MONTREAL PROTOCOL
ON SUBSTANCES THAT DEPLETE
THE OZONE LAYER

UNEP

REPORT OF THE
HALONS TECHNICAL OPTIONS COMMITTEE

DECEMBER 2014

VOLUME 3

2014 SUPPLEMENTARY REPORT #2

GLOBAL HALON 1211, 1301, AND 2402 BANKING

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Preface

The December 2014 HTOC Report consists of three volumes:

Volume 1: 2014 Assessment Report

Volume 2: 2014 Supplementary Report #1 – Civil Aviation

Volume 3: 2014 Supplementary Report # 2 – Global Halon 1211, 1301, and 2402 Banking

Supplemental Report #2, *Global Halon 1211, 1301, and 2402 Banking*, expands on the abbreviated information contained in the main body of the 2014 Assessment Report of the UNEP Halon Technical Options Committee (HTOC), which briefly introduces the subject of *Global Banking* and refers the interested reader to this document. The HTOC elected to take this approach because the information is constantly changing and can more easily be updated on an as available basis. In the 2010 Assessment Report this information was split into two separate chapters, *Global Halon 1211 and 1301 Banking* and *Global Halon 2402 Banking,* and an Appendix, *Halon Bank Management Programmes*. *Halon Banking* was reported in previous editions of the Assessment Report in chapters of the same titles. Some of the information such as maritime banking facilities has not changed much over the past few Assessment Reports; whereas, specific country reports changed significantly as did the specific countries from which reports were available. Additionally, space restricted the number of country reports that could be included. Nevertheless, the chapters provided important examples of how some Parties have handled halon banking and what their current status is for the various halons; this information is of a very specific nature and it is the committee's expectation that the information will be more easily updated and accessible now that it is available in the form of a Supplemental Report. By this approach those having particular interest in specific cases of halon bank management or details on halon uses and stocks in individual countries can access a self-contained document addressing those issues.

1.0 Introduction

Halon banking is a critical part of the management of halons. Remaining halon users exist in most countries and include commercial aviation, the military sector, and some applications in IT, banking, telecommunications, oil & gas, etc. The use of halon may continue for several decades especially in cases where the vehicle/space configuration was designed specifically for halon (and cannot be changed) because at this time there still are NO drop-in replacements. Halon banking is a critical part of the management of halons and is essential for the remaining sectors that must continue to rely upon them. All halon users must be made aware of the cessation of halon production and the need to cease emitting halon. Countries must develop halon bank programmes even if it is simply a guidance document utilized by the National Ozone Unit (NOU) to facilitate halon users. Halon bank programmes must be accessible to all halon users or the risk of accelerated atmospheric emissions will escalate as users find themselves with redundant stock, and an increase in unsafe fire hazards could occur if end-users are unable to obtain vital refills. As halon becomes scarcer, there is a significant risk of unscrupulous vendors and users filling halon cylinders with contaminated halon. This group could in turn sell this contaminated halon as "clean" agent, thereby creating non-functioning halon systems in

remaining applications such as commercial aircraft or tanks. Such practices put the passengers and operations at risk not only from a non-functioning system, but also from the contents which could be flammable and/or hazardous combustion by-products.

A facility or organisation can either perform the banking function physically as a "physical" bank with halon actually stored and maintained in specific locations, or they can act as a clearinghouse where halon users can be facilitated in turning-in halon and/or obtaining halon. Virtual halon banking is a clearinghouse whereby halon transfer is facilitated between users.

A halon bank is all halons contained in fire extinguishing cylinders and storage cylinders within any organisation, country, or region. Likewise the 'global halon bank' is all halon presently contained in halon fire equipment plus all halon stored at halon recycling centres, at fire equipment companies, at halon users premises, at halon producers' stores, etc., i.e., it is all halon produced but yet to be emitted or destroyed. The collection, reclamation, storage, and redistribution of halons are referred to as "Halon Banking".

For the purposes of this Report, "banking" is considered as all functions both physical and virtual that involve the use, recovery, recycling, reclamation, transfer, storage, and disposal of all halons used for fire protection.

This Report is a synopsis of the current state of halon banking globally to the extent that the members of the HTOC were able to obtain responses from Parties.

Many Parties have halon banking programs that are fully operational. The early halon production phase-out schedule imposed on the non-Article 5 Parties resulted in early establishment of halon banking programs. As a result, their programs have been tested and have matured. Previous HTOC reports have covered the development, implementation, and operation of many successful halon banking programs within non-Article 5 Parties. A UNEP study conducted in 2008 found that the CEIT's and Article 5 Parties were in many cases still struggling to establish halon banks or to set up protocols for participation in regional halon banks. At this time, there still remains a need in many countries to implement regulations, procedures, and/or programs to facilitate the effective management of remaining halon inventories. In many cases, the inventories are highly inaccurate or unknown. There can be no sense of urgency for a country to address the issues of bank management if they do not have knowledge of the remaining halon users or if they are unaware at the highest levels of the need to continue halon use in so many of their critical applications such as aviation and military.

2.0 Halon 1211 and 1301 Banking

As stated above, halon banking programmes are well established in the non-Article 5 Parties that need them. This section therefore refers only to updates to Article 5 Parties' programmes and provides the most well-known examples of A-5 Parties that have initiated operational halon management programmes. Numerous additional examples were provided in the 2010 Report of the Halon Technical Options Committee.

2.1 African Countries

The HTOC has status on only one country in Africa. Attempts at contacting ozone offices have been met with silence. It is not clear to the HTOC whether these offices are staffed or there is no halon management activities occurring.

South Africa: The halon bank of South Africa has been in operation since 1995, by volunteers under the auspices of the South African Government's Department of Environment. The main objective of the bank has been to manage consumption of halon down to zero, facilitate the return of halons from containers in the field, and to provide halons for end-uses considered to be critical by South Africa.

The halon bank of South Africa is a non-profit organisation and is run by two joint-managers; the Managing Director of the Fire Protection Association of South Africa, and a Consulting Fire Engineer, assisted by both companies' administration staff as required. The halon bank's expenses are met by funds raised mainly by levies on halon transactions and certification charges. The accounts are audited annually by independent auditors.

It acts as a clearing agent for sales and returns of used halon, 'lists and approves' companies that recycle used halons to a recognised specification, and acts as a link between South African users and halon banks in other countries. It also provides advice and investigations on all matters relating to halon and alternative fire protection methods, arranges for assay testing of halon samples, and issues a variety of certificates, for example a certificate of 'halon return' to end users.

The halon bank serves South Africa and neighbouring countries, such as Swaziland, Lesotho, Namibia, Botswana and Zimbabwe, although operational experience has been that these neighbouring countries have little halon refill needs or stock to return. It has also responded to returns applications from Nigeria, Cameroon, and the Republic of Seychelles.

A containerised recycling plant, originally delivered to South Africa in 2005 by GTZ Proklima, was dormant for some years before being relocated to an alternative vendor in South Africa by the halon bank in early 2008. Since re-commissioning it has been used to decant into bulk tanks the contents of portable containers, returned to the halon bank that accumulated during a number of years. Refills of halon containers are done by an approved vendor or by two end-users. Refills are usually from returned stock of halon saturated with nitrogen, i.e., the nitrogen is generally not fully extracted before refilling.

During the period of 2006 and 2010, the halon bank experienced a significant increase in the quantity of halon returns (disposal by end-users), with stock returned being of the order of 30 MT during this period. By 2010, the Bank's service provider reported a severe burden, with additional storage space being needed with associated rental costs.

At the end of 2010, the Bank's records indicated an accumulated stock quantity of some 33 MT (mostly halon 1301, of uncertified purity).

Since 2010 however, returns have reduced substantially (being only a total of 3.3 MT in the past 3 years).

To date, the halon bank has authorised about 120 refills for uses considered to be critical, and has processed some 130 returns. Over 2,000 documents have been generated or processed in the course of the management of halons.

A recent review of the halon stock inventory indicated that the Bank's service provider supplied large quantities of halon 1301 to the military, without authorisation by the Bank – apparently for fixed installations that would most probably not be considered an essential use by the Bank.

The Bank's service provider reported that most of the remaining halon 1301 stock or returns received since 2010 fail the purity meter test. The operator suspects the contamination of halon 1301 is due mainly to halon 1211, but simple attempts to remove the suspected 1211 by distillation attempts have not been successful.

The amount of halon 1301 stock on hand suitable for refilling has thus become insufficient for critical uses such as the refilling of aircraft protection systems.

In South Africa, difficulties have been encountered with the recycling equipment provided in 2005, in that equipment failures occur with some replacement parts being difficult to obtain. It appears the equipment is reaching a life-cycle stage where maintenance costs are increasing and repair times are lengthy. This affects the operational cost and quality of refilling service.

Control of import or export of halons is by the Customs Department. In 2011 Legislation was developed by the Department of Environmental Affairs to regulate the import, export, possession, trade, transaction, and disposal of halons. This did not come into force during the ensuing promulgation period, but a revised draft regulation was published in August 2013. This draft makes no mention of the operation of any halon bank. The future of the Halon Bank of SA is thus presently uncertain.

The previous HTOC Assessment Report stated that the Bank had identified a destruction facility in Johannesburg. This facility has since closed, and currently there is no local capability authorised for the destruction or disposal of halons. Stock of contaminated halon is currently being kept in bulk containers, and there is thus an unknown financial liability in the form of an unresolved disposal issue. *Other banks, particularly in under-developed countries, may encounter similar financial risks in the future and thus require unexpected financial support from their governments.*

In summary, the situation in South Africa is one of (a) lack of pure 1301 stock for critical use, (b) tonnes of contaminated stock requiring a complex separation process to extract the 1301, or alternatively means to dispose of this as waste, (c) increasing maintenance and repair costs, (d) equipment operator issues, and (e) shortage of funds to deal with these challenges. Without government intervention, the halon bank will no longer function and critical users may find themselves with systems out of service.

