freight forwarder because logistics is not the core business of industrial demilitarization companies. Optimizing the ammunition's volume, or net explosive weight, and overall packaging before transport will reduce freight costs. Better still, assigning the ammunition's transportation logistics to the country's armed forces will significantly reduce the cost of the contract.
- Accurate and comprehensive RfPs that portray the exact state and quantity of the ammunition to be demilitarized should be submitted. Too often, research on the ammunition is performed only once the contract is awarded or once the ammunition is in the demilitarization plant's warehouse. Sometimes the ammunition does not come in its original logistics packaging and is in such bad condition that new machinery must be developed and new safety instructions applied. Not knowing the state of the ammunition will increase demilitarization costs.
- Economies of scale and homogeneous lots of ammunition should be aimed for. Demilitarization plants must invest funds to research, develop, or retool demilitarization lines to meet the requirements of various contracts. Significant funds are also spent on specialized labour and qualified personnel. Spreading these expenditures over a large quantity of homogeneous ammunition allows the plant to optimize its production process, reduce lead times, and ultimately reduce costs. Planning the contract over several years will result in further savings for the customer because investments made for highly automated machinery can be amortized.

Consequently, national authorities may wish to cooperate with other states in order to achieve larger economies of scale and hence more cost-effective demilitarization. In theory, ammunition from a number of states could be dealt with under a single, larger contract, leading to cost savings for individual states.

Pooling and sharing are becoming common practice in the field of ammunition procurement. Given the reduction of defence spending throughout much of Europe, NATO's secretary-general, A. Rasmussen, has repeatedly urged European allies to pool their resources to benefit from economies of scale through international cooperation (BBC, 2010; Mason, 2011). Cooperation can be of a financial nature. For instance, on 15 December 2010 Estonia and the United Kingdom concluded a framework agreement on the joint acquisition of defence equipment, thereby 'opening the road for information-sharing on defence, arms or munitions acquisitions planned or contemplated' (EU Parliament, 2011, p. 64). Non-financial cooperation can involve information sharing on munitions acquisition: a recent example is the memorandum of understanding between the Dutch Defence Materiel Organization and its German counterpart, the Federal Office for Defence Technology and Procurement, signed on 4 January 2011. The agreement fosters closer cooperation in the field of medium- and large-calibre ammunition, and may in the future be extended to cover ammunition development, testing, purchasing, and storage. In addition, test data will be easily exchanged without charge, and the two organizations will also be able to use each other's testing facilities and equipment (Netherlands MoD, 2011).

Ideally, pooling and sharing could be considered in almost every phase of the equipment life cycle, including demilitarization.

National authorities may wish to cooperate with other states in order to achieve larger economies of scale and hence more cost-effective demilitarization.

Conclusion

To remove many of the safety and security risks associated with the accumulation of stockpiles of surplus, shelf-life expired, or potentially unstable ammunition, national authorities, international organizations, and industrial companies have developed a range of physical demilitarization processes to deal with their surplus stockpiles and are actively promoting them over other disposal techniques. Yet the costs of ammunition demilitarization are often a burden for cash-strapped governments. Solutions are sought to anticipate and, if possible, reduce these costs.

Some states may feel that reducing demilitarization costs is only a matter of bargaining for the cheapest offer at the last moment from the demilitarization industry. In practice, however, demilitarization costs are better dealt with in the framework of a 'whole-life management' approach that integrates the costs generated by ammunition throughout its entire life cycle: from design to procurement, storage, use, and demilitarization.

Initiatives such as DfD indicate a designer's willingness to incorporate demilitarization considerations very early on in the ammunition life cycle. Savvy MoD procurement staff looking to purchase new conventional ammunition can (and should) now enquire whether the acquisition documentation incorporates demilitarization design requirements and a demilitarization plan describing the procedures, processes, and technologies to be used.

Substantial savings can also be made at a later stage, e.g. during storage, by implementing a methodical ammunition in-service surveillance plan to monitor the age, shelf life, and overall serviceability of the stockpile.

Similarly, states' surest way to reduce demilitarization costs is to consider demilitarization years before the end of the stockpile's life cycle. Planning for demilitarization implies decision making at the earliest stage possible to prioritize items, select a demilitarization method, optimize logistics, and ultimately outsource part of the process to demilitarization companies under the best possible technical and financial terms. ■

Endnotes

1 'Demilitarization' is understood as 'the complete range of processes that render weapons, ammunition and explosives unfit for their originally intended purpose' (UNODA, 2011b, p. 8). The process involves transportation, storage, accounting, and pre-processing operations, as well as the final destruction process. 'Disposal' is understood as a wider concept that includes the removal of ammunition and explosives from a stockpile through a variety of methods, which may *not* necessarily involve destruction. Armed forces around the world traditionally use one or more of six methods of disposal: (1) sale, (2) gift, (3) increased use during training, (4) deep-sea dumping, (5) land fill, and (6) destruction or demilitarization (UNODA, 2011b, pp. 9–10). Surplus sales are covered by previous RASR and Small Arms Survey publications (see Gobinet and Gramizzi, 2011; Gobinet, 2011).

