Bosnia and Herzegovina

THREAT RESOLUTION LIMITED

BOSNIA AND HERZEGOVINA SMALL ARMS AND LIGHT WEAPONS AMMUNITION DEMILITARIZATION FEASIBILITY STUDY

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Organisations

Centre for Security Studies
GOF Unis – Pretis
GOF P.S. Vitezit
GOF Binas d.d.
SFOR - MND (SW) JMA
JMA MNB North
MNTF JMA cell NW
JMA MNB SE
MNB SE
UXB International (Sarajevo)

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EXECUTIVE SUMMARY

1 INTRODUCTION

1.1 The South Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons (SEESAC) has identified that BiH is facing "a potentially significant threat to human life due to the storage conditions and the physical condition of their ammunition stockpile". SEESAC judge that a co-ordinated international effort to establish a safe and effective Logistic Ammunition Disposal system is necessary to mitigate the hazard and associated risks.

1.2 There are 38 major ammunition storage sites under control of the Entity Armed Forces (EAF) in BiH, which they intend to reduce to only six to meet planning requirements recently published by the Office of the High Representative (OHR). SEESAC asserts that "little technical ammunition advice was taken to support this decision and no formal risk analysis was conducted", concluding that it is "probably unachievable logistically, and that there would certainly be major explosive safety concerns should any large-scale physical movement of ammunition take place".

1.3 The Stabilisation Force (SFOR) estimates the total ammunition stock levels are in the region of 67,000 tonnes All Up Weight (AUW), of which at least 50% has already been identified as requiring disposal. This figure is almost certainly likely to rise within the next three years as the BiH Armed Forces reorganise. Due to its age the remainder of the stockpile could require destruction over the next ten years. An immediate cause for concern is the chemical stability of the mortar and gun propellant in storage.

1.4 The Feasibility Study is sponsored by the UNDP BiH SALW Reduction Project (SARP), which has a demilitarization capacity building component included in its project document.

2 AIM

2.1 The aim if the Feasibility Study is to examine the detailed practicality, humanitarian, environmental, technical, security, financial and political requirements for the establishment of an Ammunition Disposal Facility (ADF) in BiH in order to provide the necessary information for potential international donor investment in the project.

3 THE STUDY

3.1 The Threat Resolution Ltd (TRLtd) Study Team possessed the significant advantage of extensive knowledge and experience of a recent project in Albania, which has substantial synergy with the situation in BiH.

3.2 Despite persistent efforts by the Study Team and UNDP staff in Sarajevo neither the EAF nor SFOR were able to provide lists of the ammunition already identified for disposal, or indeed the full stockpile. Therefore, the Study Team was unable to clearly identify the full range and quantities of ammunition natures involved, but nonetheless obtained sufficient data from which to formulate a strategic plan to resolve this challenge.

3.3 Members of the Study Team made two field trips to BiH, the first of which was to conduct a technical assessment of existing ammunition storage facilities. During the second potential sites for demilitarization, at Government Ordnance Factories (GOF) in Vitez, Bugojno and Vosgoca were visited to assess their suitability for the future construction and operation of an Ammunition Disposal Facility (ADF).

4 CONCLUSIONS

The study team's conclusions are summarised below:

4.1 Humanitarian

4.1.1 The EAF ammunition stockpile presents a genuine and current threat to the civilian population living nearby for the following reasons:

- The age and inappropriate storage conditions of the ammunition.
- The critical nature of safety infringements.
- The lack of inspections to verify the condition of ammunition or a surveillance system to establish the chemical stability of propellants.
- The excessive Net Explosive Quantities (NEQ) of the ammunition held in the ESH.

4.1.2 The OHR action plan, to consolidate the ammunition stockpile in only six sites, is unworkable, since it will significantly increase the already excessive Net Explosive Content (NEC) of these sites and therefore increase risks.

4.1.3 The chemical analysis facility in Vitez is not capable of undertaking the significant number of analyses likely to be needed to bring the surveillance of propellant stability up to date. The facility requires refurbishment and investment in new equipment.

4.1.4 Although the ADF project will initially require the employment of international technical managers this reliance will diminish as the competence and experience of local staff is enhanced. The project will offer sustainable employment opportunities for BIH citizens.

4.2 Environmental

4.2.1 Whilst necessary as emergency measure current demilitarization techniques, especially Open Burning and Open Demolition (OBOD) of certain ammunition natures, present a significant environmental threat. Although there will be a continued requirement for OBOD to destroy unstable ammunition, its long-term use can only be applied to specific munition types. Evidence has been presented to demonstrate the considerable opposition shown by the civilian population in specific areas to these methods of demilitarization.

4.2.2 Proven environmentally benign demilitarization technology that meets the requirements of applicable EU Legislation is commercially available. Its introduction in BiH would dramatically decrease the environmental impact currently experienced.

4.3 Technical

4.3.1 The Study Team found that the physical condition of the BiH ammunition is generally visually acceptable but that poor storage conditions are contributing to rapid deterioration. Of most significant concern was is the lack of basic safety measures in storage, in direct contravention of applicable NATO regulations, issued in the Instructions to Parties (ITP) as part of the 1995 General Framework Agreement for Peace. The resultant hazard is significantly exacerbated by the presence of a considerable amount of ammunition, which is not properly packaged, and further stocks that are stored in the open, between storehouses.

4.3.2 The Study Team was unanimous in the conclusion that the GOF at Unis Pretis was the most appropriate site for development as an ADF.

4.3.3 A phased approach to the building of an indigenous Ammunition Disposal Facility (ADF) is proposed using the principle of technical ease commensurate with highest risk, which allows considerable stocks of surplus ammunition to be quickly destroyed and reducing the significant hazard caused by overstocked ammunition storage facilities. Furthermore, a phased approach offers greater project visibility and is more likely to attract donor interest.

4.3.4 The team compared the cost and performance of different technologies available but advises that the most appropriate technology for BiH is an Explosive Waste Incinerator (EWI) and appropriate pre-processing equipment.

4.3.5 An outline of the proposed development of an ADF is follows:

- **Phase A** – An incineration facility designed to dispose of unstable and obsolete ammunition.
- **Phase B** – Upgrading the Phase A facility to include the salvage of TNT explosive from large calibre shell. Alternatively, the Project Execution Agency may consider exporting of this element of the stockpile to the European demilitarization industry,
- **Phase C** – Viability to be confirmed by Project Executing Agency. Possible further enhancements of the existing facilities to process more complex munitions and compete in the European marketplace.

4.3.6 The team has identified that there may be difficulties in logistic support for the proposed ADF since the EAF in BiH appear not to currently possess the resources needed to support a major demilitarization operation. Some vehicle and mechanical handling equipment enhancements may, therefore, be necessary. Additional training in procedures and applicable regulations will be necessary to mitigate risks in the movement of the ammunition stockpile.

4.4 Financial

4.4.1 The Study Team concludes that the approximate cost of the project to destroy 33,500 tonnes of surplus munitions would be approximately US$20m over a period of up to 6.5 to 7 years. The cost per tonne is approximately US$ 570 based on the assumption of an amortisable life of 7 years[1]. When the revenue generated from sale of recovered metals is taken into consideration, this cost may be reduced by up to 13% to US$ 527 per tonne. A detailed financial summary is at Annex A.

4.5 Security

4.5.1 Overall security precautions at the weapons and ammunition storage sites are inadequate. The Study Team have made general recommendations to bring the facilities up to a minimal standard.

4.5.2 Security arrangements at the working GOFs (potential demilitarization facilities) is considerably better and appropriate for demilitarization work.

4.6 Training

4.6.1 There was little evidence that the EAF is complying with regulatory requirements regarding training levels for those undertaking ammunition duties, which are laid

[1] This figure includes capital expenditure of the EWI and pre-processing equipment.

down in Chapter 13 of the ITP, specifically "*only those individuals with sufficient technical training and experience should be employed within ammunition related appointments*".

4.6.2 Urgent training is required to improve the safety of ammunition in storage at all EAF locations and eliminate the critical safety infringements identified during a technical assessment of ammunition storage sites.

4.6.3 It is improbable that the EAF will succeed in meeting the December 2004 deadline of the Compliance Schedule specified in Annex H to Chapter 13 of the ITP, which requires the presentation of a strategy to develop Ammunition and Explosives Specialist Training.

5 KEY RECOMMENDATIONS

5.1 The Study Team makes the following recommendations in order of priority:

5.1.1 The introduction and maintenance of an effective ammunition surveillance system, to identify threats from potentially unstable ammunition including propellants.

5.1.2 The facility at Vitez is upgraded to conduct propellant testing of the EAF stockpile. This is necessary to reduce the possibility of an unplanned explosive event, prioritise ammunition stock for disposal and to continue to monitor propellant stability in the residual operational stockpile.

5.1.3 A short-term ammunition management-training course for EAF personnel is conducted at the earliest opportunity. In the interest of expediency, it is recommended that UNDP/SFOR endeavour to arrange direct bilateral support for the training aspect, rather than inclusion in the proposed ADF project.

5.1.4 Weapon and ammunition storage site security is enhanced to provide a basic level of effective security.

5.1.5 A 100% technical audit of the weapons and ammunition stockpile is undertaken by a competent, external organisation and the data is captured in an electronic database.

5.1.6 Urgent action is taken to remove anti-personnel mines from the perimeters of ammunition storage sites and Government Ordnance Factories in order to improve human safety and comply with the terms of the Mine Ban Treaty which BiH signed on 3 December 1997 and ratified on 8 September 1998.

5.1.7 An ADF, capable of handling large quantities of ammunition[2], is constructed to destroy the estimated 33,500 tonnes of ammunition currently earmarked for disposal. The Study Team recommends that the proposed ADF is operated within the existing GOF at Unis Pretis.

5.1.8 The introduction of long-term training of ammunition specialists at a suitable NATO military or commercial training establishment is introduced to develop a core of experienced ammunition specialists within the EAF.

5.1.9 That the appointed Executing Agency capacity build the BiH GOFs already undertaking demilitarization work with a view to attaining compliance with EU legislation.

5.1.10 EU environmental legislation relating to emission levels is used as the basis for any Invitations to Tender (ITT) for the emission control system for the proposed EWI.

[2] Up to 5,000 tonnes all-up weight per annum.

5.1.11 A full Environmental Impact Assessment (EIA) on the proposed technical solution is conducted prior to project implementation.

6. SUMMARY

6.1 The Study Teams confirms the concerns of SEESAC and the requirement to demilitarize up to 33,500 tonnes of ammunition in BiH. The existence of this ammunition poses a significant threat to human security.

6.2 Suitable conditions prevail in BiH for the development of an indigenous industrial based ADF and that existing, proven technology can be effectively operated under current political conditions.

6.3 The cost of the project is very favourable compared with demilitarization at commercial facilities in Europe and has the added advantage of offering suitable employment to the local populace.

ANNEX A TO
EXECUTIVE SUMMARY

FINANCIAL SUMMARY

Item	Cost US$				
	Year 1	Year 2	Year 3	Year 4-7	*Totals*
Capital Equipment					
Installation of EWI	2,680,000	0	0	0	***2,680,000***
Pre-processing equipment	422,800	0	0	0	***422,800***
Sub total	*3,102,800*	*0*	*0*	*0*	***3,102,800***
In Country Project Management					
Supervisory Team	474,000	412,800	220,800	883,200	***1,990,800***
Sub total	*474,000*	*412,800*	*220,800*	*883,200*	***1,990,800***
Propellant testing					
Capital equipment	65,000	0	0	0	***65,000***
Running costs	18,000	18,000	18,000	72,000	***126,000***
Sub total	*83,000*	*18,000*	*18,000*	*72,000*	***191,000***
ADF Operation					
EWI Running costs	0	355,680	711,360	2,845,440	***3,912,480***
Pre-preparation costs	0	231,192	462,384	1,849,536	***2,543,112***
Other ADF Overheads	0	320,112	640,224	2,560,896	***3,521,232***
Sub total	*0*	*906,984*	*1,813,968*	*7,255,872*	***9,976,824***
Totals	***3,659,800***	***1,337,784***	***2,052,768***	***8,211,072***	***15,261,424***
Project Overheads					
Executing Agency costs at 14%	512,372	187,290	287,388	1,149,550	***2,136,599***
Total Budget	**4,172,172**	**1,525,074**	**2,340,156**	**9,360,622**	***17,398,023***
Contingency at 15%	625,826	228,761	351,023	1,404,093	***2,609,704***
Grand Totals	**4,797,998**	**1,753,835**	**2,691,179**	**10,764,715**	**20,007,727**

GLOSSARY OF TERMS AND ABBREVIATIONS

A/C	Aircraft
ACA	Ammonical Copper Arsenate - A toxic chemical historically used to preserve wooden ammunition packages
ADF	Ammunition Demilitarization Facility
AEA	Atomic Energy Authority (UK)
AFAM	Armed Forces Ammunition Manager
AFBiH	Armed Forces of Bonsia and Herzegovina
ANFO	Ammonium Nitrate and Fuel Oil – A common mining explosive
AP	Armour Piercing
APCS	Air Pollution Control System
APE	Ammunition Peculiar Equipment
APM	Anti Personnel Mines
AP-T	Armour Piercing Tracer
ASA	Ammunition Storage Area
ASS	Ammunition Storage Site
A/Tk	Anti Tank
ATO	Ammunition Technical Officer
Autoclave	Equipment for the removal of high explosive from ammunition by the injection of steam
AUW	All Up Weight
BHMAC	Bosnia and Herzegovina Mine Action Centre
BiH	Bosnia and Herzegovina
CCA	Chromated Copper Arsenate - A toxic chemical historically used to preserve wooden ammunition packages
CCTV	Closed Circuit Television
CG	Compatibility Group
CMD	Conventional Munitions Disposal – The detection, identification, field evaluation, rendering safe, recovery and final disposal of unexploded ordnance (except improvised explosive devices, biological, chemical and nuclear weapons) which has become hazardous by damage or deterioration.
CO^2	Carbon Dioxide
COMSFOR	Commander of the Stabilisation Force
COTS	Commercial Off-The-Shelf
CSS	Centre for Security Studies (Sarajevo)
CWP	Contaminated Waste Processor (Car-bottom furnace)
DERA	Defence Evaluation and Research Agency (UK)
DOD	Department of Defense (USA)
EAF	Entity Armed Forces
ECA	Explosion Consequence Analysis
EEI	Eldorado Engineering Incorporated
EIA	Environmental Impact Assessment
ELL	Explosive Limit License
EOD	Explosive Ordnance Disposal **-** The detection, identification, evaluation and final disposal of unexploded explosive ordnance. It may also include the rendering safe and/or disposal of such explosive ordnance which have become hazardous by damage or deterioration when the disposal of such explosive ordnance is beyond the capabilities of personnel normally assigned the responsibility for routine disposal
EPA	Environmental Protection Agency (USA)
ES	Exposed Site – Any building, structure, facility or place of assembly that is hazarded by a Potential Explosion Site (PES)

ESH	Explosive Store House
EU	European Union
EWI	Explosive Waste Incinerator
FFE	Free From Explosives
GFAP	General Framework Agreement for Peace – signed in Paris in 1995
GOF	Government Ordnance Factory
HD	Hazard Division
HDZ	Croatian Democratic Union
HE	High Explosive
HEAT	High Explosive AntiTank
HEI	High Explosive Incendiary
HEI-T	High Explosive Incendiary Tracer
HGV	Heavy Goods Vehicle
HQ	Headquarters
HVO	Croatian Defence Council
IED	Improvised Explosive Device
IEDD	Improvised Explosive Device Disposal
IT	Information Technology
ITP	Instructions To Parties – Introduced in 1995 to implement military aspects of the GFAP
ITT	Invitation To Tender
IQD	The distance from a PES to an ES (other magazines and process buildings) inside ammunition storage or processing facility
JMA	Joint Military Affairs (SFOR led)
JNA (or VJ)	Yugoslav National Army
KM	Konvertible Marka – Currency in BiH
LSU	Logistic Support Unit
MANPADS	Man portable Air Defence Systems – See also SAM
MHE	Mechanical Handling Equipment
MIP	Mission Implementation Plan
MNTF	Multi National Task Force (SFOR Led)
MoD	Ministry of Defence
MoFTER	Ministry of Foreign Trade and Economic Relations (BiH)
NATO	North Atlantic Treaty Organisation
NAMSA	NATO Maintenance and Supply Agency
NEC	Net Explosive Content
NEQ	Net Explosive Quantity
NEW	Net Explosive Weight (USA)
NGO	Non-Governmental Organisation
NHI	New Croat Initiative
NOx	Nitrous Oxides
OBOD	Open Burning and Open Demolition – Demilitarization techniques
OEW	Ordnance and Explosive Waste
OHR	Office of the High Representative – responsible for implementing civil aspects of the 1995 Dayton Peace agreement
OQD	Outside Quantity Distance – The distance from a PES inside an ammunition storage or processing facility to an ES outside the perimeter (Inhabited buildings, vulnerable buildings and public traffic routes)
OSCE	Organisation for Security and Co-operation in Europe
PATO	Principal Ammunition Technical Officer (UK)
PCP	Pentachlorophenal – A toxic chemical historically used to preserve wooden ammunition packages
PCS	Pollution Control System

PEP	Propellant, Explosives and Pyrotechnics
PES	Potential Explosion Site – Any building or site that contains, or is intended to contain ammunition
PfP	Partnership for Peace – NATO programme
PIC	Peace Implementation Council
PiP	Project implementation Phase
PM	Project Manager
PST	Project Supervisory Team
QA	Quality Assurance
QC	Quality Control
QD	Quantity Distance – The distance from a PES to an ES which is used to calculate the amount of ammunition which can be stored in a particular building.
QRF	Quick Reaction Force
RDX	Research Developed Explosive – Cyclotrimethylenetrinitramine, a high explosive commonly used in military ammunition
Retort	The cylindrical sections of a rotary kiln furnace
RPG	Rocket Propelled Grenade
SAA	Small Arms Ammunition – munitions equal to or les than 12.7mm calibre.
SAM	Surface to Air Missile
SAP	Small Arms and Light Weapons Reduction Project – A UNDP sponsored project in BiH
SCC	Secondary Combustion Chamber
SDP	Social Democratic Party
SEESAC	South Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons
SFOR	Stabilisation Force – A NATO led multinational military force
SFRY	Socialist Federal Republic of Yugoslavia
SNSD	Alliance of Independent Social Democrats
SOP	Standard Operating Procedure
SPRS	Socialist Party of the Republica Srpska
SPSEE	Stability Pact for South East Europe
TNA	Training Needs Analysis
TNT	Trinitrotoluene – A high explosive commonly used in military ammunition
TOR	Terms of Reference
UK	United Kingdom
ULC	Unit Load Container – A method of bulk packing for ease of transportation and storage
UN	United Nations
UNDP	United Nations Development Programme
UNHCR	United Nations High Commissioner for Refugees
USA	United States of America
UXO	Unexploded Ordnance – Explosive ordnance which has been primed, fuzed, 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 reason
VAT	Value Added Tax
VBIED	Vehicle Borne Improvised Explosive Device
VF	Federation Army
VOC	Volatile Organic Compounds

VRS	Army of the Republika Srpska
WP	White Phosphorous

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Chapter 1
INTRODUCTION

CHAPTER 1 - INTRODUCTION

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INTRODUCTION

1. BACKGROUND

1.1 The South Eastern Europe Small Arms and Light Weapons (SALW) Monitor[1], published by the South Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons (SEESAC) describes the recent history of Bosnia and Herzegovina (BiH) as follows:

"Previously a key country in the former socialist Federal Republic of Yugoslavia (SFRY) defence complex, Bosnia and Herzegovina produced a substantial amount of military equipment, including the bulk of Yugoslav-manufactured SALW.[2] When war broke out in 1992, thousands were killed by small arms as BiH society split into different factions contesting the secession of the country from the federal republic. Domestic arms production and holding facilities were a source of supply during the fighting and additional weapons were smuggled into the country from neighbouring countries and further afield in spite of a UN embargo;[3] the then Yugoslav state army, the JNA or VJ, and territorial defence also distributed substantial amounts of weapons to local militias."[4]

1.2 SEESAC has a mandate from the United Nations Development Programme (UNDP) and the Stability Pact for South East Europe (SPSEE) to provide assistance and support to the partner nations within South Eastern Europe (SEE) on SALW destruction issues. Under that mandate they are responsible, in line with their operational objectives, for the identification of knowledge gaps and assistance in the design, and implementation where necessary, of projects to meet specific needs for the destruction of weapons and ammunition in the region.

1.3 As a result of recent meetings of the national SALW coordination committee, combined with a brief analysis of the major SALW problems within Bosnia and Herzegovina, SEESAC has concluded that[5]:

- "It is apparent that the management of SALW, (particularly the related ammunition), is an area that has not received sufficient attention from the international community".
- "The recent decision by the Office of the High Representative (OHR) to reduce ammunition storage areas within BiH from forty-eight to eight is probably unachievable logistically, and that there would certainly be major explosive safety concerns should any large-scale physical movement of ammunition take place".

[1] South East Europe SALW Monitor, p35.
[2] "Development Denied", Small Arms Survey 2003, OUP, 2003, p43.
[3] BICC Survey 2002, p131.
[4] "The links between Belgrade and the Serbian paramilitary forces were so substantial that the republic's forces were considered to be a "branch of the Yugoslav Army", with officers holding dual rank in both military formations and salaries being paid from clandestine Yugoslav sources", Ibid
[5] See Terms of Reference at Annex A.

- "BiH is facing a potentially significant threat to human life due to the storage conditions and the physical condition of their ammunition stockpile. It has been assessed by SEESAC and the NATO Stabilisation Force (SFOR) Ammunition Technical Officer (ATO) that the only realistic solution to this problem is a co-ordinated international effort to establish a safe and effective Logistic Ammunition Disposal System".

- The Establishment of an Ammunition Demilitarization Facility(s) in BiH is the only practical, safe and financially viable alternative for the mid and long term, whilst open burning and open detonation techniques may provide a solution to the short term destruction of ammunition with chemical stability problems.

1.4 Between the publication of the UNDP Request for Proposal on 3 March 2004 and the award of contract on 21 April 2004 estimates of the Entity Armed Forces (EAF) stockpile, provided for use in the Study, decreased by more than 50%.[6] Verification of the latest figures was sought by TRLtd and on 7 August 2004 the SFOR ATO confirmed the latest stockpile estimate to be 67,000 tonnes in 38 storage sites, of which 33,500 tonnes is for disposal. However, despite many requests to date, the Study Team has been unable to clearly identify the full range and quantities of ammunition natures involved. Nonetheless, they obtained sufficient data from which to formulate a strategic plan to resolve this challenge.

1.5 The Feasibility Study is sponsored by the UNDP BiH SALW Reduction Project (SARP), which has a demilitarization capacity building component included in its project document.

2. AIM OF FEASIBILITY STUDY

2.1 The aim of the Feasibility Study is to examine the detailed practicality, humanitarian, environmental, technical, security, financial and political requirements for the establishment of an Ammunition Disposal Facility (ADF) in BiH in order to provide the necessary information for potential international donor investment in the project.

3. TERMS OF REFERENCE

3.1 The UNDP and SEESAC agreed Terms Of Reference (TOR) for the Feasibility Study are at Annex A.

4. METHODOLOGY

4.1 The detailed requirements for the deliverables and outcome were extracted from the TOR. The requirements were analysed and detailed tasks were allocated to the relevant consultants.

4.2 The methodology matrix, summarising the detailed tasks undertaken by the Feasibility Study team is at Annex B.

[6] See paragraph 5 of Annex A – Terms of Reference and footnote 11.

5. SYNERGY WITH THE ALBANIA SITUATION

5.1 There is a great deal of synergy between the situations in Albania and Bosnia and Herzegovina involving the challenge of removal and destruction of surplus weapons and ammunition. Personnel from TRLtd and Eldorado Engineering Incorporated (EEI) have been heavily involved in the Albania situation and have drawn on experience gained in the development and execution of weapons and ammunition demilitarization projects there.

Annexes:

A. SALW Ammunition Demilitarisation Feasibility Study BIH Technical Consultancy Team Terms of Reference.

B. Methodology Matrix.

ANNEX A
TO CHAPTER 1

SALW AMMUNITION DEMILITARISATION FEASIBILITY STUDY
BOSNIA AND HERZEGOVINA
TECHNICAL CONSULTANCY TEAM – TERMS OF REFERENCE[7]

BACKGROUND

1. SEESAC has a mandate to provide assistance and support to the partner nations within South Eastern Europe (SEE) on SALW[8] destruction issues. Under that mandate they are responsible, in line with their operational objectives, for the identification of knowledge gaps and assistance in the design, and implementation where necessary, of projects to meet specific needs for the destruction of weapons and ammunition in the region. Therefore SEESAC has agreed to partially fund (50%) of the costs of a weapons and ammunition demilitarization feasibility study, to be conducted through the UNDP Bosnia and Herzegovina (BiH) SALW Reduction project (SAP), (which has demilitarization capacity building component included in its project document).

2. As a result of recent meetings of the national SALW coordination committee, combined with a brief analysis of the major SALW problems within Bosnia and Herzegovina, it is apparent that the management of SALW, (particularly the related ammunition), is an area that has not received sufficient attention from the international community.

3. A recent decision of the Office of the High Representative (OHR) requires the entities to decide future force structures by the end of 2003, with a concurrent reduction of the ammunition storage areas from forty-eight to eight. Little technical ammunition advice was obtained to support this decision, and no formal risk analysis was conducted. It is the technical opinion of SEESAC that this decision is probably unachievable logistically, and that there would certainly be major explosive safety concerns should any large-scale physical movement of ammunition take place.

4. BiH is facing a potentially significant threat to human life due to the storage conditions and the physical condition of their ammunition stockpile. It has been assessed by SEESAC and the NATO SFOR ATO that the only realistic solution to this problem is a co-ordinated international effort to establish a safe and effective Logistic Ammunition Disposal system.

5. In Bosnia and Herzegovina there are 47 major ammunition storage sites under control of the Entity Armed Forces (EAF).[9] The total stock levels are in the region of 137,760 tonnes All Up Weight (AUW)[10], of which 34,000 tonnes[11] has already been identified as requiring disposal. This figure is almost certainly likely to rise within the next three years as the BiH Armed Forces (AFBiH) reorganise. Due to its age the remainder of the stockpile could require destruction over the next ten

[7] Terms of Reference provided by the UNDP on 22 April 2004.
[8] SALW includes weapons and ammunition by definition.
[9] 20 VRS and 24 VF.
[10] VRS = 66,470 tonnes, VF(B) Bosnian = 25,200 tonnes and VF (H) Croat = 46,090 tonnes.
[11] Updated figure from ATO HQ SFOR suggest that the stock figure is now nearer 67,000 tonnes. No information as to the apparent discrepancy has been received from SFOR.

years. An immediate cause for concern is the chemical stability of the mortar and gun propellant in storage. Further advisory information is at Annex A.

6. It has been suggested that the establishment of an Ammunition Demilitarization Facility(s) in BiH is the only practical, safe and financially viable alternative for the mid and long term, whilst open burning and open detonation techniques may provide a solution to the short term destruction of ammunition with chemical stability problems.

PROJECT DELIVERABLES

7. A high quality consultancy report, covering in detail all of the relevant factors, to be used as the base document for future donor investment in the establishment of an Ammunition Demilitarization Facility in BiH, and to identify appropriate weapons destruction capacities. Recognised leading experts in their area must compile the report in order to give it the credibility necessary to attract international donor interest. The following areas must be covered.

7.1 Humanitarian

- The humanitarian effects of any unplanned explosive events in the current BiH ammunition storage environment. This should take the form of a Consequence Analysis of an accidental explosive event at an above ground Explosive Storehouse.

- Identify employment opportunities for BiH citizens during the design, development, construction and operation of the proposed facility.

7.2 Environmental

- The environmental impact of the establishment of a Demilitarization Facility, (the Facility).

- Recommendations as to the use of environmentally benign demilitarisation techniques compliant with European Community environmental directives.

7.3 Technical

- Assess the overall condition of the BiH ammunition stockpile.

- Quantify the immediate, short term and long term demilitarization requirements.

- Identify the potential technology for an environmentally benign Facility.

- Identify explosive safety factors for the development of a Facility and make recommendations.

- Develop process flows for the demilitarization and the scrap/salvage processes.

- Identify the explosive hazards in storage at, and transportation to the Facility and make recommendations.
- Identify the engineering dimensions of the project together with specific requirements.
- Determine the project engineering phases of the development process and evaluate the relationships with other components of the project.
- Identify technical legal requirements.
- Identify appropriate capabilities for the destruction of weapons.

7.3 Security

- Examine the security factors for the weapons and ammunition storage at, and movement to the proposed Facility(s).
- Make recommendations for the physical security of the weapons and ammunition storage at the proposed Facility(s).

7.4 Financial

- Develop a financial model for the proposed Facility(s).
- Quantify the projects key fixed costs including equipment and appropriate building and infrastructure renovations.
- Estimate operating costs taking into consideration local labour market conditions and expatriate staff requirements.
- Compare the different legal structures available for the management of the proposed Facility and their taxation implications.
- Carry out a preliminary study on the national and international market for the various grades of scrap that could be produced.

7.5 Political

- Identify potential locations for the proposed Facility and on this basis put forward alternative schemes for the development of the project.
- Develop options for the acquisition of the necessary real estate, together with anticipated problems and recommended solutions.
- Liaise with national authorities to obtain information on the necessary statutory and regulatory approvals.

7.6 Training

- Evaluate training levels of BiH ammunition specialists and make recommendations for training requirements to international best practices.

7.7 Diary

- The final report should include a diary of activities for the Project Team.

7.8 Contact Details

- Details of all individuals consulted in the preparation of the report are to be submitted as part of the final report.

COMPETENCY AND EXPERTISE REQUIREMENTS

8. General. The complex and highly technical nature of the Feasibility Study demands that a composite team should be assembled with individual expertise in the various technical areas. Prior knowledge and experience in BiH would naturally be highly advantageous. The final selection of the successful tender will be largely based on CVs of proposed consultants.

9. Project Manager. The Project Manager (PM) should be experienced in the management of multi-disciplined consultancy projects. It is likely that s/he will have worked for an international organisation at a senior level, and it is highly desirable, but not essential, that the individual has specialist knowledge of BiH. The PM may be 'double-hatted' as one of the specialist consultants.

10. Technical Consultant. The consultant will be a qualified Ammunition Technical Officer, or equivalent, with both Explosive Ordnance Disposal and Demilitarisation experience. The individual will be familiar with the technology available and the potential demilitarisation techniques to be used. The individual will be capable of analysing the recommended engineering processes in terms of explosive safety and developing a comprehensive explosive safety plan.

11. Financial Consultant. The financial consultant should have experience of operating in the Central and Eastern European financial environments and have knowledge of BiH. The individual should have advised at governmental level and have worked with major donor institutions including UNDP, the European Union or the World Bank.

CONDUCT OF THE WORK

12. The work will be carried out under the direction of the Consultancy Team Leader. It is anticipated that the full team will need to visit BiH for orientation, to determine the problem and to view the ground for approximately thirty days. UNDP and SFOR will coordinate and arrange meetings and visits as necessary. Other key team members will require longer in country. The final report and recommendations will be compiled in the home location of the successful tenderer.

TARGET DATES

13. To be discussed further during contract negotiations:

05 April 2004	Consultant Appointed.
05 June 2004	Draft Report submitted to UNDP BiH SARP Project/SEESAC.

05 July 2004	Final Report submitted to UNDP BiH SARP Project/SEESAC.[12]

TRAVEL

14. It is anticipated that the consultant will have a need to travel to Sarajevo and around Bosnia and Herzegovina to consult with the all-appropriate stakeholders. Travel costs should be clearly indicated within the Financial Proposal element of the tender, and should not exceed current UN Daily Subsistence Allowance (DSA) rates.