2.2 Latin American Countries

South American countries continue in their efforts to eliminate the use of the halons in fire protection applications where feasible such as communications, banks, transportation, and marine vessels. Meanwhile civil aviation and military branches still use halons in their

equipment. Legislation has been passed in most Latin American countries to prohibit the import and export of halons (including recycled).

Inert gases and FK-5-1-12 are being used more extensively to replace halon fire suppression systems. Sales of HFCs in the fire protection sector are flat, although in Columbia HFC-125 is widely used in portable fire extinguishers.

Halon banks are in operation in Argentina, Brazil, Mexico, Venezuela, and Uruguay. Recycled halons can be sold only to refill fire systems installed on 'critical' uses.

Argentina: In 1998 the Environmenta Secretariat established the Oficina del Programa del Ozone (OPROZ); the OPROZ established the National Program of Halons Bank and gave authority for the operations of the halon bank to INTI Construcciones – U.T. Fuego, a government company in the marine sector. This company received the equipment to recycle halons and was authorized to provide technical information to halon users and to verify the correct use of halons. This company also selected several companies within the fire protection sector to collect, store, and sell recycled halons to critical users. The government also mandated that all import/export of ODS, including halons, should be authorized by the OPROZ.

To improve the halon bank operations, in 2009 the Ozone Program Office selected a private company, Giacomino S.A., to receive the halon recycling equipment from INTI. It was anticipated Giacomino S.A. would provide better services to fire protection companies and government-owned shipyards.

Brazil: The Brazilian Program for the Elimination of the Production and Consumption of Ozone Depleting Substances, as defined in the Montreal Protocol, was created in 1994. Another action taken in 1995, with the approval of the Resolution CONAMA nr.13/1995, established the rules for the elimination of substances controlled by Annex A and B of the Montreal Protocol. CONAMA Resolution nr 267/2000, which supersedes Resolution nr. 13, allows from the year 2001, the importation of halons only for uses in fire extinguishing in aerial and maritime navigation, military applications, cultural and artistical patrimony, in stations for electric and nuclear energy generation and distribution, and oil offshore platforms.

The Brazilian Halon Recycling Project was done with Canada and approved in 1996. Since 2008 there has been no consumption of halon in Brazil. Only recycled halon is being used and two companies are authorized to do the recycling. The halon banking was created and is managed by the company GESPI. Any need of recycled halon must be requested by the government Agency IBAMA, which is responsible for the halon importation licenses.

Chile: While Chile was approved for MLF support in 2006, there was a delay in implementation due to governmental changes. In 2013, the UNDP, working closely with the National Ozone Office (NOU), contracted expert assistance to help in the development of a national plan, provide technical assistance to halon users, and assist in the development of halon banking operations. The NOU developed a list of the users with the most essential halon needs including civil and military aviation, the navy and army, and the telecommunications/financial/oil & gas sectors and provided workshops as well as conducting on-site visits. This proactive involvement allowed the NOU to identify several keys areas to focus attention on to heighten awareness of halon phaseout

and move the nation towards a comprehensive halon management plan. Through the NOU's aforementioned efforts they were able to determine that Chile has on-going halon requirements for their military branches and civil aviation and that these 'critical' users will require halon servicing for 20-40 more years. Many of the current users, while being aware of the importance of their halon fire suppression systems, were unaware that production ceased in 2010 and that prices had significantly increased in the intervening years. During the NOU's on-site visits, they ascertained that most of the users had not yet developed a plan for servicing their halon for the life of the systems. The NOU found that two sectors have on-going contracted servicing occurring outside of the country, but neither sector had contingency plans if the outside sources were to become unable to provide halon servicing and refills.

The NOU sent out detailed questionnaires on more than one occasion when developing the national halon inventory and found during their on-site visits that the voluntary reporting by halon users significantly underrepresented the quantity of installed halon in "critical' systems. This underreporting was not deemed intentional. The national inventory is still under assessment. The NOU was able to determine that in spite of the on-going need for halon, there is virtually no halon available from dismantled systems to supply a halon banking operation, and it was reported that all non-critical halon systems have been removed. Legislation was passed in 2010 prohibiting the importation of halons, including recycled halons. If halon supplies are identified within the borders of Chile, banking may still be problematic as there is currently no recycling/reclamation equipment available or in use in the country. The current legislation and the apparent lack of halon supplies make it difficult to see how the country will address the halon needs of its critical users in the not too distant future. It is believed the situation in Chile is not unique to this one country. An important step taken by the NOU is the formation of a Steering Committee made up of Key Stakeholders empowering them to begin developing solutions to potential halon shortages and crafting a halon bank management plan tailored to Chile's needs.

Chile has recognized its gaps in halon bank management; the NOU is simultaneously working on facilitating the Steering Group while developing the policies and activities to phaseout agents implicated in Climate Change. They are maximizing their limited resources by finding synergy between halon phaseout and the Climate & Clean Air Coalition (CCAC) objectives.

Halon Bank Management is a very difficult problem and is not limited to this one country, but is just one indicator of the forward work that needs to be done with many of the A5 Parties. There are many other A5 Parties that are not as far along as Chile in addressing these issues. Chile's NOU is a great example for others to look to in setting a roadmap forward in halon phaseout.

Peru: Peru does not have a halon bank. It is the understanding of the HTOC that the Department of Environment conducted a survey in 1994 of the installed halons in the country. Quantities of halon reported in this survey were less than 1 MT, so they decided not to establish a halon bank.

Venezuela: Venezuela received halon reclamation equipment and a gas chromatograph in 1996 with MLF assistance. A commercial entity was selected by the Venezuelan government to operate the national halon bank; they have five branch locations within the country one of which provides the halon recycling and storage. They have approximately 5 MT of halon 1301 in stock. Halon 1211 is not available locally except in fire extinguishers on a very few applications such as small ships, small planes, and helicopters; therefore, the expended extinguishers are being

refilled with a halon alternative. The halon 1301 is used for recharging fire protection systems in military and civil aviation, subway transportation systems, and on some oil tanker ships. Venezuela prohibits the import and export of halons. Venezuela prohibits halon destruction as do most South American countries. There is information on halons in the web pages of the Ministries of Environment for most Latin American countries; however it may not be up-to-date. The Ministry of Environment of Venezuela has an organisation called FONDOIN which controls all ODS related activities. They have a website, www.fondoin.gob.ve, whereby halon users are directed to the national bank to purchase, sell, or recycle halons. Since the bank is a commercial entity, this arrangement provides them with the opportunity to offer halon alternatives to the system users. Such an arrangement has been formed by many countries providing a successful pairing of a government organisation with the fire protection industry to enable halon phase-out while enriching business for the commercial entity. In the case of Venezuela, the commercial entity has five branches that cover the total Venezuelan market and serves a market of over 100 small distributors and fire extinguisher service companies. While turning over the national halon banking operations to a commercial entity provides a significant market advantage for the company, the selection of this particular company with its network of smaller businesses ensures a much higher likelihood of halon collection and transition. In terms of the banking systems operations, they do not buy contaminated halon. They perform a gas chromatography test of each halon cylinder/system before buying or receiving it as part of the payment for a new alternative fire suppression system. They test the halon after they have reclaimed it; however, they do not test stored halon unless a customer requires a certification. Most of their halon is stored in 2,000 pound horizontal tanks. A downside to this government/industry partnership is that the bank is not compensated for taking in cross-contaminated halons, and the country does not appear to have procedures in place to handle those halons, so they are likely to be vented to the atmosphere. There are companies in other countries that will purchase and “clean” cross-contaminated halons; however, cross-contaminated halons are a financial liability in Venezuela because of the halon export prohibition.

More recently the Venezuelan Ministry of Environment has trained their inspectors, while making their on-site visits to all types of industries, to request decommissioning of the halon fire systems and replacement with non-ODP alternatives.

2.3 Asian Countries

China: A halon 1211 recycling facility was established in 2005–2006 timeframe with assistance from the MLF. It was reported in 2010 that the facility encountered three problems: 1) the first halon 1211 collected was severely cross-contaminated so that the recycling equipment could not clean the halon, 2) the Ministry of Environment issued a regulation in 2008 classifying halon as hazardous waste, and 3) remaining stock of newly produced halon 1211 covered the demand for halon 1211 at a cost lower than the cost of recycled halon thus eliminating the demand for recycled halon 1211. As of 2014, the halon 1211 recycling facility is no longer in operation due to the lack of demand for recycled halon 1211. There is still sufficient stock of halon 1211 available for sale from a former producer (approximately 2,000 MT with annual sales of 20 MT), which has contributed to the closure of the recycling facility. The hazardous waste regulation continues to be a barrier as none of the fire equipment companies are willing to spend time and money in order to obtain a HW license. It appears that a disastrous result of the availability of the newly produced halon and the HW legislation is most of the halon 1211 in service was

vented since it was not recycled. This environmental cost should not be understated. Another significant factor contributing to the venting of halon 1211 was the country-levelled safety requirement that halon extinguishers be "retired" after 10 years of service.

It was reported in 2010[1] that China was in the process of setting up a halon 1301 reclamation facility with assistance from the MLF; however, the facility has not yet been established. China was producing halon 1301 up until the end of 2009 and therefore did not see a need for reclamation capabilities until after production cessation. China estimates there is sufficient halon 1301 installed nation-wide to make a halon 1301 recycling facility viable. It is unknown at this time whether a former halon 1301 producer will have stocks of halon sufficient to undermine the 1301 recycling operations as has occurred with the 1211 operations. Several high throughput halon 1211/1301 reclamation units have been purchased and delivered to China. At this time it is not known who is operating those units.

