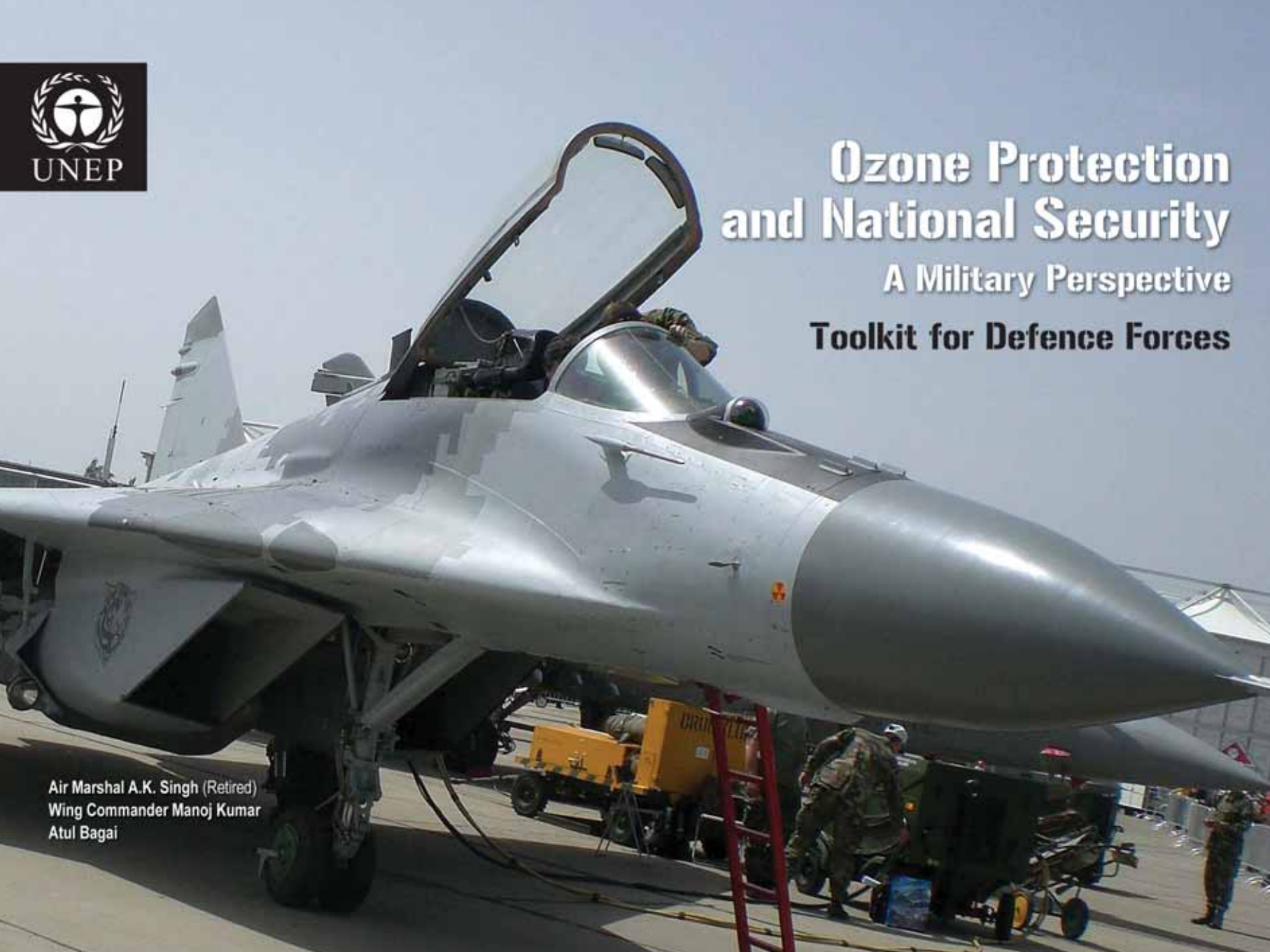

UNEP

Ozone Protection and National Security

A Military Perspective

Toolkit for Defence Forces

Air Marshal A.K. Singh (Retired)
Wing Commander Manoj Kumar
Atul Bagai

Cover photo:
Military aircrafts, like this MiG29 and C-5, burn fuel and leave emissions in the stratosphere with considerable environmental impact. In addition, ozone-depleting solvents are required for the manufacture and maintenance of military aircraft. Halons are found in ground crew fire extinguishers and on board in engine housings, cockpits, cargo bays, and back-up power units. Avionics pods and cockpits may rely on ODS refrigerants. But manufacturers are now working to use alternatives and to rewrite maintenance manuals to allow the use of alternatives.

VECTOR1 (WWW.VECTOR1MEDIA.COM)

Designed and printed in Nepal
at Jagadamba Press
www.jagadambapr.com

Ozone Protection and National Security

A Military Perspective

Toolkit for Defence Forces

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and
Wing Commander Manoj Kumar, (Active) Indian Air Force
with
Atul Bagai, UNEP DTIE OzonAction Programme
Compliance Assistance Programme,
Regional Office for Asia and the Pacific

KUNDA DIXIT

CONTENTS

ACKNOWLEDGEMENTS

The authors are grateful for the contributions of the peer group for their review:

- **Dr. Stephen O. Andersen**, Co-Chair, UNEP Technology and Economic Assessment Panel (TEAP) of the Montreal Protocol
- **Mr. K. Madhava Sarma**, Senior Expert Adviser, UNEP Technology and Economic Assessment Panel of the Montreal Protocol
- **Mr. Durwood Zaelke**, President of the Institute for Governance and Sustainable Development, Director of the International Network for Environmental Compliance and Enforcement
- **Mr. Thomas Morehouse**, Institute for Defense Analyses, US Department of Defense
- **Mr. Anton Janssen**, Netherlands Ministry of Defence
- **Mr. Liu Boqiang**, Division Chief, Ministry of Defence, China

We are grateful to **Air Commodore Jasjit Singh** (Director) and **Air Vice Marshal Kapil Kak** (Additional Director) of the Centre for Air Power Studies, New Delhi as without their valuable guidance at every stage, this document would not have been possible.

We are especially grateful to **Ms. Kristen K. Taddonio**, U.S. EPA for the invaluable assistance she has provided for collecting the photographs for this toolkit.

The authors would also like to thank the following people/organizations who have provided visual contributions to this toolkit:

- The US Coast Guard
- The Netherlands Ministry of Defence
- The Indian Air Force
- **Mr. Wataru Ono** and **Mr. Ryosuke Takahashi** of the Ministry of Environment, Government of Japan
- **Mr. Wilman Rajiman**, the Indonesia Halon Bank Project Manager at Soekarno-Hatta International Airport in Jakarta and expert in halon in the aviation sector from Garuda Indonesian Airlines
- **Mr. Robert S. Thien**, US Department of Defence
- US Defence Logistics Agency

We are thankful to **Mr. Kartikeya Sarabhai**, Director of the Centre for Environment Education, (CEE, India) and his team: **Mr. R. Gopichandran**, **Ms. Darshana Patel**, **Mr. Jigar Deliwala**, **Mr. Shalin Shah** and **Mr. Praveen Prakash** for facilitating the consultations of the peer group and for collecting the wide range of library materials.

We would also like to extend our thanks to UNEP DTIE Head, **Ms. Sylvie Lemmet** for her overall guidance. Our special thanks to **Mr. Young-Woo Park**, the UNEP Regional Director and Representative for Asia and the Pacific, **Mr. Rajendra Shende**, the Head of the OzonAction and his Compliance Assistance Programme (CAP) team in Paris, specifically **Mr. Jim Curlin**, **Dr. Ezra Clark**, and **Ms. Samira de Gobert**.

Thanks to the untiring efforts of the OzonAction CAP team in UNEP's Regional Office for Asia and the Pacific (ROAP): **Mr. Balaji Natarajan** (now UNDP), **Ms. Priya S. Lift**, **Mr. Mahmood Riya**z, **Ms. Charuwan Tintukasiri** for their valuable inputs on the draft.

We would also like to extend our thanks to **Dr. A. Duraisamy**, Director, Ozone Cell, Ministry of Environment and Forests, India for organising interface with the Indian Army that provided valuable inputs to the toolkit.

Our special acknowledgment to **Dr. Sita Ram Joshi**, Director General of Nepal Bureau of Standards and Metrology, for facilitating the printing and production of this toolkit.

Finally, the authors would like to thank the defence forces and the ozone officers of Bangladesh, India, Iran, Indonesia, Malaysia, Pakistan and Sri Lanka who were present at the "Subregional Workshop on ODS Phase out in Military Application" in Colombo, Sri Lanka, 16-17 April 2009 for providing practical inputs on the draft toolkit and exchanged useful information which is reflected in this toolkit.

The toolkit was edited by **Ms. Nujpanit Narkpitaks**, UNEP DTIE OzonAction CAP ROAP. Overall, the project was coordinated by **Mr. Atul Bagai,** Regional Coordinator (Networking), South Asia Network, UNEP DTIE OzonAction CAP ROAP.

FOREWORD

Thinking Out of the Barracks

Guarding national frontiers is the seminal duty of the military. As we navigate the 21st century, the military is broadening its potential. The defence sector is taking an enhanced role in safeguarding the global environment in areas such stratospheric ozone layer protection and combating climate change, and these areas recognise no national borders.

Military organisations are thinking 'out of the barracks' and have become increasingly aware of their environmental impact at the local, regional, and global levels. In many countries defence forces have assumed a leadership role in specific areas of environmental protection.

Environmental conditions affect military readiness and hence national security. One substantive environmental issue that can impact military readiness is the need to protect the stratospheric ozone layer from the damaging effects of ozone depleting substances (ODS).

In 2000, UNEP OzonAction produced ,for the first time, a set of guidelines for armed forces in the developing countries entitled *Maintaining Military Readiness By Managing Ozone Depleting Substances.* Since then there have been significant activities in developing countries in ODS phasing-out in the defence sector.

In February 2001, a workshop on the theme "Importance of Military Organizations in Stratospheric Ozone and Climate Protection" was held in Brussels with the participation of 160 military officers, environmental authorities and technical experts from 33 countries. One of the key conclusions was that environment and security interests are interrelated and should be mutually supportive. It was also recommended to develop guidance on the implementation of environmental legislation in defence establishments, including practical measures to reduce the use of ODS and to authorise ODS use for 'mission-critical uses', those for which no technically or economically feasible alternatives exists.

UNEP, in collaboration with defence force contributors, has developed this tool-kit for national security and the environment focusing on ozone issues. It has drawn inputs from workshops and international conferences held on military and environment protection, as well as real life experiences and good practices from different parts of the world. The main purpose of this document is to provide information to

defence establishments across the globe so that they can design and implement ozone-friendly approaches in their regular equipment operation and maintenance activities.

UNEP is encouraged that in many countries national military officials collaborate with the National Ozone Units (NOU) in developing detailed summaries of military applications using ODS in their respective country and seek to find the best solutions in adopting environmentally/ozone-friendly policies and practices. I would like to express my appreciation to the officers of the Indian Air Force who authored this document together with UNEP's OzonAction Compliance Assistance Programme team in Bangkok and Paris for their excellent work in creating such a useful toolkit. I hope this guide will assist defence forces in developing countries to undertake a safe and orderly phaseout of ODS without prejudicing their operational readiness.

The Montreal Protocol now stands at the crucial juncture. The Parties, which now represent every country in the world, have agreed to the accelerated phase out of last remaining ozone-depleting substances: HCFCs. We have to defeat this last enemy of the ozone layer to finally repair the ozone hole.

Rajendra Shende
Head, OzonAction Branch

Mr. Rajendra Shende is a Chemical Engineer from the Indian Institute of Technology. He joined the international programme at UNEP DTIE in Paris in 1992 and led the task force of the Indian Government that decided the strategy for India in negotiating the Montreal Protocol and negotiating the establishment of the Multilateral Fund to assist the developing countries. He helped build the OzonAction Programme and helped strategically reorient it in 2002 into a uniquely regionalised Compliance Assistance Programme (CAP) that now consists of a team in Paris and in UNEP's Regional Offices in Panama City, Bahrain, Bangkok and Nairobi.

PREFACE

Throughout the world, proactive military organizations are taking action to protect the global environment. In the United States, military organizations own the largest wind and photovoltaic systems and are at the cutting edge of hybrid, electric, and many other green technologies. In Europe, military organizations are publishing climate action plans that are comprehensive and visionary. In India, where the authors serve, cadres of military service personnel have planted tens of thousands of trees that help recharge aquifers and restore micro-climates. Worldwide, military organizations are organizing similar cooperation on climate technology that researched, developed, certified and implemented replacements for ozone-depleting halons and electronic and aerospace solvents.

One measure of the importance of military organizations to climate protection is that more global and national awards for leadership and technology for stratospheric ozone protection have been presented to military experts and military contractors than to any other category of award winners.

K. Madhava Sarma held senior positions in India's Ministry of Environment and Forests for many years. He served as the Executive Secretary, Ozone Secretariat, and on retirement the Parties to the Montreal Protocol appointed him in 2001 to the Technology and Economic Assessment Panel (TEAP) as a senior expert advisor, a position which he still holds. He is a consultant on ozone and climate issues.

Today, the world faces abrupt and irreversible climate change that threatens the culture, prosperity and survival of hundreds of millions of people. Environmental protection has therefore become a national security concern that will require fast action by both civilian and military organizations.

With cooperation, military organizations can help transform markets to avoid climate change and can demonstrate leadership in explaining to the public that we will be more prosperous and safe from conflict if we make every effort now to curb excess emissions.

This document demonstrates how military strategy, organization and actions can be applied to solve a wide range of environmental challenges including stratospheric ozone depletion, climate change, and ecological restoration. Civilian policy makers will want to take on board this strategic approach and explore how environmental authorities can expand cooperation with their own military organizations to keep the world safe for future generations.

K. Madhava Sharma
Durwood Zaelke
Dr. Stephen O. Andersen

Durwood Zaelke is President of the Institute for Governance and Sustainable Development, Director of the International Network for Environmental Compliance and Enforcement, and co-Director of the Program on Governance for Sustainable Development at the Bren School of Environmental Science and Management, University of California, Santa Barbara. He is the author of *International Environmental Law & Policy* (with Hunter & Salzman) and editor of *Making Law Work: Environmental Compliance & Sustainable Development* (with Kaniaru & Kruíková).

Dr. Stephen O. Andersen is founding chair of Technology and Economic Assessment Panel (TEAP) and former Director of Strategic Climate Projects and Deputy Director of Stratospheric Ozone Protection at the United States Environmental Protection Agency. With K. Madhava Sarma, Stephen is author of *Protecting the Ozone Layer: the United Nations History*, with K. Madhava Sarma and Kristen N. Taddonio author of *Technology Transfer for the Ozone Layer: Lessons for Climate Change* and with Durwood Zaelke author of *Industry Genius: Inventions and People Protecting the Climate and Fragile Ozone Layer.*

A wind turbine at the US Ascension Auxiliary Airfield, South Atlantic Ocean. Each of the six turbines at the facility generates 900 kW, reducing the fossil fuel requirement.

U.S. AIR FORCE/LANCE CHEUNG

I. INTRODUCTION

MILITARY ORGANIZATIONS AND THE ENVIRONMENT

The environment and its relationship with growth and development have become critical global issues today. The relationship between national security and the environment, meanwhile, is increasingly being assessed for evolving risks and potential for action. Environmental degradation affects not just nature, but human livelihood and harmonious coexistence, and can have adverse effects on national security. For example, melting Himalayan glaciers, failed monsoons, dried rivers, the shortage of water and desertification could lead to cross-border migration, placing undue pressure on social and economic capabilities of this region as well as overwhelming an already inadequate infrastructure.

In a recent TV interview on the strategic implications of emerging security threats, NATO Secretary-General Jaap de Hoop Scheffer warned: "You cannot deny that the melting of the polar cap, the ice cap on the North Pole is having a lot of security consequences..."

Military organizations operate with the primary goal of providing national security by combating and eliminating threats. Their role is both **reactive** (addressing a situation after it has emerged) and in many cases **proactive** (anticipating and resolving the regional factors like social issues, political changes, etc) before they result in conflicts. To ensure that their primary goal is fulfilled, military organizations operate through a systematic command and controls-based operating processes and manage them in the most effective manner possible.

There is an increasing recognition that improving the effectiveness of operating procedures needs to include environmentally responsible management of these processes. Important aspects that need to be addressed include:

- evolution and implementation measures which would result in sustainable resource utilization along with material resource recovery and reuse
- minimization of use of ozone depleting substances, energy use and promoting energy efficiency enhancement
- adopting processes to minimize hazardous wastes emissions during operations and maintenance.

These actions could support efforts undertaken by military organizations in operating in an environmentally responsible manner and facilitate compliance with the commitments made by their governments under multilateral environmental agreements, primarily the Montreal Protocol.

II.

MILITARY ORGANIZATIONS AND THE MONTREAL PROTOCOL

When ozone layer destruction was recognized as a global problem, the Vienna Convention for the Protection of the Ozone Layer in 1985 was the first international framework to tackle this issue. In 1987, The Montreal Protocol on Substances that Deplete the Ozone Layer was adopted and concrete regulations to control ozone-depleting substances (ODS) were set out.

In the following years it was found that the depletion of the ozone layer was proceeding faster than predicted, and the Montreal Protocol was amended several times to accelerate the schedule of ODS destruction. Today, 22 years since the adoption of the Montreal Protocol, the Meeting of Parties is held every year to discuss the reduction of ODSs in developing countries. Developed countries have contributed to the Multilateral Fund for the Implementation of the Montreal Protocol (MLF), to support efforts in developing countries to protect the ozone layer. CFC, CTC, halons and HCFCs are the main ODS which are widely used in industry, including in military organizations.

Military uses of Ozone Depleting Substances (ODS)

ODS applications in the armed forces fall into one of five categories: solvents, refrigerants, halons, aerosols and foams. Several different ODSs feature in each category.

Solvents

CFC-12 and CFC-114 have primarily been used as propellants in aerosols, while CFC-113 and methyl chloroform are the most widely used solvents. In both cases they are emitted directly into the atmosphere and cannot be recovered once they have been used. In developed countries, the use of ODS for these purposes has been phased out almost entirely. Such CFC applications were also among the least expensive to replace, offering some of the greatest cost savings. All routine maintenance applications involving solvents and aerosols have been phased out.

Refrigerants

CFC-11 and CFC-12 are used as refrigerants on ships and aircraft and in ground vehicles and facilities, while CFC-114 is used in chilled water plants aboard ships and submarines and in the electronics needed by aircraft cooling systems. In a number of cases, alternative HFC blends have been developed that can be used in military cooling plants with little or no modification to existing equipment.

Halons

Halons 1211 and 1301 are used as firefighting agents on board aircraft and ships, in armoured combat vehicles, and for ground/shore facility fire protection.

Halon-1211 is a streaming agent used in hand-held systems for onboard fire protection and for aircraft protection aboard aircraft carriers, in crash, fire, and rescue (CFR) vehicles, and in portable fire extinguishers at ground facilities.

Typical Military ODS Uses

	Aircraft	Ships	Tactical Vehicles
CFC Refrigerants	Cockpits/cabins (certain aircraft only) Avionics pods	Electronics and onboard computer/ communications facilities	Crew compartments
Halons	Engine housings Back-up power units Cargo bays Cockpits/cabins Dry bays Fuel tanks (certain aircraft only) Lavatories	Electronics facilities Machinery rooms	Crew compartments Engine compartments
CFC Solvents	Maintenance procedures (cleaning and degreasing) Electronics and precision cleaning	Maintenance procedures (cleaning and degreasing) Electronics and precision cleaning	Maintenance procedures (cleaning and degreasing)

Halon-1301 is a total flooding agent, used to protect shipboard propulsion machinery areas, armoured combat vehicles, flammable-liquid storerooms, fuel pump rooms, facility computer and communications/electronics centres, and aircraft simulators. It is employed as a fire-prevention agent in engine housings, dry bays and cargo bays, and for protecting fuel tanks on several types of aircraft. In a few cases, it is also used in hand-held extinguishers on board aircraft, ships, and tactical vehicles.

Halon-2402 is used as a thrust vector control system in certain missile systems. In a few countries, notably in Russia and in Italy, it was used more widely in the engine compartments of combat vehicles and in some facility and aviation applications.

Fire protection in tactical vehicles (such as this M1A1 tank) typically involves the use of halon fire-extinguishing systems for crew and engine compartments.

When the Montreal Protocol was signed, military organizations depended on ODS for virtually all aspects of their operations and nearly every weapon system. The challenge of phasing out ODS was daunting, but armed forces around the world have established phaseout projects for all but mission-critical[1] uses where proven alternatives are not yet available. For these few critical uses, military organizations have perfected ODS banking and destruction of surplus or unusable ODS.

The Parties to the Montreal Protocol choose to eliminate emissions from ODS applications, so there is a wealth of information available from civilian and military experts to maximize environmental benefits and minimize costs. During the 8th Conference of the Parties to the Vienna Convention and the 20th Meeting of the Parties to the Montreal Protocol in Doha, Qatar, November 2008, military organizations from the Netherlands, Australia, and the United States offered to support collection and destruction with information sharing and consulting on logistics. The goal is an online library of best practices, laboratory techniques, and business strategies, with direct links to companies offering equipment and services for collection and destruction of surplus military ODS. The Ozone Secretariat will act as coordinator with the Basel Convention Secretariat and other conventions to ensure the transport of surplus ODSs to countries with authorized critical uses or destruction facilities is correctly permitted. This activity itself will be helpful because it will streamline the desirable shipments of chemicals to proper destruction facilities.