ANNEX A TO TOR

FURTHER TECHNICAL ADVISORY INFORMATION

An examination of the fundamental principles of ammunition management, when combined with the political and security interests of the international community, suggests that the following criteria should be considered when planning safe, effective and efficient stockpile management and destruction within BiH. They are listed in human security priority order:

A.1 Chemical stability

The stability in storage and degradation or deterioration rates of the explosive content will influence the degree of urgency for disposal, type of transport that can safely be used and destruction methodology. The primary brisk is that of autocatalytic decomposition of propellant, which has the potential to result in spontaneous ignition leading to mass explosions in ammunition storage areas. Such explosions will result in the requirement for long, dangerous and expensive explosive ordnance disposal (EOD) clearance operations. Only effective ammunition surveillance systems combined with an effective explosive test laboratory can quantify this risk.

A.1.1 VRS ammunition

The VRS claim to have a limited ammunition surveillance system, but the SFOR ATO has seen little evidence to support this on the ground. Their propellant lot samples are centrally held and tested in the Republika Srpska, with irregular bulletins informing them of the condition of their stocks. The accuracy and efficiency of this system is not known.

A.1.2 VF ammunition

The VF seems to have a well organised ammunition tracking system but lack information on their holdings and do not have a standard testing system. Their problem is compounded by the fact that their ammunition has come from a wide range of sources [13] and they have virtually no technical data. Therefore they have no

[12] Delays in the identification of accurate information in-country have led to an extension of the deadline. This was agreed with UNDP.

[13] 10% Former Yugoslavia, 60% war production of low quality, 20% from an international equipment programme (US, UK, Turkish origin ...) and 10% 'spoils of war'.

means of identifying ammunition at risk from propellant instability, and the **risks of an undesirable explosive event during storage must be assessed as very high.**

A.2 Physical degradation of ammunition

This can impact on the inherent safety of safe to arm mechanisms, fuzing systems or explosive exudation. This risk again requires an effective physical examination component of the ammunition surveillance system. The Entity Armed Forces (EAF) appear to have a limited surveillance system in place, but the HQ SFOR ATO considers that they only tackle visible problems when they become obvious. It is a reactive, rather than a pro-active system, and is dependent on the EAF identifying exudation or corrosion when they open the ammunition containers during training. The potential for major problems being missed is significant, which means that the risks of an **undesirable explosive event during transport or use at training must be considered to be significant.**

A.3 Safe systems of work

Safe systems of work are a pre-requisite when handling and processing any types of ammunition and explosives. This includes the implementation of basic explosive safety systems in storage and processing and the imposition of adequate explosive danger areas. The explosive safety standards of the EAF could, at best, be described as variable and they require international assistance to move towards NATO standards.

A.4 Security

The security of ammunition natures that is attractive for terrorist use (SAM 7, RPG, bulk explosives and detonators) is a primary concern for the international community. It is recommended that a full security survey of their storage locations and systems be conducted.

A.5 Safe 'Shelf Life' of ammunition

The shelf life is an indication of the performance of the ammunition for operational or training use. The effects of physical degradation and chemical stability determine the safety of ammunition in storage.

A.6 Armed forces reform and restructuring

Ammunition destruction planning should form part of wider planning for armed forces reform and restructuring. 'What are the future realistic and achievable ammunition requirements of the national Armed Forces'? However, from a human safety and security factor this is the lowest priority criteria, yet the decision by the OHR has moved this to the top of the criteria priority list. This cannot be supported by the limited available technical information without a formal risk analysis being conducted. Such an analysis would be a lengthy operation due to the wide spread dispersion of storage areas, lack of technical data and possible inertia within the EAF.

ANNEX B
TO CHAPTER 1

METHODOLOGY

SER	TERMS OF REFERENCE DELIVERABLE	TASKS	CONSULTANT
(a)	(b)	(c)	(d)
HUMANITARIAN			
1	The humanitarian effects of any unplanned explosive events in the current BiH ammunition storage environment. This should take the form of an Explosive Consequence Analysis involving an accidental explosion at an above ground Explosive Storehouse.	• Inspect ammunition storage Sites (ASS) as directed by UNDP. • Measure Outside Quantity Distances (OQDs). • Assess stocks by Hazard Division (HD). • Quantify effects of an accidental explosion. • Write Explosion Consequence Analysis (ECA).	**Technical**
2	Identify employment opportunities for BiH citizens during the design, development, construction and operation of the proposed facility.	• Establish manpower for the operation of the demilitarisation equipment. • Establish manpower for the operation of the scrap/salvaging equipment. • Establish manpower required to design the site. • Establish manpower required to construct the site/s.	**Technical**
ENVIRONMENTAL			
3	The environmental impact of the establishment of a Demilitarization	• Assess the environmental compliance of the	**Technical**

	Facility, (the Facility).	recommended demilitarisation equipment. • Assess the environmental compliance of the recommended scrap/salvage equipment. • Evaluate the damage to the environment caused by the construction of the facility. • Develop strategies and design measurements to mitigate/reduce the environmental impact and ensure local legal compliance.	
4	Recommendations as to the use of environmentally benign demilitarisation techniques compliant with European Community (EU) environmental directives.	• Evaluate the environmental compliance of the recommended demilitarisation equipment in accordance with EU directives. • Evaluate the environmental compliance of the recommended scrap/salvage equipment in accordance with EU directives.	**Technical**
	TECHNICAL		
5	Assess the overall condition of the BiH ammunition stockpile.	• Obtain stockpile levels if released by Entity Armed Forces (EAF) or Ministry of Defence	**Technical**
6	Quantify the immediate, short term and long-term demilitarization requirements.	• Estimate the detailed demilitarisation requirements in the immediate, short and long term.	**Technical**
7	Identify the potential technology for an environmentally benign Facility.	• As TOR deliverable	**Technical**
8	Identify explosive safety factors for the development of a Facility and make recommendations.	• Quantify maximum permissible stock limits awaiting destruction in relation to appropriate Inside Quantity Distances (IQD) and Outside Quantity Distances (OQD). • Recommend areas to be covered by Operating	**Technical**

		procedures.	
9	Where possible, develop process flows for the demilitarization and the scrap/salvage processes.	As TOR. • Identify requirements and assess the level of interference between construction and technological components of the project.	**Technical**
10	Identify the explosive hazards in storage at, and transportation to the Facility and make recommendations.	As TOR.	**Technical**
11	Identify the engineering dimensions of the project together with specific requirements.	• Determine the scale of institutional involvement and identify respective authorities. • Develop strategies to satisfy short and long term statutory requirements. • Identify potential risks associated to the project and recommend strategies in reducing these risks.	**Technical**
12	Determine the project engineering phases of the development process and evaluate the relationships with other components of the project.	• Develop models that incorporate full life cycle of the facility. • Determine the resources required for each phase of development. • Establish a procurement strategy and develop construction-contracting procedures. • Identify milestones for project development review and establish strategies in enhancing value.	**Technical**
13	Identify technical legal requirements	• Determine BiH legislation applicable to this area. • Identify the requirements in obtaining planning permission and prepare structures which	**Technical**

		incorporate these requirements.	
SECURITY			
14	Examine the security factors for the weapons and ammunition storage at, and movement to the proposed Facility(s).	• Identify physical and protective security threats. • Identify technical security threats (Ammunition design etc.).	**Project Leader** Technical
15	Make recommendations for the physical security of the weapons and ammunition storage at the proposed Facility(s).	• As TOR	**Project Leader** Technical
FINANCIAL			
16	Develop a financial model for the proposed Facility(s).	• Work with project consultants on costing of equipment and necessary housing specified.	**Financial**
17	Quantify the projects key fixed costs including equipment and appropriate building and infrastructure renovations.	• Review local labour and expatriate costs of employment.	**Financial**
18	Estimate operating costs taking into consideration local labour market conditions and expatriate staff requirements.	• Collate all financial information and develop spreadsheet analysis.	**Financial**
19	Compare the different legal structures available for the management of the proposed Facility and their taxation implications.	• Interview relevant local and foreign experts, review laws and prepare report.	**Financial**
20	Carry out a preliminary study on the national and international market for the various grades of scrap that could be produced.	• Review current prices and trends from available sources of information.	**Financial**

POLITICAL			
21	Identify potential locations for the proposed Facility and on this basis put forward alternative schemes for the development of the project.	• Conduct reconnaissance of possible sites. • Discuss availability with relevant government department.	**Project Leader** Technical
22	Develop options for the acquisition of the necessary real estate, together with anticipated problems and recommended solutions.	• Examine compulsory purchase by the BiH government, purchase by a commercial company and land donation by BiH government.	**Project Leader** Technical
23	Liaise with national authorities to obtain statutory and regulatory approvals.	• As TOR	**Project Leader** Technical
TRAINING			
24	Evaluate training levels of BiH ammunition specialists and make recommendations for technical training requirements to international best practices.	• As TOR	**Technical**
DIARY			
25	The final report should include a diary of activities for the Project Team	• As TOR	**Project Leader**

Bosnia and Herzegovina

THREAT RESOLUTION LIMITED

Chapter 2
HUMANITARIAN

CHAPTER 2 – HUMANITARIAN

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CHAPTER 2

HUMANITARIAN

1. DELIVERABLES

1.1 The humanitarian effects of any unplanned explosive events in the current BiH ammunition storage environment. This should take the form of a Consequence Analysis of an accidental explosive event at an above ground Explosive Storehouse.

1.2 Identify employment opportunities for BiH citizens during the design, development, construction and operation of the proposed facility.

2. BACKGROUND

2.1 Ammunition Storage

In BiH there are 38 major ammunition storage sites (ASS)[1] under control of the Entity Armed Forces (EAF) which, according to a recent action plan from the Office of the High Representative (OHR), they intend to reduce to only 6. The total stock levels are in the region of 67,000 tonnes All Up Weight (AUW), of which the SFOR ATO estimates approximately 50% (33,500 tonnes) has already been identified as requiring disposal.[2] The ammunition varies in age but much of the stock is in excess of 20 years old and comes from a wide variety of manufactures in many countries. Full technical reports of the ASS which were visited are at Annex A.

2.2 Ammunition Regulations

Ammunition regulations concerning the safe storage of military ammunition and explosives are contained in Chapter 13 of the Instructions To Parties (ITP). The ITP is published on behalf of the Commander of SFOR (COMSFOR) and is intended to give clear direction on compliance with the military aspects of the General Framework Agreement for Peace (GFAP), which was signed in 1995. The requirements of Chapter 13 have been drawn from NATO publications regarding the safe storage, movement and classification of military ammunition and are intended to be implemented by all armed forces in BiH

2.3 Safety in Storage

2.3.1 On the recommendation of the SFOR ATO[3] technical inspections were conducted by the TRLtd consultant in June 2004, at only the 6 storage sites which are intended to remain in use. A significant number of critical safety infringements were noted, which are summarised below:

- In most locations ammunition is not correctly stored according to its Compatibility Group (CG), the purpose of which is to ensure the

[1] Information provided by the SFOR ATO 7 August 2004.
[2] Ibid.
[3] Recommendation made by e-mail from the SFOR ATO on 21 May 2004.

segregation of sensitive natures to prevent them contributing unnecessarily to the effects of an explosion or fire.

- There are large quantities of unpackaged ammunition, some of which is stored in the open or in temporary facilities such as steel storage containers. Such conditions considerably increase the likelihood of this ammunition contributing to the effects of a fire or explosion.

- Leaking containers of unidentified chemicals, possibly a liquid propellant oxidizer that presents both a significant fire and health risk, are stored alongside other explosives.

- There is inadequate or out of date fire-fighting equipment at all locations.

- There were no records of the conduct of inspections or the existence of an ammunition surveillance system.

2.3.2 Potential Consequences

Any failure to implement the highest standards of safety in ammunition storage will significantly increase the likelihood of an unplanned explosive event occurring. For example, on 20th June 2003, an ammunition storage building near Derventa exploded, killing two soldiers[4]. To date the cause of the explosion has not been officially ascertained, although apocryphal evidence suggests that tampering by unqualified personnel was the cause.

3 CHEMICAL STABILITY OF AMMUNITION

3.1 General

Monitoring of the chemical stability of explosives in ammunition during storage is vital to ensure that those stocks that are deteriorating can be readily identified and removed for destruction in a timely manner.

3.1.1 High Explosives

With high explosives long term stability is not considered to be a problem that could compromise safety, providing reasonable levels of storage are maintained. An efficient routine inspection programme will normally be sufficient to monitor the general condition of ammunition for signs of exudation of the main filling and other indications of deterioration, such as corrosion.

3.1.2 Propellants[5]

In March 2000 Dr Stephen Murray from the Royal Military College of Science, at Cranfield University in the UK, conducted an analysis of the potential for propellant instability during storage in Albania. There, storage conditions exist that are very similar to those currently found in BiH and his report described the following hazards associated with propellants in storage:

Propellants may be either Single Base containing only nitrocellulose as the energetic component or Double Base containing both nitrocellulose and nitroglycerine as energetic components. Even if the propellant is kept in ideal

[4] Gumley, J., "Weapon Storage Sites in BiH" NATO SFOR Informer, September 2003.
[5] S. G. Murray, Propellant Stability Analysis, Albania Demilitarisation Study, 31 March 2000.

storage conditions these components will begin to decompose over time to form oxides of nitrogen, mainly dinitrogen tetroxide. If these oxides of nitrogen are not removed from the propellant as they are formed they will catalyse further decomposition. This is an example of autocatalytic decomposition since the impurity being formed accelerates the chemistry creating more of the same impurity, which, therefore, causes further decomposition and so on. One factor that can increase the rate of chemical reaction is temperature. Thus any increase above 20°C will have an adverse effect on the storage life of propellant.

This autocatalytic decomposition of propellants is a serious safety issue, as it is known to lead to spontaneous ignition (see below). To prevent this occurrence, chemical additives are introduced into the propellant formulation and are known as stabilisers. They do not stop the slow decomposition of the nitrocellulose and nitroglycerine but rather prevent the accelerated chemical decomposition by removing the oxides of nitrogen, which would cause it to happen. Thus, the stabiliser reacts chemically with these oxides removing them from the system. Of course, to do this, the stabiliser will slowly be consumed.

Thus, the reduction in stabiliser content will lead to a point where it becomes insufficient to guarantee safety and this should be a measure of the storage life of that propellant. Both chemical analysis and instrumental methods can be employed to measure the stabiliser content, the latter being a more recent advance in propellant analysis.

Two chemicals are used routinely as stabilisers; one is diphenylamine (DPA) used in Single Base propellants from the early years to the present time. Chemically it behaves as a base reacting with the initial decomposition products of nitrocellulose, initially to form nitrosodiphenylamine, which is then converted into various nitro-derivatives of diphenylamine. This stabiliser is too basic to be used if nitroglycerine is present and therefore is not used in Double Base propellants. Instead the stabiliser of choice is diphenyldiethylurea also known as carbamite or ethyl centralite. This acts as a weak base reacting with the decomposition products again to form nitro- and nitroso-derivatives. The overall chemistry of the action of stabilisers is extremely complex but the end result is to keep the propellant chemically stable.

Dr Murray also conducted a survey,[6] which recorded more than 30 ammunition accidents worldwide that were attributed to spontaneous propellant ignition. In one accident 2,273 tonnes of mixed explosives and ammunition were present. One explosion caused initially by ignition of unstable explosive there were fragments out to a distance of 360 m, concrete from the structure to 450 m and firebrands to 600 m. Windows were broken by the blast wave at a distance of over 3 km. A crater remained which was 21 m in diameter and 5 m deep. DR Murray concluded, *"It is imperative that all propellant in magazines must be included in a surveillance programme".*

3.2 Chemical Analysis Facilities

The GOF at P.S. Vitezit in Vitez includes limited facilities where propellant stability tests are conducted, but does not have any system capable of testing propellant manufactured elsewhere. Only two qualified staff are employed there, using a minimal amount of old equipment, to conduct Quality Control

[6] Ibid, p 28.

tests of propellant samples which are taken from the ammunition produced in the factory. The building, however, has a floor space of approximately 400 sq m and it is believed that there is adequate space for considerable expansion.

4 EFFECTS OF UNPLANNED EXPLOSIVE EVENT IN AMMUNITION STORAGE AREA

4.1 General

An Explosion Consequence Analysis (ECA) for an unplanned explosive event in a typical BiH surface Ammunition Storage Area (ASA) was conducted as part of the Feasibility Study. The following documents were used as the main source of technical reference material for the ECA:

- NATO AASTP – 1, Annexes A and C.
- Explosion Hazards and Evaluation, *W.E. Baker et al*, Elsevier, Oxford, 1983.
- TRLtd Limited ESH Inspection Report of 03 June 2004.

4.2 Methodology

4.2.1 The ECA quantifies the effect of the following consequences of an unplanned explosive event on civilian houses, public traffic routes and other Explosive Store Houses (ESH), collectively known as Exposed Sites (ES), identified in a survey of the area:

- Blast.
- Fragmentation.
- Ground effects.

4.2.2 The following assumptions have been made:

- Thermal Radiation effects have not been considered.
- Due to the poor storage conditions all of the explosive contents will fully detonate.
- The worst case item of ammunition is a 152mm High Explosive shell

4.3 Results

The detailed ECA for a typical surface ASA in BiH is at Annex B.

4.4 Findings

The ECA for this particular site clearly identifies that:

- The physical infrastructure of the site means that individual ESH could not be licensed to store ammunition in accordance with NATO standards. The site would have to be treated as a single Potential Explosion Site (PES); even then the short safety distances to buildings inhabited by civilians (400m) means that the site could not safely store the quantity of ammunition that it currently holds.

- Personnel working in other buildings within the site would be seriously at risk should an undesired explosive event occur in ESH 25. They would certainly suffer from Eardrum Rupture, although it could safely be assumed that their injuries due to fragmentation injuries would be far worse.
- Civilian personnel in the nearest inhabited building would not suffer significant hearing or lung damage should an undesired explosive event occur. Eardrum Rupture could be expected out to a distance of 207 metres from ESH 25.

- An explosive event in ESH 25 would lead to significant damage to the surrounding ESH, and there would be extreme structural damage.

- Vehicles on the road are not at risk of overturning should there be an undesired explosive event.

- Civilian personnel in the area would be at risk of death or injury from large metal fragments, which will travel between 99m and 269m from the site.

- An undesired explosive event would inevitably lead to Unexploded Ordnance (UXO) contamination of the local area if either a high or low order detonation of the stocks occurs. Ammunition would be projected out of the ESHs at high velocity during the explosion in a ballistically unstable trajectory. This “kicked out” ammunition could have been subjected to external forces similar to those found when fired from a weapon. These forces, (spin, set back, centripetal and set forward), are the forces used by the fuze designer to arm the munition, so that in effect, the ammunition could end up in an armed condition and therefore be unsafe.

5. CONCLUSIONS

- The ammunition stockpile held by the EAF presents a real and present danger to the civilian population living nearby for the following reasons:

  (1) The age and storage conditions of the ammunition.

  (2) The critical nature of safety infringements.

  (3) The lack of inspections to verify the condition of ammunition or a surveillance system to establish the chemical stability of propellants.

  (4) The excessive Net Explosive Quantities (NEQ) of the ammunition held (quantities held in the ESH.

- The OHR action plan, to accommodate the ammunition stockpile in only six sites, is unattainable, as it will significantly increase the already excessive Net Explosive Content (NEC) of these sites.

- The chemical analysis facility in Vitez is not capable of undertaking the significant number of analyses likely to be needed to bring the surveillance of propellant stability up to date. The facility requires refurbishment and investment in new equipment.

6. RECOMMENDATIONS

- An ammunition surveillance system is introduced as soon as possible.
- The capability of the facility at Vitez is upgraded to conduct propellant testing of the EAF stockpile. This is necessary to reduce the possibility of an unplanned explosive event, prioritise ammunition stock for disposal and to continue to monitor propellant stability in the residual stockpile.
- An Ammunition Demilitarisation Facility, capable of destroying large quantities of ammunition is constructed to destroy the estimated 33,500 tonnes of ammunition currently earmarked for disposal.

7. EMPLOYMENT OPPORTUNITIES FOR BiH CITIZENS

7.1 General

The Feasibility Study team has examined the labour requirements to design, construct and operate both an ammunition demilitarisation and scrap processing facilities. The methodology used for these assessments is contained in the relevant chapter of this report.

7.2 Manpower requirements

The estimated manpower requirements to operate the ammunition demilitarisation facility are at Annex C.

The estimated manpower requirements to construct the ammunition demilitarisation facility is at Annex D.

7.3 Project Supervisory

The ADF project Supervisory team will be responsible to the lead agency or authority that, it is assumed, will also be the fund holders. The team assumes that this supervising role is likely to be an appointed agency such as the NATO Maintenance and Supply Agency (NAMSA), which has an active interest and high profile in demilitarisation throughout Europe and in the Balkans.

The Team has identified the following political factors that will be essential to the success of Phase A and B Supervisory:

- Maximum support from the BiH Government, Parliament and the MoD.
- Project transparency and information flow for donors, the Government of BiH and the general public.
- Maximum utilisation of local resources, facilities and personnel.

The Team proposes a three-tier organisation consisting of an *Executive Board, the Project Supervisor* and the *Supervisory Team*.

7.3.1 Executive Board

The role of the Executive Board is to create policy for the ADF Supervisory Team and to monitor progress against approved targets. Additionally the Board provides an essential level of local participation and therefore most likely to ensure continued support. A suggested structure for the Board is:

- Chairman - BiH Minister BiH Minister appointed to implement Demilitarisation policy.
- Ministry of Defence representative.
- Representative(s) of donor/coordinator organisations.
- EAF Chief of Logistics.
- Other invited non-executive participants. (E.g. UNDP, SFOR, OSCE, SEESAC, etc)
- Project executors.

7.3.2 Executing Agency

An agency appointed by the fund holders to provide contractual and financial control over the project. The executing Agency will award contracts to a variety of organisations and agencies to the Lead Agency shall appoint the supervisor team and shall develop and direct technical policy.

7.3.3 Supervisory Team

The Supervisory Team will execute the policy of the Executive Board. Primary responsibilities will be to oversee the construction, installation and commissioning of the proposed plan. The Supervisory Team will require a structure that dovetails to any continued SFOR effort and should be composed of lead personnel in the following areas:

- In country Project management.
- Local Finance.
- Oversee construction engineering.
- Demilitarisation equipment specialist.
- Ammunition technical specialists.
- Logistics.

The ADF Supervisory Team will require full administrative support and operating bases in Sarajevo and the operating facility.

The estimated manpower requirements to design and project manage the construction of the ammunition demilitarisation facilities are at Annex E.

7.4 Summary.

A summary of employment opportunities, for both International and Local personnel, at the peak periods for each activity is as follows:

	Role	Int	Local
• **Supervisory**	Project Management	1	0
	Finance		2
	Technical	3	1
	Construction		1
	Secretarial		4
	Other		3
	Total	**5**	**12**
• **Phase A**[7]	Management	1	0
	Construct/ Demilitarization	3	43
	Administration	1	3
	Total	**5**	**46**
• **Phase B**[8]	Management	1	2
	Demilitarisation	3	26
	Scrap Recovery	0	7
	Administration		6
	Total	**4**	**41**

[7] Phase A - Installation and operation of an incineration facility designed to dispose of unstable and obsolete ammunition.
[8] Phase B – Upgrade ADF to include facilities for the recovery of TNT.

ANNEX A
TO CHAPTER 2

AMMUNITION STORAGE SITES - VISIT REPORTS

ASSESSMENT OF AMMUNITION STORAGE SITE EF 007 – GABELA

1. INTRODUCTION

Gabela is an ammunition storage site for the Federation Army located approximately 5 Km SE from Capjlina and approximately 30 Km from Mostar. The site was originally built by the Yugoslavian Army in the 1953 and the majority of the buildings date from that period. The site has been damaged during the conflict and many of the buildings show structural damage.

The site contains 13 ammunition storage buildings of standard Yugoslavian Army construction. There are also 2 ISO type containers used to store ammunition. Due to the structural damage, lack of blast protection for the windows and the double skinned construction of the doors none of the buildings meet NATO standards.

2. SECURITY

2.1 Existing Measures

- Perimeter Fence. The perimeter fence is complete, but needs the barbed wire top replacing with razor wire.

- Main Entrance. There is only one entrance to the site which is permanently manned. The entrance is closed by means of a heavy steel gate.

- Electronic Security. There are no alarms on the ESHs or the perimeter. There is no lighting within the explosive compound. There is no CCTV.

- Guard Force The guard force is adequate to secure the area, in the absence of any electronic security measures. Any reduction in the guard force would severely compromise security.

- Security of Weapons. The weapons held for the guard are easily accessible by all guard force members. The padlock securing the weapons is not high security.

- ESH Security. The ESH are secured by low quality padlocks and wire seals. In addition to this many of the windows are broken, with security bars missing or loose.

2.2 Recommended Improvements.

- The perimeter fence should be reinforced.
- The main gate requires replacement.
- A lighting system should be installed in the explosives compound.
- The ESHs require an alarm system

- The locks to the ESH should be replaced with integral locks or high security padlocks.

3. AMMUNITION STORAGE CONDITIONS

3.1 Free Standing ESH

The buildings are generally in a good state of repair. Some of the free standing ESHs have leaks from the roof but the stocks are not affected. All the ESHs have double skinned doors and are not of NATO standard. Several of the buildings have broken windows and bars missing. None of the buildings have any lighting.

3.2 Outside Storage

A large amount of ammunition is stored in the open in close proximity to the ESH doors. Although this ammunition is covered by tarpaulin, is still exposed some moisture and to extremes of temperature. It is likely that the condition of this ammunition will degrade rapidly.

3.3 Ammunition Stocks

- General The site is severely overstocked with a large amount of ammunition ageing and obsolete ammunition but there is no surveillance system. Large amounts of artillery shells, grenades and anti-tank mines are held, much of which is surplus to future requirements. The majority of the ammunition is locally produced, there are also natures from the Soviet Union, USA, China and Romania.

- Fire Hazard. Although there is a fire engine on site, there is a lack of fire fighting equipment available at the ESH. Fire extinguishers are present but have not been checked or serviced. The area is prone to fires in the summer, to date these have not affected the ammunition storage area.

- Storage. Although attempts have been made to store the ammunition with regard to Hazard Division (HD) and Compatibility Group (CG) overstocking has lead to multiple infringements. There appears to be a lack of proper training and no inspection of the storage conditions. Inspections are carried out by SFOR in an attempt to enforce ITP chapter 13, however the inspectors are not themselves technically trained.

4 SUMMARY

Gabela is a suitable location for an ammunition storage site, however safety is, at the moment, severely compromised by the overstocking. The storage buildings require considerable renovation to reach NATO standard and become properly licensed, and the staff are lacking in the basic knowledge of ammunition storage regulations. Since there is no formal ammunition surveillance system the condition of much of the ammunition cannot be verified. The storage of ammunition in large quantities outside the ESH will only accelerate the process of degradation, and poses a serious explosion risk in the event of fire.

ASSESSMENT OF AMMUNITION STORAGE SITE EF 024 – PAZARIC KRUPA

1. INTRODUCTION

Pazaric Krupa is an ammunition storage site for the Federation Army located approximately 2 Km SE of Pazaric town and approximately 25 Km from Sarajevo. The site was originally built by the Yugoslavian Army in the 1950s and the majority of the buildings date from that period. The site is set in a steeply sided wooded valley, making access to the site difficult and providing no line of sight to civilian occupied buildings.

The site contains 22 ammunition storage buildings, 4 earth covered Igloo type and 17 purpose built stone construction storehouses. There is also a container used to store detonators.

2. SECURITY

2.1 Existing Measures

- Perimeter Fence. The perimeter fence is not complete, but due to the presence of minefields both inside and outside of the site repairs are not possible. Demining is being conducted by the army, at the present rate of clearance it will continue for another four years.

- Main Entrance. There are two entrances to the site. The second entrance is permanently blocked and cannot be easily accessed from any area where there are civilians. The main entrance is closed by a steel gate, which is not sufficient to stop a vehicle. At night the access road is blocked.

- Electronic Security. There are no alarms on the ESHs or the perimeter. There is no lighting within the explosive compound. There is no CCTV.

- Guard Force The guard force comprises 16 persons. Two guards man the main gate, one of whom is armed. There are 3 static guarding positions within the compound, rising to 4 at night. The remainder of the guard mount patrols and form a QRF. At night 4 dogs patrol the explosives compound.

- Security of Weapons. The weapons held for the guard are easily accessible by all guard force members. The padlock securing the weapons is not high security.

2.2 Recommended Improvements

- The perimeter fence should be replaced.
- The main gate requires replacement.
- A lighting system should be installed in the explosives compound.
- The ESHs require an alarm system
- The current guard force is adequate to provide security, however there are concerns over reduction in the size of the force as part of the army

downsizing. Should the guard force be reduced security would be severely compromised.

3. AMMUNITION STORAGE CONDITIONS

3.1 Free standing ESH

The buildings are generally in a good state of repair. Some of the free standing ESHs have leaks from the roof but the stocks are not affected. All the ESHs have double skinned doors and are not of NATO standard. Several of the buildings have broken windows and bars missing. Many of the ESHs have traversing on 3 sides, however this is not of sufficient height. None of the buildings have any lighting.

3.2 Igloos

The Igloos appear to be structurally sound; however again the doors are of double skinned construction therefore the building is not of NATO standard. The depth of soil on top of the building could not be ascertained. The Igloos have suffered from rock falls onto the top and back of the buildings; these falls have come from areas believed to be mined.

3.3 Ammunition Stocks

- General The site is overstocked with a large amount of ammunition due to the closure of smaller sites. Much of the ammunition held comprises HE artillery, MLRS type sub munitions dispensers and Grenades. The majority of the ammunition is of Yugoslav or Russian origin. and dates from the last 20 years. There is also a quantity of war production ammunition. Large amounts of the ammunition stocks have already been earmarked for disposal.

- Storage The ammunition is generally stored with regard to HD and CG, however overstocking has lead to some infringements. There appears to be a lack of proper training and no inspection of the storage conditions. Inspections are carried out by SFOR in an attempt to enforce ITP chapter 13, however the inspectors are not themselves technically trained.

4. SUMMARY

Pazaric Krupa is a well-situated site with scope for expansion, once the demining is completed, if the buildings were improved to NATO standard and licensed. The site is heavily overstocked and the staff are not trained for their tasks. There is no verifiable program for inspection of the storage conditions or for technical inspection of the ammunition. The guard force is adequate but physical security measures need significant improvement.

ASSESSMENT OF AMMUNITION STORAGE SITE EV 076 - RUDO

1 INTRODUCTION

Rudo is an ammunition storage site for the Army of the Republica Srpska located approximately 10km from Visegrad. The ammunition storage buildings within the explosives area were built by the Yugoslavian Army in the 1950s.

The site contains 14 ammunition storage buildings of standard Yugoslavian Army construction. The buildings are in a generally poor state of repair, with obvious cracks in the walls and water leaking in from the roof. Due to the structural damage, lack of blast protection for the windows and the double skinned construction of the doors none of the buildings meet NATO standards.

2. SECURITY

2.1 Existing Measures

- Perimeter fence. The perimeter fence is not complete, but repairs are not possible due to the presence of mines.

- Main entrance. There is only one entrance to the site which is permanently manned. The entrance is closed by means of a dilapidated gate which is not sufficient to stop a vehicle.

- Electronic Security. There are no alarms on the ESHs or the perimeter. There is lighting within the explosive compound but it is not sufficient to illuminate the whole area. There is no CCTV.

- Guard force The guard force is adequate to secure the area, in the absence of any electronic security measures. Any reduction in the guard force would severely compromise security.

- Security of weapons. The weapons held for the guard are easily accessible by all guard force members. The padlock securing the weapons is not high security. Ready use ammunition is stored with the weapons.

- ESH security. The ESH are secured by low quality padlocks and wire seals. In addition to this many of the windows are broken, with security bars missing or loose.

2.2 Recommended Improvements

- The perimeter fence should be replaces, once demining has been completed.
- The main gate requires replacement.
- A more efficient lighting system should be installed in the explosives compound.
- The ESHs require an alarm system

- The locks to the ESH should be replaced

3 AMMUNITION STORAGE CONDITIONS

3.1 Free Standing ESH

All but two of the ESH are traversed, however the traverses are not of sufficient height to prevent the ejection of high velocity projectiles and therefore cannot be considered for licensing purposes. The ingress of moisture is affecting the ammunition and the damage to the buildings is in some cases severe.