It is estimated that the former producer's stock of halon 1211 is sufficient to meet the commercial aviation and military needs for numerous decades. This is a result of China's continued halon production through 2010. No other country has this advantage in halon reserves.

India: India received MLF assistance to purchase halon reclamation equipment for halon 1211, 1301, and 2402, and laboratory equipment to test and certify halon both before and after reclamation. They also received six half-ton capacity storage tanks and a "halon identifier". India discontinued producing halon in 2003. A national bank was set up in 2004. An Awareness Campaign was completed in 2006 that included training and numerous workshops. At that time a website was established; however, it is no longer functioning. Indian regulations to control import and export of virgin halon came into force through a Government of India gazette notification. Initially (2004–2007) some halon, approximately 1 MT, was processed through the national halon banking facility, primarily for military organisations. Approximately 1 MT of new halon was imported for the bank, presumably just prior to the importation prohibition.

In 2009, the HTOC attempted to contact the halon bank's management for an update on the operation of the bank. The management was non-responsive. It was presumed the non-responsiveness was indicative of problems with the banking operations. Every indication is that the bank is currently non-functional. It appears the military, as well as the power and oil sector, have developed their own halon management programmes and facilities. The military has established their own storage in a limited scale and it is reported the military has no halon reclamation capability or quality control.

India has reported they have been recovering about 5 MT of halon 2402 and 25-30 MT of halon 1301 annually from shipbreaking in Alang; no halon 1211 was reported to have been recovered. It was also reported that the recovered halon was being disposed as scrap in the Indian market and being reused by some civilian users; however, the whereabouts of these reported uses is unknown. It appears that recently some scrap dealers in Alang have been given permission to

[1] 2010 Assessment Report of the Halons Technical Options Committee

recover the halon for recycling in India or other countries “in a safe manner”. In 2013, it was reported that India has no difficulty in acquiring halons for their essential/critical needs.

The following is a summary of some of the halon alternatives in use as of 2013; 1) floating roof tanks are being equipped with foam systems in place of halon 2402; 2) more than 50% of the portable halon extinguishers have been replaced with dry powder extinguishants, where about 20% are now using carbon dioxide, and less than 20% are utilizing HFCs; and 3) some existing fixed systems have been replaced with HCFCs and inert gas systems. No new halon is being used in the civil sector. It should be noted, HCFCs and its blends were being used as halon alternatives both in portable and fixed systems in the civil and military applications. However, as a result of technological improvements, improved quality standards, and the increasing availability of dry powders and clean agents such as HFC and CO_2 for portables and systems, the use of HCFC and it blends has been decreasing and is now less than 5% of the alternative installations. Additionally, a regulation was passed in 2014 banning the import of HCFCs and limiting their use in many applications.

It is reported that the Air Force utilizes halon 1211 and halon 1301 and has recently procured the quantities needed to support their remaining applications. The military does not currently use dry powder systems, water mist systems, or halon 2402 for armoured vehicles; they still require halon 1301for their armoured vehicles and are in the process of developing banking to support this application as it is expected to be a long term requirement. The naval ships are considering replacing their halon systems with HFC 227 and/or water mist systems.

India has an HCMP in place to address the phase-out of HCFCs. Multi-lateral Fund support is being provided to assist India in moving forward the phase-out dates for HCFC from 2040 to 2025. A draft Gazette Notification (government of India) has been published and is currently in the public comments stage. The new legislation, if passed, will require a 50% reduction of HCFCs and it blends from all applications including firefighting by 2020. Importation of HCFC and it blends will not be permitted 6 months following passage of the legislation.

Bangladesh, Bhutan, Malaysia, Nepal, Pakistan, and Sri Lanka: There is no known halon banking, reclamation, or quality control in the countries neighbouring India including Bangladesh, Bhutan, Malaysia, Nepal, Pakistan, and Sri Lanka. While the use of halons in each of these countries is reported to be minor, there are apparently quantities of installed halons in each for which their governments are reported to be unaware of.

It is understood that Pakistan and Bangladesh decommission a substantial quantity of halon 1301 from ship breaking, but again they have no facilities for the recovery and reclamation of these decommissioned halon systems, therefore the halon is being emitted in order to recover the cylinders for scrap. Confounding this situation is the lack of regulations for trans boundary/export of the halons to other countries that do have halon recovery & reclamation facilities.

There is a need for halon in each of these countries; however, the remaining “critical” users have not reported shortages of any of the halons. Some are reported to be meeting this requirement from recovered halon from their own countries and some are meeting their needs by importing recycled halon from the U.S. and Europe.

South Korea: The halon manufacturing facilities in South Korea closed down in 2010 and no new halons have been produced since. From 1990 through 2009 a total of 6,000 MT of halon 1301 was produced and supplied to critical users such as the military, museums, electric facilities, and basic industry (steel, automotive, chemistry, and gas/oil). As of 2014, the amount of halon 1301 installed in South Korea is still estimated at more than 3,000 MT even allowing for the amount vented into the atmosphere or reclaimed so far. On a yearly basis, approximately 50–60 MT of recycled halon 1301 is recovered from existing facilities and is expected to continue for 20 years to come based on the historic data and considering the life span of the existing fire extinguishing systems.

In 2010, the South Korean Government promulgated a regulation that defines the qualification for halon banking companies "qualified" to provide the service of halon recovery, recycling, analysis, and storage. A good result from this new regulation is that the contamination issues for recycled halon have subsided. But this regulation does not contain any enforceable measures against violations. Also, there is no data base for the information of existing halon fire extinguishing systems installed for critical users. The actual halon recovery amount per year has fluctuated for the past decade and the actual inventory amount is consistently declining. So, the difficulty lies in prediction or estimation of a recovery schedule and quantities. Because of this uncertainty, many critical users are concerned about the halon supply for their existing systems even though there are considerable potential inventories in South Korea. The halon banking system might work more efficiently and with less uncertainty if the government were to introduce a regulation that would serve to establish a data base of existing halon systems. Such a regulation/database should provide some assurance to critical users there is adequate halon 1301 as the recovery is still expected to be sufficient on a long term basis to meet the needs of critical users in the future even though the current inventory is recorded to be low.

2.4 Middle Eastern Countries

Jordan: The halon banking program was initiated by the Jordanian Government; a steering committee consisting of both private and public sectors commenced working on a halon bank concept in 1999. The halon bank of Jordan officially started in 2002, under the auspices of the Jordan Armed Forces and the Ministry of Environment. The halon bank of Jordan completed a Multilateral Fund project in 2005. The halon bank facility consisted of recovery, recycling, and reclamation machines for halon 1211 and 1301 and has been operational since 2005.

The steering committee originally intended for the bank to serve Jordanian halon needs and to build up strategic reserves for uses considered critical by Jordan. The recycling was provided as a charged service to users (of which many were governmental departments). The halon bank intended to stockpile halons to be provided to users for future uses considered critical by Jordon.

The bank was conceived to be a self-sustained organisation run by a management committee led by the Managing Director of the King Abdullah II Design and Development Bureau (a semi-governmental agency). Bank expenses were intended to be met by funds raised mainly by charges generated from recovery, recycling, and reclamation of halons with accounts audited annually by independent auditors.

No legislation has been proposed or implemented by the bank. Control of import or export of halons is regulated by the Customs Department. The strategy has been to rely on the Ministry of

Environment to follow the intention of the Montreal Protocol and Amendments, with regard to halon consumption; whereby, halon was imported/exported with an authorisation by the Bank and with full coordination with the Ministry of Environment's Ozone Unit. The quality of the 'halon' was tested both before and after R&R via an independent party, the Royal Scientific Society Laboratories, to determine the purity.

The Halon Bank of Jordan closed on June 10, 2013. The following reasons were given for the closure:

- The Halon Bank and the Jordan Ministry of Environment, Ozone Unit jointly implemented an awareness program in 2002 and continued it throughout the operations. One of the key program aims was to encourage 'critical user' decision-makers to plan for the replacement of their existing halon systems with halon alternatives. The replacements occurred and led to the reduction of the annual turnover at the Halon Bank.
- There was a scarcity, and in some cases unavailability, of recycled halons available for importation from regional and international markets to supply to the existing systems in Jordan.
- The Halon Bank board of director (King Abdullah II Design and development Bureau) issued verbal directives "to avoid competing with the private sector in the local market and only commit to supply halon systems in Jordan." This directive was referring to the fact that the project was originally established to be a non-profit environmental program.
- The high prices that recycled halon reached recently in the international market.
- The cost of running the halon bank was unaffordable over the previous two years (2011 & 2012), and no funds were granted to the project since initiating operation in 2005 to help cover the cost of operations.

3.0 Halon 2402 Banking

Halon 2402 had been produced nearly exclusively in the former USSR, and production was continued by the Russian Federation after 1991 until the end of 2000. The bank of halon 2402 was very small at the time of production phase-out and therefore, through Decision VIII/9, from 1996 through 2000 production was continued under the essential use exemption procedure approved by the Parties to the Montreal Protocol, the objective being to build a bank of halon 2402 that existing applications could rely on for the remaining useful life of their equipment.

However, as reported in the 2006 HTOC Assessment Report, the inventory of this bank was significantly reduced owing to the use of halon 2402 as a process agent in the chemical industry during the period 2002-2003, when the average price of halon 2402 was low. More recently, halon 2402 has been commercialised for the Russian market as an encapsulated component of a flame retardant material, which can be used as a painting or coating, further reducing the inventory for existing uses.