Parties to the Montreal Protocol are working to quickly collect and destroy ozone-depleting greenhouse gases (ODGHG). The TEAP estimates that end-of-life measures across all sectors could recover approximately 300,000 Ozone Depleting Potential (ODP) tonnes of chemicals that have the equivalent of approximately 6 billion tonnes of CO_2.

The most accessible portion amounts to almost 200,000 of CFCs (equivalent to approximately 2 billion tonnes of CO_2) and almost 500,000 tonnes of HCFCs (equivalent to approximately 770 million tonnes of CO_2-eq.). The combined CO_2-eq. of ODS refrigerants, foam blowing agents and contained in products and equipment is equal to three years of global Kyoto targets. Action is needed now because ODS that leaks cannot be recovered from the atmosphere. The Technology and Economic Assessment Panel (TEAP) estimates that without immediate action, by 2015 approximately 90% of the CFCs and 50% of the HCFCs in “reachable” refrigeration and air conditioning products in non-A5 Parties and over 75% in A5 Parties, will have been emitted.

[1]Critical applications may be defined as those ODS uses which have the potential of adversely impacting operational training during peace, combat missions during operations, and for which no alternative have yet been identified, developed or implemented. They include applications integral to military hardware systems, absence of which would directly degrade their operational capability.

Military organizations worldwide are cooperating to achieve greater success in ODS management. United Nations workshops, such as the Sub-Regional Workshop on ODS Phaseout in Military Applications held in Colombo in April 2009, have helped military leaders from developing and developed countries meet to discuss best practices and lessons learned. One of the key lessons is that military organizations worldwide need to select alternatives to ODSs that have low global warming impacts. Military experience in managing, collecting and destroying ozone-depleting gases will be a useful model in managing ozone-safe chemicals.

Environmental issues play an important part in the preparedness and peacetime operations of military. For example, the military establishment of a country which continues to rely on chlorofluorocarbons (CFCs) in refrigeration and air-conditioning and halons in firefighting will face a threat of being "unprepared" for specific operations due to non-functional equipment because no more virgin CFCs and halons will be available beyond 1 January 2010.

Military organizations therefore need to have long-term plans for meeting servicing requirements and critical applications for maintaining military readiness. If they don't, critical actions could be impaired and equipment like planes and tanks may not be operational. This is why it is important for the military to be aligned with national Montreal Protocol activities and targets to assure continuity of operations (more information on the Montreal Protocol and the ODS phaseout schedule can be found in Annex 1).

Maintenance manuals for the Bradley Tank once required ODS solvents for many cleaning applications. These manuals have now been changed to specify the use of non-ODS alternatives that perform as well as the earlier solvent or better.

Militaries depend on materials provided by the commercial marketplace. To avoid being surprised when materials needed to support military systems become expensive or unavailable, militaries must invest the time and effort needed to understand which materials they rely on, and how market and regulatory forces beyond its control may be affecting their current and future availability.

Military organisations can also positively contribute towards the larger cause of safeguarding the environment and build a positive image by implementing practices customised to their environs. For example, military organizations could use recycled CFCs and halons for their remaining CFC and halon-based applications and can share logistical knowhow on collection and destruction of all ozone-depleting substances (ODSs). This would result in lower demand from military for virgin ODS, namely CFCs and halons. Military organisations can also adopt policies for procuring refrigeration and air-conditioning systems which have lower direct greenhouse gas (GHG) emission impact (using non-ODS with low Global Warming Potential) and indirect GHG emission impact from fuel use (substances which are more energy efficient in their operations). These policies not only help avoid negative environment impact of military operations but also ensure cost-effective and sustainable operating practices.

Militaries are generally perceived not to be ecologically-conscious. However, although it appears that many military organizations have not kept pace with advances in environmental management, the perception of military organizations being indifferent about environment is not true. Examples of militaries around the world addressing environmental concerns are in Exhibit 1.

Exhibit 1
Selected Actions by Militaries on ODS Phaseout

- In 1998, UNEP OzonAction in cooperation with military and civilian experts developed guidelines entitled "Maintaining Military Readiness by Managing Ozone Depleting Substances" to assist armed forces in developing countries with establishing and implementing their own programmes to manage and reduce use of ODS in accordance with their national obligations under the Montreal Protocol. http://www.unep.fr/ozonaction/information/mmcfiles/3189-e.pdf.
- UNEP OzonAction, the United States Environmental Protection Agency, and the United States Department of Defence organised an international workshop entitled "The Importance of Military Organisations in Stratospheric Ozone and Climate Protection" (6-8 February 2001, Brussels) with the support of military and governmental and environmental organisations from Australia, Canada, United Kingdom, and the United States and the participation of developing countries.
- The Institute for Governance & Sustainable Development and UNEP co-sponsored a meeting on the Importance of Military Organizations in Protecting the Climate in Paris, France in November 2008.
- The Indian Air Force (IAF) organised and participated in high-level expert forum meetings (2005 and 2008) on halon management organized jointly by UNEP DTIE's OzonAction Programme, Ministry of Environment and Forests, India and the TEAP. Sensitisation of IAF personnel is expected to facilitate reduction in use of ODS such as CFCs and halons.

- UNEP DTIE OzonAction's CAP Regional Office for Asia and the Pacific organized the Sub-regional Workshop on ODS Phaseout in Military Applications in Colombo, Sri Lanka during 16-17 April 2009. The workshop was organised in collaboration with the Multilateral Fund, National Ozone Unit and Ministry of Defence of Sri Lanka. Representatives and delegates in defence sectors of sub-regional countries in the Asia-Pacific region, including Bangladesh, India, Iran, Indonesia, Malaysia, Pakistan and Sri Lanka were also present.
- As part of the South-South Cooperation initiative, representatives of military organizations and the NOU of Sri Lanka and India visited Garuda Airline's halon bank facility in August 2009 to learn good practices on halon bank management and to exchange views on CFC, halon and CTC phaseout in defence establishments.
- The US military prioritized the phaseout of CFC 114 and halons. The Navy established an aggressive program to conserve CFC-114 and other ODS considering mission-critical reserves. The draw-down of the reserve is monitored to guard against premature depletion. Four replacements: E-134, HCFC-124, HFC-236ea and HFC-236fa were considered. Proof-of-concept demonstrations with HFC-236fa in fleet air-conditioning plants in submarines were secured. Conversion kits for all met critical design requirements, increased energy efficiency and reduced emissions by about 15%.
- A US research centre developed a viable alternative to the halon 1301 automatic fire and explosion suppression systems (AFES). A HFC-227ea plus 5% dry powder AFES system was designed and qualified. The first non-halon crew compartment fire and explosion suppression system in the world was fielded in October 2003.
- The U.S. Army Research, Development and Engineering Command (RDECOM), constructed a unitary CO_2 air conditioner, a prototype CO_2 Environmental Control Unit (ECU). For personnel cooling, REDECOM also completed successive generations of a retrofit to the M1114, the "up-armored" Humvee that equips it with CO_2 cooling. In the M1114 Humvee, the CO_2 cooling system provided substantially higher cooling capacity while fitting into a 30% smaller space with 8% lighter overall weight.
- The US Defence Logistics Agency (DLA) Defence Supply center Richmond (DSCR) established an ODS Reserve Program for ODS collection, storage, recycling and clearing house services.
- Ministries of Defence in the European Union jointly tackle ODS and greenhouse gases. Most ministries have started a HCFC phase out program. Recycled halons (1301, 1211 and 2402) meet the critical defence uses. A few halon banks have also been established to serve the needs of industry and defence. In the Netherlands a national Halon Bank Association has been established tackling collection, storage, recycling and clearinghouse services which the Ministry of Defence has joined. The US Department of Defence also joined the bank to manage halons for its assets and bases in Europe.
- Under the Australian Defence Leadership Programme halon 1211 was gathered from hand-held extinguishers from hangar walls, replacing them with water, dry chemical powder and carbon dioxide extinguishers, while halon 1301 was removed from Australian Defence Organisation (ADO) buildings' flooding systems. The government's non-military Antarctic facilities were also targeted. Aqueous Film Forming Foam (AFFF) was used in tarmac trolleys for fire suppression. New platforms or equipments that are purchased containing ODS or Studies Guidance Group (SGG) are covered by a national product stewardship program. The Defence Energy Efficiency Program (DEEP) targeted high energy use sites within the organization and implemented scores of energy conservation measures.
- The Australian MOD established a Halon Bank in 1993 for the collection, storage, recycling and clearing house services of halons. The USDOD DSCR also joined the bank in 2001 to manage halons for their assets and bases in the Asian region.

Operational Readiness and Why the Armed Forces Need to Take Action on ODS

In developed countries the phaseout of ODS production could have had an adverse effect on the armed forces and on the industries providing them with support and equipment. In the years immediately following ratification of the Montreal Protocol in 1989, developed countries surveyed their ODS uses and discovered their presence in virtually every weapon system. ODS were actually required in standards, specifications, and codes governing operations ranging from design, engineering, manufacture, and purchasing to operations and maintenance activities.

Given the widespread reliance of armed forces on these chemicals, any sudden shortage or interruption to supply could have had serious repercussions for both operations and personnel. Without CFCs, cooling systems and halon-based fire-protection systems in aircraft, ships, and tactical vehicles might not function. If that happened, critical weapons systems would fail, or become more vulnerable to fire and explosion. For every ODS application, an alternative chemical, process and/or new system design had to be identified, engineered, demonstrated, tested to meet operational requirements, and introduced as standard. Many armed forces took advantage of the phase-out, seeing it as an opportunity to modernize industrial processes which had remained unchanged for years. In many cases, the alternatives eventually implemented resulted in higher reliability and lower production costs.

Some of the new initiatives may be identified based on national and international environmental priorities (phaseout of ODS, and its linkages with promotion of climate-friendly technologies, adoption of renewable energy in certain areas, disposal of lubricants in an environment friendly manner). Constant interfaces by the organisation focal points with the Ministry of Environment and specialised organisations would be useful. Chapter VI Library, Part 2 presents information on Awareness Programs and Environment Management Tools and Techniques implemented in different countries. Defence organisations would need to forge strong ties with civil sectors, NGOs and other specialist government organisations for implementation of these tools and techniques within

the organisation and mutually benefiting from each others' experience. This would also enable receiving technical support during implementation.

Similarly, in the case of Article 5 countries, failure to plan for the imminent phaseout of ODS production could compromise military readiness. Each organization in the armed forces should undertake detailed surveys of all ODS uses. This task may be performed either by military personnel or by outside contractors (or both). Failure to identify ODS uses and to plan for the end of ODS production could render weapons systems, and facility infrastructures inoperative as soon as the ODS supplies required to keep them working are no longer available.

To prevent the phaseout of ODS production from impacting adversely on operational readiness, armed forces must establish comprehensive programmes to manage their ODS requirements. Like any other military operation, this means forward planning, resource programming, and ensuring a strategy is in place. This toolkit describes the basic elements of planning that have worked successfully for many developed countries and are equally applicable to armed forced in Article 5 countries. It also sets out a number of real-case scenarios detailing how specific ODS uses were phased out in particular military applications, and describing others where informed management will facilitate a successful phaseout.

Potential Impacts on Military Readiness

Halons	Refrigerants	Solvents
Protection against fire/explosion in:	Maintaining electronic equipment at operational temperatures in:	Maintenance to:
Aircraft and tactical vehicles	Tactical vehicles	Keep systems in operation readiness
Ships (flash fires in electronics/ machinery rooms)	Combat and communications centres (ships)	Prevent failures
	Avionics and weapons pods (aircraft)	

Getting military organizations to operate within the constraints of the need to protect the environment is not easy. It is a relatively recent phenomenon and it has not yet percolated down through the operations departments of militaries and their rank and file.

It must however be recognized that militaries have been operating with a singular aim of achieving excellence in the art of fighting wars for national security and have had limited time or opportunity to pay adequate attention to matters concerning environment. The main factors that have contributed to this situation include:

- expensive military technology and hardware making it costly to replace and compact, and the inaccessibility of components and assemblies which make them difficult to retrofit
- by nature, militaries are sensitive to change: particularly in areas not related to combat situations and equipment used in the war front
- long gestation in training personnel on adoption of new technologies

Difficulties in resolving these challenges have resulted in delays in the introduction of cleaner, environment-friendly technologies.

Militaries are focused on having a well-honed, lean and mean fighting machine, and althiough possibilities of military organizations operating in an environment-friendly and cost-effective manner exist there could be potential military preparedness risks in certain cases due to elimination of products from the market. Adequate attention has not been paid on analysing risks associated with operating in an environment-friendly and cost-effective manner.

This situation calls for an important and urgent need to re-examine the case of environment-friendly operation of military organizations and define mechanisms to systematically move forward towards a “Green Army”. Insights and guidelines that are presented in this document we hope will facilitate the process by promoting thinking and planning towards positive action within the military organizations to operate in an environmentally responsible manner specifically with regards to ozone protection and its linkages with climate change.

The present document focuses on opportunities available and highlights the crosscutting nature of environmentally relevant activities and impacts. These opportunities can change the way environmental management is dealt with inside a military organisation.

This is a toolkit to facilitate positive action. Given that ozone layer depletion is a an important issue that affects preparedness and operations of the military this documents many examples and case studies of positive action. Included is information on initiatives around the world highlighting opportunities for operations, maintenance, and administration components of military organizations to start a joint campaign for a better environment without compromising national security.

This document also describes how the military leadership can address environmental threats like ozone layer depletion and its climate links that have a potential to ignite conflict. Environment management tools mentioned in this document can assist decision makers in the military organizations access relevant information and suitably adapt them by building on the existing knowledge base. Lessons learnt from examples cited can also be used by training programmes in military organizations as part of their curricula.

More information on the connection between defence organizations and the Montreal Protocol can be found in Annex 3 and 4.

Thai and US troops using handheld field radios. Electronics systems such as these were manufactured using ODS solvents, and maintenance procedures called for those same solvents. Manufacturing and maintenance processes in developed countries have been changed and now use non-ODS alternatives.

GMF AeroAsia
GARUDA INDONESIA GROUP

As part of the South-South Cooperation initiatives, in August 2009 representatives of the military organizations and the NOU of Sri Lanka and India visited Garuda Airline's halon bank facility to learn good practices on halon bank management and to exchange views on CFC, halon and CTC phase out in defence establishments.

Garuda Indonesia
HALON BANK PROFILE

PT Garuda Maintenance Facility (GMF) is the Technical Division of Garuda Indonesia, the country's flag carrier airline. GMF became the business unit of Garuda Indonesia in 2002 in order for it to focus on MRO (Maintenance Repair and Overhaul) for commercial aircraft and its components and engines. The MRO facility is approved by the DGCA Indonesia, FAA (Federal Aviation Administration), EASA (Europe) and also US DOT for Halon Fire Extinguishing Service (for aircraft) and Hazardous Material Handling. GMF maintains not only the Garuda fleet, but also airlines in the region and some from the Americas, Middle East and Africa.

Since Indonesia's ozone protection program began, GMF has been a participant not only in halon phaseout but also in replacement of the degreaser machine for cleaning (thriclourmethane) of aircraft parts replaced by aquaeous detergent. It has also changed/phased out the solvent for laundry machines. Based on these achievements, the Indonesian government appointed GMF to manage the Halon Bank activities in March 2000 and it was officially announced and launched in September 2003 during the celebration of Ozone day by the Minster of Environment.

Although the project was being planned since 1994, due to the economic crisis in 1998 capital investment was put off till 2000. Since then the bank has conducted public awareness seminars and workshops for halon phaseout program in Indonesia including in the miltary and aviation sectors. With the help of the World Bank (Multilateral Fund) the Halon Bank has been able to set up:

- REACH Machine for Recycling
- Storage Cylinders
- GC (Gas Chromatography) for Quality Control Check
- Portable Halon Identifiers
- Transfer Pump and Comporessor machine for Air Supply.

Other activities include:

- Participating in workshops and seminars on Indonesia's ozone protection programmes
- In collaboration with UNEP DTIE OzonAction CAP ROAP, sharing experience of halon bank management
- Participated in the Meeting of Parties
- Re-inventoried halon stock in Indonesia
- Collected 25,000 kg of Halon 1301 and 1211
- Supplying recycled halon for critical use especially in aircraft maintenance

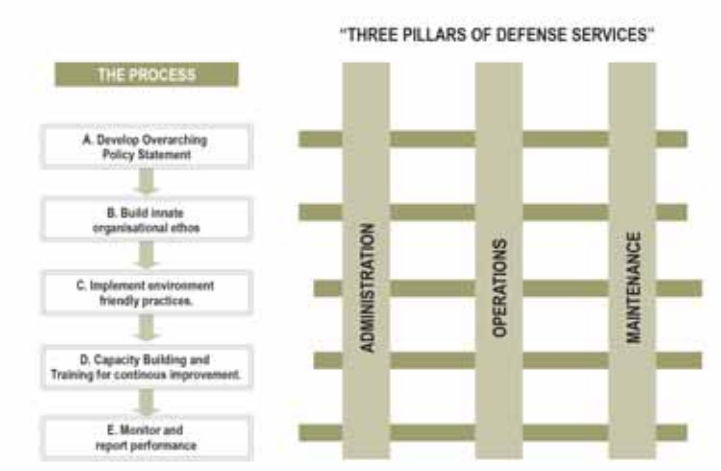
A Su30 of the Indian Air Force takes off from a military base. Armed forces around the world are increasingly recognising that switching to ozone-friendly chemicals will contribute to their overall preparedness.

INDIAN AIR FORCE

III.

FRAMEWORK FOR IMPLEMENTATION OF ENVIRONMENT-FRIENDLY PRACTICES

Military organizations can design and implement measures for environment-friendly operations cutting across "Three Pillars" of military organizations: Operations, Maintenance and Administration *(see chart)*. The framework follows the requirements of standard 14001 of the International Organization for Standardization (ISO) with respect to Environmental Management Systems.



Useful Phaseout Strategies

There are a number of useful strategies available to any military organization intent on implementing a phaseout plan. Those that have been used successfully by developed countries include:

- announcing policies restricting purchase of new ODS using equipment once alternatives are available
- modifying technical specifications to phase out ODS requirements as soon as alternatives are identified
- coordinating efforts with private industry and other branches of the armed forces
- conducting training and awareness for maintenance personnel working on systems using ODS
- monitoring the ODS bank and reviewing deposits and withdrawals
- using existing technical assistance and cooperation agreements with other organizations and armed forces in other countries to exchange experiences in phasing out ODS
- conducting periodic programme reviews to ensure the phase-out is on schedule and keeping the high command abreast of any problems
- funding the phaseout as an integral part of military forward budget planning
- using national and international forums on military issues to address ODS phaseout issues.

Details of the coverage on each of these five components (Develop, Build, Implement, Capacity Building and Training, Monitor and Report) are detailed in the following sections.

A. Develop Overarching Policy Statement of Defence Services

The first component of making the defence services environment-friendly in relation to Operations, Maintenance and Administration activities is to formulate a policy statement. This can have five elements:

- Purpose of defining the policy
- Objective and intent along with boundary conditions,
- medium of achieving objectives (through orders/instructions/ actions/ departments etc) along with reporting channels and civil support
- Timeframe of implementation
- Measurable performance standards including audit arrangements that facilitate continuous improvement

It is important to harmonize efforts and output and in this regard organisational units have to customise their approaches. Some important aspects of the policy relevant to the entire gamut of military organisation are:

- Plan and apply internal standards for each process of the organisation where environmental impact is obvious. The reporting channels with regards to these processes should also be specified. It may also be useful to identify processes where environment impact is highest and actions can result in significant measurable and demonstrable results.
- Training and capacity building of relevant officials oriented towards sensitising the officers on environmental issues are important. Innovative cost-effective techniques such as “train the trainer” approach, training modules as a part of regular training programs, mandatory training through equipment/product suppliers, electronic e-based training and inter-divisional cooperation on training personnel could be helpful.
- Stakeholders for each organisation should be chosen with care and should include civilian support organizations and supplemental financing. The stakeholders could be divisions/ departments dealing or advising on the processes having environmental footprints.
- A clear policy should institutionalise audit arrangements for these processes and specify the expected improvements in standards with regard to environment issues. These audit processes should not only facilitate measurement of conformance to standards but should also be facilitative in nature for identification of methods for improvement of performance.

While national security and related interventions should not be compromised, it should not become a plea for avoiding environmental action. A healthy environment is important for a strong nation. Military organizations are often looked to for leadership and as examples of excellence. Conducting military activities in a way that protects the environment sends an important message to the rest of government as well as to the private sector and individual citizens. Military effectiveness and preservation of the environment can be mutually reinforcing objectives.

B. Build on the Innate Organisational Ethos

Defence services world over have a strong ethos of discipline that compels them to treat every order from the higher leadership as ‘must comply’. This could be a valuable basis for infusion of

environmental values and the top rung must show its commitment to the cause. The "buy-in" of operational staff needs to be obtained through strong communication and information outreach programs. Wherever feasible, these programs should involve experts in different fields of environment from reputed organizations, and such involvement would not only communicate seriousness to the staff but also provide technical clarification on modalities of implementation of environment friendly practices.

The heads of the organization and different departments/divisions need to issue policy guidelines that follows the overarching policy of the defence services and spell out priorities and appropriate practices to be followed in their operating processes. This would then lead to action plans to be adopted by the different arms of the defence services and work towards a safe environment including activities aligned with country's commitment to the Montreal Protocol, Kyoto Protocol and other multilateral environmental agreements.

