Edited by James Bevan

CONVENTIONAL AMMUNITION IN SURPLUS

A REFERENCE GUIDE

small arms survey

A Small Arms Survey publication in cooperation with partners

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About the Project Partners

BICC is an independent non-profit organization dedicated to promoting peace and development through the efficient and effective transformation of military-related structures, assets, functions, and processes. Having expanded its span of activities beyond the classical areas of conversion that focus on the reuse of military resources (such as the reallocation of military expenditures, restructuring of the defence industry, closure of military bases, and demobilization), BICC is now organizing its work around three main topics: arms, peacebuilding, and conflict. The Bonn International Center for Conversion was established in 1994 with support from the State of North Rhine-Westphalia (NRW). The Center's Trustees include the two German states of North Rhine-Westphalia and Brandenburg as well as the NRW.BANK, and the Landesentwicklungsgesellschaft NRW (LEG).

GRIP (Groupe de recherche et d'information sur la paix et la sécurité), located in Brussels, is an independent Belgian research centre focusing on the study and dissemination of information and training on problems of peace, defence, and disarmament. GRIP works with the aim to contribute to improving international security in Europe and throughout the world by assisting in political decision-making processes. Its current work on small arms, light weapons, and related ammunition focuses on the thematic issues of transparency and restraint in arms transfers, controls on arms brokering, and tracing illicit arms. www.grip.org

The Federation of American Scientists (www.fas.org) was formed in 1945 by atomic scientists from the Manhattan Project. Endorsed by 68 Nobel Laureates in biology, chemistry, economics, medicine, and physics as sponsors, the Federation has addressed a broad spectrum of national security issues in carrying out its mission to promote humanitarian uses of science and technology. Today, FAS projects study nuclear arms control and global security; conventional arms transfers; proliferation of weapons of mass destruction;

information technology for human health; and government information policy. FAS has also expanded to include programmes in innovative learning technologies and energy-efficient building technology.

The **Small Arms Survey** is an independent research project located at the Graduate Institute of International Studies in Geneva, Switzerland. It serves as the principal source of public information on all aspects of small arms and as a resource centre for governments, policy-makers, researchers, and activists.The Survey sponsors field research and information-gathering efforts, especially in affected states and regions. Established in 1999, the project is supported by the Swiss Federal Department of Foreign Affairs, and by sustained contributions from the governments of Belgium, Canada, Finland, France, the Netherlands, Norway, Sweden, and the United Kingdom. The project has an international staff with expertise in security studies, political science, law, economics, development studies, and sociology. It collaborates with a worldwide network of researchers, partner institutions, non-governmental organizations, and governments. www.smallarmssurvey.org

Since 1993, **Viva Rio** (www.vivario.org.br)**,** an NGO based in Rio de Janeiro, has worked to combat a growing wave of urban violence—a problem that affects mainly young people—in Brazilian cities. Campaigns for peace and against the proliferation of small arms, as well as projects aiming to reduce criminal behavior and armed violence, are the hallmarks of the organization's work. Activities to confront problems associated with the proliferation and misuse of firearms are carried out at the local, national, and international levels. Viva Rio has three main objectives: to reduce the demand for guns (actions to sensitize civil society to the risks involved with using or carrying firearms and to respond to the gun industry lobby); to reduce the supply of guns (curb illicit arms trafficking and control the production, sales, exports, and imports of small arms and ammunition); and to improve stockpile controls (destruction of excess guns and improvement of secure storage facilities).

About the Authors

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James Bevan is a Researcher for the Small Arms Survey. He has conducted extensive field research on the dynamics of illicit arms proliferation, armed violence, and armed violence reduction policies. In addition to all aspects of armed violence and security, he specializes in technical aspects of conventional weapons and their production, deployment, and use. He is currently devising field protocols for tracing ammunition and provides technical advice to a number of organizations, including UN Sanctions Inspectors. He is assisting the German Government in preparation for the 2008 UN Group of Governmental Experts on Conventional Ammunition in Surplus. He has published widely on issues ranging from the structure and organization of armed groups, to studies on small arms and light weapons production and trade, man-portable air defence systems, and ammunition tracing.

Ian Biddle spent 20 years in the British Army and most of this time as an Ammunition Technical Officer. He also has significant experience of the commercial weapons sector, including the production and export of small arms and ammunition. He is a specialist consultant for the British Ministry of Defence, the United Nations Development Programme, and the Small Arms Survey. He has worked all over the world, including the Balkans, Eastern Europe, Somalia, the Republic of Congo, and Sierra Leone. He is an explosives and small arms and light weapons expert, with a keen interest in international affairs and specialist military operations, particularly those involving counter-insurgency and counter-terrorism.

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Matt Schroeder is Manager of the Arms Sales Monitoring Project at the Federation of American Scientists (FAS). Since joining FAS in 2002, he has written on US arms transfers, arms export policies, and the illicit trade in small arms. He is the author of *The Small Arms Trade* (Oneworld Publications, 2007) and has written on the illicit small arms trade for *Arms Control Today*, the *Bulletin of Atomic Scientists*, *African Analyst*, Jane's *Intelligence Review*, and the Small

Arms Survey. He has given dozens of media interviews, appearing most recently on CNN, BBC, and Public Radio International. He graduated from Wittenberg University with a bachelor's degree in history and received a master's degree in international security policy from Columbia University.

Adrian Wilkinson currently works as the consultant Programme Manager for Explosion and Ballistic Protection at the UK Home Office Scientific Development Branch. Prior to this he was Head of SEESAC, a joint disarmament and small arms and light weapons control mission of the United Nations Development Programme and the Stability Pact for South Eastern Europe, for five years. Previous appointments include being the Head of Technology and Standards at the Geneva International Centre for Humanitarian Demining (GICHD), where he was responsible for the review and revision of the International Mine Action Standards (IMAS) and the provision of technical advice to international organizations and national governments. Adrian Wilkinson also served for 20 years in the British Army as an Ammunition Technical Officer (ATO), which included operational and counter-terrorist bomb disposal experience in numerous theatres. He also established the UK Demilitarization Facility at Shoeburyness. His education includes a Master of Science degree in Explosive Ordnance Engineering from Cranfield University and a Master of Arts degree in International Conflict Analysis from the University of Kent, Canterbury. He has written and contributed to many publications on disarmament, small arms and light weapons control, and DDR.

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Foreword

Germany has long been committed to raising the international profile of safe and secure ammunition management. Poorly managed and insecure stocks of conventional ammunition are a problem of global concern. They pose an imminent risk to public safety and a security threat to societies. Hundreds of people die each year because of the failure to manage and maintain dangerous stocks of ammunition. Many more people lose their lives because ammunition diversion from national stockpiles keeps fuelling violent conflict, armed crime, and terrorism. Accidents are not confined to specific regions of the world, and diversion to the illicit market obeys no international borders. The mismanagement of ammunition has the potential to affect all states and a host of stakeholders, ranging from state security forces to the populations that reside close to ammunition stockpiles.

Germany is committed to supporting the United Nations Group of Governmental Experts (GGE) that will convene in 2008 to consider steps to enhance cooperation with regard to the issue of conventional ammunition stockpiles in surplus. The decision to convene the GGE is based on UN General Assembly Resolution 61/72 entitled *Problems Arising from the Accumulation of Conventional Ammunition Stockpiles in Surplus*, which was first presented by France and Germany in 2005, thereby formally putting the issue on the international agenda.

As part of its support for the 2008 GGE, the Federal Foreign Office requested that the Small Arms Survey produce a reference guide that would provide information on the full spectrum of issues related to conventional ammunition in surplus. This guide, entitled *Conventional Ammunition in Surplus*, is designed to be a one-stop reference for all those involved in the process, from governments to international organizations and advocacy groups. Designed to be easily accessible, the guide provides a concise review of key issues, progress, and new policy priorities in the field of ammunition management. *Conventional Ammunition in Surplus* is a companion for all stakeholders with an interest in ammunition.

Frank-Walter Steinmeier
Federal Minister for Foreign Affairs
Federal Republic of Germany

About This Reference Guide

James Bevan

This is a reference guide designed to quickly impart to its readers the most important information pertaining to the management of conventional ammunition.

First and foremost, it is a book for policy-makers and for people closely involved in policy-making processes. Its small size and spiral binding ensure mobility and ease of use.

The book responds to the requirement for a single source of easily accessible, reliable, and authoritative information. As a result, some of the book's chapters restate and update existing information, with the aim of providing readers with the most authoritative, publicly available information within a single, easy-to-read volume. Other chapters break new ground by presenting unexplored, or under-explored, issues related to arms and ammunition management.

Due to the cross-cutting nature of the field, many of the chapters cover closely linked themes. This is because effective arms and ammunition management is a system rather than a series of isolated activities.

The book's chapters note these issue linkages and have been carefully cross-referenced so that readers can easily navigate between related issues within the book. These cross references appear in the text and indicate the relevant chapter in upper case. For example, reference to Chapter 15 appears as (CHAPTER 15).

Chapters also feature 'Further reading' lists. The book is designed to be the first port of call for information on conventional ammunition, but also a gateway to the best available information on particular issue areas, should readers want to explore a subject in greater detail.

Acknowledgements

On behalf of the authors, I would like to express my thanks to the following people for their contributions to this book. First and foremost, we are grateful to the staff of the German Federal Foreign Office and, in particular, Michael Hasenau for making this project a reality, and for their continued support for the Small Arms Survey's ammunition projects. In addition to co-authoring two chapters in this volume, Ian Biddle and Holger Anders provided expertise, advice, and reviews of the other sections. Jasna Lazarevic provided research assistance throughout the process and deserves a special acknowledgement for her hard work and diligence. Thanks go to Glenn McDonald and Eric Berman for their insight and for intervening when it mattered most. We also thank Alex Potter for his copy-editing skills, Janine Vigus for the layout, Donald Strachan for proofreading, and Tania Inowlocki and Susan Lee for planning and directing the publication process. Members of the Small Arms Survey staff—especially Silvia Cattaneo, Jennifer Hazen, Stéphanie Pézard, and Chris Stevenson—also provided critical assistance.

James Bevan

Abbreviations and Acronyms

AAM	air-to-air missile
AAP	Allied Administrative Publication (NATO)
AASTP	Allied Ammunition Storage and Transport Publication (NATO)
ADF	ammunition demilitarization facility
AGM	air-to-ground missile
AH	anti-helicopter
ALARP	as low as reasonably practicable
AMPS	Ammunition Management Policy Statements (SEESAC)
AP	anti-personnel
APB	ammunition-process building
APE	ammunition-peculiar equipment
ASS	ammunition storage site
AT	anti-tank/ammunition technician
ATGM	anti-tank guided missile
ATGW	anti-tank guided weapon
ATO	ammunition technical officer
AUW	all up weight
AV	anti-vehicle
CBC	Companhia Brasileira de Cartuchos
CMD	conventional munition disposal
COTS	commercial off-the-shelf
CSBM	confidence- and security-building measures
CWIED	command wire IED
DAER	daily ammunition expenditure rate
DCSR	daily combat supply rate
DDR	disarmament, demobilization, and reintegration
DTRA	Defence Threat Reduction Agency (United States)
ECA	explosion consequence analysis
EFP	explosively formed projectile

EOD	explosive ordnance disposal
ELL	explosive limit licence
ERW	explosive remnant of war
ESA	explosive storage area
ESH	explosive storehouse
EWI	explosive waste incinerator
FFR	free-flight rocket
GGE	Group of Governmental Experts
HCC	hazard compatibility code
HD	hazard division (United Nations)
HE	high explosive (noun); high-explosive (adjective)
HEAT	high-explosive anti-tank
HME	home-made explosives
HPLC	high performance liquid chromatography
HSEOEL	health and safety executive occupational exposure limits
IED	improvised explosive device
IQD	inside quantity distances
IRFNA	inhibited red fuming nitric acid
ISFE	igniter safety fuse electric
JACIG	Joint Arms Control Implementation Group (United Kingdom)
LVBIED	large vehicle-borne IED
MANPADS	man-portable air defence system(s)
MHE	mechanical handling equipment
MLRS	multiple launch rocket system
MMH	monomethyl hydrazine
MoD	ministry of defence
NATO	North Atlantic Treaty Organization
NEC	net explosive content
NEQ	net explosive quantity
OBOD	open burning and open detonation
OEM	original equipment manufacturer
OQD	outside quantity distances
OSCE	Organization for Security and Co-operation in Europe
PBIED	person-borne IED

PCIED	projectile-controlled IED
PCS	pollution control system
PES	potential explosion site
PETN	penta-eurythyl tetranitrate
PfP	Partnership for Peace (NATO)
RCIED	radio-controlled IED
RDX	Research Department Explosive (Octagen)
RFNA	red fuming nitric acid
SAA	small arms ammunition
SAADS	small arms ammunition disposal system (commercial)
SALW	small arms and light weapons
SAM	surface-to-air missile
SEESAC	South Eastern and Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons
SOP	standing/standard operating procedure
SSR	security sector reform
TLV	threshold limit value
TNT	trinitrotoluene
UDMH	unsymmetrical dimethyl hydrazine
UKMoD	United Kingdom Ministry of Defence
ULC	unit load container (pallets)
UNDP	United Nations Development Programme
UNDPKO	United Nations Department of Peacekeeping Operations
USD	United States dollar
USDoD	United States Department of Defense
USGAO	United States Government Accountability Office
UXO	unexploded ordnance
VBIED	vehicle-borne IED
VOC	volatile organic compound
VOIED	victim-operated IED

Glossary of Conventional Ammunition Terminology[1]

James Bevan and Adrian Wilkinson

Abandoned explosive ordnance (AXO)

Explosive ordnance that has not been used during an armed conflict, has been left behind or dumped by a party to an armed conflict, and is no longer under control of the party that left it behind or dumped it. Abandoned explosive ordnance may or may not have been primed, fused, armed, or otherwise prepared for use.[†2]

(ammunition) Accounting

Information management systems and associated operating procedures that are designed to record, numerically monitor, verify, issue, and receive ammunition in organizations and stockpiles.

Ammunition

A complete device (e.g. missile, shell, mine, demolition store, etc.) charged with explosives; propellants; pyrotechnics; initiating composition; or nuclear, biological, or chemical material for use in connection with offence, or defence, or training, or non-operational purposes, including those parts of weapons systems containing explosives[3] (cf. **Munition**).

Artillery ammunition

Medium and large calibre ammunition for weapons, such as mortars, howitzers, missile, and rocket launchers, that are primarily designed to fire indirectly at targets (cf. **Ammunition**).

Blank cartridge

Used to simulate a live round, primarily used for training, containing propellant and a wad, but no bullet or other projectile. Not designed for offensive military use (cf. **Cartridge**).

Bomb
Explosive munition, not subject to centrifugal forces and with a nearly vertical angle of descent, usually delivered from an aircraft or mortar (cf. **Munition**).

Burning ground
An area authorized for the destruction of ammunition, mines, and explosives by burning.

Charge
A fixed quantity of explosives designed for a specific purpose (cf. **Explosives**; **Charge (bursting)**; **Charge (demolition)**; **Charge (expelling)**; **Charge (propelling)**).

Charge (bursting)
A small charge, frequently of black powder, used to break the case of a carrier projectile to enable the release of its payload, classically used in shrapnel shells.

Charge (demolition)
A charge made up from bulk explosive for the express purpose of destruction by blast or brisance.

Charge (expelling)
A charge of generally low or deflagrating explosive designed to eject the payload from a parent munitions dispenser by gas pressure without damage to the sub-munitions (cf. **Sub-munitions**; **Deflagration**).

Charge (propelling)
Articles consisting of a propellant charge in any physical form, with or without a casing, for use in artillery, mortars, and rockets, or as a component of rocket motors.

Cluster munitions
Containers designed to disperse or release multiple sub-munitions (cf. **Munition**; **Sub-munitions**).

'Cooking off' (within a weapon)
Unintended firing of a weapon caused by the propellant exceeding its flashpoint and initiating. This happens when a weapon has become very hot due to repeated firing and is left loaded. The heat contained in the weapon is conducted to the charge, causing it to heat up, eventually to the point at which it initiates.

'Cook-off'
The premature detonation or deflagration of ammunition due to the influence of heat from the surrounding environment.

Daily ammunition expenditure rate (DAER)
The amount of ammunition that a single weapon uses in one day of combat of a given intensity.

Danger area
(cf. **Explosive danger area**)

Deflagration
A chemical reaction proceeding at subsonic velocity along the surface of and/or through an explosive, producing hot gases at high pressures.

Demilitarization
The complete range of processes that render weapons, ammunition, mines, and explosives unfit for their originally intended purpose.[4]

Demilitarization not only involves the final destruction process, but also includes all of the other transport, storage, accounting, and pre-processing operations that are equally as critical to achieving the final result.[†]

Destruction
The process of final conversion of weapons, ammunition, mines, and explosives into an inert state so that they can no longer function as designed.[†]

Destruction in situ
The destruction of any item of ordnance by explosives without moving the item from where it was found—normally by placing an explosive charge alongside it.

Detonation
The rapid conversion of explosives into gaseous products by means of a supersonic shock wave passing through the explosive. (Typically, the velocity of such a shock wave is more than two orders of magnitude higher than a fast deflagration.) (cf. **Deflagration**)

Detonator
A device containing a sensitive explosive intended to produce a detonation wave in response to some stimulus.† It may be constructed to detonate instantaneously, or may contain a delay element.

Diurnal cycling
The exposure of ammunition and explosives to the temperature changes induced by day, night, and change of season.†

Disposal (logistic)
The removal of ammunition and explosives from a stockpile by the utilization of a variety of methods (which may not necessarily involve destruction).[5] Logistic disposal may or may not require the use of render safe procedures.

There are five traditional methods of disposal used by armed forces around the world: 1) sale; 2) gift; 3) use for training; 4) deep sea dumping; and 5) destruction or demilitarization.†

Disposal site
An area authorized for the destruction of ammunition and explosives by detonation and burning.†

Diversion
The unauthorized transfer of arms and ammunition from the stocks of legal users to the illicit market.

Drill
An inert replica of ammunition specifically manufactured for drill, display, or instructional purposes.

Explosive
A substance or mixture of substances that, under external influences, is capable of rapidly releasing energy in the form of gases and heat.†

Explosive danger area
The area surrounding a demolition ground or ammunition storage area determined by the distances any fragments resulting from the detonation of ammunition may be expected to travel.†

Explosively formed penetrator (EFP)
(cf. **Shaped charge**)

Explosive materials
Components or ancillary items that contain some explosives, or behave in an explosive manner, such as detonators and primers.†

Explosive ordnance
All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads; guided and ballistic missiles; artillery, mortar, rocket, and small arms ammunition; all mines, torpedoes, and depth charges; pyrotechnics; clusters and dispensers; cartridge- and propellant-actuated devices; electro-explosive devices; clandestine and improvised explosive devices; and all similar or related items or components that are explosive in nature.†

Explosive ordnance disposal (EOD)
The detection, identification, evaluation, rendering safe, recovery, and final disposal of unexploded explosive ordnance.

EOD may also include the rendering safe and/or disposal of such explosive ordnance, which has become hazardous by damage or deterioration, when the disposal of such explosive ordnance is beyond the capabilities of those personnel normally assigned the responsibility for routine disposal. The level of EOD response is dictated by the condition of the ammunition, its level of deterioration, and the way that the local community handles it.†

Explosive remnants of war (ERW)
Unexploded ordnance (UXO) and abandoned explosive ordnance (AXO) that remain after the end of an armed conflict.[6] (Cf. **Unexploded ordinance; Abandoned explosive ordinance**)

Fragmentation hazard zone

For a given explosive item, explosive storage, or mine- or UXO-contaminated area, the area that could be reached by fragmentation in the case of detonation.

Several factors should be considered when determining this zone: the amount of explosive, body construction, type of material, ground conditions, etc.†

Fuse

A device that initiates an explosive train.†

Grenade

Munitions that are designed to be thrown by hand or to be launched from a rifle. Excludes rocket-propelled grenades (cf. **Rocket**).

Guided missiles

Guided missiles consist of propellant-type motors fitted with warheads containing high explosives or some other active agent and equipped with electronic guidance devices.

Hazard divisions (HDs)

The UN classification system that identifies hazardous substances.† For example, Class 1 (explosives) is sub-divided into six hazard divisions.

Hypergolic reaction

The spontaneous ignition of two components—particularly relevant in the case of liquid bipropellants (cf. **Rocket motor**).

Illuminating munition

Ammunition designed to produce a single source of intense light for lighting up an area. The term includes illuminating cartridges, grenades, and projectiles; and illuminating and target identification bombs.

Improvised explosive device (IED)

A device placed or fabricated in an improvised manner incorporating destructive, lethal, noxious, pyrotechnic, or incendiary chemicals and designed to kill, destroy, incapacitate, harass, or distract. It may incorporate military stores, but is normally devised from non-military components.[7]

Alternatively: An explosive device, constructed using non-commercial methods, usually in a domestic setting; or a device using ammunition that has been modified to allow it to be initiated in a non-standard way and for a purpose not envisaged by the original equipment manufacturer (OEM).[8]

Incendiary munition

Ammunition containing an incendiary substance that may be a solid, liquid, or gel, including white phosphorus.

Inert

An item of ammunition that contains no explosive, pyrotechnic, lachrymatory, radioactive, chemical, biological, or other toxic components or substances.

An inert munition differs from a drill munition in that it has not necessarily been specifically manufactured for instructional purposes. The inert state of the munition may have resulted from a render safe procedure or other process to remove all dangerous components and substances. It also refers to the state of the munition during manufacture prior to the filling or fitting of explosive or hazardous components and substances. (cf. **Drill; Lachrymatory ammunition; Pyrotechnic**)

Lachrymatory ammunition

Ammunition containing chemical compounds that are designed to incapacitate by causing short-term tears or inflammation of the eyes.[†]

Logistic disposal

The removal of ammunition and explosives from a stockpile, utilizing a variety of methods (which may not necessarily involve destruction).

Logistic disposal may or may not require the use of RSPs (cf. **Render safe procedure (RSP)**).[†]

Magazine

Any building, structure, or container approved for the storage of explosive materials.[†] Includes detachable magazines fitted to small arms and light weapons.

Making safe

(cf. **Render safe procedure (RSP)**)

Marking

The application of marks—including colours, descriptive text, and symbols—to munitions, parts, and their components, and associated packaging, for the purposes of identifying, among other things, their role, operational features, and age; and the potential hazards posed by those munitions.

Mine

An explosive munition designed to be placed under, on, or near the ground or other surface area and to be actuated by the presence, proximity, or contact of a person, land vehicle, aircraft, or boat, including landing craft.[9]

Munition

Used in this volume—and in common usage—to refer to military weapons, ammunition, and equipment. A number of armed forces and ammunition specialists, however, use the term munitions to refer solely to complete rounds of ammunition (cf. **Ammunition**).

National stockpile

The full range of ammunition stockpiles in a country under the control of separate organizations such as the police, military forces (both active and reserve), border guards, ammunition-producing companies, etc.

It includes all ammunition types, irrespective of classification (i.e. operational, training, or awaiting disposal). (cf. **Stockpile**)

(ammunition) Nature

Denotes specific types of ammunition. A means of categorizing ammunition or munitions by their function; e.g. anti-tank ammunition or riot control ammunition.

Neutralize

The act of replacing safety devices such as pins or rods into an explosive item to prevent the fuse or igniter from functioning.[10]

Neutralization does not make an item completely safe, as removal of the safety devices will immediately make the item active again.[†]

Open burning and open detonation (OBOD)

Ammunition destruction methods using burning, deflagration, and detonation techniques (cf. **Deflagration**; **Destruction**).[†]

(white) Phosphorous

A flare or smoke-producing indendiary weapon, or smoke-screening agent, made from a common allotrope of the chemical element phosphorous.

Primer
A self-contained munition that is fitted into a cartridge case or firing mechanism and provides the means of igniting the propellant charge.[†]

Proof
The functional testing or firing of ammunition and explosives to ensure safety and stability in storage and intended use.

Propellant
A material that is used to move an object by applying a motive force. This may or may not involve some form of chemical reaction. It may be a gas, a liquid, or, before the chemical reaction, a solid. Chemical propellants are most usually used to propel a projectile from its position in the breech, down the barrel, and through its ballistic trajectory to the target. Propellant operates by deflagrating in the breach, producing large volumes of gas at high pressure. Traditionally, propellants were classified as low explosives and, depending on the number of ingredients, were single-, double-, or triple-based. In the pursuit of higher muzzle velocities, however, some propellants now incorporate significant quantities of high explosives, such as RDX. These propellants are constrained from detonating by carefully controlling the means of initiation and the conditions under which the deflagration takes place.

Pyrophoric
A substance capable of spontaneous ignition when exposed to air, such as white phosphorous (cf. **(white) Phosphorous**).

Pyrotechnic
A device or material that can be ignited to produce light, smoke, or noise.

Render safe procedure (RSP)
The application of special explosive ordnance disposal methods and tools to provide for the interruption of functions or separation of essential components to prevent an unacceptable detonation.[11]

Risk
Combination of the probability of occurrence of harm and the severity of that harm.[12]

Risk analysis
Systematic use of available information to identify hazards and estimate risk.[13]

Risk assessment
The overall process comprising a risk analysis and a risk evaluation.[14]

Risk evaluation
The process based on risk analysis to determine whether the tolerable risk has been achieved.[15]

Rocket
Munitions consisting of a rocket motor and a payload, which may be an explosive warhead or other device.[16] The term often includes both guided and unguided missiles, although has traditionally referred to unguided missiles.

Rocket motor
Article consisting of a solid, liquid, or hypergolic fuel contained in a cylinder fitted with one or more nozzles. It is designed to propel a rocket or a guided missile[17] (cf. **Hypergolic reaction**).[18]

Safe to move
A technical assessment by an appropriately qualified technician or technical officer of the physical condition and stability of ammunition and explosives prior to any proposed move.

If ammunition and explosives fail a 'safe to move' inspection, then they must be destroyed in situ, or as close as is practically possible, by a qualified EOD team acting under the advice or control of the qualified technician or technical officer who conducted the initial safe to move inspection.[†]

Safety
(cf. **Stockpile safety**)
Security
(cf. **Stockpile security**)

Shaped charge
A type of ammunition designed to focus the energy of a quantity of high explosive, usually to pierce or cut armour. Shaped charges typically consist of a

cone-shaped metal liner backed by high explosive, contained within a steel or aluminium casing. Once initiated, a detonation wave collapses the liner, which forms a high velocity metallic jet (or broader diameter projectile), which is intended to penetrate armour.

Shelf life
The length of time an item of ammunition may be stored before the performance of that ammunition degrades.

Small arms ammunition
Small arms ammunition (less than 20 mm, and usually less than 14.5 mm, in calibre) consists of cartridges used in rifles, carbines, revolvers, pistols, sub-machine guns, and machine guns, and shells used in shotguns (cf. **Small arms and light weapons (SALW)**).†

Small arms and light weapons (SALW)
All lethal conventional arms that can be carried by an individual combatant, a team of people, or a light vehicle that also do not require a substantial logistic and maintenance capability.

There is a variety of definitions for small arms and light weapons circulating, and international consensus on a 'correct' definition has yet to be achieved. For the purposes of this document, the above definition will be used.†

Smoke munition
Ammunition containing a smoke-producing substance.

Stability
The physical and chemical characteristics of ammunition that impact on its safety in storage, transport, and use.

Standard/Standing operating procedures (SOPs)
Instructions that define the preferred or currently established method of conducting an operational task or activity.

The purpose of SOPs is to promote recognizable and measurable degrees of discipline, uniformity, consistency, and commonality within an organization, with the aim of improving operational effectiveness and safety. SOPs should reflect local requirements and circumstances.†

Stock
A given quantity of weapons and explosive ordnance (cf. **Stockpile**).

Stockpile
A large, accumulated stock of weapons and explosive ordnance. Often used interchangeably with stock, or to denote the weapons retained in a specific ammunition storage facility or depot (cf. **Stock**; **National stockpile**).

Stockpile destruction
The physical activities and destructive procedures leading to a reduction of the national stockpile (cf. **Destruction**; **Demilitarization**; **Disposal (logistic)**; **Stockpile**).[†]

Stockpile management
Procedures and activities regarding safe and secure accounting, storage, transportation, and handling of munitions (cf. **Stockpile**).[†]

Stockpile safety
The result of measures taken to ensure minimal risk of accidents and hazards deriving from weapons and explosive ordnance to personnel working with arms and ammunition, as well as to adjacent populations.

Stockpile security
The result of measures taken to prevent the theft of weapons and explosive ordnance; entry by unauthorized persons into munitions storage areas; and acts of malfeasance, such as sabotage.

Sub-munitions
Any munition that, to perform its tasks, separates from a parent munition (cf. **Cluster munitions**).

Surplus weapons
Weapons that are labelled unnecessary within the framework of a state's national defence and internal security systems.[19]

Surveillance
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.

Tracer ammunition
Ammunition containing pyrotechnic substances designed to reveal the trajectory of a projectile.

(ammunition) Tracing
Methods used to identify ammunition, its origins, and patterns of transfer. Shares some similarities with accounting, but usually used to refer to efforts made to identify diversion and the sources of illicit trade in ammunition.

Transfer
The import, export, trans-shipment, re-export, intangible transfer, licensed movement during production, brokering, and transport of small arms and light weapons.†

Unexploded ordnance (UXO)
Explosive ordnance that has been primed, fused, armed, or otherwise prepared for action, and which has been dropped, fired, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material, and remains unexploded either by malfunction or design or for any other cause.†

Warhead
Munition containing detonating explosives. Designed to be fitted to a rocket, missile, or torpedo.