Equipment associated with halon 2402 systems was almost exclusively manufactured in the USSR until its dissolution in 1991, and in the Russian Federation and the Ukraine since. In other countries of the former Eastern Bloc (e.g., Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, and Slovakia) use of halon 2402 was associated with the use of Russian military equipment and civilian aircraft. However, now many of these are no longer used. Halon 2402

based fire protection equipment was also exported to some Asian countries together with Russian products, mostly for use in military vehicles, ships, and aircrafts.

Countries that still use halon 2402 as a fire protection agent can be grouped as follows:

- Russian Federation, Ukraine, Belarus;
- Former USSR and other countries of the former Eastern Bloc:
  Caucasus: Armenia, Azerbaijan, Georgia; Central Asia: Kazakhstan, Kyrgyzstan, Tadzhikistan, Turkmenistan, Uzbekistan; Non-EU states of East-South Europe: e.g., former Yugoslavia; EU member states: Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia; and
- South-East and East Asia: India, Vietnam, Japan.

Some military and aviation equipment employing halon 2402 may still be in use in countries that purchased equipment from the USSR, and later from Russia, e.g., Afghanistan, Algeria, China, Cuba, Egypt, Libya, Mongolia and Syria.

The needs of some Parties for halon 2402 cannot be estimated due to the unavailability of market information, but it should be assumed that a demand for halon 2402 for the servicing of operating equipment exists and that halon from outside sources will be required, as banking and recycling facilities do not exist. While there is no apparent shortage of halon 2402 on a global basis, there are regional shortages today that Parties may wish to address.

Parties that have initiated operational halon 2402 management programmes are described below:

3.1 Russian Federation

Russian national regulations restrict the export of ozone depleting substances (ODSs), including halons. According to the Decision of the Russian Government No. 1368 (adopted 9th December 1999), export requires special permission from the Ministry of Natural Resources and is allowed only for uses deemed critical by the Russian Federation. Similarly, the installation of halon 2402 in new fire suppression systems in the Russian Federation is allowed for such uses only. In such cases an application for special permission from the Ministry of Natural Resources is also required.

Even today the Russian Federation remains the largest user of halon 2402. According to the most recent data, the total amount of halon 2402 installed was estimated at 932.2 MT in 2013. The main users are the military sector, Gazprom and other oil and gas companies. Despite expectations that the demand for halon 2402 would increase in the Russian military sector, information for 2011-2012 shows no increase in demand. This suggests that alternative agents are now being used instead of halon 2402 in some military applications. The market can be estimated as currently well balanced with no surplus available for outside markets. Approximately 25 MT/year of the halon 2402 were available as a free agent ready for purchase in a period from 2010 to 2013. Table 1 provides information on the Russian installed base, recycling, and emissions from 2007–2015.

Table 1: Changes in Russian Bank of Halon 2402

	2007	2009	2010	2011	2012	2013[1]	2014[2]	2015[2]
Recycled amount, MT	80.0	120.0	21.0	23.0	23.0	25.0	30.0	30.0
Annual offer of free agent, MT	10.0	20.0	24.0	25.0	25.0	28.0	30.0	30.0
Emissions, MT	8.0	10.0	1.6	3.0	2.2	2.0	3.0	3.0
Total bank, MT	947.0	941.0	939.4	936.4	934.2	932.2	929.2	926.2

Note 1: Data obtained by January 2014
Note 2: Forecast

There is growing concern regarding the appearance of contaminated halon offered for purchase. This information is confirmed by differences in amounts of recycled halon and annual offer of the halon as shown in Table 1 for a period from 2010-2013. The annual offer of halon 2402 exceeded the recycled amount of the halon for the same period by 10 MT.

Halon 2402 is no longer used in a "fire suppressive" paint product in Russia with the halon being replaced by C_3F_7I or a mixture of HFCs.

3.2 Ukraine

Ukraine is the second largest consumer of halon 2402 after the Russian Federation. A halon 2402 collection, recycling and reclamation facility was established at the Spetsavtomatika Institute at Lugansk. Spetsavtomatika collected halon from various locations and returned reclaimed and purified halon to users. For the period 2005 to 2008, the total quantity of recovered, reclaimed and reused halon was about 3 MT of halon 2402. As opposed to the situation in the Russian market, there are no signs of usage of halon 2402 as a processing agent in the Ukraine.

At least one local company offers recycling and banking services to the market. Approximately 6-7 MT of halon 2402 were recycled during 2007. Ukrainian national regulations restrict the export of ozone depleting substances, including halons.

The most recent data on banks of halon 2402 contained in existing installed firefighting systems in the Ukraine are shown in Table 2. During the preparation of a draft concept of the National Halon Management Strategy for the Ukraine for the period 2004-2030 (final version of the document was adopted by the Decision of the Ukrainian Government No. 256, 4th March 2004) it was concluded that the installed base of halon 2402 in the Ukraine ranges from 552 to 602 MT. According to some Ukrainian experts, the current Ukrainian bank of halon 2402 can be estimated at 300–340 MT (1.5–2 times reduction in comparison with 2003). As shown in Table 2, the main users are the military sector, oil – gas industry, transport system and telecommunication facilities.

Table 2: Installed Halon-2402 in the major sectors in Ukraine

Sector	Halon-2402, MT
Oil and gas industry	40.0
Metallurgy, engineering	30.6
Transport, communication	11.5
Public health, culture and education institutions	6.2
Commercial banks	27.2
Military	12.3
TOTAL	**128.1**

Fire suppression equipment contains approximately 128 MT. Based on this, the total bank of halon 2402 in the Ukraine is less than is required to support important uses – Ukrainian national regulations require a 100% reserve of halon to support existing fire suppression units. The market price for halon 2402 in the Ukraine is not known, but Ukrainian experts do not believe the situation is a problem for the country because it plans to accelerate the adoption of halon alternatives.

Export is allowed to support the important needs of Article 5 Parties, but special permission of the Ukrainian government is required for the export. At this time the situation in Ukraine can be considered to be similar to that in Russia.

(*Source*: GEF Impact Evaluation Information Document n. 18, *GEF Impact Evaluation of thePhase-Out of Ozone-Depleting Substances in Countries with Economies in Transition,* VolumeTwo: Country Reports, October 2009. pp 223–242)

3.3 Belarus

The Parties to the Montreal Protocol endorsed the provision of international assistance to Belarus at its 7th Meeting. The Global Environment Facility (GEF) provided financial assistance to Belarus.

A small subproject financed a national workshop to provide technical assistance to stakeholders in the fire protection sector to discuss technology options for the conversion of halon-based fire protection systems. One of the main conclusions of the workshop was that Belarus needed to develop a system to recover, reclaim and recycle halon. The cost of this was outside of the current project's scope and a halon recycling system has not yet been established with national funds. Halon 2402 continues to be used in Belarus in the petrochemical industry, aviation and military. Notwithstanding that some end-users utilise recycling and reclamation equipment, the absence of centralised halon bank management creates the risk of avoidable and unavoidable emissions of halon to the atmosphere.

The total 1996 consumption of halon was 24 ODP tons and was reduced to zero in 2000. (*Source*: GEF Impact Evaluation Information Document n. 18, *GEF Impact Evaluation of the Phase-Out of Ozone-Depleting Substances in Countries with Economies in Transition*, Volume Two: Country Reports, October 2009. pp 25–36). According to a Decision of the Belarusian Government No. 1741 (adopted 13th November 1998), export/import operations of ozone

depleting substances are banned in Belarus. The main users of the halon 2402 are the military sector, oil – gas industry and civil aviation. At least one local company offers recycling and banking services to the market. Information on the Belarusian halon bank is unavailable.

At this time bureaucratic procedures have inhibited communication and work on these subjects with Belarus.

3.4 Caucasus: Armenia, Azerbaijan, Georgia

Armenia: The Country Programme (CP) was prepared by the Ministry of Nature Protection, UNEP and UNDP with financial assistance from the GEF. Upon a request from the National Ozone Unit of Armenia, a technical assistance mission on the status of halons management was carried out in Armenia in July 2007. The technical assistance mission demonstrated that there was a clear lack of awareness concerning halon management and available alternatives among the main halon stakeholders and parties with important uses/applications of halon 2402, such as the Armed Forces, the Fire Service and the Civil Aviation. The Armed Forces, the Fire Service and the Civil Aviation expressed their concern and need for further capacity building and technical awareness relating to halon management and suitable available alternatives.

The last survey of installed capacity of halon 2402 was carried out in 2005. Since then, the data have not been updated. The bulk of quantities of installed halon have not been identified and updated to provide a clear picture of the installed capacity and demand for halon 2402 in the country.

(Source: GEF Impact Evaluation Information Document n. 18, *GEF Impact Evaluation of the Phase-Out of Ozone-Depleting Substances in Countries with Economies in Transition,* Volume Two: Country Reports, October 2009. pp 1–14).

Azerbaijan: The initial country programme for the phase-out of ODS was compiled in 1997 at the initiative of the UNEP/IE, based on the data survey of ODS consumption in various sectors, conducted by the National Ozone Team. Azerbaijan reported halon consumption of 501.2 ODP tons, but UNDP later determined that this might be installed in equipment rather than consumed.

The GEF (Global Environment Facility) paid $135,000 of financial assistance to establish a Halon Bank and to implement halon recovery and recycling. The Fire Department was identified as being the operator of the national facility. The facility was designed to be operated under the guidelines that were to be developed by the Fire Department as part of the Azerbaijan Country Programme, with the assistance in the beginning from UNDP. It was not possible to obtain any meaningful information on the outcome of this subproject, which was completed in June 2001.