Implementing a Step-by-step ODS Management Plan

Ensuring continued military readiness without ODS production phaseout can be thought of as a military operation. It is a useful analogy to think of ODS as a strategic materiel vital to the ongoing viability of a military system. A step-by-step approach to ODS management may include the following:

Step 1: The plan

- commit the leadership to a timetable compatible with national regulations to implement the Montreal Protocol
- assign responsibilities for particular tasks
- set up the team
- identify ways of monitoring progress
- prepare an outline budget and assign resources

Step 2: Determine the magnitude of the problem

- compile an inventory of all equipment and applications using ODS
- compare the inventories from different branches of the armed forces
- prepare a definitive inventory of all ODS applications

Step 3: Choose appropriate replacement technologies

- identify potential alternatives for each application
- select the appropriate alternative
- implement that alternative
- link implementation to the Article 5 phaseout schedule.

Step 4: Identify mission-critical uses

- identify uses for which no alternative is currently available
- identify uses which cannot be phased out before ODS production ends
- determine which uses are critical to operational readiness

Step 5: Secure supplies to meet critical needs

- implement conservation and recovery/recycling programmes
- estimate the quantities of ODS needed to meet mission-critical needs
- establish or join an ODS bank to cover those needs

Step 6: Keep progress on track

- establish a programme to collect data on ODS purchases, recycling, and consumption
- collect and collate periodic progress reports
- assess progress on the basis of the collected data and the timetable established under Step 1
- adjust the timetable as circumstances dictate

Reporting relationships are required to be set up for effectively controlling the ODS management in military organizations. A nodal agency on ODS and other environment matters should be formed at the level of Service HQ and regional/ Command HQs. An information flow on ODS inventories within the defence production industries and military services should be formalised by the MoD.

Since the military organizations cannot work in isolation on this vital issue, the reporting relationship would be required to be established both externally and internally. A recommended reporting channel for management of environment related issues in the military establishment is attached as Annex 2. This may be adopted with whatever modifications needed to suit the individual organization.

Exhibit 2 below gives examples from high-level military policy statements issued by Ministers or Secretaries of Defence, the Chiefs of Staff of Defence ministries, and the Armed Forces Departments in developed countries.

Exhibit 2
Military Policies to Comply with the Montreal Protocol

It is the policy of the Ministry of Defence to comply with national commitments made under the Montreal Protocol on Substances that Deplete the Stratospheric Ozone Layer.

Under the terms of the Montreal Protocol on Substances that Deplete the Ozone Layer, which has been ratified by our national government, the worldwide production of ozone-depleting substances will end.

Ozone-depleting substances are used for the manufacture, maintenance, and operation of virtually every weapons and support system used by our armed forces.

In order to avoid adverse impact on our military readiness, I am immediately implementing a programme to adopt alternatives to ozone-depleting substances.

By 1 January each branch of the armed forces will appoint a General or officer of comparable rank who will be responsible for developing and implementing a plan to comply with the Montreal Protocol on Substances that Deplete the Ozone Layer.

This directive establishes an Inter-Service ODS Committee to coordinate Defence Department efforts to eliminate ODS use.

The Inter-Service ODS Committee will report to a council consisting of the Generals and/or officers of comparable rank from each branch of the armed forces responsible for the ODS programme.

By 1 June each branch of the armed forces will survey its uses of ozone-depleting substances as defined under Annex A of the Montreal Protocol and will report its findings to the commanding officer with overall responsibility for the ODS programme.

With effect from today, ODS emissions from testing and training activities will cease, including halon emissions used in firefighter training.

With effect from [date], no new halon fire-suppression systems will be installed in buildings.

With effect from [date], procurement of CFC refrigeration and cooling equipment is prohibited.

With effect from [date], the purchase of ODS solvents will be prohibited without a specific waiver granted by the commanding officer in overall charge of the ODS programme.

C. Implement Activities for Adopting Environment-friendly Policies and Practices

This step converts intent specified in the policy statements into actions. These could include organization-wide activities which would cut across the "Three Pillars" and individual unit level projects. The type of projects/activities that would be implemented should be based on priorities identified in the policy statement–both at organisation level as well as divisional/department level.

Details of the steps needed for defining and implementing an action plan for adopting environment friendly practices, under the overall framework established earlier, is presented below and they include examples of Montreal Protocol implementation, armaments and linkages climate change activities.

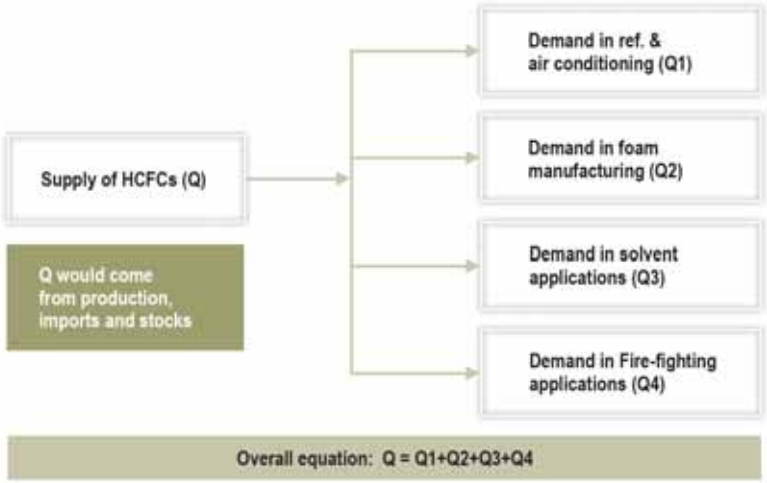
- ✓ **Inventorize current emission and usage levels of environmentally sensitive substances by different end-use categories and project their future use**

Inventorisation should be a high priority. A list of environmentally sensitive substances need to be first defined, taking into account priority action areas. To begin with, a list of substances controlled under Montreal Protocol[2] listed in Annex A Group I, Annex A Group II, Annex B Group I, Annex B Group II, Annex B Group III, Annex C and Annex E, emissions and substances of the six greenhouse gases identified under the Kyoto Protocol (CO2, nitrous oxide, methane, HFCs, PFCs and SF6) the substances identified under the Stockholm Convention on Persistent Organic Pollutants (POPs) and other environmentally sensitive chemicals (fuels and lubricating oils used in machinery etc.) can be used as a reference.

Beyond ODS, the European Union has enacted a law entitled "Registration, Evaluation, Authorisation and Restriction of Chemicals" or REACH. It will affect the cost and availability of materials important to the manufacture, maintenance and operation of military systems. Its purpose is to ensure a high level of protection of human health and the environment from the risks that can be posed by chemicals and the promotion of less hazardous alternative materials.

One needs to know how much of environmentally sensitive substances are being used along with characteristics of usage and levels of use. End-use definitions can be based on technical studies conducted on inventorisation, documents published on similar studies, guidance from relevant organisational divisions/units in Ministry of Environment (National Ozone Unit for controlled substances under the Montreal Protocol) and internal consultations held within defence establishments. A simple, mutually-exclusive and exhaustive list is a key for successful end-use definition for inventorisation. For example, HCFCs (which are controlled under the Montreal Protocol) are typically used in refrigeration and air-conditioning uses, foam manufacturing uses (in case such uses exist especially spray foams in temporary structures used in operations) and to a limited extent, fire-fighting equipment and solvent uses. Supply (procurement from production, imports and stocks) and consumption (quantities used for different end-uses) are relevant. Through the procurement processes that exist within the defence establishments, the procurement levels (annually) needs to be assessed and should be mapped to the end-uses as illustrated in this chart:

[2]Of the group of substances listed, inventorisation of Annex A Group I substances (CFCs) , Group II substances (halons) and Annex C substances (HCFCs) may be of interest to Defence establishments. This how is not prescriptive and based on usage pattern other substances such Methyl Chloroform (list in Annex B Group III) may be included.



Though a 100% match of supply and demand may not exist owing to emissive losses, inventory levels etc., overall supply demand match needs to serve as a check for inventorisation. This work can also estimate the reduction in demand resulting from efforts to better contain, recover and recycle chemicals for future use or destruction.

In case of substances which can be released into the atmosphere, an inventory of emissions would need to be made. This is more complex than the direct supply-demand inventory depicted above and would involve estimates based on scientific and/or practical field level studies. For example, the emission of greenhouse gases from vehicles would be based on estimated distances of transportation used by vehicles, quantity of load carried and emission performance standards (fuel consumption efficiency). In case of certain chemicals, this would be more based on outputs produced (quantity of chemicals emitted per unit of output produced, quantity of storage losses per ton of chemical procured) and past experience, field conditions, supportive scientific studies etc. would form a basis for estimation of emission inventory. Noting the current use levels (both consumption and emission) and the expected future trends, best estimates of future uses/emissions for different identified environmentally sensitive substances needs to be made. This would be based on future plans on the specific uses and technological trends on availability of these substances/ alternatives.

One important area while assessing environment impact is to look into the use of ODS and linked greenhouse gases. Chapter VI Library, Part 1 provides details of ozone protection and its linkages with climate change and their relevance to defence activities and list some of the initiatives to overcome the impacts.

✓ **Definition of procedures for purchase, transport, storage, use and disposal of substances**

Following inventorisation and estimation of use trend, procedures for purchase and use of these substances have to be established. The idea is to minimise demand and eventually eliminate the use of environmentally sensitive substances. For some substances, this can be done faster (CFCs can be phased out very quickly from use in refrigeration and air-conditioning systems) and for others, it may take longer. Irrespective of this, minimising demand and eliminating use needs to be adopted in definition of procedures.

For substances where substitutes which are environmentally friendly are readily available, procurement procedures should allow for immediate substitution and restriction on procurement of environmentally sensitive substances. For making these assessments, technical experts could be consulted to ensure fast track elimination of harmful substances.

For substances for which environment-friendly substitutes are not available, procedures should examine options for minimising demand by a combination of the following:

- Adopting good maintenance practices in equipment using these substances including recovery, reuse and/or safe disposal. For example, in case of lubricants, careful recovery of contaminated lubricant and safe disposal can help in avoiding environmental damage.
- Using recovered and recycled substances: this will directly reduce demand for virgin substances like CFCs and halons. Recovered and recycled substances may be available from a select group of chemical suppliers and hence, inventory of such suppliers could be developed and maintained.
- Implementation of technical retrofit options whereby the previously used environmentally unfriendly substances can be phased out / use can be minimised.
- Definition of usage and/or maintenance standards for utilisation of these substances and operations and servicing of equipment using these substances.

While these procedures can be easily defined for non-critical applications, it may pose difficulties in case of mission critical applications. Further, decisions should also take into consideration quantities procured, storage requirements, time taken for material movement and quantities (there may be difficulties in procuring small quantities of certain substances) and need for maintenance of storage centres etc. Such issues can be addressed through a phased approach in addressing substitution of environmentally sensitive chemicals with friendly substitutes.

A holistic review of the usage, procurement, storage and transportation needs of specific environmentally sensitive chemicals and overall strategies for reducing dependence on these chemicals and eventually eliminating their use should guide definition or policies and procedures. Annex 4, as a case study, provides steps that could be taken by military organizations to phase out ODSs from procurement and operations.

Military hardware consists of a wide array of equipment including ships, aircraft, tanks, support, combat and other vehicles and this vast inventory is mostly bought by developing countries from known and reliable sources. There are only a few manufacturers across the world (mostly in developed countries) that possess the know-how for producing this hardware. It is not surprising that due to a limited market, the technology used for their manufacture does not change significantly over time until competitive and cost pressures demand the next generation of equipment. Often, new technologies in military hardware are seldom driven by the customer's demand and have more to do with competition. This paradigm needs to be changed and manufacturers must produce environment-friendly hardware even if the cost is marginally higher. This can be jump-started if demand by buying countries is made on these manufacturers to provide environment-friendly technology.

Qualitative Requirements (QRs) of a new military product, as projected by a purchaser country, is a useful way of addressing this issue. QRs could include negative marks to be allotted for a product which uses environmentally unsound traits, during the comparative qualitative analysis. If this was to become a norm, the manufacturers would be forced to change to alternative technologies. Every country needs to institutionalise such requirements in defence procurement.

There may be instances where a green procurement policy may not be conducive due to operational considerations. In such cases it is recommended that the procurement contract should build in safeguard clauses as follows:

- Original Equipment Manufacturer (OEM) would pass on any advancement in technology, during the life term of the equipment, which phases out the recognised environmentally negative traits of the equipment like halon use in aircrafts.
- OEM would support, with material and servicing backup, the part of equipment which utilises environmentally harmful sub-processes/assembly/ material. For example, if a new equipment requires use of halons as fire suppressants, the onus of supplying the chemical would be on the OEM till the Total Technical Life of the equipment/assembly or till the time alternative technology is in place.
- If the preventive maintenance schedule specified by the OEM mandates use of energy inefficient processes or utilisation of harmful chemicals then a timeframe may be specified in the contract within which manufacturer would change these standards with environmentally sound ones. Since the maintenance processes are effectively grasped only when the equipment is actually put in operation, the time lines for implementing this part of contract should be suitably drawn as is the case with Mean Time Between Failures (MTBF) warranties or performance standards. The Doha Declaration mentioned earlier, at the Montreal Protocol's 20th Meeting of the Parties is an excellent approach to address this issue within defence parameters.

Chemical substances which become superfluous, surplus stocks of chemical substances which will be replaced or phased out earlier than expected and waste chemicals must be disposed of in an environmentally secure way. Procedures and contracts for proper collection, storage, disposal and recycling must be established and adequate facilities provided:

✓ **Implementation of projects to phaseout environmentally sensitive substances**

New initiatives are needed to achieve phaseout of existing uses as well as adoption of environment-friendly technologies. While a part of these projects would be ongoing project activities as a part of regular operations like construction of new buildings or adoption of new technologies, other initiatives specifically targeted at adoption of environment-friendly practices need to be identified and implemented. For example, the conversion of halon-based fire extinguishing agents to halon-free agents could be one such project. Annex 4 presents illustrations on ODS phaseout policies that can provide useful inputs for projects that could be taken up to reduce dependence on CFCs, halons and ozone depleting solvents.

The use and disposal of explosive and chemical armaments is another challenging issue which military organizations need to tackle. Based on the experiences of the Indian defence forces, the following exhibit provides information on tackling armament issues in military organizations through project initiatives.

Exhibit 3
Tackling Armament Issues

Stockpiling explosives and chemicals for use in war is necessary. Since these reserves cannot be actually used in times of peace, though, the disposal of excess inventory is a challenge. Most military establishments consume older explosives during training or demolish them when their life expires. Their disposal is an issue for the army. Environmentally-compatible disposal methods for different explosives involve expensive recycling and the market for recycled explosives is very limited or non-existent. The option is incineration, but the problem with that is emissions. The process of chemical decomposition of explosive material followed by biological degradation offers an alternative to environmentally damaging incineration process.

Any army wishing to follow this environment-friendly approach would need to incorporate it in the initial contract with the manufacturer of the explosives. Every business entity dealing with explosives needs to follow some social obligations in order to achieve one of its multiple objectives and it is this obligation that they would need to fulfill when they undertake a commitment to safely dispose off the life expired armament stores on behalf of their customers. This will not only secure them better market reputation but also contribute to a safer environment.

Use inert materials where possible. The defence services have to use explosive devices during peacetime exercises to validate their war philosophies and train their troops in as realistic a manner as possible. If these training explosives can be designed without high explosive warheads, the damage to the ecosystem due to explosions would be minimal.

Consideration at the time of procurement of the ultimate cost and environmental impact of disposal will have the desirable effect of shifting from stockpile to just-in-time manufacturing, encouraging suppliers to make disposal more cost-effective, and negotiating with security partners to jointly manage inventory to minimize new production and the resultant destruction. The impact of using high explosive bombs on the environment can be gauged by comparing the figures of explosives filled in the low explosive bombs with that filled in a normal combat high explosive bomb. Both would be dropped by air and would have the same ballistics owing to similar design and weight. A high explosive, air dropped bomb any where in the world, weighing about 500 kg, would have 40-45% (by weight) explosives. In comparison a low explosive bomb would have only 10-15%. An inert bomb would have no explosive but same ballistics and adequately fulfill training needs. If a training mission requires only validating the homing/ navigation of an armament store, it would be prudent to utilise a low explosive or inert store. The army therefore needs to self regulate its systems and restrict use of such armament stores during training exercises.

These projects should be well resourced and managed with monitoring both at the organisation level (centrally) and at the operational unit level (field level). Performance of these projects and their impact should be periodically reported and publicised to ensure “high visibility” across the organisation.

Exhibit 4
Amendment to MARPOL issued by International Maritime Organisation on ODS management

The most recent (October 2008) amendments to Annex VI (Regulations 12 & 17) of the MARPOL have covered (http://www.imo.org) five important dimensions of ODS management as stated:

i. Deliberate emissions of ODS during maintenance, servicing, repair or disposing of systems or equipment shall be prohibited.
ii. ODS & equipment containing them shall be delivered to appropriate reception facilities when removed from ships.
iii. A list of ODS equipment on – board and a log – book on quantities of ODS used and supplied to the ship have to be maintained.
iv. Reception facilities should meet the repairing needs of ships with respect to ODS & of equipment removed from ships.
v. The phase out schedule of HCFCs determines their presence on ships / in equipment containing them.

Activities for implementing IMO guidelines could be identified by Navy for implementation at national level.

✓ **Environment friendly Estate Management**

Estate management forms another integral part of any military organization. It is well known that environmental impacts are felt throughout the life-cycle of a building. The military organizations must introduce green methods in all design, construction and maintenance activities. Use of ODS in any building activities is a key component (chillers, air conditioners, refrigeration, fire extinguishers). Since the armed forces generally provide accommodation in their camp sites to the troops, a huge amount of construction activity is carried out at their behest.

They must implement environmentally efficient and safe construction practices. The US Army, for instance, has a policy on green construction practices. However, several other countries, for the want of adequate resources and information have not been able to implement these practices in actual construction. Green building guidelines and other complementing initiatives (Chapter VI Library, Parts 3, 4 & 5) are available

internationally and should be adopted. Defence HQs can provide an impetus to 'Green Construction Policy' by allotting a portion of their construction (work services) funds for such projects. This would automatically amount to a portion of defence budgets being earmarked for green activities. The Australian defence forces have been a leader in the environmental arena and has a focused Ecologically Sustainable Development (ESD) strategy with several key goals for defence buildings. The provision of healthy internal and external environments for customers, staff and contractors is a priority, as is the reduction of whole-of-life environmental impacts of buildings. Additional key goals of Australian Defence ESD strategy are to reduce:

- Use of Ozone Depleting Substances
- Greenhouse emissions (including ODS)
- Water consumption
- Pollution and emissions
- Impact on local ecology
- Use of natural resources
- Generation of waste
- Toxicity of materials used.

Defence is also leading the field in the development of ESD guidelines for other types of buildings, so that it can better tackle the challenge of developing green hangars, workshops, stores and other types of buildings. Due to its commitment to sustain Australia's environment, its military has developed tools that are now being embraced by industry as cutting edge.

Defence's internal tools, developed to assist estate managers, include Green Building guidelines and targets, as well as the Defence Green Buildings Toolbox, which is available online through the department's Infrastructure Manual found at http://intranet.defence.gov.au/im.

The following is the sequence of actions needed to adopt ozone-friendly alternatives and practices used in defence activities.

Easy first, hard last: A useful phaseout sequence

Eliminate the introduction on new ODS equipment and processes
Institute policies prohibiting the procurement of equipment using ODS and modify the design of new systems currently on the drawing board. Changes like these often require modifications to military specifications, standards, codes, and maintenance procedures. The amed forces in developed contries discovered that much of their technical documentation stipulated ODS use. Rewriting the documentation to allow the use of altematives was an important step in eliminating the requlrement for ODS in their own system.

In some cases this involved rewriting the documentation or issuing new directives themselves. In others, it involved handing over to a civilian standards authority the responsibility for issuing the documentation setting out specifications and/or standards. It was sometimes difficult at first to convince members of the amed forces that doing this would not compromise the quality of military systems, but experience has shown that civilian standards authorities are often better able to keep abreast of rapidly changing technology than are the armed forces.

Change to available 'drop-in' alternatives
Where available, implement alternatives that require little or no modification to equipment. Thre are some applications where this is possible. Solvents used for maintenance can sometimes be directly replaced by alternatives. However, this is frequently not the case with component-cleaning equipment which often has to be replaced of modified to function with water-besed cleaning agents. To ensure changes of this king are a dopted across the board, technical documentation prescribing ODS use-including military specification, weapons-system specific technical manusls, general series technical manuals, and other related handbooks-must be modified to allow the use of alternatives. Various approaches have been adopted to ensure this is what happens. In some cases, global changes have been made in the fom of a statement added to the beginning of each document to the effect that it is no longer mandatory to use ODS solvents. In others, each specific document stip ulating use of an ODS solvent has been amended to require a different material or process.

Implement recycling/reclamation
Set up a national ODS reserve (or 'bank') for those military uses in which altematives do not currently exist. The size of this bank will be detemined by the nuber of systems which must be 'vintagad' or retrofitted, the length of time such systems which must be 'vintaged' or retrofitted, the length of times such systems are expected to remain in service, and the estimated annual quantity of ODS lost to the reserve as a result of

maintenance or use. It is important to restrict the number of applications eligible to use recycled stocks to those which really are operationally vital, and to limit the quantities of ODS permitted to the absolute minimum that is necessary to maintain operational capability. It is essential to be vigllant and to mantain tight supply discipline if you are to ensure stocks remain abailable for essential military operations.