3.2 Ammunition Stocks

- General The site is heavily overstocked with a large amount of ammunition due to the closure of smaller sites. There is a large amount of bulk HE and anti-tank mines along with large calibre HE shell and grenades. Much of the ammunition is not in its original container, many of the containers are damaged exposing the contents. The majority of the ammunition is of Yugoslav or Russian origin. and dates from the last 20 years. There is also a quantity of war production ammunition. Large amounts of the ammunition stocks have already been earmarked for disposal.

- Storage The ammunition is stored with little regard to HD and CG, and there are multiple infringements. There appears to be a lack of proper training and no inspection of the storage conditions. Inspections are carried out by SFOR in an attempt to enforce ITP chapter 13, however the inspectors are not themselves technically trained.

- Unidentified Chemicals Building 21 contains fourteen containers marked “Toxic”. There is concern that they may contain liquid propellant or oxidiser. These items are stored along with large amounts of Compatibility Group B and D ammunition, which considerably increases the risk of a major explosion in the event of a fire

4 SUMMARY

Rudo is stocked far in excess of the NEQs which would be allowed were the site licensed. Furthermore, there is no ammunition surveillance system or evidence of the conduct of routine inspections. The ammunition is generally of poor quality and is deteriorating. The removal of much of the HE stores should be a priority. The lack of regard for the correct mixing of Compatibility Groups is also a cause for serious concern, as is the storage of potentially toxic chemicals. The condition of some of the buildings is so poor that renovation may not be possible. ***This site is to be used for the Explosion Consequence Analysis as it is the closest to civilian habitation (300m).***

ASSESSMENT OF AMMUNITION STORAGE SITE NB 075 - TUZLA

1 INTRODUCTION

NB 075 is an ammunition storage site for the Federation Army located approximately 20km from Tuzla. The ammunition storage buildings within the explosives area were built by the Yugoslavian Army in the 1950s with the exception of 1 smaller building that is of more recent construction

The site contains 9 earth covered igloo type buildings and 7 free standing ESH. Two buildings are currently empty. A tenth Igloo was completely destroyed by an explosion in 1995, when it is believed that an Improvised Explosive Device was being constructed in a building containing 1800 Kg of HD 1.1 ammunition.

2 SECURITY

2.1 Existing Measures

- Perimeter fence. The perimeter fence is complete, but insufficiently robust. There area inside the fence is mined. There is only one entrance to the site which is permanently manned.

- Electronic Security. There are no alarms on the ESHs or the perimeter. There is no lighting within the ammunition storage area. There is no CCTV.

- Guard force The guard force is adequate to secure the area, in the absence of any electronic security measures. Any reduction in the guard force would severely compromise security.

- Security of weapons. The padlock securing the weapons is not high security. Control of access to the weapon storage area is good.

- ESH security. The ESH are secured by low quality padlocks and wire seals. In addition to this many of the windows are broken, with security bars missing or loose. The ventilation shafts are also insecure.

2.2 Recommended Improvements

- The perimeter fence should be refurbished, once demining has been completed.
- A lighting system should be installed in the explosives compound.
- The ESHs require an alarm system
- The locks to the ESH should be replaced

3. AMMUNITION STORAGE CONDITIONS

3.1 Igloos

The igloos are of a reasonable state of repair, with no obvious water leaks. The doors are not of NATO standard. The soil depth is in excess of 60cm.

however there has been some soil slippage from the top of the Igloos that has been replaced.

3.2 Free Standing ESH

The free standing ESH are also in a reasonable state of repair, but suffer from the same faults as the Igloos. In addition, their proximity to the ESH limits them to the storage of HD 1.4. Attempts have been made to adhere to this, but there are still items of HD 1.1 and 1.2 in these storehouses.

3.3 Ammunition Stocks

- General Large amounts of unserviceable ammunition has been destroyed by the US Army at Camp Commanche. As a result Tuzla does not suffer from the severe overstocking common on BiH ammunition storage. The majority of the ammunition is of Yugoslav or Russian origin and dates from the last 20 years. There were no signs of corrosion or damage.

- Storage The site commander has ammunition storage experience, gained before the war, and is attempting to apply his knowledge. There are still infringements of the rules regarding the storage of CG H, but some attention is being paid to the storage by HD. Inspections are carried out by SFOR in an attempt to enforce ITP chapter 13, however the inspectors are not themselves technically trained.

4 SUMMARY

Tuzla is a well-maintained ammunition storage area with buildings of a good standard and in good condition. A relatively small amount of work would be required to raise the condition of the buildings to NATO standard and issue Explosive Limit Licenses (ELL).

The positioning of the free standing ESH would severely limit the ammunition holdings were the site to be licensed as one PES. Discounting these buildings would greatly increase the permitted holdings of HD 1.1 and 1.2.

ASSESSMENT OF AMMUNITION STORAGE SITE WV 096 – KULA 1

1 INTRODUCTION

WV 096 is an ammunition storage site located approximately 5km from Mrkonjic Grad. The ammunition storage buildings within the explosives area were built by the Yugoslavian Army in the 1950s and consist of 14 earth covered igloo type buildings.

2 SECURITY

2.1 Existing Measures

- Perimeter fence. The perimeter fence is complete, but insufficiently robust. There are not believed to be any mines within the area of the ammunition storage. There is only one gate on the route to both Kula 1 and Kula 2, which is permanently manned. Each storage site has it is own entrance; the gate to Kula 1 is not permanently guarded. The fence has sensors fitted but the system is not operational.

- Electronic Security. There are no alarms on the ESHs or the perimeter. There is no lighting within the ammunition storage area. There is a CCTV system within the depot, which has not been commissioned.

- Guard force The guard force has been drastically reduced recently and is comprised of junior soldiers. It is unlikely that this small force of young and inexperienced soldiers is capable of providing effective security.

- Security of weapons. The padlock securing the weapons is not high security. Control of access to the weapon storage area is good.

- ESH security. The ESH are secured by low quality padlocks and wire seals. In addition to this many of the windows are broken, with security bars missing or loose. The ventilation shafts are also insecure.

2.2 Recommended Improvements

- The perimeter fence is effective, but in view if the decreased guard force, requires reinforcement. The sensor system should be reactivated.
- A lighting system should be installed in the explosives compound.
- The ESH require an alarm system.
- The locks to the ESH should be replaced.

3 AMMUNITION STORAGE CONDITIONS

3.1 Igloos

The igloos are of a reasonable state of repair, with no obvious water leaks.
The doors are not of NATO standard and the headwalls have glass windows.

3.2 Siting

The ammunition storage area has been designed in a rough oval, leading to the headwalls of most of the ESH facing each other. This will greatly reduce the permitted NEQ in HD 1.1 and 1.2 unless remedial action is taken. To allow the depot to reach its full potential the headwalls should be strengthened, the doors and windows replaced and a traverse built in front of the headwall.

3.3 Ammunition Stocks

- General Many of the ESH carry large quantities of HD 1.1, comprising mostly anti-tank mines. The majority of the ammunition is of Yugoslav or Russian origin and dates from the last 20 years. Unserviceable ammunition is stored in the open next to the headwall of the ESH. This ammunition is suffering considerable deterioration. Large amounts of ammunition inside the ESH is not in its original packaging, in addition much of the packaging is damaged.

- Storage There is little attention to the basic rules of ammunition storage or accounting. There are no stack cards within the ESH. There appears to be no appreciation of the special storage requirements of ammunition containing WP and there are numerous infringements of the rules governing the mixing of Compatibility Groups, most seriously the mixing of unboxed detonators with HE stores.

4 SUMMARY

Kula 1 has the potential to be a safe and effective ammunition storage site, however the remedial action to the headwalls is vital to allow the storage of significant quantities of the higher hazard divisions. The current standard of safety in storage is low and without proper training for the site staff and a programme of inspections by technically qualified persons, is not likely to improve.

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ASSESSMENT OF AMMUNITION STORAGE SITE WV 261 KULA 2

1 INTRODUCTION

WV 261 is an ammunition storage site located approximately 5Km from Mrkonjic Grad within a complex that also includes Kula 1. The ammunition storage buildings within the explosives area were built by the Yugoslavian Army in the 1950s and consist of 22 earth covered igloo type buildings.

2 SECURITY

2.1 Existing Measures

- Perimeter fence. The perimeter fence is complete, but insufficiently robust. There are not believed to be any mines within the area of the ammunition storage. There is only one gate on the route to both Kula 1 and Kula 2, which is permanently manned. Each storage site has it is own entrance; the gate to Kula 2 is not permanently guarded. The fence has sensors fitted but the system is not operational.

- Electronic Security. There are no alarms on the ESHs or the perimeter. There is no lighting within the ammunition storage area. There is a CCTV system within the depot, which has not been commissioned.

- Guard force The guard force has been drastically reduced recently and is comprised of junior soldiers. It is unlikely that this small force of young and inexperienced soldiers is capable of providing effective security.

- Security of weapons. The padlock securing the weapons is not high security. Control of access to the weapon storage area is good.

- ESH security. The ESH are secured by low quality padlocks and wire seals. In addition to this many of the windows are broken, with security bars missing or loose. The ventilation shafts are also insecure.

2.2 Recommended Improvements

- The perimeter fence is effective, but in view if the decreased guard force, requires reinforcement. The sensor system should be reactivated.
- A lighting system should be installed in the explosives compound.
- The ESHs require an alarm system
- The locks to the ESH should be replaced

3 AMMUNITION STORAGE CONDITIONS

3.1 Igloos

The Igloos are in a reasonable state of repair, however there is evidence that water leaks in from beneath the doors. The doors are not of NATO standard. The headwalls have glass windows, which reduce their structural integrity.

3.2 Siting

The ammunition storage area has been designed in a rough oval, leading to the headwalls of most of the ESH facing each other. The distance between the ESH is, however, greater than that at Kula 1. This will greatly reduce the permitted NEQ in HD 1.1 and 1.2 unless remedial action is taken. To allow the depot to reach its full potential the headwalls should be strengthened, the doors and windows replaced and a traverse built in front of the headwall.

3.3 Ammunition Stocks

- General Many of the ESH carry large quantities of HD 1.1, comprising mostly anti-tank mines. The majority of the ammunition is of Yugoslav or Russian origin and dates from the last 20 years. Unserviceable ammunition is stored in the open next to the headwall of the ESH. This ammunition is suffering considerable deterioration. Large amounts of ammunition inside the ESH is not in its original packaging, in addition much of the packaging is damaged.

- Storage Attempts have been made to apply the basic rules of ammunition storage or accounting, however there appears to be no appreciation of the special storage requirements of ammunition containing WP and there are numerous infringements of the rules governing the mixing of compatibility groups, most seriously the mixing of unboxed detonators with HE stores. **There are large amounts of extraneous items within the ESH, including piles of wood and in ESH 4, a car.** These items will increase the risk of fire.

4 SUMMARY

Kula 2 has the potential to be a safe and effective ammunition storage site, however the remedial action to the headwalls is vital to allow the storage of significant quantities of the higher hazard divisions. The current standard of safety in storage is low, and without proper training for the site staff and a programme of inspections by technically qualified persons, is not likely to improve.

ASSESSMENT OF AMMUNITION STORAGE SITE WB 053 GREBEZ

1 INTRODUCTION

WB 053 is an ammunition storage site located approximately 10 Km from Bihac. The ammunition storage buildings within the explosives area were built by the Yugoslavian Army in the 1950s and consist of 6 freestanding brick built ESH.

2 SECURITY

2.1 Existing Measures

- Perimeter Fence. The perimeter fence is complete, but insufficiently robust. Approximately half the area within the perimeter fence is still mined. There is only one gate to the ammunition storage area, which is permanently manned. All visitors to the area are searched for contraband on entry and again on leaving.

- Electronic Security. There are no alarms on the ESHs or the perimeter. There is no lighting within the ammunition storage area.

- Guard Force The guard force of 12 is sufficient to provide security for the site.

- Security of weapons. The weapons are not secured, although the ammunition is secured by a high security padlock.

- ESH security. The ESH are secured by low quality padlocks and wire seals.

2.2 Recommended Improvements

- A lighting system should be installed in the explosives compound.
- The ESH require an alarm system
- The locks to the ESH should be replaced

3 AMMUNITION STORAGE CONDITIONS

3.1 ESHs

The igloos are of a good state of repair, with no evidence of water leaks however, the doors are not of NATO standard and the walls have glass windows, which reduce their structural integrity. All buildings have an earth traverse on 4 sides.

3.2 Ammunition Stocks

- General All ESH are overstocked with ammunition in Hazard Division 1.1. There is a large range of natures, many of which have been deemed unserviceable or surplus to requirements.

- Storage Ammunition in this site is stored in accordance with ITP chapter 13. The ammunition storage is of a high standard and there were no infringements of the rules governing the mixing of Compatibility Groups.

4 SUMMARY

Grebez is a well-maintained and run site with a high standard of ammunition storage. The ESH are in a good condition and the traversing is the most effective seen in BiH.

ANNEX B
TO CHAPTER 2

EXPLOSION CONSEQUENCE ANALYSIS
SURFACE AMMUNITION STORAGE AREA – EV 076 RUDO[9]

References:

A. TRLtd Limited ESH Inspection Report of 03 June 2004.
B. NATO AASTP-1, Annexes A and C.
C. Explosion Hazards and Evaluation, *W E Baker et al*, Elsevier, Oxford, 1983.

1. INTRODUCTION

1.1 Explosive Storehouse (ESH) 25 at the EV 076 RUDO Ammunition Storage Area (ASA) was chosen for the subject of this Explosion Consequence Analysis (ECA) as, although it does not contain the highest Net Explosive Quantity of the surface explosive storehouses (ESH) within Bosnia and Herzegovina, it is very close to human habitation and represents a typical ESH within an ammunition storage area (ASA) in BiH. Although ESH 20 within the site has a larger NEQ, the effects of an undesirable explosion at ESH 25 will illustrate the danger to the local populace.

1.2 Appendix 1 to this paper summarises ammunition stock holdings found in this ASA at the time of the visit at Reference A. There was a total Net Explosive Quantity (NEQ) of 670 tonnes of Hazard Division (HD) 1.1 and 1.2 ammunition, (all of which must be aggregated as HD 1.1). ESH 25 contains an NEQ of 84.8 tonnes.

1.3 There was no adequate segregation of different ammunition natures in the ESH, therefore it is assumed that all of the ammunition will propagate and contribute to the explosive effects.

1.4 The ammunition is stored in a single brick ESH with no effective traversing for protection. NATO explosive licensing regulations would require that the whole ASA be treated as a single Potential Explosion Site (PES) due to the very low internal quantity distances (IQD) and lack of protection provided by the buildings and traverses. However, for the purposes of this ECA, only the effects of an undesired explosion at a single ESH will be considered, as it is highly unlikely that there would be a mass detonation of the entire ASA. Experience from previous undesired explosive events in ASA suggests that the individual ESH detonate over a period of time. Although this time could be measured in minutes, the shock and blast effects of the individual detonations occur in milli-seconds; hence the requirement to examine the effects of a single ESH explosion.

2. SUMMARY OF FINDINGS

The important findings from the following Explosion Consequence Analysis can be summarised as follows:

[9] The RUDO Ammunition Storage Area (ASA) is located approximately 10 km from Visegrad.

- The physical infrastructure of the site means that **individual ESH could not be licensed to store ammunition in accordance with NATO standards**. The site would have to be treated as a single Potential Explosion Site (PES); even then the short safety distances to buildings inhabited by civilians (400m) means that the site could not safely store the quantity of ammunition that it currently holds.

- Personnel working in other buildings within the site would be seriously at risk should an undesired explosive event occur in ESH 25. They would certainly suffer from Eardrum Rupture, although it could safely be assumed that their injuries due to fragmentation injuries would be far worse.

- Civilian personnel in the nearest inhabited building would **not suffer significant hearing or lung damage** should an undesired explosive event occur. Eardrum Rupture could be expected out to a distance of 207 metres from ESH 25.

- An explosive event in ESH 25 would lead to significant damage to the surrounding ESH, and there would be **extreme structural damage**.

- Vehicles on the road are **not at risk of overturning** should there be an undesired explosive event.

3. EXPLOSIVES LIMIT LICENCE (ELL) TO NATO STANDARDS

3.1 The NATO AASPT (Reference B) defines the internationally accepted safety distances to be followed for the safe storage of ammunition and explosives in order to reduce the risk to the general public to an acceptable level.

3.2 The application of NATO AASPT regulations to the selected ammunition storage area would produce the following explosive limits.

SER	ES	DISTANCE FROM PES ESH 25 (m)	QD REFERENCE	ELL LIMIT (kg)	DISTANCE FUNCTION	REMARKS
(a)	(b)	(c)	(d)	(e)	(f)	(g)
1	ESH 24	50	D 12	NIL	$0.8Q^{1/3}$	
2	Road 1 (Group 3)	400	D11 (>270)	18,000	$3.6Q^{1/2}$	
3	House 1 (Group 4)	400	D13 (>400)	5,500	$5.5Q^{1/2}$	

Table 1: NATO Explosive Limits

3.3 ***The presence of the ESH 24 at 50m from the ESH would be the primary factor to preclude the storage of any Hazard Division 1.1 ammunition in this ESH under NATO regulations***. Should a technical waiver be granted, then the next limiting factor of House 1 at 400m would limit the NEQ to 5,500 Kg. The ESH currently stores over fourteen times the quantity that would be permitted under NATO AASPT limits, even with a waiver.

4. EXPLOSION CONSEQUENCE ANALYSIS

4.1 Blast Shock Effects

4.1.1 Determination of P_s and I Limits for Personnel

The peak side-on pressure (P_s) and Impulse (I) limits were initially derived from Reference B as follows:

(1) For the first stage of the analysis the Threshold Eardrum Rupture P_s of 34.5 kPa (*Hirsch* 1968) was taken as the acceptable blast damage level to personnel. (*Baker, Page 595)*.

(2) The total NEQ of 84.8 tonnes, (84,768 kg) was input into the Airburst Parameters v Blast calculation (*Kingery and Bulmash*). This predicted the following P_s levels for the ES at the surface, (assuming TNT equivalence of ESH contents as 1.0):

SER	ES	DISTANCE FROM PES ESH 25 (m)	P_S (kPa)	P_r (kPa)	I_s (Kpa.s)	I_r (kPa.s)	T_+ (ms)
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1	ESH 24	50	**699.21**	3424.33	6865.46	20751.60	29.79
2	Road (Group 3)	400	12.58	26.56	1014.47	1924.46	889.49
3	House 1 (Group 4)	400	**12.58**	26.56	1014.47	1924.46	889.49

Table 2: Pressure / Impulse Levels for PES (P_s = 34.5 kPa)

(3) *These results show that military personnel working in the adjacent ESH 24 would suffer from Eardrum Rupture, should there be an undesired explosive event. However, as the explosive event would so large, they are very likely to suffer from more significant injuries anyway, and therefore this particular effect can be discounted as minor compared to the other hazards.*

Civilian personnel at the House 1 would not be close to the Eardrum Rupture Threshold level and may only suffer some limited hearing damage.

If the Threshold Eardrum Rupture P_s of 34.5 K.Pa is input into the calculation, then it can be shown that significant hearing damage will be inflicted on any other personnel out to a distance of 207m.

(4) The Lung Damage Threshold levels at the House 1 were then investigated using the figures from Serial (3), Table 2 above. The methodology at *Baker, Page 593* was used to calculate the following:

Scaled Pressure $\mathbf{P_{sp}}$ = **P_s / Ambient Pressure (P_0)**

Ambient Pressure at Sea Level = 102 kPa.
Peak Side On Pressure (P_s) = Ambient Pressure + P_s (Table 2).

Therefore, $\mathbf{P_{sp} = (102 + 12.58)/102 = 1.123}$

The Scaled Impulse, $\mathbf{I_{si} = I_s / P_0^{1/2} m^{1/3}}$, where m = mass of person was then investigated. Assuming the Mass of an Adult Female as 55kg, the Scaled Impulse at ESH 25 for the figures at Table 2 above are:

$$\mathbf{I_{si} = 1014.47 / (102{,}000^{1/2} \times 55^{1/3}) = 0.8353\ Pa^{1/2}.s/kg^{1/3}}$$

These Scaled Pressure and Scaled Impulse figures are below the 99% Survival Curve for Lung Damage. It can therefore be assumed that females will survive with minimal lung damage injury.

This methodology was then used to calculate the effects on a young baby at the House 1; (babies being the most vulnerable targets).

The Scaled Pressure and Scaled Impulse for a young baby of Mass = 5kg at the House 1 was then calculated from

Scaled Pressure $\mathbf{P_{sp} = P_s / Ambient\ Pressure\ (P_0)}$ and
Scaled Impulse $\mathbf{I_{si} = I_s / P_0^{1/2} m^{1/3}}$:

$$\mathbf{P_{sp} = (102 + 12.58)/102 = 1.123}$$

$$I_{si} = 1014.47 / (102{,}000^{1/2} \times 5^{1/3}) = \mathbf{5.432\ Pa^{1/2}.s/kg^{1/3}}$$

These Scaled Pressure and Scaled Impulse figures are below the 99% Survival Curve for Lung Damage. It can therefore be assumed that babies will also survive with minimal lung damage injury.

4.1.2 Effect of Blast on Exposed Site (ES) Structures

ESH 24

(1) General. ESH 24 is of similar construction to that of ESH 25 and is designed to protect its contents from the explosion effects of an adjacent ESH. There are no windows to be considered, only a single brick structure with no traverse protection.

(2) Scaled Distance Evaluation. *Reference C, Page 567 - 568* discusses the effects of blast on structures. The US Department of Defense uses the criteria that Range / Charge Weight$^{1/3}$ = Constant, (**K = R/W$^{1/3}$**). Although this criterion implies a constant overpressure, which infers response in the quasi-static loading realm, it is the basis of all blast pressure effect qualitative assessment. Therefore it is used in this Consequence Analysis. A comparison of the figures from Table 1 v those obtained from *Table 8.1 at Reference C* is as follows at Table 3:

SER	DATA SOURCE	R/W$^{1/3}$ (m/kg$^{1/3}$)	P_s (kPa)
(a)	(b)	(c)	(d)
1	US DoD (Reference C) Requirements	4.4	55
2	*Kingery* (Table 1 Above)	1.14	698.66

Table 3: Comparison of Data for ESH 25

(3) Conclusion. ***The NEQ stored in ESH 25 will cause major damage to ESH 24 in the event of an undesirable explosive event as the R/W$^{1/3}$ is approximately 25% of the DOD required level.*** *Reference C, Page 565 - 566* discusses the use of *Jarret's Equation* to predict the damage level. If the i_s and P_s figures from Table 1 above are interpolated against *Figure 8-1* in *Baker* then it can be predicted that ***there will be extreme structural damage***, as the interpolated figures fall outside the parameters of the curve.

House 1

(1) General. The House 1 is a brick built structure with windows to be considered. It is unprotected from the effects of an event in ESH 25.

(2) Scaled Distance Evaluation. Using the same methodology as that for ESH 24, a comparison of the figures from Table 4 v those obtained from *Table 8.1 at Reference C* is as follows at Table 4:

SER	DATA SOURCE	R/W$^{1/3}$ (m/kg$^{1/3}$)	P_s (kPa)
(a)	(b)	(c)	(d)
1	US DoD (Reference C)	4.4	55.0
2	*Kingery* (Table 1 Above)	9.11	12.58

Table 4: Comparison of Data for Range

There will be no significant structural damage caused by blast at House 1.

(3) Effect on Windows. It has been assumed that the parameters for the windows are:

Type of Glass: Sheet (Use *Reference B, Figure 8-3)*
Pane Area: 0.5 m^2
Pane Thickness[10]: 0.003 m
Pressure (P_s): 12.58 K.Pa (Window not in Line of Sight)

Interpolation of the graph estimates that there will be ***no glass breakage*** due to P_s loading resulting from an event in ESH 25, as the glass needs to be subjected to a side-on pressure of approximately 22 N.m^2.

Road

Assuming that the target to be considered on the Road is a large truck, 5m long, 2.7m high and 2m wide, with a high centre of gravity @ 1.35m and Mass of 6000 kg. The following is derived in Excel from *Reference B, Figures 8-4 and 8-5* (Enclosure 4):

[10] Equivalent to 1/8 inch.

Scaled P_s = P_s / P_0 = 12.58 / 102 = 0.1233

Scaled Free Field Impulse = $(a_0 C_D I_s)/P_0 H)$
= (329 x 1.8 x 1014.47)/(102000 x 2.7)
= 2.18

Entering *Figure 8.4* gives a Scaled Specific Impulse (I_S) applied to the target vehicle of approx 0.18. The Average Specific Impulse (I_t) can then be calculated from:

I_t = $(I_S . P_0 . H)/a_0$
I_t = 11.55 (Units not necessary as it is a direct comparison)

(where a_0 = ambient sound velocity, C_D = Air Drag Coefficient (taken as 0.5), H = Target Height)

Then,

Scaled Target Height (h/w) = 1.35
Scaled C of G Location = 0.50

Entering *Table 8.5* gives a Scaled Critical Impulse Threshold (I_{sci}) of 0.56.

I_θ = $(I_{sci} A h_{bl}) / m g^{1/2} b^{3/2}$
= $(I_{sci} m g^{1/2} b^{3/2}) / A h_{bl}$
= $(0.56 \times 6000 \times 9.8^{1/2} \times 2^{3/2}) / ((5 \times 2.7) \times 1.35)$

.

(Where I_θ = Critical Threshold Impulse, A and h_{bl} = Centre of Pressure Height (Assumed to be ½ Vehicle Height, m = Vehicle Mass, g = gravity and b = Width of Vehicle)

Therefore

I_θ = 2020 (Units not necessary as it is a direct comparison)

As I_t is less than I_θ ***the vehicle will not overturn***.

4.2 Effect of Fragmentation on ES

4.2.1 General

The lack of an effective Interceptor Traverse means that any Low Angle, High Velocity fragments from heavy cased munitions within ESH 25 will present a risk. The threat to the ES is therefore from both Low Angle, High Velocity and High Angle, Low Velocity fragments.

4.2.2 Calculation of Large Fragment Velocity

It is assumed that the worst-case munition is a 152mm Shell HE with the following masses:

Mass of Shell Body and Filling	30.87 kg
Mass of Filling	6.25 kg
Mass of Shell Body	24.62 kg

Assume that on detonation the worst-case **large fragment** is the shell base, which is approximately 20% of the mass of the shell body, this equates to a maximum Fragment Mass of 4.924 kg. Therefore, from the Gurney Equation:

$$\mathbf{V_0 = (2E)^{1/2} (\mu/(1 + 1/2\mu)^{1/2}}$$

(Where $(2E)^{1/2}$ = Gurney Constant and μ = Charge Mass / Body Mass)

Gurney Constant for TNT = 2097 m/s

$$\mathbf{V_0 = 995.28\ m/s}$$

4.2.3 Calculation of Large Fragment Throw Distance

Two simple methods can be used to estimate the Fragment Throw Distance:

(1) <u>From Fragment Slowdown Equation</u>.

$$\mathbf{V_s = V_d \exp \frac{(-2C_d \rho_{air} A s)}{2m}}$$

(where C_d = Drag Coefficient (=0.64), ρ_{air} = Air Density (=1.225 kg/m^3), A = Base Area (=0.01815m^2) and m = Base Mass (=4.924))

Assuming vertical or horizontal throw for the fragment, then V_s will be 0 in the vertical and horizontal directions. Therefore:

$0 = 995.28 \exp(-2.898 \times 10^{-3}\ s)$

Taking logs:

$1 = -1.1854 \times 10^{-3}\ s$
Vertical Throw Distance = 346 m

The worst-case launch angle for maximum range can be assumed to be 39^0

Then assuming that the worst case fragment throw distance in the vertical plane is that predicted from the Gurney equation and Fragment Slowdown equation is 346m, using Hypotenuse predictions:

Horizontal Distance Travelled $D_h = \cos 39^0 \times 346$

$$\mathbf{D_h = 268.9m}$$

(2) <u>From Ballistic Equation</u>. The range of a projectile can be estimated using the formula, (assuming $\theta = 39^0$ for maximum range):

$$R = \frac{V_0}{g} \sin 2\theta$$

$$= (995.28/9.81) \sin (2 \times 39)$$

$$R = 99.24\text{m}$$

4.2.4 Conclusions

The maximum fragment throw distance for a large fragment will travel between 99.24m and 268.9m, therefore all of the PES are vulnerable to base fragment attack from any base fragments of 152mm HE shell stored in ESH 25. Further quantitative assessment is required to evaluation the mathematical chance of such a scenario.

The danger area for more ballistically stable, smaller fragments from the shell will be equivalent to the danger area for the munition, which in this case can be expected to be in excess of 900m.

4.3 Effect of Ground Shock on ES

A simple formula, derived from experimentation, is used by the UK Defence Evaluation and Research Agency to estimate the distance over which the Ground Shock induced by an event is transmitted:

$$D = 32\,(NEQ)^{1/2}$$

$$= 32\,(84768)^{1/2}$$

$$D = 9316\text{m}$$

This estimated distance means that significant Ground Shock will be experienced by all of the ES.

5. ADDITIONAL TECHNICAL IMPACTS

An undesired explosive event would inevitable lead to Unexploded Ordnance (UXO) contamination of the local area if either a high or low order detonation of the stocks occurs. Ammunition would be projected out of the ESHs at high velocity during the explosion in a ballistically unstable trajectory. This "kicked out" ammunition could have been subjected to external forces similar to those found when fired from a weapon. These forces, (spin, set back, centripetal and set forward), are the forces used by the fuze designer to arm the munition, so that in effect, the ammunition could end up in an armed condition and therefore be unsafe.

Lagos, Nigeria 2002: Effects of 'kick out' scenario after an undesired explosive event. This incident alone resulted in over 1500 civilian fatalities!

(Photo courtesy PATO, HQ LAND Command, UK)

This "kick-out" scenario would require a full planned UXO clearance operation of the entire area around the demolition pits, an operation that is expensive, time consuming and dangerous. It would add significantly to the workload of the BiH Mine Action Centre (BHMAC).

Appendix:

1. Ammunition Stored in EV076 RUDO ASA.

APPENDIX 1
TO ANNEX B

EV 076 RUDO
AMMUNITION STORAGE STATISTICS

ESH	NEQ (KG)	HD	REMARKS
(a)	(b)	(c)	(d)
ESH 11	70,628	1.1	
ESH 12	45,631	1.1	
ESH 13	16,342	1.1	
ESH 14	60,464	1.1	
ESH 15	22,306	1.1	
ESH 16	72,850	1.1	
ESH 17	18,630	1.2	
ESH 18	53,007	1.1	
ESH 19	65,694	1.1	
ESH 20	92,036	1.1	
ESH 21	2,758	1.1	
ESH 23	22,242	1.1	
ESH 24	42,365	1.1	
ESH 25	**84,768**	**1.1**	**Selected for ECA**
TOTAL NEQ	**669,721**	1.1	**(670 Tonnes)**

ANNEX C
TO CHAPTER 2

ESTIMATED MANPOWER REQUIREMENTS
OPERATION OF AMMUNITION DEMILITARISATION FACILITY

1. Phase A[11] - Demilitarisation Staff. The following table provides an estimate of the manpower requirements for the initial phase of the demilitarisation project.

SER	GRADE	ROLE	INT	LOCAL
1	Project Manager	General manager. Overall responsibility for demilitarisation, logistics and scrap recovery.	1	
2	Technical Manager	Technical manager of demilitarisation facility and logistics safety officer.	1	
3	Deputy Technical Manager	Technical manager of demilitarisation facility and logistics safety officer.		1
4	2nd Shift Supervisor.	Assistant technical manager.		1
5	Engineer.	Chief equipment engineer.	1	
6	Deputy Engineer.	Deputy equipment engineer.		1
7	Lead Operators.	Equipment operators supervisors.		2
8	Equipment Operators.	Operators of demilitarisation equipment.		10
9	Labourers.	General duties personnel.		5
	TOTAL		**4**	**19**

2. Phase A - Administrative Support. The following table provides an estimate of the manpower requirements for the initial phase of the demilitarisation project.