2 Author interview with D. Towndrow, NATO Maintenance and Supply Agency (NAMSA), 8 February 2012.

3 PBX is a castable explosive that can be washed out but not melted.

4 Author interview with A. Wilkinson, ammunitions specialist and consultant, 20 January 2012.

5 Author interview with D. Towndrow, NAMSA, 8 February 2012.

6 Author interview with D. Towndrow, NAMSA, 8 February 2012.

7 Author interview with D. Towndrow, NAMSA, 8 February 2012.

8 Author interview with D. Towndrow, NAMSA, 8 February 2012.

9 According to Meyer, Köhler, and Homburg (2007, p. 136), exudation is '[t]he separation of oily ingredients out of explosives during prolonged storage, especially at elevated temperatures. . . . Prolonged storage, especially in wet climates, may cause exudation of gelatinous nitroglycerine explosives. Highly dangerous is the exudation of unbounded nitroglycerine; it occurs when the gelatinization with nitrocellulose (blasting soluble) was faulty or the nitrocellulose of bad quality'.

10 Because propellants are inherently chemically unstable, stabilizers are added to slow the ageing process. The stabilizer will slowly be consumed and will drop to a point where it is not sufficient to prevent an accelerated decomposition. At this point the propellant may auto-ignite.

11 White phosphorus, an extremely toxic substance, melts at around 45°C.

12 Also referred to as 'in-service surveillance' (ISS). According to NATO Munitions Safety Information Analysis Centre terminology, ISS forms part of the munitions' safety and suitability for service and reliability management process (Sharp, n.d.).

13 For instance, according to UNODA (2011d, p. 10), '[t]he most extreme example of chemical degradation of stability is that of nitrate ester based explosives, which at the end of their safe lives, will auto-ignite; usually resulting in the loss of a storehouse. Most gun and many rocket propellants contain nitrate esters such as nitrocellulose and nitro-glycerine.'

14 Operations should obviously be performed in appropriate ammunition-processing buildings and not in the storage warehouse itself.

15 For example, certain ammunition types and components must be incinerated to obtain a piece of metal that can be classified as free from explosive. An incinerator must be heated up to some 500°C. During this energy-demanding phase, the production rate is nil. In order to ensure optimum return, it should be operated round the clock. Government-run facilities may not be able to achieve this.

16 Kick-out is the ejection of undetonated devices and can be minimized by the proper placement of multiple charges.

17 Man-portable air defence system.

18 Wilkinson and Watt (n.d., para. 5) explain that '[i]f the munitions are regarded as dangerous goods then their transportation will be undertaken in accordance with national legislation based on the UN classification system, the "Orange Book"'. If the munitions are classified as hazardous waste, their transportation and storage will be subject to additional regulation and permit requirements, governed by countries' environmental agencies. With the reported exception of Sweden, European Union regulations

preventing the shipment of hazardous waste to developing countries currently do not apply to munitions being transported for demilitarization in Europe where, 'in common with the US, military munitions are regarded as already regulated more tightly than hazardous waste' (Wilkinson and Watt, n.d., para. 5.2).

19 To sponsor weapons and ammunition disposal programmes, the European Community and the European Defence Agency also coordinate the procurement of certain high-value items such as explosive waste incinerators.

20 AQAP: Allied Quality Assurance Publications; AQAP 2130 is the NATO quality assurance requirements for inspection and test (NATO, 2003).

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The Small Arms Survey serves as the principal international source of public information on all aspects of small arms and armed violence, and as a resource centre for governments, policy-makers, researchers, and activists. The Survey distributes its findings through Occasional Papers, Special Reports, a Book Series, and its annual flagship publication, the *Small Arms Survey*.

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About the Regional Approach to Stockpile Reduction (RASR) Initiative

The Regional Approach to Stockpile Reduction (RASR) is a long-term, coordinated, regional approach to address the threats posed by excess, unstable, loosely secured, or otherwise at-risk stockpiles of conventional weapons and munitions.

RASR encourages affected governments and relevant organizations to develop a proactive, coordinated, regional approach to secure and destroy small arms and light weapons by building local capacity, sharing best practices and lessons learned, and synchronizing resources in order to maximize their efficiency.

The ultimate aim of the RASR initiative is to prevent disastrous explosions or destabilizing diversions of conventional weapons and munitions.

Funding for this Issue Brief was provided by the US Department of State's Office of Weapons Removal and Abatement.

For more information see www.rasrinitiative.org.

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