Recent estimates indicate that 53 MT of halon 2402 is in Azerbaijan. The Centre on Climate Change and Ozone (CCCO) received information from the Caspian Sea Navigation indicating that the total quantity of firefighting agent was 40.316 MT installed in fire suppression systems on 40 ships, including 1.0885 MT of Halon 2402. The communication from the Force Major Ministry, which is responsible for the Fire Fighting Service, reported that no halon was used in firefighting systems in Azerbaijan. The evaluation team was unable to verify the present situation with regard to halon use in ships.

(Source: GEF Impact Evaluation Information Document n. 18, *GEF Impact Evaluation of the Phase-Out of Ozone-Depleting Substances in Countries with Economies in Transition*, Volume Two: Country Reports, October 2009. pp 15–24).

Georgia: Based on other countries' experiences, it should be assumed that a demand for halon 2402 for the servicing of operating equipment exists and that halon from outside sources will be required.

3.5 Central Asia: Kazakhstan, Kyrgyzstan, Tadzhikistan, Turkmenistan, Uzbekistan

Generally speaking, all these countries have substantial halon 2402 stocks and needs related to the oil industry, but no coordinated information is actually available.

Kazakhstan: The GEF budgeted $163,231 for equipment that would allow halon to be recovered and reclaimed. Although halon consumption has been reported as zero from 1 January 2003, the programme for collecting and safely storing halon has been in abeyance for at least 5 years, which increased the prospects for unintentional halon emissions

Halon users were surveyed from 2002 until 2006, and a database of the halon type, quantity and location established. The database was not updated after 2006 because there was no financial support for this activity. It is estimated that 85 MT of halon 2402 has been stocked over the 4-year period.

(Source: GEF Impact Evaluation Information Document n. 18, *GEF Impact Evaluation of the Phase-Out of Ozone-Depleting Substances in Countries with Economies in Transition*, Volume Two: Country Reports, October 2009. pp 93-110).

Kyrgyzstan: On behalf of the Government of Kyrgyzstan, in March 2006 UNIDO submitted a project aimed at establishing and implementing a national halon management programme to support Kyrgyzstan in meeting its obligations under the Montreal Protocol (*Source*: United Nations Environment Programme, UNEP/OzL.Pro/ExCom/48/34, 3 March 2006).

There were no data available concerning halon stockpiles, contaminated halons and uses of halon. The project proposal indicated that Kyrgyzstan had potential halon users including the military, the national airlines, hydropower facilities, gold mines, oil and gas industry.

In 2006, the installed base was estimated at 80.7 MT of halon 2402.

Uzbekistan: The GEF provided financial assistance to Uzbekistan in order to assist it to become compliant with the requirements of the Montreal Protocol. Uzbekistan banned the import of halons except those intended for vital uses from 1st January 2000. Omitting plans to manage halon decommissioning and bank formation appeared to be an oversight in Uzbekistan's Country Plan, particularly as the country required the use of halon for about 22 aircraft. Thus Uzbekistan should develop a Halon Management Plan as soon as possible. The Plan should include decommissioning halon uses where alternatives are available, and storing the decommissioned halon for uses of halon that do not have an alternative, such as those uses in aircraft. Reclamation and banking equipment would be essential in order to stock as much decommissioned halon as possible.

SJSC Tapoich (TAPC) supplies halon-2402 fire extinguishing equipment for use on 3 types of aircraft that are used for fire and explosion suppression. The fire extinguishers and systems are used in different parts of the aircraft such as the engine nacelles, wings, cargo hold and crew-passenger compartments. The last of the halon stocks held by TAPC were depleted in 1996.

The National Ozone Unit (NOU) only discovered the need for halon after 2002 when an aircraft assembly plant requested a license to import halon-2402, as well as halon-1211 and halon-1301.

A total of about 1.9 MT was requested in 2002, 2003 and 2004. The Parties to the Montreal Protocol did not approve Uzbekistan's request, but instead recommended that the halon be imported from the Russian Science Federation (in St. Petersburg). The halon has been imported and the quantities stored at each location are known to the NOU.

(*Source*: GEF Impact Evaluation Information Document n. 18, *GEF Impact Evaluation of thePhase-Out of Ozone-Depleting Substances in Countries with Economies in Transition*, Volume Two: Country Reports, October 2009. pp 243–262).

3.6 European Union

In general there is only a minor demand for halon 2402 in some Member States of the European Union: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia. The majority of former halon 2402 applications have been switched to other agents and technologies, but a small sector of industry and the military sector continue to employ halon 2402.

Poland: Halons were imported from Russia and Western European countries. The majority of these halons, and the halon-based fire equipment, were imported in the late 1980s, meaning that the halon systems and other halon-based fire equipment installed in Poland are relatively new.

Halon 2402 was imported from the Russian Federation (in relatively small quantities), mostly for military equipment. Fire protection codes require fire-extinguishing systems in some categories of public and industrial buildings however they do not specify the type of the system that must be used. Halon 2402 has been used in fixed systems in military equipment and in portable fire equipment used for military applications. A small amount of halon 2402 is in use in the aviation sector on aircraft produced in Russia (Source: "Eliminating Dependency on Halons – Case Studies", UNEP DTIE Ozone Action Programme under the Multilateral Fund for the Implementation of the Montreal Protocol).

In 1998 there were three companies in Poland that were licensed to recover, reclaim and manage a halon bank. However, only two companies were equipped with halon reclamation equipment, which they financed themselves. There is no database held by the government that records the quantity of banked halon, so this could not be reported (Source: GEF Impact Evaluation Information Document n. 18, *GEF Impact Evaluation of the Phase-Out of Ozone-Depleting Substances in Countries with Economies in Transition*, Volume Two: Country Reports, October 2009, pp 139–154).

At the end of 2008, the installed quantity of halon 2402 in Poland was 6.549 MT, primarily being used by the military sector for their applications and by some users in industry. At the end of 2009, halon 2402 installed in applications had risen to about 10 MT, while the stockpiled

quantity for uses (deemed critical by Poland), export, or destruction more than doubled, changing from 1 MT at the end of December 2008 to 2.8 MT at the end of December 2009. Poland believed that it had enough halon 2402 to support its projected needs. (Source: Dr Janusz Kozakiewicz, Head of Ozone Layer and Climate Protection Unit – Industrial Chemistry Research Institute - 8, Rydygiera Street, 01-793 Warsaw, Poland).

At the end of 2011 the amount of halon 2402 installed in critical equipment was 9328 kg (slightly increased with respect to the previous year, 9096 kg) while the total quantity of halon 2402 stockpiled for critical use/export/destruction in the same period resulted to be 4231 kg, having doubled with respect to 2010. And in 2013, Poland reported having 9500 kg of installed halon 2402 and 1150 kg of stored halon 2402. (Source: Jadwiga Poplawska-Jach, Head of Ozone Layer and Climate Protection Unit – Industrial Chemistry Research Institute - 8, Rydygiera Street, 01-793 Warsaw, Poland).

Hungary: A GEF/World Bank Project, which was approved on 9 November 1995 and completed at the end of 1998, provided financial assistance to Hungary to phase out ODS. Within this project, Fajro Ltd – a small company that installs ODS-free fire protection equipment in Hungary – recovered and reclaimed halon. Reclaimed halon was used for refilling fire protection systems that Hungary qualified as 'critical' – that is, those uses that were without an alternative.

Fajro reported that the costs of halon reclamation had increased to €6-8/kg, depending on the time required, because of increased energy (electrical, transport fuel) costs.

The amount of halons reclaimed from 1994 to 2008 was 66 MT, which was much less than 2,900 MT estimated to have been installed as of 1994. Fajro currently has strategic reserves of about 7 M*T. (Source: G*EF Impact Evaluation Information Document n. 18, *GEF Impact Evaluation of the Phase-Out of Ozone-Depleting Substances in Countries with Economies in Transition*, Volume Two: Country Reports, October 2009. pp 77–92).

In 2006, the representative of the Hungarian Ministry of Environment and Water reported that the inventory of halon 2402 in Hungary was less than 10 MT. (Source: Róbert Tóth, "Halon-bank in Hungary", 5th Meeting of the Regional Ozone Network in Europe & Central Asia, 11-13 April 2006, Tbilisi, Georgia).

Czech Republic: The Czech Republic was one of the first eligible for GEF grant funds to launch a comprehensive ODS phase-out program, and it became the first project on ozone-layer protection approved by the GEF. In a sub-project, the reclamation centers were not supplied with equipment to recover halon. After the completion of the Project, decommissioned halon was collected, recovered and recycled, and stored by ESTO Cheb. These activities were supported by Czech legislation. Esto Cheb was also a partner in the Phare Program 2000 "Transfer of Advanced Fire and Explosion Protection Technologies", which financially supported the implementation of halon alternatives in the Czech Republic. (Source: GEF Impact Evaluation Information Document n. 18, *GEF Impact Evaluation of the Phase-Out of Ozone-Depleting Substances in Countries with Economies in Transition*, Volume Two: Country Reports, October 2009. pp 53–64).

For the 2006 reference period, the Czech Republic reported to EC Environment Directorate that the installed quantity of halon 2402 for applications considered critical by the EC was 5.09 MT.

Estonia, Latvia, and Lithuania: Halon 2402 is the most widely used halon in all three countries and seems to have been used in blends as well as more conventionally as a neat agent. This agent was used very little outside the former Russian sphere of influence, and as a consequence there was almost no international installed base to give rise to a market for trade in recycled agent. The Russian Federation was the major supplier of halon for these countries. (Source: GEF Impact Evaluation Information Document n. 18, *GEF Impact Evaluation of the Phase-Out of Ozone-Depleting Substances in Countries with Economies in Transition*, Volume Two: Country Reports, October 2009. pp 65–71).