Notes

1 The definitions were compiled from a number of sources. Those based on or derived from SEESAC (2006) are marked †. Ian Biddle also contributed definitions and revisions.
2 UN (2003).
3 UKMoD (2006, sec. 4.3, p. 2).
4 IMAS (2003).
5 This is an obvious area where confusion can be caused by the use of incorrect terminology or translation. One party may assume that when the other mentions disposal, they are really talking about destruction. This may not be the case.
6 UN (2003).
7 NATO (2007).
8 British Army Ammunition Technical Officers Course, provided by Ian Biddle. See Chapter 14 of this volume.
9 NATO (2007).
10 NATO (2007).
11 NATO (2007).
12 ISO (1999).
13 ISO (1999).
14 ISO (1999).
15 ISO (1999).
16 FAS (1998).
17 FAS (1998).
18 FAS (1998).
19 BICC (1997).

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Introduction: Conventional Ammunition in Surplus

James Bevan

Overview

Unstable and ineffectively secured accumulations of surplus conventional ammunition pose a risk to public safety, a security threat to societies, and, ultimately, a challenge to the state's monopoly on the use of force. Surplus is a problem in its own right, but one that must be understood as part of a wider set of safety and security risks that are inherent to national stockpiling of conventional ammunition.

The risk posed by conventional ammunition

Unlike weapons, many of the components in ammunition are designed to detonate or combust (CHAPTER 2). Propellants, primers, and explosives are inherently unstable and require comprehensive physical and chemical surveillance (CHAPTER 6). Managing them requires thorough planning and attention to their safe storage, handling, transportation, and disposal. A failure to institute these necessary management practices can have severe consequences. Ammunition that is allowed to become unstable or is mishandled may ignite, explode, or contaminate the environment (CHAPTER 13). Because stockpiles of conventional ammunition often run into thousands of tonnes, any one of these occurrences can lead to large-scale loss of life, drastic impacts on local economies, and the destruction of high-value military assets. Stockpiles of large calibre conventional ammunition and hazardous toxic components, such as liquid rocket fuel (CHAPTER 11), represent serious threats in this regard.

Conventional ammunition is also in high demand on the illicit market. It is a commodity that has many applications, ranging from misuse in illegal firearms to unlawful mining and fishing. Stockpiles therefore require comprehensive measures to protect them against theft or any losses that might result in illegal acquisition (CHAPTER 7). These measures include adequate physical security to protect against illegal entry to stockpiles, and comprehensive inventories, accounting practices, and oversight mechanisms that are designed to detect and prevent the misappropriation of ammunition. When these management systems fail, state stockpiles provide criminals, insurgent groups, and terrorist organizations with ammunition (CHAPTER 15)—whether in the form of small arms cartridges; advanced light weapons, such as man-portable air defence systems (CHAPTER 12); larger conventional ordnance; or components of improvised explosive devices (CHAPTER 14).

These are the essential risks posed by conventional ammunition—on the one hand, a safety risk to the public, and on the other, a significant security risk to states and societies. As these introductory remarks make clear, conventional ammunition is always a latent threat from either perspective. Containing that threat is largely contingent on effective stockpile management.

The specific problem with surpluses

The one area, however, where this set of risk is not completely dependent on stockpile management is the issue of ammunition surplus. Surpluses, as their name suggests, are not required. But this does mean that they are unwanted. States have a considerable incentive to either retain them, in case of future need, or to transfer them.

Surplus retention

If they have the capacity to identify surpluses (CHAPTER 10), states have already made the decision that the ammunition in question is beyond their existing requirements. This decision may be based on a number of factors, including anticipated excess, obsolescence, and instability. However, if states do not have the capacity to thoroughly inventory and monitor the contents of their stockpiles, they may not even recognize that they have a surplus in the first place.

Whether or not they detect surpluses, states often have a tendency to retain ammunition stocks and, indeed, arms and ammunition more generally. To some extent, this results from the difficulty of planning for future emergencies. The severity of a potential emergency is hard to predict, and so too is the possible demand for ammunition. But many states do not even attempt to forecast future requirements. Combined with a failure to properly inventory and monitor conventional ammunition stockpiles, this means that the states in question cannot make any *expected demand vs extant supply* calculation—even should they wish to. The retention of surplus is therefore not a decision, but a non-decision based, perhaps, on the erroneous rationale that 'more is probably better'.

The result is an excessive build-up of conventional ammunition, and with it, an excessive build-up of the potential safety and security risks it poses.

Surplus transfer

It is expensive for states to dispose of ammunition, and there are many potential buyers on the international market, ranging from other states to non-state armed groups and criminal organizations.

The one thing these potential recipients have in common is relatively weak purchasing power. They acquire surplus ammunition because it is cheap and because they do not have the funds to purchase newly manufactured supplies. Very often, such purchases are a function of urgent need: states may feel pressured to maintain armament parity with their neighbours, while states or armed groups involved in conflict will have a critical need for continuous supplies of ammunition.

Transferring the problem

Even if surpluses do not fuel instability, there is an added risk that any surplus that is cheaply acquired will be subsequently stored under conditions of minimal investment. There is, arguably, a direct correlation between the acquisition of surplus ammunition and the likelihood that the recipient state has ineffective management practices. States that purchase surpluses are largely confined to the developing world, and it is here that conventional ammunition stockpiles pose the greatest safety and security risks. The result is not only a transfer of surplus ammunition, but a transfer of the latent threat it poses, whether from the perspective of safety or security.

In cases in which states have, themselves, generated large surplus stockpiles, the process of surplus accumulation is often a result of systemic failures in the management of the entire national stockpile of arms and ammunition. Surplus ammunition is therefore in itself indicative of ineffective national inventorying and, with it, minimal regard for the safe and secure management of arms and ammunition.

The scale of the surplus ammunition problem

National surplus ammunition stockpiles continue to increase in size as states reduce the size of their armed forces, invest in new weaponry, or simply maintain acquisition rates above their national requirements. The countries of Eastern Europe and the former Soviet Union provide the most high profile examples of surplus stockpiles that are the direct legacy of force reductions, but the problem is not restricted to these countries. The surplus stockpiles of China, India, Iran, and Iraq are also thought to be very large.

At the national level alone, the scale of conventional ammunition surpluses can be vast. Ukraine, for instance, was formerly a base for strategic reserves of arms and ammunition during the cold war, in addition to having a large domestic military-industrial complex. The country is now faced with conventional ammunition stockpiles that, by some estimates, exceed 2.5 million tonnes (see Table 1). A significant percentage of this stockpile resides in exposed and inappropriately equipped storage facilities, a situation that serves to accelerate its deterioration.

Ukraine is not alone in the challenges it faces. As Table 1 illustrates, for a mere 10 countries, national surplus ammunition stocks accumulate to around 4.5 million tonnes. Global estimates remain elusive due to a lack of transparency and adequate record keeping on the part of national authorities.

The risk posed by surpluses, however, is not necessarily proportional to their size. Despite the fact that the world's largest surplus ammunition stockpiles have received the lion's share of public interest, relatively small amounts of ammunition can cause loss of life when they are allowed to become unstable, whether by explosion or contamination (CHAPTER 13).

The scale of stockpiles can also be misleading from the perspective of the security risk they pose. Small calibre ammunition, for example, is relatively stable under most circumstances. It poses only a minor explosive risk when stockpiled in the most decrepit conditions. Even when stored or deployed in

Table 1
Selected national ammunition stockpile estimates*

Country	Estimated stockpile (tonnes)
Afghanistan	100,000+
Albania	120,000
Belarus	1,000,000
Bosnia and Herzegovina	67,000
Bulgaria	153,000
Iraq**	400,000
Montenegro	11,200
Serbia	200,000+
Ukraine	2,500,000
Total	**4,551,200+**

* Estimates compiled by Adrian Wilkinson.

** The United States has already destroyed more than 200,000 tons.

relative small amounts, however, it can easily be diverted (CHAPTER 15) to the illicit market when accounting and monitoring procedures are lax.

The origins of surplus

National ammunition surpluses accrue for a number of reasons, including major changes in the amount of ammunition required by states, changes in types of weapons in service or in doctrine, and through a lack of planning and monitoring that allows surpluses to accumulate undetected.

Large-scale force reductions

The most publicized cases of surplus accumulation include the states of the former Soviet Union and Eastern Europe. These countries represent extreme cases, whereby the rapidly diminishing size (downsizing) of armed forces following the break-up of the Soviet Union created large surpluses of arms and ammunition. Such states typify several effects of changing ammunition requirements.

First, by virtue of their former strategic location, some states retained excess munitions that had been destined for larger (effectively multinational) forces. Second, other countries reduced the size of their armed forces due to a combination of economic and strategic factors, which made large militaries either untenable or unnecessary. A large part of the arms and ammunition formerly required for these demobilized forces was designated as surplus. Third, several arms-manufacturing states maintained previous rates of arms production irrespective of decreasing domestic demand, which contributed to growing national surpluses.

All of these impacts resulted from the difficulties that states faced in adjusting to rapid changes in 'domestic' demand for arms and ammunition. Surpluses were, to a large extent, made problematic through ineffective stockpile management—including safe storage (CHAPTER 8) and stockpile security (CHAPTER 7), which together might have alleviated the threat of munition instability and theft. Additionally, more rapid disposal or destruction (CHAPTER 9) could have removed the temptation for states to transfer their surpluses to the world's conflict zones.

Changes in the deployment of troops and materiel

Changes in doctrine prompt military reorganization that can result in requirements for different quantities and types of weapons. These changes may result in reduced demand for weapons among some users, which can prompt surplus accumulation. The impact of such changes differs little from the effect of downsizing, except in scale and the fact that they tend to create surpluses of specific varieties of weapon. For example, revised doctrine and tactics often lead to the declining utility of some types of weapons. Large conventional munitions, for instance, may be relegated to surplus if states decide to create smaller, more mobile forces.

Similar processes occur when states acquire new weapon systems. New acquisitions prompt the retirement of older weapons and can lead to surpluses of particular types of weapons and their components. States might, for example, choose to replace 175 mm and 210 mm artillery with multiple-launch rocket systems; or they might reduce the number of units deploying man-portable air defence systems (CHAPTER 12); or replace particular types of missiles, leaving surpluses of older systems and rocket fuel (CHAPTER 11). Importantly, surplus accumulation under these conditions may be localized and specific to particular units within a state's security forces.

Hidden surplus accumulation

Often states do not have the accounting and monitoring mechanisms in place to discriminate between the arms and ammunition that are required for the efficient functioning of their security forces (often termed operational stocks) and surplus munitions (CHAPTER 10). Although most conventional ammunition is marked (CHAPTER 3) and therefore identifiable, without the necessary accounting procedures in place, states cannot ascertain where, and in what quantities, different types or batches of ammunition are stored. Surpluses effectively remain hidden, and their accumulation is directly attributable to a lack of comprehensive stockpile management—particularly accounting procedures (CHAPTER 5).

In these cases, analysis has to take the worst-case scenario—the entirety of the national ammunition stockpile (whether surplus or otherwise) may be poorly managed to the extent that it poses great dangers to safety and security. The problem is not one of surplus per se, but of state policies regarding the treatment of *all* arms and ammunition within the national stockpile.

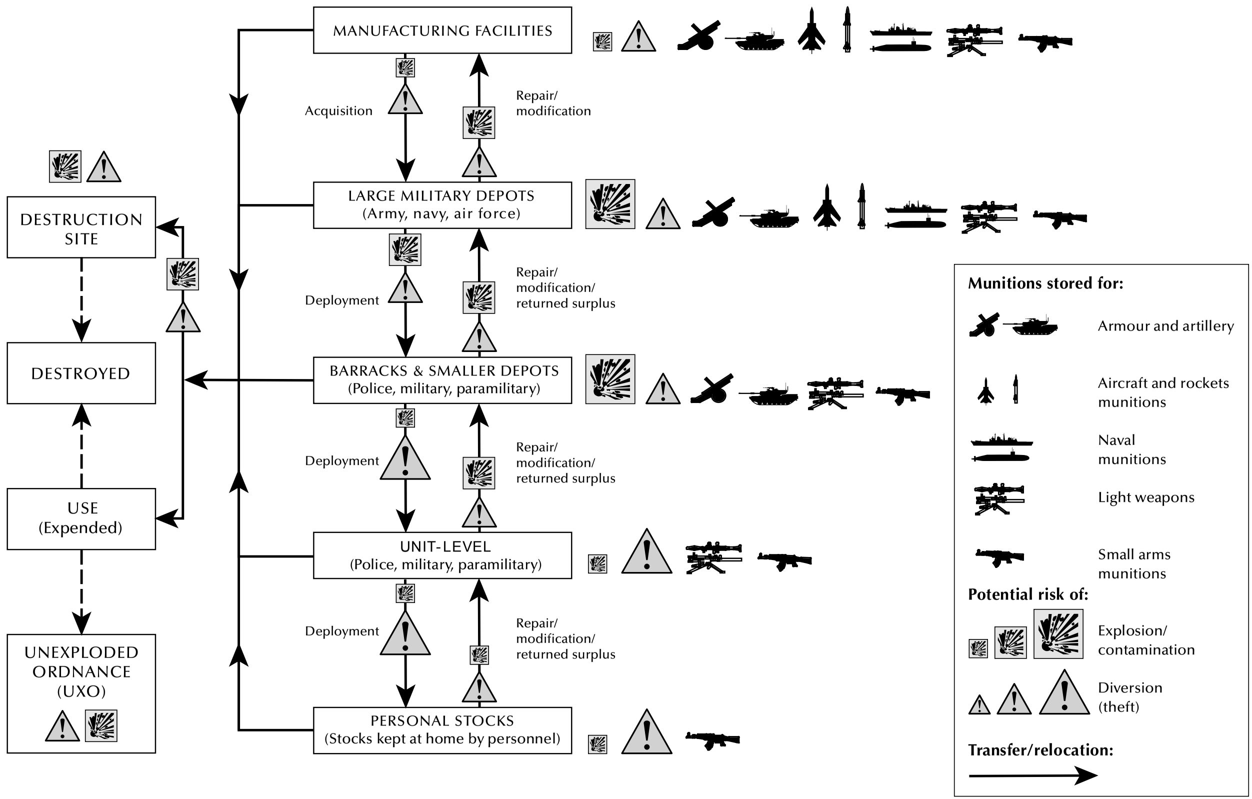
The chapters in this book recognize this to be the case in many states. In these countries, the issue of ammunition surplus is so seamlessly linked to broader stockpile management failures that any analysis of conventional ammunition in surplus must be situated within these wider concerns.

Addressing the problem

Most of the problems related to surplus accumulation, and the risks posed by conventional arms and ammunition more generally, are contingent on lax state stockpile management procedures. These failings can be broken down into a number of factors, which are explored in depth by the chapters in this book.

First, states that fail to maintain effective accounting procedures (CHAPTER 5) cannot assess the quality and quantity of their national stockpiles with any degree of accuracy. They are therefore limited in their capacity to distinguish

Figure 1 **The national stockpile: risks and hazards in the conventional ammunition life cycle**



surplus stocks from ammunition that is required for the efficient operation of their security forces (CHAPTER 10). Moreover, they have little means to identify the loss or diversion of ammunition (CHAPTER 15). Without adequate systems for marking and recording—and, in some cases, lot marking (CHAPTER 16)—ammunition, many states remain unaware that they have a problem.

Second, a lack of surveillance and technical inspection of ammunition (CHAPTER 6) leads to the accumulation of unreliable, potentially unstable, and ultimately unsafe stocks. These stocks pose numerous risks, ranging from a loss of efficiency at best, to environmental contamination and major stockpile explosions (CHAPTER 13) in the worst cases.

Third, poor physical security (CHAPTER 7) of munitions facilitates theft and sabotage. The failure to institute measures ranging from depot and perimeter security to the most basic lock and key systems leads to diversion and tampering, and, in the final analysis, jeopardizes the capacity of security forces to maintain law and order (see Figure 1).

These three sets of factors are facets of the same problem—a systemic failure in the management of many national ammunition stockpiles. Ineffective systems in one area, whether related to accounting, surveillance, or security, threaten the integrity of the entire management process. Planning for national stockpile management (CHAPTER 8), and thereby addressing the factors listed above, needs to be a comprehensive process. It is applicable not just to large stockpile facilities, but across the national stockpile: at the place of manufacture, in barracks and police stations, or when arms and ammunition are issued to members of the security forces.

Progress to date

Estimating ammunition stockpile levels is problematic due to a combination of insufficient national data and a 'culture of secrecy'. Records kept in many developing or post-conflict countries have not been reliably maintained, and ammunition stockpiles are regarded as national secrets. Even where information on the disposal of surplus ammunition is made available, states provide inconsistent figures. The lack of transparency and accuracy makes assessing the global or regional problem, and hence developing plans to deal with it, very difficult.

While modest attempts have been made to improve stockpile management in the countries that experience the most significant surplus ammunition stockpiles, these initiatives have concerned a relatively small number of states. But defective stockpile management is the norm rather than the exception in many developing countries and in states recovering from armed conflict. In these countries, it is not necessarily surplus stocks of ammunition that should be the focus of attention, but policies related to the management of all conventional munitions. Continued failure to improve stockpile management will ensure: 1) that states remain unaware that they have surpluses; 2) that their national stockpiles of all munitions remain poorly maintained and a risk to public safety; and 3) that national stockpiles will continue to be a source of illicit weaponry used in crime and armed violence.

Recent initiatives (CHAPTER 1) to reverse these dangerous trends have culminated in the appointment of a United Nations Group of Governmental Experts, which is scheduled to address the issue of conventional ammunition comprehensively in 2008. For the numerous stakeholders (CHAPTER 17) in the issue—from states and security forces to the communities at risk from unsafe stocks (CHAPTER 18)—these efforts can only be welcomed.

Conclusion

The problem of surplus ammunition is much more than that of dealing with the consequences of downsizing militaries and the relics of past wars. Destruction programmes offer the best hope of removing the temptation for states and other parties to transfer surplus ammunition stocks to the world's conflict zones, or to simply leave unstable surpluses as a future threat to their populations. But, in the vast majority of cases across the globe, destruction is not the final solution. Without addressing the underlying reasons why states accumulate unsafe and unsecured ammunition surpluses, destruction will remain a short-term fix to a recurrent problem. This problem is primarily one of inadequate stockpile management.

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1

Ammunition-related Political Developments

James Bevan

Overview

Comprehensive attention to conventional ammunition in surplus remains outside of the scope of existing international instruments that address conventional weapons. Stockpile management receives some coverage, but still needs to be exhaustively addressed. Growing international interest in conventional ammunition management, however, is exemplified by a 2008-scheduled UN Group of Governmental Experts (GGE), which is tasked with considering the issue of surplus ammunition in greater depth and to clarify ways to achieve further international cooperation.

The GGE is a promising development and will be able to draw on a wide range of best practices that have been developed in a number of bilateral and multilateral stockpile management and destruction initiatives. Although no global instrument dedicated to the question of stockpile management and surplus conventional ammunition currently exists, the field is well defined, and extant measures provide a stable platform upon which to develop any future instruments.

Global instruments

At present, no global instrument comprehensively addresses the issue of conventional ammunition in surplus. This is equally true of stockpile management, within which the field of surplus ammunition is firmly situated. However, stockpile management is addressed, among other issues, in certain global instruments, and is increasingly covered in more recent measures.

1991 UN Register

The UN Register of Conventional Weapons is a repository for information on military holdings and procurement. While it does not make reference to either surplus or ammunition, it invites states to make available 'relevant policies' related to national holdings and procurement (UNGA, 1991, paras. 7; 10), which could plausibly include information pertaining to stockpile management practices and surplus.

2001 UN *Firearms Protocol*

The UN *Firearms Protocol* (UNGA, 2001a) covers all cartridge-based small arms and light weapons ammunition, but excludes larger calibre conventional weapons and a significant subset of light weapons ammunition (McDonald, 2006, p. 126).

The *Firearms Protocol* makes no explicit reference to stockpile management of conventional weapons or to surplus, and its scope is limited to 'appropriate measures' taken to secure 'firearms, their parts and components and ammunition at the time of manufacture, import, export and transit' in order to 'prevent loss or diversion' (UNGA, 2001a, art. 11.a). However, Article 11.a arguably covers the security of some parts of the national ammunition stockpile—notably at the place of manufacture. Even in these cases, however, it only concerns small arms ammunition and ammunition designed for a limited number of types of light weapons.

2001 UN *Programme of Action*

The UN *Programme of Action* does not explicitly address ammunition, although there is debate as to whether its scope includes the ammunition, in addition to the weapons, categorized by the *UN Panel Report* (UNGA, 1997).[1] It makes reference to a wide range of stockpile management procedures, including:

> appropriate locations for stockpiles; physical security measures; control of access to stocks; inventory management and accounting control; staff training; security, accounting and control of small arms and light weapons held or transported by operational units or authorized personnel; and procedures and sanctions in the event of thefts or loss (UNGA, 2001b, para. II.17).

It also refers to measures taken to identify, secure, and dispose of surplus stocks (UNGA, 2001b, para. II.18). While these measures are relevant to all varieties of conventional ammunition, their scope in the *Programme of Action* is limited to small arms and light weapons and potentially their ammunition.

2003 Wassenaar Arrangement

The Wassenaar Arrangement's *Initial Elements* includes almost all varieties of conventional ammunition within the *Munitions List*, but is focused on the transfer of weapons and ammunition and their potential impact on regional and international stability (WA, 2003b; 2004). The *Elements for Objective Analysis* does not refer to stockpile management, and it is unclear whether references to the 'risk of diversion to unauthorised end-use/end-users' include diversion through lax stockpile security (WA, 1998, para. 1.b).

The *Elements for Export Controls of MANPADS*, however, refers explicitly to stockpile management and stipulates that exporters should consider stockpile security arrangements in the recipient country before transferring man-portable air defence systems (MANPADS). These measures are designed to prevent loss or diversion, and include: accurate and regularly updated inventories; separate storage of component parts; 24-hour surveillance; and other safeguards, including protection in transit (WA, 2003a, paras. 2.7; 2.9).

The *Best Practice Guidelines for Exports of Small Arms and Light Weapons* similarly stipulates that exporting countries should take into account the 'stockpile management and security procedures of a potential recipient, including the recipient's ability and willingness to protect against unauthorised re-transfers, loss, theft and diversion' (WA, 2002, para. II.1).

While the *Munitions List* covers most items of conventional ammunition, the Wassenaar Arrangement's scope with regard to stockpile management is limited to small arms and light weapons, and moreover, detailed only in relation to MANPADS (CHAPTER 12).

International instruments are clearly varied and uncomprehensive with respect to conventional ammunition. Neither the *Programme of Action* (UNGA, 2001b) nor the *Firearms Protocol* (UNGA, 2001a) address medium or large calibre ammunition. The Wassenaar Arrangement's *Initial Elements* (WA, 2004) covers most types of conventional ammunition, but only addresses stockpile management in relation to specific weapons systems, and then only in terms of export criteria.

Regional instruments

At the regional and sub-regional levels, attention to the issue of stockpile management, and by extension to ammunition surpluses, is equally varied. However, there is increasing (and more detailed) attention to stockpile management—and to surplus stocks—in more recent initiatives, as the following sections outline chronologically.

1997 *OAS Convention*

Despite its title, the Organization of American States' *OAS Convention* (OAS, 1997) probably covers all conventional ammunition, on account of its extremely broad definition.[2] The definition includes any barrelled weapon and its ammunition (of any size), in addition to rockets, missiles, and mines (again, without qualification). The *OAS Convention* makes no explicit reference to stockpile security. It focuses on the security of exported, imported, or transiting ammunition rather than on national stockpiles (art. VIII)—although this may include parts of the national stockpile.

2001 *SADC Protocol*

The Southern African Development Community's *Protocol on the Control of Firearms, Ammunition and Other Related Materials* includes within its scope only ammunition for small arms and portable weapons. The category portable weapons is, however, arguably larger than that of the *UN Panel Report* (UNGA, 1997), and subsequent iterations of the report's categories. It includes (oddly) howitzers, automatic cannons, and unspecified air defence weapons (arts. 1; 2). The *SADC Protocol* makes reference to specific elements of national stockpile management, including maintaining inventories and secure storage, and the disposal of ammunition (arts. 8a–b; 10.2b–c). It is safe to conclude that stockpile management of a number of types of conventional ammunition is included in the scope of the *SADC Protocol*.

2002 *EU Joint Action*

The *EU Joint Action* is a commitment by European Union states to provide financial and technical assistance to programmes and projects to combat the proliferation of small arms and light weapons (EU, 2002). Importantly, while the *EU Joint Action* does not detail specific measures that are required to address poor stockpile management or the accumulation of ammunition surpluses, it aims to provide assistance for surplus disposal or destruction and safe storage (art. 4.c). The 2005 EU Strategy on Small Arms and Light Weapons formalized the EU's existing small arms policies.

2003 *OSCE Document*

The Organization for Security and Cooperation in Europe's *OSCE Document on Stockpiles of Convention Ammunition* (OSCE, 2003) covers the stockpiling of all types of conventional ammunition.

The *OSCE Document* lists the major aspects of stockpile management (sec. IV, para. 21.i–xiii), ranging from indicators of a surplus to stockpile security—such as physical security of facilities (CHAPTER 7)—and surveillance (CHAPTER 6) of stockpile conditions. It also includes information pertaining to procedures required to obtain assistance from other OSCE states in stockpile management and destruction programmes (sec. V). Moreover, it contains within it a commitment to develop a best practice guide (in practice, a set of guides) for the destruction of conventional ammunition and explosives and the management and control of stocks, to cover, among other things:

- indicators of surplus and risk;
- standards and procedures for the proper management of stockpiles;
- norms to be used in determining which stockpiles should be destroyed; and
- standards and technical procedures of destruction (OSCE, 2003, sec. VII, para. 38).

2004 *Nairobi Protocol*

The *Nairobi Protocol* (2004, art. 1) considers the same categories of small arms and light weapons ammunition as the *UN Panel Report* (UNGA, 1997). References to stockpile management are relatively general, with its signatories undertaking to 'establish and maintain complete national inventories of small arms and light weapons held by security forces and other state bodies, to enhance their capacity to manage and maintain secure storage of state-owned small arms and light weapons' (art. 6.a). Neither this article, nor the subsequent article related to accountability and tracing of national stocks, mentions ammunition. The fact that ammunition is, however, only referred to in the definitions section (art. 1) of the *Nairobi Protocol* may be interpreted to mean that all provisions within the instrument implicitly cover ammunition.

2006 *ECOWAS Convention*

The Economic Community of West African States's *ECOWAS Convention* (ECOWAS, 2006) includes the same generic categories of small arms and light weapons as detailed in the *UN Panel Report* (UNGA, 1997). Although its definition of ammunition is unorthodox, it effectively includes ammunition for those weapons (ch. 1, art. 1, paras. 1–3). The *ECOWAS Convention* stipulates that signatories ensure the safe management, storage, and security of national stockpiles (art. 16, para. 1), including the establishment of effective standards and procedures related to:

- appropriate site;
- physical security measures of storage facilities;
- inventory management and record keeping;
- staff training;
- security during manufacture and transportation; and
- sanctions in case of theft or loss (art. 16, para. 2.a–f).

The signatories also undertook to conduct regular reviews of storage facilities and conditions of storage, and to identify surplus and obsolete stocks for disposal (art. 16, para. 4). Ammunition at the place of manufacture, or collected in peace operations, is subject to appropriate and effective 'standards and procedures' (art. 16, paras. 3; 5).

There is clearly a great disparity among regional instruments in the degree to which they address aspects of stockpile management. Stockpile management is often tangential to the main objectives of existing instruments and processes, or it is addressed partially, and with reference only to certain categories of conventional arms and ammunition. Importantly, however, the *SADC Protocol*, *EU Joint Action*, *Nairobi Protocol*, and *ECOWAS Convention* all give explicit recognition to the problem of surplus accumulation, in addition to stockpile management procedures to combat it. The *OSCE Document* is the most comprehensive of the instruments (whether global or regional) and gives a detailed breakdown of issues and prescriptive measures pertaining to the management of conventional ammunition—including surpluses.

It is clear from the above descriptions of each of the instruments that there is a broad trend towards greater and more detailed consideration of conventional ammunition stockpiles and the issue of surplus ammunition.

Progress to date

Despite uneven coverage in international and regional instruments, current international attention to stockpile management and the issue of surplus ammunition appears to be shifting towards greater international cooperation.

In recent years, a number of states have made considerable efforts to raise the profile of surplus conventional ammunition and of stockpile management more generally. France and Germany, in particular, have tabled two UN General Assembly resolutions in 2005 and 2006 entitled *Problems Arising from the Accumulation of Conventional Ammunition Stockpiles in Surplus* (UNGA, 2005b; 2006). The latter requested the creation of a UN GGE on Conventional Ammunition in Surplus (UNGA, 2006, para. 7).

The resolutions are notable because they treat national conventional ammunition stockpiles as a problem that deserves attention in its own right, rather than exclusively as a contributing factor to illicit trafficking and diversion (particularly of small arms and light weapons). For instance, the resolutions address the two fundamental risks associated with surplus stocks on an equal footing. On the one hand, they note the risk of explosion or pollution resulting from inadequately managed stocks. On the other hand, they recognize the risk of diversion arising from unsecured stockpiles (UN, 2005b; 2006, paras. 1–4).

Both resolutions also call for measures at the domestic, sub-regional, regional, and international levels to combat the two sets of risks: through improved management of stockpiles and elimination of surpluses (para. 3) and through measures to address illicit trafficking (para. 4). Crucially, the resolutions do not focus entirely on the issue of surplus, and there is implicit recognition that stabilizing, eliminating, or securing surplus stocks is contingent on effective management of all stockpiles of conventional ammunition—arguably evidenced by references to conventional ammunition more generally (paras. 1; 5).