Determine cost and alternative availability

There are times when it may be theoretically possible, but not practical, to implement an alternative. For other applications, alternatives may not yet have been developed. Submarine cooling systems could theoretically be replaced and yet the cost of doing so might be prohibitive because of a number of factors, including the need to make modifications to the hull. Halon systems in aircraft engine nacelles are just one example where solutions have not yet been indentified. Since aircraft typically use smaller quantities of ODS than do ground facilites, 'vintaging' is appropriate.

Adopt interin solutions

In some cases, interin solutions (such as the use of HCDs) will be appropriate-and even desirable in cases where they represent the only viable solution, are readily available, and their adoption involves little or no capital investment. The reason why capital investment is an important factor here is that the implementation of an interim solution or 'transitional substance' (such as an HCFC) still leaves additional conversion coots to be met in the future when HCFCs are now being phased out.

'Vintage' equipment

There are important military applications for which feasible alternatives have not yet been indentified or developed. Such applications are candidates for 'vintaging', the last resort that should only be adopted when all other options have been exhausted. The principle of 'vintaging' is that the quantity of ODS that will be needed to keep the equipment running for the rest of its experted life is established at the outset, and a plan is then developed ensuring, through recovery and recycling, the continued availability of the ODS concerned. It is critical that emissions are reduced to the absolute minimum since maintaining an ODS bank can be expensive. Minimizing the quantities deeded reduces coots and makes the management of the bank that much easier.

Early replacement

Early replacement of ODS systems near the end of their useful lives is often an option worth considering. As ODS production declines in response to the Montreal Protocol, prices will climb. The cost of repairing systems that leak large quantities of ODS can also often be steep. As a result maintence becomes expensive, whether or not you fix the leaks. In such a scenario. Phasing out a system as soon as possible and replacing it with one that is ODS-free can be the most cost-effective option.

A Comprehensive Plan for Collection and Destruction of ODS Can:

- Create incentives to prevent intentional discharge of ODSs. Regulations that require owners to pay for destruction can be transformed in a military's chain of command that is pre-eminently structured to include, collect and destroy ODS and ODGHG as part of their logistics management.
- ODS banking, in particular halon banking, by military organizations or civil/military cooperation can be managed in a cost-effective manner on a non-profit/non-loss bases for approximately US$ 1/kg. These banking facilities can be a useful model for collection of ODGHG for redeployment and eventual destruction.
- Facilitate collecting and eventual destroying of inventories of ODS and ODGHG regulated in the IMO Convention on Ship Recycling or regional agreements such as for aircraft recycling, including in the military.
- Stretch budgets by accumulating ODS in regional storage facilities until a full shipment can be justified. Ask military and civilian logistical experts to serve as volunteer consultants to national and regional, authorities and the Multilateral Fund and its implementing agencies. In some cases, military-ministry partnerships may be able to work with enterprises seeking to properly collect and redeploy or destroy surplus/excess ODSs. In some cases it may be more cost-effective to bring mobile destruction equipment to the chemicals rather than shipping chemicals to a stationary destruction facility.
- Motivate military organizations to work with public and private carbon trading experts to examine possibilities to reward greenhouse gas destruction based on effective accounting frameworks.

D. Capacity building and Training for Continuous Improvement

Catch them young. It is a well understood and an appreciated fact within the defence services that younger personnel are easily mouldable and the regimentation required for a rigorous life of defence personnel can be easily inculcated during the initial training. Leadership qualities are engrained by correct and effective training techniques. It would thus be prudent to include a course on 'environment in the army' in training modules for every young soldier.

Training curriculum

Every country has developed its own training standards and methodology for soldiers belonging to different arms of the defence services. However a minimum curriculum should include functional and structural aspects of the environment, the defence perspective for effective management and protection of environment, specific activities of the military organizations that impact the environment, international agreements and approaches and actions on environment protection, role of UN agencies, the concept of 'Green Army', the role of the individual and a road map for the future. A broad based training curriculum may be designed in consultation with known and reputed consultants in the field. Exhibit 4 *(below)* contains a proposed training curriculum for young soldiers/junior commanders.

Exhibit 5
Title of the Course: Fundamentals of Environmental Management for Military Organizations

Suggested training curricula for young soldiers

Guiding principles

1. The course must introduce concepts of environment management highlighting responsibilities of environmental protection of individuals and national institutions
2. The interrelationships between human action and environmental impacts across eco-systems must be made clear.
3. Preventive tools, mitigation and adaptation measures have to be presented along with an introduction to some of the models for estimating / projecting impacts.
4. Information on targets, commitments and institutional mechanisms as part of national, regional and global agreements will help them know about principles of collective action.
5. Trainees must be able to access information based on the important sources that will be represented in the training materials.

These can be expected to build the essential core competence of young soldiers so that the knowledge can be gainfully used in the future.

Module 1
Ecosystem and environmental impacts of civilian and military activities

Module 2
Tools and techniques for assessment and abatement of impacts

Module 3
Environmental Agreements and civil programs: Legislation & Commitments

Module 4
Organizational policies and programs on environmental issues

Some of the important awareness programmes organised by military organizations and the topics covered by them with special reference to environmental management tools and techniques are presented in Chapter VI Library, Part 2[3].

Train the leaders

Introducing a young soldier to the concept of a safe world environment will not be complete if the existing leadership of the services is not brought into the act. Thus training matured (and probably set) minds of military leaders on their roles and obligations to protect the environment is not only a challenge, but a necessity. From there will flow the authority for action by the rank and file.

Innovation and contribution for a safe environment by motivated lower echelons would then follow. They would be effectively managed when the leadership is in the know of things and is positively inclined. Leaders need to be oriented towards the goal of their environmental duty by various capacity building interactive techniques.

Operational Training

Soldiers are required to be trained as close to battle scenarios as possible. This requires realistic training on military hardware including aircraft and mechanised vehicles. There is no substitute for 'hands on training'. However, there are areas where honing of skills can be suitably carried out using a simulator. Every country has a different take on the quantum of training that can be done on the simulator vis-à-vis the actual usage of the hardware. Therefore, it is required that they draw up their own quantitative simulator requirements. Simulators for small arms firing, vehicle or aircraft would lead to proportionately less release of ozone depleting substances, GHGs and less consumption of fossil fuels. A soldier on an average fires anything between 1,000-10,000 rounds of small arms ammunition per year. The amount of lead and other related harmful effects of this ammunition across its complete chain can be gauged from the experience in the US where lead from firing of ammunition in a range contaminated the ground water source. The number of rounds actually being fired can be reduced, with the quantum varying for each country,

[3]Chapter V Library, Part 2 includes examples on Awareness programmes & Environment Management tools & techniques adopted in other countries. Training topics should be identified keeping in mind the training needs of Defence services staff.

by increasing the use of simulators for any country and investing in same should be encouraged by the defence forces. Exchanges of personnel for training between military organizations of friendly countries are a regular practice and it would be the best course of action if the agenda of these exchanges would also include an update on the actions having been taken by the respective armies on environmental issues.

It was clear during a recently held workshop on "National Security and Ozone Protection" under the aegis of UNEP DTIE OzonAction in India (Centre for Air Power Studies, New Delhi October 13-14, 2008) that lack of specific information on the subject was a big stumbling block for the defence forces. This can be removed to a large extent if sharing of information on good environmental practices between the military organizations of the world becomes an acceptable agenda. Since this would not have an impact on the security of information, the defence forces should be willing to share such information and further their friendly interactions.

Reloading fuel truck during Poland-German-Netherlands joint exercise in Poland.

E. Monitoring Implementation through Audit and Feedback

Performance check through Environment Audit needs to be an integral part of the process. All Standard Operating Procedures of the defence services are refined by monitoring their implementation by an audit body within the particular arm of services. This checks the capability of individual formations to undertake activities commensurate with expectations. Since such bodies are already available in one form or another within all defence services, it would be prudent to task them to audit the environment friendly orientation of the formation they are visiting. For this, it would be essential to first lay down the measurable parameters, which could take include some of the identified variables presented in earlier sections of this document, which needs to be checked during the audit against set standards**.**

Monitoring implementation of activities and environment audit leading to environment friendly initiatives is a very important part of the whole approach on account of the following:

- ✓ Facilitate timely implementation of activities in a cost-effective manner
- ✓ Provide learning opportunities for improving project implementation performance in future
- ✓ Communicate widely (within and outside defence establishments) information on actions and their impact

The specific parameters and standards would vary across different defence services according to the roles and geographical locations of the formations. Among the many environmental parameters that can be checked, energy consumption of the unit on a yearly basis with respect to domestic and official segments is a major area. Work on this issue as well as the success stories of different military organisations are presented in the annexes. It readily emerges that effective military leadership in this area can play a major role in decreasing environmental degradation and also help in fulfilling national goals. The audit body should examine trends of energy consumption and corrective action adopted by

the formation. They could also compare fossil fuel consumption across similar operating units; establish benchmarks and stimulate competition for better performance. The defence equipment production companies should similarly define their own performance parameters and assessments and secure relevant certification. Use of hazardous materials and generation of hazardous waste are also performance metrics that could be established for industrial units, such as maintenance depots.

Standardised methods for communicating these performance measures need to be developed and implemented. Here, integration at the top level is needed based on data collected and reported at division and department level. Simple procedures for data collection, preferably based on already monitored and reported information (procurement of ozone depleting substances, inventory of ozone depleting substances, power consumption), need to be established and followed. In this process, IT tools would be of relevance and to the extent possible, should be used effectively.

"Smart weapons" such as this shoulder-fired assault weapon rely heavily on electronics, which are often manufactured and maintained using ODS solvents. Encourage weapons suppliers to switch to non-ODS manufacturing processes, and ensure that maintenance procedures do not require ODS.

An Indian Navy Sea Harrier jumpjet takes off from a carrier. Militaries must take a lead in environment-friendly measures since they directly impact on security.

INDIAN NAVY

IV.

LEAD FROM THE FRONT

Military leadership across the world prides itself in being the sharpest and 'ruggedly' best. It should also be willing to take the lead in undertaking and implementing activities good for the global environment. Besides systemic impacts, militaries can also restore the topography (forest land areas) use ozone-friendly equipment and alternative energy and reduce their carbon footprint. As an example, the Indian Army and Indian Air Force have installed solar heaters at almost all places where large needs exist. They could use alternative energy for transportation in times of peace and set targets for emission reduction from all types of equipment.

What is needed is to innovate and plan a course of action that is environmentally safe and sustainable. It is essential to secure adequate financial support for implementing activities within the defence systems. The best of the intentions cannot be implemented if not backed by financial resources. Governments therefore have a big role to play in earmarking funds for exclusive use of defence projects based on environmentally-clean policies, institutionalised and open for internal defence audits of the respective countries. Keeping aside funds for environmental projects would not only show the best intentions of the national leadership, but also provide a thrust to such actions to be audited and remain in the public domain, thus building consensus for more such affirmative actions.

These 80-meter tall wind turbines provide as much as 25% of the electrical power needed on the Ascension Island military base and provide payback on their initial installation costs in less than seven years.

U.S. NAVY PHOTO

V.

CONCLUSION

A strong commitment at the highest leadership level among the armed forces is the most important guarantee of success. If senior military officials do not believe a programme to eliminate ODS dependence is really necessary, resources will not be made available and decision makers will not have the necessary incentive to expend resources, in terms of man-hours and finance, on solving the problem. Military readiness will suffer in the long run because the materials necessary for the manufacture, maintenance, and operation of weapons systems and support systems will not be available.

A strong commitment at the highest level has been shown to be vital in every company and in all armed forces affected so far by the Montreal Protocol, and that commitment has been the most important indicator of success. In developed countries, policy statements committing the armed forces to comply with the Montreal Protocol were usually signed at the highest level, often by Secretaries and Ministers of Defence and by military Chiefs of Staff. That level of commitment underlines the importance of ODS phaseout in sustaining the operational readiness of the armed forces and of weapons and support systems. It has proved a crucial first step in gaining the internal support needed to develop a realistic plan of campaign and ensuring its successful implementation.

The plan itself should identify specific objectives and assign responsibilities. The six-step process outlined in this guide mirrors the procedures followed successfully by the developed nations where armed forces have been operating without CFC production since January 1996 and without halon production since January 1994. Operational readiness has been maintained throughout as a result of determined leadership and the successful implementation of a carefully designed plan.

The armed forces also have a key role to play in the broader national effort to phase out ODS without any adverse impact on industry, the public at large, or the armed forces themselves. Many national phase-out plans were designed along the lines of a military campaign, with the specifications, codes, and standards that typify orders in the armed forces. The documentation was initially drawn up to identify technical specifications required by the armed forces. In many cases, however, those specifications became industry standards. In many developed countries, the armed forces took the lead by issuing new standards, specifications, and codes prohibiting ODS use, and also procurement regulations making it clear that the armed forces would no longer purchase certain types of equipment containing ODS.

Examples of such declarations can be found in this toolkit. Leadership of this kind benefits both the armed forces and also the private sector. Firstly, it stops the armed forces purchasing equipment which they would find difficult to maintain in the future, and, secondly, it harnesses the purchasing power of the armed forces to begin moving private industry towards ODS alternatives. Proactive policies like this are good for the armed forces, good for industry, and good for national compliance with the Montreal Protocol.

In many countries, the armed forces are among the most technologically sophisticated and stable organizations. Because the Montreal Protocol affects both the armed forces and industry alike, it offers the military a unique opportunity to act as a catalyst to improve the strength and capacity of government and of a country's established industries. The experience of developed countries demonstrates that when the armed forces contrive work together with other government agencies and industry, both the armed forces and industry can phase out ODS use faster and at a lower cost than either could by working alone.

It is therefore important that the armed forces' ODS management plan includes collaboration with industry and government agencies. By establishing working groups and committees to formalize working relationships and assign specific responsibilities, it is possible to avoid duplication of effort, share the cost burden, and accelerate the identification, verification and implementation of alternatives. The plan should identify specific investment projects, and provide mutual technical support so that projects can be successfully implemented.

Some of the organisations established in developed countries to coordinate the efforts of government, industry and the armed forces proved so successful that they continues to operate once their initial short-term goals had been achieved, even expanding their mandate to take on board their environmental issues of mutual concern: issues such as the handling and disposal of hazardous materials, air pollution, pollution prevention and climate change. Similar organisations dedicated to mutual security could address Montreal Protocol compliance.

Environmental protection has to be a commonly shared responsibility. The defence services must participate in its conservation in a sustained manner. The military leadership has to adapt its procedures and assess and integrate environmentally friendly alternatives in all their actions across echelons of the defence forces. There should to be a sharper focus on improved environmental management to reduce impacts by adopting environmentally efficient measures. It is equally important to evolve a consensus on utilizing a part of the defence budget for improving environmental performance and protect the global environmental commons.

Last, but not least, it is important for military authorities to continue efforts like this publication that share perspectives, knowhow, and technical information and encourage global environmental cooperation in making the world safe, prosperous and sustainable for future generations.

Sample of Technology Solutions Being Developed and Implemented by Militaries around the World

Halon stocks at the facilities of the Netherlands Halon Bank Association which also manages Ministry of Defence, Netherlands (MODNL) and US Department of Defence Halons

2009 OZONACTION SPECIAL ISSUE

The ULTRA armored patrol vehicle. The ULTRA has the potential to achieve a 50% increase in fuel efficiency in wartime conditions and a 200% increase in fuel efficiency in garrison or local use.

U.S. NAVY PHOTO/JOHN F. WILLIAMS

A technician performs operational checks of the spinning rotor blades and drive line of the 900kW wind turbine at 45th Operations Group Detachment 2, Ascension Auxiliary Airfield (AAF), South Atlantic Ocean in June 2009. The unit sits atop a 110 foot tower that holds the power generation components. It takes only a few seconds for the disk brake to stop the 20-ton three-bladed 182-foot rotor from turning in the wind. This is part of the self sufficient, power,water and waste infrastructure of the base. Computer Sciences Raytheon is responsible for maintenance of the wind turbine facility which work in parallel with low-load diesel generators powering the airfield, Space Command sites and facilities, and a Royal Air Force airfield facility. Ascension AAF's award winning self-sufficiency solutions also includes drinking water production and waste water treatment. Ascension island is located midway between Brazil and Angola.

U.S. AIR FORCE/LANCE CHEUNG

A solar wall collects rays at Elmendorf Air Force Base, Alaska. Two of these walls hang on the outside of the 3rd Logistics Readiness Squadron, and have saved base officials US$ 15,000 in energy costs since November 2008 when they were built.

U.S. AIR FORCE PHOTO/AIRMAN 1ST CLASS CHRISTOPHER GROSS

Bulbous bows provide fuel savings from reduced water resistance in naval ships.

NORTHROP GRUMMAN NEWPORT NEWS PHOTO

The German Navy is a world leader in development of fuel cell propulsion systems. In 2005, the first fuel cell-powered submarine in the world was commissioned by the German Navy. There are currently four of these Class 212A fuel cell submarines in the German Navy and they have sold several others to navies around the world. A fuel cell submarine has many advantages over a conventional diesel-electric submarine which must charge batteries using a noisy diesel generator on the surface or by using a snorkel mast. Since the fuel cell is an air-independent propulsion system, these submarines can cruise under water for weeks without surfacing. In addition, the fuel cell makes almost no noise and produces no give-away exhaust heat.

HOWALDTSWERKE-DEUTSCHE WERFT PHOTO

A Soviet badge commemorating a Drifting Polar Station. These stations have carried out scientific research in the artic, including ice studies critical to monitoring the effects of climate change.

A U.S. Military Sealift Command (MSC) chartered ship escorted by a Swedish ice breaker resupplies the U.S. Antarctic Expedition in February 2008. Personnel from both the U.S. Navy and the New Zealand Royal Defence Force unloaded supplies from this ship and another MSC-owned ship. After offloading supplies they loaded nearly 4 million kilograms of equipment, research products, trash and waste to be hauled off the continent. Among the research products were ice core samples to be used by scientists studying global climate change.

U.S. NAVY PHOTO

Portable, flexible solar cells provide soldiers power. In remote regions, these types of solutions could offer an alternative to burning fossil fuels.

GLOBAL SOLAR

Solar Carports at a Naval Station in San Diego, California. These four solar carports provide 155,000 kilowatts of clean, renewable electricity to the base every year – enough energy to power approximately 27 homes at today's average consumption.

U.S. NAVY PHOTO

An unmanned ground vehicle. Eliminating the need for a passenger cabin reduces weight, improves fuel efficiency and keeps soldiers out of harms way.

These 70,000 solar panels were placed on 140 acres of unused land, and make up just one third of Nellis Air Force Base, Nevada's solar arrays, the largest photovoltaic system in the Americas. Base officials and SunPower Corp. finalized a commission of 14.2 megawatts in solar power that is reported to save Nellis AFB $1 million annually and provide about 25% of the base's electricity requirements.

U.S. AIR FORCE PHOTO/AIRMAN 1ST CLASS NADINE Y. BARCLAY

The D-2000, a 1930s precursor to modern blended wing body aircraft, like the proposed design below that can reduce drag considerably thereby improving fuel efficiency.

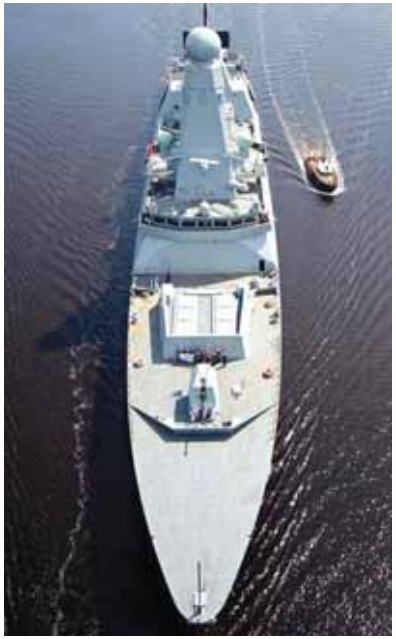
EADS

BOEINGMEDIA.COM

The Rolls-Royce azimuth thruster, type Contaz. In naval applications, contra-rotating propellers can improve propulsion efficiency by 5-10 percent. Rolls-Royce

HMS Daring, the first Royal Navy Type 45 Destroyer which uses advanced propulsion technologies to reduce fuel consumption. They are one of the first combatant vessels to use an integrated electric drive system. They are also the first ships to use the intercooled recuperated (ICR) gas turbine engines. In addition to saving fuel ICR engines also reduce the thermal signature of the ship. These ships also use bulbous bows to reduce ship resistance.

ROYAL NAVY PHOTO



USCGC Morgenthau (WHEC 722) was the first ship to be fitted with a new contour stern flap which reduced fuel consumption by nearly 10%. Working closely with the U.S. Navy, the U.S. Coast Guard funded development of a new boomerang-shaped stern flap designed to fit the contour of the highly curved transom found on many older vessels. This "contour" stern flap was retrofit to the High Endurance Coast Guard Cutter Morgenthau in 2001. In addition to being installed on Coast Guard cutters and patrol boats, stern flaps have also been installed on Navy destroyers, frigates, and patrol craft all of which exhibited significant power and emissions reduction, fuel savings, and top-end speed increases.

U.S. COAST GUARD/SEAMAN CALEB CRITCHFIELD

VII. LIBRARY

This section presents resources that could be accessed for use in connection with adoption of ozone friendly measures. This library of resources is presented below in five parts and is not exhaustive. This will guide the readers to further resources for deeper understanding.