A *UNDP/UNEP* Project (the "Project") was approved on 9 February 2000 and completed in December 2007, after 3 extensions, when additional time was necessary to finalise subproject implementation. The project's objective was to provide a (Baltic) regional centre for the recovery and reclamation of halon-2402, as well as of halon-1301 and halon-1211. In May 2002, a halon seminar was conducted on halon decommissioning and alternatives to halon, and technicians were trained in the use of halon recycling equipment. A Reclamation Centre was established to receive and store Estonian ODS. The Centre was also a regional base for receiving, reclaiming and storing halon 2001, 2402 and 1301 that had been decommissioned from fire protection equipment held in Estonia, Latvia and Lithuania. Halon that cannot be reclaimed will be sent to Sweden (Sakab AB) for destruction when sufficient quantities have been accumulated to make an economic shipment, but so far none has been shipped. The cost was €4-5/kg in 2005.

Eight Estonian-flagged ships were fined for not decommissioning halon, which has encouraged them and other ships to replace the halon with alternatives. There are 4–5 companies operating in Estonia that install non-halon alternatives on ships when they arrive at the port for a refit. As of May 2009, the NOU reported that there are no known ships flagged to Estonia that have halon on board, and the only halon deemed as necessary remains in aircraft and military equipment. (Source: GEF Impact Evaluation Information Document n. 18, *GEF Impact Evaluation of the Phase-Out of Ozone-Depleting Substances in Countries with Economies in Transition*, Volume Two: Country Reports, October 2009. pp 72–76).

Lithuania reported that halon for fire protection has been replaced by ODS-free alternatives where possible, thereby eliminating almost all uses.

Consumption of halons in each of these three countries was difficult to quantify to any acceptable degree of accuracy. However, Table 3 shows the estimated status as of May 1999.

Table 3: Halon 2402 data for Estonia, Latvia, and Lithuania (1999)

Country	Installed capacity, tons	Yearly Consumption, MT
Estonia	12.0	1.0
Latvia	15.0	1.5
Lithuania	8.0	0.5

There was no halon recovered in 2000 and 2001 from Estonia, but in 2007, the Reclamation Centre recovered and recycled about 0.8 MT of halon 2402 when all of the halon in the TV tower (about 1.8 MT) was replaced with an alternative. The quantities of halon 2402 recovered and recycled in Estonia from 2002 until 2008 are listed in Table 4. The quantities of halon 2402 sent by Latvia to the Estonian halon bank are shown in Table 5. So far, Lithuania has not sent any halon to the bank, as negotiations on the price for the halon failed.

Table 4: Halon 2402 Recovered and Recycled In Estonia from 2002 until 2008

Year	Halon 2402 Recovered, kg	Halon 2402 Recycled, kg
2002	1200	1200
2003	445	445
2004	2472	1777
2005	1338	1320
2006	1182	1182
2007	1857	800
2008	442	142
TOTAL, kg	**8936**	**6866**

Source: GEF Impact Evaluation Information Document n. 18, 2009

Table 5: Halon 2402 Quantities Sent By Latvia to the Reclamation Centre in 2008

Year	Halon 2402 Recovered, kg	Halon 2402 Recycled, kg
2008	1139	–

Source: GEF Impact Evaluation Information Document n. 18, 2009

Two MT of reclaimed halon were exported to the Indian Navy in 2006, and there have since been requests from India for Estonia to supply more halon from local or other sources (such as the Ukraine). In May 2009, the Reclamation Centre had stored about 1.5 MT of halon 2402. A certain amount of this was obtained from merchant ships. Determining the amount of halon from ships was problematic because data on halon were not recorded by the Maritime Administration. The NOU surveyed ship owners and as a result of the responses, estimated that the total halon on 463 ships was about 400 MT.

In Latvia, firefighting use in 1995 was reported to be 5 MT of halon 2402. Once imports of halon systems stopped, the number of halon systems in the country dropped and consequently the annual use. Since 1993, some 45–50 large computer facilities protected by halon systems have been dismantled. The annual use estimate for halon 2402 is 1.5 MT. Annual use of "BF-2" (a mixture of 37% halon 2402 and 63% methyl bromide (Brometil)), typically used only on ships, was ignored since all ships were sold to other countries, and service to existing systems or a change to other alternatives was not within this mission's scope. The status of such systems is questionable as to reliability, effectiveness, usage and compliance to fire and environmental standards.

In Lithuania the most widely used halon is 2402, including a mixture of 85% carbon dioxide with 15% halon 2402. The estimated amount of halon 2402 was about 8 MT. Determining the amount of halon on ships was problematic because no data were available at the time of the estimate. During 2006–2008, Lithuania decommissioned the halon systems on 28 ships and recovered 2.526 MT of halon including BF-2. According to information available to the Ministry

of Environment, today there are no Lithuanian-flagged merchant ships using halons. One ship with 0.214 MT of halon 2402 changed flag State and is no longer under Lithuanian jurisdiction.

Another ship is a special-purpose search and rescue ship with 0.420 MT of halon 2402 that was transferred to the military. (Source: GEF Impact Evaluation Information Document n. 18, *GEF Impact Evaluation of the Phase-Out of Ozone-Depleting Substances in Countries with Economies in Transition*, Volume Two: Country Reports, October 2009. pp 124–138).

The Environmental Ministry of Estonia, in collaboration with the Statistical Office, reported that 3.631 MT of halon 2402 were banked in 2004, and 0.124 MT of halon 2402 was sold at the end of the year. In total, about 1.280 MT of halon was contained in existing installed firefighting systems. (Source: GEF Impact Evaluation Information Document n. 18, *GEF Impact Evaluation of the Phase-Out of Ozone-Depleting Substances in Countries with Economies in Transition*, Volume Two: Country Reports, October 2009. pp 155–160).

In December 2012 the amount of halon 2402 banked in Estonia was 443 kg, and the Ambient Air Department confirmed that Estonia doesn't use halon 2402 anymore for any critical application. (Source: Kaidi Virronen, Senior Officer of the Ambient Air Department, Ministry of Environment in Estonia).

Slovakia: The Country Program for Czechoslovakia was undertaken in 1992. The total halon consumption was less than 10 MT. The country was qualified for assistance from the GEF. In Slovakia halon is used only for uses that are critical in accordance with EU Regulations in the following applications: aircraft and the military and petrochemical sector. The halon will be gradually replaced by acceptable and available alternatives and then stored in the Halon bank. (Source: GEF Impact Evaluation Information Document n. 18, *GEF Impact Evaluation of the Phase-Out of Ozone-Depleting Substances in Countries with Economies in Transition*, Volume Two: Country Reports, October 2009. pp 155–160).

Cyprus: 144 kg (0.144 MT) of halon 2402 are installed in aircraft (Mi-35P) protection, while no halon bank exists in this country. (Source: Ministry of Agriculture, Natural Resources and Environment – Cyprus, 2008).

Italy: In 2007, Italy reported to EC Environment Directorate that about 7 MT of halon 2402 were available to satisfy the market needs – no data was available for 2008.

According to information from the Italian Ministry of Environmental Protection, in 2002 the halon banks of some other EU Member States contained 1394 MT of halon 2402 – Netherlands (1100 MT), Italy (219 MT), Denmark (70 MT), Germany (5 MT). However, these quantities have not been confirmed and are not included in the HTOC assessment of global supplies of halon 2402.

3.7 India

Halon 2402 was traditionally used in the Indian Military in equipment of USSR origin for fire and explosion suppression systems and portable and mobile extinguishers. These systems and extinguishers were part of the equipment in Armoured Fighting Vehicles (e.g., T-54, T-60, T-70, T-80 produced in the 1990s), Ships, Submarines, Fighter & Transport Aircraft including

Helicopters. These halon based systems and extinguishers were also used in USSR supplied ground based Missile Complex.

Halon 2402 was never manufactured in India and servicing and refilling activities have always been supported by USSR suppliers. Typically, India has used pure halon 2402 and also its blends, e.g., halon 2402 and ethyl bromide.

Licenses are needed to import halon, but there are no other barriers. In 2007, India received 9 MT of halon 2402 from the Russian Ministry of Defence. These quantities were necessary to support those users who still need to maintain their fire protection systems for which effective alternatives have not been identified.

After India signed the Montreal Protocol, the military planned to replace this high ODP substance wherever possible. Supply for servicing and refilling was depleting fast from the former USSR, and therefore users such as the Air Force planned to gradually switch over to halon 1211 for engine and portable extinguishers; the Navy to halon 1301; and the Army to halon 1301 and halon 1211. Other alternatives (e.g., HFC-236fa) have been tested. Although the Military is still using halon 2402 in very limited applications, no new systems based on this halon have been installed. Currently there is a sufficient quantity available and there is no difficulty in sourcing it from outside the country if needed.

There was limited use of halon 2402 in the civil sector, primarily by oil companies for fire and explosion suppression in floating roof tanks. Supplies of halon 2402 came from Europe as well as servicing and repairs of equipment. However, the oil companies have replaced these systems with foam flooding systems or other gaseous systems (Triodide). From a recent limited survey, including at a Conference and Exhibition of Fire India Mumbai, it seems that halon 2402 is no longer used in any civil fire protection system.

About 8-10 MT of halon 2402 were recovered from ship breaking up until 2010. It is understood that 2-3 MT/year is still recovered and sold as scrap. Recently one vendor at Alang Shipbreaking Yard has received permission to get the scrap managed through recycling in India or abroad.

3.8 Vietnam

In 2005, the Government of Vietnam requested financial support from the MLF for a project to cover part of their phase-out costs over a period of five years (from 2005 to 2010).