Conclusion

Despite the absence of existing global instruments, operationally oriented stockpile management initiatives have extensively defined best practice. These initiatives range from multilateral programmes, such as those of the OSCE and the North Atlantic Treaty Organization, to bilateral partnerships, such as those between the United States and a growing number of countries that receive stockpile management assistance.

The UN GGE (which is scheduled to convene in January 2008) has the potential to shape an emerging international agenda to comprehensively address all issues related to the management of conventional ammunition. The GGE is greatly aided in its task by being able to draw upon a wide range of experiences, documentation, and best practice.

Notes

1 For a discussion of the 'definition' contained in the 1997 *UN Panel Report*, and its implications for the scope of subsequent documents and processes, see McDonald (2006, p. 126).

2 The *OAS Convention* notably defines firearms as: 'a. any barreled weapon which will or is designed to or may be readily converted to expel a bullet or projectile by the action of an explosive, except antique firearms manufactured before the 20th Century or their replicas; or b. any other weapon or destructive device such as any explosive, incendiary or gas bomb, grenade, rocket, rocket launcher, missile, missile system, or mine.' Ammunition is defined equally broadly as 'the complete round or its components, including cartridge cases, primers, propellant powder, bullets, or projectiles that are used in any firearm' (OAS, 1997, arts. I.3–4).

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2

Generic Types of Conventional Ammunition

James Bevan and Adrian Wilkinson

Overview

The typology of ammunition is a complex issue due to the wide range of ammunition types now available. For example, a North Atlantic Treaty Organization (NATO) armoured division is likely to stock over 1,600 different types of ammunition, which range from small items, such as 'igniter safety fuse electric' (ISFE), to much larger items such as free-flight rockets (FFRs) for multiple launch rocket systems (MLRSs). There are many different and often contradictory ways of categorizing ammunition types.

This chapter is therefore designed only for convenience in order to provide non-specialists with an overview of the more significant ammunition systems. It also provides a rough presentation of the potential each variety can pose when poorly managed or secured, including the risk of instability or mishandling leading to explosion (CHAPTER 13); the facility with which it can be diverted from national stockpiles (CHAPTER 15); and its utility in the construction of improvised explosive devices (IEDs) (CHAPTER 14).

Artillery

Artillery includes weapons and ammunition that are in the range of 75 mm calibre and above (some mortars also fall within this calibre range, and although not strictly classified as artillery, have been included here for convenience). Artillery is designed to deliver primarily indirect fire and includes the types discussed below. Because artillery ammunition is large in calibre, it often contains significant amounts of explosive and incendiary material, which may become unstable when inadequately managed (CHAPTER 6).

Mortars over 100 mm in calibre[1]

Mortar 'bombs' are loaded with various explosive and non-explosive substances, including high explosive (HE), HE fragmentary, HE armour-piercing, and smoke and illuminating material (Ness and Williams, 2006, pp. 481–524). They range considerably in weight from under 10 kg to 130 kg.

Explosive risk	High
Risk of low-order diversion[2]	Moderate
Use in IEDs[3]	Yes

Field artillery

Field artillery ammunition is cartridge-based and manufactured in a range of formats to suit different applications, including: HE, HE fragmentary, and sub-munition-dispensing varieties for anti-personnel purposes; armour-piercing rounds for field and mountain guns; and smoke and illuminating cartridges (Ness and Williams, 2006, pp. 527–674). Ammunition designed for field artillery ranges in size from around 75 mm in calibre to close to 250 mm.

Explosive risk	High
Risk of low-order diversion	Moderate
Use in IEDs	Yes

Tank and anti-tank guns

Tank and anti-tank gun ammunition is cartridge-based and primarily designed to defeat armoured vehicles. There are various types with various applications, including: HE anti-tank (HEAT), which utilize hydro-dynamic[4] penetration; saboted[5] rounds, which use kinetic energy derived from high velocity to penetrate armour; and a range of complementary types, such as smoke and illuminating cartridges. Calibres range from around 60 mm to 125 mm (Ness and Williams, 2006, pp. 272–385).

Explosive risk	High
Risk of low-order diversion	Moderate
Use in IEDs	Yes

Naval and coastal defence guns

Naval and coastal defence guns use cartridge-based ammunition that is designed to defeat either surface (ship) or airborne targets. Ammunition types include mechanically fused fragmentary warheads that are designed to explode in the air, and HE rounds or armour-piercing ammunition for anti-ship purposes. Naval and coastal defence ammunition ranges in calibre from around 75 mm to 130 mm (Ness and Williams, 2006, pp. 389–404).

Explosive risk	High
Risk of low-order diversion	Moderate
Use in IEDs	Yes

Free-flight rockets

FFRs are unguided and designed to be used for area denial purposes. Early types were fired in barrages to improve the likelihood of hitting targets, but later types use sophisticated guidance systems and can be fired singly with great accuracy. They consist of a solid-fuel rocket motor and a variety of different warheads for various applications. They include HE fragmentation warheads for anti-personnel roles; anti-tank warheads; cargo (sub-munitions) and mine-laying variants; warheads for mine-clearing; and incendiary and smoke varieties. FFRs come in various calibres, from 50 mm multiple-launch, area-denial ammunition to single-launch, mine-clearing rockets of over 400 mm (Ness and Williams, 2006, pp. 683–717).

Explosive risk	High
Risk of low-order diversion	Moderate
Use in IEDs	Yes

Small arms, light weapons, and cannon ammunition

Small arms, light weapons, and cannon ammunition features a range of different ammunition types, from non-explosive cartridge-based ammunition to rocket-propelled HE projectiles. These varieties each pose different challenges for safe and secure stockpile management.

Cartridge-based small arms and light weapons ammunition

Small calibre cartridge-based ammunition is used in firearms and machine guns, and ranges from the smallest cartridges to those of 20 mm calibre (usually less than 14.5 mm). It is composed of a bullet, propellant, and primer, sealed within a (usually metallic) cartridge (Bevan and Pézard, 2006, pp. 26–27). Bullets are generally inert, and complete rounds of small calibre ammunition are designed to be durable and stable. In contrast to larger, explosive types of ammunition, they represent a minimal explosive or incendiary risk when poorly managed.

Explosive risk	Low
Risk of low-order diversion	High
Use in IEDs	No

Cannon ammunition

Cannon ammunition is cartridge-based and operates in the same way as ammunition designed for firearms. It is, however, larger (ranging from 20 mm to 57 mm) and often features armour-piercing, HE, and incendiary warheads, or combinations of the three (Ness and Williams, 2006, pp. 207–72). The addition of explosive and incendiary warheads makes them potentially less stable than small arms ammunition when poorly managed.

Explosive risk	Moderate
Risk of low-order diversion	Moderate
Use in IEDs	No

Projected grenades and hand grenades

Projected grenades are explosive weapons that are designed to fire from a cartridge (similar to a firearm) or from the muzzle of a rifle (termed a rifle grenade). Hand grenades are designed to be thrown by hand, and without the aid of a delivery weapon. The two types of grenade come in various formats and are filled with a variety of explosive and incendiary charges, ranging from white phosphorous to HE fragmentation. Most hand grenades and projected grenades are designed to detonate on impact, although some spin-stabilized grenades (a variety of projected grenade) are designed to explode in the air when in proximity to a target (a process known as air bursting). White phosphorous grenades pose a particular incendiary risk when inadequately managed.

Explosive risk	High
Risk of low-order diversion	High
Use in IEDs	Yes

Unguided light weapons ammunition

Unguided ammunition for use in light weapons varies considerably in type and application. Most types feature a two-stage, solid-fuel rocket motor and HE, HE fragmentation, or incendiary warhead. More recent developments include fuel-air 'thermobaric' warheads.

Mortar bombs of 82 mm calibre and below may also be considered as unguided light weapons ammunition.

Explosive risk	High
Risk of low-order diversion	High
Use in IEDs	Yes

Guided light weapons ammunition

Guided ammunition for light weapons includes missiles for use in anti-tank guided weapons (ATGWs) and man-portable air defence systems (MAN-

PADS) (CHAPTER 12). These weapons all use two-stage, solid-fuel rocket motors and explosive warheads. Most anti-tank missiles employ HE warheads, which include shaped charges that are designed to defeat modern armour and two-stage warheads designed for use against reactive armour. MANPADS warheads are generally fragmentary. Both ATGW and MANPADS missiles are delicate pieces of equipment, which require careful handling. Because of their sophistication and capacity against modern military targets, they are politically sensitive, and controls on their transfer have received increasing attention in recent years.

Explosive risk	High
Risk of low-order diversion	High
Use in IEDs	No[6]

Mines

Mines are usually defined as anti-personnel (AP), anti-vehicle (AV),[7] or anti-helicopter (AH). There are many different types of mines, which are designed for widely differing applications and employ different fuses. In many respects, they are harder to categorize than other conventional munitions.

AP mines may be blast or fragmentation, ground laid, or scatterable, with mechanical, tripwire, or electronic fusing systems. The explosive weight is usually below 250 g, although there are exceptions.

AV mines may be pressure, tripwire, electronic, or sensor fused. They can be buried, surface laid, or off-route, and contain an explosive weight of up to 7.5 kg. Warhead options include blast, shaped charge (HEAT), ballistic disc self-forging fragment (Misznay Schardin), or explosively formed projectiles.

AH mines are relatively new, highly complex, and unlikely to be encountered in large numbers in post-conflict environments or decaying stockpiles.

Whatever the type of mine, they all contain: 1) a warhead; 2) a fuse and/or sensor; 3) a power source (even if one reliant on chemical potential energy); and 4) a safety and arming unit.

Explosive risk	High
Risk of low-order diversion	High
Use in IEDs	Yes

Pyrotechnics

The range of pyrotechnic devices is vast, from safety matches and smoke grenades, through gas generators to explosive bolts, and it is not practical to list them all in this short overview. They are often defined by the desired effect, e.g. 1) light; 2) sound; 3) heat; 4) mechanical movement; 5) decoy; 6) cutting, etc.

Pyrotechnic devices combine high reliabilty with very compact and efficient energy storage, essentially in the form of chemical energy that is converted via expanding hot gases into the desired effect. The controlled action of a pyrotechnic device (initiated by any of several means, including an electrical signal, optical signal, or mechanical impetus) makes possible a wide range of automated and/or remote mechanical actions, e.g. deployment of safety equipment and services (ejector seats), or precisely timed release sequences (carrier shells).

Incendiary risk	Moderate
Risk of low-order diversion	Low
Use in IEDs	No

Explosives

Explosives may be categorized as primary high explosives, which are shock- and flame-sensitive, and are used in detonators and initiators; or secondary high explosives, which are initiated by shock and are used in main fillings of other ammunition or as demolition charges.

Modern military secondary high explosives have good long-term stability and are specifically formulated for the type of ammunition that they are to be used in (e.g. RDX/Wax for demolition charges, or RDX/TNT for main fillings).

The chemical formula of an explosive should also be checked, as different nations often refer to the same type of explosive in different ways (e.g. RDX by NATO and Hexogen by former Warsaw Pact countries).

Explosive risk	High
Risk of low-order diversion	High
Use in IEDs	High

Guided missiles

Guided missiles come in a wide range of types, sizes, and functions, from shoulder-launched anti-tank (ATGMs) and shoulder-launched surface-to-air missiles (MANPADS), through medium systems such as ATGWs to large surface-to-surface guided systems such as the Army Tactical Missile System (ATACMS) launched individually from an MLRS platform. The smaller, man- or vehicle-portable varieties are considered under guided light weapons ammunition (see above).

Guided missiles differ from FFRs in that they have a guidance system and usually a much more sophisticated fusing system.

Explosive risk	High
Risk of low-order diversion	Low
Use in IEDs	No (too valuable for other uses)

Notes

1 Mortars under 100 mm in calibre are designated light weapons due to their portability; see UNGA (1997; 2003).

2 Low-order diversion is the theft of relatively minor quantities of munitions by individuals and small groups of individuals (CHAPTER 15).

3 Conventional ammunition is now often used as the main explosive charge in IEDs in post-conflict environments (CHAPTER 14).

4 In non-specialist terms, hydro-dynamic penetration equates to a shaped explosive charge that, upon detonation, creates a high-velocity jet of molten metal (technically in a state of 'superplasticity') in order to penetrate solid armour.

5 A sabot is support that is designed to carry a dart-shaped projectile along a rifled barrel. Upon leaving the barrel, the sabot falls away after having imparted momentum to the projectile.

6 When in ready-to-fire configuration.

7 Or, alternatively, anti-tank (AT).

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3

Conventional Ammunition Marking

Pablo Dreyfus

Overview

This chapter focuses on marking practices applicable to conventional ammunition. It is intended to present, in brief, the utility of systematic ammunition marking for improving the safety and security of conventional ammunition stocks, particularly in relation to the risk of accidents (including explosive and incendiary risks) and the potential for illicit diversion. The chapter also provides an overview of common marking methods and the rationale behind them.

Marking, safety, and security

Conventional ammunition marking can be defined as the application of marks—including colours, descriptive text, and symbols—to munitions, parts, and components thereof, and associated packaging, for the purposes of identifying, among other things, their role, operational features, and age; and the potential hazards posed by those munitions (UKMoD, 2006a, p. 4; US Navy, 2001, p. 1). Marking is a critical precursor to effective stockpile management and, ultimately, has considerable bearing on the safety and security of ammunition stocks.

Marking and safety

From the perspective of safety, ammunition marks facilitate effective stockpile management because they classify munitions that are subject to differing safety procedures (UKMoD, 2006a, p. 4). Marks identify the class of explosive or propellant contained in the round (the *nature* of the ammunition) and any explosive or contamination hazards that each might pose to personnel and infrastructure (US Navy, 2001, p. 1). In so doing, they provide information that enables stockpile personnel to carry out safe storage and handling procedures that are specific to different ammunition types.

Ammunition marks also detail the expected shelf life of munitions. While this information cannot be used to determine the physical condition of munitions—which can only be ascertained through physical and chemical examination (CHAPTER 6)—such marks can indicate which stocks may require testing and possible reclassification or disposal.

Marking practices, furthermore, exist to ensure that the correct munitions are deployed to security forces. Marks designate which types of ammunition are suitable for particular weapons systems (indicating the 'role' of a particular round) and, notably, are used to discriminate among inert, practice, and explosive ammunition. These distinctions have critical safety implications, because a failure to use the correct ammunition or the potential for accidentally substituting inert training rounds with high-explosive warheads could be fatal.

Marking and security

Marking also diminishes the security risks associated with lost, misplaced, or stolen munitions entering the illicit market (CHAPTER 15). Not only can it be used as the basis of an accounting system to monitor for potential losses and thefts, but it can also establish the origins of ammunition recovered from illegal users.

Effective management dictates that personnel keep records of all ammunition movements (including relocations and transfers into and out of stockpiles). Systematic recording by munition type and lot number enables personnel to detect misplaced or missing stocks and launch immediate investigations into why they are absent.

Marks can also be used to 'trace' ammunition that has been recovered from the illicit market to a factory or branch of the security forces. This can be facilitated if unique lot numbers are assigned to ammunition batches that have been issued to particular units or locales (CHAPTER 16). Failing that, any marks that indicate the calibre, year, and origin of ammunition—notably in the case of small arms ammunition—can be used to indicate potential paths of illicit diversion (Bevan and Dreyfus, 2007, pp. 288–315) (CHAPTER 4).

Marking classification systems

In the case of both small arms ammunition and major conventional munitions, marks are used to identify some or all of the following characteristics:

- the type of ammunition and its uses;
- the production or filling lot;
- the manufacturer;
- the propellant;
- the type of explosive used in the warhead;
- the model designation of the ammunition;
- any modifications made to the ammunition; and
- the condition of the ammunition (serviceable or unserviceable).

The meaning of some of these features is self-evident. It is, however, worth explaining the importance of lot or batch numbering marks, which have particular saliency for safe storage and handling, and can minimize the risks of illicit diversion.

Lot and batch numbering

The lot number comprises a code that is systematically assigned to each ammunition batch or 'lot' at the time of manufacture, assembly, or modification. It identifies a fixed quantity of ammunition that has been assembled from uniform components under similar conditions and that, as a result, is expected to function in a similar manner (US Navy, 2001, p. 4; USDoD, 1998, p. 3).

When employed in conjunction with effective accounting procedures (CHAPTER 5), lot numbering can be used to track the location and movement of certain groups of munitions. From a safety perspective, it can be used to identify—and subsequently recall—batches of defective or unstable and potentially dangerous stocks. Lot numbers are also a useful means to trace illicitly diverted ammunition to its original purchaser or to the security force unit to which it was issued (Anders, 2006, pp. 207–27; Dreyfus, 2006, pp. 173–206).

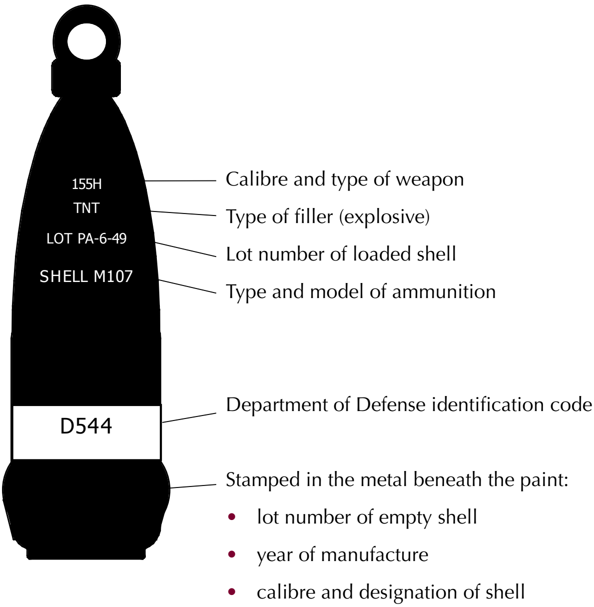
In the case of small arms ammunition, lot numbers usually feature on packaging rather than on the round itself, due in part to the limited space available on small calibre cartridges. Direct lot marking on small arms ammunition is not a standardized practice in most countries, although some countries have begun to lot mark security force ammunition (CHAPTER 16).

By contrast, lot marks are usually directly applied to the warheads of light and major conventional weapons. These indicate the batch of propellant or explosive contained within the warhead, and their application is facilitated by the larger size of the ammunition in question. For example, the shell illustrated in Figure 3.1 displays a lot number that designates that it is one of a batch of shells loaded with the same consignment of TNT. It also displays a lot number that identifies the body of the shell as one among a batch of empty shells that were manufactured at the same time and under similar conditions.

Modes of marking

Effective classification of ammunition necessitates a system that is clear, consistent, and easily comprehensible. The UK's Ministry ofDefence (UKMoD, 2006a, p. 5) notes the following principles of conventional ammunition marking:

Figure 3.1 **Example of marks on an artillery shell**



Source: Adapted from USMC (2006, chap. 10, sec. 3)

- *Clarity*: Identifying marks should be clearly visible. For reasons of speed and efficiency, primary identifying marks should also be more prominent in size and position than those required for detailed identification. Complicated symbols and superimposed colours should also be avoided wherever possible.
- *Uniformity*: The style and position of marks should be consistent for stocks that have similar characteristics, thereby minimizing the potential for personnel to overlook stocks that are of the same type, nature, or lot.

Marks can be applied to munitions in a number of ways (see Table 3.1), ranging from paint coding to the application of other types of code, symbols, and letters.

Table 3.1

Types of media used to mark munitions

Medium	Application	Notes
Painting	Paint colour is designed to signify the type of use (operational, training, etc.) that the round is intended for, in addition to the explosive hazard presented by the munition. Colour-coded paint comprises the final body coating for ammunition, ammunition components, and their packaging.	In some instances, the choice of paint colour has no code significance.
Coding	Coding involves the application of coloured spots, bands, or symbols to ammunition, ammunition components, or their packaging. Codes, by their colour or shape, identify ammunition fillers (i.e. explosives or propellants), the presence of specific ammunition components, or directions for handling and lading.	Coding is almost always accompanied by text, which provides a more detailed description of the ammunition components in question.
Lettering	Letters, words, abbreviations, or numerals are applied to ammunition, ammunition components, or their packaging by die stamping, stencilling, decals, etching, or rubber-stamping. Lettering identifies the type, version, potential modifications, ammunition lot number, and lading information of the munition.	Lettering applied in black or white may not have colour-code significance.

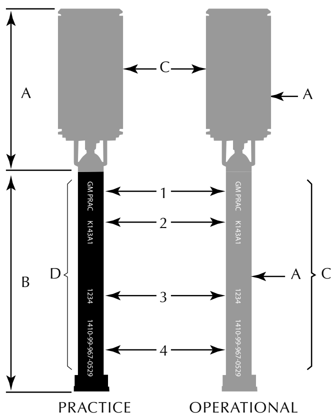
Source: US Navy (2001, p. 3)

Systematic marking practices are particularly essential when the armed forces of different countries require interoperability of munitions. The 26 North Atlantic Treaty Organization (NATO) member states provide a good example in this respect. The following sections present a number of NATO standard munitions in which combinations of paints, codes, and letters comprise a standardized and easily comprehensible designation system.

Paint codes

Distinguishing the ‘role’ of munitions (e.g. practice or operational) is made easier through allocating specific colours consistently to those roles. As Figure 3.2 illustrates, however, for the case of a ground-to-air guided missile, colour codes are often only significant when applied to specific parts of the ammunition in question. In this case, while the overall body colour of the ammunition is insignificant, blue denotes its role as a practice munition. The colour alone, however, is not deemed a sufficient indicator of a weapon’s role and associated safety risks. Colour-coded lettering in this respect has greater significance than body paint, with yellow lettering designating the munition as operational (see Figure 3.2).

Figure 3.2
Typical markings for ground-to-air guided missile container/ missile canister



A	Overall body colour: non-significant – deep bronze green
B	Role colour: deep Saxe blue
C	Stencilling: significant – golden yellow
D	Stencilling: non-significant – white
1	Abbreviated service designation
2	Model number of missile/cannister assembly
3	Serial number of missile/cannister assembly
4	NATO stock number

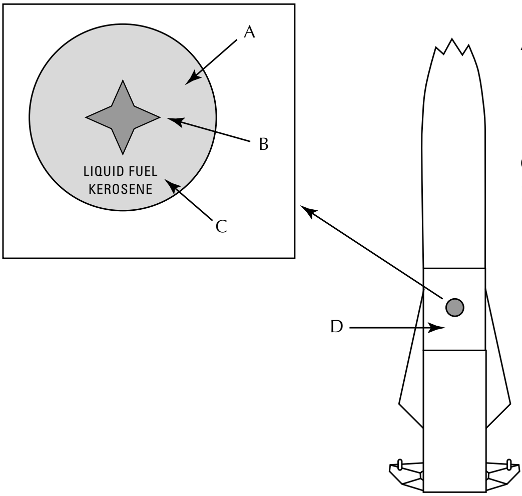
Source: UKMoD (2006d, p. 10)

Coding

Codes, and notably symbols, provide rapid indication that a munition contains components that are potentially hazardous (CHAPTER 8). As Figure 3.3

illustrates, in the case of a guided missile, a red star on a pale green background provides clear indication that the ammunition contains liquid fuel. The text, which accompanies the symbol but is less visible, details the type of liquid fuel. In this case, brightly coloured symbols impart the most important information first—the hazard—and smaller text outlines the particular nature of that hazard.

Figure 3.3
Hazard marking on a guided missile



A	Safety marking: background colour – pale green
B	Safety marking: symbol colour – red
C	Type of fuel: lettering – black
D	Filled fuel tank section of guided missle

Source: UKMoD (2006d, p. 12)

Letters

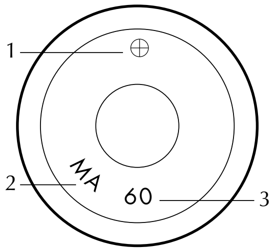
Letters provide detailed information about the nature and role of the munition in question, as well as providing historical information, such as date and origin of manufacture. Like colours and codes, they provide 'significant' information for successfully identifying hazards and appropriate storage and handling practices.

Combinations of marking media

The munitions illustrated in Figures 3.2 and 3.3 demonstrate that the use of paints, codes, and letters is designed to provide multiple and mutually supporting indicators of the potential hazards posed by specific types of ammunition and their components. In practice, most effectively marked pieces of ammunition display such multiple marking systems.

This is even the case for munitions that are generally deemed to pose a relatively small explosive or contamination hazard. NATO classification marks for small arms ammunition are illustrative. Basic information regarding the cartridge is stamped onto the cartridge base, which is called the headstamp (see Figure 3.4). In addition, paint is used to mark the tips of bullets with colours that signify the role of each round (see Table 3.2).

Figure 3.4
Minimum basic markings on NATO small arms ammunition



1 NATO design mark (denotes approved NATO ammunition)
2 Code designating manufacturer
3 Last two digits of year of manufacture

Source: Canadian Army (n.d., p. 4)

Table 3.2
NATO bullet tip colours and their roles

Bullet tip colour	Role
No colour	Ball
Red	Tracer
Black	Armour-piercing
Silver	Armour-piercing incendiary
Yellow	Observing
Blue	Incendiary

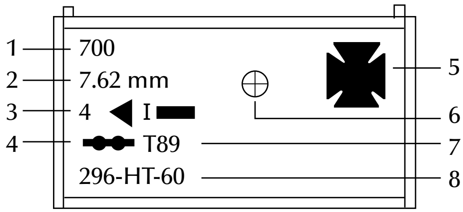
In most cases, small arms ammunition lot numbers appear only on packaging (see Figure 3.5) (CHAPTER 16).

Packaging and container marks

The markings on packaging are as important for safe and secure handling, transportation, and storage as the markings on the ammunition within it. Adequate labelling of packages and containers entails reproducing the same symbols and lettering that are marked on the ammunition, including hazard warnings. In some cases, packaging will feature a number of standard symbols that apply to the hazards presented by the various components of the ammunition within it. These symbols may also comprise a hierarchy, indicating primary and subsidiary risks in the event of accident.

For logistical and safety reasons, munitions packages often detail the modes of loading applicable to the ammunition inside them, as Figure 3.5 illustrates for the case of small arms ammunition.

Figure 3.5 **Basic NATO small arms ammunition package markings**



1 Quantity of ammunition
2 Calibre and nomenclature
3 Symbols for nature of bullets as loaded
4 Symbol for type of pack
5 NATO symbol for interchangeability
6 NATO design mark
7 Model of link
8 Lot number, code designating manufacturer, and the last two digits of the year of manufacture or packing

Source: Canadian Army (n.d., p. 3)

Progress to date

The vast majority of conventional ammunition is marked, despite the fact that many states fail to use these marks as the basis for effective accounting

(CHAPTER 5) and comprehensive stockpile management (CHAPTER 8). One area of critical concern, however, is marking small arms ammunition. Numerous states fail to mark small calibre ammunition, which means that ammunition circulates on the illicit market that cannot be attributed to a source (CHAPTER 15). While lot marking (CHAPTER 16) has gained favour with some states, these are few in number. Small calibre ammunition marking is potentially one of the most powerful ways to control diversion, but it is rarely employed.

Conclusion

This chapter is a short introduction to the rationale behind marking practices for conventional ammunition. Ammunition marking is crucial for effective stockpile management, because it enables personnel to identify, classify, and count munitions. It also provides hazard information that is essential for efforts to minimize the risks posed by ammunition, whether stockpiled, in transit, or awaiting destruction. Moreover, an adequate marking system can deter diversion and help trace ammunition that has already been diverted to the illicit market. Combined with effective stockpile management and security procedures, marking is a fundamental tool for ensuring the safe and secure administration and disposal of ammunition surpluses.

Further reading

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4

Conventional Ammunition Tracing

James Bevan

Overview

Tracing is a set of diverse methods used to identify ammunition, its origins, and patterns of transfer. It is a prerequisite for successful ammunition management and a crucial means of identifying diversion and the illicit trade in all munitions.

Tracing is contingent on being able to identify specific production runs, batches, lots, and other collections of ammunition, and to ascertain where they have come from. It therefore shares many similarities with ammunition accounting procedures (CHAPTER 5), but its application is usually retrospective and applied to illicitly circulating arms and ammunition—notably diverted munitions (CHAPTER 15).

This chapter sketches a number of modes of ammunition tracing, ranging from identifying stocks via systematic and accurate markings to methodologies that can be applied where ammunition is poorly marked or bears no markings at all. It concludes that ammunition tracing is in its infancy, but offers considerable hope for identifying and alleviating illicit arms proliferation.

Modes of tracing

There are two modes of ammunition tracing: direct identification using marks on the ammunition in question and indirect identification by a process of elimination. As Table 4.1 illustrates, the degree to which each method is employed is contingent on the degree of specificity in the way ammunition is marked.

Table 4.1
Ammunition tracing methods for investigating cases of diversion

Tracing components	Explanation
Marked ammunition	
Manufacturer codes	Tracing ammunition to a particular manufacturer through unique factory codes
Dates of production	Identifying the age of ammunition through date stamps: older stocks may have passed through numerous hands; younger stocks are 'closer' to the point of diversion
Batch/lot numbers	Tracing ammunition to particular units or facilities by the batch/lot number of munitions on consignment notes
Unmarked ammunition	
Metallurgical analysis of components	Testing for trace elements that can be used to determine the manufacturer of metals*
Chemical analysis of primer, propellant, and explosives	Testing for the chemical footprint
Manufacturing processes	Analysis of extrusion marks specific to the blank and die used
Inference	Establishing the primary users of specific types of ammunition and investigating whether they are the source of diversion

* Questionable in some cases; see Randich et al. (2002).