Library, Part 1
Ozone and its linkages with climate change – Some initiatives

1	Ozone protection and its linkages with Climate change are important to the military organizations: This paper by Sherri W. Goodman, Deputy Under Secretary of Defence (Environmental Security) highlights the issues of climate change and ozone protection and their relevance to military organizations and list some of the initiatives to overcome the impacts. These include the • 21st Century Truck Initiative to Achieve 50 to 60 percent fuel savings, • New Vehicle Power Sources Hybrid-Electric High Mobility Multipurpose Wheeled Vehicle (HMMWV) • Energy Efficiency Technologies to include Diesel fuel reformers; Fuel cells for Naval marine applications; Hybrid power-sharing systems & Advanced jet fuel technology • Eliminate the Use of Ozone Depleting Substances. The author states that "The Department of Defence (DoD) believes that supporting climate change initiatives, protecting stratospheric ozone, and preserving military sustainability, operations, and readiness are mutually supportive goals. Climate change and ozone protection are important to DoD for three reasons: • Potential national security implications of climate change and ozone protection • Sustain training to maintain military readiness • Reduce GHGs and increase energy efficiency.	http://www.p2pays.org/ref/21/20958.htm

2	Naval Technologies and practices to save fuel and reduce emissions by CAPT RNLN (E) Marcel Hendriks, NL DMO Head Marine Engineering	http://www.igsd.org/conferences/Paris2008/2e%20Hendriks.pdf
3	National Military Leadership: Country-Specific Case Studies ● Australian Defence Leadership in Climate and Stratospheric Ozone Layer Protection ● Climate Change Strategy of the ● Finnish Defence Administration ● The Importance of Military Organizations in Protecting the Climate ● Actions to address climate change: Indian Army ● Defence and Climate Change in the Netherlands ● The Swedish Armed Forces and the Swedish Environmental Objectives: Reduced Climate Impact and Clean Air ● UK MOD Climate Change Strategy ● US DoD Climate Leadership	http://www.igsd.org/conferences/Paris2008.php

Library, Part 2
Awareness programmes and environment management tools & techniques

1	Office of the Secretary of Defense, Defense Environmental Network & Information Exchange – Emerging Contaminants: Describes the process used by the US Defense Department to identify materials becoming subject to new regulations, determining whether they are important to military operations, developing options for finding alternatives or controlling usage, and adopting appropriate changes to military operations.	https://www.denix.osd.mil/portal/page/portal/denix/environment/MERIT/DoD
2	U.S. Army Sustainability - Environmental Management Systems (EMS): Consists of five awareness training courses, several training products, EMS assessment tools, procedures; templates for management plans and success stories.	http://www.sustainability.army.mil/tools/programtools_ems.cfm
3	Environmental Considerations in Military Operations pertaining to planning, training, base support operations, health and environment. This manual states the purposes of military environmental protection, describes legal requirements, and some military programs. It describes how to apply risk management methods to identify actions that may harm the environment and appropriate steps to prevent or mitigate damage.	http://www.combatindex.com/store/MCWP/Sample/LOGISTICS_OPERATIONS/MCRP_4-11B.pdf
4	The Environment: An Important and Increasingly Urgent Military Concern: a paper published in the Journal of the Singapore Armed Forces authored by Maj Ng Pak Shun describes issues of security and the environment, military and the environment as a two way relationship, international laws related to environment and wartime military, peace time military environmental policies and limitations. The special case of environmental efforts the Singapore Air Force is presented.	http://www.mindef.gov.sg/imindef/publications/pointer/journals/2008/v34n3/feature6.html
5	Sustainable Development Report and Action Plan 2008 is of the MoD, UK on Sustainable Consumption and production focusing on procurement, waste management, design and construction opportunities, Climate change mitigation, adaptation and energy aspects; Natural resources protection and environmental enhancement.	http://www.mod.uk/NR/rdonlyres/D8407A1C-CA68-4AD4-8E17-9F71B151AF6A/0/SusDevReport2008.pdf

6	Sustainable Development and Environment Manual, MoD, UK is comprised of two volumes. Volume 1 is predominantly about policies and institutional arrangements. Volume 2 provides practical guidelines for implementing conservation and other preventive actions. Some of the important thrust areas include • climate change mitigation and adaptation • management of Fluorinated GHGs, • ozone depleting substances • green munitions • management of hazardous chemicals • local air quality • radiation • marine environment • water pollution • utilities management	http://www.mod.uk/DefenceInternet/AboutDefence/CorporatePublications/DefenceEstateandEnvironmentPublications/JSP418/Jsp418Documents.htm
7	Defence Environmental Strategic Plan 2006-2009, MoD, Australia covers • Defence Environmental Policy • Future challenges • Implications for defence • 20- year Environmental Vision • Defence Environmental Principles • Integration of Best Practice into Defence Activities • Resource Efficiency • Biodiversity Conservation • Landscape Management • Sustainability • Contamination Management • Heritage management	http://www.defence.gov.au/environment/strat_plan.pdf http://www.defence.gov.au/environment/Section 1.pdf

8	ENVIRONMENTAL ASPECTS of MILITARY COMPOUNDS – NATO Science for Peace and Security Programme Short Term Project, May 2007-May 2008. A study on the environmental aspects of military compounds to enhance interoperability and the feasibility of implementing an Environmental Management System for deployed operations.	http://www.nato.int/science/topical_ws/eamc/283-final_report_Compounds_phaseII.pdf
9	Fire Protection- Critical Equipments and facilities: This document provides information on Defence policy for the fire protection of critical equipment and facilities; risk assessment processes for determining suitable fire protection measures and gaseous agents acceptable to Defence as halon replacements.	http://www.defence.gov.au/IM/policy/technical/manual_fire_protection/20.pdf
10	Ecologically Sustainable Development and Environmental Performance is a part of Annual Report of Department of Defence, Australia and contains information on energy use and GHG emissions, water conservation, pollution prevention and Ozone depletion. It also states that the MoD continued its commitment to improve energy efficiency and reduce energy wastes consistent with the Commonwealth energy policy. In order to achieve this, the Defence reports that • The construction of all new and re-furbished buildings will take into account energy efficiency measures, including augmentation using solar energy in some remote locations. • The incorporation of energy efficiency as a key objective in guidance and relevant contract documents for the planning, design, development and delivery of all Defence capital projects, including refurbishment. • The continuing participation as a board member of the Green Building Council, to promote energy efficiency innovations applicable to Defence. • The application of energy rating tools to new buildings including assessments of energy performance. • The provision of Defence energy consumption data to the annual whole-of-government energy report, Energy Use in the Australian Government's Operations.	http://www.defence.gov.au/budget/03-04/dar/07_10_eco_2.htm

11	Energy Management and Water Conservation presents information about efforts to improve energy efficiency in multiple aspects of installations including energy assessments at sites.. This is published through The U.S. Army Installation Management Agency.	http://www.imcom.army.mil/hq/kd/cache/files/A0587EBA879241A885B717FAEA4A4F9C.pdf
12	U.S. Army Acquisition Support Programme is highlighted with reference to Environmental Quality Life-Cycle Cost Estimate (EQLCCE) for M2A3/M3A3 Bradley Fighting Vehicle System. This can be used to identify and quantify such areas as material substitution, process change, recycling and opportunities to reduce the cost of weapon systems.	http://aec.army.mil/usaec/acquisition/success00-bradley.pdf
13	Defence Environmental Restoration Program (DERP) is to identify, assess and cleanup or control hazardous waste contamination due to DoD activities. This includes scoping, site characterization, alternatives for management and implementation.	http://www.p2pays.org/ref/10/09690/chapter9.htm
14	Environmental management: Relevance and implications for management of Defence installations for sustainability is with special reference to India. The author states that “The defence sector in India has generally not been explicitly included within the purview of environmental regulation, perhaps out of deference to the military mission. But this is not likely to remain so into the future. This article presents how procedures for addressing environmental concerns, which are based on developments in ecosystems science and environmental management, can be integrated into the military mission in India.”. The paper also presents the international Defence forces perspective on environmental management; Environmental policy in the US Department of Defence; EMS and standards.	http://www.ias.ac.in/currsci/jun102005/1753.pdf

Library, Part 3
Case Studies of Green Buildings: The Ozone Dimension

1	The United States Environment Protection Agency has in its website created a separate section for "green buildings". This provides useful information regarding the components of green buildings and tools for applying various ozone friendly building principles for different types of such buildings.	http://www.epa.gov/greenbuilding/
2	The Sustainable Building Information System is described focusing on energy and environment issues in the building sector. Information regarding the International initiative for a Sustainable Built Environment, planning for reduction of GHGs through ozone friendly technologies and projects from several parts of the world is presented.	http://www.greenbuilding.ca/
3	Basic guidance on green buildings for non-residential types focusing on • Building envelope • Sustainable summer comfort • Heating • Combined heat and power • Solar hot water and heating • Air conditioning with ozone friendly refrigerants and energy efficient systems • Lighting • Office equipment • Benchmarking is presented along with information regarding 77 cases from various EU countries on best practices.	http://www.eu-greenbuilding.org/
4	**Building 850 Port Hueneme, CA** Public Works Department administrative building has as alternatives to ODS technologies, a natural gas heat pump A/C system; high efficiency pulse boilers, innovative glazing elements; occupancy & photo sensors controls.	

5	**Personnel Support Facility NAB Little Creek, VA:** 21% reduction in energy usage (ASHRAE 90.1); 50% reduction in water usage; Over 75% construction waste diverted from landfill; Energy savings = 146,910 kWh/yr >$11,370/yr; Water savings = 517,458 gal/yr >$3,000/yr.	http://www.hrgbc.org/presentations/gim_presentations/maryaustin_navfac.pdf
6	**Police and Security Operations Facility Little Creek Amphibious Base:** 25% reduction in energy usage over ASHRAE 90.1; 30% reduction in Water Usage.	
7	**P-201V Airborne Mine Countermeasures Facility & Aircraft Maintenance Hangar, NAVSTA, Norfolk, VA:** 30% water use reduction; 20% reduction in energy usage over ASHRAE 90.1; Low-emitting materials for adhesives & sealants, carpet and composite wood.	
8	**Energy efficiency at Army garrisons in the European Region:** Energy consumption has reduced from 209 kWh/ a x m2 in 2000 to 186 kWh / a x m2 in 2005 which shows reduction of 23 kWh / a x m2. This was achieved through non ODS and energy efficient technologies in building envelope, HVAC & Lighting. This has achieved a savings of: 300,000 MWh energy per year; 13.5 Million Euro per Year.	http://www.annex46.org/kd/cache/files/82E6E1D893B2423FB85B8973B9FB460F.ppt
9	Following the UNEP SCBI (Sustainable Building & Construction Initiative), in December 2008, the Piedmontese Government, Italy, in cooperation with Northern Military Headquarter, wrote a draft of agreement to build flats for professional soldiers' families. These flats will be sustainable and ITACA Protocol will assess the sustainability level. The Piedmont Region and the Northern Military Headquarter focus a lot of attention on the environment. The flats will be built with regional financial support and this agreement will promote the renewal of old real estate. The Piedmont Region President and the Military Commander of the Northern Region have signed this agreement in Turin the 29th January 2009.	http://ediliziaecologica.blogspot.com/2009/01/agreement-to-build-sustainable.html

Library, Part 4
The ozone dimension in Green Initiatives - tools & techniques

(Following resources while covering broader environmental issues have sections on how adopting ozone friendly technologies by the military organizations can help them in greening their operations)

A. Search results for ozone layer and military related documents available/ referenced in the UNEP DTIE OzonAction Multimedia Collection http://www.uneptie.org/ozonaction/

General awareness

1 "Military Responsibility", article in Financial Times, 5 February 2001
Author not indicated | Financial Times | Newspaper article | 2001

Methyl bromide

2 Aircraft Disinsection: A Guide for Military & Civilian Air Carriers
R.A. ELLIS | Advisory Group for Aerospace Research & Development | France | Report | 1996

Multiple sectors

3 The Importance of Military Organizations in Stratospheric Ozone Protection and Climate Protection, Brussels, Belgium, 6-8 February 2001
Author not indicated | United Nations Environment Programme (UNEP) Division of Technology, Industry and Economics (DTIE) OzonAction Programme | France | Conference proceedings | 2001

4 MILITARY COOPERATION EMPHASIZED TO TACKLE OZONE AND CLIMATE ISSUES - UNEP Workshop in Brussels, Belgium, 6-8 February
Author not indicated | United Nations Environment Programme (UNEP) Division of Technology, Industry & Economics (DTIE) OzonAction Programme | France | Press release | 2001

5 Maintaining Military Readiness by Managing Ozone Depleting Substances: Guidelines for Armed Forces in Developing Countries - Information Note - New Publication
Author not indicated | United Nations Environment Programme (UNEP) Division of Technology, Industry & Economics (DTIE) OzonAction Programme | France | Press release | 2000

6 Maintaining Military Readiness by Managing Ozone Depleting Substances
Author not indicated | United Nations Environment Programme (UNEP) Division of Technology, Industry and Economics (DTIE) OzonAction Programme | France | Report | 1998

7 Proceedings of the 1997 International Workshops on Military Progress in Implementing the Montreal Protocol and the Military Role in Global Climate Protection, 6-7 November 1997, Herndon, Virginia, USA
Multiple authors | Department of Defense: USA , Australia, Canada, US EPA, USA IDA, Climate Institute, Business Council for Sustainable Energy, ICEL | United States of America | Conference proceedings | 1997

8 Policies and Technologies for Phasing Out Military ODS Uses, A presentation to the International Workshops on Viable Alternatives to ODS Solvents, Bangalore and New Delhi, India, November 1997
Tom Morehouse | UNEP Technology and Economics Assessment Panel, Institute for Defense Analyses | Kenya | Conference paper | 1997

9 The Role of the Military in Protecting the Ozone Layer. 2nd International NATO/ CCMS Conference, 24 - 25 January 1994, Brussels, Belgium, (Vol. 2 of 2)

Multiple authors | US EPA, US Dept. of Defense, NATO, Global Change, AEA, EIA | United States of America | Conference proceedings | 1994

10 The Role of the Military in Protecting the Ozone Layer. 2nd International NATO/ CCMS Conference, 24-25 January 1994, Brussels, Belgium, (Vol. 1 of 2)
Multiple authors | US EPA, USA Dprt. of Defense, NATO, Global Change, AEA, EIA | United States of America | Conference proceedings | 1994

11 Statement on Ozone Depletion/Overview of the Military Efforts of the Federal Armed Forces to Implement the Montreal Protocol
Heinrich Kraus, Wolfgang Belling, Gerd Stein | Federal Armed Forces | United States of America | Conference paper | 1991

12 Proceedings, The Role of the Military in Implementing the Montreal Protocol, 11-13 September 1991, Williamsburg, Virginia,
Multiple authors | United States Environment Protection Agency, NATO, CDSM, Department of the Air Force | United States of America | Conference proceedings | 1991

Solvent

13 Ultrasonic Cleaning for Military PWAs
Author not indicated | Electronics Manufacturing Productivity Facility (EMPF) | United States of America | Report | 1989

14 Ultrasonic Cleaning of Military PWAs
Bill Vuono, Tim Crawford | Electronics Manufacturing Productivity Facility (EMPF) | United States of America | Report | 1989

Multiple sectors

15 Eliminating Ozone-Depleting Chemicals at Army Installations, Paper Presented at the International Conference on Ozone Protection Technologies, 21-23 October 1996, Washington DC, USA
Author not indicated | Ocean City Research Corp. | United States of America | Conference paper | 1996

16 Guidance for Eliminating Cadmium from U.S. Army Weapon Systems
Multiple authors | U.S. Army Acquisition Pollution Prevention Support Office | United States of America | Report | 1996

17 Strategic Guidance and Planning for Eliminating Ozone-Depleting Chemicals from U.S. Army Applications
George H. Evans | Prospective Technology Inc. | United States of America | Report | 1995

Policy

18 Department of the Army, Ozone Depleting Chemicals (ODC) Elimination at Army Installations
Author not indicated | United States Department of Defence (DOD) Office of the Assistant Secretary Installations Logistics and Environment | United States of America | Report | 1996

Multiple sectors

19 U.S. Department of Defense: Climate Change, Energy Efficiency, and Ozone Protection, Protecting National Security and the Environment
Office of the Deputy Under Secretary of Defense (Environmental Security) | Department of Defense | United States of America | Conference paper | 2000

20 The DoD (Department of Defense) Ozone Depleting Substances Reserve
Author not indicated | Defense Logistics Agency, US Department of Defense | United States of America | Flyer | 2000

21 The DoD (Department of Defense) Ozone Depleting Substances Reserve
Author not indicated | Defense Logistics Agency, US Department of Defense | United States of America | Conference paper | 2000

Solvent

22 Innovations in American Government Award Winner, 1995, Aerospace Guidance and Metrology Center, Newark AFB, Ohio, U.S. Department of Defense, Ozone Depleting Chemical Elimination, Report on Technical and Managerial Innovation

Jonathan Linton | The Council for Excellence in Government | United States of America | Report | 1996

23 "Blue Initiatives for Green - India Air Force joins UNEP to find an alternative to Halon thas is being used worldwide as a fire-fighting agent", article in Sainik Samachar, a fortnightly publication of the Ministry of Defence
R. Chindambaranathan | Ministry of Defence, Directorate of Public Relations, Sainik Samachar Division | India | Newsletter article | 2005

Customs

24 UNEP represents Green Customs Initiative at Weapons Convention
The Tide Online published by Rivers State Newspaper Corporation | Journal article | 2005 |

Multiple sectors

25 Conference of the States Parties, Sixth Session 14-19 May 2001,Report of the OPCW on the Implementation of the Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on their Destruction in the Year 2000
Author not indicated | the Organization for the Prohibition of the Chemical Weapons (OPCW) | Netherlands | Conference proceedings | 2001 | 3504 | 3209

26 Guidance for Eliminating Cadmium from U.S. Army Weapon Systems
Multiple authors | U.S. Army Acquisition Pollution Prevention Support Office | United States of America | Report | 1996

Halons

27 "Blue Initiatives for Green - India Air Force joins UNEP to find an alternative to Halon thas is being used worldwide as a fire-fighting agent", article in Sainik Samachar, a fortnightly publication of the Ministry of Defence
R. Chindambaranathan | Ministry of Defence, Directorate of Public Relations, Sainik Samachar Division | India | Newsletter article | 2005

28 United States Air Force, Halon Replacement Program, Solving a Global Environmental Problem
Author not indicated | Headquarters Air Force Civil Engineering Support Agency, Air Force Civil Engineering Laboratory | United States of America | Report | 1991

Solvent

29 Development and Implementation of CFC-Free Manual Cleaning Solvents at Air Force Plant No. 4, for Presentation at the 86th Annual Meeting and Exhibition, Denver, Colorado, 13 - 18 June 1993
Tony L. Phillips, Henry J. Weltman, Stephen P. Evanoff, Bruce D. Campbell | Lockheed Fort Worth Company, Air and Waste Management Association | United States of America | Conference paper | 1993

Policy

30 EPA Stratospheric Protection Applicability Determination Sales of Refrigerant to Marine Vessel Personnel
Author not indicated | United States Environmental Protection Agency (USEPA) | United States of America | Regulation | 1990 | 2801 | 2098

B. Other websites

1	Maintaining Military readiness by managing ODS presents important guidelines for armed forces in developing countries. This includes a step-by-step management plan for phasing out ODS and catering to mission – critical needs. Some examples of successful ODS management by armed forces are also presented.	http://www.unep.fr/ozonaction/information/mmcfiles/3189-e.pdf
2	The information kit Halon Management: Banking for the future presents the various dimensions of conservation and reuse to tackle challenges due to phase out.	http://www.unep.fr/ozonaction/information/mmcfiles/1507-e.pdf
3	A comprehensive overview of the management of HCFCs is presented in the special volume published by UNEP. The dual benefits of Climate and Ozone layer protection due to phase out of ODS are highlighted. A summary of important decisions of the Montreal Protocol pertaining to the phase out of HCFCs is also presented.	http://www.unep.fr/ozonaction/information/mmcfiles/3139-e-oanHCFCspecialissue.pdf
4	The partnership between military organizations, associated institutions and UNEP signifies cooperative action to strengthen phase out initiatives and other preventive measures for achieving dual benefits of Ozone layer and Climate protection.	http://www.unep.fr/ozonaction/information/mmcfiles/6251-e-prelease_military_&_ozone.pdf
5	A summary of the deliberations by military organizations and UNEP on opportunities for strengthening climate protection action is presented.	http://www.envirosecurity.org/activities/diplomacy/gfsp/militaryclimate/Workshop_Summary_Paris_15_Dec_clean.pdf
6	Defence Green Building Requirements is a comprehensive guideline document developed by Department of Defence, Australian Government. It provides information on • Ecologically Sustainable Development (ESD) goals for buildings • Defence Infrastructure Asset Development Process • Defence Green Buildings Policy Hierarchy • Performance targets and essential requirements • Maintenance checklists	http://www.defence.gov.au/im/policy/green_building/gbrpart1.pdf
7	Department of Defence, Australia, has also developed a fact sheet on “Defence Green Building Requirements - Operation and maintenance requirements” that covers aspects of Defects Liability Period (DLP) and Post Occupancy Evaluation (POE).	http://www.defence.gov.au/im/policy/green_building/140836 GBR Fact Sheet Part 2.pdf