At that time Vietnam estimated their total installed base of halon 2402 was 11.7 MT. An estimated reduction to 3.617 MT was anticipated for 2010.

Vietnam has experienced difficulty in sourcing halon 2402 from international markets, but the project should provide halon 2402 recovery and recycling equipment and also technical assistance to identify proper non-halon alternatives for those applications where alternatives are already available.

The CFC/Halon sub-project (US$ 1,260,000) was completed in 2010 and all phase-out targets have been met. By January 1st, 2010, a total of 319.4 ODP tons of ODSs (CFCs, Halon and CTC) had been phased out under the project.

(Source: The World Bank, Project (P083593), Report No: ISR6393, Implementation Status & Results Vietnam Vietnam National CFC and Halon Phaseout, December 2012).

Vietnam needs to set up a halon bank for halon 2402 particularly for the petroleum industry.

Currently no information is available about this project.

Vietnam also has a demand for halon 2402 to support important applications in the military sector. Information on the amount of requested halon is unavailable, but it is known that an attempt to find the product in the Russian market was unsuccessful.

3.9 Japan

Halon 2402 is mainly used for floating roof tank protection in the petrochemical industry. It was also used for explosion suppression but these may have already been replaced. When replaced the halon was collected and some was destroyed. The cost of destruction was close to 10 USD/kg.

Halon 2402 is a vital material for the fire safety of oil tanks in Japan and, as the timing of decommission/replacement of halon 2402 fire protection systems is not clear, there are no plans to export halon 2402.

Total installed halon 2402 has been estimated to be 181 MT as of March 2013. With respect to the amount of halon 2402 in ships, aircraft and the military, it was estimated to be 4 MT as of December 2006. Japan does not have any surplus halon 2402 to support other Parties' needs.

3.10 Afghanistan, Algeria, China, Cuba, Egypt, Libya, Mongolia and Syria

Information on the installed capacity and demand for halon 2402 in Afghanistan, Algeria, Egypt, China, Cuba, Mongolia, Libya and Syria is not currently available. However, it is reasonable to assume that in these countries a demand for halon 2402 for the servicing of operating equipment exists and that halon from outside sources is required, in particular from Russia and Ukraine.

As previously said, currently the purchase of halon 2402 from Russia appears to be virtually impossible, since Russia itself had to acquire 15 MT of halon 2402 from the USA to satisfy its internal demand.

3.11 USA

The United States has a limited amount of excess halon 2402 available for export. This halon was likely from a non-fire extinguishing application. The product is ready for purchase and can be used to support the needs of any customer. The supplier is responsible for all export paperwork and duties while the buyer is responsible for import paperwork, taxes and duties.

Confirmed amount of reclaimed halon 2402 in the US halon bank is about 11 MT. It is anticipated that most or all of this halon came from non-fire protection uses.

4.0 Support for International Maritime Operations

The International Maritime Organisation (IMO) Sub-Committee on Fire Protection has provided information on the availability of halons at various ports of the world for existing maritime halon systems that may need to be recharged with recycled halons in compliance with the relevant requirements of the 1974 Safety of Life at Sea (SOLAS) Convention. Member Governments provided information on available halon banking facilities. Table 6 is an updated list of country facilities and their halon services available, extracted from IMO FP.1/Circular 44 dated 26 January 2012, see reference [2].

Table 6 Halon Banking and Reception Facilities at Various Ports around the World Available for Maritime Halon Needs

Country	Facilities	Type of Bank
Argentina	INTI	Virtual Halon Bank
Australia	Australian National Halon Bank	Full Service Halon Bank
Brazil	One Facility	Halon Receiving, Recharging, and Supply
Canada	One Commercial Entity	Dismantling, Recovering, Recycling, and Banking Halon1301
Croatia	One Facility	Halon Bank
Egypt	Two Facilities	Halon Bank
Finland	Federation of Finnish Insurance Companies	Virtual Halon Bank
France	Numerous Facilities	Halon Recycling, Recovery, and Supply
Italy	Numerous Facilities	Halon Recycling, Recovery, and Supply
Norway	Numerous Facilities	Halon Recycling, Recovery, and Supply
Poland (1)	Savi Technologies and Pož-Pliszka	Halon Recovery, Recycling, Reclamation, and Supply
Republic of Korea	One Commercial Entity	Halon Recycling, Recovery, and Supply
Russian Federation	One Facility	Halon Recycling, Recovery, and Supply
United States	Halon Recycling Corporation	Virtual Halon Bank
Hong Kong, China (1)	Environmental Protection Dept.	Virtual Halon Bank

Note 1: Not listed in the IMO Circular

5.0 Pathway to Halon Management and Banking

Halon banking comprises but a portion of an overall Montreal Protocol compliance programme. The other features of a comprehensive programme should occur before a halon bank is established. Examples of these features include:

- Establish governmental policy and program
- Implement Awareness Campaigns
- Choose appropriate replacements or alternatives
- Develop or adopt Standards for the Design, Installation, and Maintenance of fire protection systems (including halon and halon alternatives)
- Survey installed capacities & establish database of halon users
- Identify remaining mission-critical uses and quantity requirements
- Identify acquisitions or halon sources (recoverable and available for reclaiming) from uses not considered critical by the Party
- Identify & involve stakeholders
- Establish National Halon Steering Committee
- Open discussions with the military, civil aviation, shipping, & airlines
- Plan for decommissioning of halon systems

A decision can then be made whether to establish or join a halon bank to meet mission-critical uses.

Important policies that have been shown to help ensure successful implementation of a banking program include:

- Emphasize to stakeholders that supplies are limited with no future production
- Prohibit new halon systems in facilities or new equipment designs
- Prohibit halon emissions in testing and drills – use only on real fires
- Replace discharged halon systems with other forms of fire protection
- Require that all halon removed from retired systems be sent to the bank
- Prohibit purchases of halon on the market – all transactions via the bank – through regulations or voluntary agreements
- Exchange information and expertise regionally
- Develop halon regulations, e.g., importation of halons, a quota system.
- Develop and approve code of conduct/strategy

The Concept of Operation is as follows:

- The bank acts as a centralized warehousing and repair facility
- The bank becomes a “one stop shop” for all halon transactions; e.g., turn in, reclamation, storage and reissue
- All used halon is turned in to the bank
- Deliver the type and quantity of halon bottles where and when needed
- Bank provides clean halon for applications, as needed
- Bank provides testing of halon quality and certification
- Information available in the form of brochures, newsletter, website, phone, etc.

Record keeping and program management are greatly simplified by strict adherence to the banking concept because multiple, dispersed physical storage locations and information systems are eliminated. Bank users should be apprised of the benefits they derive from their participation in a banking program, such as consistent quality and predictable supplies of halon.

Options for setting up a halon bank include contractor-operated, government-operated or a combination of these. The combination option allows for a contractor to run 'normal' operations, but ownership and control of government halon is maintained by government personnel who monitor turn-ins and approve issues, as well as retaining overall program control.

A purely contracted operation would be less expensive to set up initially, but it may be more difficult for a private concern to obtain halon or ensure compliance with national policies than a government or military organisation would experience.

A purely government operated bank would ensure stricter control of quantities and availability of halon, but would likely be more expensive to set up and maintain. The expertise required to operate the halon bank may be difficult to obtain in a government organisation.

Halon bank rules should be clearly established up front and strictly adhered to during operation. The bank concept is that you can't take out more than you put in. Issues will be limited to those required for authorised uses and not for convenience. Examples include aircraft, tactical vehicles, and shipboard uses. Some important command, control, and communications facilities could be included. A list of authorised users must be created and issues to those users should be made in approved quantities.

Halon removed from service must be sent to the bank for reuse. Owners are not allowed to sell, trade, give away or dispose of halon. The bank must provide shipping and containers free of charge. It must be easy and cost nothing to encourage field units to turn in used halon. After encouraging and facilitating all possible sources to turn in their halon, the Bank may then turn to commercial sources to obtain recycled halon. This can be expensive, but should be considered to meet necessary requirements.

The basic functions of the bank are to receive, test, recycle/reclaim and repackage, store, and issue halons. In addition, the bank must either refurbish cylinders in-house or contract out this function.

Safety is critical in the operation of a halon bank. Workers must be fully trained to know and avoid common safety problems when dealing with compressed gas cylinders. Hand held leak detectors should be used at receiving facilities. Each cylinder should be inspected for valve type and integrity to include all safety devices. Workers should always assume a cylinder is fully pressurised regardless of gauge reading.

Cylinders should always be chained down when being evacuated or worked on in any way. Workers need to be trained to know the different types of valves and how they activate, e.g., Burst Disk/Initiator, Mechanical/Cutter Valves, and Schrader Valves. Everyone working on halon cylinders needs to be fully trained to avoid fatal accidents.

In addition to safety training, workers need to be competent to perform the routine functions of the bank:

- Leak test incoming cylinders
- Verify product and possible contaminants

- Remove/recover all halon to specified level of vacuum
- Repackage into larger cylinders
- Clean halon to specification
- Repackage for storage and Issue
- Certify workers
- Use certified equipment
- Administer and produce dated and signed documentation that certifies halon has been decontaminated (certificate of analysis)

All incoming halon must be tested. Cylinders may not contain what the label states. Halon may be contaminated and unsuitable for use. Always test before repackaging as small impurities can contaminate large amounts of otherwise good halon. All halon that cannot be recovered should be sent to a nationally approved facility for destruction.