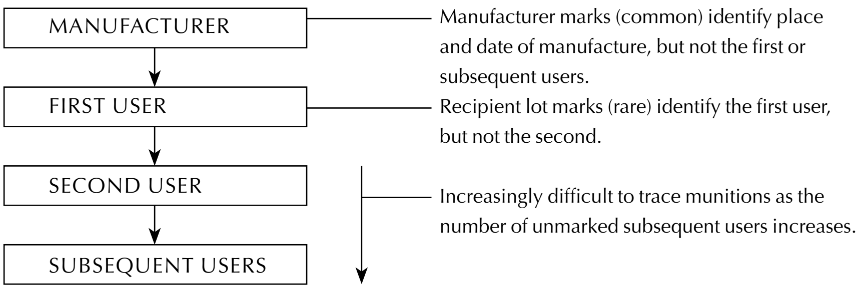
Direct tracing

Direct tracing entails analysis of ammunition markings to establish its source. Most conventional ammunition is marked at the point of manufacture (CHAPTER 3).[1] These marks relay basic information required for the effective management, safe storage, and efficient use of ammunition. They can also be used to trace ammunition back to the particular manufacturer and production period. Markings that identify the individual production run of the ammunition (lot or batch markings) may identify the recipient of that lot or batch of ammunition, if adequate records are kept.

For example, in 2002, non-state actors fired two man-portable air defence system missiles at an Israeli airliner in Mombasa, Kenya (CHAPTER 12). The manufacturer and date marks on the missile tubes and gripstocks found at the scene enabled investigators to trace their origin to factories in the Russian Federation and Bulgaria (Bevan, 2004, p. 88).

This form of tracing can be particularly useful in establishing diversion from a manufacturer or from first recipients of weapons and ammunition (CHAPTER 15). However, the utility of direct tracing is significantly reduced when munitions have changed hands numerous times since manufacture (see Figure 4.1). This is particularly so when states retransfer weapons and ammunition (e.g. surplus ammunition). In the Mombasa case, it proved very difficult to ascertain the intermediate links in the supply chain between the first user (Yemen) and the subsequent illicit users of the weapons in Mombasa (UNSC, 2003). With the exception of ammunition that is lot-marked according to recipient (CHAPTER 16), factory marks cannot usually identify the subsequent users of the ammunition (see Figure 4.1).

Figure 4.1
The chain of ammunition transfers and deteriorating tracing possibilities



Indirect tracing

In the vast majority of cases, tracing ammunition requires more than analysis of marks. As Figure 4.1 illustrates, in the absence of recipient-identifying lot marks, or for second and subsequent users, it becomes impossible to attribute ammunition to particular users by markings alone. Under these conditions, tracing becomes more a process of eliminating where the ammunition in question *did not* come from, rather than establishing where it originated.

Like all commodities, basic patterns of ammunition demand and supply lead different users to adopt particular types of ammunition. National stockpiles therefore vary considerably, and there are key differences in the ammunition used by different security forces. This means that an item of ammunition found on the illicit market can have a relatively restricted set of potential sources. The case of small arms ammunition is a good example.

There are in excess of 70 small arms ammunition manufacturing countries in the world, each producing ammunition over a range of years (Anders and Weidacher, 2006, p. 48). The result is an extremely large number of cartridges in circulation that, while they may be of the same calibre, display a wide range of combinations of different manufacturer, date, and calibre marks (CHAPTER 3). Although each round of ammunition is far from unique—a given factory may produce hundreds of thousands of identically marked cartridges in a year—sheer diversity of manufacturers and years of production make each more easily identifiable. Trade barriers, defence agreements, domestic production for domestic consumption, and varying calibres in service mean that ammunition found on the illicit market is more likely to come from some state armed forces than from others.

Ammunition marks are never a definitive means of tracing. Even a lot-marked cartridge may have been transferred several times after having been diverted from its intended military or police unit. But marking, in conjunction with in-depth analysis of ammunition procurement and deployment patterns, does indicate where to *begin* looking for the sources of illicit proliferation.

Complementary methods

Tracing by marks alone can only indicate an ultimate or penultimate source (i.e. manufacturer or military unit, respectively). It cannot substantiate any intermediate sources that may have been involved in transfer to the illicit market (see Figure 4.1). A number of methods need to be applied to make tracing more precise and to better establish these intermediate linkages if they are to be addressed. These include:

1. studies of defence acquisitions (defining what types of ammunition circulate in which states and how they are marked);
2. parallel, comparative studies of illicit ammunition types and markings (e.g. ammunition retrieved post-conflict or following crime);
3. field-based assessments of illicit markets, the regional demand for weapons, and existing patterns of trade in all commodities; and
4. analysis of broader politico-economic factors that may induce diversion from legal to illicit markets (notably in the security sector, but also elsewhere).

Bevan and Dreyfus (2007, pp. 289–315) provide an illustration of how these very different methods should triangulate with one another to build up an accurate picture of illicit proliferation. Their studies employ a combination of analyses, including ammunition collection and records of markings; key informant interviews; press reviews; the findings of formal investigations; and assessments of regional security dynamics, in order to highlight diversion in two countries.[2] The studies provide clear evidence of the dangers of diversion, but also of the critical role tracing can play in identifying its sources. Tracing can therefore provide the first step in dealing with the problem of diversion.

Progress to date

There is no single method for tracing ammunition, and, given the many different means through which ammunition reaches the illicit market, there is unlikely to be one. However, accurate marking—particularly lot marking—facilitates all tracing endeavours, and national governments could greatly improve the practice.

At present, there are considerable variations in the degree to which states mark ammunition. Most major conventional munitions are well marked (CHAPTER 3). The same is not true for small calibre ammunition, which, paradoxically, is far easier to divert (CHAPTER 16). Around 10 per cent of illicitly circulating small arms ammunition in parts of East Africa, for instance, is completely unmarked, which makes tracing a complicated process and one that is heavily dependent on expansive qualitative research (Bevan and Dreyfus, 2007, p. 293).

To date, very few countries apply lot marks to ammunition that specify the security force units that use it. Moreover, few countries seem set to adopt the practice—one that could significantly reduce the resources spent on tracing illicit ammunition. Ammunition marking—particularly of small arms cartridges—continues to receive minimal international attention. The 2004–05 UN Open-ended Working Group on Tracing Illicit Small Arms and Light Weapons, for instance, notably failed to address the issue of marking small arms ammunition (McDonald, 2006, pp. 102–3).

If there is no substantive improvement in marking practices, there is a strong case to be made for increased transparency in existing marking procedures (many states refuse to make public information on their ammunition and manufacturers' marks) and in the types of ammunition that comprise national stockpiles. Increased transparency would greatly aid existing tracing methodologies by allowing researchers and monitoring organizations—including state armed forces and UN sanctions inspectors—to cross-check potential sources of diverted ammunition more effectively.

Conclusion

Ammunition tracing is an important tool for identifying sources of ammunition on the illicit market. While there is no single, agreed-upon method of tracing, initial studies suggest that tracing is a process that should draw on a number of triangulating approaches and not simply involve analysis of ammunition marks.

That said, comprehensive marking—particularly lot marking of small arms ammunition—would greatly facilitate tracing. Lot marking, in conjunction with improved accounting, offers states a means to detect diversion from national stockpiles and subsequently address security failings. In states where monitoring and oversight of personnel are often ineffective, lot marking could prove a valuable 'second source' of oversight.

There is currently growing international interest in ammunition tracing. A number of organizations, including the Small Arms Survey, are in the process of refining existing methods and piloting new approaches. There is also, however, a clear need for greater transparency on the part of states and security forces. Marking—and knowledge of marking practices—greatly facilitates ammunition tracing. At present, too few states make such information public.

Notes

1 Ammunition may also be re-marked if repair or modification changes the nature of the ammunition in question.

2 Uganda and Brazil.

Further reading

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5

Stockpile Management: Accounting

James Bevan

Overview

Ammunition accounting refers to information management systems and the associated operating procedures that are designed to record, numerically monitor,[1] verify, issue, and receive ammunition in stockpiles.

Accurate accounting of stockpiles is an essential control measure in stockpile management and security, one that can quickly identify stockpile losses or inaccuracies resulting from misplaced munitions, and wrongly issued or illicitly diverted stocks.

Comprehensive accounting procedures are also a core component of effective technical surveillance of ammunition. When used to record physical inspection reports, they facilitate the management of unstable ammunition and thereby help to minimize the risks of explosion.

Maintaining a comprehensive national stockpile inventory

Stockpile safety and security apply to all state security force stocks of ammunition within a given country. These stocks, which encompass those of militaries, police forces, and other government agencies, can together be termed the 'national stockpile'.[2]

They comprise operational ammunition stocks (used to support routine operations), war reserve ammunition, training ammunition, experimental ammunition, ammunition at the point of manufacture, and ammunition awaiting disposal (Wilkinson, 2006, p. 232). Effective accounting procedures need to apply to all these categories of ammunition if states are to keep risks to safety and security within acceptable limits and maximize the efficient use of the national stockpile.

As Table 5.1 illustrates, accounting is a core component of most stockpile management and security procedures. It can be roughly divided into two broad activities, contributing to the safety of stocks (i.e. minimizing the risk of explosion) and maintaining security (i.e. minimizing the risk of loss or diversion that could result in ammunition entering the illicit market). Accurate accounting of the national stockpile therefore necessitates the classification of ammunition for the purposes of monitoring: 1) the physical and chemical condition of stocks; and 2) the necessary measures required to secure particular types of stocks from loss or theft.

Table 5.1

The pivotal role of accounting in stockpile and security activities

Stockpile management and security activity	Role of effective accounting procedures
Determination of required stockpile levels	• Sustains accurate records of types and quantities of ammunition stocked. • Comprises a balance sheet of ammunition acquisition and consumption for the purposes of forecasting required stock levels.
Recording location of stockpiles	• Provides information on the physical properties of ammunition types and their storage requirements. • Records the physical location of stocks, whether in a permanent facility or in transit.
Financial management of stockpiles	• Facilitates rapid analysis of acquisition, storage, transfer, and disposal costs. • Aids identification of existing stocks that could be used as a substitute for new purchases.
Safe-keeping, storage, and transport of ammunition	• Allows easy identification of handling and storage protocols for specific types of ammunition. • Classifies stocks according to the results of physical inspection and chemical analysis of stability.
Ensuring security of stockpiles	• Provides a regularly audited balance of stocks against which to identify potential losses and theft. • Facilitates the detection of illicit diversion by recording all transits and persons/units responsible for transportation.
Disposal, demilitarization, and destruction of surplus stocks	• Records the status of ammunition awaiting disposal, demilitarization, or destruction. • Provides a means of verifying whether surplus stocks have been destroyed or not.

Recording the physical and chemical condition of stocks

Ensuring the safety and stability of ammunition and explosives requires an ammunition surveillance system (CHAPTER 6) that involves the periodic physical inspection and chemical analysis of stocks by trained personnel. Accounting procedures are a critical part of this surveillance system, because they enable personnel to classify stocks of ammunition according to their stability and to assess potential risks to safety and reliability.

Because the shelf life of ammunition is often no indicator of the explosive risks it can pose when unstable,[3] personnel allocate codes that describe the condition and specify the treatment of ammunition. While these codes differ from country to country, they always distinguish between operational ammunition that is deemed safe and reliable to use; ammunition that is subject to further physical inspection and reclassification; and redundant ammunition that has been verified as unstable, unreliable, or subject to destruction. Box 5.1 is based on the United Kingdom's classification system, which incorporates all of the classification strata mentioned above.

Box 5.1 **A classification system for national ammunition stockpiles (based on the system currently used in the United Kingdom)**

Classification of ammunition condition:

Condition A: Serviceable stocks available for use

Condition B: Stocks banned from use pending a technical investigation

- B1 – Unrestricted handling and movement
- B2 – Subject to handling or movement constraint
- B3 – Applicable to certain lot and batch numbers only
- B4 – Shelf life expired

Condition C: Stocks unavailable for use pending technical inspection, repair, modification, or test

- C1 – Minor processing or repair required
- C2 – Major processing or repair required
- C3 – Awaiting inspection only
- C4 – Awaiting manufacturer's processing or repair

Condition D: Stocks for disposal

- D1 – Surplus but serviceable stocks
- D2 – Unserviceable stocks

Source: SEESAC (2006a, p. 3)

The failure to institute effective accounting procedures can result in the misclassification or improper storage and transport of stocks, leading to potential risks of explosion (CHAPTER 13).

Security measures particular to certain types of ammunition

A stockpile security risk (CHAPTER 7) can, in part, be defined as the potential for ammunition to enter the illicit market, whether by theft or loss from state stocks (CHAPTER 15). Effective accounting procedures are used to rapidly identify the theft of ammunition stocks and monitor for possible breaches in security.

These accounting procedures serve at least three security-enhancing functions by: 1) providing an accurate and up-to-date inventory of ammunition, which can be used as a baseline from which to detect theft or loss; 2) documenting the movement of ammunition and persons handling it to ensure accountability and prevent theft; and 3) prioritizing security measures for types of ammunition that could pose a particularly acute and immediate security risk should they fall into the wrong hands.

Accurate and audited inventories

Maintaining accurate inventories requires certain basic accounting procedures. As a prerequisite to accurate inventory keeping, stockpiles need to be thoroughly documented. Each item should, at minimum, be uniquely registered by type, lot, and/or batch number (CHAPTER 3); storage site; and location within that site.

A computerized and networked inventory system, developed to meet the needs of a particular country, is the most effective option. Such systems greatly facilitate accounting and audit procedures because data is easily accessible and can be recovered rapidly. In addition, computerized systems facilitate easy identification of:

- stockpile quantities, whether aggregate or disaggregated by type and category;
- protocols relating to the storage and transport of certain types of ammunition;
- the financial value of stocks and the costs of storage; and
- the shelf life of ammunition and results of physical and chemical inspections.

If the development of such a system is not feasible, paper-based accounting systems can also be very effective—although they are more labour-intensive and time-consuming than computerized inventories. Whether states opt for one system or the other, backup records should be kept at a separate location in case of fire or explosion and the potential need to reinventory stocks or assess risks in the event of such a disaster (OSCE, 2003a, p. 7).

Inventory records should also be subject to periodic auditing, which must also be combined with routine physical inventories to assess the veracity of records against the physical presence of ammunition. The Organization for Security and Co-operation in Europe, for instance, specifies that records should ideally be inspected at least once every six months (OSCE, 2003a, p. 8). It is clear, however, that more frequent auditing has the potential to uncover loss or theft of stocks in a timelier manner; indeed, many nations employ a 'rolling' (continuous) stocktaking system.

Certain countries specify differing auditing intervals, depending on the location of the stocks. Operation ammunition that is deployed with security force units, for instance, may be more frequently targeted for audit under the rationale that it may be more susceptible to loss (CHAPTER 15) than ammunition held in dedicated storage depots (USDoD, 2000, p. 31).

Any irregularities revealed in audits and stocktaking must be acted upon immediately. Discrepancies between physical inventories and the accounted balance that cannot be reconciled should be made the subject of 'missing/lost' reports and should initiate prompt investigative action (OSCE, 2003a, p. 8; 2003b, p. 4).

Accountability related to the movement of ammunition

All transactions (inflows and outflows of ammunition) that affect the balance of a stockpile need to be recorded. For the purposes of verifying transfers, this information should include: the type, lot number, and classification of the ammunition in question; the destination (whether within a stockpile facility or leaving the premises); and the person(s) responsible for handling the ammunition and recording its transfer.

In addition, a number of checks and balances can be instituted to ensure that the same stock management personnel are not simultaneously responsible for storekeeping, accounting, and auditing. These measures, which could be described as a 'separation of powers', are an important means of discouraging theft and illicit diversion.

Such measures can include prohibitions on individual responsibility for both physically verifying the transfer of ammunition and compiling records of ammunition transactions. In the case of the United States, personnel tasked with storage functions are not allowed access to records. Similarly, record-keeping personnel are prohibited from conducting physical inventories without the supervision of storage personnel (USDoD, 2002, p. 8). These procedures also ensure that law-abiding personnel are better protected from blame should a loss or theft occur.

Prioritizing the security of certain types of ammunition

Different varieties of ammunition and their component parts present different security risks if they are lost or stolen from stockpiles. These risks are proportional to: 1) the operational (i.e. tactical and destructive) potential of the ammunition in question; and 2) the ease and speed with which persons illicitly acquiring the ammunition can make it operational and use it. While it is clear that all ammunition poses risks to security when in the wrong hands, certain states have attempted to prioritize risks for different types of ammunition and allocate specific security measures accordingly.

For these reasons, the US Department of Defense (USDoD, 1989, p. 30) classifies conventional ammunition according to 'the degree of protection needed against loss or theft by terrorists or other criminal elements'. As a result, the USDoD ranks ammunition higher in sensitivity (see Table 5.2) when it is explosive, can threaten high value military assets, and can be deployed quickly. In this system, category denotes risk (with Category I being the highest) and code indicates the degree of protection required (with Code 1 being the highest).

For example, Code 1 munitions include man-portable air defence systems and anti-tank guided weapons that are either stored or transported as a complete system (missile and launcher) or sufficiently proximate to one another to enable quick assembly into a functioning weapons system. Code 2 ammunition includes explosive munitions that are either ready to use (such as grenades and mines) or could be improvised for other purposes (such as raw explosives and missiles) (CHAPTER 14). All of these weapons could either be used quickly and with great effect or used in weapons already circulating on the illicit market.

Table 5.2
US military ammunition and explosives security risk codes

Code	Designation	Category of ammunition included
1	HIGHEST SENSITIVITY	**Category I** Ready-to-fire (ammunition and weapon) missiles, including Hamlet, Redeye, Stinger, Dragon, LAW, and Viper. This category includes non-nuclear missiles and rockets in a *ready-to-fire configuration*. It also applies when the launcher (tube) and the associated explosive rounds, though not in a ready-to-fire configuration, are stored or transported together.
2	HIGH SENSITIVITY	**Category II** (a) Grenades, both high explosive and white phosphorous. (b) Anti-tank and anti-personnel mines with an unpacked weight of 100 pounds or less each. (c) Explosives used in demolition operations, such as C-4, military dynamite, TNT, and the like. (d) Explosive rounds for missiles and rockets other than Category I that have an unpacked weight of 100 pounds or less each.
3	MODERATE SENSITIVITY	**Category III** (a) Ammunition, .50 calibre and larger, with an explosive-filled projectile and having an unpacked weight of 100 pounds or less each. (b) Incendiary grenades and grenade fuses. (c) Detonators. (d) Detonating cord. (e) Supplementary charges. (f) Bulk explosives.
4	LOW SENSITIVITY	**Category IV** (a) Ammunition with non-explosive projectiles and having an unpacked weight of 100 pounds or less each. (b) Fuses, except those in Category III. (c) Grenades, illumination, smoke and practice, and CS/CN (tear-producing). (d) Incendiary destroyers. (e) Riot control agents in packages of 100 pounds or less.

Source: USDoD (1989, pp. 30–37)

This accounting system is designed to ensure that Category I and II weapons listed under Code 1 are subject to enhanced security at all times. These measures include specific regulations on physical security, such as guard levels at storage facilities, modes of perimeter security, and communications equipment to alert authorities to a loss or theft of munitions (USDoD, 2000, pp. 24–25).

It is worth noting that the USDoD ranks small arms ammunition as Code 4 (low sensitivity), despite the often-ready availability of arms capable of firing military calibres. Given the potential destabilizing impact of leakages of most types of ammunition, it is probably safe to conclude that security measures should be as comprehensive as possible for all categories.

However, it is also important to note that, while the codes listed in Table 5.2 prioritize protective measures to prevent loss or theft, they do not allocate differing accounting standards. The US stockpile management and security system requires comprehensive accounting of *all* stocks—regardless of assigned codes—if it is to function adequately.

The importance of accounting in sustaining military efficiency

Ammunition is an expensive commodity and one that, due to lengthy production runs and national security commitments, needs to be procured in advance so as to be available on demand. In effect, it is part of a 'national insurance' policy. Accurate physical and financial accounting enable security forces to better forecast the demand for ammunition and also the costs of its procurement, maintenance, and disposal.

Effective accounting also brings operational benefits to security forces. Stocks that are accurately classified for reliability help ensure that serving personnel are issued with the best stocks of ammunition, thereby contributing to user confidence.

Cost saving and financial management of stocks

Accurate financial accounting, as part of broader accounting procedures, can help states make financial savings and, at the same time, deter the unnecessary accumulation of surplus stocks. For instance, states that are able to accurately estimate the costs of storing surplus stocks may find that ammunition disposal is a cheaper option in the medium to long term (Wilkinson, 2006, p. 237).

Further savings may also be made with regard to maximizing the use of existing stocks. One notable example is the use of surplus ammunition for training purposes, where the performance requirements are less stringent than for operational ammunition.

In 2001 a US Government Accountability Office (USGAO) report indicated that the US Army had purchased ten types of ammunition, despite the fact that over two million[4] rounds of equivalent calibre ammunition were listed in the army's records as 'being of sufficient quality (either new or in like-new condition) for training purposes' (USGAO, 2001, pp. 14–15). This estimate was made feasible by comprehensive accounting procedures.

Ensuring reliability for the end-users of ammunition

States that employ effective accounting procedures alongside physical and chemical inspection regimes minimize the risk of issuing unstable or inoperable ammunition to security force personnel. Conversely, states that have ineffective or non-existent accounting procedures risk criticism from their forces for quality failings, which can also lead to a potential loss of morale.

Accounting procedures can help minimize the risks associated with ammunition malfunctions in two ways. First, systematic inventorying, which includes physical and chemical inspection reports, can prevent unstable ammunition from being issued to serving forces. Second, records of lot numbers of ammunition issued to forces, combined with systematic ammunition malfunction reporting,[5] enable the tracing and inspection of suspect lots of ammunition.

Progress to date

Accounting procedures are inadequate, or non-existent, in many states. As a result, national security forces remain unable to document the ammunition within their stockpiles. The accumulation of surplus stock (CHAPTER 10) often proceeds unnoticed and arms and ammunition diversion escapes detection (CHAPTER 15).

Despite growing international attention to the issue of stockpile security, very few states have requested external assistance with the management of national stockpiles—including in the area of accounting.

Paradoxically, where accounting procedures remain ineffective, the vast majority of problematic stockpiles go undetected and many states fail to realize that they have a problem. Accounting failures impair diagnosis of loss, theft, or dangerous accumulations of surplus stock and, in the final analysis, dissuade states from taking measures to control national stockpiles.

Because it comprises the basis for sound stockpile management, effective accounting is a priority for all national stockpiles. National stock audits are a critical first step in improving stockpile management, because they provide a baseline from which to assess whether stocks are unsafe, in surplus, or subject to diversion.

Conclusion

Accounting is a fundamental component of stockpile management and security. It can assist greatly in identifying stockpile losses or illicitly diverted stocks, as well as facilitating the management of shelf life expired and unstable ammunition. Whether as a security- or safety-enhancing strategy, effective accounting is a priority for all states.

Ideally, accounting mechanisms should comprise comprehensive networked systems that link information on types and quantities of ammunition stocks, the risks they pose to storage and transport, and information on the transfer and relocation of stocks.

The record-keeping component of accounting is, however, only effective when used in conjunction with a comprehensive set of reporting procedures, including the technical inspection of ammunition stocks and physical inventory audits.

Accounting is the first step in assessing whether the management of national stockpiles is secure or not. In many states, this baseline does not exist, leading to unchecked accumulation of surpluses, unstable stocks, and continued diversion from national stockpiles.

Notes

1 Technical monitoring is known as surveillance and is covered elsewhere in this volume (CHAPTER 6).

2 For a discussion of accounting practices in the context of disarmament and weapons collection programmes, see SEESAC (2006).

3 Shelf life refers to the length of time an item of ammunition may be stored before its performance degrades. Shelf life is not a sufficient indicator of the stability of ammunition and explosives, and the latter can only be established by a comprehensive ammunition

4 These items, totalling 2,203,745 in number, were of mixed calibre, and included 7.62 mm, .30, .45, and .50 calibre cartridges for small arms and light weapons; 60 mm mortar rounds;

105 mm artillery rounds; 155 mm propellant charges; M228 hand grenades; and M18 red smoke grenades. This is based on USGAO (2001, p. 15) analysis of stockpile data provided by the Defense Ammunition Centre and purchases provided by Operations Support Command.

5 For an example of ammunition-malfunction-reporting procedures in the US Army, see USDoD (2001).

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6

Stockpile Management: Surveillance and Proof[1]

Adrian Wilkinson

Overview

Surveillance and proof are essential to ensuring the safety, reliability, and operational effectiveness of conventional ammunition. This chapter summarizes the requirement for the in-service proof and surveillance of ammunition within national stockpiles.[2] It stresses that many states suffer a deficit of technical expertise in ammunition management. The importance of surveillance and proof in these cases is often poorly understood, leading to failings in ammunition safety and stability.

Surveillance and proof

Surveillance is a systematic method of evaluating the properties, characteristics, and performance capabilities of ammunition throughout its life cycle. It is used to assess the reliability, safety, and operational effectiveness of stocks. Proof is the functional testing or firing of ammunition and explosives to ensure safety and stability in storage and intended use.

In-service proof and the surveillance of ammunition are undertaken to ensure that the ammunition continues to meet the required quality standards throughout its life. Quality, from this perspective, includes the performance of ammunition during use and its safety and stability during storage. The chemical, electrical, and mechanical properties of ammunition change and degrade with time, leading to a finite serviceable life for each munition. The accurate assessment of munition life is of paramount importance in terms of safety and cost.

Although the life of an item of ammunition is often determined by safety considerations related to energetic materials, this may not always be the case. The deterioration, due to ageing, of non-energetic components such as rubber seals, electronic components, and structural materials can also limit the safe life of the ammunition by affecting safety or performance parameters. It is important that the whole system is considered when assessing life-limiting factors for ammunition, not just the propellant or other energetics.

States often initially use the fact that shelf life has expired to try and justify the use of donor resources to fund stockpile destruction. This justification is technically inaccurate, as shelf life only provides an indication of the performance of ammunition, and not necessarily of its safety and stability in storage.

Rationale for surveillance and proof

The safety and stability of ammunition and explosives in storage can only be established by a comprehensive ammunition surveillance system that uses a methodology of both physical inspection by trained personnel and chemical analysis. Surveillance is carried out systematically by evaluating the characteristics and properties that the ammunition type possesses and measuring how the ammunition performs throughout its entire life cycle. This will, in turn, allow assessment of the safety, reliability, and operational effectiveness of the ammunition. Only then can safety in storage be properly assessed. The use of ammunition surveillance can then be used to extend shelf life, if appropriate. Shelf life extension may provide significant financial savings, as there will be no need to procure new ammunition.

Ammunition is subjected to technical surveillance and in-service proof for a wide range of reasons. It is a vitally important component of responsible ammunition stockpile management, and is the only way that the safety and stability of ammunition stockpiles can be properly addressed. Major reasons include:

- ensuring the safety and stability of ammunition in storage;
- ensuring the safety, reliability, and performance of ammunition during use;
- predicting, and therefore preventing, ammunition failures that are inherent in their design or are the result of ageing;

- monitoring the environmental conditions that the ammunition has been stored in;
- ensuring that the first point of detection of catastrophic failure is not the user;
- predicting failure and degraded performance in order to support effective ammunition procurement cycles;
- predicting future performance, service life, and limitations; and
- identifying and monitoring critical characteristics of the ammunition that change with age and exposure to the environment.

Degradation and service life

Each ammunition type will age slightly differently from every other, and within ammunition types there are many complicating factors that will affect how they age. In addition, there will always remain the risk of a random, unforeseen event (such as from an error in manufacture) that can cause an individual item, within an otherwise homogeneous group, to fail over time. For most ammunition, one or two of the degradation mechanisms will limit its available life. Some of the more common failure mechanisms include (but are not limited to):

Energetic materials:

- de-bonding between the material and inert surfaces;
- stabilizer depletion within the energetic material;
- migration of the mobile species within the energetic material;
- cracking of brittle materials; and/or
- compatibility problems.

Electronics:

- component ageing; and/or
- component shock damage.

Structure:

- O-ring failure;
- mechanical damage (impact, corrosion); and/or
- vibration.

In addition to the physical damage caused by shocks and vibration, ammunition also degrades chemically. The energetic items that cause the explosive effect are invariably of organic chemical composition, and, in common with all other chemical compositions, they break down, migrate, or change over time. This change is normally accelerated with increased temperatures. Degradation may also be hastened by large variations in temperature (i.e. cycling from hot to cold), low temperatures, high or low humidity, vibration, shock, and pressure.

In order to assess the rate at which these factors may develop, ammunition is tested during its introduction to service, and a service life is assigned to it. The service life is based on the expected in-service usage of the ammunition and the amount of time its chemical components are expected to remain within performance limits and safe for use. As this is an inexact science, and to ensure that the service life prediction remains valid, worst-case assumptions are traditionally made regarding the environment that the ammunition will experience. Thus, when the end of service life is approaching, a life-extension programme should be formally sought. This will inevitably require non-destructive testing or live firing to determine the condition and performance of the ammunition. If this condition is better than predicted, extra life may be approved.

Progress to date

In many post-conflict and developing countries there is no residual technical expertise in ammunition management and often no understanding within the wider military as to the importance of surveillance and proof in terms of ammunition safety and stability. This can result in a range of consequences. First, ammunition can be unsafe in storage, with the subsequent likelihood of undesirable explosive events leading to fatalities (CHAPTER 13) and major unexploded ordnance clearance requirements. Second, individuals within the military may be unnecessarily placed at risk while working in ammunition storage areas. Third, it may cause unnecessary accidents during training, leading to fatalities and injury. Finally, the poor performance of ammunition during operations can result in misfires and stoppages, leading to a breakdown in the morale of troops as they lose confidence in the ammunition.