SER	GRADE	ROLE	INT	LOCAL
1	Finance & Administration.	Financial and administration officer.	1	
2	Ammunition Accounts and Audits	Control, issue & receipt of ammunition stocks. Auditing of technical accounts.		1
3	Clerical Support / Interpreters.	Act as clerical support for the admini-strative and technical management staff.		2
	TOTAL		**1**	**3**

3. Phase B[12] - Demilitarisation Staff. The following table provides an estimate of the manpower requirements for the second phase of the demilitarisation project.

SER	GRADE	ROLE	INT	LOCAL
1	Director	General manager. Overall responsibility for demilitarisation, logistics and scrap recovery.	1	
2	Technical Manager	Technical manager of demilitarisation facility and logistics safety officer.	1	
3	Deputy Technical Manager	Technical manager of demilitarisation facility and logistics safety officer. (Takes over from International)		1
4	2nd Shift Supervisor.	Assistant technical manager.		1
5	Engineer.	Chief equipment engineer.	1	

[11] Phase A – installation and operation of incineration facility designed to dispose of unstable and obsolete ammunition
[12] Phase B – Upgrade ADF to include facilities for the recovery of TNT.

SER	GRADE	ROLE	INT	LOCAL
6	Deputy Engineer.	Deputy equipment engineer.		4
7	Lead Operators.	Equipment operators supervisors.		4
8	Equipment Operators.	Operators of demilitarisation equipment.		18
9	Labourers.	General duties personnel.		7
	TOTAL		**3**	**35**

4. Phase B - Administrative Support. The following table provides an estimate of the manpower requirements for the second phase of the demilitarisation project.

SER	GRADE	ROLE	INT	LOCAL
1	Finance & Administration.	Financial and administration officer.	1	
2	Ammunition Accounts and Audits	Control, issue & receipt of ammunition stocks. Auditing of technical accounts.		2
3	Clerical Support / Interpreters.	Act as clerical support for the administrative and technical management staff.		4
	TOTAL		**1**	**6**

5. Summary. The summary of manpower requirements for the operation of the proposed facility is as follows.

SER	GRADE	Phase A		Phase B	
		International	Local	International	Local
1	Director	1		1	
2	Technical Manager.	1		1	
3	Deputy Technical Manager.	1			1
4	2nd Shift Supervisor.		1		1
5	Engineer.	1		1	
6	Deputy Engineer.		1		4
7	Lead Operators.		2		4
8	Equipment Operators.		10		18
9	Labourers.		5		7
10	Finance & Administration.	1		1	
11	Ammunition Accounts and Audits		1		2
12	Clerical Support / Interpreters.		2		4
TOTALS		**5**	**22**	**4**	**41**

ANNEX D
TO CHAPTER 2

ESTIMATED MANPOWER REQUIREMENTS
CONSTRUCTION OF AMMUNITION DEMILITARISATION FACILITY

Note: These tables are designed to show local manpower that will be used in the construction/refurbishment phases of the ADF. Costs for this activity are include in refurbishment and equipment installation charges.

Table 1 – Estimated Manpower Requirements – ADF Refurbishment.

SER	GRADE	ROLE	INT	LOCAL
1	Carpenter.	Refurbishment of doors, panelling and windows.		2
2	Glazier.	Refurbishment of windows.		1
3	Electrician.	Rewiring of Ammunition process Buildings.		2
4	Construction.	Repairs to flooring. Repairs to air and water supply system		3
5	Labourer.	General duties/assistants.		4
	TOTAL			**12**

Table 2–Estimated Manpower Requirements – Equipment Preparation & Installation.

SER	GRADE	ROLE	INT	LOCAL
1	Construction.	Laying of incinerator bed.		4
2	Labourer.	General duties/assistants.		2
3	Electrician.	Equipment electrical installation.		2
4	Plumber	Equipment water supply installation.		2
5	Crane operator.	Large equipment handling.		1
6	MHE operator	Equipment handling.		1
	TOTAL			**12**

ANNEX E
TO CHAPTER 2

ESTIMATED MANPOWER REQUIREMENTS
DESIGN AND PROJECT MANAGEMENT OF AMMUNITION DEMILITARISATION FACILITY

Table 1 - ADF Supervisor Team.

SER	GRADE	ROLE	INT	LOCAL
1	Project Supervisor *(Full time, probably a consultant development specialist)*	• Donor/coordinator project Manager • Contracts manager.	1	
2	Accountant. *(Part-time)*	• Project finances.		1
3	Secretarial. *(Full time)*	• General clerical duties / Interpreter		2
4	Driver. *(Full time)*	• Supervisor team driver.		1
	TOTAL		**1**	**5**

Table 2 – ADF Supervisory Team. (Commercial)

SER	GRADE	ROLE	INT	LOCAL
1	Project Manager. *(Full-time international, non-technical)*	• Project Manager. • Team control. • High-level Liaison (Donors, NATO, political)	1	
2	Deputy Project Manager. *(Full time local, technically qualified.)*	• Act as Deputy Project Manager. • Manage all local staff and liaison.		1
3	Finance. *(Part-time local)*	• Financial administration and planning.		1
4	Construction engineering. *(Part-time local)*	• Oversee refurbishment and construction phases.		1
5	Demilitarisation equipment specialist. *(Full time international)*	• Design of Phase A facility. • Supervision of selection, procurement, shipping and installation of demil equipment.	1	
6	Ammunition technical specialist. *(Full time international)*	• Phase A design assistants. • The production of procedures, regulations and instructions appertaining to demilitarisation • activity.	1	

SER	GRADE	ROLE	INT	LOCAL
7	Assistant Ammunition technical/logistics specialist. *(Full time international)*	• Planning of in-loading, storage and logistics. • Storage licensing. • Liaison official to the BiH MoD. • EWI equipment commissioning.	1	
8	Clerical support *(Full time locally recruited)*	• General clerical duties for all staff. • Act as interpreters as required.		2
9	Driver *(Full time locally recruited)*	• General driving duties for team • Act as interpreter as required		2
	TOTAL		**4**	**7**

Bosnia and Herzegovina

THREAT RESOLUTION LIMITED

Chapter 3
ENVIRONMENTAL

CHAPTER 3 – ENVIRONMENTAL

TABLE OF CONTENTS

CHAPTER 3

ENVIRONMENTAL

1. DELIVERABLES

1.1 The environmental impact of the establishment of a Demilitarization Facility.

1.2 Recommendations as to the use of environmentally benign demilitarization techniques compliant with European Community environmental directives.

2. BACKGROUND

2.1 The Feasibility study has examined the type of demilitarization and scrap processing equipment necessary to operate an Ammunition Demilitarization Facility. The environmental compliance of each type of equipment has been considered in accordance with European Union environmental legislation.

Factors to be considered when identifying the impact on the local environment of the construction of such a facility have been identified. It is recommended that a full environmental impact study be conducted as part of the project management phase of any future project, once a site has been finally selected.

The environmental impact of current demilitarization activities, in particular Open Detonation have also been examined in order to demonstrate that, whilst these activities make an important contribution to reducing the existing stockpile there may be a significant environmental penalty.

3. CURRENT DISPOSAL ACTIVITY

3.1 General

At present EAF ammunition is disposed of by the following methods:

- Logistic disposal at Government Ordnance Factories (GOF).
- Disposal by Open Demolition and Open Burning, i.e. using serviceable high explosives to destroy unserviceable or surplus ammunition or burning ammunition (e.g. propellants).

3.1.1 Disposal at GOFs

Limited demilitarization activity at GOFs at P.S.Vitezit in Vitez and Binas d.d. at Bugojno was observed during a visit by TRLtd staff, accompanied by representative from the UNDP and Ministry of Defence. The processes in these facilities utilises either locally manufactured machinery or equipment adapted from pre-war production and disposal processes. All are were slow and inefficient and at Vitez, where an autoclave was being used to melt TNT explosive from mortar bombs, there was no evidence of any environmental protection measures in place to limit potentially unacceptable emissions to the environment. The SFOR ATO also reported[1] that demilitarization of Anti-

[1] Meeting with the SFOR ATO on Thursday 22 July 2004

Tank mines was currently conducted in GOF 18 at Doboj in the Republika Srpska but that, due to potential dangers posed by it's proximity to local houses, this activity is likely to be halted soon and this facility was, therefore not visited. Further discussion of the suitability of GOFs for future demilitarization is at Part 4 – Technical.

3.1.2 Disposal by Open Demolition and Open Burning (OBOD)

There are reported to be 16 demolition areas in use by SFOR and the EAF[2] where unserviceable ammunition is destroyed by OBOD. In Operation Armadillo, the stated aim of which is to "Support the Entity Armed Forces (EAF) with their efforts to reduce their current stocks of unserviceable, unsafe and surplus ammunition, in order to reduce the number of Ammunition Storage Sites (ASS) in BiH",[3] and in 2003 over 1100 tonnes of ammunition was destroyed". At this rate the 33,500 tonnes awaiting disposal, identified in Chapter 2, would take approximately 31 years to destroy. These activities have also faced considerable opposition from the civilian population and it was recently reported in a local newspaper that more than 100 villagers in Velika Ribnica and Brezovaca blocked the road between Banovici and Zavidovici in protest at the use of a nearby range, where SFOR have conducted demolitions over the last 2 years. According to villagers, since SFOR started to use the range damage has been caused to houses and stables and the local watercourse has become polluted and is unusable. They also claimed that the noise generated by these activities leaves local children in a "constant state of shock"[4].

Further evidence of civilian opposition to the detrimental environmental effects of disposal by demolition is provided in a UNDP Needs Assessment Report, which recently noted that:

"*The current practice of ammunition destruction has, to date, been greatly problematic. Local populations residing in close proximity to destruction sites often complain and protest destruction activities. Local residents cite two problems: first the loud noise and earth tremors that occur when destruction activities take place, and second, the increasing concentration of heavy metals that are accumulating close to areas where destruction takes place, which pose a hazard to both human and animal health. Flying debris from ammunition destruction activities is also a concern. Citizens' protests have been increasingly vocal. In Mostar, citizens recently cut off access with truckloads of sand to an area surrounding a destruction polygon in protest at activities, which left houses in the vicinity of the polygon damaged*"[5]

4 SUMMARY OF ENVIRONMENTAL HAZARDS

4.1 Those hazards noted above are not the only potential environmental hazards associated with the disposal of ammunition by OBOD. A comprehensive summary of hazards and potential consequences is shown at Annex A.

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[2] Information provided by the SFOR ATO on 9 May 2004
[3] "SFOR Operation Armadillo", SFOR Factsheet, February 2004.
[4] "Detonations From the Shooting Range Destroying Houses and Water Source", Daily Voice, 15 June 2004, p 12.
[5] UNDP Needs Assessment Report, 2003, p 54.

5 ENVIRONMENTAL LEGISLATION

5.1 BiH Legislation

Environmental legislation in BiH is very immature and unenforced. No information could be found by the study teams of any plans to introduce such legislation in the immediate future.

5.2 European Union (EU) Environmental Legislation

There is a wide range of EU environmental legislation on the statute books of all EU members, which is all based on EU Directives from Brussels, to which the Government of BiH aspires to comply, in order to satisfy the requirements of international donors of financial assistance. The one most applicable to demilitarization operations is the directive that lays down emission levels and rates. All demilitarization equipment manufacturers are aware of this legislation in detail and can indicate to what level their products comply with this legislation.

It is therefore recommended that EU environmental legislation relating to emission levels is used as the basis for any Invitations To Tender (ITT) submitted, as this is the most stringent legislation in the region. The Ammunition Demilitarization Facility (ADF) Implementation Team should discuss this requirement with potential manufacturers and suppliers during the design phase of the project.

6. ENVIRONMENTAL COMPLIANCE OF DEMILITARIZATION EQUIPMENT

6.1 Current BiH Equipment

The BiH GOFs currently have a limited demilitarization capacity. This current capability is developed upon locally- manufactured equipment and redundant ammunition manufacturing equipment which has been adapted to demilitarization purposes. No Pollution Control Systems (PCS) are incorporated and therefore they do not meet any of the European Directives on Emissions.

6.2 Proposed Demilitarization Technology

The technology alternatives for the demilitarization facility PCS are discussed in detail in Chapter 4 - Technical. Of the two alternatives for emission control, Bag House v Dry Ceramic Filtration, only the latter has a proven record of meeting the EU Directive. Because of the dynamics of the situation, further detailed information should be gained from proposed suppliers during the tendering phase. Details of the compliance of Dry Ceramic Filtration have been included in this report to illustrate the compliance is technically feasible; it does not indicate that this is the only available, complaint technology.

6.3 Dry Ceramic Filtration Compliance

The structure of ceramic filter media comprises a substantial thickness, 10mm, of a very low pore size material. These materials give filtration efficiencies that are higher than any other cleanable gas filter medium. In the UK, three tests are used to classify gas filter media. The tests, in ascending

order of discrimination, are for arrestance to BS6540, dust spot efficiency to BS6540 and sodium flame efficiency to BS3928.

Filter media are rated according to the Eurovent (Eu) classification on grades from Eu1 to Eu 14 and the ceramic filtration medium used by the UK system at Shoeburyness is classified Eu 10. Previously ratings of Eu 10 and above had been achieved only by disposable HEPA filter modules. Most bag filter media are rated in the range Eu 3 to Eu 8 and well-operated electrostatic precipitators can achieve Eu 8 standard.

The sodium flame test is performed on a sample of the virgin filter medium that is challenged with an aerosol of sodium chloride. The aerosol has a mean particle size of 0.09 micron, (particle number basis), 0.6 micron (particle mass basis). A capture efficiency in excess of 95% is required to gain a rating of Eu10. The UK ceramic elements typically achieve efficiencies of 99%. However, this efficiency is a measure of the performance of the virgin element only. The conditioning process creates a composite layer of dust and medium at the filter surface. This layer greatly enhances the removal efficiency of the filter to the extent that many operators find it difficult to collect an adequate sample for an efficiency determination. (In the environmental assessment trials of the UK facility, the commercial company conducting the trials had to use non-standard equipment in order to gain any results at all).

7. ENVIRONMENTAL COMPLIANCE OF SCRAP PROCESSING EQUIPMENT

7.1 Necessity for Scrap Metal Processing

There are 2 reasons why the introduction of a scrap processing is necessary. Firstly smelting, shredding, granulating or fragmenting of cartridge cases, shell bodies and other components is an essential element of ensuring that all scrap materials that leave the ADF will be Free From Explosives (FFE). By definition it is a fundamental requirement of demilitarization to “Render munitions unfit for their intended purpose”[6] A further benefit of processing scrap metal is that cartridge cases and shell bodies are hollow and volume reduction (densifying) is required to make export viable.

7.2 At the Unis-Prentis GOF in Vogosca, there is a working foundry that produces mortar bomb bodies and large calibre cartridge cases. It does not have suitable pollution control equipment and will require upgrading to meet EU standards. The Study Team was also made aware of metal recycling facilities at Zenica and Jelsingrad, but the extent of their compliance with EU standards is not yet known and their suitability should be included in the Environmental Impact Assessment recommended at paragraph 2 above.

8 RECYCLING OF WOOD

8.1 Much of the EAF ammunition stockpile is contained in wooden packaging. The demilitarization process will result in large amounts of scrap wood per day during Phase A. The Team have identified that a certain amount of serviceable packaging will require to be reused by the EAF to replace that which is broken or rotten and also to pack unpacked stock. Although the recovered wood will have no financial value in BiH, the volume of wood

[6] International Mine Action Standards, Chapter 04.10, First Edition, 1 October 2001.

arising from the demilitarization process makes it desirable that an environmentally benign disposal route should be considered.

8.2 The most likely disposal route is chipboard production, however a number of important factors need to be considered such as the possible use of toxic wood-preservatives. Factors requiring consideration for wooden packaging recycling are at Annex D.

9. CONCLUSIONS

- Whilst they are necessary as an emergency measure current demilitarization techniques, especially OBOD of certain ammunition natures, present a significant environmental threat. Although there will be a continued requirement for OBOD, to destroy unstable ammunition, its long term use can only be applied to specific munition types[7].

- Environmentally benign demilitarization equipment that meets the requirements of applicable EU Legislation is available. Its introduction in BiH would significantly lessen the environmental impact currently experienced.

10. RECOMMENDATIONS

- That the appointed Executing Agency capacity build the BiH GOFs already undertaking demilitarization work with a view to attaining compliance with EU legislation.

- EU environmental legislation relating to emission levels is used as the basis for any Invitation To Tender (ITT) for the emission control system for the proposed Explosive Waster Incinerator.

- A full Environmental Impact Assessment (EIA) on the proposed technical solution is conducted prior to project implementation.

[7] In this context "Long Term" is assumed to be more than 5 years.

ANNEX A
TO CHAPTER 3

HAZARDS ASSOCIATED WITH DISPOSAL OF AMMUNITION BY OPEN DEMOLITION AND OPEN BURNING[8]

SER	HAZARD	THREAT/IMPACT	CONSEQUENCE
1	Explosions	Changes to local topography.	Open detonation will generate craters and the associated loss of quantities of soil and sub-soil. Re-instatement of the local topography may not be possible using displaced soil.
		Possible effects on water table.	Shock waves from open detonation may affect the local porosity of sub-soils and so impact on the efficiency of local wells and ground water resources
		Damage to third party assets.	Shock waves from open detonation can be encountered locally but very rarely at considerable distances form the site. Damage to civilian property may occur although predictive equations are available that should prevent such incidents.
		Disturbance to local wildlife	Species disturbed by explosions are likely to have been displaced from the area, although other studies indicate an increase in wildlife, notably where the demolition area is a 'protected area' from human encroachment.
		Land contamination.	Metal fragments may cause sufficient contamination of local grazing land and/or present sufficient potential hazard to farm animals to render land unusable until cleared of scrap metal.
		Smoke and noise pollution.	Open detonation and open burning will release smoke and toxic fumes to the atmosphere. Local air pollution may affect health of civilians and animals. Long term pollution caused by the release of smoke and toxic gases into the atmosphere. Noise pollution may have a detrimental social effect on civilians, but this is usually due to the unusual frequency of the sound rather than its intensity.
2	Explosive Residues	Possible soil contamination.	Open detonation and open burning may result in explosive residues contaminating soil and local watercourses – thus preventing use for agricultural and domestic purposes. There is however contrary evidence to shows an increase in nitrate levels, and hence productivity[9].

[8] Extracted from an Environmental Impact Study, conducted to support opposition to the use of National Parks for military training, including Open Detonation, by the UK Ministry of Defence, August 1996.
[9] "SALW – ammunition destruction – environmental releases from open burning (OB) and open detonation (OD) events", 30 May 2004.

SER	HAZARD	THREAT/IMPACT	CONSEQUENCE
3	Fire	Loss of agricultural land, wildlife habitat and species.	Sparks and firebrands accidentally projected by open burning and open demolition may cause fires in local area resulting in the destruction of fauna and vegetation.
4	Fuel and Lubricating Oils	Possible contamination of soil and water.	Vehicles and machinery used to transport munitions may require refuelling in the field and careless use can cause contamination by spillage during refuelling operations from portable jerry cans.
5	General Hazardous Waste	Litter and ground contamination.	Poor management may cause general waste materials, including human waste, which may cause contamination.

ANNEX B
TO CHAPTER 3

RECYCLING OF WOOD

1. BACKGROUND INFORMATION

1.1 Wood is a naturally occurring building material. Waste wood has been defined as "all wood, wood fibre and bark that is discarded, unused or unwanted by manufacturing, construction or demolition operation, municipality, government agency or other organisation".[10]

2. TECHNOLOGY

2.1 There are five major activities associated with reusing and recycling wood: refurbishing, processing, manufacturing, composting and incineration for energy from wood. Refurbishing is the act of cleaning and fixing a wood product without necessarily making a different product. Repairing pallets for resale is an example of refurbishing. Processing is the grinding or chipping or wood in preparation for use or for further manufacturing. Manufacturing is the act of creating a new product from processed wood. Using wood as a drying agent is a common practice in large-scale composting. Using wood as an energy source is also an option. Refurbishing requires that the broken boards of pallets be removed and replaced with new boards. The pallets are then sent to the marketplace. Refurbishing is not a technically skilled industry but is labour-intensive.

2.2 Before waste wood can be processed by chipping or grinding, it must pass through a cleaning process. Non-wood materials such as nails, staples, plastic and bits of masonry often adhere to wood. These contaminants are easily removed through manual or mechanical methods. Vibration and flotation can also be used to separate and clean the contaminated wood. There are, however, non-wood materials that are chemically bound to wood such as creosote, paint, glues, varnish, urea formaldehyde resins and others. Processors of wood waste may require that loads of delivered material be sorted to remove most or all the chemically treated wood.

2.3 At some facilities, accepted materials are loaded into a flotation tank in which wood material floats, while other material sinks. The flotation tank also provides the opportunity to rinse dirt, dust and other material from the wood, before processing. The wood is then loaded with a grapple or front-end loader onto a conveyor belt. In some systems, the conveying system is designed to vibrate. Non-wood materials to be processed later are put in storage piles adjacent to the unloading area. The wood on the conveyor is inspected and sorted manually to remove contaminated wood that should not be processed. The wood is conveyed past a large magnet to separate out additional pieces of metal, such as nails, staples and bits of flashing. Once past the magnet, materials move along an in-feed conveyor into the top of a hammer mill similar to those used in the lumber and wood products industries. Hammer mill processing produces small, uniform wood chips from multiple sizes and shapes of wood waste material. The wood materials pass from the base of the hammer mill past a second magnet that removes any remaining ferrous

[10] "Wood Waste Generation and Management in Ontario", Ontario Ministry of the Environment, April 1991.

metal. The processed material then passes over a double-decker vibrating screen that separates over-sized pieces (the "overs") and under-sized pieces (the "fines") from the processed material. The processed wood material travels from the shaker screen to a conveyor that loads the material into a truck or into a storage hopper.

2.4 Manufacturing technology varies according to the product that is being produced. Generally, all wood must be chipped or ground before manufacturing. Composting requires that wood waste be processed into suitable sizes. First, wood must be cleaned of contaminants such as nails through a magnetic process. Then, a double process of grinding may be required to reduce the size of the wood. The particles that are produced may be used as bulking or drying agents in both outdoor and enclosed vessel composting. Harnessing energy from wood waste requires the use of boilers and other equipment. Wood must be processed into three-inch diameters then chipped to a size less than 0.5 inches. Boilers, wood waste storage structures, feed conveyors and piping, exhaust and electrical systems must be installed. Small-scale energy from wood systems can be used to heat greenhouses in the winter. Larger-scale projects have shown that it is possible to garner enough energy for heating and domestic hot water purposes.

3. ENVIRONMENTAL IMPACTS

3.1 The diversion of wood waste from landfills can reduce the need for disposal space thus lengthening the lifespan of existing landfills. By reusing and recycling discarded wood we save trees thereby preserving wildlife habitat, minimising soil erosion and maintaining air quality.

3.2 Pentachlorophenal (PCP), creosote, Chromated Copper Arsenate (CCA) and Ammonical Copper Arsente (ACA) are the most common preservatives used to treat all types of wood-based products which are designed to endure a harsh environment or with longevity in mind. Such chemicals are commonly used in ammunition packaging and there is a clear need for tests prior to disposal.

3.3 Research into the environmental, health and safety effects of placing treated wood into or near aquatic or landscape environments is ongoing." It has been found that these chemicals can leach into water over a period of time, affecting small organisms. Skin contact can cause dermatitis. The U.S. Environmental Protection Agency has found that the chemicals exceeded the risk criteria for tumour production. The risk is greater to those who apply the chemical than to those exposed to them.[11]

3.4 The US Academy of Natural Sciences found that when pressure-treated lumber is used in the building of piers and decks substantial amounts of arsenic, chromium and copper leach into surrounding bodies of water.[12]

3.5 Non-sustainable harvesting of trees (or clear cutting) can lead to degradation or destruction of both temperate and tropical forests. Wiser use - or reuse - of wood products can help to ensure the preservation of forests.

[11] Wood Preservatives Decision Fact Sheet", EPA
[12] Dr. James Sanders, Benedict Estuarine Research Laboratory, 215-299-1199

Bosnia and Herzegovina

THREAT RESOLUTION LIMITED

Chapter 4
TECHNICAL

CHAPTER 4 – TECHNICAL

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TECHNICAL

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1.1 Identify potential locations for the proposed Facility and on this basis put forward alternative schemes for the development of the project.

2. CONDITION OF EAF ARMED FORCES AMMUNITION STOCKPILE

2.1 During the period 28 May – 11 June 2004 a project team member visited the six Ammunition Storage Sites (ASS) at which the EAF intend to consolidate the ammunition stockpile[1]. Four of the sites, at Tuzla (NB 075), Gabela (EF 007), Grebez (WB 053) and Pazaric Krupa (EF 024) are run by the Federation Army and the remaining two at Rudo (EV 076) and Kula 1&2 (WV 096) are run by the Army of the Republika Srpska. These sites are all former Yugoslav Army facilities that were built in the 1950's but a significant number suffered serious structural damage during the conflicts of the 1990's.

2.2 The physical condition of the BiH ammunition is generally good on visual inspection, but the poor conditions in much of the storage are contributing to deterioration and there is already evidence of corrosion on some artillery shell. Of most significant concern is the lack of basic safety measures in storage as most ammunition is not stored according to its Compatibility Group, the purpose of which is to ensure the segregation of sensitive natures to prevent them contributing unnecessarily to the effects of an explosion or fire. The resultant hazard is significantly exacerbated by

[1] Recommended by the SFOR ATO on 21 May 2004.

the presence of a considerable amount of ammunition, which is not properly packaged, and further stocks that are stored in the open, between storehouses. The buildings in which the ammunition is stored do not have Explosive Limit Licenses (ELL) and storage limits are governed only by the physical capacity of each store. Furthermore, many of the storehouses are not constructed to NATO standards. An Explosion Consequence Analysis of the storage facilities at Rudo, detailed in Annex A to Chapter 2, revealed that the external and internal safety distances are severely compromised and an unplanned explosive event in one store would result in severe damage to the others and could lead to a major explosive incident[2] in the storage site.

The lack of a structured surveillance system, in particular the conduct of propellant stability testing which is described in Chapter 2 – Humanitarian, significantly increase the risk of an unplanned explosion if spontaneous ignition of propellant occurs.

In Rudo and Kula 2 there are unidentified chemicals, possibly a liquid propellant oxidizer, which presents both a significant fire and health risk, stored alongside other ammunition and some of the containers are leaking.

Examples of the condition of both ammunition and storage facilities are provided in the Photographic Supplement.

2.3 The ammunition was manufactured in a number of countries including the former USSR, China, Romania and Yugoslavia. Consequently it does not have the United Nations Serial Numbers required for transportation under international guidelines. The ammunition can be legally moved within BiH, as long as the government is prepared to underwrite the risk. It could not however, be easily moved outside the borders of BiH for demilitarization at another nation's demilitarization facility. In order to gain UN Serial Numbers, a national body would need to be established a system for number allocation.

3. AMMUNITION DEMILITARIZATION REQUIREMENTS

3.1 Establishing precise quantities of ammunition that require disposal is problematic since there appears to be no centralised authority to coordinate this task. The EAF and SFOR have estimated that approximately 33,500 tonnes of surplus ammunition requires disposal. Of the remaining stock, also estimated to be approximately 33,500 tonnes, some will be required for use once the overdue EAF force restructuring has been finalised, but precise quantities are not known at present. The BiH government is also attempting to negotiate the sale of some surplus ammunition but the result of this venture will not be known until at least December 2004[3].

3.2 If an enhanced system of propellant stability testing is introduced in the future it is likely to identify further stocks for disposal, which cannot at this stage be quantified. However, those stocks (or at least the propellant element), which fail propellant stability testing, will require urgent disposal action.

[2] A single explosive event within a storage site caused by the propagation of explosions between individual explosive storehouses.
[3] Information provided by UNDP representative during a meeting on Thursday 22 July 2004.

4. POTENTIAL LOCATIONS

4.1 Options

The Study Team considered a number of options for the location of the proposed demilitarization facility. Key factors that would influence the location recommendation were as follows:

- Existing facilities. (Explosive limits, ammunition manufacturing and demilitarization activity).
- Accessibility. (Logistics).
- Utilities supply.
- Land ownership issues.

The Study Team concluded at an early stage that a 'greenfield' site was inappropriate due to:

- Potential property rights issues.
- The existence of suitable GOFs.

The Study Team decided to examine a number of GOFs which were either redundant or had spare infrastructure capacity.

4.2 Existing Facilities

BiH possesses a small but encouraging demilitarization capability based in the following locations:

- GOF No 26 - Vitez
- GOF No 18 - Doboj
- GOF Binas - Bugojno

Additionally, one other site was considered that has not conducted demilitarization work but appeared to have potential:

- GOF Unis Pretis (Vogosca)

Many ammunition demilitarization facilities have evolved or been developed in government facilities and ammunition manufacturing bases for the following reasons:

- The site is often government owned lessening development procedures.
- Adequate explosive safety distances Outside Quantity Distances (OQD) already exist along with some explosive storehouses.
- Reconstruction costs can be significantly reduced by the utilisation of existing facilities.
- A local pool of semi-qualified labour often exists in the area.

Due to a number of functional parameters[4], the Study Team considered only the sites at Vitez and Vogosca further.

[4] GOF 18 was discounted due to close proximity of civilian houses to demilitarization facilities (100m), documented in Chapter 3 – paragraph 3-1-1. Binas was discounted as, although it has almost identical facilities to P.S.Vitezit it has only half the storage capacity and no propellant testing facility.

4.2.1 GOF No 26 (Vitez).

The Vitez facility is a High Explosive (HE) and propellant manufacturing facility that also possesses a chemical laboratory. The facility produces explosives for the local mining and construction industries on an ad-hoc basis. There seems to be no continuous demand for the facility's production. Largely, the facility, including the laboratory, is considered to be almost redundant.

4.2.2 GOF Unis Pretis (Vogosca).

This facility was a former manufacturer of artillery and mortar ammunition. It is situated in a vast area that is quite remote in a mountainous area that offers the potential of almost unlimited explosive storage capacity. The facility currently employs over 100 staff, principally at the foundry that manufactures mortar and artillery shell for the UK and US governments.

A tabulated comparison of the sites is made at Annex C.

The Study Team was unanimous in the conclusion that GOF at Unis Pretis was the best site for developments as an ADF.

5. RECOMMENDED DEMILITARIZATION TECHNOLOGY

5.1 Open Burning / Open Detonation

Open Detonation (OBOD) is considered to be the simplest solution to the problem of ammunition identified as unstable during routine inspection or for propellant that fails stability testing. However, the large quantities of surplus ammunition involved in the BiH situation will take many years to destroy by this method and the only viable option is to use industrial demilitarization technology.

5.2 Industrial Demilitarization Technology and Options

5.2.1 General

There are a wide variety of technology options available throughout the world. This report does not aim to consist of a full evaluation of the advantages and disadvantages of each technology. It does, however, cover those technologies with a **proven track record** that are available Commercially Off The Shelf (COTS). The study team consider that BiH is not an appropriate environment to take a "technical risk" in the adoption of new technology in parallel with trying to achieve significant production rates in the short term.

Ammunition, explosive, propellant and pyrotechnic materials fall into three basic treatment categories as illustrated in the table below. The first category is material that is easy and relatively inexpensive to treat. Simple technologies exist and are proven and relatively inexpensive. The second category is material that is more difficult or risky to treat and more expensive to design for. In the second category, multiple technologies might be required, and more handling and manipulation of the items prior to final disposal increases the risk and the costs. The third category is material that requires new development or technically challenging approaches to treat and, thus, becomes very expensive and risky. Although materials in the third

category of "difficult and very expensive" are usually only a small percentage of the workload, they have the potential to absorb a disproportionate fraction of technical and financial resources.