8	"Whole Building Design Guide" is developed by National Institute of Building Sciences, USA. It is a comprehensive guide on water conservation and highlights ▶ *Water Conservation Strategies* Water savings potential is enormous with relatively low cost expenditure ● System optimization (i.e., efficient water systems design, leak detection, and repair); ● Water conservation measures; and ● Water reuse/recycling systems. A wide range of technologies can be employed to save water and associated energy consumption. ● Water-efficient plumbing fixtures (ultra low-flow toilets and urinals, waterless urinals, low-flow and sensored sinks, low-flow showerheads, and water-efficient dishwashers and washing machines) ● Irrigation and landscaping measures (water-efficient irrigation systems, irrigation control systems, low-flow sprinkler heads, water-efficient scheduling practices, and Xeriscape) ● Water recycling or reuse measures (Gray water and process recycling systems), and ● Methods to reduce water use in HVAC systems. ▶ *Best Management Practices* ● Information and Education Programs ● Distribution System Audits, Leak Detection, and Repair ● Water-Efficient Landscaping ● Toilets and Urinals ● Showerheads and Faucets ● Boilers and Steam Systems ● Single-Pass Cooling Equipment ● Cooling Tower Management ● Miscellaneous High Water-Using Processes ● Water Reuse and Recycling	http://www.wbdg.org/resources/water_conservation.php
9	The US Army energy security implementation strategy has five goals: ● Reduce energy consumption ● Increase energy efficiency across platforms and facilities ● Increased use of renewable/alternative energy ● Assured access to sufficient energy supplies ● Reduced adverse impacts on the environment, with the main focus on leadership, partnership and ownership.	http://www.hrgbc.org/presentations/gim_presentations armybrief_gim_3feb09.pdf

10	Green Building Toolbox is a companion reference resource for the Defence Green Building Requirements. This provides further guidance including checklists, tools, case studies, specification templates and other sources of information.	http://www.defence.gov.au/im/policy/green_building/toolbox.htm
11	DOE to revise Federal building standards to ensure that use of energy generated from fossil fuels is reduced by: • 55% in 2010 • 65% in 2015 • 80% in 2020 • 90% in 2025 • 100% in 2030 (Zero Carbon Buildings)	www.hrgbc.org/presentations/gim_presentations/mattgray.pdf http://www1.eere.energy.gov/femp/pdfs/epact05_fedrenewenergyguid.pdf
12	**Guiding principles for green buildings:** • Employ Integrated Design Principles • Optimize Energy Performance • Protect and Conserve Water • Enhance Indoor Environmental Quality • Reduce Environmental Impact of Materials	http://www1.eere.energy.gov/femp/pdfs/water_guidance.pdf http://www.wbdg.org/references/sustainable_eo.php
13	**Recommended Energy Conservation Measures (ECM)** • Premium Efficiency Motors • Improved Lighting Design • Occupancy Sensors • Ultra High Efficiency Chillers • Outdoor Air Total Heat Recovery • High Performance Windows • High Efficiency Condensing Boiler • Economizers • Static Pressure Reduction • Daylight Dimming	http://www.hrgbc.org/presentations/gim_presentations/rudy_perkey_navfac.pdf
14	**Green Construction: Efficient design for Military facilities** (by Todd Sheller for Institute for National Security Studies, USAF Academy, Colorado) provides information on various energy codes, policies, current military design & energy guidelines, case studies on applications and green construction design approaches for military facilities.	http://www.aepi.army.mil/internet/green-const-efficient-design.pdf

15	**United States Air Force Infrastructure Energy Strategic Plan 2008** provides detailed information on the status of energy and strategic approaches to manage supply – demand and describes goals and governance aspects to meet specific objectives.	http://www.afcesa.af.mil/shared/media/document/AFD-081029-038.pdf
16	**Revised handbook for Promoting Behaviour-Based Energy Efficiency in Military Housing** developed by Pacific Northwest National Laboratory for USDOE is a useful guideline document which provides information on energy efficiency in military housing.	http://www.eere.energy.gov/femp/pdfs/military_hndbk_complete.pdf
17	**"Defence PWC statements under Energy Efficiency in Government Operations Policy of Department of Environment and water resources, Australian Government"** is developed in consultation with Defence and the main purpose is to help improve energy efficiency in Defence buildings**.** It provide guidelines and procedures to be followed for different types of building with respect to energy efficiency measures	http://www.defence.gov.au/im/policy/green_building/toolbox/EEGO%20clauses%20for%20Defence%20PWC%20statements%20Version%201%2022-5-07.pdf

C. Other Useful Resources

1	**Alternative Fluorocarbons Environmental Acceptability Study** An industry consortium providing general information about ozone depletion, global warming, and alternative fluorocarbons as well as production, sales, and emissions date	http://www.afeas.org
2	**Enviro$ense/Integrated Solvent Substitution Data System (ISSDS)** Gateway to a number of database on the Internet that contain substitution and process alternatives to ODS. Enquiries can be addressed to more than one database at a time so that information can be retrieved from several with just the one query.	http://es.inel.gov/
3	**Halon Alternatives Research Corporation (HARC)** A voluntary, non-profit trade association formed by concerned halon users and the fire protection industry to assist users of halons to redeploy the existing bank of halons from applications where alternatives have replaced halons, to those still requiring halons. HARC facilitates halon recycling, helps determine critical use, acts as an information clearinghouse, and is a focal point for national/international halon recycling.	http://www.harc.org

4	**Halon Users National Consortium (HUNC)** A UK-based halon bank that assists members with legislative information and advises on halon purchase and sales, together with advice on alternative replacement. HUNC is associated with the Refrigerant Users Group (RUG)	http://www.hunc.org
5	**International Cooperative for Environmental Leadership (ICEL)** An international industry consortium providing technical information on climate change and ozone depletion issues.	http://www.icel.org
6	**Multilateral Fund Secretariat** Information about the Secretariat and Executive Committee of the Multilateral Fund of the Implementation of the Montreal Protocol	http://www.unmfs.org
7	**Programme for Alternative Fluorocarbon Toxicity Testing (PAFT)** An industry consortium that conducts research on the toxicology of substitute fluorocarbons	http://www.paft.org
8	**UNEP Ozone Secretariat** On-line versions of official reports of the Vienna Convention and Montreal Protocol meetings, ratification status, ODS consumption and production data, and the text of the Montreal Protocol	http://www.unep.org/unep/secretar/ozone/home.htm
9	**UNEP Technology and Economic Assessment Panel (TEAP)** Information about background and current activities of the TEAP and its Technical Options Committees (TOCs), including full-text reports, meeting schedules, members etc.	http://www.teap.org
10	**UNEP DTIE OzonAction Programme** A wide range of on-line technical, policy, and general awareness information, including full-text reports relating to ODS management, alternative substances, halon banking, policies, case studies, etc. Includes links to other ozone-protection web sites, contacts for further assistance, and an on-line newsletter	http://www.uneptie.org/ozonaction
11	**US Airforce Centre for Environmental Excellence (AFCEE)** A field-operating agency of the Civil Engineer of the US Air Force, providing a complete range of environmental, architectural and landscape design, planning, and construction management services and products. The site includes success stories, fact sheets, and discussion forums that address ozone protection and other environmental topics affecting the US Air Force.	http://www.afcee.brooks.af.mil/pro_act/pro_actHOME.htm

12	**US Army Acquisition Pollution Prevention Support Office** The central point of contact for US Army regulations and expertise related to ozone protection, providing information about the Ozone Depleting Chemical Elimination Programme, including policies, programme, Army ODS reserve, et.	http://www.aappso.com/odc/odc.html
13	**US Department of Defense's Defense Environmental Network & Information eXchange (DENIX)** Provides US DoD personnel in the environmental security arena with information and guidance supplied by the DoD on compliance with environmental legislation, restoration and clean-up, and occupational health and safety. Includes the on-line Guide to Decommissioning Halon Systems.	http://denix.cecer.army.mil/denix/denix.html
14	**USEPA's Solvent Alternatives Guide (SAGE)** A comprehensive on-line guide designed to provide pollution-prevention information on non-ODS solvent and process alternatives for component cleaning and degreasing. It operates both as an 'expert system' evaluating alternative processes and chemicals for particular problems and as a hypertext manual on cleaning alternatives	http://clean.rti.org/
15	**USEPA Stratospheric Ozone Protection Homepage** Website with information on the science of ozone depletion, US regulations designed to protect the ozone layer, information on methyl bromide, flyers about the UV index, information for the general public, and other topics.	http://earth1.epa.gov/ozone/
16	**US Navy Shipboard Environmental Information Clearinghouse (SEIC)** Formerly known as the Navy CFC & Halon Clearing house, SEIC provides the US Navy with a central point of contact for information, data, and expertise on US Navy environmental policy, regulations of the US Environmental Protection Agency (USEPA), and alternative chemicals, processes, and equipment. Contains an on-line newsletter, full-text documents, news, links to other sites, military specifications, and technical information on ODS alternatives	http://www.navyseic.com

D. Military-Related Publications

1	The safety guide for decommissioning halon systems. USEPA/USDOD/HARC/HRC. 1998. Available from the Navy SEIC and DENIX web	http://www.navyseic.com http://denix.cecer.army.mil/denix/denix.html
2	Materiel developer's guide for pollution prevention. Second Edition. 1994 Available from: Headquarters Army Materiel Command, 5001 Eisenhower Avenue Alexandria, VA 22333-0001, USA	
3	Navy's CFC and halon elimination programme. David A. Breslin, Gregory Brunner, Joseph Thill. Available from the Navy SEIC and DENIX web sites listed previously	
4	Proceedings of the role of the military in implementing the Montreal Protocol, Williamsburg, Virginia, USA, 11-13 September 1991	
5	Proceedings of the second international NATO/CCMS conference on the role of the military in protecting the ozone layer, Brussels, Belgium, 24-25 January, 1994. Volumes I and II	
6	Proceedings of the 1997 international workshops on military progress in implementing the Montreal Protocol and the military role in global climate protection, Herndon, Virginia, 6-7 November 1997.	

7	Strategic guidance and planning for eliminating ozone depleting chemicals from US Army applications. Evans, George H., 1995. Available from Prospective Technologies, Inc PO Box 1106, Graham, NC 27253, USA	
8	USDoD ODS Milspec database. Navy Shipboard Environmental Information Clearinghouse. Available from the Navy SEIC web site listed previously	
9	US Airforce halon replacement programme: solving a global environmental problem. 1991 Available from Headquarters, Air Force Civil Engineering Support Agency, Air Force Civil Engineering Laboratory, Fire Protection and Crash Rescue Systems Branch, Tyndall AFB, Florida 23404, USA	
10	NAVFAC shore facilities ODS conversion guide for heating, ventilation, air-conditioning/ refrigeration and fire-protection systems. Bell, B., Mestey, F., Gott, J. US Naval Facilities Engineering Command, December 1997. Available from the US Navy SEIC web site	

E. USEPA/ ICEL Ozone Depleting Solvent Alternatives Manuals

1	Alternatives for CFC-113 and methyl chloroform *in metal cleaning. Washington, DC. US EPA.* 1994. Reference: EPA/400/1-91/019	http://www.icel.org
2	Aqueous and semi-aqueous alternatives for CFC-*113 and methyl chloroform cleaning of printed* circuit board assemblies. Washington, DC US EPA. 1994. Reference: EPA/400/1-91/016	http://www.icel.org
3	Eliminating CFC-113 and methyl chloroform in *precision-cleaning operations. Washington, DC.* US EPA. 1994. Reference: EPA/400/1-91/018	http://www.icel.org
4	Eliminating CFC-113 and methyl chloroform in *aircraft maintenance procedures. Washington,* DC. US EPA. 1993. Reference: EPA/430/B-93/006	http://www.icel.org
5	No-clean soldering to eliminate CFC-113 and *methyl chloroform cleaning of printed circuit* board assemblies. Washington, DC. US EPA. 1993. Reference: EPA/430/B-93/005	http://www.icel.org
6	Conservation and recycling practices for CFC- *113 and methyl chloroform. Washington, DC.* US EPA. 1991. Reference: EPA/400/1-91/017	http://www.icel.org
7	Manual of practices to reduce and eliminate *CFC-113 use in the electronics industry.* Washington, DC. US EPA. 1990. Reference: EPA/400/3-90/003	http://www.icel.org
8	Source book of technologies for protecting the *ozone layer: specialized solvent uses.* UNEP TIE/US EPA/ICEL. Paris. 1996	http://www.icel.org

Library, Part 5
Assessment of the Ozone Dimension in Energy Correlates

U.S. Army Energy Program is a very useful resource on various energy tools, fact sheets, standards, modelling etc. Some of the important tools that also examine ozone dimension are indicated in the following:

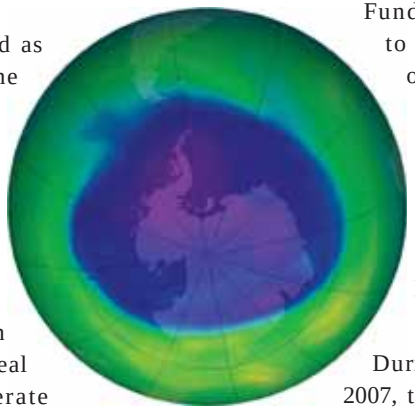
1. **AIRMaster+** for assessing compressed air systems, including modeling, existing and future system upgrades, and evaluating savings and effectiveness of energy efficiency measures.	http://www1.eere.energy.gov/industry/bestpractices/software.html#air
2. **MotorMaster+ 4.0** is a management tool to help select energy-efficient motors. It includes a catalog of over 20,000 AC motors; motor inventory management tools, maintenance log tracking, efficiency analysis, evaluation of savings, energy accounting, and environmental reporting.	http://www1.eere.energy.gov/industry/bestpractices/software.html#mm
3. **NOx and Energy Assessment Tool (NxEAT)** helps assess and analyze NOx emissions and applications of energy efficiency improvements.	http://www1.eere.energy.gov/industry/bestpractices/software.html#nox
4. **Steam System Tool Suite** can help save 10 - 20 % in fuel costs by evaluating and identifying steam system improvements.	http://www1.eere.energy.gov/industry/bestpractices/software.html#ssat
5. **FEMP Toolbox:** Energy Efficiency and Renewable Energy (EERE), United states Department of Energy (USDOE) has developed diagnostic tools and maintenance strategies for air compressors, boilers, building automation systems, chillers, cooling towers, fans, lighting, motor, pumps and steam traps.	http://www1.eere.energy.gov/femp/
6. **RoofWise version 2.0** is a software with graphical methods for constructing roof assemblies that evaluate thermal efficiency and estimates energy costs under normal operating conditions. The program uses ASHRAE Standard 90.1-1999 to determine minimum thermal insulation requirements for roof systems in a manner that is consistent with state energy codes. The program also assesses a roof assembly's solar reflectance (e.g., for "cool roof" choices) when determining the building's minimum thermal insulation requirements and the associated heating and cooling costs.	http://www.nrca.net/
7. U.S. Army Energy Program is a very useful resource on various energy tools, fact sheets, standards, modeling etc.	http://army-energy.hqda.pentagon.mil/energy_tools.asp

Chapter VIII: Annexes

Annex 1
Montreal Protocol on Substances that Deplete the Ozone Layer

Montreal Protocol

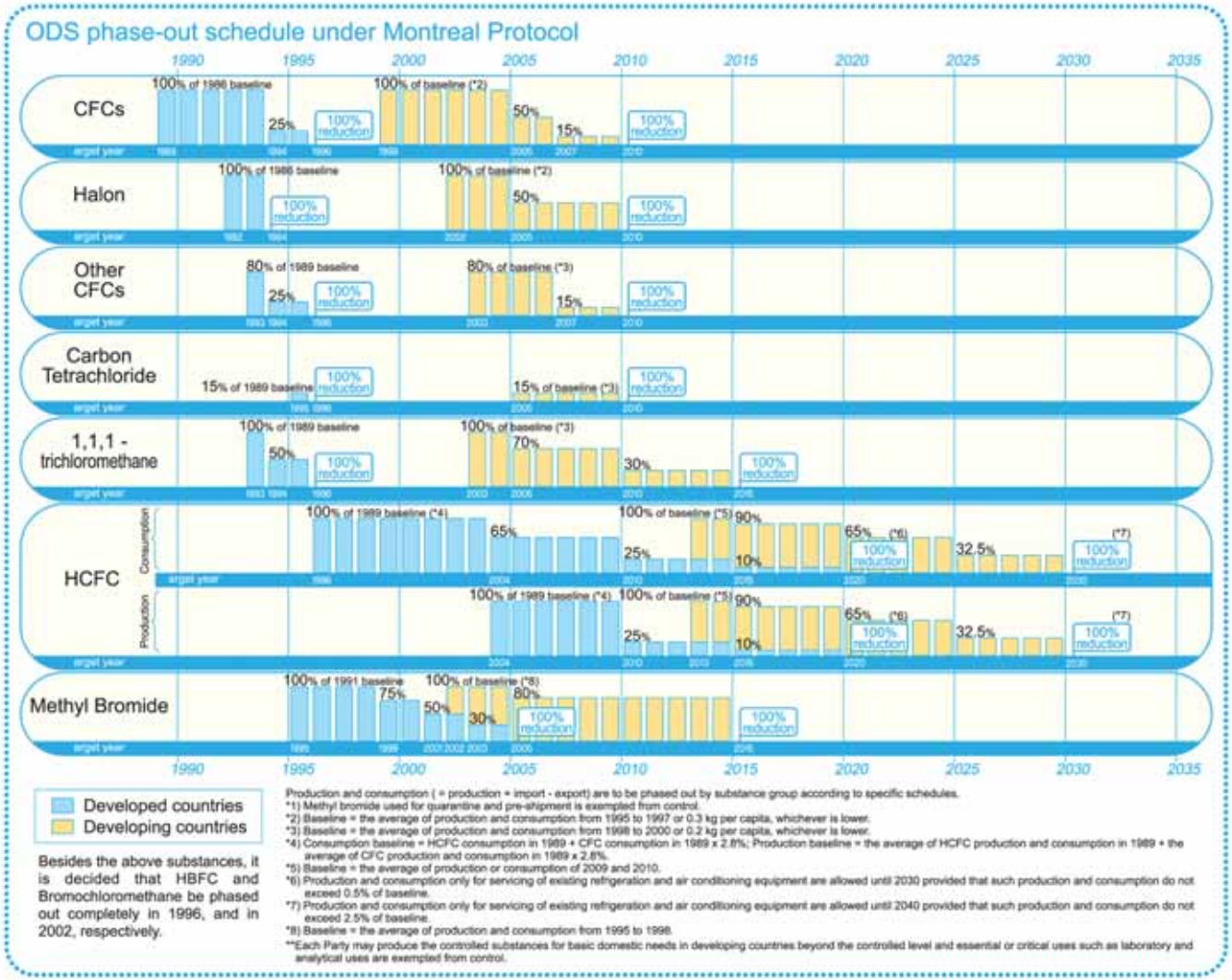
When the ozone layer destruction was recognized as a global problem, the "Vienna Convention for the Protection of the Ozone Layer" was agreed in 1985 as the first international framework to tackle this issue. In 1987, the "Montreal Protocol on Substances that Deplete the Ozone Layer" was adopted based upon the Convention and concrete regulations to control ozone depleting substances were set out. In the following years, since it was found that the ozone layer depletion was proceeding faster than predicted, the Montreal Protocol was amended several times to accelerate the schedule of ODS destruction. Still today, 20 years since the adoption of the Montreal Protocol, the Meeting of Parties held every year to discuss the reduction of ODSs in developing countries.



Developed countries created and have contributed to the Multilateral Fund for the Implementation of the Montreal Protocol (MLF), to support efforts in developing countries to protect the ozone layer.

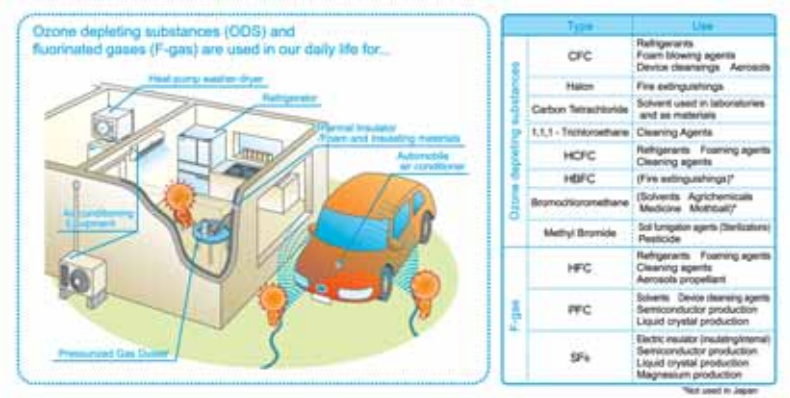
Although the three fluorinated gases (HFC, PFC and PF6) do not destroy the ozone layer, they are controlled under the "Kyoto Protocol to the UN Framework Convention on Climate Change" of 1997 from the viewpoint of the prevention of global warming.

During the 19th Meeting of Parties to the Montreal Protocol in 2007, the Parties called for the accelerated phase out of HCFCs, with specific reduction targets, as well as directions for the Executive Committee and the Parties to expedite actions that will prioritise projects and programmes to meet this phase out (Decision XIX/16).