Effective ammunition management, including surveillance and proof, requires a systems-based approach implemented by appropriately trained and qualified personnel (CHAPTER 8). Training of ammunition technical specialists is a long-term process. For example, the North Atlantic Treaty Organization course for ammunition technical officers is now over 15 months long. Even basic ammunition management training takes months, not weeks, and is often overlooked by state security forces in post-conflict or developing countries during security sector reform.

Conclusion

Ammunition is required to function correctly and predictably, despite having to withstand exposure to a wide range of environmental conditions. In addition, it must remain safe during handling, storage, transport, use, and disposal. The level of degradation of its components determines the safety and suitability for use of a particular ammunition type, whether through being subjected to a normal service environment or after exposure to extreme conditions (such as shock damage, heat, humidity, rough handling, etc.).

The accurate assessment of ammunition life is therefore of paramount importance in terms of safety, performance, and cost. Historically, this lifespan has been calculated based on worst-case assumptions and generic environmental storage conditions, but the introduction of ammunition life assessment is now refining this process to ensure the best use of resources.

Many countries do not have the technical expertise to conduct effective ammunition surveillance and proof. As a result, ammunition deteriorates, becomes unsafe and unstable, and poses a risk to military assets and the public. While some donors provide technical assistance and training to countries that lack ammunition management expertise, many more national stockpiles remain at risk from a combination of inadequate ammunition management and ignorance as to the vital role of surveillance and proof.

Notes

1 This is now developing into a wider-ranging concept of munitions life assessment as part of an integrated test, evaluation, procurement, management, and disposal process.

2 The chapter does not cover the testing, evaluation, and proof of ammunition during development and acceptance into service. Nor is it designed to provide information on the wide range of proof or surveillance techniques available.

3 The references are only available from NATO or the UKMoD on formal request.

Further reading[3]

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7

Stockpile Management: Security

Michael Ashkenazi

Overview

Stockpile security refers to the protection of ammunition, weapons, and explosives against any malevolent actions, including theft, sabotage, damage, or tampering.

Damage, tampering, and sabotage create explosive risks to the safety of personnel and surrounding populations (CHAPTER 13) and impair the functioning of security forces. The diversion of munitions (CHAPTER 15) contributes to the illicit trade in ammunition and allows criminal factions and politically motivated groups to augment their firepower. Stolen ammunition from the national stockpile can also be attractive because of its application in wealth-generating civilian pursuits, such as illegal fishing and quarrying. Ensuring stockpile security is therefore a primary consideration for all conventional ammunition stockpiles, whether they are small or large in volume.

Securing stockpiles

The most effective means to ensure security is by limiting the access of unauthorized personnel. This can be achieved through a variety of ways, which are discussed below. While the following sections address measures taken to limit unauthorized entry, it is important to stress that ensuring physical security is only one component of comprehensive security measures applicable to the national stockpile. Planning (CHAPTER 8), accounting (CHAPTER 5), and marking (CHAPTER 3) also have a critical role to play in discouraging or disrupting malevolent actions.

Controlled access measures

Stockpile best practice is to store batches of different types of ammunition in separate storage areas and bunkers. Effective stockpile planners control access to these different locales, and to different lots within them, through the following physical means:

- Access routes to bunkers are locked and relatively impermeable (e.g. reinforced doors and well embedded doorframes).
- Immovable and lockable cages separate lots.
- All locks have individual keys (a master key can be kept, well-secured, in case of emergency).

The perimeter of the stockpile facility is also subject to procedures that are designed to ensure controlled access to personnel and materiel:

- When not actually in use, gates are locked and supervised.
- Entering and departing personnel, vehicles, and materiel are fully registered, with no exceptions.
- Normally, all movement of materiel is checked against attached dockets.
- Authorized personnel display visible security badges at all times.

Best practice also suggests that controlled access should extend to the safety zone (from which civilian and non-essential buildings are excluded). Moreover, persons accessing the zone should be constantly monitored, even in cases where access (e.g. by surrounding communities) is restricted only to a limited degree.

Fencing and external lighting systems

Fencing and external lighting allow stockpile security personnel to monitor the movement of personnel and materiel in and out of the stockpile, and ensure passage occurs only through controlled access points.

Fences should provide security, but also facilitate monitoring. Supported chain-link fencing, embedded in concrete, is a good option in this case because it provides a security barrier, but does not hinder observation. However, maintaining security necessitates regular inspection of the physical integrity of fences and immediate repairs to fences that are damaged and potentially insecure.

Due to the fact that fences can be pierced or climbed, effective stockpile security dictates constant observation of any points where persons could approach them.

Approach points should be well lit (from around 15 minutes before dusk and after dawn) and regularly maintained. If power is drawn from a national grid, backup transformers should be in place to supply lighting in the event of power failure.

The most sophisticated systems include sensor fences, which notify personnel of any attempts to bypass or penetrate perimeter security. These fences are, of course, expensive and require regular maintenance and training for personnel.

Surveillance equipment

Visual (and sometimes audio) surveillance increases the monitoring capacity of stockpile security personnel. However, it is important to note that while these surveillance media augment the vigilance of personnel, they do not replace them. Well-secured stockpiles require that cameras should operate during the day and night and should be:

- located so that they cover all gates; doors; the perimeter fence; and, ideally, the interiors of storage bunkers;
- monitored, in real time, by personnel; and
- linked to recording facilities to enable review in the event of loss or theft.

In some cases, visual and audio equipment can be computerized with routines that identify hostile movement.

Sophisticated surveillance equipment can substantially improve stockpile security, but it requires constant upkeep and trained personnel to ensure that it functions properly. The cost of its upkeep must therefore be a factor in any long-term stockpile security budgeting.

Guarding the site

Walls and fences do not prevent unauthorized access to a stockpile, but merely delay illegal entry until security personnel can intervene to prevent it. The physical presence of stockpile security personnel is essential and is the most important factor in security. Training, motivation, and regular pay are key ingredients in ensuring the effectiveness of the personnel charged with securing stocks. By contrast, poor pay and training can encourage staff involvement in malfeasance (including being subject to bribery or tempted into the theft of ammunition for sale) or misfeasance (such as laxity in carrying out guard duties and failing to follow procedures).

Guarding patterns vary considerably, but there are essentially three different guard functions:

- *Static guard posts* enable personnel to oversee the stockpile and intercept potential intrusions. Static guards need to be able to both see and act (either physically or by alerting mobile guards) to stop intrusion or extrusion of people and materials.
- *Mobile guards* are a deterrent to potential intrusion or extrusion, and can intercept any unauthorized movement of persons and materiel. Randomized patrolling patterns hinder planned illicit entry to the stockpile.
- *Inspection* is a function that can only be performed by well-supervised personnel and includes physical checks on the integrity of security devices, including fences, locks, lighting, and cameras.

The use of animals assists the guarding of stockpiles. Dogs are a notable security measure, but geese and other animals that audibly respond to intrusion can be used to supplement human guards.

Alarm systems

Alarm systems alert stockpile security personnel to unauthorized entry. Ideally, alarm systems should be fitted to all doors and access points, including fences and barriers that are not under constant observation.

Security regulations

One of the most critical aspects of stockpile security is compiling and advocating comprehensive security regulations (which include the measures noted above). While security regulations are always a national responsibility, they constitute a minimum standard for security. Local security authorities (such as the base commander or station chief) can and do augment national measures where deemed necessary. Although the following points appear elementary, the most effective national stockpile security regulations are:

- published in an authoritative version;
- available to all personnel that require familiarization;
- clear, to the extent that they can be understood by all personnel;

- consistent and without internal contradictions;
- feasible within the framework of available personnel, skills, and technologies; and
- universal, and applicable to all stockpiles under the national authority.

In particular, effective national stockpile security authorities carry out the following functions:

- regular publishing of comprehensive security regulations;
- the provision of adequate resources to ensure the implementation of these regulations; and
- regular inspection to ensure that local stockpile managers comply with the regulations.

At the local level, stockpile security authorities have a pivotal role in augmenting national regulations by ensuring that:

- all personnel at the stockpile are aware of the national and local regulations;
- all personnel are trained in, and adhere to, the regulations; and
- additional regulations are issued to meet specific local conditions, if necessary.

Model security plan

Countries' stockpile security measures differ in scope and scale, but it is clear that a security plan is the foundation of effective stock security. In cases where stockpile security is comprehensive, plans follow national regulations, adapt to the specific realities of the stockpile in question, and are known in detail to the management and staff of stockpile facilities.

The following model security plan has been adapted from the Organization for Security and Co-operation in Europe's *Best Practice Guide on National Procedures for Stockpile Management* (OSCE, 2003). The plan is not technical in nature, but is intended to provide a background for those who need to supervise and evaluate security aspects of stockpile management. It can also be used as a checklist by non-security personnel to assess whether security needs have been properly attended to. Other guides, such as the United States's (2005) *Physical Security Handbook 440-2-H*, are also available.

Table 7.1

Model security plan

Item	Comments
1. Registration of the name, location, and telephone number of the establishment security officer	There must be one, single security authority. This person, or a deputy, must be contactable 24 hours a day.
2. Scope of the plan	What does the plan cover: which areas, individuals, and possible scenarios?
3. Content of the stockpile	Types of weapons Types of ammunition
4. Security threat	What sorts of interests might try to remove weapons, and when (e.g. night-time theft, armed robbery, children)?
5. Detailed geographic map of the site location and its surroundings	This should clearly indicate fences, access roads, bunkers/storage areas, access points, and the safety zone at around 1:20,000 resolution.
6. Detailed diagram of the layout of the site, including locations of: • all buildings and structures; • entry and exit points; • electricity generators/substations; • water and gas main points; • road and rail tracks; • wooded areas; • hard- and soft-paved areas; and • guard points	Ideally a proper survey map of the site at around 1:5,000 scale or smaller
7. Outline of the physical security measures to be applied to the site, including, but not limited to, details of: • fences, doors, and windows; • lighting; • perimeter intruder detection systems; • intruder detection systems; • automated access control systems; • guards; • guard dogs; • locks and containers; • control of entry and exit of persons; • control of entry and exit of goods and materiel; • secure rooms; • hardened buildings; and • closed-circuit television	

8. Security responsibilities (including, but not limited to, the following personnel, as applicable): • security officer; • guards and guard commanders; • transport officer; • inventory management and verification personnel; and • all personnel authorized to have access to the site	The greatest possible specificity of responsibilities, even on a case-by-case basis, e.g. 'In the event of an attempted break-in, the security officer shall be responsible for …' Even personnel with no specific security brief (transport officer, other personnel) may have security responsibilities, e.g. 'You are responsible for locking all doors that you have previously unlocked.'
9. Security procedures to be followed in: • stock reception areas; • pre-storage processing; • bunkers; and • during all stock withdrawals	For example, how are people to be admitted to perform these functions? What security procedures should be followed when withdrawing stocks?
10. Control of access to buildings and compounds	Details of fences, gates, how they operate, for whom they are to be opened, etc.
11. Transport procedures	• Who provides security? • How is handover to another authority to be secured? • How are external recipients to be identified?
12. Control of security keys (those in use and their duplicates)	• Where are keys to be located? • Who can have access to them? It is often a good idea to attach keys permanently to large, metal key tags so that they are highly visible. New technologies such as embedded radio frequency identification chips can aid in locating keys.
13. Security education and staff briefing	• How are the staff to be briefed? • When? • By whom? New personnel must be briefed as soon as possible. Refresher briefings should be conducted as a matter of course.
14. Action on discovery of loss	• The security aspects of *every* loss must be investigated. • Lessons must be drawn and amendments made to the security plan if necessary.
15. Details of response force arrangements (e.g. size, response time, orders, means of activation and deployment)	How and when to activate the site's guard response force? Expected response times and actions? How to contact the police/security forces? How long will it take them to respond?
16. Actions to be taken in response to activation of alarms	Who must deploy where when an alarm is sounded?

17. Security actions to be taken in response to security emergency situations (e.g. robbery, attack)	Clear instructions on the use of force, on alerting police and security services, and on post-event investigation
18. Security actions to be taken in response to non-security emergency situations (e.g. fire or flood)	Procedures must be in place to coordinate activities of rescue and emergency teams with the security needs of the site (access in times of emergency, securing keys, avoiding theft during the confusion).

Source: OSCE (2003)

Progress to date

Many of the world's ammunition stockpiles remain critically insecure. In some countries, it is common to find unlocked and unguarded ammunition storage facilities that present very few obstacles to even the most casual intruder.

To date, the largest stockpiles have received the lion's share of international stockpile security attention. However, research by the Small Arms Survey suggests that scale is often unrelated to insecurity, and that the smallest stocks can pose a severe threat to societies (Bevan, forthcoming).

The vast majority of insecure stocks—whether large storage facilities or smaller collections of munitions in police stations and military barracks—will not be addressed in the near future unless there is a radical change in international attention devoted to national stockpile security.

Although progress has been made in a handful of countries, and most notably by unilateral and multilateral assistance programmes, these cases remain the exception rather than the rule. One of the primary driving forces behind these international initiatives has been the security—and often destruction—of politically sensitive weapons such as man-portable air defence systems (MANPADS) (CHAPTER 12).

Nevertheless, the smallest of stocks, when subject to diversion (CHAPTER 15) and subsequent use in crime, insurrection, or unlawful commercial activities such as mining or fishing, arguably pose the greatest immediate danger for communities that reside in the immediate and near vicinities of stockpiles. Addressing high-significance weapons like MANPADS is a priority, but the effects of low-order stockpile insecurity may have equally deleterious impacts on lives, livelihoods, and development.

Conclusion

Improving stockpile security can be resource-intensive, but it need not be in the short-term. In the world's worst-secured stockpiles, mere marginal improvements in security—such as the addition of a padlock or posting a guard—could drastically improve the security of national stockpiles. International assistance programmes are not a prerequisite, therefore, to achieving significant gains in stockpile security. In many countries, the only real barrier to achieving basic security, rather than a complete absence of security, is political will and recognition of the problem at hand.

That said, while such marginal improvements would undoubtedly have a real impact on the safety and security of the world's most insecure stockpiles, they are only a first step. The security of arms and ammunition has the potential to benefit a wide range of stakeholders (CHAPTER 17) equally, including governments, militaries, and civilian populations. Expenditure on stockpile security should not, therefore, simply be calculated as an investment in the security sector.

Stockpile insecurity is a growing issue on the international arms management agenda, but it is yet to be understood in sufficient depth. Until it is, the majority of the world's insecure stocks are likely to remain undetected and unaddressed.

Further reading

OSCE (Organization for Security and Co-operation in Europe). 2003. *Handbook of Best Practices on Small Arms and Light Weapons: Best Practice Guide on National Procedures for Stockpile Management and Security*. FSC.GAL/14/03/Rev.2. Vienna: OSCE. 19 September.

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United States. 2005. *Physical Security Handbook 440-2-H.* 'Appendix E: Firearms and Ammunition Storage Site Checklist.' Washington, DC: Office of Administrative Policy and Services/ Office of Management Services. August. <http://www.usgs.gov/usgs-manual/handbook/hb/440-2-h/440-2-h-appe.pdf>

8

Stockpile Management: Planning[1]

Adrian Wilkinson

Overview

Stockpile management is a wide-ranging term that covers specific technical areas related to the safety and security of ammunition and explosives, in addition to issues such as the determination of stockpile size, types of stockpiles, and the management of ammunition in service. Effective stockpile management requires comprehensive planning in order to ensure that all activities related to stockpile management work together as an integrated system.

The critical role of planning

The 'national stockpile' describes the full range of individual ammunition and explosive stockpiles within a country. It includes the stocks of various separate organizations, including the police, military (both active and reserve), border guards, paramilitaries, and manufacturers. Furthermore, it encompasses both large and small ammunition storage facilities, in addition to stocks that are deployed with security forces.

Faced with such a large and varied national stockpile, planning is critical to ensuring that all of the stockpile's sub-components, wherever located, are subject to adequate management procedures, ranging from accounting (CHAPTER 5), through to surveillance (CHAPTER 6), security (CHAPTER 7), and the destruction of surplus ammunition (CHAPTER 9). Not only is this necessary for explosive safety requirements, but it is also the only cost-effective method of efficient stockpile management. Ammunition is a necessary part of states' defence and deterrence capabilities. Therefore, effective planning must cover all aspects of conventional ammunition—from the defence policy that determines requirements, through procurement, storage, and deployment, to safe disposal.

Definition of stockpile types

One core function of effective planning is to understand the specific demand for ammunition. This enables the ammunition procurement system to determine the quantity and types of ammunition needed to implement national defence and security strategies. For military actors, ammunition requirements will ultimately be determined by the force structure and defence tasks that are derived from the national defence strategy. For police and other agencies, ammunition requirements will comprise a smaller percentage of the national stockpile, and they should be derived from the national security strategy.

Within these sub-divisions, any national stockpile consists of a range of smaller function-specific stockpiles, including the following:

1. *operational ammunition and explosives:* ammunition and explosives necessary to support the routine operations of military, police, and other security agencies over an agreed period of time;
2. *war reserve ammunition and explosives:* ammunition and explosives necessary to support the operations of military, police, and other security agencies during external conflict or general war over an agreed period of time. This is likely to be by far the largest part of the national stockpile;
3. *training ammunition and explosives:* ammunition and explosives necessary to support the routine training of military, police, and other security agencies. This will usually be an agreed percentage of the war reserve holdings;
4. *experimental ammunition and explosives:* very small quantities of ammunition used in trials and the development of munitions;
5. *production ammunition:* ammunition and explosives that have been produced and are awaiting sale under the control of the manufacturer. These may be available to the military during general war, but would not form part of the war reserve, as their availability cannot be guaranteed; and
6. *ammunition and explosives awaiting disposal:* the ammunition and explosives that are surplus to requirements because they are obsolete, unsafe, or damaged.

When states are unable to ascertain these or similar categories, it becomes impossible to accurately gauge realistic ammunition requirements, such as quantities that might be required in the future, or whether there is excessive surplus (CHAPTER 10).

Planning safe storage and handling

National ammunition management systems are only effective if plans also lead to the development of accurate accounting procedures (CHAPTER 5) and thorough and effective rules and procedures for personnel involved in classifying stock.

Risk management

A critical element of planning is the implementation of a robust, effective, and integrated risk management system. Risk management is an often-misunderstood term, within which there are common misconceptions in terms of the relationship between, for example, risk assessment and risk analysis. Figure 8.1 illustrates the relationships between the different components of risk management.

Figure 8.1
Risk management matrix

- **Risk management**
  - **Risk assessment**
    - Risk analysis
      - Hazard identification and analysis
      - Risk estimation
    - Risk and ALARP* evaluation
  - **Risk reduction**
  - **Risk acceptance**
  - **Risk communication**

* As low as reasonably practicable.

Planning for the national stockpile should consider not only explosive risks (CHAPTER 13), but also financial, environmental, and security risks inherent in the storage of large stockpiles of ammunition and explosives. A risk management system is integral to planning, and should be utilized within all aspects of ammunition management.

Although *risk assessment* requires technical skills and time, it is not a particularly costly component of planning. What is expensive is the *risk reduction* process, which may require significant investment in infrastructure to ensure safe storage conditions. Should this investment not be possible, then the risk that remains must be formally accepted (*'risk acceptance'*) at the highest political levels. In other words, the minister of defence must take political responsibility for any casualties or damage that may result from a lack of investment in an effective ammunition management system. Where there is a significant risk remaining, e.g. to civilians resident within explosion danger areas, then the risk that they are under should be formally communicated (*'risk communication'*) to them so that they may make informed decisions (CHAPTER 18). This again will have political consequences.

Classification systems[2]

Successful stockpile planning requires a classification system to prevent the accidental use of unsafe, unreliable, or unsuitable ammunition. Effective 'risk management systems' rely on classifying ammunition and explosives according to the potential hazard that they represent. They should include two separate systems.

First is a set of standard classifications that relate to the generic risks posed by the materiel in question. These are diverse, but include the following standards: dangerous goods classification, UN serial number, hazard division codes, compatibility group, and hazard classification code. However, these classification schemes indicate latent hazards. They are not based on the technical surveillance (physical and chemical) and proof of the stocks held of specific ammunition types (CHAPTER 6).

A second classification system records the results of technical surveillance and proof. This denotes the precise condition of batches of specific ammunition, rather than the more generic hazards that the ammunition nature might pose. Best practice dictates that the scheme uses codes that define the degree of serviceability of the ammunition and any constraints imposed on its use, such as the following categories, which are outlined more fully in the chapter of this book dealing with accounting (CHAPTER 5):

- condition A: serviceable stocks available for use;
- condition B: stocks banned from use pending a technical investigation;
- condition C: stocks unavailable for use pending technical inspection, repair, modification, or test;
- condition D: stocks for disposal (SEESAC, 2006, p. 3).

Regular inspection and surveillance (CHAPTER 6) are core components of effective stockpile management planning. These procedures inevitably identify defects, which necessitate the reclassification of ammunition into different condition groups, which are determined by those defects. Within the North Atlantic Treaty Organization (NATO), the following generic classifications are applied to ammunition defects:

Critical: defects affecting safety in storage, handling, transportation, or use;

Major: defects that affect the performance of the ammunition and that require remedial action to be taken;

Minor: defects that do not affect the safety or performance of the ammunition, but are of such a nature that the ammunition should not be issued prior to remedial action having been taken;

Insignificant: any defect that does not fall into any of these categories, but which could conceivably deteriorate into one of them if no remedial action is taken; or

Technical: any defect that requires further technical investigation (SEESAC, 2006, p. 3).

Condition classification systems, such as these, prioritize the disposal of ammunition on the grounds of ammunition stability (CHAPTER 9) and are a vital part of ensuring maximum safety in ammunition stockpiles.

Service life documentation

Safe, effective, and efficient ammunition management necessitates stockpile management personnel recording, and being able to retrieve, a variety of information related to the origins, nature, role, deployment history, planned service life, and potential shelf life extensions of ammunition. This information relates to marked (CHAPTER 3) batches of ammunition, and it is best practice for it to remain with these batches throughout their life cycle, from manufacture, through storage or deployment, to their eventual use or disposal.

Documentation varies from state to state, but the Ammunition Management Policy Statements (AMPS) system listed by the South Eastern and Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons (SEESAC, 2006, Annex C) is illustrative of the detail required.

Planning stockpile size

The basic determining factors used to define the size of a national stockpile are the force structure, equipment levels, and the strategic concept of deployment or operations derived from military tasks within the national defence strategy.[3] There are many intervening—often political, rather than strategic—imperatives that account for significant differences in the way states formulate these three factors. However, at the level of stockpile management, these remain the basic stockpile size planning considerations:

1. *force structure*: the numbers and types of units in a given military (or other security) force;
2. *equipment levels*: the numbers and types of equipment (weapons) in a given unit; and
3. *concept of strategic deployment*: the number of days that the unit is expected to sustain itself at various levels of conflict (SEESAC, 2006, p. 4).

Any planning for national stockpiles necessitates calculating daily ammunition expenditure rates (DAERs) of single weapons at varying degrees of combat intensity, and then processing this information through factors 1, 2, and 3, above. The (deteriorating) condition of ammunition over a given period of time also has to be factored into the equation, as does ammunition used in training or during specific operations, such as peacekeeping duties.

DAERs are usually kept secret, and states are responsible for assessing their required expenditure rates, based on the strategic situation and any collective security obligations they may have. In conjunction with accurate inventorying of stockpiles, however, these calculations are critical to planning the size of the required national stockpile—and, by extension, reducing surplus or ensuring sufficient supply (CHAPTER 10). It is clear, however, that many countries do not calculate their DAERs, and (often in conjunction with poor inventorying) this poses problems for stockpile forecasting and the accumulation of surplus stockpiles.

Planning the location of stockpiles

As several chapters in this book note, planning stockpile location is critical from the perspective of both stockpile security (CHAPTER 7) and the safety of surrounding populations (CHAPTER 18). Information on where to locate stockpiles can be found in the Organization for Security and Co-operation in Europe's *Best Practice Guide on National Procedures for Stockpile Management and Security* (OSCE, 2003a).

The *Guide* notes a number of features that relate to efficiency, including the proximity to security force personnel (i.e. consumers), for reasons of logistical efficiency; and the dispersal of stockpiles among two or more locations in order to limit loss should the stockpiles be attacked or destroyed in an accident.

These national security considerations should, however, also be balanced by imperatives that have implications for a broader set of stakeholders (CHAPTER 17), foremost of which is preventing harm to civilian populations by minimizing casualties in the event of an accident. These measures include keeping stockpiles at any one facility to the minimum levels and consistent with the role of the personnel and/or the explosive safety capacity of the site; and creating danger areas and safety distances in accordance with appropriate regulations, such as NATO's *AASTP-1: Manual of NATO Safety Principles for the Storage of Military Ammunition and Explosives* (NATO, 2006).

Progress to date

Stockpile management planning that is based on recognized technical standards, such as the NATO (2006) *Manual of NATO Safety Principles*, and equivalents, is generally recognized to comprise international best practice.

In many countries, however, these technical standards are seldom followed. Even when the states in question have national stockpile management legislation, it is often not based on a modern risk management system. This often equates to a tolerable risk level that is considerably higher than international best practice. For example, a comparison between the *Manual of NATO Safety Principles* and the former Soviet Union's *USSR Armaments and Ammunition Safety Manual* (USSRMoD, 1989)—which is still in use in many Eastern European countries—shows radical differences in terms of safety distances and permitted safe stockpile levels.

Although international support is provided to countries to assist with improving stockpile security and the disposal of surplus stocks, there are few projects that address the development of an integrated ammunition management system.

Conclusion

Comprehensive, integrated ammunition management and planning systems are critical to the safe, effective, and efficient accounting, procurement, storage, and disposal of ammunition. The expertise and knowledge are available within the wider international community to assist other countries in improving their ammunition stockpile management and planning in order to achieve international best practice.

Current levels of donor assistance and funding, and the scope of donor-assisted projects, however, will need to increase dramatically if the extant ineffective management systems prevalent in many states are to be addressed.

Notes

1 This chapter is intended to provide an introduction to stockpile management planning, but its scope is limited by space. Readers are recommended to consult the 'Further reading' section at the end of the chapter for more detailed information.

2 This presents information from SEESAC (2006). It has been condensed and updated where applicable.

3 For example, the number of days of sustainable use required for the various levels of conflict.

Further reading

NATO (North Atlantic Treaty Organization). 2006. *AASTP-1: Manual of NATO Safety Principles for the Storage of Military Ammunition and Explosives*. Brussels: NATO. May.

OSCE (Organization for Security and Cooperation in Europe). 2003. *Best Practice Guide on National Procedures for Stockpile Management and Security*. FSC.GAL/14/03/Rev.2. Vienna: OSCE. 19 September.

SEESAC (South Eastern and Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons). 2006. *RMDS/G 05.50: Ammunition and Explosives Stockpile Management*, 4th edn. Belgrade: SEESAC. 20 July.

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SEESAC (South Eastern and Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons). 2006. *RMDS/G 05.50: Ammunition and Explosives Stockpile Management*, 4th edn. Belgrade: SEESAC. 20 July.

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9

Stockpile Management: Disposal and Destruction[1]

Adrian Wilkinson

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.

10

Identifying a Surplus

James Bevan and Aaron Karp

Overview

There is no 'quick-fix' solution to the problem of identifying a surplus of conventional ammunition. Surplus identification must differentiate functioning, operational ammunition, which is required for a nation's armed services, from ammunition that either fails to meet or exceeds those requirements. The identification process requires making qualitative and quantitative assessments of ammunition and maintaining a precise 'balance sheet' that can be used to calculate projected ammunition expenditure rates against the types, quantities, and condition of ammunition within national stockpiles. Surplus identification therefore depends on having a comprehensive monitoring and accounting system that covers the entire national stockpile. When these systems are not in place, states have no means to determine whether their stockpiles meet or exceed requirements.

Estimates and calculations

It is important to make a distinction between a *surplus estimate* and the process of *calculating a surplus*. The first is a broad gauge of a given state's propensity to accumulate surplus. The second is an accurate assessment of a country's ammunition needs and how the composition and scale of its stockpile relate to these needs.

Surplus estimates are constructed from incomplete information to assess whether a given national stockpile *may* contain excessive surpluses of arms and ammunition. They are not, and should not, be used by national stockpile managers, but are a tool to be used by external observers, such as prospective donors and researchers. The methods used are indicative of potential excess accumulations of surplus, but cannot be employed to determine whether surpluses (or indeed the broader national stockpile) pose safety or security risks. Surplus estimates derive from assessments made of the changes to the structure and dimensions of security forces and how these changes relate to the size of national stockpiles. They include, among other things: force reductions; changes in doctrine; and defence acquisitions—sometimes in conjunction with information (where available) on the size of national stockpiles.

Calculating a surplus, on the other hand, requires knowing the exact composition, condition, and size of a national stockpile. It is the only way to accurately determine whether the national stockpile is sufficient for the requirements of a state's security forces, or whether the stocks within it are excessively large, unsuitable in the context of military doctrine, or unreliable. Because states are reluctant to make this information available to other parties, it is usually a task for national stockpile managers. However, it is an essential task, and the failure to implement the comprehensive monitoring and accounting procedures necessary to achieve it is the reason why many states accumulate large surplus stocks of conventional ammunition and, in the final analysis, fail to address the problem of surpluses.