CATEGORY	DESCRIPTION	TYPE
1	Easy / Inexpensive (Minimal processing required)	SAA up to 25mm Fuzes, Igniters and Detonators (No Boosters) Bulk Gun Propellant Bulk Explosives (Non TNT Based) Some Landmines
2A	Difficult / More Expensive (Pre-processing before Incineration)	Cartridges and Mortars > 25mm but < 75mm Grenades Fuzes, Igniters and Detonators (With Boosters) Detonating Cord, Linear Charges
2B	Difficult / More Expensive (TNT Recovery)	Projectiles > 75mm (TNT based fill) Demolition Charges Bangalore Torpedoes Mines (TNT Fill) A/C Bombs (TNT Fill)
3	Most Difficult Expensive (Advanced Technology required)	Liquid Energetics Flares Some Landmines. Projectiles (Non TNT Fill) Rocket Motors

Past international experience shows that in a phased programme it is best to develop a track record with the easy items to establish in the minds of potential sponsors that the project is a success. More difficult items can then be added with less risk that unsuccessful tests will hurt the project. Conversely, if difficult items are unsuccessfully attempted early, the results must be explained before the project will be deemed successful.

The lowest risk approach to developing and operating the desired disposal facility is to implement the project by logical phases. In keeping with the "easy items first" philosophy, the first phase should be the installation of a simple, proven explosive waste incinerator (EWI). The first phase would involve the destruction of technically simple items (see table above), which would also address the need to destroy ammunition for SALW as a priority. Metal components may be recovered as decontaminated scrap: separated brass may yield a higher value. Bulk propellants and explosives will also be pre-measured into appropriately sized packages and fed to the EWI.

In the second phase, there are two categories of items: those that are capable of being incinerated with a small amount of preparation (Category 2a items) and items that contain salvageable quantities of TNT-based explosives (Category 2b items). Items with too much Net Explosive Weight (NEW) to be directly incinerated without risking the EWI will be prepared by accessing the explosive charges and exposing them. This can be accomplished by disassembly, punching, shearing, drilling, sawing, etc. Then the items can be fed to the EWI without the risk of high order detonations. Many items larger than 75mm with TNT-based fillings can be processed though an autoclave process to reclaim the explosive. The melted explosive will be re-solidified for other non-military uses such as construction, mining,

etc. Both processes are included in the second phase since they are both fully developed and demonstrated.

The third phase includes items that require high technology approaches, or for which processes need to be developed and demonstrated. This category may include items such as some flares, smokes and dyes that cannot be incinerated within environmental standards. It also includes complex munitions such as mines, rocket motors, etc, for which special one-of-a-kind machines must be created.

It is also important to note that each of these phases build on the previous one. The preparation processes fielded in Phase 2 require that an incinerator be installed in Phase 1. For example, fuzes, primers and boosters from munitions disassembled for TNT melt-out will be processed in the EWI. Further, many parts of items that originally start in the Phase 3 category will probably be moved to the second category as their nature, and configurations are better known. Some parts of these items will naturally fit in another category as the item is disassembled. For example, rocket motor fuzes might revert to Phase 1 incineration, and torpedo warheads might be moved to TNT recovery in Phase 2.

If sufficient funding was available at early stage of project implementation, Phase 3 in entirety could be replaced by the exporting of these items to the existing European Demilitarization industry. This option could be considered subject to the following conditions:

- Donor support and available funding.
- Identification of spare capacity and capability in exiting European Industry.
- Assurance that the ammunition involved is safe to move.[5]

5.2.2 The following factors should be considered before any firm decision can be taken as to the most suitable technique or system to be adopted. These factors should be considered in fine detail by the Project Management team for any demilitarization facility within BiH:

- Chemistry of Explosives.
  - Stockpile degradation.
  - Stability in storage.
- Knowledge of ammunition design.
- Quantity for disposal.
- Available technology.
- Safe systems of work.

[5] This will involve the obtaining of UN Serial Numbers for this ammunition, but this should not be seen as a significant obstacle.

- Production rates.
- Environmental considerations.
- Security.
- Logistics.
  - Availability of suitably qualified and trained manpower.
  - Availability of ranges and demolition grounds.
  - Availability of transport.
- Commercial v Military disposal route.
- Transparency and accounting.
- Disposal of residue.
- Scrap salvage.
- National legislation.
- Integrated approach.
- Financial factors.

5.2.3 The Demilitarization Cycle

The following activities are considered to be part of the demilitarization cycle. These activities cover all aspects of the demilitarization process; it must be emphasised that the destruction of the ammunition is only one process within the complete demilitarization cycle.

- Initial storage location.
- National ammunition account.

- Demilitarization production planning.
- Decide destruction technique.
- Call forward for demilitarization.
- Transportation.
- Receipt accounting into demilitarization facility storage.
- Storage.
- Unpacking operations.
- Transport to pre-processing or destruction facility.
- Pre-processing operations (including preparation of donor charges if OBOD used).
- Destruction.
- Accounting and certification of destruction.
- Scrap processing operations.
- Scrap disposal.
- Disposal of residue.
- Maintenance and repair of specialist equipment.
- Training of manpower.

5.2.4 Pre-processing

The ammunition that cannot be incinerated directly, Category 2a, requires processes and equipment required to disassemble them and prepare the relevant components for incineration. Preparation consists of disassembly of the item followed, in some cases, by exposing the explosive charge. Opening up the explosive charge to the atmosphere reduces the confinement that can lead to high order detonations, which could damage an Explosive Waste Incinerator. The exposed explosive then burns harmlessly, without detonations. Exposing explosives can be done by sawing, shearing, punching, disassembly, etc.

A variety of manual, semi-automatic, and automated equipment can be used to prepare the items for incineration. Some operations, because of the explosive hazards involved, must be performed remotely with operating personnel behind protective barricades, blast walls, or protected by shielding integral to the equipment. This section of the report identifies preparation equipment based on past international demilitarization experience. Equipment function and capabilities are briefly described at Annex A.

5.2.5 Recovery of TNT

Traditionally there is little value in the recovery of TNT due to the competitive price of Ammonium Nitrate / Fuel Oil (ANFO) explosive on the world market. However, representatives at the GOF at Vitez, indicated that they would use the TNT in Ammonite explosive for commercial sale. This requirement has been borne in mind throughout the study period.

Many of the munitions in the BiH inventory contain TNT-based explosive compositions. These materials have some commercial value if they can be recovered. TNT-based explosives can usually be safely recovered by melting the explosives, collecting the run-out and re-solidifying the materials. This process, in various forms, has been implemented and proven to be safe at installations throughout the world. One process uses autoclaves and steam heat to power the process. It is noted that this process is most effective with munitions above approximately 75mm in diameter. Smaller munitions may also work, but the yield may not be worth the effort. It is also noted that in order to prepare many of the munitions for this process, many of the pre-processing operations described above, for Category 2a ammunition, must be in place: fixed rounds must be pulled apart, fuzes must be removed, etc. The process description is at Annex B.

5.2.6 Destruction Technology

Once the ammunition has been pre-processed (if necessary) then the energetic materials need to be destroyed. The more traditional, and hence proven method, utilises some form of Explosive Waste Incinerator (EWI). Each different type of EWI has advantages and disadvantages or is more suitable for one ammunition nature than the other. This study has examined two serious competitive technologies in detail, and has summarised alternatives with a “higher technical risk”:

- Rotary Kiln EWI - Details at Annex C
- Plasma Arc EWI - Details at Annex D
- “Higher Technical Risk” Technologies - Details at Annex E

5.2.7 Pollution Control Systems (PCS)

There are a number of pollution control technologies available, but an effective system requires an integrated approach. The technologies that follow are currently in use in different demilitarization facilities around the world. All PCS have the following requirements:

- Interface with incineration system.
- Process all gases arising from kilns.
- Remove Volatile Organic Compounds (VOC).
- Remove particulate matter.
- Remove acid gas.

- Prevent or reduce dioxin formation.
- Remove heavy metals.

There are two competing, proven technical solutions.

- Bag Houses - Details at Annex F
- Dry Ceramic Filtration - Details at Annex G

5.2.8 Disposal of Explosive Contaminated Waste

Some demilitarization facilities utilise a "Car Bottom Furnace", which operate at a feed rate of 100 – 350 kg/hour. These are used to process the waste from the EWI to ensure that all explosive residues are destroyed. They can be linked into the PCS of the main EWI.

6. EXPLOSIVE SAFETY FACTORS

6.1 General

Based on the CSS Needs Assessment[6] and safety advice from the SFOR ATO[7], who has recently conducted visits to confirm the suitability for limited demilitarization activities, those GOFs, which are compared at Annex H, were identified as potentially suitable sites where industrial level demilitarization facilities could be constructed and operated. Each still retains a significant reserve of former employees who are experienced in working with explosives and in an explosive environment. Although they will require retraining on new equipment the Team considerers that explosive safety can be achieved through planning, procedures, training and monitoring.

6.2 Outside Quantity Distances (OQD)

An OQD is the minimum safety distance that must be maintained from any explosive store to vulnerable locations nearby, the most critical of which is civilian habitation. Within any ammunition storage area each storehouse is normally given a "license" which states how much and what type of explosives can be stored there. They are normally renewed every 2-3 years and the licensing authority on a regular basis to confirm their validity, conducts routine inspections. The OQD at all facilities listed in Annex H were adequate for the bulk storage of ammunition prior to the war, when the factories were producing ammunition to its maximum capacity, but have lapsed and there is no evidence of their recent renewal. Providing no encroachment (i.e. where new building has occurred) within the distance originally specified ha taken place since the war the ammunition storage facilities within the factory should be capable of being re-licensed. Although none was immediately apparent during the team's visit, in those circumstances where encroachment has occurred, the OQDs must be recalculated to determine new explosive storage limits.

[6] Needs Assessment on Small Arms and Light Weapons in Bosnia and Herzegovina, Centre for Security Studies, 2003, p54.
[7] Meeting with SFOR ATO on Thursday 22 July 2004.

At the time of the team's visit in July 2004 the national authority for licensing could not be readily identified. Further investigation by UNDP representatives[8] has subsequently revealed that, according to a Government decision in 1996 responsibility for the licensing and inspection of all GOFs was delegated to the Entities Ministries of Defence. More recent reforms resulted in agreement that the ownership of GOFs should be transferred to the Entity Ministries for Energy, Mining and Industry but only the Republika Srpska completed the transfer process. The Federation Government is still discussing the issue since the Laws on a new Ministry of Defence are not due to be enforced in mid-September 2004. It is probable that the Ministry of Foreign Trade and Economic Relations (MoFTER), the state level institution issuing license for production, export and import, will form an inspection committee, introducing a new inspection regime; they will require international technical assistance to introduce a safe and appropriate system.

Whilst the process for reviewing the licensing arrangements at the potential sites should take only a relatively short period of time, it is critical to the future safety of the general public and must be completed during the early stages of project planning.

6.3 Inside Quantity Distances (IQD)

IQDs are those safety distances applied between individual explosive stores within any explosives area. Their calculation is an integral component of the licensing procedure described above.

6.4 Standing Operating Procedures (SOP)

SOP for the following areas will require development for the safe and efficient operation of an ammunition demilitarization and scrap processing facility:

- General Explosives Safety.
- Accident Procedures.
- Ammunition Storage.
- Ammunition Movement.
- Ammunition Accounting.
- Ammunition Processing Operations.
- Scrap Processing Operations.
- Quality Control.
- Demolition Ground Orders.
- Specific Equipment Operating Instructions.
- Disposal of Residues.

[8] Information provided by the UNDP on 30 July 2004.

6.5 Transportation to and Storage Hazards at the ADF

The safe transportation of ammunition to the ADF will depend on whether the EAF or a civilian contractor is responsible for the movement of the ammunition. In the case of the EAF procedures for the movement of ammunition are contained in Chapter 13 to the ITP, issued by SFOR. Civilian transport contractors will be governed by national legislation. Storage hazards at the ADF will be regulated by national legislation and applied through the SOPs described above.

7. PROCESS FLOWS

7.1 The team was unable to recommend any detailed process flows until the final decisions are taken on the technology to be used for the disposal of the ammunition. Process flows require development for the following generic areas:

- Ammunition Accounting.
- Ammunition Movement.
- Ammunition Storage.
- Pre-processing Operations.
- Destruction Operations.
- Disposal of Residue.
- Scrap Processing Operations.
- Administration Functions (including Certification of Destruction).

8. ENGINEERING DIMENSIONS

A summary of the system requirements for the alternative pre-processing and destruction technologies is at Annex I.

9. PROJECT ENGINEERING PHASES

9.1 General

The team was unable to recommend any detailed project engineering flows until the final decisions are taken on the technology to be used for the disposal of the ammunition. The layout of the plant can be designed when anticipated quantities and production rates are established and the technology is chosen.

9.2 Conceptual Design

The team estimates that a conceptual plant design, to a 95% confidence level, could be completed in three months at a cost of approximately US $ 120,000. This should be undertaken by a reputable demilitarization company in conjunction with a the Project Executing Agency. The conceptual design should consist of:

- Overall Top Level Plant Layout.
- Estimate of utilisation of current buildings, facilities and infrastructure.
- Define process flows.
- Preliminary equipment layouts for each processing building.
- Compilation of detailed equipment list.
- Development of firm cost estimates based on selected technology. (The cost estimates contained within this study are designed to provide a "rough order of costs".
- Identification of issues requiring additional development and engineering.
- Planning for phased introduction and integration of equipment and processes.

10. LEGAL REQUIREMENTS

10.1 Applicable BiH Legislation

See paragraph 5.2 above.

11. LOGISTIC SUPPORT

11.1 Introduction

The phased introduction of ADF will demand an input of between 10 and 20 tonnes of ammunition per working day[9]. Although in terms of mass this does not represent a large quantity of ammunition, the challenges to logistical support are examined below.

11.2 Ammunition Location

Whilst most of the main roads to the current EAF storage locations are in good repair many of those inside the facilities are very narrow and in a poor condition.

11.3 Security

See Chapter 5 paragraph 3.2.

11.4 Bulk Handling – Containment of Ammunition

The vast majority of the BiH ammunition stockpile is stored in its primary containers and is not bulk packed in Unit Load Containers (ULC's), such as palletised loads. Furthermore, many Explosive Store Houses (ESH's) were designed and built for the manhandling of individual ammunition containers. Therefore the vast majority of the ESH's have doorways less than 0.7m wide which prevents the immediate introduction of a ULC type storage and transportation system.

11.5 Infrastructure

Much of Bosnia's infrastructure, including its roads and railways was devastated in the war, during which about 35% of the country's roads and 40% of its bridges were damaged or destroyed. Damage to the railway system was estimated at about $1 billion. The fourth donors' conference for Bosnia and Herzegovina held in Brussels, Belgium, in May 1998, made improvement of infrastructure a continued priority for

[9] Volume is dependent on prioritised type of ammunition for demilitarization.

future aid. Currently the majority of the roads in BiH are in reasonable condition but congested. The rail system is slowly being renovated but in many places the track is in a very poor condition. Although there is international assistance to upgrade the rail system, the remoteness of a significant element of the stockpile and the lack of bulk handling, preclude the use of the rail system to transport a large proportion of the ammunition stocks.

11.6 Options for Containment of Ammunition During Transportation

Ideally, the EAF should take on the task of ammunition supply to the ADF but due to the poor equipment levels, ongoing reorganisation and lack of funding, it is considered that they will experience financial difficulties undertaking this task. Therefore financial responsibility of ammunition transportation must rest with the Executing Agency or ADF. Essentially there are 3 options for the containment of ammunition for movement from storage to the ADF:

11.6.1 Loose Boxed

It is feasible to move the ammunition in bulk carrying vehicles loose in boxes utilising conventional bulk carrying vehicles.

11.6.2 Palletisation

To ease bulk handling it is possible to palletise into ULC's on site prior to transposition. This would require a considerable increase in manpower requirements and the initial purchase of mobile, rough terrain Mechanical Handling Equipment (MHE) and ongoing requirements for pallets, furniture and banding. Additionally, pallet configuration design would be necessary since none currently exists.

11.6.3 Containerisation

The containerisation option proposes the use of demountable ISO containers that could be delivered to the storage area and loaded by hand. The loaded ISO container would then be delivered to the demilitarization storage area and would act as the storage container until the ammunition is required for disposal action. This proposed solution would require the one-time procurement of specialist vehicles, containers and equipment.

11.7 Recommended Solution

Each of these is examined stating advantages and disadvantages of each option at Annex J. Despite the challenges involved, the handling of loose boxes is probably the most economic option and will also offer employment opportunities for BiH citizens.

The Team recommend that the EAF are responsible for the transportation of ammunition feedstock to the ADF under a performance-related repayment system operated by the Executing Agency or ADF.

The above recommendations are based upon an objective assessment of the ground situation and experience gained in the NATO PfP Albania 1 Demilitarization project.

Annexes:

A. Pre-Processing Equipment and Capabilities.
B. TNT Recovery Process.
C. Rotary Kiln Explosive Waste Incinerators.
D. Plasma Arc Explosive Waste Incinerators
E. Higher Technical Risk Technologies.
F. Bag House Pollution Control Systems.
G. Dry Ceramic Filtration Pollution Control Systems.
H. Advantages and Disadvantages of Possible ADF Sites.
I. Engineering Dimensions to Possible Technologies.
J. Advantages and Disadvantages of Movement Options

Appendices:

1. Estimated Production Rates.

ANNEX A
TO CHAPTER 4

PRE-PROCESSING EQUIPMENT AND CAPABILITIES

1. General.

The following pre-preparation equipment is that approved by the US government and in common use throughout many countries. It has been included in this report to illustrate to proven and available technology. **The fact that it is referred to in this report in no way suggests that this is the only specific type / make that would be suitable.** There is also some equipment suitable for conversion available in the GOFs that could be utilised for pre-processing purposes.

2. Pull Apart (APE 1001M1)

This operation separates the projectile from the cartridge case for fixed ammunition. The assembled cartridge is manually loaded in a vertical, nose up orientation into the machine. If an operational shield has been installed, the loading door closes and the cartridge case and projectile are separated. If the shield is not installed, the operator walks around behind a blast resistant wall and remotely starts the machine cycle. Upon cycle completion, the operator manually removes cartridge case and projectile from the machine. When the operational shield is installed, an optional high speed, automatic deluge system can be used to aid in extinguishing burning propellant accidentally initiated during pull apart.

Fixed round pull-apart equipment.

3. Fuze and Tracer Removal (APE 1002M3)

This operation unscrews the fuzes or tracers from artillery and mortar projectiles. This machine is used when it is not safe to manually unscrew the fuzes or tracers from the projectiles. The operator manually loads two items at a time into the machine. He then walks around behind a blast resistant wall and remotely starts the machine cycle. Upon cycle completion, the operator manually removes the separated components from the machine.

4. Debanding (APE 1042M3)

This operation is not a required operation for demilitarization, but may be used to recover higher value metals for recycling and cost recovery. The operation is performed when removal of the gilding metal rotating bands from 57mm through 155mm projectiles is justified due to increased value from separated scrap metals. The debanding operation must be performed before the projectiles are processed through the EWI. The operator manually loads and unloads the machine. Operational shielding is not required.

5. Fuze Disassembly (APE 1118M2)

This operation removes the boosters from bomb, artillery, and mortar fuzes. Booster removal is required for some fuzes to prevent damage to the EWI, caused by repetitive detonation of the larger boosters inside the EWI. Booster removal is sufficient if separation from the fuze adequately vents the booster so it will burn out without detonation. Otherwise the booster must be punched or sheared in the APE 2196 in order to achieve adequate venting. The operator stands by the machine and manually loads and unloads the fuzes and boosters. The machine is fitted with an operational shield.

6. Mortar Fin Removal (APE 1153M1)

This operation removes the fins (with ignition cartridges) from mortars whose fins cannot safely be removed manually. The machine can also remove ignition cartridges from the fins. (The machine can also defuze projectiles and mortars, although it does not have as great a torque or production capability as the APE 1002M3.) Note that increment charges must be removed from the mortars in a previous operation. The operator manually loads one munition item into the machine. He then walks around behind a blast resistant wall where he remotely starts the machine cycle. Upon cycle completion, the operator manually removes the separated components.

7. Grenade Pitch-In Barricade (APE 1213M1)

This barricade is located adjacent to hand grenade operations. It provides a safe place for an operator to throw a hand grenade whose fuze may have been initiated. The barricade captures fragments and mitigates blast effects. It is not suitable for impact-sensitive hand grenades.

8. Depriming (APE 1229M1)

This operation punches the primers out of 37mm to 106mm cartridge cases. This allows the primers to be demilitarised in the EWI. The operator stands by the machine and manually loads the cartridge cases and unloads the cases and punched and primers. The machine is fitted with operational shielding.

9. Vice (APE 1065, 1204, and 1294)

This operation is performed when it is safe to manually remove fuzes, tracers, fins, booms, ignition cartridges, etc. from ammunition. The individual items are manually loaded into the vice and clamped. The operator then performs the required operation.

10. Hand Grenade Defuzing (APE 2156)

This operation removes the fuzes from hand grenades. The operator manually loads the fuzed grenades onto a transport belt at one side of the machine. The grenades are moved by this belt inside an operational shield where the fuzes are unscrewed and separated from the grenades. The fuzes and grenades are retained inside the shield for sufficient time for an accidentally initiated fuze to time out and function before exiting the shield. The operator manually unloads the transport belt.

11. Projectile Cutting (APE 2175)

This operation saws through the high explosive cavity of projectiles to expose the explosive so that the projectile sections will burn out in the EWI without detonation. The explosive in the projectiles must be adequately exposed (vented) to prevent the burn out process from accelerating into a detonation. The degree of exposure (venting) required varies with explosive type and quantity. TNT filled projectiles are relatively easy to vent and burn, while RDX based fillers are much more difficult. In some cases, the quantity of RDX must be limited so that the explosive is consumed before the transition from burning to detonation is completed. It is anticipated that the HEAT projectiles must be cut open regardless of calibre since defuzing generally does not provide adequate (or any) venting. The saw machine is designed to be located in a blast containment operating bay, with operators located behind blast resistant walls on either side of the saw bay. The machine has 10-foot long feed and discharge conveyors to accommodate this arrangement. Larger calibre (75 mm to 120 mm) projectiles are manually loaded one at a time onto the feed conveyor. This conveyor moves the projectile into the saw machine where the projectile is cut into two pieces. The cut pieces are removed by the discharge conveyor to the adjacent bay where an operator removes them from the conveyor. Smaller calibre projectiles could be loaded and clamped into fixtures to allow gang sawing.

12. Punching and Shearing (APE 2196)

This operation punches or shears boosters, defuzed hand grenades, and 40mm M384 and M406 grenades. This operation exposes and vents the explosives so they will burn without detonation in the EWI. The operator stands in front of the machine and manually loads the munitions into two stations. The punching or shearing automatically takes place inside an operational shield. The machine automatically discharges the processed munitions down gravity chutes through the bottom of the shield.

13. Estimated Production Rates.

Estimated production rates for these equipments against selected BiH ammunition natures are shown at Appendix 1.

Appendix:

1. Estimated Production Rates.

APPENDIX 1
TO ANNEX A
TO CHAPTER 4

ESTIMATED PRODUCTION RATES

SER	NATURE	AMMUNITION PECULIAR EQUIPMENT (APE) ITEMS / HOUR								
		1001M1	1002M3	1042M3	1118M2	1153M1	1229M1	2156	2175	2195
		PULL APART	DEFUZE / DETRACE	DEBAND	FUZE DISASSEMBLY	DISASSEMBLY	DEPRIME	DEFUZE HD GREN	PROJECTILE SAW	SHEAR
1	Grenades Hand							500		360
2	Grenade, 40mm A/Tk									360
3	Cartridge, 60 mm Mortar		70 to 100		350	100			70	360
4	Cartridge, 30mm HEI-T	75	70 to 100 (1)				360			
5	Cartridge, 30mm AP	75					360			
6	Cartridge 37mm HEI-T	75	70 to 100 (1)				360		120(2)	
7	Cartridge 37mm AP-T	75					360			
8	Cartridge, 57mm HEI-T	75	70 to 100 (1)	300	350		360		60	360
9	Cartridge, 57mm AP-T	75		300			360			
10	Cartridge 75mm HE & HEAT	75	70 to 100(1)	275	350		300		60	360
11	Cartridge, 85mm HE	75		275	350		300		60	360
12	Fuze				350					360

(1) Production rate varies with munition condition and operating bay setup
(2) Assumes use of a two munition gang sawing fixture (to be developed)

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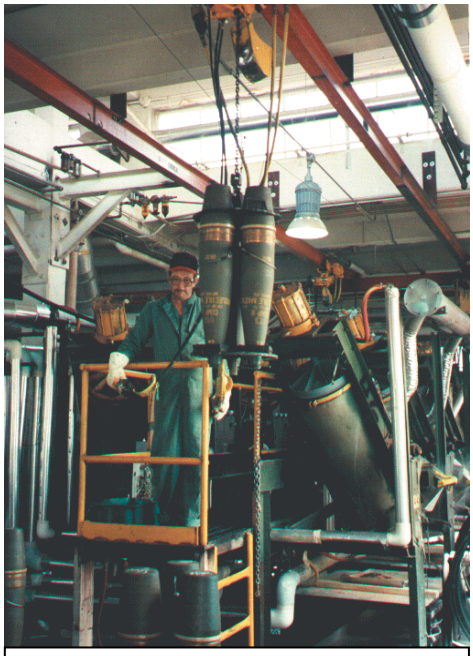
ANNEX B
TO CHAPTER 4

TNT RECOVERY PROCESS

1. This process description assumes that the munitions have been previously prepared for this process. In general, munitions to be processed through a melt-out process will need to be in the following state:

   - Unpacked
   - Fixed rounds pulled apart
   - Defuzed
   - Nose closures removed
   - If applicable, burster wells removed, or munition sawed to expose explosive

2. Each munition will then be loaded into a fixture that determines how many munitions of that type can fit inside an autoclave. The fixture is then attached to an overhead crane, which transports the munitions to the autoclaves. The upper autoclave door is opened (pneumatic actuators) and the fixture loaded with munitions is placed inside the autoclave. The autoclave door is closed and five psig steam is applied to the autoclave. The hot steam heats the outside of the munition shell causing the explosive inside the shell to melt and drain into melt kettles. For large munitions, a steam lance can be applied to the inside of the munition to significantly speed the melting, but condensate can then contaminate the explosive.

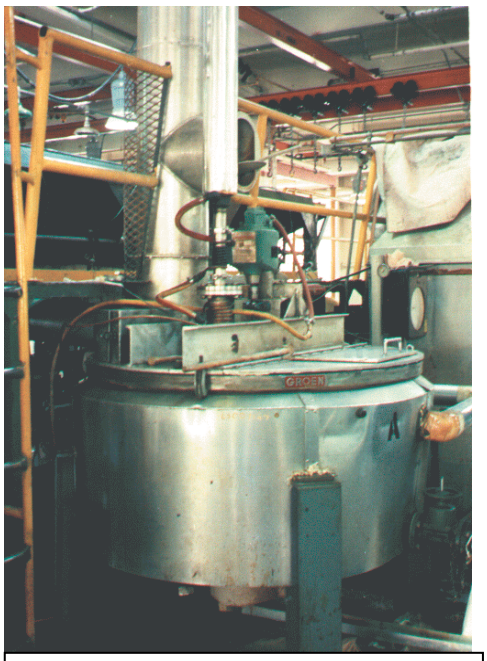


A typical ammunition autoclave

Safety note: Minol-type explosives should never be directly exposed to steam.

3. The melt kettles are connected to the autoclaves by a network of steam jacketed pipes and/or troughs. The steam-jacketed melt kettles are equipped with stirring paddles. A vacuum of 6 to 28 inches of Hg is drawn on the melt kettles to remove both explosive and water vapours. The paddle mixer maintains a homogenous explosive mixture. The desired vacuum range on the melt kettles and associated piping is maintained by a vacuum pump or steam-powered ejector, which draws up to 125 CFM to achieve the desired vapour removal rate from the molten explosives. The molten explosives inside the melt kettle then drain through a steam jacketed manifold onto the belt flaker for cooling and solidification. The manifold evenly distributes the explosive across the entire width of the belt.

4. The belt flaker is a flat, horizontal belt conveyor. It is equipped with a stainless steel belt that travels between 5 and 30 feet per minute. After the molten explosive is deposited onto the conveyor belt, it is cooled by chilled water sprayed on the underside of the belt. A pivoted roller mounted over the head pulley is used to break-up large pieces of solid explosive into "flakes." A plastic-covered scraper placed just after the roller removes explosives that adhere to the belt surface. The flaked explosive is then dropped onto a small chute with a vibratory feeder that guides the explosive into a shipping container or bag.



A melt kettle

5. The following major pieces of equipment inside the work area will be required:

- <u>Autoclaves</u>

  Autoclaves are used to melt and remove explosives from inside munitions by applying steam to the exterior munition surface. An autoclave is a thermally insulated cylinder fitted with a steam inlet and condensate drain. An inverted dome is fitted into the bottom end of the cylinder. A steam-heated funnel fitted with a seal matching the configuration of the munitions fixture is attached to the lower dome. As molten explosive drains from the munitions, it drains into the funnel and out of the autoclave by the drain tube. The other end of the autoclave is fitted with a hinged dome lid. The lid is opened and closed by a pneumatic cylinder. Autoclaves must meet the following general requirements:

  (1) The main body of the autoclave is 22 inches in diameter by 60-3/4 inches long.

  (2) Configuration - Insulated, cylindrical, carbon steel pressure vessel with one fixed end and one openable end.

  (3) Rated for a maximum of 15 psig steam.

  (4) Capable of handling a large variety of munitions ranging from 75 mm to 160 mm, and some types of large bombs. This is accomplished by special fixtures designed for each munition type (kits).

  (6) Controls - Steam pressure and steam admission time, lid open/close, latch lock/unlock, air vent valve, vacuum-breaker valve.

  (7) Utilities Required - Approximately 15 cfm of air at 100 psig and 100 lb of steam per hour at 5 psig, per autoclave.

- <u>Melt Kettles</u>

  Melt kettles collect molten explosives, reduce moisture content by vacuum and deliver molten explosives to the belt flaker. They also re-mix binary explosives

(such as Composition B) into a homogenous mixture prior to discharging onto the belt flaker. Each melt kettle has a steam-jacketed hemispherical bottom with a removable steam-jacketed top cover. The cover is equipped with a mixer motor, speed reducer, bearing housing and seal, mixer paddle and agitator, cleaning access port with sight glass, and two thermowells. The bottom of the mixer bowl is fitted with two horizontal explosive outlets and the outer steam jacket is fitted with a condensate outlet. The entire surface of the mixing bowl assembly is insulated. Because the vacuum treatment process is usually a batch-type operation, a minimum of two mix kettles will be required. Both mix kettles are connected to one vacuum pump and pneumatic control valves control the vacuum "flow" between the mix kettles. Under normal conditions, each melt kettle will only be filled to only 60 percent capacity to provide enough volume or freeboard to break up foams produced during the vacuum process. Each melt kettle must meet the following specifications:

(1) Capable of mixing up to 180 gallons of explosive.

(2) Shell and jacket are constructed from T-304 Stainless steel.

(3) A two-inch diameter T-304 stainless steel calandria

(4) A T-304 mixer paddle and agitator powered by a 10 hp, TEXP Class I, Div I, Group C & D and Class II, Div I, Group E, F, & G gear motor with an output agitator speed of 25 RPM.

(6) Dimensions - 48 inches diameter by 42 inches deep.

(7) Pressure - The shell must be rated for full vacuum to 15 psig design pressure at 250° F temperature. The jacket must be rated for 90 psig design pressure at 332° F.

(8) Vacuum pump - A two-stage, water sealed, 10 hp, rotary type, 125 cfm/28 inches Hg.

- <u>Belt Flaker</u>

A belt flaker cools molten explosives into solidified flakes for future processing or sale. The belt flaker must meet the following conditions:

A TNT Belt Flaker

(1) Hydraulically driven, flat, stainless steel belt 48 inches wide by 32 feet long.

(2) Variable and reversible speed drive ranging from 5 to 30 feet per minute.

(3) Three cooling zones, each zone is approximately 8 feet long and containing a set of water spray nozzles. Water is cooled and circulated by a chilled water system. Chiller has a capacity of approximately 208,000 Btu/hr capable of cooling water to 42°F.