ODS phase-out schedule under Montreal Protocol
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
CFCs
100% of 1986 baseline
25%
100% reduction
100% of baseline (*2)
50%
15%
100% reduction
target year
Halon
100% of 1986 baseline
100% reduction
100% of baseline (*2)
50%
100% reduction
Other CFCs
80% of 1989 baseline
25%
100% reduction
80% of baseline (*3)
15%
100% reduction
Carbon Tetrachloride
15% of 1989 baseline
100% reduction
15% of baseline (*3)
100% reduction
1,1,1 - trichloromethane
100% of 1989 baseline
50%
100% reduction
100% of baseline (*3)
70%
30%
100% reduction
HCFC
Consumption
100% of 1989 baseline (*4)
65%
100% of baseline (*5)
90%
25%
10%
65% (*6)
100% reduction
32.5%
(*7)
100% reduction
Production
100% of 1989 baseline (*4)
100% of baseline (*5)
90%
25%
10%
65% (*6)
100% reduction
32.5%
(*7)
100% reduction
Methyl Bromide
100% of 1991 baseline
75%
50%
30%
100% of baseline (*8)
80%
100% reduction
100% reduction
Developed countries
Developing countries
Besides the above substances, it is decided that HBFC and Bromochloromethane be phased out completely in 1996, and in 2002, respectively.
Production and consumption (= production + import - export) are to be phased out by substance group according to specific schedules.
*1) Methyl bromide used for quarantine and pre-shipment is exempted from control.
*2) Baseline = the average of production and consumption from 1995 to 1997 or 0.3 kg per capita, whichever is lower.
*3) Baseline = the average of production and consumption from 1998 to 2000 or 0.2 kg per capita, whichever is lower.
*4) Consumption baseline = HCFC consumption in 1989 + CFC consumption in 1989 x 2.8%; Production baseline = the average of HCFC production and consumption in 1989 + the average of CFC production and consumption in 1989 x 2.8%.
*5) Baseline = the average of production or consumption of 2009 and 2010.
*6) Production and consumption only for servicing of existing refrigeration and air conditioning equipment are allowed until 2030 provided that such production and consumption do not exceed 0.5% of baseline.
*7) Production and consumption only for servicing of existing refrigeration and air conditioning equipment are allowed until 2040 provided that such production and consumption do not exceed 2.5% of baseline.
*8) Baseline = the average of production and consumption from 1995 to 1998.
**Each Party may produce the controlled substances for basic domestic needs in developing countries beyond the controlled level and essential or critical uses such as laboratory and analytical uses are exempted from control.

ODS controlled under the Montreal Protocol

CFCs and HCFCs have been in wide use



There are various types of ozone depleting substances

CFC is one of the fluorocarbons which is a man-made substance. Being chemically stable, safe and easy to handle, it offered many advantages. Therefore, it has been used in various ways: for example, as refrigerants in air conditioning systems, as a blowing agent in the production of building insulation foam, as propellants in spray cans and as solvents for cleaning semiconductors and liquid crystal displays. However, when emitted into the air, CFCs reach the stratosphere where its chemical stability it eventually destroys the ozone layer. The production of CFCs is therefore now under global control and nearly phased out. The production of HCFCs, which have often are used as CFC alternatives, is also controlled due to their capacity to destroy the ozone layer (though their impact is less than that of CFCs). Today, these substances have mostly been replaced by an alternative fluorinated substances called hydrofluorocarbons (HFCs), which do not destroy the ozone layer but which are potent greenhouse gases. While the atmospheric concentration of CFCs has stopped increasing thanks to the Montreal Protocol controls, levels of HCFCs and HFCs continue to soar.

CFCs and HCFCs are not the only ODS. For instance, halon, used in fire extinguishers, 1,1,1- trichloroethane, used for industrial washing, and methyl bromide, used for soil fumigation are also ozone depleting chemicals controlled under the Montreal Protocol.

ODS Control Measures

Things we can do in our daily life to protect the ozone layer and prevent global warming

Handle product using fluorocarbons with care

Commercial air-conditioners, refrigerators and chillers containing fluorocarbons usually come with a label that indicates the use of fluorocarbons.

Avoid leakage of fluorocarbons by maintaining the machine constantly
If your domestic or automobile air conditioner does not work properly, it may be because if leakage of refrigerant fluorocarbons. Instead of just refilling it with refrigerant fluorocarbons, get it checked by a trained/certified servicing technician and, repaired if necessary. Make sure there is no leak of refrigerant fluorocarbon refrigerants.

Commercial air-conditioners, refrigerators and chillers contain significant fluorocarbons. It is therefore important to handle and maintain them such as to minimize any fluorocarbon leakage.

Choose non-fluorocarbon products
Try to choose products that do not contain fluorocarbons (i.e. non-fluorocarbon products) as much as possible. When buying a product, take a moment to consider whether or not non-fluorocarbon alternatives are available.

Participate in fluorocarbon recovery (The Japan Model)
There are laws requiring specified appliances containing fluorocarbons to be discarded according to their specifications. The "Home Appliance Recycling Law" sets out the rules concerning the disposal of domestic air conditioners, refrigerators, freezers and heat-pump washer-dryers, while the "End-of-Life Vehicle Recycling Law" and the "Law Concerning the Recovery and Destruction of Fluorocarbons" stipulate details of the disposal of automobile air conditioners (i.e. automobiles) and that of commercial freezers, refrigerators and air conditioners, respectively. These laws require the specified devices and appliances to be discarded after the proper recovery and disposal of fluorocarbons, so that no fluorocarbons are released into the atmosphere. When renovating or dismantling stores, factories, offices or buildings, do not forget to consult your construction professional and remind him of the need to recover fluorocarbons that may be contained in the furnishings such as refrigerators, freezers and air conditioners.

How the fluorocarbon recovery works

End-of-life refrigerators, freezers, A/C and heat-pump washer-dryers

Will be recycled under "Home Appliance Recycling Law"

Request the shop from which you bought the end-of-life product or the shop from which you buy a new product to take back the end-of-life product

Pay for collection, transportation and recycling when handing over the end-of-life product

*Price for collection and transportation differs between shops.
*Recycling fee differs between product manufacturers.

After you have paid the recycling fee, request the shop to issue a home appliance recycling ticket

You can monitor the status of recycling on the Internet with the ID number on the ticket.

Fluorocarbons → Recovered for reclamation or destruction

Iron, aluminum, etc. → Recycled as resources

End-of-life automobiles

Under "End-of-life Vehicle Recycling Law"

Hand over the end-of-life vehicle to collection operators registered with local governments. (Car dealers or servicing workshops)

Pay recycling fee

*Recycling fee differs between car manufacturers.

When and to whom to pay

*Purchase of a new car	When purchasing	To the car dealer
*For already owned cars	Before next periodical inspection	To Transport Bureau or servicing workshops
When you discard a car before next automobile inspection	When discarding	To the collection operator

*Once the payment has been made at the time of purchase or periodical inspection, no more payment is required at the time of discarding the vehicle

Fluorocarbons → Recovered for reclamation or destruction

Iron, aluminum, etc. → Recycled as resources

End-of-life commercial refrigeration and A/C

Under "Law Concerning the Recovery and Destruction of Fluorocarbons"

- Commercial A/C
- Cold showcase and freezers
- Commercial refrigerators and freezers
- Freezing units for transportation

etc.

Request Fluorocarbon recovery operators registered with prefectural governments to recover fluorocarbons

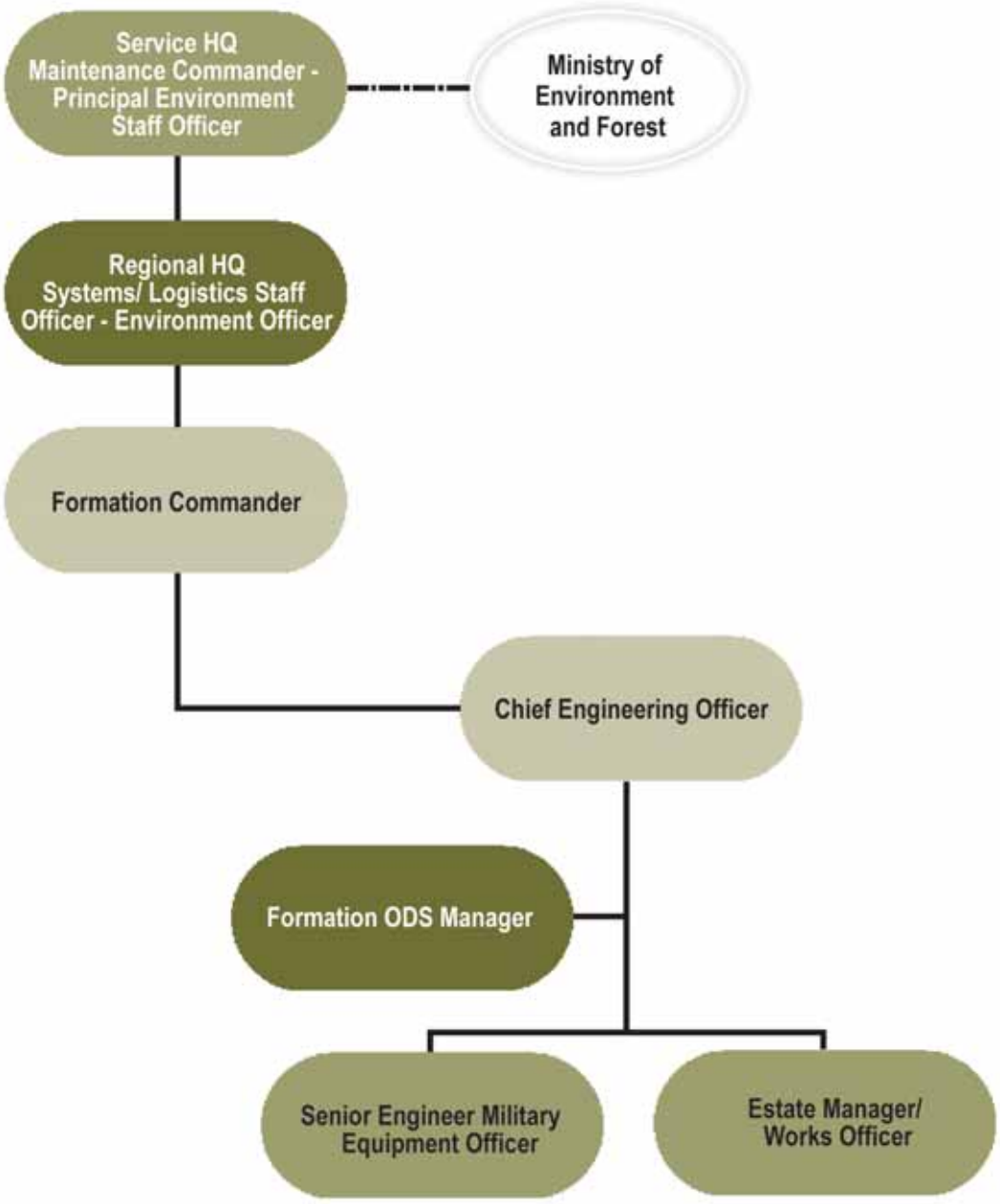
When requesting a Fluorocarbon recovery operator (i.e. car dealers or servicing workshops) registered with a prefectural or municipal government with a public health center to recover fluorocarbons,

1) Issue a "Recovery request form" or a "Consignment confirmation form" in accordance with the relevant law. (They are applied only at the time of a disposal.)

2) Pay the fee for recovery, transportation and destruction of fluorocarbons.

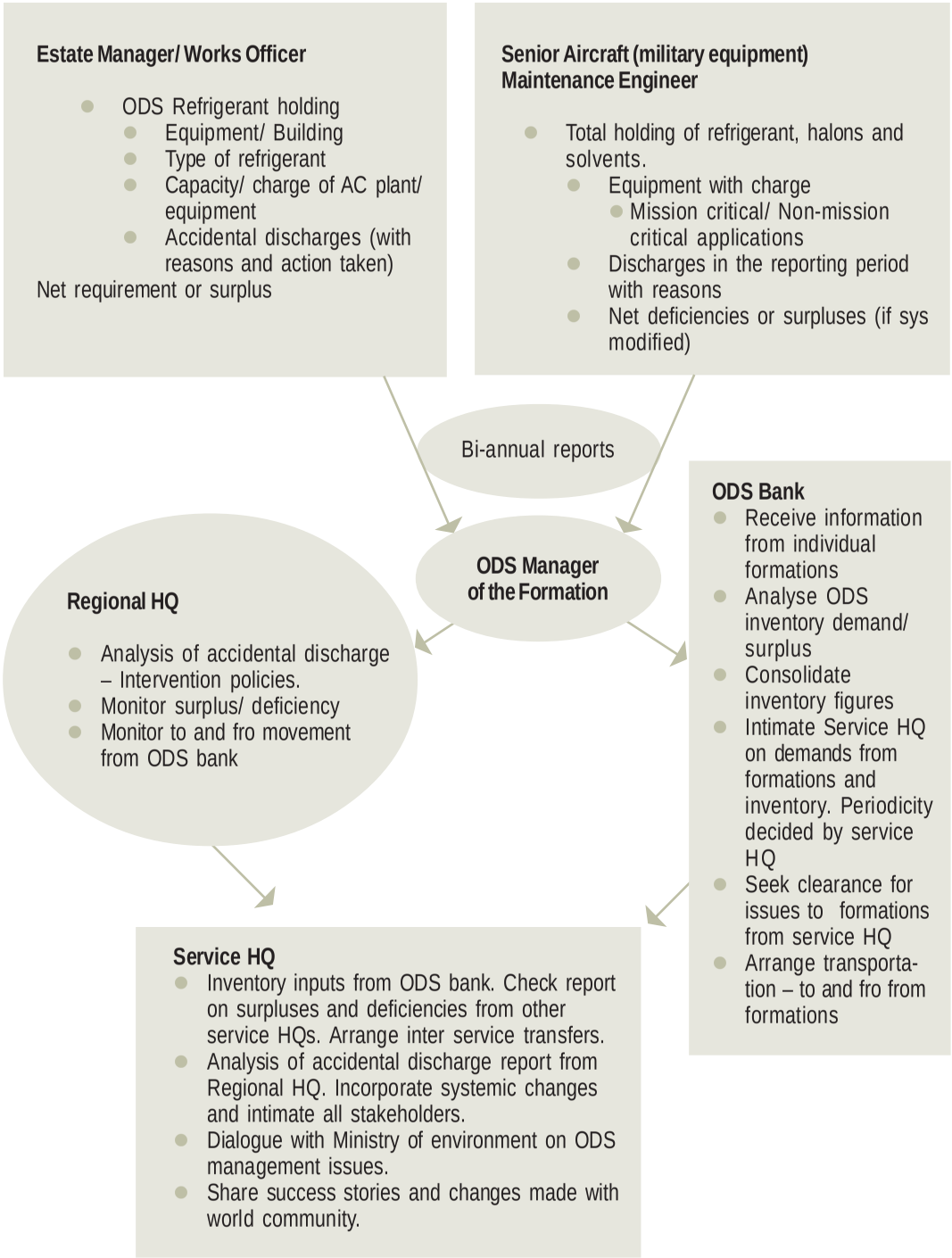
Annex 2

Notional Environment Organisation Structure in the Military Organisation



Annex 3

Possible Reporting Relationships/ Communication Channels for Effective ODS Management in a Military Establishment



Annex 4

Illustration of definition of policies and procedures for phasing out ODSs in procurement and operations

This annex presents the steps to be taken to lay down specifications and standards for phasing out ODSs in procurement and operations in military organizations.

- Specifications and Standards laid down by the maintenance and administrative directorates for systems/ processes that require ODS should be revised to change over to non-ODS alternatives. The concerned stakeholders (hardware maintenance engineers and estate managers) **at the field formation level** should be asked to forward a request for revision of these specs and standards. This bottom-up approach would result in a microscopic examination of ODS usage at the field level, thus ensuring no details are missed out. This would be a one-time exercise and purge the organisation of standards mandating ODS use.

- After standards have been changed, certain processes would be noted wherein only ODS usage is possible. These processes should be compared across every service HQs to ensure that there are actually no alternatives for the same. These usages/processes would need to be compared internationally for economically – feasible alternatives and in the event no such alternatives are found, the service HQ should then ensure that adequate provisions are made for the availability of that ODS through internal or external sources of recycled chemicals.

- The hardware servicing schedules development department of the military establishments would examine all servicing schedules to undertake similar exercise as outlined above.

- It should also be ensured that in case substitute chemicals are being proposed for an ODS, the same should not contradict the accelerated phase-out schedule of HCFCs or a Kyoto Protocol-controlled substance. The alternative strategies outlined for refrigerants can be used for such evaluation.

- The Service HQ shall implement procedures whereby the use of non-OD alternatives should be a technical Qualitative Requirement (QR) in all future Air Force procurements. If Service HQ determines that a feasible alternative is available for use in a contract under evaluation, the appropriate directorate shall enter into negotiations to modify the contract so as to mandate the use of the alternative.

- Supplies out of ODS bank should be a controlled and properly monitored. An external audit of ODS bank by the central audit team of the service HQ should be an annual exercise as per the SOP laid down for an operational formation. This would ensure that no emissions from the bank are taking place.

Note that this process can be applied to manage other hazardous materials, such as industrial solvents, solvent containing materials (e.g. paints and adhesives) and heavy metals (e.g., chromium).

Annex 5

Variables of ODS phase-out matrix in an air force

CFC Policy

a. Refrigerants Use and Purchase:

As per the local legislations new ODS-based Refrigeration and Air Conditioning (RAC) equipment cannot be manufactured in member countries of the Montreal Protocol including India. Therefore, the need of the hour is to conserve CFC for use in legacy equipment and where possible use replacements. Refrigerants are used in the military establishments for various air-conditioning – in buildings and automotive usage, chiller plants and food service refrigeration units in the Officers' and the OR messes etc. Various types of CFCs and its blends are used for the purpose.

The ODS manager in each formation would have to coordinate with the controlling manager of each of these assets to ensure that adequate CFC refrigerants are available for RAC applications till the replacements are in place. The acquisition of new air conditioning systems, Ground Equipment (GE) and other refrigeration and support equipment, using ODS will have to be prohibited in military establishments as per the local legislation. This aspect would have to be built in procurement of both administrative and maintenance assets including buildings and vehicles.

This policy would in most cases be drafted and implemented at the Service HQ level. The existing equipment using ODS refrigerants may be used till the end of their economic life or if the retro-fit with the alternative refrigerant is not cost effective considering the years of life left. However, any equipment having more than 75% of its TTL left should be retro-fit with alternative refrigerant system; provided the same is available. Retro-fitment would be the responsibility of the maintenance staff at the service HQ along with the concerned Defence Research labs.

b. Refrigerant Leak Rate, detection and Training on preventive management :

A good equipment maintenance program should be in place to avoid accidental discharge of ODS into the atmosphere. Purchase of recycled ODS should only be permitted to charge these equipment whenever required.

For example, the US EPA does not permit discharge of more than 15% for comfort cooling and 35% for refrigeration and process cooling applications, on an annualised consumption rate. This maintenance benchmark would ensure reduced release of ODS to the atmosphere as well as maintain the inventory level for future uses. All technicians who work with refrigerants should be trained to reduce accidental emissions and certified. Training includes improved maintenance practices and refrigerant conservation measures. This training should be inclusive and has to cater to stakeholders such as the Civil Engineering (CE) organisation in charge of the construction and maintenance of the buildings. Further, to conserve and properly manage the base refrigerant resource, a routine inspection program and record keeping of the RAC applications needs to be drawn up by the base commander.

c. Inventory Management:

As in the case of halons, inventory management of refrigerants till they are in service is very important. The Service HQ would have to designate concerned administrative/ maintenance directorates to identify total annual ODS refrigerant required to meet mission critical applications, by quantity, type, and application for Service-managed systems until their requirement no longer exists. The CE directorate/ branch should identify requirements for the buildings being managed by them. Correcting leaking systems shall be a top priority for system managers.

Banking and recycling of refrigerants would be simpler as the time spans involved would be much lesser than in the case of halons. This is also due to availability of alternatives. However, till the time ODS refrigerants are in use, standard maintenance processes outlined above have to be established so as to not allow their escape to the atmosphere.

Purchase of recycled ODS refrigerants from commercial sources is permitted to maintain this equipment. However, this approach shall not be seen as a substitute for effective management and recycling of existing refrigerant inventory and proper repair and maintenance of equipment. ODS refrigerants would have to be recovered from equipment being retired at the end of their economic life, and utilised to service the remaining ODS systems in the inventory.

The existing military hardware using ODS refrigerants would be considered as mission critical. Refrigerants needed to meet mission critical applications will be obtained by using existing stocks from the ODS banks till the alternative/ retro-fit takes place. The ODS bank would be responsible for mapping the entire inventory of ODS refrigerants of the service; as without this information no serious and measurable efforts can be mounted for their phase out. Such information is to be shared within establishments of the Ministry of Defence for ease of transfer of ODS. The underlying idea would be to avoid procurement of these ODS from an outside source without exhausting the sources within.

d. Alternatives

Research on alternatives to ODS refrigerants would include refrigerant containment and conservation options, equipment retrofit options, equipment replacement options and/ or refrigerant replacement options. The defence research labs would have to work in conjunction with civil consultants for designing the retro-fitment. The individual service HQ may consider hiring a civil consultant for undertaking this retro-fitment design change till it meets the MILSPEC requirements. The long-term ramifications of using HCFC-based alternatives must be carefully evaluated. These are also recently subject to a phase out because of their global warming potential. For this reason, AF policy may allow their use only as a last resort after all other alternatives for a particular application have been evaluated and ruled out.

e. Screening and Selection:

A feasibility-and-cost screening analysis is essential for each alternative and equipment. Each option should be rated, based on engineering, environmental and economic factors including age and reliability of existing equipment, efficiency, maintenance, effect on environment, safety, cost, and likely sources of availability. For the military hardware utilising CFC based air-conditioning, it may now be feasible to develop in-house alternative through suitable redesigning, as alternatives are equally efficient. Retrofitting existing equipment is less expensive than total replacement. However, incompatibilities between replacement refrigerants and lubrication oil, age and

reliability of existing equipment, and complexity of the retrofit all play a major part in the decision to retrofit or not. Therefore, this option needs to be exercised with due diligence. A few examples of alternatives is compiled below as a precursor to further scientific studies before eventually settling for an alternative.