Surplus estimates

A range of estimates can be used to determine whether states may be at risk of accumulating excessively large surpluses of conventional arms and ammunition. The following sections briefly outline how these estimates operate.

Force reduction

Reductions in the size of security forces can result in states retaining quantities of armaments that were previously stockpiled to supply much larger armed forces. Major changes to national security forces are easily apparent because they are either the consequence of major politico-military reorientations (such as the break-up of the Soviet Union), or result from military modernization programmes, which states are usually keen to advertise. Force reductions are well documented in publications, such as the International Institute for Security Studies' *Military Balance* series (e.g. IISS, 2007). Time series data derived from these sources can often indicate states that have large surpluses, or countries that may become prone to surplus accumulation in the future.

Changes to military doctrine

Military doctrine shapes the composition of national security forces and the relative size of their component parts. Major doctrinal changes usually result in states adopting different types of weapons and ammunition or making alterations to the quantities of armaments stocked by specific units within national armed forces. Either measure often results in the redundancy or displacement of weapons systems, and hence in the potential for surplus accumulation. Analysis of national doctrine, in a variety of forums, can indicate where, within a given nation's armed forces, surpluses may accrue.

Acquisition trends

The acquisition of new or improved military materiel displaces older varieties of weapons and ammunition. These relegated weapons may be used to supply reserve forces. However, given that these forces probably possess weapons already, acquisition often has a cascading effect (Bevan, 2006, p. 25), whereby new and improved arms and ammunition displace older varieties through successively 'lower' strata of the national defence establishment. The result can be surplus accumulation, and, given knowledge of large-scale acquisitions of defence materiel, it may be possible to ascertain what kinds of surplus may accrue. Defence acquisitions are generally not transparent, but larger purchases are often documented in the public domain in publications such as the Stockholm International Peace Research Institute's annual *Yearbook* (e.g. SIPRI, 2007).

Stockpile size estimates

Estimating the scale of national stockpiles in comparison to the size of national armed forces may indicate cases in which stockpiles are sufficiently large that they might indicate excessive surplus. This technique is limited by deficient data on the size of most national stockpiles. The method relies on calculating a ratio of national stockpiles (in tonnes) to numbers of serving personnel. As Table 10.1 illustrates, these ratios indicate excessive national stockpile-to-personnel ratios for countries that are internationally recognized as having excessive surplus. These countries contrast distinctly with countries where the development of surplus is (or has been) better controlled, such as the United States, illustrated in Table 10.1, with a ratio of only 0.5 tonnes per person for the US Army.

Table 10.1
Ratios of ammunition (metric tonnes) to military personnel

Country	Year	Total tonnes	Total military personnel	Total tonnes/ person
Albania	2000	180,000	11,020	16.3
Moldova	2007	40,000	6,750	5.9
Bosnia and Herzegovina	2005	33,500	11,865	2.8
US Army	2003	540,000*	1,164,394	0.5

* 600,000 non-metric tonnes converted to metric tonnes.

Sources: Albania: SEESAC (2005, p. 28; 2006, p. 17); Bosnia and Herzegovina: SEESAC (2006, p. 6); Moldova: SEESAC (2005, p. 115); US Army: Erwin (2003); military personnel (active and reserve) data: IISS (2007)

To some extent, the ratio method is superfluous, because it relies on some assessment of national stockpile size, which in turn necessitates a basic audit that might have revealed an extreme case of surplus accumulation in the first place.

For states that do not audit their stockpiles, the aggregate data necessary to calculate an ammunition-to-personnel ratio would not exist. In fact, it could plausibly be argued that analysis of force reduction, changes to military doctrine, or acquisition trends is potentially just as indicative of extreme cases of surplus accumulation and, moreover, does not depend on the (scant) availability of information on national stockpile size.

The limitations of surplus estimates

Surplus estimates are arguably useful, particularly from the perspective of external observers, such as other states, multilateral organizations, and the research community. They indicate where surplus stockpiles might have accrued, or where national defence policies might lead to future surplus excess. However, they are limited on two counts:

1. They make no qualitative assessment of the stability (CHAPTER 6) of surplus ammunition (should it exist) and hence no analysis of the possible risks it might pose to public safety.
2. They offer no indication of the physical security (CHAPTER 7) that states apply to the stockpiles in question to prevent them becoming diverted to the illicit market (CHAPTER 15).

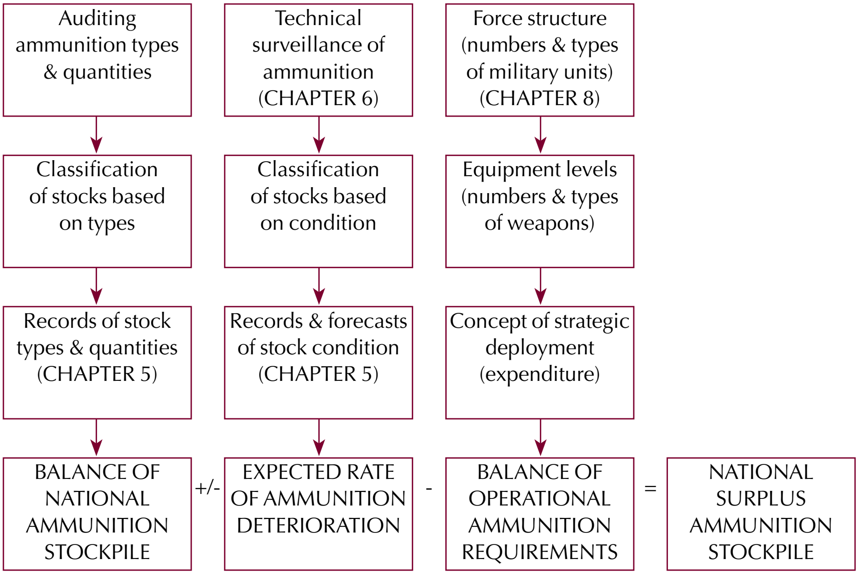
In short, these methods of estimating a surplus are not reliant on comprehensive systems for monitoring and recording the size, composition, or condition of national stockpiles, and therefore can offer no assessment of the risks they pose. Estimates are restricted to identifying states where surplus has the *potential* to become problematic. Moreover, they do not identify cases where the entire national stockpile poses safety or security risks.

Calculating surplus

Calculating surplus requires comprehensive national stockpile management systems and procedures. As Figure 10.1 illustrates, these measures are required to: 1) sustain an accurate inventory of the types and quantities of ammunition in the national stockpile; and 2) monitor, classify, and continually reclassify ammunition based on technical surveillance (CHAPTER 6) of its condition (stability and serviceability). These two processes comprise part of the same, comprehensive management system, which is often called a 'systems-based' approach to stockpile management (CHAPTER 8). Together with a parallel system of forecasting the ammunition requirements of national security forces, this is the only means of accurately assessing the relative balance of operational and surplus ammunition.

Figure 10.1

Processes required for calculating surplus (simplified)



Some of the necessary considerations for calculating a surplus (with reference to small arms and light weapons) are explored in the Organization for Security and Cooperation in Europe's *Best Practice Guide on the Definition and Indicators of a Surplus of Small Arms and Light Weapons* (OSCE, 2003a). Further guidance related to identifying conventional ammunition in surplus will be published by the OSCE as a result of a commitment in the *OSCE Document on Stockpiles of Conventional Ammunition* (OSCE, 2003b).

Progress to date

A lack of transparency is the most obvious feature of national conventional arms and ammunition stockpiles. This has posed considerable obstacles for external analysis of surplus accumulation. As a result, it remains very difficult to ascertain to what extent states retain surplus stocks. In most cases, outside observers can only point towards extreme cases of surplus accumulation. Surplus estimation, however, should not be dismissed for its lack of specificity.

For example, one of the core complaints made by international stockpile management assistance personnel is that they have too few requests for assistance[2]—something that can be attributed to the fact that many states do not recognize that they have a problem with surplus or unsafe or insecure stockpiles. Surplus estimates may point the way to more active outreach strategies for the assistance agencies concerned, strategies that could be based on identifying and approaching the states that might be most at risk of accumulating surpluses.

Additionally, when used in conjunction with information pertaining to national export practices, surplus estimates may also help to identify states that a) might have accrued surplus and b) might be tempted to transfer it to regions where its presence might have destabilizing consequences.

However, while externally generated surplus estimates may point towards potential problems, they do not offer solutions. Comprehensive national stockpile management is the only way to accurately calculate and address a potential surplus. Many states do not have the systems to do so and will continue to generate surplus unless these failings are addressed.

Conclusion

Systemic failings in the management of arms and ammunition allow surplus stockpiles to grow unchecked. Without adequate systems to monitor, classify, and account for national stockpiles, there is no accurate way of determining a surplus. Externally derived surplus estimates do not, and cannot, replace comprehensive ammunition management systems. Unless these systems are in place, states will remain unable to discriminate between operational and surplus stock. Moreover, entire national stockpiles will remain unsafe or insecure, regardless of whether they contain surplus.

Notes

1 Author's conversations with representatives of the UK Joint Arms Control Implementation Group and the US Defense Threat Reduction Agency.

Further reading

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11

Liquid Rocket Propelllant

Adrian Wilkinson

Overview

Large stockpiles of liquid rocket propellants remain in the stockpiles of many countries, with many concentrated in Asia, Eastern Europe, and the Commonwealth of Independent States. These liquid rocket propellants were used as the primary propulsion mechanism for a number of weapons systems (see Table 11.1), although how many of each are still in storage is unknown.

Stockpiles of liquid rocket propellants have necessitated a number of technical operations to alleviate the risks they pose, including their safe disposal. This chapter does not aim to provide a detailed technical study of liquid rocket propellants, but rather an overview to illustrate the basic theory of minimizing the risks they pose.

There are numerous reasons why the clearance or disposal of liquid-propellant-fuelled systems hazards may be desirable in a post-conflict or developing country, including: 1) to reduce the risk to human health; 2) to allow the destruction of unserviceable or unstable ammunition; 3) to safeguard the environment; or 4) to permit clearance of the area.

Many of these liquid fuels are stored in the open, or in unventilated buildings that have no drainage channels. Due to the lack of appropriate storage conditions and the effects of climate (humidity and high temperatures), containers have been discovered that are corroded and are not hermetically sealed. The result is a very strong probability of uncontrolled evaporation of the chemicals into the atmosphere and the possibility of wider leakage, leading to significant environmental pollution.

Table 11.1
Summary of weapons systems using liquid propellants

Weapon system		Use	Remarks
Type	**NATO* designation**		
Volga-2 S-75	SA-2 'Guideline'	Surface to air	China: HQ-2 version Iran: Sayyed-1 version North Korea: own version
Angara/Vega S-200	SA-5 'Gammon'		
R-1	SS-1a 'Scunner'	Surface to surface	Initial design that led to 'Scud' Iraq: Al-Hussein 1 and 2
R-11 (8K11), R-17 (8K14), R-300 Elbrus	SS-1b/c 'Scud'		There was a range of further theatre ballistic missile derivatives, including SS-4 'Scandal' (8K53), etc.
P-15, P-20, P-21, P-22, P27 Termit	SS-N-2 'Styx' SSC-3 'Styx'	Ship to ship Surface to ship	Also produced in India, North Korea, and possibly Egypt
R-13 (4K50)	SS-N-4 'Sark'	Ship to surface	SS-N-5 also referred to as 'Sark'
R-21 (4K55)	SS-N-5 'Sark'		Submarine-launched ballistic missile
R-27 (4K10)	SS-N-6 'Serb'		
R-29 (4K75)	SS-N-8 'Sawfly'		
R-29K (4K75D)	SS-N-18 'Stingray'		
R-29RM (4K75RM)	SS-N-23 'Skif'		
C-201 SY-1/HY-1	CSS-N-1 'Scrub-brush'	Ship to ship Surface to ship	
C-201 HY-2/FL-1/FL-3A	CSS-N-2 'Silkworm' CSS-N-3 'Seersucker'		Also produced in Iran

* North Atlantic Treaty Organization.

What are liquid propellants?

Liquid propellants are used in some rocket motors, and are divided into monopropellants and bipropellants. Monopropellants consist of a single compound, although some may require the action of a catalyst. They have a low specific impulse[2] and tend to be used mainly in small rocket motors, such as thrusters, or in gas generators. They are unsuitable as a main propulsive source in a munition, and therefore they are not discussed further here.

Bipropellants use a combination of a liquid fuel and a liquid oxidizer (often called melange). They are stored in separate tanks within the missile and injected into a combustion chamber. They then come into contact and violently react, producing hot gas for the purpose of propulsion. This spontaneous ignition of the fuel and oxidizer is called a hypergolic[3] reaction. Highly volatile hypergolic reactions will also occur if leakage or poor storage conditions allow the two components to mix, resulting in a major deflagration event.

Fuels

The most common fuels likely to be encountered in ammunition stockpiles are listed in Table 11.2.

Table 11.2
Common liquid propellant fuels

Compound	Generic name	Chemical formula	Remarks
Unsymmetrical dimethyl hydrazine	UDMH	$(CH_3)_2N\text{-}NH_2$	Mainly NATO
Monomethyl hydrazine*	MMH	$(CH_3)NH\text{-}NH_2$	
Triethylamine/ xylidene**	Tonka TG-02		Mainly Soviet and Chinese
Kerosene	Kero	C_8H_{18}	The formula varies, as kerosene is a complex mixture of petroleum hydrocarbons and other constituent compounds. The formula given is an 'average'.

* Used with dinitrogen tetroxide.

** Also known as ksilidin, dimethylaminobenzene, dimethylaniline, dimethyl-phenylamine, or aminodimethyl benzene.

The hydrazine fuel family are colourless, oily liquids with ammonia-like or fishy smells. The triethylamine/xylidene mixture is an oily liquid that easily vaporizes under normal climatic conditions. The colour varies from yellow to brown and it has the characteristic scent of oily amines.

Oxidizers

The oxidizer is the most difficult component of the propellant to deal with safely. If oxidizers are stored for lengthy periods, the water composition percentage can significantly increase as a result of shrinkage and corrosion, and the effectiveness of the inhibitor may decrease by 50–60 per cent, thus leading to the destabilization and active decomposition of the oxidizer itself.

The oxidizers most likely to be encountered in ammunition stockpiles are listed in Table 11.3.

Table 11.3
Common liquid propellant oxidizers

Compound	Generic name	Formula	Remarks
Red fuming nitric acid	RFNA	HNO_3	
Inhibited red fuming nitric acid	IRFNA melange	HNO_3 +	The inhibitor in IRFNA is hydrofluoric acid and is designed to protect the container against corrosion caused by the RFNA.
Dinitrogen tetroxide		N_2O_4	

Technical data for the oxidizers used in missile systems is often difficult to obtain, and will inevitably be inaccurate due to poor storage conditions. The percentage compositions vary, as shown in the examples for IRFNA given in Table 11.4.[4]

Table 11.4
IRFNA chemical composition data[5]

Component	%		Remarks
	Bosnia*	Standard	
Nitric acid (HNO_3)	74.6	82	
Dinitrogen tetroxide (N_2O_4)	22.5	0	
Nitrogen oxide (NO_2)	0	17	
Hydrogen fluoride (HF) Water	4.4	0.7	The Bosnia sample also included H_3PO_4 and water.

* See endnote. 4.

Safe disposal options

Decanting the fuel and oxidizer from storage containers and subsequently disposing of both is a complex process that should only be conducted by an accredited chemical (nitric acid-capable) or waste management company on site, or in its stationary facilities outside the country (if it is an international company). A range of safe and environmentally benign disposal or recycling options is available, but dependent on an economy of scale.

Previous experience of NATO, the Organization for Security and Co-operation in Europe (OSCE), and the UN Development Programme (UNDP) of oxidizer disposal indicates that this 'economy of scale' is an important factor in the selection of disposal options. Small quantities (less than 75 tonnes) are sometimes more cost-effectively disposed of through a competitive commercial contract. For larger quantities (greater than 300 tonnes), it is often more cost-effective to build national capacity 'on site'—through the procurement of specialist equipment, which is used to convert the oxidizer into fertilizer—or to develop the capability for destructive disposal in the host country.

In the case of South-eastern and Eastern Europe, disposal and/or recycling operations must be in accordance with the appropriate international and European Union environmental and safety hazardous goods and waste transport and disposal directives.[6] Previous safe disposal options within the region have included those given in Table 11.5, although some of these have not complied with environmental safety requirements.

Table 11.5 **Liquid propellant disposal options**

<table>
<tr><th>Disposal option</th><th>Fuel</th><th>Oxidizer</th><th>Remarks</th></tr>
<tr><td>Leak sealing and overpacking</td><td>Yes</td><td>Yes</td><td rowspan="2">Prior to removal to commercial waste disposal facility</td></tr>
<tr><td>Acid dilution/neutralization</td><td>No</td><td>Yes</td></tr>
<tr><td>Incineration</td><td>Yes</td><td>Yes</td><td></td></tr>
<tr><td>Fertilizer conversion</td><td>No</td><td>Yes</td><td></td></tr>
<tr><td>Open burning</td><td>Yes</td><td>No</td><td>Environmental limitations</td></tr>
<tr><td>Decanting and contained burning</td><td>Yes</td><td>No</td><td>Requires integrated pollution control system for environmental compliance</td></tr>
<tr><td>Dilution with low-grade fuel</td><td>Yes</td><td>No</td><td>Recycling option
Improves fuel octane rating</td></tr>
</table>

Toxic risks

For any given substance, toxic risk depends on: 1) the toxicity of the substance; 2) the duration of exposure; and 3) the intensity of exposure. The main routes by which any toxic substance may enter the body are: 1) ingestion;[7] 2) percutaneous entry;[8] 3) ocular entry;[9] and/or 4) inhalation.

A compound's toxicity alone is an insufficient guide to the level of risk it may pose due to inappropriate storage or during disposal operations. For example, in the case of contaminant vapours, the volatility of the parent compound must be considered in addition to its toxicity. In practice, a compound with a higher volatility may pose a greater hazard than a more toxic compound with lower volatility. This is because, at a given ambient temperature, higher volatility compounds are present in the immediate atmosphere in higher concentrations than less volatile compounds. There is no universally recognized method of quantifying risk on the basis of both volatility and toxicity, but one simple method uses the 'Hazard Index':

Hazard Index (HI) = Volatility / Toxic dose

To illustrate the relationship among toxicity, volatility, and risk, a comparison has been made between UDMH and MMH in Table 11.6.

Table 11.6
Toxicity/volatility comparison MMH/UDMH

Compound	Vapour pressure @ 25° C (mm Hg)	Toxicity* Index	Hazard Index
Monomethyl hydrazine (MMH)	49.6	74	0.67
Unsymmetrical dimethyl hydrazine (UDMH)	156.8	252	0.62

* The LC_{50} limit is the concentration of substance, which under defined conditions, is lethal to 50 per cent of those exposed. In this case, the LC_{50} limit is for a four-hour period.

While UDMH is nearly four times less toxic than MMH, its higher volatility (caused by much higher vapour pressure) means the two compounds are ranked equally in the Hazard Index. It must be emphasized that the Hazard

Index is not a universally agreed concept, but it does present a rough guide that can be used operationally to assess the relative risk posed by different chemical substances.

Hydrazines

The hydrazine derivatives (MMH and UDMH) tend to be local irritants, convulsants, and blood-destroying agents[10] that are absorbed by all routes of administration to the body. They are almost all suspected of causing cancer in humans. Hydrazine itself is a strong skin and mucous membrane irritant and a moderate blood-destroying agent. It can be absorbed through intact (undamaged) skin. Exposure to the vapour results in: 1) eye irritation; 2) lung congestion; and 3) nervous system convulsions.

Similar effects are exhibited by UDMH contamination, but the compound is less irritating to the skin, and has less severe percutaneous toxic effects. It also has a lower oral toxicity than hydrazine, but its acute vapour toxicity is greater. UDMH therefore poses greater risks in cases of localized atmospheric contamination.

The American Conference of Governmental Occupational Hygienists is an advisory body that sets standards for threshold limit values (TLVs).[11] These standards are similar to the United Kingdom health and safety executive occupational exposure limits (HSEOEL), which although internationally preferred, do not publish limits for UDMH and MMH. Therefore, TLVs have to be used, as shown in Table 11.7.

Table 11.7
Threshold limit values (TLV) for hydrazine/MMH/UDMH

Compound	TLV		Remarks
	ppm*	$mg.m^3$	
Hydrazine	0.1	0.10	UK HSEOEL = 0.10 $mg.m^3$. Same as TLV
MMH	0.2	0.35	
UDMH	0.5	1.00	

* Parts per million.

Hazard reduction

Reducing hazards when working in liquid-bipropellant-contaminated environments does not consist solely in adopting the appropriate operating procedures and the provision of suitable personal protective equipment. The following measures are also essential: 1) the education of employees; 2) regular monitoring of the working environment; 3) emergency contingency planning; 4) management of work schedules to reduce exposure; and 5) frequent medical monitoring of worker health. Regrettably, in many countries that still have liquid-propellant stockpiles, little of this is implemented at the operational level, and therefore workers and local communities are exposed to the risks.

Table 11.8

Liquid propellant disposal projects (as of September 2007)

Country	International agency	Quantity (tonnes)	Disposal method	Remarks
Armenia	OSCE	862.0	Conversion to mineral dressing	Ongoing (700 tonnes completed)
Azerbaijan	NATO/NAMSA*	1,200.0	Conversion to liquid soil enhancer	Ongoing (1,000 tonnes completed)
Bosnia and Herzegovina	UNDP	45.6	Over-pack and subsequent removal to Western Europe hazardous waste disposal facility	Complete
Georgia	OSCE	400.0	Conversion to fertilizer	Complete
Kazakhstan	OSCE	410.0	*Contractual negotiations ongoing*	
Moldova	NATO/NAMSA	250.0	Incineration	Complete
Montenegro	UNDP/OSCE	128.8	*Competitive tender process ongoing*	
Ukraine	OSCE	16,336.0	*Competitive tender process ongoing*	
Uzbekistan	To be confirmed	1,500.0	*Uzbekistan is still to decide on a partner international organization.*	
Total		**21,132.4**		

* NATO Maintenance and Supply Agency.

Progress to date

National governments, with the support of international organizations and donors, have initiated a range of disposal programmes within South-eastern and Eastern Europe (where the majority of the liquid propellants may be found). These have included projects to dispose of both oxidizers and fuels (see Table 11.8).

Conclusion

The safe disposal of liquid rocket propellants, although a potentially hazardous process, is now well understood, and a range of technical solutions are possible. There is now little doubt as to the potential environmental hazards that the majority of current storage systems present should leakage occur, but the exact scale of the problem has yet to be defined.

The issue of liquid rocket propellant disposal is also beginning to be understood by a range of donors, and disposal projects have, or are being, initiated by NATO, the OSCE, and UNDP. The success of these projects will depend on a sustainable level of donor funding.

Notes

1 This chapter is based on Wilkinson (2002). It has been condensed for this volume and updated where appropriate.

2 This can be defined as the thrust per unit mass rate of burning of the propellant. Ideally, it should be a constant for a given propellant. It is an important performance parameter.

3 The spontaneous ignition of two components.

4 The following information is based on a technical report and chemical analysis for the disposal of a similar substance by UNDP Bosnia and Herzegovina in 2005. It was AK-20 oxidizer.

5 AK-20 oxidizer.

6 These directives include: Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the Incineration of Waste; Directive 2003/105/EC of the European Parliament and of the Council of 16 December 2003 on the Control of Major-Accident Hazards Involving Dangerous Substances; Directive 2006/12/EC of the European Parliament and of the Council of 5 April 2006 on Waste; and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal.

7 Entry into the body by eating or swallowing.

8 The penetration of substances through the skin.

9 Entry into the body via the eyes.

10 Agents that can attack and contribute to the destruction of the red blood cells.

11 TLV is the maximum concentration levels of a toxic substance in air, which, under certain conditions, is considered acceptable for the exposure of industrial workers.

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12

Man-portable Air Defence Systems (MANPADS)

James Bevan and Matt Schroeder

Overview

Man-portable air defence systems have received increasing political attention in recent years, because of the demonstrable risk that they pose to both military and civilian aircraft. They have been catalogued in some of the most poorly secured national stockpiles. In many more cases, questions remain about their numbers and the security measures in place to protect them from diversion. Because of the threat they pose and the fact that they have become a highly politicized issue, MANPADS have been one of the driving forces behind a number of international initiatives to secure, stabilize, or destroy surplus stocks. Although MANPADS remain a problem in their own right, they have helped focus the lens of international scrutiny on the dangers associated with surpluses of all varieties of conventional munitions.

The problem with MANPADS

MANPADS pose no greater risk from the perspective of stability and safety than any other light weapon. Explosive risk is generally perceived to be small in comparison to larger weapons systems. Their chief danger lies in their potential for diversion from national stockpiles (CHAPTER 15).

The weapons are attractive to non-state actors because they offer a means to reduce power asymmetries between themselves and conventional state forces. As Table 12.1 illustrates, the majority of recent attacks have been against military targets. These attacks have resulted in the deaths of over 150 people and the loss of assets and transport-associated revenues worth hundreds of millions of dollars.

Table 12.1
MANPADS attacks on aircraft, 2002–07

Date	Location	Aircraft	System used	Result	Mil./ civ.	Deaths
19/08/2002	Khankala, Chechnya	Mil Mi-26	Igla (SA-16/18)	Hit	Mil.	127
28/11/2002	Mombasa, Kenya	Boeing 757	Strella (SA-7)	Missed	Civ.	0
02/11/2003	Falluja, Iraq*	Boeing CH-47	Unknown	Hit	Mil.	15
22/11/2003	Baghdad, Iraq	Airbus A300	Strella (SA-7)	Hit	Civ.	0
09/12/2003	Baghdad, Iraq	McDonnell Douglas C-17	Unknown	Hit	Mil.	0
08/01/2004	Baghdad, Iraq	Lockheed C-5	Unknown	Hit	Mil.	0
27/06/2005	Mishahda, Iraq*	Boeing AH-64	Unknown	Hit	Mil.	2
06/05/2006	Basra, Iraq	Westland Lynx	Unknown	Hit	Mil.	5
10/01/2007	Buhruz, Iraq**	Sikorsky UH-60	Strella (SA-7)	Missed	Mil.	12
02/02/2007	Taji, Iraq	Boeing AH-64	Unknown	Hit	Mil.	2
07/02/2007	Al-Karma, Iraq	Boeing CH-46	Unknown	Hit	Mil.	2
23/03/2007	Mogadishu, Somalia	Ilyushin 76	Unknown	Hit	Civ.	11
13/08/2007	Sulaimaniya, Iraq*	McDonnell Douglas MD-83	Unknown	Missed	Civ.	0
Total deaths						**176**

* Unverified by military sources.

** Unclear whether the aircraft was actually struck by the missile, or small arms fire alone was responsible for the crash.

Sources: BBC (2003; 2005); Chivers (2007); Kramer (2004, p. 34); Knights (2007); UKMoD (2006, p. 21)

All of the attacks listed in Table 12.1 were conducted by non-state actors. Although MANPADS are notoriously difficult to use successfully without comprehensive training, these attacks illustrate that they are used, and to deadly effect.

The impact of MANPADS use may pale into insignificance beside the loss of life in depot explosions (CHAPTER 13), or armed criminality fuelled by the diversion of small arms (CHAPTER 15), but a successful MANPADS attack against a civilian airliner could claim many hundreds of lives and affect national economies. Civilian aircraft are particularly vulnerable, particularly when landing at or taking off from airports, where they may be in range of MANPADS strikes for 20–30 kilometres or more (Savill, 2006).These factors often mean that non-state groups will go to great lengths to acquire MANPADS, giving their diversion an international rather than local dimension.

Between 9 and 13 non-state groups have obtained MANPADS, and the number may be double that (Hunter, 2001; USGAO, 2004, p. 11). US intelligence agencies have declined to release information on the number of illicitly proliferating MANPADS, and this information remains classified (USGAO, 2004, p. 11).

MANPADS diversion and ineffective stockpile management

The Small Arms Survey notes that MANPADS are in the national stockpiles of over 100 state armed forces (Bevan, 2004, p. 78). These states include developing countries with highly insecure stockpiles; states that are recovering from armed conflict; and collapsed states, such as Somalia.

MANPADS, like other small arms and light weapons, pose a particular threat of diversion because they are small, light, and easily concealed. They are designed as an infantry defence against aircraft and, for this reason, they are deployed as self-contained systems, consisting of weapon, ammunition, and guidance system within a rugged weatherproof case.

These features facilitate illicit acquisition and use, for the following reasons. First, thefts can be rapid and relatively discrete, because the system is designed to be portable. Second, due to the small size of systems, illicit transfers—including international transfers—may be difficult for state authorities to detect. Third, and critically, weapons can quickly be made ready to fire by trained unauthorized users.

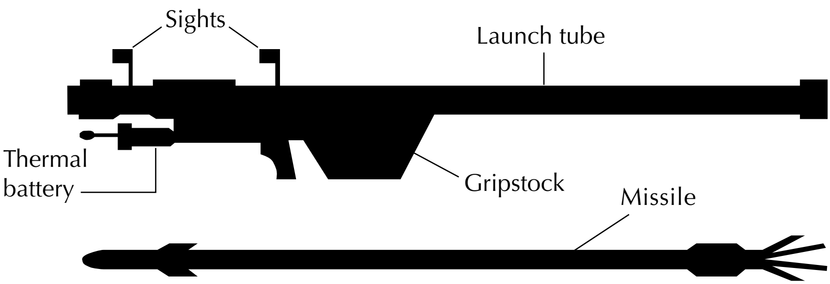
It is important to recognize, however, that these 'diversion-facilitating' features are conditioned by a number of factors that deter theft. These include: the high value of the systems, which *may* induce some states to better secure them; and the limited number of applications for the weapons (in contrast to small arms, for instance), which means that demand is relatively low in most contexts.