(4) A deluge fire protection system is typically required.

(5) A fume hood is required over the entire flaker belt to collect fumes from the molten explosive.

(6) Utilities - Approximately 30 KW for the chiller, 27 lb/hr of 15 psig steam. Three 1-hp circulating pumps, one 3-hp belt drive unit, and approximately 3 gallon per minute makeup water.

- Vibratory Feeder

The vibratory feeder directs the flakes into shipping and storage containers. The following requirements apply:

(1) Pneumatically powered, variable speed

(2) Approximately 5 ½ feet long by 12 inches wide.

(3) Open flat tray with 3 inch high sides

(4) Approximate 3,000 lb/hr of 1/8 inch thick flakes of 50 lb/cu-ft material.

(5) Controls - Start/stop control

(6) Approximately 15 cfm of 100 psig compressed air.

- Scale

The scale weighs the containerised explosive to assure consistent packaging. It is explosion proof, beamless and bench mounted, with gravity rollers on the platform. The capacity is 25 to 125 lb. measured in ½ pound increments on a dial read-out.

- Roller Conveyor

The roller conveyor is used to take away full containers of flaked explosives. It is gravity powered, 24 inches wide by 6 ft. long.

- Bridge Crane

The bridge crane allows operators to move fixtures full of munitions into the autoclaves. It should be explosion proof with a 5 ton capacity minimum. Span and travel will be determined by the building.

- Fume Collector

The device collects fumes from the process and filters them through charcoal filters before release. The size is dependent upon the system and the building. Pre-filters and HEPA filters or a wet scrubber system is typically installed prior to fan unit.

- Fixture Loading Equipment

  The specific configuration of the fixture loading equipment depends upon the building design and the types of munitions to be processed. It can be as simple as a manual loading table, or a more complex semi-automated system. Where heavier munitions are involved, lift-assist devices are also required.

- A mechanical equipment room to support melt-out operations is also required. It is anticipated that the mechanical room may contain:

  (1) Steam boiler equipment (if not otherwise available).

  (2) Hydraulic power equipment.

  (3) Air compressor.

  (4) Water chiller.

  (5) Other ancillary equipment.

  (6) Inert material storage.

- Production Rates.

  For a pure TNT fill, a single autoclave can achieve the following production rates:

SER	CALIBRE	TYPE	PRODUCTION RATE PER HOUR
1	75 mm - 90 mm	Cartridge, mortar; projectile	24 - 30
2	105 mm	Cartridge, mortar; projectile	12
3	120 mm	Cartridge, mortar; projectile	10
4	150 mm - 160 mm	Cartridge, mortar; projectile	3
5	Other	Demolition Charges, Mines, Bombs	Depends on size: 750 lb bomb requires approx 1.5 hour each

ANNEX C
TO CHAPTER 4

ROTARY KILN EXPLOSIVE WASTE INCINERATORS

1. INTRODUCTION.

The Explosive Waster Incinerator (EWI) system can be operated on either a continuous or intermittent basis with appropriate start-up and cool down times. Materials for treatment are semi-automatically fed into the kiln via a manually loaded feed system. The materials are fed at rates based on safety requirements and heat and draft limitations established by empirical testing. The materials enter the system at the cooler end of the kiln and progress toward the hotter end that contains the burner. The kiln exit gas temperature is maintained by adjusting the burner using an automatic control system.

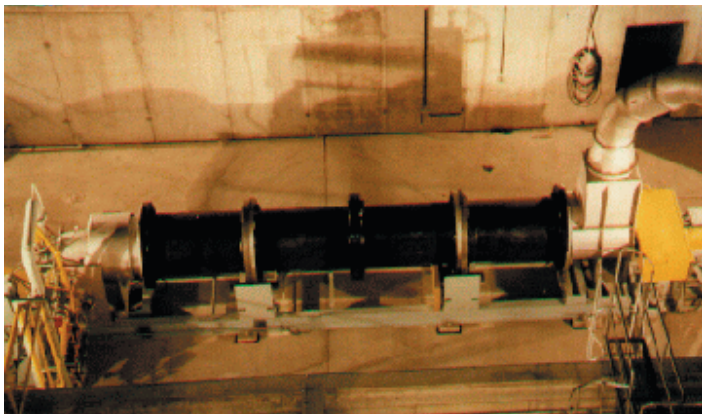


Figure 1: The burner assembly is attached to the discharge housing (silver cylinder, centre). Note the auxiliary control panel, right.

2. COMPONENTS

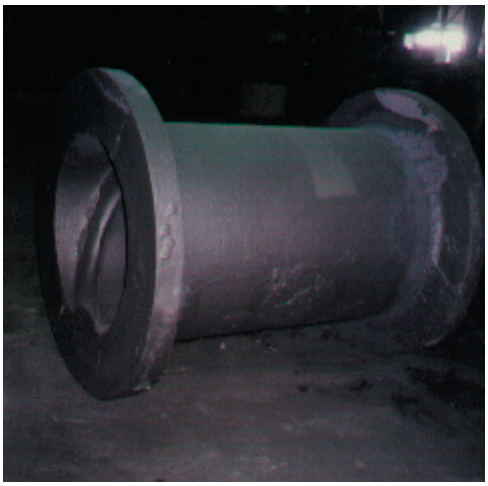


Figure 2. Rotary retort section has an internal spiral flight to keep waste moving and to isolate explosives to minimize explosive propagation.

2.1 Rotary Kiln

The rotary kiln is an unlined rotary furnace originally designed to destroy small arms and bulk explosives. The kiln (shown in Figures 2 and 3) is made up of four 5-foot long, 36-inch outer diameter retort sections bolted together. The 2.5 to 3.5 inch thick walls of the kiln are designed to withstand small detonations. The kiln contains internal spiral flights that move the waste in an auger-like fashion through the retort as the kiln rotates (see Figure 3 above). The flights also provide charge separation for the in-process materials, and discourage sympathetic detonations and scattering of materials. The kiln is equipped with a variable speed drive, which allows varying rotation speeds and material residence times.

The burner (is a combination proportioning burner designed to operate on fuel oil, natural gas or propane. Combustion air is provided to the burner by a direct drive turbo blower. The EWI support components consist of the retort, frame, trunnion, feed and discharge systems, and variable speed drive. The retort assembly rests on trunnion assemblies. The trunnion assembly consists of four rollers mounted on shafts, and pillow block bearings bolted to brackets on the frame. Rotation of the retort is accomplished by friction between the kiln flanges and drive rollers. A shaft and a sprocket/roller chain to the drive rollers connect the

variable speed rotation drive motor. End sections are installed to match with the feed and discharge assemblies. Two thrust roller assemblies restrict the longitudinal travel of the retort on the trunnion assemblies. Thermal expansion is provided for by the gaps between the rotating portion and stationary portions of the rotary kiln.

The frame assembly is constructed to support the trunnion assemblies, variable speed drive motor, retort assembly, feed and discharge assemblies. The feed assembly is installed on one end of the frame assembly. The feed assembly supports the feed chute, the feed conveyor, and the furnace exhaust stack. Doors in the feed assembly permit interior inspection of the furnace retort and positive feed system charging into the retort. The discharge assembly directs treated materials from the retort assembly onto the discharge conveyor.

Figure 3: The main control panel displays operating parameters and allows system control

The main control panel (Figure 3) is located in the feed room. The control panel allows for adjustments of kiln and afterburner fuel flow rates, combustion air flow rates, and kiln rotation speeds. The panel also monitors system draft pressures and system temperatures. An Auxiliary Control Panel is located on the support stand near the burner assembly. The Auxiliary Control Panel provides local control of the burner while making initial adjustments as well as during maintenance.

There are two thermocouples continuously recording furnace temperatures. The first thermocouple, located at the base of the exhaust stack (feed end), provides a reference temperature to the controller to maintain the preset operating temperature. The temperature preset may be changed with each feedstock, if required. The other thermocouple, located immediately above the burner flame, provides a reference temperature at the burner end of the furnace.

A flame detector senses the presence of flame at the burner. Upon flame failure, the sensor causes a flame-safeguard unit in the control panel to close the fuel solenoid valve, shutting off fuel flow to the burner. It also activates visible and audible alarms at the control panel, and signals the local controller of the fault.

2.2 Feed Systems

Two feed systems can be utilized depending on the anticipated feed streams: the standard feed conveyor and the positive feed system.

2.2.1 Standard Feed Conveyor System (Gravity Feed)

The standard feed conveyor system consists of an inclined pan conveyor that moves items from the feed room through a reinforced concrete barricade wall to an elevated location above the feed chute. Items drop off the conveyor end and slide by gravity down a feed

chute into the first section of the rotary kiln. The standard feed conveyor system is simple, rugged, well controlled, safe and requires little training or maintenance.

2.2.2 Positive Feed System (PFS) (Pan/box Feed)

The positive feed system (Figures 4 and 5) feeds bulk granular and powdered explosive materials into the kiln by injecting containers of these materials by use of a ram. The PFS can also be used to feed sheared or punched items (Phase 2a items) if spilling explosives or dusting are concerns. Open-top steel pans or consumable boxes can be fed with this system. The PFS eliminates the chance of explosive propagation back to the loading point, and positively controls the feed rate to insure that only one container may be placed in the furnace at any one-retort spiral flight spacing.

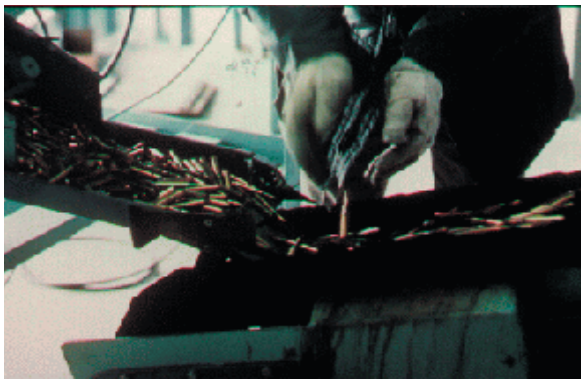


Fig 4: An operator feeds small arms (28,000 rounds per hour) to the EWI.

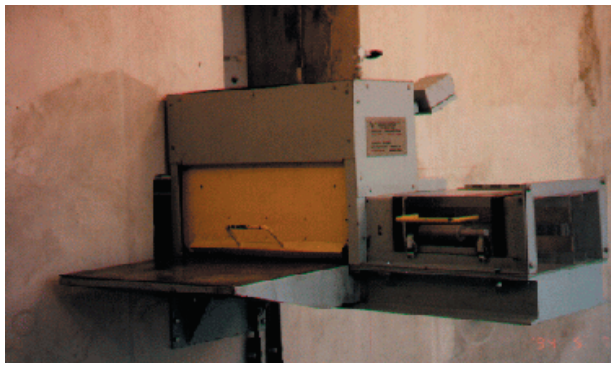


Fig 5. The PFS is used to feed bulk PEP materials while eliminating line-of-sight hazards to operators

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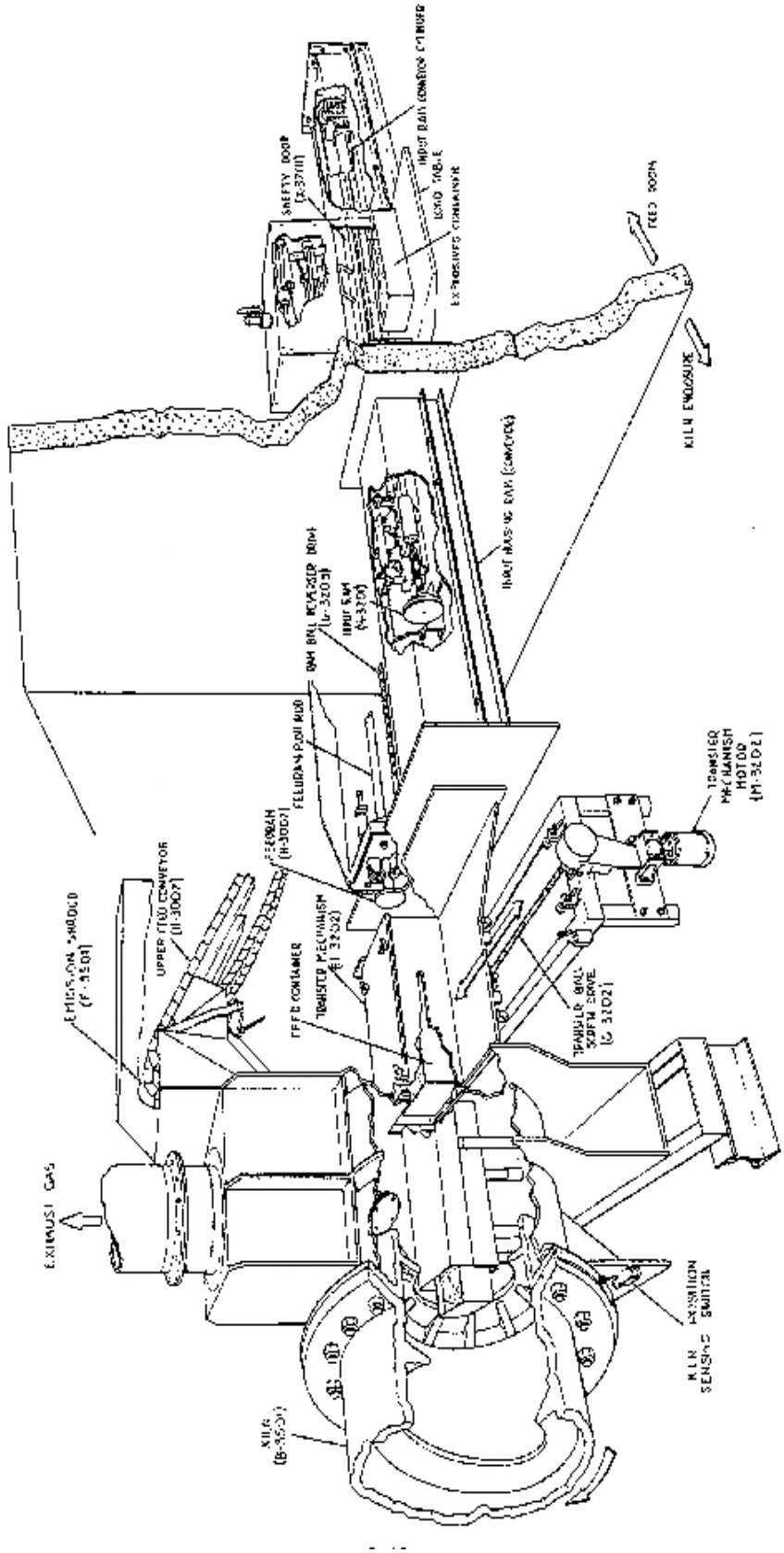


Figure 6. The Positive Feed System

3. SOLIDS DISCHARGE SYSTEM

Metal components from configured items or small arms are discharged from the furnace onto the discharge conveyor. The discharge conveyor transports this material through a hole in the reinforced concrete barricade wall to a discharge point.

3.1 Afterburner

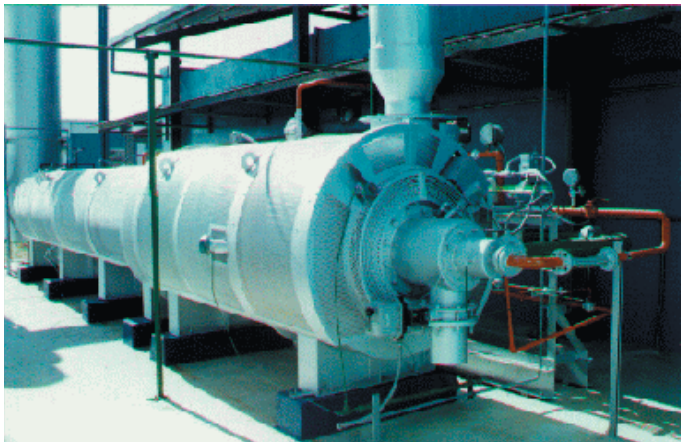


Figure 7 - Afterburner

The purpose of the afterburner (shown in Figure 7) is to raise the temperature of the exhaust gases exiting from the kiln to ensure the complete combustion of any remaining hazardous and/or incompletely combusted material. The afterburner is capable of heating 2,400 SCFM of air at 400-1100 F to 1800 F with a minimum residence time of one second. It is a refractory-lined, horizontal cylinder supported by five weight-bearing saddles attached to the foundation. The afterburner is divided into two sections or chambers. The first section is the mix chamber, and includes the burner, rotary kiln exhaust inlet, and a baffle plate. The burner is a cold air baffle type designed to operate at 35% stoichiometric air. The baffle plate is located between the mix chamber and the residence chamber. The baffle plate provides a restriction that increases the velocity and enhances the mixing of the heated exhaust to ensure a uniform temperature distribution prior to entering the residence chamber. The residence chamber provides the residence time at the operating temperature.

3.2 Pollution Control System

Figure 8 – Pollution Control System

Following the afterburner, the APCS consists of various units, including the gas cooler, bag-house, draft fan, and exhaust stack. The gas cooler cools the hot exhaust gases from the afterburner down to the operating temperature of the fabric bag-house. The bag-house is a fabric filtration collector, used for final particulate cleansing of the gas stream. The bag-house has a total filter area of approximately 1356 square feet. The gas stream is pulled through the APCS by a draft induction fan, which keeps the entire system under a negative draft to minimize fugitive emissions. Exhaust gases then exit out the exhaust stack. Note: While no indication of munitions chemistry has been made available to EDE, we are aware that some WW II era munitions contain mercury in primers, etc. Equipment to eliminate mercury exists and can be included in the APCS train if required. Since Equipment costs depend on the quantities involved, mercury vapour control has not been included in the cost estimate below.

Note on Oxides of Nitrogen (NO_X)
Oxides of nitrogen (NO_X) have two general sources: thermal NO_X is created when incinerator temperatures are high enough to create NO_X from atmospheric nitrogen; species NO_X is formed from nitrogen contained in the incinerated materials, such as munitions. Incinerating munitions can create some of each; as the munitions ignite, a spike of NO_X is created. Then there is a lull in NO_X emissions until the next charge ignites. Although the EWI is capable of complying with all emissions regulations, given enough investment in equipment, it has been EDE's experience that it is not cost effective to meet some of the instantaneous NO_X emissions regulations while burning munitions. EDE has designed NO_X control systems and examined many others. It would be expected that a NO_X control system would cost in excess of $1 million US, and would possibly still not meet all standards. Although many equipment manufacturers claim that NO_X control is feasible, they frequently retract their claims in the face of the non-steady-state, widely fluctuating NO_X emissions. A very expensive NO_X control system was installed in Lubben, Germany, but still did not meet all European standards.

NO_X controls are typically not required in the U.S. as the total NO_X emissions are so low. Since the European standards are based upon parts per million--or instantaneous measurements--they are more difficult to achieve while burning munitions, which do not reach steady state. The system described and estimates herein assumes that an agreement can be reached with regulators to manage total NO_X emissions, and that NO_X control systems will not be required.

4 CONTINUOUS EMISSIONS MONITORING

A system can be installed to allow continuous monitoring of regulated emissions such as oxygen, CO, CO_2, NO_X and SO_X, in the stack. The system is readily available and does not require advanced technology. It samples stack emissions on a timed basis and sounds an alarm in the control room when preset levels are exceeded.

5 EQUIPMENT LIST AND TECHNICAL SPECIFICATIONS

EWI Overall specifications

- Nominal processing rate of up to 220 lbs of TNT equivalence per hour
- Operates continuously or intermittently
- Barricaded for operator safety (not included in equipment cost estimate below)

Rotary Kiln Retort Sections

- ASTM A217 grade WC9 steel
- 3.25 inches thick centre sections, 2.25 inches thick end sections
- approx 36 inches OD
- approx 60 inches long
- approx 8,000-10,000 lbs shipping weight, each
- spiral flights spaced at 30 inches, varying heights

Frame Assembly/Trunnion Assembly

- Variable speed drive adjustable from 1.0 to 3.5 rpm (options available for faster or slower rotation)
- Framing of 12 inch I-beams
- Includes drive and idler trunnions, thrust rollers, charge end assy and discharge end assy.

Burners and Controls

- Natural gas, propane or oil-fired (select one) proportioning burner
- Flame detector interlocked with fuel supply
- Temperature feedback loop to control burner
- Continuous temperature recording
- Includes low-pressure centrifugal combustion air blower
- Main control panel in control room, auxiliary panel near burner stand
- Main control panel purged and pressurized to reduce hazards
- Visible and audible alarms to signal upset conditions

Feed System--Standard Conveyor

- Inclined pan conveyor type (8 inches wide)
- Transfer feed materials through barricade
- Deposits items in gravity feed chute

Feed System--Positive Feed System

- Eliminates line of sight exposure of operators
- Designed for loading bulk powder or explosives, punched/sheared items
- Cycle time approximately once per retort revolution
- Accommodates consumable containers

Solids Discharge System

- Conveys residual materials (metal scrap) from discharge end
- 40 pound load per lineal foot
- Approximately 20 feet long, 18 inches wide

Afterburner

- Sub-stoichiometric burner to run on same fuel as furnace burner
- 2,400 SCFM
- 1,800 F maximum temperature (1400-1600° F nominal)
- 1 second residence time
- Baffle design to provide mixing and residence time

Gas Cooler

- Air-to-air heat exchanger design
- Stainless steel construction
- Reduce 2,400 SCFM to 250° F

Bag-house

- Fabric filtration media
- Air to cloth ration of approximately 4:1
- Self-cleaning, “pulse-jet’ system
- Closed dust collection drum

Draft Fan

- 6,700 CFM at 30 inches water column
- 300° F operating temperature
- Manually adjusted outlet damper
- Severe duty, TEFC, class F insulation motor
- 50 hp, 3 ph, 60hz, 208-230/460 VAC

Emission Stack

- A36 carbon steel
- 30 feet minimum height
- 20 inches diameter

Power/utility requirements

- Electricity: 208-230/460 VAC, 60 HZ, 150 KVA, total
- Burner fuel: 10,000 gallon fuel oil tank, (30 day supply, one-shift operations)
- Steam: none
- Water: none
- Compressed air: 10 CFM at 90 psig
- Other: none

Site preparation

The following considerations must be made when preparing the site for installation:

- The entire retort a suitable barricade wall, typically reinforced concrete, must enclose area
- The feed room and scrap collection area must be separated from the retort area by suitable barricade walls
- Footings and foundations are required for this equipment
- Weather protection over retort area not required
- Lighting must be provided
- Lightning protection must be provided
- Grounding system is required in any location where live explosives are included

ANNEX D
TO CHAPTER 4

PLASMA ARC EXPLOSIVE WASTE INCINERATORS

1.1 General

Plasma arc technology has been around since the 1960's. The technology was originally developed for and used by the Aerospace Industry for the simulation of re-entry conditions on space vehicles. The technology was then picked up by the specialty metals business and used for the development of high purity metal components. During the late 1980's the U.S. Government funded considerable research in applying the technology to the most difficult to treat waste produced by our society. These wastes included nuclear waste, very toxic chemical waste, and excess military ordnance. Elsewhere in the world other governments and organizations were also in the process of applying plasma technology to the treatment of these wastes.

The interest in the technology arises from the high temperatures capable of being produced by the technology. These high temperatures, on the order of 12,000 F are sufficient to melt any inorganic compound and thoroughly destroy any organic constituents. The effluent streams resulting from a plasma treatment system are also much more benign than currently used technology. The resulting slag has been proven to be very benign and non-leachable. In addition to the resulting slag, the emissions resulting from plasma arc technology are much less than resulting from a fossil fuel fired system. Plasma technology gas volume emissions are typically 10% of a comparable fossil fuel fired system and emission have been proven to meet even the most environmental standards and regulations. In addition to the environmental and operational benefits listed, the U.S. Army has also found that the operational cost associated with a plasma system for the destruction of ordnance are comparable to those of the standard 1236 deactivation furnace.

Because of the advantages associated with the technology, the U.S. Army has contracted with MSE to build two separate plasma treatment systems for the disposal of energetics. The first was a fixed facility to be used for the destruction on pyrotechnic devices as well as other materials. This facility will be installed at the Hawthorne Army Depot in Hawthorne Nevada. The second was a transportable system to be used for energetic devices around the DoD complex.

Many people are constantly looking for that elusive "silver bullet" technology. Plasma technology is not that silver bullet. However plasma technology represents a good environmentally friendly and cost competitive alternative technology for the destruction of energetics and energetic devices. As with other incineration technologies, Plasma is not a blast chamber and is not designed for high order detonations. Therefore, the system is meant to be used in conjunction with other pre-processing technologies, just as the APE 1236 incinerator.

1.2 Performance Capabilities

A mobile plasma treatment system that could be used in BiH can provide the destruction capability in a de-mil system operation. The system requires pre-processing of some components as any other EWI, however it has the flexibility with proper pre-processing to

treat the majority of the items present. With proper pre-processing and operation the system is capable of meeting the following production levels:

SER	NATURE	PRODUCTION RATE
1	TNT	140 kg/hr
2	Fuzes	1000/hr
3	Primers	20,000/hr
4	Bulk Propellant	150 kg/hr
5	Bulk Illuminate	200 kg/hr
6	Bulk Smoke	100 kg/hr

1.3 Plasma Technology

The major system components of the Mobile Plasma Treatment System are:

- Primary chamber;
- Primary chamber feed system;
- Plasma arc torch;
- Secondary combustion chamber;
- Pollution Control System

The primary chamber is a sealed vessel in which the plasma treatment process takes place. The vessel consists of a water cooled dome, spool piece, and hearth sections with ports installed in the dome and spool for the plasma torch, process offgas, feed, oxidation air, and viewing cameras. During operation, the plasma torch heats and oxidises the feed material using a high temperature plasma gas, creating a molten pool in the primary chamber hearth. In addition to the torch gas, supplemental oxidation air is supplied to the chamber to help maintain an oxidising atmosphere and keep the oxygen content above stoichiometric conditions. Once the hearth is full, it is tapped and the molten slag pours into drums where it cools into a glassy-ceramic solid.

The primary chamber feed system consists of separate feeders for ordnance and soil. Ordnance devices are fed to the primary chamber using a conveyer belt feeder that dumps the ordnance through a rotary valve into a feed tube. A pneumatically actuated rammer then feeds the ordnance through the side of the primary chamber vessel into the hearth.
The soil and flux materials are fed to the top of the furnace using a flexible screw conveyor and hopper. The material is conveyed to the top of the primary chamber, fed through a valve, and dropped into the plasma hearth.

The plasma arc torch system consists of a 500 kW non-transferred arc torch, a plasma gas supply system, a closed loop deionised cooling water supply system, and a power supply. The torch assembly has four water-cooled circuits; the outer housing or ram, the cathode, the anode, and the ball assembly. Deionised water kept in a closed loop system

is used to cool the plasma torch during operation. The D.I. water is kept cool using a plate and frame heat exchanger fed by the plant cooling water supply. Because it is easier to ionise than the plasma torch gas, helium is used as the torch gas for ignition. Also, a small flow of argon is maintained during operation as a shroud gas to keep the tungsten electrode from oxidising. Immediately after ignition, the torch gas is switched from helium to the main torch gas. The torch can be positioned in the primary chamber with a three-axis, electrically powered motion control system. Pinhole cameras installed in the dome and spool sections of the primary chamber allow operators to control torch position and view the plasma arc.

Hot combustion gases generated during the plasma treatment process are drawn off the top of the primary chamber and routed to the Secondary Combustion Chamber (SCC) via a refractory lined pipe. The SCC is a horizontal vessel consisting of two refractory lined chambers.

The first chamber is a mixing section in which combustion gases are mixed and heated to over 2000 ^{0}F. A diesel/air fired burner is mounted on the inlet end of the mixing section with the burner flame directed horizontally into the chamber. Combustion gases, from the primary chamber, enter the mixing section tangentially to the burner flame to provide a turbulent atmosphere for mixing. The combustion gases and diesel/air products then enter a plug flow section designed to ensure a two-second residence time through the SCC. The combination of high temperature and residence time in the SCC ensures complete combustion of any remaining organic material or products of incomplete combustion (PICs).

ANNEX E
TO CHAPTER 4

"HIGHER TECHNICAL RISK" TECHNOLOGIES

1. "Silver II".

An electro-chemical oxidation process. The organic waste is treated by the generation of highly oxidising species in an electro-chemical cell. The cell is separated into two compartments by a membrane that allows ion flow but prevents bulk mixing of the anolyte and catholyte. In the anolyte compartment a highly reactive species of silver ion attacks organic material ultimately converting it to CO_2, H_2O and non-toxic inorganic compounds. The UK trials have been conducted by AEA Technologies:

- Advantages.

  (1) Can be applied to a wide range of explosives.

  (2) No toxic waste produced.

  (3) Operates at low temperatures.

  (4) The reaction can be stopped at any stage.

  (5) Can handle waste products from other demilitarization technologies.

  (6) Can deal with continuous feed.

- Disadvantages.

  (1) Only reached development stage. No production facility has ever been built or tested.

  (2) High electrical requirements.

2. Biological Degradation.

The use of "bugs" to "eat" explosive compounds.

- Technically feasible.
- Prototype systems available.
- Requires extensive storage capacity whilst bio-remediation is taking place.
- Limited applications.
- Often requires an element of mechanical breakdown.

3. Chemical Processing.

The use of chemical solvents to breakdown the explosive compounds.

- Limited applications.
- Often requires an element of mechanical breakdown.

4. Open Pit.

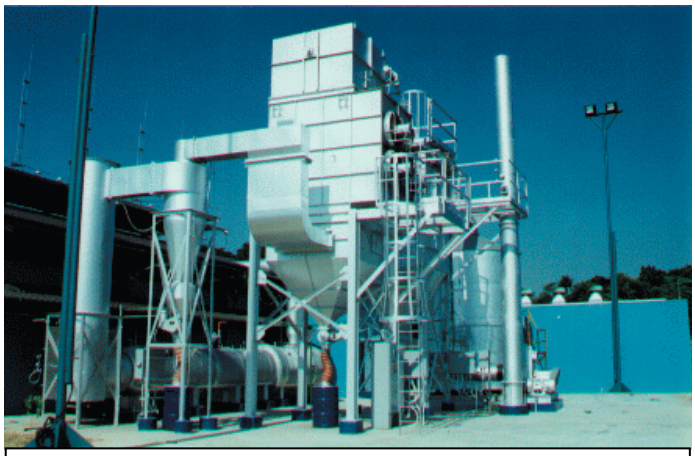
Waste material is placed on a tiled floor in a purpose built pit equipped with perforated air pipes to supply forced air to the system. A turbulent air current is created above the fire that re-circulates the combustion gases and particulates, which assists in full oxidation of the evolving gases. The principle has been tested, but no large scale trials have yet being conducted.

ANNEX F
TO CHAPTER 4

BAG HOUSE POLLUTION CONTROL SYSTEMS

1. Following the afterburner, the APCS consists of various units, including the gas cooler, baghouse, draft fan, and exhaust stack. The gas cooler cools the hot exhaust gases from the afterburner down to the operating temperature of the fabric baghouse. The baghouse is a fabric filtration collector, used for final particulate cleansing of the gas stream. The baghouse has a total filter area of approximately 1356 square feet. The gas stream is pulled through the APCS by a draft induction fan, which keeps the entire system under a negative draft to minimise fugitive emissions. Exhaust gases then exit out the exhaust stack. Equipment to eliminate mercury exists and can be included in the APCS train if required.

2. Oxides of nitrogen (NOx) have two general sources: thermal NOx is created when incinerator temperatures are high enough to create NOx from atmospheric nitrogen; species NOx is formed from nitrogen contained in the incinerated materials, such as munitions. Incinerating munitions can create some of each; as the munitions ignite, a spike of NOx is created. Then there is a lull in NOx emissions until the next charge ignites. Although an EWI is capable of complying with all emissions regulations, given enough investment in equipment, it has been international experience that it is not cost effective to meet some of the instantaneous NOx emissions regulations while burning munitions. NOx control systems have been designed and many others examined. It would be expected that a NOx control system would cost in excess of US $1 M, and would possibly still not meet all standards. Although many equipment manufacturers claim that NOx control is feasible, they frequently retract their claims in the face of the non-steady-state, widely fluctuating NOx emissions. A very expensive NOx control system was installed in Lubben, Germany, but still did not meet all European standards.