Natural Refrigerants: As discussed above refrigerant choice is normally a function of several considerations – economic and property based. The GWP and ODP of the alternative, flammability, and efficiency (thermo-physical properties) etc become important determinants. Natural refrigerants are most beneficial due to their least impact on the environment with almost nil GWP and nil ODP . These refrigerants include Ammonia (NH3, R-717), Carbon dioxide (CO2, R-744), and Hydrocarbons (iso-butane R-600a, propane R-290, propylene R-1270, and mixture thereof). These are the three most commonly used natural refrigerants in compression system.[1] In view of the accelerated HCFC phase-out program this aspect needs to be a part of the AF policy.

Halon Policy: Use Pattern, Future Needs Assessment and Purchases

The purchase of newly produced or virgin halons is to be prohibited as per existing regulations. Halons needed to meet mission critical applications will be recycled from existing stocks at the ODS bank. Mission critical halon applications in the AF may be defined as that used on- board aircraft; to meet flight safety and flight-survivability requirements. In the event the ODS bank is unable to meet requirements, recycled halons may be purchased from commercial sources. However, it is to be ensured that all aircrafts being developed at the defence PSU or are being contracted for, do not use ODS - based systems. If however halons are used for fire fighting, it is essential to ensure its supply for the entire duration of the aircraft life. This should however be the responsibility of the aircraft supplier and this aspect should be incorporated in the initial contract.

Aircraft halon systems such as fuel tank inerting tend to discharge to the atmosphere for other than actual fire situations. This shall be used only in actual operations. Correcting fire warning systems and operational procedures that result in false alarms and discharges shall be a top priority of system engineers at the respective production/ overhaul facility. Halon fire fighting systems in the flight line or Crash Fire Tenders (CFT) have to be disabled or replaced with non-halon alternatives; widely available and used in many civil airfields across the globe. Halons so retrieved may be used for mission critical operations after recycling, where possible; or returned to the bank.

a. Inventory management:

The major user of halon is the system maintenance group. Therefore, it would be the responsibility of maintenance group head at the service HQ to identify total annualised halon requirement needed for mission critical applications. Precise information on the quantity, type and application system is needed to help develop a suitable management plan. The operational/ administrative group would identify the same for the ground based fire fighting system, which in any case needs to be replaced with alternatives identified.

Total AF requirement should then be matched against the availability in the halon bank. The halon bank manager would verify the inventory level of each type of halon projected. The requirement would have to take into consideration the halon lost during recycling, minimal losses due to accidental discharge and an amount that may actually be required for fire fighting. A typical halon inventory management instruction from the service HQ should ensure that

- halons be removed from aircraft being retired and be redeployed or added to the AF bank;
- all servicing of aircraft halon systems should capture the filled halon for recycling;
- there is no atmospheric discharge during servicing,
- other than bare minimum is not permitted;
- halon captured by Base/ Major Repair organisations shall be recycled for reuse by returning to the bank or recycling plant if co-located;
- halon removed from crash rescue vehicles and other non-mission critical applications which have been declared excess, be added to the AF halon bank;
- banking of halon which are not fit for use till its destruction; and
- the halon bank itself does not discharge halon into the atmosphere for any reason.

Halon filling operations are mostly carried out at system repair/ overhaul workshops. The operations of filling, removal and testing and transportation of halons – from aircraft bottle as well as source tank/ bottle, should be standardised for all workshops including defence industry by an internal standardisation body already existing in each country. Annualised losses while undertaking these operations should be calculated as a percentage of total quantity handled and measured against a benchmark (theoretically established with the help of system consultants). System operations would then be improved for meeting these standards. Halon not restorable/ recyclable to usable condition shall be stored in the bank until approved destruction facilities are made available.

The AF bank should have the complete details of the inventory of halon being used at each operational base as well as Base/ Major Repair depots through effective communication amongst themselves. This inventory should include halons in the aircraft. The net figures should be easily accessible between the service HQ of each sister service for ease of transfer in case of excesses and shortages. These figures could also be shared with the Defence Production/ Overhaul agencies who may be also involved in mutual share of the resources in case of shortages. At the national level this information bank would have to be handled by MoEF, viz, the National Ozone Unit.

b. Banking Strategy:

Since the production of halons has stopped world over, two courses of actions are open to the users. As mentioned above, the first and the best course of action would be to use this opportunity to change the technology requiring the use of halons. However, in most military applications where legacy equipment is being used this is presently not economically and operationally feasible. Therefore, the next course of action is to set up halon banks where its stocking is feasible for some times to come till alternatives are in place.

Working out the exact requirement is very important as excess quantity would lead to the requirement of its disposal in future. A good estimate would take into account the Total Technical Life (TTL) of the equipment with respect to the type of fire suppressant and then working out the requirements considering the overhaul life, servicing discharges, actual usage and minor amount of accidental discharge. Some amount of War Reserves would also have to be catered for taking into account discharges and fast supply cycle required during operations. Setting up recycling plants along with the banks as well as at the hardware servicing facilities or the repair depots would be essential so that halons can be retrieved if its purity was observed to have deteriorated.

The Parties to the Montreal Protocol have defined recovery, recycling and reclamation as follows:

- Recovery relates to the collection and storage of controlled substances from machinery, equipment, container vessels, etc., during servicing or prior to disposal.
- Recycling refers to re-use of recovered controlled substances following a basic cleaning process such as filtering and/or drying.
- Reclamation is about reprocessing and upgrading a recovered controlled substance through such mechanisms as filtering, drying, distilling, and chemical treatment. This is to ensure that the substance once again meets specified performance standards. Such processing often takes place off-site at designated central facilities.

ODS Solvents: Policy

The existing legislation on ODS in any country would specify a ban on ODS solvents. Sufficient advancements have taken place wherein ODS solvents utilised for cleaning avionics and micronic filters, lubricating compounds and preservation of parts in the past, may be replaced with available alternatives. No solvent uses should be considered mission critical. Most of these solvents are CFC based or Methyl Chloroform. For their replacement, the standards are to be specified by the central standardisation body of each military establishment. Sharing this information may be very useful in this context. However, for this to happen, an inventory of use in different applications should be drawn up by the Logistics Maintenance managers at the service HQ level.

Halon stocks at the facilities of the Netherlands Halon Bank Association which manages the Netherlands Ministry of Defence as well as the US Department of Defence halons.

SOURCE: 2009 OZONACTION SPECIAL ISSUE

The USEPA, for instance has a Significant New Alternatives Policy (SNAP) program to evaluate and regulate substitutes for the ozone-depleting chemicals that are being phased out under the stratospheric ozone protection provisions of the US legislation - The Clean Air Act (CAA) http://www.epa.gov/ozone/snap/aerosol/list.html. They have identified many alternatives to aerosol-based solvents and the details can be seen on the site. With so much of international effort already undertaken on this front phasing out ODS solvents should be a priority of the system managers at field and production level.

Annex 6

Glossary and Acronyms

Aerosol
Aerosol is a suspension of very fine solid or liquid particles in a gas. Aerosol is also used as a common name for a spray (or 'aerosol') can: a container filed with a product and a propellant, and pressurized so as to release the product in a fine spray.

Article 5 country
A developing country which is a Party to the Montreal Protocol and has, on the date of the entry into force of the Montreal Protocol or at any time thereafter, an annual calculated level of consumption less than 0.3kg per capita of the controlled substances listed in Annex A, and less than 0.2 kg per capita of the controlled substances listed in Annex B. Such countries are permitted a ten-year grace period in respect of the phase out schedule laid down by the Montreal Protocol for developed countries.

Blends/mixtures
A blend is a mixture of two or more pure fluids (a ternary blend contains three such fluids). Given the right composition, blends can achieve properties to fit almost any refrigeration purpose. For example, a mixture of flammable and non-flammable components can result in a non-flammable blend. Blends can be divided into three categories: azeotropic, non-azeotropic, and near-azeotropic blends.

Carbon dioxide (CO2)
A gaseous compound (CO2) formed by, for example, the combustion of carbon. Carbon dioxide contributes to the greenhouse effect.

Carbon tetrachloride
A chlorocarbon solvent (CCI4) with an ODP of approximately 1.1 that is controlled under the Montreal Protocol. It is considered toxic and a probable human carcinogen as classified by the International Agency for Research on Cancer. Its use is strictly regulated in most countries and it is employed primarily as a feedstock material for the production of other chemicals.

Chlorofluorocarbon (CFCs)
A family of organic chemical composed of chlorine, fluorine and carbon atoms, usually characterized by high stability contributing to a high ODP. These fully halogenated substances are commonly used in refrigeration, foam blowing, aerosols, sterilants, solvent cleaning, and a variety of other application. CFCs have he potential to destroy ozone in the stratosphere.

Controlled substances
Under the Montreal Protocol, any ozone-depleting chemical that is subject to control measures, such as a phase-out requirement.

Environmental policy
A statement issued by a company setting out its principles and intentions in relation to its overall environmental performance. It establishes a framework for action and for setting environmental objectives and targets.

Global warming potential (GWP)
The relative contribution of certain substances (or greenhouse gases such as carbon dioxide, methane, CFCs, HCFCs, and halons, to global warming when released into the atmosphere by the combustion of oil, gas and coal (CO2), by direct emission, leakages from refrigeration plants, and so on. The standard measure of GWP is one which is consistent with the approach to indexing promoted by the Intergovernmental Panel on Climate Change (IPCC) and is expressed in terms of a comparison with carbon dioxide, which has a GWP of 1.0 GWP can be expressed in relation to a time horizon for integration of 20, 100 or 500 years. There is no agreement within the scientific community on which of these is the proper time horizon, but 100 years is the period most commonly used.

Greenhouse gas
A gas, such as water vapour, carbon dioxide, methane, a CFC or an HCFC, that absorbs and re-emits infra-red radiation, warming the Earth's surface and contributing to climate change.

Halons
A bromochlorofluorocarbon (BCFC) consisting of one or more carbon atoms surrounded by fluorine, chlorine, and bromine. Halons are commonly used as flame retardants and fire-extinguishing agents. Halons have high ODPs.

Hydrocarbons (HCs)
Chemical compounds consisting of one or more carbon atoms surrounded only by hydrogen atoms. HCs are commonly used as substitutes for CFCs in aerosol propellant and refrigerant blends. They have an ODP of zero. Hydrocarbons are volatile organic compounds, and their use may be restricted or prohibited in some areas. Although they are used as refrigerants, their highly flammable properties normally restrict their use as low-concentration components in refrigerant blends.

Hydrochlorofluorocarbon (HCFCs)
A family of chemicals related to CFCs and containing hydrogen, chlorine, fluorine, and carbon atoms. HCFCs are partly halogenated

and have much lower ODPs than do CFCs. Example of HCFC refrigerants are HCFC-22 (CHCIF2) and HCFC-123 (CHCI2CF3)

Methyl bromide
A colourless, odourless, highly toxic gas composed of carbon, hydrogen, and bromine, used as a broad-spectrum fumigant in commodity, structural, and soil fumigation. Methyl bromide has an ODP of approximately 0.6.

Montreal Protocol
The Montreal Protocol on Substances that Deplete the Ozone Layer, an international agreement limiting the production and consumption of chemicals that deplete the stratospheric ozone layer, including CFCs, halons, HCFCs, HBFCs, and methyl bromide. Signed in 1987, the Protocol commits Parties to take measures to protect the ozone layer by freezing, reducing, or ending production and consumption of controlled substances. This agreement is a protocol to the Vienna Convention.

Multilateral Fund
Part of the Financial Mechanism under the Montreal Protocol. The Multilateral Fund for Implementation of the Montreal Protocol was established by the Parties to provide financial and technical assistance to Article 5 countries.

National Ozone Unit (NOU)
The government unit in an Article 5 country responsible for managing the national ODS phase out strategy as specified in the Country Programme. NOUs are responsible for, among other things, fulfilling data-reporting obligations under the Montreal Protocol.

NATO
North Atlantic Treaty Organization.

Natural refrigerants
Naturally existing substances already circulating in the biosphere which can be used as refrigerants. Examples of natural refrigerants are ammonia, hydrocarbon, carbon dioxide, air and water. Natural refrigerants do not deplete the ozone layer and have zero or minimal global warming potentials.

Ozone
A reactive gas consisting of three oxygen atoms, formed naturally in the atmosphere by the association of molecular oxygen (O2) and atomic oxygen (O). It has the property of blocking the passage of dangerous wavelengths of ultraviolet radiation in the upper atmosphere. Whereas it is a desirable gas in the stratosphere, it is toxic to living organisms in the troposphere.

OzonAction Programme
UNEP DTIE's OzonAction programme provides assistance to developing country parties under the Montreal Protocol through information exchange, training, networking, country programmes, and institutional-strengthening projects.

Ozone depleting substances (ODS)
Any substances with an ODP greater than zero that can deplete the strastosphere ozone layer. Most ODS are controlled under the Montreal Protocol and its Amendments, and include CFCs, HCFCs, halons, and methyl bromide.

Ozone layer depletion
The accelerated chemical destruction of the stratospheric ozone layer by the presence of substances produced, for the most part, by human activities. The substances that deplete the ozone layer most acutely are the chlorine-free and bromine-free radicals generated from relatively stable chlorinated, fluorinated, and brominated products by ultraviolet radiation.

Ozone depletion potential (ODP)
A relative index indicating the extent to which a chemical product may cause ozone depletion. The reference level of 1 is fixed at the potential of CFC-11 and CFC-12 to cause ozone depletion. If a product has an ODP of 0.5, a given weight of the product in the atmosphere would, in time, deplete half the ozone that would be depleted by the same weight of CFC-11. ODP is calculated using mathematical models that take into account factors such as the stability of the product, the rate of diffusion, the quantity of depleting atoms per molecule, and the effect of ultraviolet light and other radiation on the molecules. The substances implicated generally contain chlorine or bromine.

Ozone layer
An area of the strastosphere, approximately 15 to 60 kilometers (9 to 38 miles) above the earth, where ozone is found as a trace gas (at higher concentrations than other parts of the atmosphere). This relatively high concentration of ozone filters out most ultraviolet radiation, preventing it from reaching the earth.

Ozone Secretariat
The Secretariat to the Montreal Protocol and the Vienna Convention, staffed by UNEP and based in Nairobi, Kenya.

Party
A country that signs and/or ratifies an international legal instrument (e.g. a protocol or an amendment to a protocol), indicating that it agrees to be bound by its rules. Parties to the Montreal Protocol are countries that have signed and ratified the Protocol.

Perfluorocarbons (PFCs)
A group of synthetically produced compounds in which the hydrogen atoms of a hydrocarbon are replaced with fluorine atoms. The compounds are characterized by extreme stability, non-flammability, low toxicity, zero ODP, and high GWP.

Phaseout
The ending of all production and consumption of a chemical controlled under the Montreal Protocol.

Phaseout plan
Part of the Country Programme based on the strategy declared by the government and defining the phase out calendar for each controlled substances as well as the government actions to be taken for achieving phase out. It contains a prioritized list of projects to be undertaken and takes into account the specific industrial, political, and legislative situation of the country concerned.

Reclamation
Reprocessing and upgrading of a recovered controlled substance through such mechanisms as filtering, drying, distillation, and chemical treatment in order to restore that substance to a specified performance standard. Chemical analysis, often involving processing off site at a central facility, is required to determine that appropriate product specifications are met.

Recovery
The collection and storage of controlled substances from machinery, equipment, containment vessels, and so on, during servicing or prior to disposal without necessarily testing or processing it in any way.

Recycling
Re-use of a recovered controlled substance following a basic cleaning process such as filtering and drying. For refrigerants, recycling normally involves reinstallation and often occurs on site.

Refrigerant
A heat-transfer agent, usually a liquid, used in equipment such as refrigerators, freezers, and air-conditioners.

Retrofit
The upgrading or adjustment of equipment so that it can be used under altered conditions; e.g. of refrigeration equipment to use a non-ODP refrigerant in place of ODS.

Servicing
In the refrigeration sector, all kinds of work undertaken by a service technician, from the installation, operation, inspection, repair, retrofitting, redesign, and decommissioning of refrigeration systems to the handling, storage, recovery, and recycling of refrigerants as well as record keeping.

Solvent
Any product (aqueous or organic) designed to clean a component or assembly by dissolving the contaminants present on its surface.

Stratosphere
That part of the Earth's atmosphere above the troposphere, at a height of about 15 to 60 kilometers (9 to 38 miles). The stratosphere contains the ozone layer.

TEAP
Technology and Economic Assessment Panel.

USEPA
United States Environmental Protection Agency.

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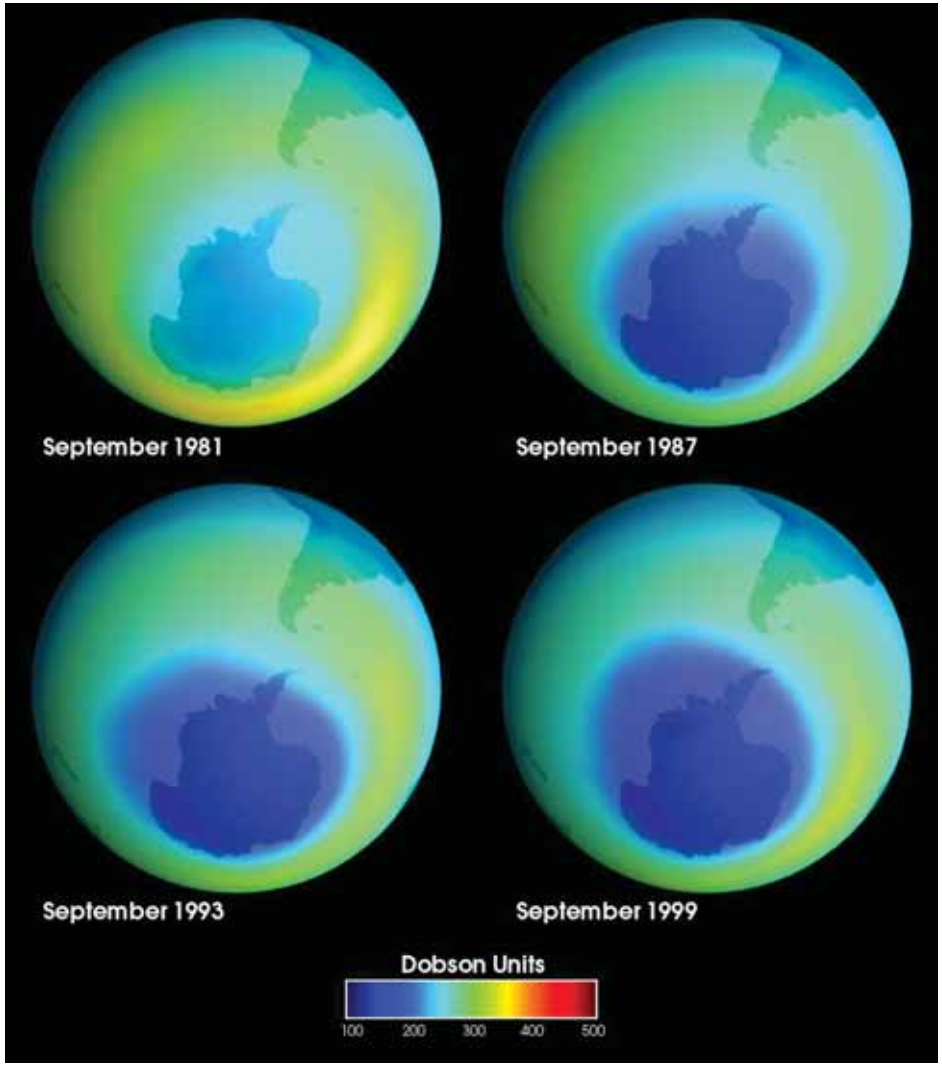
Air Marshal AK Singh (Retired) has had a long and illustrious career with the Indian Air Force (IAF). He retired as Air Officer Commanding in Chief of an operational Command of the IAF, and is an alumnus of National Defence College. He has been awarded with many presidential and gallantry awards as well as the Mahatma Gandhi Service National award besides holding various important military and civil appointments. He has been an invitee and speaker at many national and international conferences on security, climate and Ozone Depleting Substances management. He is currently Chairman of an international Military Advisory Council working towards a safer environment.

Wing Commander Manoj Kumar is a Mechanical engineering graduate from IT BHU, India and a post graduate in human resource management. He is a serving Indian Air Force (IAF) officer and has held many important staff and field assignments in the last 23 years of his engagement with the IAF. He has recently been awarded the Presidential Medal for his work on energetic materials and for distinguished service. He is presently working at the Centre for Air Power studies on a two year research project on 'Climate Change and Security' which also focuses on Montreal Protocol. He has presented research papers on the subject at both national and international levels. He provides specialist advice to the IAF on phaseout of Ozone Depleting Substances.

Atul Bagai joined the OzonAction programme initally as a Training Officer in August 2000 before being appointed as the Regional Officer (Networking) for South Asia on November 1, 2002. Before joining the programme, he worked as the Ozone Cell Director at the Ministry of Environment and Forests, Government of India. As Training Officer, his work included organising workshops for refrigeration technicians and customs officers in South Asia, South East Asia and CEITs. He is now part of the ROAP CAP team assisting countries under UNEP's reoriented Compliance Assistance Programme. He has worked in a variety of field and policy level assignments at both federal and provincial levels in India as an Indian Administrative Service officer.



Satellite imagery showing the growing ozone hole over the South Pole between 1981 and 1999. International cooperation has led to the slowing down of ozone depletion.

NASA

Centre for Air Power Studies

ISBN: DTI/1216/PA

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