These factors, however, have not deterred numerous instances of theft. For example, dozens of MANPADS have been diverted from unsecured Eastern European surplus stockpiles to war zones across sub-Saharan Africa—ranging from the arsenals of UNITA in Angola to those of LURD in Liberia. Such transfers have involved major international arms traffickers, such as the infamous Victor Bout, and this international dimension to illicit MANPADS trade is important to note (see UNSC, 2000; 2003).

MANPADS stockpile security

As with all munitions, protecting MANPADS from diversion is contingent on basic accounting practices (CHAPTER 5) and on the physical security of stocks (CHAPTER 7). These measures are outlined elsewhere in this volume in considerable detail, but it is worth considering some measures that are applicable to MANPADS.

Figure 12.1
Anatomy of a MANPADS



Source: Bevan (2004, p. 79)

MANPADS consist of several detachable components, including the missile, launch tube, and gripstock (see Figure 12.1). These features permit the separate storage of MANPADS components, which can substantially reduce the potential for an entire system to be diverted if the security of a single storage unit is compromised and its contents stolen. As the US military notes, weapons that are stored in ready-to-fire configuration present the most imminent security risk when diverted (USDoD, 1989, p. 32). It is therefore preferable to minimize the number of situations in which MANPADS (and similar weapons systems, such as anti-tank guided weapons) are stored in this manner (CHAPTER 5). With this in mind, the *OSCE Handbook of Best Practices on Small Arms and Light Weapons* notes: 'Where the design of MANPADS permits, missiles and firing mechanisms (gripstocks) should be stored in separate storehouses and in locations sufficiently separate so that a penetration of one site will not place the second site at risk' (OSCE, 2006, p. 32d).

The Wassenaar Arrangement's *Elements for Export Controls of MANPADS* also notes the desirability of recipients making provision for separate storage as one of the criteria for export (WA, 2003, para. 2.9).

Progress to date

Over the past decade, the United States and like-minded states have pursued several important initiatives aimed at improving the security of MANPADS stocks. In 2000 members of the Wassenaar Arrangement adopted the *Elements for Export Controls of MANPADS*—the first multilateral agreement aimed at curbing the illicit trade in MANPADS. While primarily focused on export controls, the *Elements*—and particularly an expanded version adopted in 2003—also identify several important stockpile security standards that exporters are expected to require of their clients (WA, 2003). These standards are similar to decades-old US requirements for importers and co-producers of Stinger missiles, which include, among other requirements, separate storage of missiles and launchers, 24-hour surveillance, and monthly 100 per cent physical inventories.

Versions of the *Elements* have been adopted by members of several other multilateral forums, and have been endorsed by dozens more countries through UN General Assembly resolutions. Along the same lines, in 2006 the OSCE adopted the first multilateral best practice guide on MANPADS stockpile management and security procedures. The document contains detailed guidelines on all aspects of stockpile security, including physical security, access control, handling and transport, and inventory management and accounting (OSCE, 2006).

Recognizing that many countries lack the know-how and resources to bring their practices in line with emerging international standards, several donor states have launched assistance programmes aimed at helping foreign militaries to improve their stockpile security practices and 'rightsize' their MANPADS arsenals through the destruction of surplus or obsolete missiles. US assistance programmes alone have facilitated the destruction of over 21,000 surplus, obsolete, and poorly secured MANPADS, and improved security practices at depots containing thousands more missiles (Johnson, 2007; Schroeder, 2007).

One spin-off of increasing attention to MANPADS security has been the concurrent securing of stocks of other varieties of weapon—notably small arms and light weapons—during MANPADS-specific assistance programmes. MANPADS initiatives have attracted attention and resources to key small arms and light weapons threat reduction programmes, including those that help secure and reduce foreign stockpiles by destroying surplus weaponry. Since 2003, funding for the US State Department's Small Arms/Light Weapons Destruction Programme has nearly tripled, increasing from USD 3 million in the 2003 fiscal year to USD 8.6 million in the 2007 fiscal year (USDoS, 2004; 2007a). The MANPADS threat has featured prominently in budget justifications for the programme, and most of the additional funding has gone towards MANPADS-specific projects.

Conclusion

MANPADS remain a threat to military and civilian aircraft. Although they have received probably the greatest attention of any variety of conventional weapon, national stocks of MANPADS remain uncounted and unsecured in many states. The MANPADS issue has cast a spotlight on the management of conventional arms and ammunition, however. Measures taken to address insecure stocks of MANPADS have also been broadened to encompass other types of weapons and ammunition within the same facilities. Despite the threat they pose, however, it is a relatively minor one in contrast to insecure conditions prevalent in stockpiles of conventional arms and ammunition.

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13

Ammunition Depot Explosions[1]

Adrian Wilkinson

Overview

In almost all post-conflict environments and in many developing countries, the physical risk to communities from the presence of abandoned, damaged, or inappropriately stored and managed stockpiles of ammunition and explosives can be significant. Table 13.1 summarizes those accidents resulting in explosions in ammunition depots that have been identified from open source information, although it is very likely that there will have been more incidents than this. It

Table 13.1

Summary of known explosive events in ammunition depots, 1995–2007[2]

Year	Number of countries	Number of explosive events	Casualties	
			Fatalities	Injuries
1995–2000	11	31	351	636
2001	10	16	80	243
2002	11	16	1,587+*	557
2003	9	21	166	356+
2004	10	16	88**	1,290+***
2005	16	21	159	529+
2006	15	18	11	128
2007	12	14	133+	525+
Total		**153**	**2,575+**	**4,264+**

* Includes 1,500 fatalities in one incident in Nigeria.

** Does not include unconfirmed reports of more than 1,000 fatalities in North Korea.

*** Includes more than 1,200 injuries from a separate confirmed explosion in North Korea.

Source: SEESAC (2007b)

should also be noted that two particular incidents (in Nigeria in 2002 and Mozambique in 2007) heavily impact on the statistics for those particular years.

Further analysis identifies those countries where there have been, or still are, obvious problems with ammunition safety in storage from the frequency of accidents over the period. The data does not identify any relationship between the number of fatalities and injuries per explosion, but this is not surprising, considering the number of variables involved, i.e. size of stockpile, ammunition types, proximity of a civilian community, time of explosion, etc. (see Table 13.2).

Table 13.2
Known explosive events in ammunition depots by country, July 1995–June 2007

Country	Number of explosive events	Casualties		Remarks
		Fatalities	Injuries	
Afghanistan	16	199	452+	
Russian Federation	16	35	94	
Albania	16	57	64	15 incidents during the political instability of 1997
Iraq	12	131	90	
India	10	35	67	
Ukraine	6	7	17	4 incidents at Novobogdanovka
Mozambique	5	115+	464+	4 incidents at Malhazine
Taiwan	5	8	2	
Thailand	5	21	165	
Ecuador	4	10	473	
Kazakhstan	4	0	0	
Sudan	4	82	260+	
Total	**103**	**700+**	**2,148+**	

Source: SEESAC (2007b)

Causes of explosions

There are many possible causes of undesirable explosions in ammunition depots, but they can usually be categorized into to the following generic areas: 1) deterioration of the physical or chemical condition of the ammunition and explosives; 2) unsafe storage practices and infrastructure; 3) unsafe handling and transport practices; or 4) deliberate sabotage.

Regrettably, the dramatic consequences of an ammunition explosion normally make the key witnesses to the event among its first victims. Therefore any subsequent investigation tends to concentrate on the practices and regulations in force at the time, as key witnesses are not available. Due to the fact that a degree of technical knowledge is required for an effective investigation, the investigating authority is also usually the authority responsible for the ammunition management and storage in the first place. This complicates the

Table 13.3
Reported causes of recent ammunition depot explosions, July 1995–June 2007

Cause*	Total	%**
Cause not known or not confirmed	51	33.3
Fire	30	19.6
Movement/handling	21	13.7
Security/sabotage	22	14.4
Auto-ignition of propellant***	8	5.2
Lightning strike	8	5.2
Electrical	5	3.3
Other	8	5.2
Total	**153**	**100.0**

* The causes are as stated in official reports or confirmed press reports. They may not necessarily be completely accurate, as the efficiency of the incident investigations could not be verified by SEESAC. The exact cause is sometimes difficult to establish, due to the destruction of evidence.

** The total of the figures given is not exactly 100, due to rounding.

*** This is a major risk where ammunition surveillance is limited or non-existent, but a minor risk where appropriate ammunition surveillance practices are applied.

Source: SEESAC (2007b)

impartiality and independence of the investigation, and can lead to a reluctance to allocate responsibility.

The limited information available suggests several major causes of the known explosions (see Table 13.3).

The cause of fire is not identified in the data available. A percentage of this figure will relate to external fires resulting in explosions, such as the one in Nigeria in 2002, but some causes will be fires accidentally started during inappropriate activities within ammunition storage areas, or unidentified auto-ignition of propellant. What is of more concern, however, is the number of events where the cause is not known. This suggests either a lack of transparency on the part of the authorities, or a shortage of the technical skills necessary to properly investigate such accidents. In either case, it means that the remedial action necessary to prevent a recurrence is unlikely to take place, and further explosions should be expected.

The three major causes identified from the current available data strongly suggest that the risk of undesirable explosions can be significantly reduced by: 1) sound training; 2) the development of appropriate ammunition management systems (CHAPTER 8); 3) the short-term prioritization of stocks for destruction; and 4) their subsequent destruction on a priority basis (CHAPTER 9).

Impact of explosions

The damage, casualties, and impact on communities of an explosion within an ammunition depot can be devastating, and the economic costs of the subsequent explosive ordnance disposal clearance can be far greater than the prior implementation of safer procedures, limited infrastructure development, and stockpile disposal would have been. It is difficult to identify the real costs of clearance, as in cases where this has happened, the government financial systems have lacked the sophistication to accurately estimate the real costs. Yet a comparison with the costs of humanitarian mine and unexploded ordnance (UXO) clearance would not be inappropriate in terms of costs per square metre.[3]

It is also important to remember that there will inevitably have been a number of 'near misses', where an undesirable explosive event has been prevented or contained by the ammunition management or storage practices in place at the time. A major problem, however, is that during conflict, in post-conflict environments, or during force restructuring as part of security sector reform, the specialist technical personnel that should be responsible for ammunition management may well have become casualties or left the armed forces, and they are very difficult to replace without a comprehensive and effective training programme.

There are also economic costs in terms of the capital value of the stockpile itself, although this is really a factor for national consideration. National funds that are used for the replacement of destroyed ammunition stocks could potentially have been committed to social and economic development. Such replacement costs can run into millions of dollars. As an example, the ammunition explosion in Bharatpur, India on 28 April 2000 resulted in an estimated ammunition stock loss of USD 90 million. This explosion was the result of a fire at the ammunition depot, which was exacerbated by excessive vegetation. Ironically, the grass had not been cut for two years as a cost-saving measure. In this case, prevention would certainly have been cheaper than the resultant cure.

Progress to date

Ammunition depot explosions continue to kill and injure many hundreds of people each year. While some states have made great advances in managing ammunition stockpiles, they remain few in number.

Several developed countries offer both unilateral and multilateral assistance programmes that are designed to improve the management and physical security of stockpiles. These programmes include comprehensive stock auditing, assessments of risk (of both explosion and diversion), improvements to the physical storage of arms and ammunition, and training and assistance for stockpile management personnel. Despite the range of measures on offer, however, relatively few states have requested stockpile management assistance.

Assistance agency representatives repeatedly stress that the problem stems from a lack of information on the subject by recipient governments and security forces. On the one hand, many states remain unaware of the fact that their stockpiles are unsafe. On the other hand, the means to identify these problems—comprehensive improvements to stockpile management—remain nascent because states are unaware of the potential benefits of improved stockpile management. Donor states and international agencies clearly have a critical role to play in better promoting assistance programmes and advertising the benefits—whether from an economic or public safety perspective—that these programmes can offer.

Conclusion

The frequency of undesirable explosions of ammunition storage depots has been increasing over the last five years. This trend can only continue as the surplus stockpiles remaining from the cold war and previous conflicts continue to deteriorate. Ineffective stockpile management in many countries, combined with the slow pace of destruction, means that further explosive events will inevitably occur and more innocent lives will be lost.

Yet many explosive events in ammunition storage areas are preventable by a combination of sound training, the development and implementation of appropriate ammunition management systems, the ongoing short-term prioritization of stocks for destruction, and their subsequent destruction on a priority basis. International focus should be strengthened in these areas.

The economic and social impact of such explosions should not be underestimated, and further research should try to identify these very real costs.

Notes

1 This chapter presents information originally published in Wilkinson (2006). It has been comprehensively updated and amended where necessary.

2 Since 2006 the statistics include incidents during demilitarization and explosive ordnance disposal clearance after a depot explosion.

3 The costs of mine and UXO clearance vary depending on a range of factors, including location, the state of the national economy, topography, type of contamination, etc. Therefore, an 'average' figure is difficult to identify, although many sources suggest that USD 1 per square metre is a sound average (email from Alistair Craib, BARIC Consultants, 28 February 2006).

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14

Improvised Explosive Devices (IEDs): An Introduction[1]

Adrian Wilkinson, James Bevan, and Ian Biddle

Overview

In January 2003 the International Atomic Energy Agency sealed bunkers at the Iraqi Al Qaqaa facility. By the time US forces reached the facility on 10 April 2003, 377 tonnes of premium quality high explosive had been looted. Yet this stockpile probably accounted for less than 0.06 per cent of the total Iraqi ammunition and explosive stockpile (Bradley and Ricks, 2004).

Between July 2003 and October 2007, IED attacks in Iraq resulted in the deaths of over 1,600 coalition personnel (ICCC, 2007). Not surprisingly, these attacks have received escalating publicity in the international news media.

Yet it is the use of conventional ammunition in these weapons that remains less well publicized, and it is this use that impacts on the policy debate surrounding the effective stockpile management of conventional ammunition in all scenarios. In Iraq, and increasingly in Afghanistan and the Occupied Palestinian Territories, a significant majority of IEDs are manufactured from conventional ammunition, explosives, and other items diverted from military stockpiles.

Introduction

IEDs can be made from a wide range of non-military components, chemicals, and compounds that are readily available to civilians in most countries. However, the construction, and to an extent the deployment, of IEDs is made considerably easier if factory-manufactured explosives or complete rounds of ammunition are readily available for adaptation to illicit uses.

Diverted conventional ammunition (CHAPTER 15), explosives, and military demolition items can be used in a wide range of IED types, ranging from anti- personnel 'booby traps' and improvised mines to roadside bombs and armour-piercing projectiles.

Large calibre ammunition, such as artillery shells and mortar bombs, are particularly useful for IED construction, because they contain relatively large quantities of explosive. In addition, military stockpiles frequently contain demolition stores, such as detonators, detonating cord, and plastic explosives, that can greatly facilitate the construction of IEDs.

What is an IED?

The standard North Atlantic Treaty Organization (NATO) definition of an IED is:

> A device placed or fabricated in an improvised manner incorporating destructive, lethal, noxious, pyrotechnic or incendiary chemicals and designed to destroy, incapacitate, harass or distract. It may incorporate military stores, but is normally devised from non-military components. (NATO, 2007, Part 2, sec. I, p. 2)

The phrase 'normally devised' is arguably context specific. At the global level, the majority of explosives for use in IEDs are manufactured using commercially available components, such as compounds derived from nitrate-based agricultural fertilizers or hydrogen peroxides. Yet, recent experience in post-conflict environments such as Iraq and Afghanistan suggest that, in situations where large volumes of conventional ammunition circulate among non-state actors, it is often more expedient to use military ammunition, explosives, and associated materiel. Military explosives also have the added advantage of being more powerful in terms of TNT equivalence than the majority of home-made explosives.

In recognition of increasing attention to the role of conventional ammunition used in IED construction, the following definition of an IED, which originates from the UK armed forces, can be considered supplementary to the NATO one:

> An explosive device, constructed using non-commercial methods, usually in a domestic setting; or a device using ammunition that has been modified to allow it to be initiated in a non-standard way and for a purpose not envisaged by the original equipment manufacturer (OEM).[2]

This chapter combines the definitions, but focuses on explosive devices, rather than the other (noxious, pyrotechnic, etc.) variants listed in the NATO definition.

IED component parts

It is generally accepted that all IEDs consist of the following component parts[3]:

- main charge;
- initiator;
- firing switch;
- safety and arming switch; and
- container.

The subject of this chapter is the use of conventional ammunition as the main charge of an IED. The chapter does not discuss other component parts.

Applications for conventional ammunition

The ongoing conflict in Iraq provides perhaps the best illustration of how a range of IEDs can be fabricated from conventional ammunition and explosives.

In Autumn 2003 US military commanders estimated that Iraqi military sites contained between 600,000 and 1,000,000 tonnes[4] of ammunition and explosives in over 130 ammunition storage sites (Klingelhoefer, 2005, p. 2). Yet this did not include the ammunition that was stored in over 10,000 cache sites that were subsequently discovered by coalition forces throughout Iraq prior to August 2004. The true scale of the losses from storage depots that are available to warring factions and non-state actors will probably never be known, other than that it was significant. A 9 November 2003 US Defense Intelligence

Agency report is alleged to have noted that the vast majority of explosives and ordnance used in anti-coalition IEDs has come from pilfered Iraqi ammunition stockpiles. Yet the problem was so large and the coalition forces so unprepared to deal with it that even by December 2003 only 250,000 tonnes[5] of ammunition were partially secured (Klingelhoefer, 2005, pp. 4–5).

Insurgent groups had therefore gained easy access to the full range of conventional ammunition types, including hand grenades, land mines, mortar rounds, and artillery shells—almost all of which have potential applications in IED construction.

Large calibre ammunition

The use of these types of ammunition varies. Some are hastily laid as single devices; others are used to manufacture more complex devices that use multiple linked main charges[6] that have been extracted from a number of projectiles and assembled into one powerful explosive device.

Although device construction varies significantly, most of the remotely initiated[7] roadside IEDs in Iraq illustrate a similar fusion of civilian commodities and conventional ammunition.

The 'firing pack' usually consists of a wireless device, such as a mobile phone, a battery pack, and a safe to arming switch/timer. An electrical detonator is usually placed in a small quantity of booster explosive, which is then placed in or next to the main explosive charge. The main charge will consist of one or more items of large calibre conventional ammunition.

Explosively formed projectiles (EFPs)

Explosively formed projectiles are often referred to as shaped charges, although this can be confusing to the technically uninitiated, because EFPs do not perform like the majority of more traditional high-explosive anti-tank (HEAT) shaped charges. HEAT shaped charges consist of a metallic cone, whereas EFPs utilize a metallic disc, which results in different target effects. A HEAT warhead will produce a molten jet of metal that penetrates the target by hydro-dynamic effects; an EFP produces a fragment that mainly uses kinetic energy as the attack mechanism (although at shorter ranges it may act as a 'dirty' HEAT warhead). A rough estimate is that an EFP can penetrate a thickness of armour equal to around the diameter of its charge, whereas a typical shaped charge will go through six or more charge diameters. The EFP has the advantage that it can be effectively used as a 'stand-off' (longer-range) weapon; a HEAT round cannot be effectively used this way, due to jet disintegration effects over distance.

Given access to explosives, EFP warheads can be easily manufactured to high standards by a metal machinist, using readily available materials such as metal piping or copper sheeting. The pipe is filled with high explosive and capped with a concave steel or copper liner. The explosive shapes and compresses the liner into a hot metallic fragment, which can penetrate thick armour at optimum range. This IED warhead can be effective against modern main battle tanks and armoured personnel carriers.

Armoured vehicles are becoming increasingly sophisticated and well protected against EFPs. One way to counter this is to use large quantities of explosive. Even the best armoured vehicle cannot survive an explosion large enough to throw it into the air. These large buried IEDs are not particularly common, being used in less than 10 per cent of attacks in Iraq (Stevens, 2006), perhaps because of the significant quantities of explosive used and the relatively long time they take to emplace, with the consequent risk of detection during the process. When they are used, however, they tend to produce catastrophic results: in November 2005 a large buried IED killed 13 and wounded 7 coalition personnel.

Types of IED and initiation modes

IEDs will differ depending on the role that the users intend them to perform. They may be designed to cause widespread loss of life and destruction of infrastructure, or for targeted attacks on personnel and vehicles. Their role (and intended impact) depends on where they are situated, their destructive capabilities, and how the explosive device is 'delivered' to the target. The list of types of delivery in Table 14.1 is not exhaustive.

IED technology is only limited by the ingenuity of the person manufacturing or deploying the devices, so multiple configurations are always plausible. One design constraint, however, relates to the attackers' preferences for proximity to the target. In some cases, the attackers may choose to commit suicide in the process of carrying out the attacks; in others, they may wish to escape harm or detection by remaining distant from the device. The modes of initiation given in Table 14.2 are intended to provide an illustration and are not comprehensive.

Table 14.1
Types of IED delivery systems

Type of delivery	Target	Remarks
Vehicle-borne	Personnel/infrastructure	LVBIED* VBIED**
Person-borne	Personnel	PBIED***
Passive	Personnel/vehicles	Land mine types
Directional	Vehicles/infrastructure	Projected devices, missiles, and rockets
Placed	Personnel/vehicles/infrastructure	

* Large vehicle-borne IED.

** Vehicle-borne IED.

*** Person-borne IED.

Effect on development

Readily available ammunition and explosives from unsecured stockpiles fuel armed violence, which can cause significant loss of life and damage, but can also potentially impact on post-conflict development. For example, on 19 August 2003 an IED that used conventional ammunition as its main explosive charge detonated at the UN headquarters in Baghdad, resulting in the deaths of the UN Special Representative and 22 international and NGO staff. As a result of this incident, the UN withdrew the majority of its personnel from Iraq, and UN operations in the country, including reconstruction and development activities, effectively ceased.

Table 14.2
IED initiation modes

Initiation mode	Initiation system	Remarks
Timed	Chemical decay	
	Clockwork	
	Electronic timer	
Command-initiated	Suicide	PBIED Can also be timed
	Radio-controlled (RCIED)	
	Command wire (CWIED)	
	Passive infrared	
	Active infrared	
	Projectile-controlled (PCIED)	Uses a rifle bullet to connect a circuit from a distance
Victim-operated (VOIED)	Booby traps	
	Pressure pads	
	Pull switches	

Progress to date

Unsecured conventional ammunition and explosives stockpiles are a risk for any state that experiences insurgency or civil war. Iraq is not a unique case, but it stands as an example of how access to ammunition stockpiles in post-conflict environments can provide heavy firepower to non-state actors and, ultimately, compromise post-conflict recovery. However, most commentators have failed to make the critical link between IEDs and conventional ammunition—and, notably, the issue of stockpile security. Recognizing these linkages again stresses the need for effective stockpile security and the rapid securing of stockpiles that are left open to looting. Failings in Iraq stand testament to the dangers that can arise when states or international forces fail to take such necessary measures.

Conclusion

The easy availability of ammunition stocks in immediate post-conflict environments can, unless properly secured (CHAPTER 7), act as a major source of operational capability for warring factions or non-state actors.

Failure to identify and secure such stockpiles in immediate post-conflict environments can have strategic implications for peace-building processes by adversely affecting the balance of power within a developing state. Iraq should serve as a classic example of initial tactical military success leading to strategic failure due to ineffective planning for the immediate post-conflict environment. While it is clear that ammunition stockpiles did not prompt the insurgency, its pace and intensity would arguably have been much less vigorous if these armaments had not been available.

Notes

1 This chapter is designed to illustrate the use and impact of conventional ammunition as components of IEDs. It is not intended to cover counter-IED philosophy, principles, techniques, tactics, technology, or procedures.

2 British Army Ammunition Technical Officers Course, provided by Ian Biddle.

3 Sometimes also simplistically referred to by the mnemonic SPICE: switch, power source, initiator, compartment, and explosives.

4 540,000 to 900,000 metric tonnes.

5 227,000 metric tonnes.

6 The primary explosive component of a projectile.

7 Remote initiation can be achieved using a variety of civilian wireless technologies, including garage door openers, car alarms, key fobs, door bells, and toy car remote control systems. Some IEDs use personal mobile radios and mobile phones, which allow attackers to initiate IEDs from greater distances and are more effective against countermeasures.

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15

Conventional Ammunition Diversion[1]

James Bevan

Overview

Diversion is the unauthorized transfer of arms and ammunition from the stocks of legal users to the illicit market. Throughout the world, it sustains the activities of non-state armed groups, terrorist organizations, and armed criminality. It is one of the principal sources of illicit weaponry and represents a grave threat to the safety of civilian populations, as well as to the security of the state itself.

Diversion takes many forms, ranging from large international transfers organized by corrupt military officials to low-level, localized theft and resale of munitions by military and police forces. Diversion affects all countries, and it occurs at all points in the national stockpile chain.

This chapter systematizes types of diversion from national stockpiles. In each case, it highlights relevant stockpile management and physical security measures that can be taken to curtail diversion. It concludes that diversion is largely a self-inflicted problem that stems from poor stockpile management by national authorities. However, many of the factors that facilitate diversion can often be made less problematic by relatively simple, low-cost measures.

Diversion in context

Diversion poses a risk to any legally held quantity of arms and ammunition. It is a threat to operational ammunition stocks (used to support routine operations), reserve ammunition, training ammunition, experimental ammunition,[2] ammunition at the point of manufacture, and ammunition awaiting disposal (Wilkinson, 2006, p. 232). Certain types of ammunition, however, pose a greater and more widespread risk than others. This is particularly so of small, portable munitions, such as small arms, light weapons, and their ammunition. These weapons are not only distributed throughout the national stockpile, but are often deployed outside of secured facilities and under little centralized control. That said, it would be wrong to focus only on the smallest of conventional munitions. As the following sections outline, when conditions are permissive, almost any munitions can be (and are) subject to diversion.

Table 15.1

Types of ammunition diversion from the national stockpile, impacts, and regulatory frameworks

Type of diversion	Dynamic	Description	Reach	Regulatory framework
Low-order	Intra-security force theft	Theft by members of the armed forces	Localized	Stockpile management
	Extra-security force theft	Theft through unauthorized access to stocks or attack	Regional to international	Stockpile management/security sector reform
High-order	High-level corruption	Defence sector officials orchestrate diversion	International	Institutional capacity building/combating corruption/security sector reform
	Mass looting or dispersal	State or security sector collapse leading to the dissolution of stockpiles	Regional to international	Political (domestic governments prior to collapse; possibly occupying powers)

The following sections make a simple dichotomy between low-order diversion from the national stockpile, which involves the theft of relatively small volumes of arms and ammunition, and high-order diversion (see Table 15.1). The latter is both larger in scale and, arguably, a more challenging task from the perspective of controlling unchecked illicit arms proliferation. As Table 15.1 illustrates, diversions from different levels in the national stockpile have differing impacts and must be addressed within different regulatory frameworks.

Low-order diversion

Low-order diversion of the national stockpile is the theft of relatively minor quantities of munitions by individuals and small groups of individuals. It may occur at all levels of the national stockpile, but is generally characterized by its links to localized illicit trade rather than regional or international transfers. It takes two broad forms: intra- and extra-security force diversion.

Intra-security force diversion

Lower-order, intra-security force theft involves the diversion of munitions by military, police, or paramilitary personnel, and can take two forms—theft from arms and ammunition storage facilities, and illicit transfers from the deployed stocks of members of the security forces. Small calibre ammunition (and, indeed, arms) is particularly susceptible, but theft can extend to larger weapons systems and their parts.

In the first instance, theft is often orchestrated by stockpile security personnel who are themselves charged with monitoring stocks and securing them from theft. Small facilities, such as police stations and military barracks, may be particularly susceptible if few personnel are responsible for record keeping and the physical inventorying of stocks. In virtually all cases where individuals or small groups of military personnel appear to have been able to divert munitions, their actions have been facilitated by a number of factors. First, they frequently perform duties that give them regular access to stocks and to stock accounting systems. Second, they often have access to stocks that are poorly inventoried. Both of these factors can be made critical if the personnel concerned are poorly monitored by peers or superiors—facilitating both theft and account tampering.

A second type of intra-security force theft occurs when members of a state's armed forces or other state agents divert *issued* stocks of munitions to the illicit market. Issued munitions are those that are required by personnel to perform their duties. They rarely include light weapons. In most countries, they consist of small calibre weapons and ammunition, such as pistols and assault rifles. These firearms comprise the personal weapons of police, military, paramilitary, and other government agents.

While many states only issue arms and ammunition in time of need, others allow personal weapons (and their ammunition) to remain in the hands of security force personnel, whether on or off duty. Because these munitions are already in the charge of personnel, access to them is not subject to entry to an armoury or other weapons storage facility, they can pose a particular risk of diversion.

Accounting (CHAPTER 5) and oversight are two fundamental pillars of arms and ammunition management that can be employed to address low-order diversion. Effective accounting covers three basic processes:

1. *Stocks issued*: The numbers and types of munitions issued to security forces (at all levels) are recorded and this information is stored securely at progressively higher administrative levels.
2. *Stocks expended*: The numbers and types of munitions expended (whether in training or combat) are documented and the circumstances in which they are used specified.
3. *Stocks audited*: All stocks are thoroughly audited and the balance checked against reports detailing issuance and expenditure.[3]

These three procedures are contingent on functioning command and control systems within security force administrations. Where there is little oversight, it is unlikely that any such measures will operate effectively.

In these cases, however, where internal monitoring of personnel is weak, external monitoring can be employed to detect instances of diversion and trace (CHAPTER 4) thefts back to the security forces responsible. Lot marking of ammunition is one such measure, whereby munitions are assigned a code that specifies the particular unit within a state's security apparatus to which the ammunition has been issued (CHAPTER 16).