A typical incineration pollution control system.

3. The European standards are based upon parts per million--or instantaneous measurements-and they are very difficult to achieve while burning munitions, which do not reach steady state. The system described and estimated herein assumes that an agreement can be reached with regulators to manage total NOx emissions, and that NOx control systems will not be required.

(The above comments regarding NO_x emission standards apply equally to the alternative Dry Ceramic Filtration PCS described later).

ANNEX G
TO CHAPTER 4

DRY CERAMIC FILTRATION POLLUTION CONTROL SYSTEMS

1. A UK Demilitarization Facility is the only known facility to use this form of PCS. It meets all current and anticipated European Union environmental legislation standards. It is an integrated system with the following components:

a. Afterburning.

- Oxidises entrained organic compounds, ash and metal fragments.
- Needs to be above 850^0C for over 2 seconds to destroy VOC.
- The VOC burn to CO_2, H_2O and acid gas.
- Organic particulate destroyed.
- Oil consumption of 15 kg per hour.

b. Quench Cooling. There is a requirement to cool hot gases after the afterburner before they flow into the next stage of the PCS. This is to protect the usually steel structure from heat treatment effects that could weaken it:

- Cools gas from 1200^0C to 500^0C.
- H_2O injection and evaporation used.
- H_2O consumption of 400 litres per hour.

c. Acid Gas Adsorption.

(1) Sodium Bicarbonate used as the medium:

- It operates effectively over a wide temperature range.
- It produces a safe and inert solid for disposal.
- It reacts well with NO_X.
- It is readily available.

(2) The Sodium Bicarbonate reacts with the acid gas in the constantly renewing fixed bed formed on the ceramic filtration rods. (See later).

(3) The relevant chemical equations are:

- $NaHCO_3 + HCl = NaCL + H_2O + CO_2$
- $NaHCO_3 + HF = NaF + H_2O + CO_2$
- $2NaHCO_3 + SO_2 + ½O_2 = Na_2SO_4 + H_2O + 2CO_2$

- $2NaHCO_3 + NO_2 = Na_2NO_3 + H_2O + 2CO_2$

d. Ammonia Injection.

- Assists in the NO_X reduction.
- Injected into afterburner.

e. Activated Carbon Adsorption.

- Required for adsorption of Hg.
- Process gas is drawn through a bed of activated carbon granules.
- The gas residence time is just less than 3 seconds.
- The fixed bed requires renewal on a bi-annual basis.

f. Dry Ceramic Filtration.

- Removes particulate down to one micron.
- Supports a bed of sorbent for gas adsorption.
- The filters are generally 1.0m x 0.06m.
- Typically 256 filter elements giving a filtration area of $48m^2$.

g. On-line Monitoring.

(1) Fully auditable by national authorities.

(2) Principles:

- IR absorption (CO, NO_x, H_2O)
- Tribo-electric (Particulate)
- Flame ionisation (VOC)
- pH of solution (HCl, HF)
- Velocity (Flow Rate)
- Zirconia Electrode (O_2)
- Thermocouple (Temperature)
- Pressure (Diaphragm Strain)

(3) Requires data processing system to calculate and display emission rates, concentration and history.

ANNEX H
TO CHAPTER 4

ADVANTAGES AND DISADVANTAGES OF POSSIBLE SITES

SER	LOCATION	ADVANTAGES	DISADVANTAGES
1	**UNIS-PRETIS** ***Vogosca*** *(Utilisation of old ammunition manufacturing complex)*	• Existing ammunition manufacturing facility, largest pre-war capacity and largest site. • Government-owned site • Adequate (almost unlimited) storage facilities. • Large semi-qualified labour pool available. • Operational foundry	• Some infrastructure damage to storage locations • Basic level of physical security • Close to only 2 current EAF storage locations • Ammunition movement may be required on main roads around Sarajevo
2	**P.S.VITEZIT** **Vitez** *(Utilisation of old explosives manufacturing complex)*	• Existing explosive manufacturing facility. • Government owned site. • Adequate storage facilities. • Large semi-qualified labour pool available. • Relatively accessible. • Ongoing demilitarization activity co-located with TNT recycling facility (mortar bombs only)[10]. • Reasonable infrastructure. • Propellant testing facility • Central to all EAF sites	• Poor physical security.
3	**BINAS** **Bugojno** *(Utilisation of old explosives manufacturing complex)*	• Existing explosive manufacturing facility. • Government owned site. • Adequate but limited storage facilities. • Relatively accessible. • Ongoing demilitarization activity reported by director (hand grenades and anti-tank mines only)[11]. • Reasonable infrastructure. • Central to all EAF sites.	• Poor physical security • Smallest site

[10] No objective evidence presented on potential capacity – estimated to be 600 mortars per week
[11] No objective evidence presented on potential capacity – no demilitarization activity evident during visit.

ANNEX I
TO CHAPTER 4

ENGINEERING DIMENSIONS TO POSSIBLE TECHNOLOGIES

1. Site Preparation

The site preparation requirements will be similar for all technologies. The following are essential:

- Operating buildings must be sized based on the process and immediate feedstock (ammunition) storage requirements. This will directly influence the Internal and External Safety Distances.
- Operating buildings should contain loading bays, unpacking areas, immediate storage areas and blast resistant operating bays.
- Routes should be sufficiently large to allow for the transportation of the largest ammunition containers.
- Outdoor lighting is required.
- Lightening protection is required for all buildings holding or processing ammunition.
- Fire protection and a suitable alarm system are essential.
- Static earth systems are required in all processing and destruction areas.
- Conductive flooring is required in processing areas.

2. Pre-Processing Technologies.

2.1 General

Nearly all pre-processing equipment will have the following engineering related support:

SER	TECHNICAL AREA	REQUIREMENTS
1	Electrical Power	208/490V AC 600 kVA
2	Diesel Fuel (30 Days Supply)	NIL
3	Water	NIL
4	Compressed Air	400 - 600 scfm @ 125 psig

SER	TECHNICAL AREA	REQUIREMENTS
5	Oxygen	NIL

2.2 Autoclave

SER	TECHNICAL AREA	REQUIREMENTS
1	Electrical Power	Standard
2	Diesel Fuel (30 Days Supply)	NIL
3	Water / Steam	I5 psig Steam @ < 120^0C
4	Compressed Air	100 psig
5	Oxygen	NIL
6	Hydraulic	1000 psig

In addition to those at Paragraph 1 above, the following additional requirements are necessary for the safe operation of an autoclave system:

- Watertight floors.
- Deluge Fire Protection System.

2.3 Typical Processing Equipments.

Again the US APE systems have been used as an example:

SER	APE	FUNCTION (APE NO)	FOOTPRINT ($FEET^2$)	WEIGHT (KG)	OPERATING AREA ($FEET^2$)
1	1001M1	Pull Apart	21	5,400	66
2	1002M3	Defuze/Detrace	11	1,200	68
3	1042M2	Debanding	24	3,600	103
4	1153M1	Disassembly	7	550	62
5	1213M1	Grenade Pitch-In	9	1,700	19
6	1229M1	Deprime	14	3,200	80
7	1294	Vice	6	200	64
8	2156	Hand Grenade Defuzer	25	4,400	142
9	2175	Projectile Saw	36	1,500	163
10	2196	Shear	32	5,000	119

3. Destruction Technologies.

3.1 Rotary Kiln EWI

Typical Rotary Kiln EWI systems will require the following engineering related support:

SER	TECHNICAL AREA	REQUIREMENTS
1	Electrical Power	208-230/490V AC 60 Hz 150 kVA
2	Diesel Fuel (30 Days Supply)	40,000L Storage Tank
3	Water	NIL
4	Compressed Air	10 scfm @ 90 psig
5	Oxygen	NIL

In addition the following should also be noted:

- The entire retort a suitable barricade wall must enclose area.
- The Feed Room and Scrap Collection Area must be separated from the retort area by suitable barricade walls.
- Footings and foundations will be required.

3.2 Plasma Arc EWI

Typical Plasma Arc systems will require the following engineering related support:

SER	TECHNICAL AREA	REQUIREMENTS
1	Electrical Power	720 kW
2	Diesel Fuel	50 litres/day
3	Water	4 litres/min
4	Compressed Air	40 scfm
5	Oxygen	125 scfm

ANNEX J
TO CHAPTER 4

ADVANTAGES AND DISADVANTAGES OF MOVEMENT OPTIONS

OPTION	METHOD	ADVANTAGES	DISADVANTAGES
1	**LOOSE BOXED**	No additional capital expenditure.	Security challenges.
		Manpower intensive offering employment.	Safety issues.
			Limited load per vehicle (stack height)
			Difficult accounting.
			Multiple handling.
2	**PALLETISATION**	Ease of handling, loading and unloading.	High cost in manpower and equipment.
		Ease of accounting.	Time consuming.
		Reduced security issues.	Financially prohibitive.
3	**CONTAINERISED**	Ease of handling, loading and unloading.	Access difficult in some locations.
		Ease of transportation.	Initial purchase of additional equipment and specialist vehicles.
		Ease of accounting	
		Ease of storage.	
		Security issues minimised.	
		Economic overall.	

Bosnia and Herzegovina

THREAT RESOLUTION LIMITED

Chapter 5
FINANCIAL

CHAPTER 5 - FINANCIAL

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CHAPTER 5

FINANCIAL

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1.2 Quantify the projects key fixed costs including equipment and appropriate building and infrastructure renovations

1.3 Estimate operating costs taking into consideration local labour market conditions and international staff requirements.

1.4 Compare the different legal structures available for the management of the proposed Facility and their taxation implications.

1.5 Carry out a preliminary study on the international market for the various grades of scrap that could be produced.

1.6 Examine future funding options for both the building and operating phases of the proposed facility and list conditions, which may have a bearing on those options – e.g. ownership of assets, disposal or profits."

2. FINANCIAL MODEL

2.1 Project Phases.

The financial model of the ADF (the Model), at Annex B, was created in order to estimate the financial requirements to create and operate the proposed ADF. The Model broke down the various stages needed to create the ADF.

2.1.1 Pre-implementation Phase (PiP)

In this phase, the project executors and the Project Supervisory Team (PST) would be responsible for drawing up the detailed specifications and work plans for the creation of the ADF in BiH. Initially based in Sarajevo, the PST will develop the necessary technical specifications of the capital equipment from which the tender documents would be drawn up.

There is considerable lead time (approximately 18 months) between the specification of the capital equipment, its tender, order and subsequent delivery to BiH. During this period, the logisticians would be able to start planning the ADF feedstock delivery. Additionally, the upgrading of the Propellant Testing Laboratory could commence and OBOD operations to destroy unstable ammunition should continue.

2.1.3 Implementation Phase (IP)

The implementation phase consists of the site preparation and the installation of the process equipment. By this time the PST will be advanced with their plans covering the different aspects of the ADF including logistics and feedstock management. The latter part of the IP will involve the commissioning of the ADF by the equipment providers.

2.1.4 ADF Operational Phase

This phase commences with the full operation of the ADF at the selected GOF. At that point the PST would complete the necessary documentation for the capital equipment and legal ownership will have been transferred.

2.2 Assumptions.

In creating this financial model, the following assumptions were made;

- Financial/Taxes:
  - No customs or other tariffs will be applied to capital items.
  - EWI fuel costs are tax free Local.
  - VAT will be recoverable.
- Existing GOF facilities, logistic support and security are provided at no additional charge to the project.
- Estimated costs (labour, offices and contractor fees) will not suffer significant inflation in the next two years.
- Health and safety measures and EWI pollution control systems are maintained to European Emission Standards.
- Where possible, the phased replacement of international staff by local staff occurs at the earliest opportunity.

The model indicates that a significant portion of the costs is incurred in project management and staffing with international technical experts. However the Team believe that it is possible to replace almost all the international staff with local experts once they have received appropriate “on the job” training.

The only other area for significant cost reduction is that of the fuel costs for the EWI. The Model has assumed that the EWI will burn diesel fuel. It also assumes that no government excise duty will be applied and that a significant discount for a long term bulk order will be obtained. It was beyond the technical scope of this study to determine whether the EWI could obtain other sources of fuel either through import or by using an alternative type of fuel such as the heavy oil residues from the refinery.

2.3 Analysis.

Analysis of financial aspects concludes that the proposed BiH ADF should be able to process the munitions for just under US$570 per tonne based on the assumption of an amortisable life of 7 years[1]. When the revenue generated for the export of the recovered metals is taken into consideration, this cost is reduced by 13% to US$527 per tonne. As previously mentioned, as the ADF

[1] This figure includes capital expenditure of the EWI and pre-processing equipment.

should remain a non commercial (GOF) operation this sale of recovered metals will not attract any form or taxation. The average cost per tonne of ammunition for demilitarization at a European facility is very broadly US$800 – US$1,200 per tonne depending on the type of ammunition.

Given the size of the BiH stockpile and the possibility of the cost of demilitarization of within the existing European market[2], it is very probable that the ADF could compete in the international marketplace in the long term.

The Study Team recommends that, computerised financial and ammunition stockpile management is installed at the commencement of the project and tight controls are maintained over all aspects of the financial management of the project. Once the ADF is commissioned, and the operating staffs have determined appropriate operating procedures, then careful observation of the cost variances will ensure that strict financial controls will be achievable.

2.4 Cost Effectiveness.

Overall the operational costs of the proposed ADF are likely to be significantly lower than that of similar facilities in Europe. There are approximately 16 demilitarization plants of varying capabilities in Europe: France, Italy, Spain, UK, Norway, Germany and Sweden. Most of these facilities currently have spare capacity but clear obstacles to the export of the entire stockpile for demilitarization are identified in the technical chapter of this Study Report.

3. PROJECT KEY FIXED COSTS

3.1 Project Management Costs

The Executing Agency will incur overheads associated with the strategic management of the project. For budgetary purposes a figure of 15% should be added to the project costs. A project contingency of 15% should also be included in the budget but only released on a case by case basis by the project sponsors.

The following estimated Project Management costs are including mandatory insurances and contributions and subsistence. A breakdown of the manpower requirements can be found in Annex I to Chapter 2.

Table 1 – Project Supervisory Team.

PST Costs	US$K Per Annum			
	Yr 1	Yr 2	Yr 3	Yr 4-7
Staff costs	384.0	384.0	192.0	768.0
Staff accommodation	18.0	18.0	18.0	72.0
PST support Office	32.0	7.2	7.2	28.8
Transport	40.0	3.6	3.6	14.4
Total	**474.0**	**412.8**	**22.8**	**883.2**

[2] Once the dangerous element of the local stockpile is destroyed.

3.2 Demilitarization Equipment Costs

The following is an example of the probable Phase A demilitarization pre-processing equipment costs:

Table 2 – Pre-processing Equipment.

SER	APE	FUNCTION	QTY	COST EA $	TOTAL $
1	1001M1	Pull Apart	2	75,000	150,000
2	1002M3	Defuze/Detrace	1	14,000	14,000
3	1042M2	Debanding	1	6,800	6,800
4	1153M1	Disassembly	1	40,700	40,700
5	1213M1	Grenade Pitch-In	1	8,200	8,200
6	1229M1	Deprime	1	18,800	18,800
7	1294	Vice	1	8,300	8,300
8	2156	Hand Grenade Defuzer	1	3,700	3,700
9	2175	Projectile Saw	1	25,800	25,800
10	2196	Shear	1	90,500	90,500
11	VAR	Spare Parts, oils & Lub.	1	56,000	56,000
	Total				**422,800**

Note: Includes shipping and export licensing.

Table 3 – Demilitarization Equipment.

The following is an example of the probable Phase A demilitarization pre-processing equipment costs:

SER	APE	FUNCTION (APE NO)	QTY	COST EA $	TOTAL $
1	NA	Site Design/Preparation	1	125,000	125,000
2	1236	EWI with basic PCS	1	1,675,000	1,675,000
3	NA	Shipping / Insurance	1	95,000	95,000
4	NA	Civil Engineering	1	350,000	350,000
5	NA	Installation	1	175,000	175,000
6	VAR	Spares	1	100,000	100,000
7	NA	Continuous emissions monitoring	1	160,000	160,000
	Total				**2,680,000**

3.3 Scrap Processing Equipment Costs

It is not intended to include any scrap processing equipment in Phase A. There may be a requirement in the proposed Phase B operation but it is anticipated that the foundry at Unis-Pretis and existing facilities at Zenica and Jelsingrad will suffice.

3.4 Ammunition Storage Costs

Apart from buffer feedstock which will require permanent accommodation, ISO containers will act as storage for the munitions for demilitarization. The maintenance costs for both the permanent storage and ISO containers are considered to be insignificant.

3.7 Physical Security Costs

Costs in improving protective security measures should be borne by the GOF. The existing security of a military guard force is considered adequate and there is no anticipated significant expenditure in physical security.

4. OPERATING COSTS

4.1 Ammunition Demilitarization Facility

It is proposed that the Executing Agency contracts the ADF to demilitarize the ammunition on a fixed rate of cost per tonne. This is the industry norm since payments are performance related and provide minimal financial risk to the sponsors.

Therefore all ADF costs associated with demilitarization are rolled up into this one figure.

5. LEGAL STRUCTURES AND TAXATION IMPLICATIONS

5.1 Discussion.

The Study Team examined various legal frameworks under which the ADF would operate, these included:

- Operation within existing GOF structure.
- Commercial operation.
- Legal entity operated by Executing Agency.

In utilising any of the above structures, the entity then has to comply with a variety of policies concerning technical, accounting, financial, certification and also comply with the BiH government regulations. These regulatory issues will impose a significant administrative burden on a business with penalties and possible sanctions for those who are regarded as having breached them.

The operation of the proposed ADF within the existing GOF structure minimises political and technical risks.

However, when considering the development of an indigenous ADF, it is fundamental to recognize that from its inception to the operations defined by Phase A, it cannot be considered as a commercial project. Whilst it is envisioned that some recovered metals will be saleable thus generating some cash, it can only be considered as a donor funded aid project and not

commercial at this stage. Therefore the ADF cannot be regarded as a project which will generate a corporate taxation liability from its activities.

Accepting this initial non-commercial status, the ADF would be an eligible project to be funded and managed by for example, NATO's Partnership for Peace (PfP) Trust Fund or UNDP Sarajevo.

Given the level of funding required for the ADF, and its importance to the nation, the Study Team recommends that acquiring direct support from the BiH government must be a prerequisite for its implementation.

The Study Team regard the Albania demilitarization project model as being ideal for replication in BiH. Phase A operations has no commercial activity therefore, this management model is regarded as being totally appropriate.

5.2 Recommendations.

The Study Team recommends that the proposed ADF is operated within the existing structure of the GOFs.

5.3 Phase B – Commercialisation.

The Team is aware that similar projects to proposed ADF have been operated on a commercial basis. There will be nations whose armed forces are willing to enter commercial contracts for the destruction of their own munitions. This is often the case with smaller nations where the construction and management of their own indigenous facility is not economic or alternatively the appropriate expertise is not available. This is certainly the case in BiH.

Progressing to commercial operations of the ADF has been termed “Phase B” and the industry specific knowledge of the Team confirms that it is a realistic option for the ADF.

Fundamental to the design of this study has been the over-riding importance of the rapid destruction of the unsafe munitions stored in residential areas.

In order to take the ADF to Phase B, additional capacity building is needed to ensure that the ADF complies with international agreements as well as increase its logistics capabilities. This would, by definition, reduce the capacity of the enlarged ADF to deal with the BiH feedstock designated as critical for processing.

This commercialisation does not necessarily mean that the ADF will generate “profit” in the accounting sense of the term. Appropriate commercialisation would generate revenues which would be reinvested in the ADF in the form of upgrading equipment and enlarging its capacity. The conversion to profit generation, as opposed to revenue generation, might create issues regarding donor support, repayment and taxation which then contradict the underlying philosophy behind the ADF.

6. INTERNATIONAL SCRAP METALS MARKET

6.1 Current Market Prices

The International scrap metals market is notoriously erratic. The calculations given in this report are based on benchmark average market prices during Q2 of 2004. In the case of export from BiH, shipping charges should be considered as well as haulage to the port. Both of the factors will erode income from sales. Indicative pricing for international shipping based on a bulk-load of 20,000 tonnes is as follows:

Europe (1) - US$10 per tonne.
Europe (2) - US$ 6 per tonne.
Asia` - US$30 per tonne.

6.2 BiH Legislation

There does not appear to be any legislation in place preventing the exporting of scrap metals.

6.3 Possible Income from National Sales

Due to the pollution problems outlined in paragraph 5 of Chapter 3 it is not proposed to dispose of any of the salvageable metals in BiH.

6.4 Possible Income from Export Sales

Table 7 – Possible Income from Export Sales

Assuming that it is possible to identify an export for the salvageable metals income during Phase A is as follows:

METAL TYPES	OUTPUT TONNES		US$ PER TONNE	TOTAL US$
	DAILY	ANNUALLY		
Ferrous	7	1,610	38	61,180
Non-ferrous	1	345	632	218,040
Total	**8**	**1,955**		**279,220**

6.5 Summary

The disposal of recoverable metals in a way that will generate some income presents the ADF with a challenge. The relative remoteness of BiH and the lack of a local, environmentally friendly disposal route will currently necessitate export of the materials at a lower than international market value due to the logistic effort required. The solution may be found in an international partner company with specialist capability in this market.

7. BIH'S MACRO-ECONOMY

An analysis of the macro-economic factors within the BiH economy is at Annex D for information.

8. SUMMARY

The Study Team consider the construction and development of an ADF in BiH as financially viable and sustainable in terms of demilitarization activity over at least a decade. The cost per tonne to demilitarize ammunition compares very favourably with that of the European demilitarization industry. A phased approach, with costs spread over up to 7 years, is more likely to be manageable by the donor community.

A summary of costs spread over the initial project lifespan is at Table 8 below.

Table 8 – Financial Summary

Item	Cost US$				
	Year 1	Year 2	Year 3	Year 4-7	*Totals*
Capital Equipment					
Installation of EWI	2,680,000	0	0	0	***2,680,000***
Pre-processing equipment	422,800	0	0	0	***422,800***
Sub total	*3,102,800*	*0*	*0*	*0*	***3,102,800***
In Country Project Management					
Supervisory Team	474,000	412,800	220,800	883,200	***1,990,800***
Sub total	*474,000*	*412,800*	*220,800*	*883,200*	***1,990,800***
Propellant testing					
Capital equipment	65,000	0	0	0	***65,000***
Running costs	18,000	18,000	18,000	72,000	***126,000***
Sub total	*83,000*	*18,000*	*18,000*	*72,000*	***191,000***
ADF Operation					
EWI Running costs	0	355,680	711,360	2,845,440	***3,912,480***
Pre-preparation costs	0	231,192	462,384	1,849,536	***2,543,112***
Other ADF Overheads	0	320,112	640,224	2,560,896	***3,521,232***
Sub total	*0*	*906,984*	*1,813,968*	*7,255,872*	***9,976,824***
Totals	***3,659,800***	***1,337,784***	***2,052,768***	***8,211,072***	***15,261,424***
Project Overheads					
Executing Agency costs at 14%	512,372	187,290	287,388	1,149,550	***2,136,599***
Total Budget	**4,172,172**	**1,525,074**	**2,340,156**	**9,360,622**	***17,398,023***
Contingency at 15%	625,826	228,761	351,023	1,404,093	***2,609,704***
Grand Totals	**4,797,998**	**1,753,835**	**2,691,179**	**10,764,715**	**20,007,727**

Annexes:

A. ADF Financial Summary.
B. ADF Project Implementation – Schedule to Phase A.
C. Financial Analysis.
D. BiH - Analysis of Macro-economic Factors.

ANNEX A
TO CHAPTER 5

EWI RUNNING COSTS

Introduction

1. The following data is based on the Study Teams experience of EWI operation, typical throughputs and recovery materials that have a significant financial value:

2. The numbers below are calculated based on one year of operation with one 8-hour shift per day and fuel consumption of 30 gallons per hour (240 gallons/day).

Labour: 1 supervisor at $ 7.5/hr (estimate at $60/day) x 2,080 hrs =	$ 15,600
6 labourers x $ 6.25/hr (estimated at $50/day) x 2,080 hrs =	$ 78,000
Power: $ 0.12/kwh (based on BiH high rate 150kw/hr) x 2,080 hrs =	$ 37,440
Fuel: $ 51/hr (estimated at $0.34/litre) x 2,080 hrs =	$ 106,080
Estimated Operating Costs for 1 year =	$ 237,120

*Capital equipment amortization = Costs / years of service
(Unable to estimate years of service without detailed stockpile information)

Income from recoverable metals

3. Income from scrap is based entirely on the munitions that are being processed. Thus, it is difficult to estimate the amount of each particular material that will be generated. However, based on the Study Teams experience an average of 1,000 lbs of mixed metal can be expected per hour.

Prices below are just approximations since the market fluctuates regularly.

Aluminium:	$ 0.38 to 0.52/lb
Yellow Brass:	$ 0.49/lb
Steel:	$ 0.13/lb
TNT:	$ 0.5/lb
Any payments for Demil:	unknown

Estimated income from full time operation - 1,000 lbs x 2,080 hrs x $0.13 (steel) = $270,400

Operating Costs minus scrap income minus demil payments = cost or profit
See operating costs for discussion see EWI feed rates

ANNEX B
TO CHAPTER 5

PROJECT SCHEDULE

Project Schedule	Project Start-Up				Pre Implementation					Implementation									Phase A Operations																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Project Management																																				
Project Manager																																				
Supervisory Team																																				
Develop contract Docs																																				
Develop ITT																																				
Bid evaluations & award																																				
Contract Review																																				
Reporting to donors																																				
Supervisoy Team																																				
Pre Implementation																																				
(Lab & IT)																																				
Design & planning																																				
Procurement																																				
Installation																																				
Commissioning																																				
Monitoring/validation																																				
ADF Implementation																																				
Design & planning																																				
Equipment procurement																																				
Site preparation																																				
Equipment installation																																				
Logistics planning																																				
Staff recruitment																																				
Logistics training																																				
ADF Operations training																																				
Commissioning																																				
Phase A Operations																																				
Feedstock stockpile																																				
ADF operation																																				
Operations report																																				

ANNEX C
TO CHAPTER 5

FINANCIAL ANALYSIS

	Year 1	Year 2	Year 3	Year 4-7	*Totals*
1. Capital Equipment					
a) Explosive Waste Incinerator					
Site Design/Preparation	125,000	0	0	0	***125,000***
EWI with basic PCS	1,675,000	0	0	0	***1,675,000***
Shipping / Insurance	95,000	0	0	0	***95,000***
Civil Engineering	350,000	0	0	0	***350,000***
Installation supervision/management	175,000	0	0	0	***175,000***
Spares Packaging	100,000	0	0	0	***100,000***
Continuous emissions monitoring	160,000	0	0	0	***160,000***
Sub total	*2,680,000*	*0*	*0*	*0*	***2,680,000***
b) Pre-processing equipment					
Pull Apart	150,000	0	0	0	***150,000***
Defuze/Detrace	14,000	0	0	0	***14,000***
Debanding	6,800	0	0	0	***6,800***
Disassembly	40,700	0	0	0	***40,700***
Grenade Pitch-In	8,200	0	0	0	***8,200***
Deprime	18,800	0	0	0	***18,800***
Vice Ammunition	8,300	0	0	0	***8,300***
Hand Grenade Defuze	3,700	0	0	0	***3,700***
Projectile Saw	25,800	0	0	0	***25,800***
Shear	90,500	0	0	0	***90,500***
Spare, oils & Lub. (Bulk purchase)	56,000	0	0	0	***56,000***
Sub total	*422,800*	*0*	*0*	*0*	***422,800***
TOTAL CAPITAL EQUIPMENT	***3,102,800***	***0***	***0***	***0***	***3,102,800***
Propellant Testing *(Illustrative)*					
HPLC	28,000	0	0	0	***28,000***
Autosampler	25,000	0	0	0	***25,000***
IT Support	12,000	0	0	0	***12,000***
Consumables	18,000	18,000	18,000	72,000	***126,000***
Sub total	*83,000*	*18,000*	*18,000*	*72,000*	***191,000***
2. In Country Project Management					
Personnel	384,000	384,000	192,000	768,000	***1,728,000***
Accommodation	18,000	18,000	18,000	72,000	***126,000***
Support Office Costs	32,000	7,200	7,200	28,800	***75,200***
Dedicated Transportation	40,000	3,600	3,600	14,400	***61,600***
Sub total	*474,000*	*412,800*	*220,800*	*883,200*	***1,990,800***
3. ADF Operation					
a) EWI Running costs					
Manpower (Incl tax and Ins)	0	140,400	280,800	1,123,200	***1,544,400***
Electrical Power	0	56,160	112,320	449,280	***617,760***
Fuel (Assumed diesel)	0	159,120	318,240	1,272,960	***1,750,320***
Sub total	*0*	*355,680*	*711,360*	*2,845,440*	***3,912,480***
b) Pre-preparation costs					
Manpower (Incl tax and Ins)	0	124,488	248,976	995,904	***1,369,368***
Power/Fuel	0	35,568	71,136	284,544	***391,248***
Consumables/Miscellaneous	0	71,136	142,272	569,088	***782,496***
Sub total	*0*	*231,192*	*462,384*	*1,849,536*	***2,543,112***
c) Other ADF overheads					
Feedstock Transportation	0	250,000	500,000	2,000,000	***2,750,000***
ADF Logistics	0	52,000	104,000	416,000	***572,000***
Building and Equipment Maintenance	0	18,112	36,224	144,896	***199,232***
Sub total	*0*	*320,112*	*640,224*	*2,560,896*	***3,521,232***
TOTAL ADF OPERATION	*0*	*906,984*	*1,813,968*	*7,255,872*	***9,976,824***
ADF Totals	**3,659,800**	**1,337,784**	**2,052,768**	**8,211,072**	**15,261,424**
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Total Budget	**4,172,172**	**1,525,074**	**2,340,156**	**9,360,622**	**17,398,023**
Contingency at 15%	625,826	228,761	351,023	1,404,093	***2,609,704***
Grand Totals	**4,797,998**	**1,753,835**	**2,691,179**	**10,764,715**	**20,007,727**

ANNEX D
TO CHAPTER 5

Taxation.

1. The Dayton agreement makes the two entities responsible for taxation. The European Bank for Reconstruction and Development describes the tax system in both entities as "onerous and complex."

   It is not absolutely clear to what extent taxpayers comply with the law or whether revenues are increasing. Payroll taxes average approximately 50 percent of gross salary. Legislation that remains valid calls for the payment of "war taxes" by returning displaced persons or refugees. Such taxes are often arbitrarily administered, with fluctuating rates, and are used to dissuade ethnic minorities from returning to their homes.

Investment.

2. There has been little reform or alteration of revenue and budget policies. The fiscal policies of the central and entity-level governments have been largely irrelevant when compared with the effect of foreign aid on the economy. In certain areas, including Sarajevo, reconstruction aid and spending by SFOR soldiers and local employees of international organizations have greatly boosted the local economy. Other areas, however, have benefited little from the $1.6 billion in international reconstruction aid pledged in 1996. Initially, nearly all of the money went to the Federation. Through 1997, the Republika Srpska receiving only approximately five percent of the aid due to the leadership's failure to abide by the Dayton agreement. The January 1998 emergence of the new, more cooperative Republika Srpska government, however, may lead to increased reconstruction aid for the entity. In 1996, remittances by Bosnian citizens working abroad totalled $424 million.

   International aid and foreign remittances are largely responsible for boosting the average wage to approximately $194 per month and cutting unemployment nearly in half from its 1996 level of 90 percent. In the Republika Srpska, however, the average wage is approximately $40 to 45 per month, and unemployment is still 80 percent.

   There has been little progress in transferring social welfare responsibilities from state-owned enterprises directly to the government. The social safety net is not self-sustaining and depends on contributions from multinational institutions and other external stakeholders.

Banking.