Extra-security force theft

Low-order, extra-security force theft involves diversion from national stockpiles by non-state actors. It is often contingent on lax stockpile management practices that allow unauthorized access to national stockpiles (CHAPTER 7). In other cases, stocks are left vulnerable to violent attack because of minimal investments in security and a lack of planning on the part of relevant authorities.

Stockpile facilities that are extremely poorly guarded allow the entry of unauthorized personnel and the theft of munitions. In many states, diversion can be a relatively simple process, whereby local people simply walk into the stockpile and help themselves to arms and ammunition.

Although such pilferage may be localized, the easy availability of high-value weapons such as man-portable air defence systems, which are in great demand by some non-state groups, suggests the potential for these local dynamics to link in with the international trade in illicit weaponry (CHAPTER 12).

Diversion under these circumstances is easily preventable through the application of basic physical security components of stockpile management. The measures required to do this need not be expensive or sophisticated. Fences and locked doors slow intruders, regular patrolling detects incursion, and police or troops stationed within easy reach of a facility serve both as an effective deterrent and as a quick-response force should a diversion of stocks be attempted.

Diversion via capture from state security forces—whether on the field of battle or through direct assault on military facilities—is a major source of illicit arms and ammunition. Captured munitions are often pivotal in allowing insurgencies to gain momentum through a process described by Bevan (2005, pp. 186–87) as the 'acquisition spiral', whereby groups capture successively larger quantities of weapons and ammunition.

The same basic tenets of physical security that apply within stockpile facilities—*slow*, *detect*, and *counteract*—also apply to how they are situated and protected in a broader sense. These include: 1) adequate garrisons of well-equipped forces to slow potential attacks and lessen the likelihood that they will result in diversion; 2) communications channels to warn against potential attack or seek assistance in the event of assault; and 3) the proximity of forces that are able to repel attacks should they occur. Very often, the susceptibility of stocks to attack is commensurate with the insecurity facing members of the security forces in many countries, who are often deployed far from central control—sometimes in dangerous border regions—with little support from other state forces. As with many factors associated with diversion, vulnerability in these cases often stems from broader security sector mismanagement.

High-order national stockpile diversion

High-order stockpile diversion involves the theft of large volumes of munitions, sometimes running into many hundreds of tonnes. Like low-order diversion, it is often facilitated by poor stockpile management practices, but in many cases it results from factors that are much broader than the management of arms and ammunition. Weak state structures, a lack of accountability within political and military administrations, and associated loopholes in transfer regulations conspire to present often highly placed individuals with the opportunity to divert munitions. Compartmentalization of arms management responsibilities appears to have the greatest bearing on diversion.

Surplus stocks are often at particular risk because their illicit transfer may not directly affect the functioning of a given state's armed forces. As a result, not only are diversions less likely to be 'missed', but individuals may perceive diversion under these circumstances as a lesser crime than stealing active stocks. This phenomenon is particularly acute in states facing economic collapse and associated political and administrative turmoil, such as those of the former Soviet Union in the 1990s. In cases such as this, highly placed military officials are able to capitalize on their command of military finances, equipment, and personnel—and the fact that their units continue to receive military equipment—to plunder state assets.

However, high-order diversion is not confined to states that experience major systemic failure. The case of contemporary Iraq suggests that, even when highly organized modern military systems are nominally responsible for arms management, control over arms and ammunition can become fragmented when insufficient attention is paid to ensuring transparency regarding and accountability for munitions (USGAO, 2007, pp. 10–11).

High-order diversion is a systemic problem, involving the plunder of all types of state assets, ranging from the theft of military funds to the illegal loan of government capital, the use of military aircraft for commercial charter, and the expropriation of military facilities and land.

Taken at face value, controlling diversion of this magnitude appears to be contingent on very broad structural changes to state administrations and has linkages to wider issues such as good governance and accountability. Curtailing high-order diversion is, however, not an insurmountable challenge. Addressing it necessitates detecting it in the first place. Effective stockpile management, and particularly accounting procedures (CHAPTER 5), have the potential to play a critical role in identifying corrupt officials and weak points in the national stockpile. High-order diversion may be a deep structural problem in the defence sectors of some states, but relatively basic management mechanisms may be pivotal in combating it in others. Foremost among these is the destruction of surplus stock (CHAPTER 9), which removes the temptation to divert from the equation entirely.

Progress to date

Some of the primary driving forces behind the most prolific cases of high-order diversion—such as those in the post-Soviet states of the 1990s—have dissipated in recent years. However, there is some justification for claiming that, while permissive economic and administrative conditions have dissipated, the broad facilitating factors—namely large surpluses and potentially compartmentalized arms management systems—remain in place in many states. Iraq stands as the most recent and vivid example of how runaway arms management systems can still develop and present huge problems of diverted munitions.

These cases excepted, the problem of low-order division probably remains undetected (or, at the very least, under-detected) in many states. Some countries simply do not have the accounting and oversight systems to identify the fact that they lose a steady stream of arms and ammunition to the illicit market. In some regions, as much as 40 per cent of illicit ammunition has been diverted via these means, with little recognition of that fact by the states concerned (Bevan, forthcoming).

Where security forces do not have to account for the ammunition they expend in engagements or training, when commanding officers cannot oversee the use of weapons, and where no records are kept of the numbers of rounds issued, munitions are easily diverted. In many countries, the scale of diversion will remain unclear unless systematic accounting procedures are adopted as part of broad, effective measures applied to the national stockpile.

Conclusion

Diversion is a problem that affects all state armed forces to greater or lesser degrees. Even the most highly organized and structured security forces lose weapons and suffer theft, leading to acquisition by criminals and other illicit users.

All stocks of arms and ammunition are susceptible to diversion, regardless of where they are stored or deployed in the national stockpile. Effective accounting and security procedures therefore need to apply to all categories of ammunition if states are to keep risks of diversion within acceptable limits and maximize the efficient use of the national stockpile. At present, however, diversion from national stockpiles (and particularly low-order diversion) remains an opaque phenomenon and one that deserves urgent policy attention.

Notes

1 An expanded version of this chapter, focusing on the diversion of small arms and small arms ammunition, will be published in the *Small Arms Survey 2008* (Bevan, forthcoming).

2 Experimental ammunition refers to ammunition undergoing development and testing.

3 For further information on accounting, see OSCE (2003).

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16

Small Arms Ammunition Lot Marking

James Bevan and Pablo Dreyfus

Overview

Lot numbers are marks that are applied to ammunition at the point of manufacture, assembly, or modification. They identify a quantity of ammunition that has been assembled from uniform components and under similar conditions. These marks are applied to facilitate accounting and general management of ammunition. Marks may be applied on ammunition components themselves and/or on the packaging of the ammunition.

Small arms ammunition is rarely lot marked on the ammunition itself, such as on the cartridge case. This chapter argues that applying lot marks directly to small arms cartridges offers some security forces the prospect of increased logistical efficiency. In addition, lot marking of small arms ammunition has proved to be an effective way of discouraging and detecting diversion from national stockpiles.

Introduction

Small arms ammunition includes cartridges for small arms and light weapons up to and including 20 mm calibre. Most small arms cartridges are marked (CHAPTER 3) with some or all of the following information: manufacturer, year of manufacture, and calibre. They are rarely marked with lot numbers.

A lot number is a code that is systematically assigned to ammunition lots (or production batches) primarily to designate the chemical compounds—explosives, propellants, and primers—within them (US Navy, 2001, p. 4; USDoD, 1998, p. 3). This information allows stockpile management personnel to monitor projected shelf life and recall batches of defective ammunition.

In the case of small arms ammunition, a code identifying the lot is usually marked on the boxes and packing cases containing the ammunition, rather than on the body of the cartridge. Very few countries apply lot marks directly to the cartridge case. However, the few countries that do arguably have the potential to benefit from improved stockpile management and increased protection from diversion (CHAPTER 15).

Improved stockpile management

In contrast to larger weapon systems, small arms ammunition is deployed to security force personnel for immediate use. In many countries, it is deployed continuously, rather than residing in armouries and other ammunition storage facilities. Deployed ammunition is generally unboxed and stored in the magazines of the security forces in question. Once issued, therefore, it becomes impossible—or at least extremely difficult—to ascertain which lots of ammunition are in circulation with specific units of the security forces.

The best managed security forces do not issue ammunition to personnel unless it is required for immediate use. Best practice is to destroy any ammunition that has been issued and to reissue new stocks when ammunition is again needed. Security forces maintain this practice for two reasons. First, there is always an element of doubt over the reliability of ammunition that has already been deployed, which may have been mistreated or made subject to extreme conditions. Second, it may be difficult to ascertain which lots of ammunition have been issued when multiple lots have been deployed with security forces.

For countries that do not institute the immediate return of deployed ammunition, this poses a problem. Defective lots cannot easily be identified and recalled once issued because they are separated from their lot-marked packaging. In these cases, lot marking of the ammunition itself has the potential to increase military efficiency by enabling identification and recall of specific lots. The impact this could potentially have on combat efficiency and the morale of security forces is obvious. Security force personnel may lose their lives when weapons fail and they lose morale if they suspect that their ammunition is unreliable (CHAPTER 6).

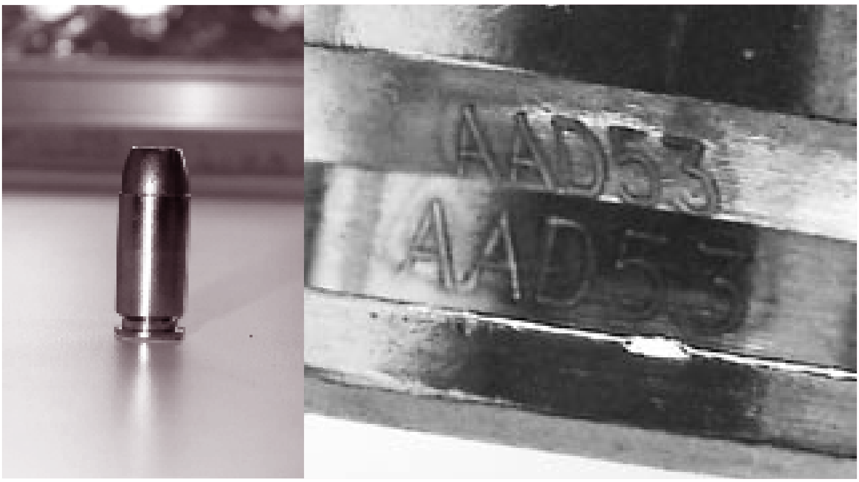
Discouraging and detecting diversion

When used in combination with effective record keeping (CHAPTER 5), lot marking can be used to establish which security force units are in possession of particular lots of ammunition. In cases of diversion (CHAPTER 15), lots found on the illicit market can then be traced back to the security force unit from which they were either lost or stolen (CHAPTER 4).

In Brazil and Colombia, for instance, security force ammunition is produced to requirement in lots of around 10,000–25,000 rounds.[1] While these lots may sound large in size, in relative terms they are small and may comprise only a single shipment destined for one battalion of the security forces (Anders, 2006b; Dreyfus, 2006; Aguirre and Restrepo, 2006). Whether it is lost from the deployed stocks of security forces or stolen from ammunition storage facilities, this lot-marked ammunition can be traced back to specific units of the armed forces or police—even if the ammunition is no longer in its original packaging.

Figure 16.1

Laser lot marking within the extractor groove of a CBC* cartridge



* Companhia Brasileira de Cartuchos.

Source: Civilian Police of the State of Rio de Janeiro, Department of the Technical and Scientific Police

Precisely with this purpose in mind, Austria, Brazil, Colombia, France, and Germany have national regulations that demand all, or certain, security forces use only lot-marked ammunition (Anders, 2006a, p. 212; 2006b). These marks are durable alphanumeric characters that are applied in the final stages of production. They remain intact when the ammunition is used, and are easily visible and legible. The cartridge depicted in Figure 16.1 is illustrative. Manufactured by Companhia Brasileira de Cartuchos, Brazil, it features a laser lot mark with the number AAD53 in two places within the extractor groove. In other cases, manufacturers stamp lot marks on the head of the cartridge.

The national legislation of these lot-marking states specifies that the lot number is unique to a particular client and that information pertaining to the lot can only be released to the client in question. These measures ensure, first, that each lot number can be linked to a specific sale in the manufacturer's records and, second, it can be attributed to the purchaser of the lot (Anders, 2006b). The same alphanumeric lot marks are reproduced on the packaging of lot-marked ammunition.

Progress to date

Only a handful of countries lot mark small arms ammunition, and many states cite expense as reason for not doing so. In the best managed security forces, this additional expenditure may well be deemed superfluous to requirements when measured against the small amount of ammunition that is lost or stolen. For other states in similar positions, the potential loss or misuse of any quantity of ammunition is clearly sufficient to prompt lot marking. This has been the case for countries that, in global terms, have negligible problems with ammunition management.

For the many countries that do face significant challenges related to the management and security of ammunition, the cost of lot marking may be better gauged in relation to expenditure on replacing unusable, lost, or diverted ammunition, or to the cost of combating armed violence. Several countries that experience high levels of armed criminality or insurgency, and have experienced problems with diversion, have clearly decided that this additional expenditure is worthwhile, whether from the perspective of efficiency, public safety, or security.

The effectiveness of lot marking is also a matter of debate. Some commentators note that lot marks—particularly laser marks—are too shallow to prevent concerted attempts by illicit users to erase them. In reality, even existing headstamps can be filed away to leave clean, unmarked cartridges, although analysis of ammunition that already circulates on the illicit markets suggests that most illicit users have neither the time nor inclination to erase marks.

Lot marks that specify particular units of the security forces would arguably pose more of a target for tampering. However, there is some justification for claiming: 1) that illicit practice would probably not be universal, thereby leaving some lot marks intact and indicative of the units from which they were diverted; and 2) that although lots might be erased, the ammunition in question would still display evidence of having been lot marked at one time, thereby narrowing the number of potential sources it might have been diverted from (CHAPTER 4).

Conclusion

Even the best managed security forces lose ammunition through human error and accident. However small these amounts are, they can be diverted to illicit uses. In the most severe cases, diversion threatens both societies and states and can seriously undermine military efficiency.

The question of whether to lot mark small arms ammunition or not is clearly related to how seriously states perceive each of these risks. It is clear that in many countries, national stockpiles are subject to particularly ineffective management. In these cases, lot marking can prove to be of great utility. Where internal controls over ammunition are weak, lot marking can help easily identify where poor control leads to loss and theft.

Lot marking is only as good as the accounting procedures that are used to record lots and their recipients. It can be an important component of stockpile management. But, as with all measures taken to ensure the safety and security of national stockpiles, it works best as part of a comprehensive ammunition management system.

Notes

1 Lots of 10,000–20,000 rounds are very small. Most lots destined for the security forces are in excess of 300,000 rounds.

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17

Stakeholders in Conventional Ammunition Management

Michael Ashkenazi and Holger Anders

Overview

Stockpiling conventional ammunition for national defence and security needs is often considered primarily a matter of concern for security forces. While these forces are certainly prominent stakeholders in the management and control of ammunition stocks, they are not the only ones. A closer look at the issue of ammunition stockpiles shows that the group of stakeholders is much larger than it is often conceived to be, and includes local, regional, and international actors. Any discussion of conventional ammunition stocks should take into account the roles and responsibilities of all relevant stakeholders to ensure that the challenges of responsible stockpile management are addressed comprehensively.

Introduction

The overall responsibility for the management and control of conventional ammunition stockpiles usually lies with the government of the state in which the stockpiles are located. The government's role includes:

- establishing a general stockpile policy and the legislative and regulatory framework for ammunition stockpile controls; and
- ensuring that national legislation is in conformity with relevant multilateral regulations on the safe and secure transport, storage, and destruction of conventional ammunition, including environmental legislation.

In addition, some governments have legal responsibility for ammunition that is stocked abroad for use by their national peacekeeping or occupation forces.

Governments act through ministries, agencies, and commissions, which can often be in competition and therefore fail to coordinate. The formulation of specific regulations on stockpile management is often left to the ministries in charge of national security forces and actors under their authority, such as local defence forces and private security companies. This can lead to the compartmentalization of arms management responsibilities.

Other stakeholders in ammunition stockpiles can be conceived of in terms of three concentric circles that indicate their degree of responsibility for and involvement in stockpile management. The inner circle includes those with direct responsibility for (or direct access to) and regular involvement with large ammunition stockpiles. They include armed security forces and some quasi-state, armed actors. The middle circle is composed of agencies whose stockpiles can be relatively minor or transitory. They include ammunition manufacturers, transporters, dealers, commercial entities, and also some quasi-state actors. The outermost circle is composed largely of the civilian population and government agencies that could be affected by insecure or unsafe stockpiles. International donors also occupy this space, because they have an impact on stockpiles (e.g. by funding security-enhancing or destruction programmes), but are not normally concerned with them on a daily basis. NGOs are involved in various areas of stockpile monitoring, and even ammunition destruction (CHAPTER 9) in some states, and are a vital link between governments and civilian populations.

The inner circle: national security forces

Armed security forces include the military and a range of law enforcement agencies, such as the national police; border guards; prison services; and, in some countries, gendarmerie and wildlife authorities. Some quasi-state actors, such as local defence forces and militias, and private security companies, may also be included in this circle.

Individual security forces are responsible for the day-to-day management of stockpiles and these stockpiles' compliance with national legislation and regulations. This includes responsibility for the related activities of subordinate actors. National security forces may also provide input and technical expertise to inform the development and implementation of national policies on ammunition stockpile management, surplus identification, and disposal.

Another area of responsibility of national security forces includes the safety and security (CHAPTER 7) of the physical surroundings of ammunition stockpiles. This is of particular importance in relation to stockpiles containing ammunition, which can potentially explode, and may require that local authorities enforce strict security distances between the stockpiles and civilian settlements (CHAPTER 18). Security forces and, where relevant, specialized agencies can also be responsible for ensuring the secure and safe transport and destruction of ammunition. This may include compliance with international environmental regulations and regulations on the transport of dangerous goods. A further area of responsibility may include monitoring and verifying the security and safety of ammunition stockpiles.

The middle circle: manufacturers, transporters, dealers, commercial entities, and security users

Manufacturers, dealers, and commercial entities are also relevant stakeholders, because they may hold or transfer conventional ammunition that is not destined for the operational ammunition stocks of the security forces. Many of these actors often stock small arms ammunition only in small quantities. Nevertheless, they come into contact with ammunition stockpiles on a regular basis, and must be considered in issues ranging from transportation to government regulation. Moreover, while small arms ammunition stockpiles may only pose a small risk of explosion, they can pose a high risk of diversion throughout the supply chain.

Manufacturers and other entities along the ammunition supply chain—notably in the civilian sector—require careful attention to both safety (protection against accidental explosion or ignition) and security (ensuring against theft and diversion).

Similarly, stocks under the control of quasi-government agencies such as self-defence militias, and of commercial entities such as private security firms, necessitate regular maintenance and monitoring by competent government agencies.

The outer circle: civilians, government agencies, international donors, and NGOs

While rarely specified in legislation and regulations, state actors have at least a moral responsibility to protect the civilian population and civilian property from the dangers posed by ammunition stockpiles. These risks include:

- accidental or intentional initiation of large masses of ammunition (CHAPTER 13);
- health risks that are caused by environmental pollution from improperly stored ammunition (CHAPTER 11); and
- the diversion of (primarily small arms) ammunition to feed crime or armed conflict (CHAPTER 15).

Civilian communities (CHAPTER 18) that surround major stockpiles have an interest in ensuring that they are protected against the possible deleterious effects of ammunition stocks, and are often concerned about stock safety. These concerns can be aggravated by a lack of adequate information provided by the state actors responsible for the management of the stockpiles. It is the responsibility of state authorities to respond to, and clarify, concerns raised by the civilian population.

Some government agencies are directly involved in the possible consequences of inadequate stockpile management, such as police, fire services, and disaster management units, who will be in the forefront of any response to problems that may arise, such as accidental explosions.

Ammunition stockpile diversion has cross-border dimensions and is the subject of international attention. Donors, and donor-funded assistance programmes, can play a critical role in capacitating national stakeholders to develop adequate national ammunition stockpile and surplus identification policies. Donor assistance can include financial and technical support for the construction of safe and secure storage facilities, training and equipment for responsible management practices, and the financing of safe and secure surplus destruction (CHAPTER 9). Assistance may be provided through subregional organizations that support arms and ammunition controls in member states. Notably, such organizations often have a mandate that covers ammunition related to small arms and light weapons, but not necessarily other categories of conventional ammunition.

Other stakeholders in the outer circle include NGOs that can monitor government policies and their implementation. These groups may provide an important link between governments and civilian populations, and can allay real and perceived fears of the risks and challenges posed by ammunition stockpiles. A number of NGOs also specialize in ammunition destruction in some states, in place of, or supplementing, state-owned destruction facilities. NGOs and other actors who are active in the area of environmental protection may also have a stake, not only in relation to the environmentally friendly storage of ammunition, but also in the cleaning up of the environment in the wake of ammunition destruction.

Progress to date

National stockpiles are no longer an issue of concern to militaries alone. Ammunition depot explosions, diversion from state stockpiles, and environmental hazards have increasingly become objects of public scrutiny and subjects of civil society debate. However, it is clear that, in many countries, national stockpiles remain a national secret. Failings in their management, and the risks they pose to all stakeholders, remain hidden from public scrutiny and are taboo in public debate.

Representative governments arguably have a duty to respond to the needs of all stakeholders in the stockpile management decisions they make. Where unstable stocks threaten to kill or maim local populations, or diverted munitions are used to fuel crime and insurgency, it is clear that the circle of stakeholders extends well beyond the traditional orbit of state security forces—a fact that requires continued attention in national policy-making and international processes (CHAPTER 1).

Conclusion

Conventional ammunition is not solely an issue for national security forces. A wide range of actors have a stake in ammunition issues, including: its safe and secure storage; the responsible management of stockpiles; identifying surpluses; and the destruction of surplus stocks. The group of relevant stakeholders is considerably larger than often conceived, especially when considering their potential to be affected by accidental explosion or the misuse of diverted ammunition. International efforts to consider possible steps to address the challenges posed by insecure and unsafe ammunition stockpiles should acknowledge the multiplicity of relevant stakeholders and their various roles.

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18

Ammunition Stockpiles and Communities

Michael Ashkenazi

Overview

Ammunition stockpiles present a dilemma to the communities that live in close proximity to them, as well as to national stockpile managers. Both interest groups 'compete' for open spaces near transportation nexuses. As a result, the security of stockpiles and the safety of communities can be at risk. Communities are dynamic entities that often grow and expand into spaces that have previously been designated as safety zones. In the event of ammunition explosion or contamination, this kind of encroachment can result in civilian casualties. Stockpiles can also be problematic because they attract members of the local community for the wrong reasons. They may provide an interesting space, or a source of interesting objects, for playing children. Other members of the community may view them as a potential source of stolen items for resale.

But stockpiles also positively benefit communities by providing employment and broader benefits to local service industries. As a result, there are often extensive linkages between stockpiles and communities, and this results in there being multiple stakeholders in their management. Stockpile authorities therefore have the responsibility to engage communities, and assist them in making provisions to ensure the safety and security of personnel and materiel, to the benefit of both parties.

Communities next to stockpiles: static and dynamic views of the population

Security force planners tend to make decisions on the location of ammunition stockpiles based on three sometimes contradictory factors. Stockpiles are normally positioned:

1. in wide open spaces to ensure security and minimize the impact of potential explosions;
2. close to transportation nexuses to ensure ease of access; and
3. close to the security forces that use them to ensure uninterrupted supply (CHAPTER 8).

A fourth consideration applies to countries that rely on local paramilitary forces as part of their military doctrine:

4. There is wide dispersal of stockpiles so that they are accessible to local militias, defence units, and other paramilitary groups.

Various permutations of the four factors quite often dictate that major stockpiles are located close to communities—since communities are themselves often positioned close to communication nexuses—and that smaller stockpiles are deliberately placed close to population centres in order to quickly supply the security forces that reside there.

Moreover, populations are dynamic, and this also encourages the proximity of stockpiles and communities. A relatively isolated area chosen for the site of a stockpile can, 20 years later, become home to a large community. In many such cases, this means that the community surrounds and often encroaches on the stockpile and the safety zone around it.

In such cases, the stockpile often becomes integral to the lives of the people living around it, in both positive and negative ways. From the negative perspective, communities are sometimes oblivious of the dangers represented by such stockpiles. The stockpile may even represent an attractive nuisance, because children often consider fences and 'Keep Out' signs to be a challenge rather than a barrier. On the positive side, the stockpile can generate wealth for communities, either as a source of legitimate income (employment, services to stockpile personnel) or illegitimate income (theft of brass casings, explosives, or other items).

Awareness

Populations that are aware—of the dangers represented by stockpiles, of security issues, and of the importance of stockpiles for national security—are a mixed blessing to policy-makers and stockpile agencies alike. On the one hand, aware populations can draw attention to weaknesses in safety and security, with positive benefits for efficiency and cost-effectiveness. On the other hand, however, local populations can also complain (justifiably or not) about the presence of a stockpile, or about storage practices that may constitute an embarrassment to national authorities. Communities may also protest against the removal of a stockpile if it is viewed primarily as a source of employment or income.

Population growth, particularly in post-conflict societies, tends to lead to all of these issues becoming prominent.

Safety of the population

Even given very high standards of safety, ammunition poses a risk to communities. Explosions at ammunition facilities occur regularly (SEESAC, 2007) (CHAPTER 13), and people that live in close proximity to stockpiles are notoriously vulnerable to such incidents, for at least two reasons:

- *Sheer proximity to events:* Communities that reside close to stockpiles are more likely to be affected by accidents than others.
- *Curiosity:* People are often drawn to the site of an accident or fire, and thus may put their own safety at risk.

Dealing with community concerns

Ensuring the safety and security of communities that reside near ammunition facilities is a primary concern. Finding a balance between providing non-confrontational security and enforcing rules and procedures without compromise is made easier if there is a dialogue with the communities in question. Critically, safety and security measures must be seen to work by the communities they are intended to protect, and this is facilitated by education and media strategies.

Community education

Educating the community on the nature and risks of a stockpile has two major benefits. First, it may reduce the number of incidents involving the intrusion of civilians (adults and children) into risky areas. A regular schedule of school or community-related talks by stockpile personnel can help educate communities about the risks of illegal entry, handling munitions, or tampering with security measures.

A second potential benefit of the increased interaction offered by education programmes is that communities can augment the security and safety of stockpiles. By virtue of their proximity, communities are often in a position to alert stockpile personnel of breaches in security (e.g. a broken fence or a case of illegal entry). From the perspective of safety, educated communities are more likely to know what to do (and what not to do) in the event of an accident—for example, taking appropriate cover in the event of an explosion or avoiding visiting the site.

Community education can take place through schools, community associations and clubs, religious institutions, and similar organizations. It is important that those responsible for the stockpile:

- engage in planned and sustained communication with the surrounding community; and
- accept that the community may have legitimate grievances about the stockpile as a potential or actual hazard, and that community complaints must be addressed and dealt with promptly.

Information and the media

The media can also provide a further channel through which stockpile management authorities can better educate communities on stockpiles. Although security concerns often mean that stockpiles and their contents must be kept secret, the ability to communicate with the media—and with the public through the media—can become critically important in case of an accident.

Communities and ecological considerations

Stockpiles can present both an ecological hazard and an ecological benefit to communities.

On the one hand, the presence of explosive/incendiary materials (and toxic chemicals seeping from deteriorating ammunition) can cause major ecological problems that can affect the health of wildlife and, notably, livestock. Toxic chemicals can also seep into the water table, causing serious problems for communities' drinking water.

On the other hand, largely unused, well-enclosed tracts of land that constitute a stockpile area and its safety zone represent potential wildlife sanctuaries and refuges that offer indirect benefits to communities.

However, because such empty areas can attract exploitation, e.g. as a source of food or grazing (notably for the poor), it is important to ensure that stockpile management and community leaders agree on their use. This may include allowing controlled entry (e.g. during certain hours in certain areas) for recreational or subsistence purposes, with the proviso that public safety remains the primary consideration.

Progress to date

While best-practice guides on stockpile management are currently being developed to include ever more detailed criteria,[1] there is little to provide for the issue of stockpile–community relations. These measures are often left to the initiative of local managers and community leaders. Recent major ammunition stockpile catastrophes, such as the 2007 Malhazine case in Mozambique (Wilkinson, 2007), demonstrate that much more progress needs to be made to ensure the safety and security of communities and stockpiles alike.

Conclusion

The tension between the security forces' need to centralize ammunition stocks and the growth of communities can, and has, led to accidents and deaths. If the relationship between communities and ammunition stockpiles is not to become a source of aggravation, certain principles need to be observed carefully and known to both sides. First, stockpile owners need to recognize that communities are dynamic entities, and periodic re-evaluation of ammunition dumps is needed to ensure that safety is maintained. Second, safety rules should never be compromised, safety zones must be enforced without exception, and access routes must be kept clear. Third, stockpile managers must take the lead in ensuring that potential dangers are well known to the populace, and that the relevant emergency procedures are put in place and practised in case of emergency.

Whatever the expense, improving the relationship between stockpile ownership and management, on the one hand, and community interests, on the other, is critical for ensuring that communities are protected to the highest degree possible from the effects of living near an ammunition stockpile.

Notes

1 See, for instance, the Organization for Security and Co-operation in Europe's forthcoming best practice guide, sections of which exist in draft form (OSCE, 2003, sec. VII, para. 38).

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