3. In June 1997, the Bosnian parliament passed a "Quick Start" package of laws that included a Central Bank Law. The bank, which formally began operations two months later, is independent and will operate for its first six years as a currency board. This means that it can only issue currency that is backed by an equivalent amount of foreign reserves. As such, monetary policy is largely out of the central bank's hands. The bank consists of one unit in the Republika Srpska and another in the Federation. Each unit holds their own reserves.

   As of June 1997, there were 27 licensed banks in the Federation and 11 in the Republika Srpska. These include 17 state-controlled banks, all of which are

insolvent and base their lending on connections rather than on due diligence. Most private banks are small, undercapitalized, and incapable of meeting growing deposit and lending needs. Nevertheless, private banks now account for the majority of new loans extended. Accounting and regulatory standards are still not market-based and need to be updated. In October 1996, the Federation created a Federation Banking Agency responsible for licensing and supervision. By June 1997, it had refused to renew of licenses for 20 banks and indicated that some of the weaker banks were being sidelined. There has been little progress on banking reform in the Republika Srpska.

Currency Stability.

4. After Bosnia's declaration of independence in 1992, the Yugoslav National Bank refused to provide Bosnia with Yugoslav dinars. The fledgling state planned to introduce a Bosnian dinar in July 1992, but this was delayed until October 1994, when the new currency entered circulation at a rate of one new dinar to 10,000 old Yugoslavian dinars.

   Under the Dayton Accords, monetary policy is the responsibility of the central government. The Central Bank has begun to issue an interim currency, the marka (KM), which is fully convertible and, under the rules of the country's currency board, pegged at parity with the German mark. The KM is used throughout Bosnia for non-cash transactions. Cash payments are currently made in the temporary currencies established in the two entities, German marks, Croatian kunas (in Bosnian Croat-controlled areas), and Serbian dinars (in Bosnian Serb-controlled areas).

   Political squabbles over the design of a permanent currency have delayed its implementation. In January 1998, High Representative Carlos Westendorp exercised his power to impose the designs of Bosnian currency. The Bosnian marka was to enter into circulation in April 1998.

Capital Market.

5. In July 1997, the government and its London Club commercial bank creditors agreed that the country would accept responsibility for $404 million of debt, or 10.58 percent of the $4.2 billion owed by the former Yugoslavia. To cover this, Bosnia will issue $150 million of German mark-denominated bonds, with principal repaid over 20 years with a seven year grace period. Interest will be charged at a fixed rate of two percent for the first four years and rise to 3.5 percent by the end of the seventh year. For the last 13 years, interest will be payable at less than one percent over the benchmark London Interbank Offer Rate. Bosnia will pay the remaining $254 million of debt by issuing a second tranche of bonds that will be amortized over 12 years. These bonds will only be issued, however, after per capita income has risen above $2,800 or at least ten years after the issuance of the first tranche of bonds.

Bosnia and Herzegovina

THREAT RESOLUTION LIMITED

Chapter 6
SECURITY

CHAPTER 6 - SECURITY

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CHAPTER 6

SECURITY

1. DELIVERABLES

1.1 Examine the security factors for the weapons and ammunition storage at, and movement to the proposed Facility(s).

1.2 Make recommendations for the physical security of the weapons and ammunition storage at the proposed Facility(s).

2. PHYSICAL SECURITY THREATS

The Study Team undertook a general security review of a number of sites containing weapons and ammunition as an element of this Study. Overall, it is assessed that there have been insignificant improvements in the security of storage sites since SFOR intervention. Inadequate physical security, coupled with poor accounting standards, does not effectively prevent pilfering of weapons and ammunition from storage sites.

Access denial systems are primitive and largely ineffective. Whilst each storage site possessed accounts that appeared to be accurate, the Study Team could not identify centralised, consolidated ammunition or weapons accounting systems and therefore it are unlikely that the EAF's have an accurate strategic picture of the situation.

2.1 Ammunition and Weapons Storage Sites

The current security conditions that prevail at ammunition and weapons storage location are superficial and therefore inadequate. Common inadequacies are as follows:

<u>Perimeter security</u>

Perimeter security at storage sites is cursory and does not preclude intrusion by unauthorised personnel.

Some sites are still protected by anti-personnel mines, which is a very significant hazard where perimeter fences are incomplete.

<u>Guard force</u>

All sites have a permanent armed guard force that is probably an effective deterrent. However, often young recruits, in inappropriate small numbers, are used to guard these sites and it is unlikely they could effectively fend off any armed attack.[1]

<u>Storehouse security</u>

Storehouse security is large cursory and ineffective:

- Inappropriate padlocks.
- Inactive intruder detection systems.

[1] According to the OSCE undermanning is due to a lack of available manpower – 20 August 2004.

- Insufficient internal and external lighting.
- Broken windows and ventilation systems often present points of access to buildings.

2.2 Ammunition Transportation

There appears to be little routine movement of ammunition in BiH except to GOFs for demilitarization. The Study Team received conflicting information on security arrangements during transportation but the norm appears to include armed guards with convoys.

The Study Team could not identify any specific procedures to be used for the transportation of ammunition.

2.3 Government Ordnance Factories (GOFs)

Overall, the security situation at the possible sites (GOFs) for development as an ADF is more satisfactory than other sites visited in BiH because the sites are operational facilities.

The sites have security systems comparable to those of demilitarization facilities in Europe with the additional benefit of armed guards. Some repairs to perimeter fencing may be necessary to prevent accidental access but this may prove difficult as in some locations anti-personnel mines have not been cleared.

3 SUMMARY

Overall security precautions at the weapons and ammunition storage sites are inadequate. The Study Team have made general recommendations to bring the facilities up to a minimal standard.

Security arrangements at the working GOFs (potential demilitarization facilities) is considerably better and appropriate for demilitarization work.

4 RECOMMENDATIONS

The following recommendations are made in concern with the security issues.

- A 100% technical audit of the weapons and ammunition stockpile is undertaken by a competent, external organisation the aim of which is to construct:
    - Accurate weapons and ammunition accounts.
    - Capture weapons serial numbers.
    - Ascertain priorities for the propellant-testing programme.
    - Make a detailed assessment of the technical condition of the stockpile.
- That weapon and ammunition storage site security is enhanced to provide a basic level of effective security. Specifically:

- A trained guard force of the appropriate strength.
- The repair or enhancement of perimeter fences and barriers.
- The repair or installation of external site lighting.
- The repair of ESH windows and ventilation.

- That the planned weapons and ammunition site reduction programme designed by OHR is revaluated and dovetailed to the ammunition demilitarization plan. There is very significant hazard in overloading ammunition storage beyond AASTP-1 licensing limits in than an unplanned explosive event would have catastrophic effect on the site and local populations. See Chapter 2 – Humanitarian.

- As an element of the ADF development, a “transportation by road” training programme is provided to the EAFs logistics organisations, to mitigate risks from accidents and incidents during transportation.

- BiH signed the Mine Ban Treaty on 3 December 1997 and ratified it on 8 September 1998, becoming a State Party on 1 March 1999. It is, therefore, non-compliant with the terms of the Treaty and it is strongly recommended that urgent action is taken to remove anti-personnel mines from ammunition storage sites and GOFs.

Bosnia and Herzegovina

THREAT RESOLUTION LIMITED

Chapter 7
TRAINING

CHAPTER 7 – TRAINING

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CHAPTER 7

TRAINING

1. DELIVERABLES

1.1 Evaluate training levels of BiH ammunition specialists and make recommendations for training requirements to international best practices.

2. BACKGROUND

2.1 The Study team initially reviewed the Regulations applicable to the training of ammunition specialists in the EAF. They also collated information gathered, on the current qualifications of those EAF staff employed in ammunition management duties, from a range of sources including the SFOR ATO, SFOR inspectors and the EAF staff at the ASS. Analysis of ongoing ammunition management and demilitarization activities, as well as those future requirements identified in the Study, has been conducted to identify what training deficiencies exist that may jeopardise the safe execution of these duties. Particular attention has been paid to the most urgent training requirements, which are those necessary to eliminate the critical safety infringements identified in Chapter 2 - Humanitarian, since they pose an immediate and severe risk to the safety of the civilian population.

2.2 Current manning levels, at similar military ASS within the UK, have been used as a guide to planning the minimum requirements for BiH ammunition specialists and to illustrate international best practice with regard to the safe management of ammunition.

3. ASSESSMENT OF CURRENT TRAINING LEVELS

3.1 Regulatory Requirements

The regulatory requirements, including the required training levels for those undertaking ammunition duties are laid down in Chapter 13 of the ITP. The ITP is published on behalf of the Commander of SFOR (COMSFOR) and is intended to give clear direction on compliance with the military aspects of the General Framework Agreement for Peace (GFAP), which was signed in 1995. The mandatory requirements of Chapter 13 have been drawn from NATO publications regarding the safe storage, movement, classification and disposal of military ammunition and are intended to be implemented by all armed forces in BiH.

Part 1 of the ITP, entitled Ammunition Programme Management, requires the EAF Corps Commander to appoint and Armed Forces Ammunition Manager (AFAM) who has prime responsibility for the “Development, implementation and monitoring of ammunition and explosives technical training”. It further specifies that “only those individuals with sufficient technical training and experience should be employed within Ammunition related appointments”. The Compliance Schedule at Annex H to Chapter 13 requires the EAF to “present the strategy to develop Ammunition and Explosives Specialist Training by December 2004.”

3.2 Current Duties

EAF staff are employed in the following key areas of ammunition management and demilitarization activities:

- Storage of ammunition at ASS.
- Routine inspections to verify the condition of stored ammunition.
- Movement of ammunition by road to demolition sites.
- Destruction of ammunition by Open Detonation.
- Licensing of ammunition stores.
- Ammunition accounting.

Should the recommendation, to urgently introduce the conduct of propellant stability testing; it is highly probable that a large amount of propellant will require destruction by Open Burning in the near future. It will therefore be necessary to ensure that suitably trained EAF personnel are available to conduct this activity.

3.2 SFOR Supervision

Whilst it is evident that some suitably qualified Explosive Ordnance Disposal (EOD) personnel, from SFOR units under command, supervise the conduct of Open Detonation activities by EAF staff there is no evidence to suggest the remaining activities listed above are similarly supervised. The Study team also noted that within the SFOR technical inspection team, which accompanied the Study team during visits to ammunition storage facilities, there were no ammunition specialists.

3.3 Ammunition Training

During the visits discussed in Chapter 4 –Technical, to those Ammunition Storage Sites (ASS) at which the EAF intend to consolidate the ammunition stockpile, the team discussed technical training with the commanders and staff to ascertain those who were qualified as ammunition specialists. Further discussions were also held with senior EAF and SFOR staff at liaison meetings held during the same period. No evidence could be found that any of these personnel had received formal training in ammunition management. Only one individual, the commander of NB 075 at Tuzla, confirmed that he had received training in ammunition management before the war and was attempting to apply the principles taught. The benefit of this experience is clear, since the ASA at Tuzla was one of only two where the overall standard of management was reported to be adequate, although not fully compliant with NATO standards.

At military ASS in the UK it is a mandatory requirement that all staff employed in ammunition management duties have been formally trained at the Army School of Ammunition[1]. The average number of trained ammunition staff

[1] UK Ammunition and Explosives Regulations, Volume 2, Part 4, Section 2 dated November 1995

employed at a single ASS in the UK, comparable in size to those examined by the Study team, is as follows:[2]

- 1 x Manager
- 2 x Supervisors
- 3 x Storekeepers.

Furthermore, either a supervisor or the manager is on call 24 hours a day to offer technical assistance in the event of an emergency.

Recent scrutiny of the last five annual ammunition inspection reports, for each of six ASS locations in UK[3], demonstrates the value of employing properly trained staff. No major safety infringements were documented and a considerable number of inspectors' comments specifically commended the high levels of proficiency and competence staff had shown in the execution of their ammunition management duties.

3.4 Planned Training

During a meeting with the SFOR ATO[4] it was reported that a 3-week training course in Conventional Munitions Disposal, for 32 members of the EAF, will commence in September 2004. It is likely that this training will be conducted by Turkish specialists but it could not be confirmed that this course will meet NATO standards. He added that if successful these soldiers will then be permitted to undertake limited destruction of unserviceable and surplus ammunition by Open Detonation. The SFOR ATO also reported that he was investigating the availability of places on the Commonwealth and Foreign Ammunition Technician course at the Army School of Ammunition in the UK, for eight EAF personnel. Further investigation by the Study Team has recently revealed that this course is historically oversubscribed and there may be a considerable delay before places can be allocated.

4. TRAINING REQUIREMENTS

4.1 General

EAF training requirements fall into two categories as follows:

- Short-Term – to redress the urgent issue of unsafe conditions and practices concerning ammunition storage, which currently prevail.
- Long-Term – to allow the EAF to implement the requirements of Chapter 13 to the ITP.

4.2 Short-Term Training

Those EAF personnel directly involved in the safe storage of ammunition require immediate training to be conducted in country. This training should

[2] Discussion with UK MOD Ammunition Technical staff on 6 September 2004.
[3] Ibid.
[4] Meeting held on Thursday 22 July 2004.

address storage, movement, inspection and accounting of ammunition to NATO standards and can be conducted by a suitable commercial provider at much lower costs than those charged by equivalent military training establishments. The successful implementation of this training will require the timely execution of the following approach:

- Conduct a Training Needs Analysis (TNA).
- Devise and prepare training course.
- Deliver in-country training.

4.3 Long-Term Training

In order to establish a cohesive strategy for future ammunition management, from which the EAF will be capable of meeting the requirements of Chapter 13 to the ITP, a higher level of training will be required, in order to develop a core of experienced ammunition specialists,[5] who could themselves undertake formal inspections and training. Given the duration and specialised nature of this training it is likely that it can only be conducted at a military establishment, such as the Army School of Ammunition in the UK. Suitable individuals to fill these roles can be identified during the TNA described above, which should also recommend the most appropriate courses available at NATO military training establishments.

5. CONCLUSIONS

- Urgent training is required to improve the safety of ammunition in storage at all EAF locations and eliminate the critical safety infringements identified at Chapter 2 – Humanitarian.
- It is highly unlikely that the EAF will succeed in meeting the December 2004 deadline of the Compliance Schedule specified in Annex H to Chapter 13 of the ITP, to present the strategy to develop Ammunition and Explosives Specialist Training.

6. RECOMMENDATIONS

- That a short-term ammunition management-training course for EAF personnel is conducted at the earliest opportunity. This training should be conducted in country by a competent organisation.
- The introduction of long-term training of ammunition specialists at a suitable NATO military training establishment is introduced to develop a core of experienced ammunition specialists within the EAF.[6]
- In the interest of expediency, it is recommended that UNDP/SFOR endeavour to arrange direct bilateral support for the training aspect, therefore excluding training as an element of the proposed ADF project.

[5] Ammunition Technicians (AT) and Ammunition Technical Officers (ATO).
[6] The UK Army School of Ammunition, German Ammunition School at Aachen or Canadian National Defence School of Ammunition are examples of the most appropriate and effective training establishments.

Bosnia and Herzegovina

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Chapter 8
DIARY

CHAPTER 8

PROJECT DIARY

1. DELIVERABLES

1.1 The final report should include a diary of activities for the Project Team.

2. DIARY

2.1 The Diary of Events for the project progress is at Annex A.

ANNEX A
TO CHAPTER 8

DIARY OF EVENTS

Serial	Date	Event	Location	Comments
1	21 April 04	Contract award to TRLtd.	Devon – UK	Notification of contract award originally due on 5 April 04.
2	21 April – 03 May 04	Initial planning and contract negotiation.	N/A	Mr Paul Carrahar (TRLtd) discussed revision of submission dates for deliverables with Ms Amna Berbic (UNDP). Extension of submission dates agreed. Contract finalised 27 April 04. TRLtd workshop and development of internal method statement.
3	6 May 04	Initial liaison meeting with UNDP and attendance by TRLtd representative at Defence Reform Committee (DRC) meeting.	Sarajevo	TRLtd attendance at DRC meeting cancelled by SFOR on 5 May. Liaison visit to UNDP subsequently postponed.
4	10 – 27 May 04	Planning for TRLtd visit to ammunition storage sites in BiH. Submission of request for data on BiH ammunition stockpile.	N/A	TOR advised planning required for representative sample of 48 sites. Final plan included only those sites recommended by SFOR.
5	27 May 04	TRLtd representative deployed to BiH		Mr T. Lawrence – Technical Consultant
6	28 May 04	Meeting at UNDP to agree programme of visits to ammunition storage facilities.	Sarajevo	Mr T. Lawrence (TRLtd) Mr Walter Fiers UNDP
7	28 May 04	Liaison meeting with SFOR ATO	Sarajevo	Mr T. Lawrence

Serial	Date	Event	Location	Comments
				Capt Francis Wight - SFOR ATO
8	31 May 04	Liaison meeting at UNDP	Sarajevo	Mr T. Lawrence Ms A. Berbic Mr W. Fiers
9	31 May 04	Liaison meeting with SFOR Technical Inspection Team - Multi National Brigade South-East (MNB-SE)	Sarajevo	Mr T Lawrence Lt B. Gotz - German Army (SFOR Technical Inspection Team)
10	31 May 04	Meeting with Site commander EF 024	Pazaric Krupa	Mr T. Lawrence Capt M. Aliya – VF
11	31 May - 01 June 04	Assessment of site EF 024	Pazaric Krupa	Mr T. Lawrence Lt B. Gotz Capt M. Aliya Mr W. Fiers
12	02 June 04	Liaison meeting with Chief of Joint Military Affairs (JMA) MNB-SE	Mostar	Mr T. Lawrence Lt Col Rathke
13	02 June 04	Meeting with site commander EF 007	Gabela	Mr T. Lawrence Lt Rase - VF
14	02 June 04	Assessment of site EF 007	Gabela	Mr T. Lawrence Lt Col Rathke Lt Rase Lt B. Gotz
15	03 June 04	Meeting with site commander EV 076	Rudo	Mr T. Lawrence Capt I. Spasojevic - VRS

Serial	Date	Event	Location	Comments
16	03 June 04	Assessment of site EV 076	Rudo	Mr T. Lawrence Capt Spasojevic Lt B. Gotz
17	04 June 04	Debrief on findings MNB SE	Mostar	Mr T. Lawrence Lt B. Gotz
18	07 June 04	Liaison with SFOR Technical Inspection team JMA MNB North	Tuzla	Mr T. Lawrence Lt Col C Whittaker - US Army Capt Smith - US Army
19	07 June 04	Meeting with site commander NB 075	Tuzla	Mr T. Lawrence Maj Suljanovic - VF Lt Nadir - VF (Ammunition Area Commander) Capt Smith - US Army
20	07 June 04	Assessment of site NB 075	Tuzla	Mr T. Lawrence Lt Nadir Capt Smith
21	08 June 04	Liaison with MNTF JMA cell NW	Tuzla	Mr T. Lawrence Capt Pope – British Army
22	08 June 04	Meeting with liaison officer for sites W V 096 (Kula 1) and W V 261 (Kula 2)	Mrkonjic Grad	Mr T. Lawrence Capt Pope Capt Duvniak - VRS
23	08 June 04	Assessment of site W V 096 (Kula 1)	Mrkonjic Grad	Mr T. Lawrence Capt Pope Capt Duvniak
25	09 June 04	Assessment of site W V 261 (Kula 2)	Mrkonjic Grad	Mr T. Lawrence Capt Pope

Serial	Date	Event	Location	Comments
				Capt Duvniak
26	10 June 04	Liaison meeting with MND (SW) JMA	Banja Luca	Mr T. Lawrence Capt Belley – US Army
27	10 June 04	Meeting with site commander WB 053	Grebez	Mr T. Lawrence Capt Pasic -VF
28	10 June 04	Assessment of site WB 053	Grebez	Mr T. Lawrence Capt Belley Capt Pasic
29	11 June 04	Debrief of UNDP	Sarajevo	Mr T. Lawrence Mr Moises Venacio – Deputy Resident Representative Mr Seid Turkovic – Manager Human Security Portfolio Ms A. Berbic Mr W. Fiers
30	14 – 26 June 04	Completion of technical reports on visits to ammunition storage sites. Preparation of Security and Political components of report	UK	Mr W.D.G. Hunt – Project Leader Mr P. Carrahar – Technical Consultant Mr T. Lawrence
31	20 July 04	TRLtd representatives deploy to BIH		Mr P Carrahar Mr C. Lasson – Financial Consultant Delay between Serials 25 and 26 due to TRLtd awaiting receipt of data on BiH ammunition stockpile from SFOR.
32	22 July 04	Liaison meeting with UNDP and SFOR ATO	Sarajevo	Mr P. Carrahar Mr C. Lasson Ms A. Berbic Mr W. Fiers Capt F. Wight

Serial	Date	Event	Location	Comments
33	22 July 04	Visit Centre for Security Studies to discuss Small Arms and Light Weapons Needs Assessment Report	Sarajevo	Mr P. Carrahar Mr C Lasson Mr W. Fiers Mr D. Hadzovic – CSS Mr A. Kadic - CSS
34	22 July 04	Visit potential demilitarization facility at Government Ordnance Factory (GOF) Unis – Prentis	Vogosca	Mr P. Carrahar Mr C Lasson Mr W. Fiers Mr K. Hasanbegovic – Executive Director UNIS - Prentis Mr Amir Odobasic – BiH Ministry of Defence
35	23 July 04	Visit potential demilitarization facilities at GOF P.S. Vitezit	Vitez	Mr P. Carrahar Mr C Lasson Mr W. Fiers Mr K. Hasanbegovic – Executive Director UNIS - Prentis Mr Amir Odobasic – BiH Ministry of Defence Mr. V. Matic – General Manager P.S.Vitezit Mr. Asim Suljagic – BiH Ministry of Defence
36	23 July 04	Visit potential demilitarization facilities at GOF Binas d.d.	Bugojno	Mr P. Carrahar Mr C Lasson Mr W. Fiers Mr K. Hasanbegovic – Executive Director UNIS - Prentis Mr. M. Gurbeta – General Manager Binas d.d. Mr. Asim Suljagic – BiH Ministry of Defence
37	23 July 04	Debrief at UNDP	Sarajevo	Mr P. Carrahar Mr C Lasson Ms A. Berbic Mr W. Fiers

Serial	Date	Event	Location	Comments
38	26 July – 15 August 04	Study draft report completion	UK/USA	Mr W.D.G. Hunt Mr P. Carrahar Mr T. Lawrence Mr C Lasson
39	16 August 04	Submission of Study draft report for review		
40	16 – 23 August 04	UNDP Review	Sarajevo	
41	27 August 2004	Submission of Study final report		

Bosnia and Herzegovina

THREAT RESOLUTION LIMITED

Chapter 9
STUDY TEAM

CHAPTER 9 – STUDY TEAM

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CHAPTER 9

STUDY TEAM

1 TERMS OF REFERENCE REQUIREMENT

1.1 General

The complex and highly technical nature of the Feasibility Study demanded that a composite team be assembled with individual expertise in the various technical areas. Key members of the Study Team had significant knowledge and experience from Albania, in the development and execution of weapons and ammunition demilitarization projects, where the challenge of removal and destruction of surplus weapons and ammunition was almost identical to the situation faced today in BiH.

1.2 TOR Requirements

1.2.1 Project Manager / Political Consultant.

The Project Manager (PM) should be experienced in the management of multi-disciplined consultancy projects. It is likely that s/he will have worked for an international organisation at a senior level, and it is highly desirable, but not essential, that the individual has specialist knowledge of BiH. The PM may be “double-hatted” as one of the specialist consultants.

1.2.2 Technical Consultant.

The consultant will be a qualified Ammunition Technical Officer, or equivalent, with both Explosive Ordnance Disposal and Demilitarization experience. The individual will be familiar with the technology available and the demilitarisation techniques to be used. The individual will be capable of analysing the recommended engineering processes in terms of explosive safety and developing a comprehensive explosive safety plan.

1.2.3 Financial Consultant.

The financial consultant should have experience of operating in the Central and Eastern European financial environments and have knowledge of BiH. The individual should have advised at governmental level and have worked with major donor institutions including UNDP, the European Union or the World Bank.

2. RELEVANT EXPERIENCE

The relevant experience of the consultancy team members has been included to reinforce the credibility of this report and is shown at Annex A.

Annex:

A. Feasibility Study Team – Relevant Experience.

ANNEX A
TO CHAPTER 9

RELEVANT EXPERIENCE OF STUDY TEAM PERSONNEL

1. Project Manager.

Mr William DG Hunt MBE, MIExpE

William Hunt is the CEO of TRLtd.

Pre TRLtd projects include:

Project Supervisor - NATO PfP Trust Fund for AP Mine Stockpile Destruction

- Country manager, NATO sponsored project to destroy 1.7m stockpiled APM.
- Designing, implementing and monitoring the technical demilitarization solutions. Facilitating internal verification.
- Capacity building indigenous workforce.
- Development and training in demilitarization procedures.
- Coordinating and monitoring the primary contractors involved.
- Developed and maintained the National Plan of Action for Ammunition demilitarization for the government of Albania.

Consultant - NAMSA/Government of Canada

- Designed Albania NATO PfP project for the demilitarization of 11,000 tonnes of ammunition for SALW. (Project implemented in 2003/4)
- Designed Albania project to demilitarize 1.6m anti-personnel mines.

Consultant - Mission for Addressing Small Arms in Niger
UNDP/ERD Field Mission, Niger

- Technical consultant for field mission tasked with the research and design of a pilot weapons collection programme and also to draft a National Plan of Action to address small arms and light weapons issues.
- Undertook research up to and including ministerial level as well as in the field.
- Research included security issues at regional, national and local in the N'Guigmi region. Liaison with the Lomé centre and PCASED.

British Army – Full Career as Ammunition Technician and Ammunition Technical Officer.

Full career in the British Army retiring as Ammunition Technical Officer (ATO). Class1 Ammunition Technician (AT). Involved principally involved in counter-terrorist operations (overt and covert) in the field of:

- Counter Improvised Explosive Device (IED) operations.
- Search for munitions and weapons.
- Render-safe of improvised IEDs.

Key appointments held include:

- Operations Manager for DERA Demilitarization.
- Second-in-Command of 521 EOD Squadron.
- Senior Ammunition Technician of 321 EOD Unit.
- Military Advisor to HM the Sultan of Brunei.

2. Technical Consultant

Mr Paul Carrahar Msc.
Mr Carrahar formally joined TRLtd in 2003 as the operations manager. Responsible for operational and financial planning of all Company projects world-wide.

HSE/Quality Advisor Sakhalin

- Consultant EOD HSE advisor to the Sakhalin II project in Far East Russia.
- Overseeing training of 250 indigenous deminers to IMAS/ISO 9000 series standards.

Training Manager South Africa

- Led an EOD Training Team in the creation and delivery of an Improvised Explosive Device Disposal (IEDD) training course in South Africa, for 21 military that achieved a pass level of 85%.
- Additionally responsible for successfully designing and acquisition of suitable IEDD weapons and other equipment to form an effective counter - IED structure and capability.

Project Manager United Kingdom

- Managed a team of 6 ammunition technicians that successfully completed a series of special military projects, including an inspection and refurbishment programme for surface to air guided missiles.
- Assisted in the development and procurement of new ammunition natures, with specific responsibility for managing the production of supporting technical publications.

British Army – Full Career as Ammunition Technician and Ammunition Technical Officer.

Full career in the British Army retiring as Warrant Officer (WO) Class1 Ammunition Technician (AT). As a Senior Non-Commissioned Officer (SNCO) and WO principally involved in counter-terrorist operations (overt and covert) in the field of:

- Intelligence gathering on terrorist operations.
- Counter Improvised Explosive Device (IED) operations.
- Search for munitions and weapons.
- Render-safe of improvised IEDs.
- Specific responsibility for the planning and implementation of a technical inspection programme for over 1,600 MOD ammunition and explosives storage locations.
- Assisted in the technical inspection of major ammunition storage locations, worldwide. Key technical advisor to senior police officers on emergency procedures related to major terrorist incidents. Managed the investigation of all Army related ammunition accidents and incidents. Additional responsibility for all radiation safety matters, including the safe storage and use of all radiographic equipment

3. Technical Consultant

Mr Trevor Lawrence

Trevor Lawrence served in the British Army as a Class One Ammunition Technician (AT). He is highly qualified and experienced in all aspects of Explosive Ordnance Disposal including Improvised Explosive Device Disposal (IEDD). Since leaving the forces he has developed a second career in commercial Explosive Ordnance Disposal (EOD), specialising in Humanitarian Demining, Quality Management and Explosives Safety Management . His experience includes:

Senior Technical Advisor (STA) Worldwide

- TRLtd EOD and explosive trials technical representative for Cranfield University.
- Conducting technical trials involving munitions and explosive devices on behalf of the UK MoD and civilian customers.
- Writing of technical standards, procedures and reports.
  Conducting Quality Assurance and Quality Control
- Supervisor of multi-national QA/QC personnel.

Technical Advisor Kosovo

- Technical Supervision of 15 demining teams working in a large range of minefields in the NW of Kosovo.
- Responsible for survey, planning of clearance, implementation and technical supervision of clearance.
- Planning and conduct of internal QA/QC.

British Army – Ammunition Technician

Served 15 years in the British Army as a Class 1 Ammunition Technician (AT). Involved in Explosive Ordnance Disposal (EOD) and all aspects of Ammunition Management including:

- Technical inspections of military ammunition storage facilities.
- Licensing ammunition storage areas.
- Providing advice on the safe movement and storage of ammunition.

4. Financial Consultant

Mr Chad Lasson

Chad Lasson is the El Dorado Inc Contracts Administration Manager of over 4 million dollars of design and turnkey projects coordinating, estimating and tracking costs, scheduling, and delivery of equipment throughout the US and overseas. His experience includes:

- Financial Planner and Contracts Administrator for a multi-million dollar demilitarization turnkey project for Albania.

- Contracts Administrator for over 3 million dollars of contracts in support of Eco Logic/PMACWA development of alternative technologies for demilitarization of chemical munitions.

- Contracts Administrator on 3.3 million dollar project to recover magnesium from obsolete flares for joint U.S. Army/US Navy program.

- Project coordinator for providing Transportable Flashing Furnace for Kaho'olawe, Hawaii, remediation project for explosive contaminated materials.

- Provided engineering review of Russian chemical munitions demilitarization program with on-site assignments in Moscow.

- Test Engineer for agent access equipment approaches for modified baseline for chemical munitions demilitarization.

- Design Engineer for agent access equipment utilizing a burster adapter press.

- Program Manager for providing replacement retorts to Taiwan Arsenal 203 for Explosive Waste Incinerator.

- Mechanical engineering design for igloo door opening mechanism for chemical agent munitions storage.

Bosnia and Herzegovina

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PHOTOGRAPHIC SUPPLEMENT

Bosnia and Herzegovina Small Arms and Light Weapons Ammunition Demilitarization Feasibility Study

PHOTOGRAPHIC SUPPLEMENT

Ammunition stored outside - adjacent to a full ESH at EF 077 - Gabela

Ammunition stored outside - adjacent to a full ESH at WV 096 - Kula 1

Damaged ammunition packaging in an ESH at WV 261 - Kula 2

Leaking containers of oxidizing agent stored in an ESH at WV 261 Kula 2

Example of incorrect storage showing unpackaged recovered explosives in an ESH at WV 261 - Kula 2

Damaged outside wall of an ESH at EV 076 - Rudo

Inappropriate storage of detonators at EV 076 – Rudo

Example of damaged and leaking ESH at EV 076 – Rudo

Example of corroded ammunition at EV 076 – Rudo

Further example of corroded ammunition at EV 076 – Rudo

Unpackaged propellant stored at EV 076 - Rudo

Poor physical security – flimsy main gate at EV 076 - Rudo

View towards nearest civilian habitation (300m) at EV 076 – Rudo (used for Explosion Consequence Analysis in Chapter 2)

General view of a potential demilitarization site at Unis-Pretis

The study team examine a potential demilitarization site at Unis - Pretis

The study team assessing a storage facility at P.S. Vitezit

Locally manufactured demilitarization equipment in use at P.S Vitezit

Hand grenades awaiting demilitarization at Binas d.d.

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