It is essential that the banking operations do more than "recover" the halon, which is simply the collection and storage of the halon prior to disposal. The bank should provide as a minimum halon recycling which is the reuse of halon after a basic cleaning process of filtering and drying. In this case nitrogen should not be vented but rather processed through a halon recycling unit in order to capture all halon. The optimum services for the bank to provide are analysis of the gases contained within the cylinder, reclamation of the halon followed by chemical analysis, and certification. Reclamation is recycling as previously defined followed by nitrogen separation in order to restore the halon to a minimum of 99.0% purity for halon 1211 and 99.6% for halon 1301 (see ISO 7201 and ASTM D5632, references [3] and [4]). Both recycled and reclaimed halons should be provided to users with certificates of analysis. Recycling/reclamation are core functions of a halon bank. Commercial recycling and reclamation machines are available on the market. Halon 1211, halon 1301, and halon 2402 are recyclable and reclaimable. Operator training is required. Reclamation equipment is more sophisticated and expensive. Reclamation is the preferred method and is usually not available at a servicing company, so it should be part of a national banking operation if at all possible. If the halon is found to have cross-contamination then it will need to be cleaned using a distillation process.

Cylinders can be refurbished for reuse by undertaking the following steps:

- Visual inspection
- Hydrostatic test
- Sand blast, prime, and paint
- Valve removal and insertion
- Valve rebuilding
- Clean interior
- Pressurise in chamber/check expansion
- Steam dry
- Certify facility and workers

Cylinders that are out of test date should be recertified by a nationally approved testing facility.

During storage, halon should be colour-tagged to denote new versus recovered, type and quantity, ready for issue or not, and owner. Halon should be kept between 20 and 100 degrees F (-7 and 38 degrees C). Cooler is better. All halon, cylinders, and operating equipment should ideally be housed within a conditioned space. Security measures should include fencing, motion sensors, and video cameras. Areas housing halon storage tanks should be equipped with leak detection and alarm systems that allow rapid identification of leaking tanks, or should have a periodic leak detection procedure in place. Facilities should also be equipped to allow transfer of halon from a leaking tank to an empty tank to avoid loss of the entire contents.

In summary, halon banking is one part of an overall halon management program. Efforts to identify equipment using halon, select replacements, identify mission-critical uses, and monitor progress all need to be accomplished. Establishing and enforcing the bank rules is critical to success. Issues must be limited to authorised users for mission-critical applications only. Safety is paramount – unsecured halon vessels can kill! Leak detection and physical security protect scarce, valuable halon.

6.0 Current Situation

In reviewing the halon recycling component of a number of halon management programmes, there is very often a conflict between the policies introduced and enforced and the objectives the halon recycling activities envisaged. One example has been the introduction of policies and regulations banning or significantly limiting the use of halons (including recycled halons), and at the same time setting up a halon recycling program with the expectation that it be financially self-supporting, while at the same time the market for halons for servicing have been more or less eliminated through the policies and regulations. Another counterproductive policy is to require all halon users turn in decommissioned halon to the bank while requiring them to pay for the testing, transportation, storage, and/or cylinder disposal. In many Latin American countries legislation has been passed prohibiting the importation of recycled halons (it appears they believed this was required by the Montreal Protocol) – this will become a long term problem for those whose supplies are inadequate to service the ‘critical’ users most importantly being the civil aviation and military.

Halon management and recycling programmes differ considerably from country to country. They are very much based on national regulations and business requirements. In some countries the fire protection industry and some of the important halon users have established a national focal point as a broker function, where halon users and buyers can register their need for or surplus of halons so that those who want to sell can announce their halons and those who want to buy can find halon available and contact the seller. The focal point is not involved in the physical transfer of halon. The focal point is normally financed through a combination of membership fees and a fee for each transaction through the focal point. In general this method has worked well in the Article 5 countries where supportive infrastructure is in place. It is not working as well in the non-Article 5 countries. Many of these countries are not able to identify the quantities of halon or the users. They do not have a central office or focal point to collect the information needed and to provide it on a regular basis (for example, while collecting the data for this report NOO’s changed or were unavailable for halon specific issues). Most countries indicated they are experiencing severe financial restrictions. Some countries reported they did not have adequate governmental fire support services and in one case they reported the state fire servicemen were

unfamiliar with halon cylinders. In many cases, the "important" users such as the military and gas producers set up their own internal recycling because there are no focal points or comprehensive national programmes.

Awareness Campaigns have been demonstrated to be very helpful to the national halon banking programmes and in some cases they have played a major role in determining the success of the programme. The Jordanian halon bank is an example of the importance an Awareness Campaign can play. In 2009, the bank manager reported the halon owners were not turning their halons into the bank. The Ministry of Environment's Ozone Unit and the halon bank manager targeted the halon users in Jordan with Awareness Workshops addressing "availability of halon in the international market". As a result, most of the halon users started turning their halons into the national bank.

A number of recycling companies exist that have evolved over time. From manufacturing halon recycling equipment, or as fire equipment companies, or fire service companies, they have developed into international halon recycling centres on a strictly commercial basis. They buy halons from existing users and owners of halons and from other recycling centres and sell it to users. As they operate on a commercial basis, the operation cost is covered by selling recycled halons. The demand and availability of recycled halon is of course a key factor in the sustainability of the operation.

Major recyclers report that the supply of halon 1211 is now limited and they anticipate this trend will continue. As we get further away from halon production cessation, the chance of halons becoming cross-contaminated increases as halon is recycled more than once, especially for halon 1211, and as older systems that may not have been charged properly or maintained properly are identified and decommissioned. Additionally, recyclers warn that as the price goes up due to lack of availability, the chances of having this material intentionally spiked with other substances also increases thus further limiting the amount of halon globally available and increasing the amount of halon needing destruction.

While halon 1301 seems to be more plentiful in availability and supply, the large individual sources of halon 1301 are getting more difficult to find. Major recyclers report the price of used halon 1301 has tripled since halon cessation in 2010.

Halon 2402 is reported to be available in at least one country, and major recyclers report there is still a demand for this material when it is located.

7.0 Challenges

The implementation of some of the projects in Article 5 Parties faced a number of challenges that limited and/or were the main reasons for failure of these projects. Below are some of these challenges:

- Competition within the fire protection industry in the country resulted in lack of general support from the rest of the fire protection industry. (Used as a platform for promotion of the company and replacement of halon fire equipment).
- Selection of a company with no prior experience within the fire protection industry.

- Selection of a company which only needed the halon for its own use.
- Regional centre concept is difficult to implement – transportation of halon or recycling equipment severely problematic.
- Not enough business to sustain operation.
- Slow or delayed programme implementation resulted in bulk of halon being removed from country prior to banking operations coming on line.
- The bulk of the project funding is exhausted in the purchase of halon recovery and recycling equipment.
- The ability of some host countries to operate and maintain halon recovery and recycling equipment centres have been problematic (sustainability of the banks).
- Finding excessive quantities of contaminated halons in some countries, particularly in Africa. As venting would be unacceptable, shipping to and cleaning up at a reclamation facility would be needed; however, it remains to be determined how to cover such costs.
- Selection of inappropriate recycling and recovery equipment and inadequate operators' training.
- Data on the installed base and stored inventories of halon is poor.
- Coordination with military branches is not being done.
- Exchange of data and information are not adequate.
- Overly restrictive national regulations that prevented the free flow of recycled halon.
- Lack of regulations in support of halon banking and phase-out.
- Lack of enforcement of existing regulations.
- No focal point for halon programme management including frequent turnover of NOOs.
- Little or no Awareness Campaign.
- Insufficient workshops and training and not including all stakeholders.
- Lack of Business Plan and/or lack of Halon Bank Management Plan

There has been an unanticipated lag in the establishment of halon banking and management programs globally. Whereas some countries and organisations were proactive, many are just now beginning implementation or the consideration of legislation and implementation. Nonetheless, despite global turmoil, changing political parties, and lack of infrastructure, the progress of halon phase-out is steady, and with continued support, the Montreal Protocol processes will allow for the utilisation of halons in the remaining important uses while minimising unnecessary emissions to the atmosphere.

8.0 Conclusions

Halon banking operations can play a significant role in ensuring the quality and availability of recycled halon, in managing the consumption down to zero, and in assisting with emission data by providing regional estimates that should be more accurate than global estimates. National or regional banking schemes that maintain good records offer the opportunity to minimise the uncertainty in stored inventory and stock availability. Parties are highly encouraged to implement awareness campaigns and maintain them on a continuous basis for the next decade, to insist upon accurate national halon inventories, and to establish national halon banking schemes in order to ensure that the needs deemed critical by a Party are met.

9.0 References

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Appendix A: List of Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
CEIT	Countries with Economies in Transition
CFC	Chlorofluorocarbons
CO_2	Carbon Dioxide
EC	European Commission
EU	European Union
GEF	Global Environment Facility
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbons
HTOC	Halons Technical Options Committee
IMO	International Maritime Organisation
ISO	International Organisation for Standardisation
kg	kilogrammes
MLF	Multilateral Fund
MT	Metric Tonnes
NOO	National Ozone Officer
NOU	National Ozone Unit
ODP	Ozone Depletion Potential
ODP tons	Weight of the ODS in metric tonnes multiplied by its ODP
ODS	Ozone Depleting Substance
SOLAS	Safety of Life at Sea
TEAP	Technology and Economic Assessment Panel
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
US	United States
USA	United States of America
USSR	Soviet Union

Appendix B: Definitions

Article 5 Parties: Parties to the Montreal Protocol whose annual calculated level of consumption is less than 0.3 kg per capita of the controlled substances in Annex A, and less than 0.2 kg per capita of the controlled substances in Annex B, on the date of the entry into force of the Montreal Protocol, or any time thereafter. These countries are permitted a ten year "grace period" compared to the phase out schedule in the Montreal Protocol for developed countries. The Parties in this category are known as "countries operating under Article 5 of the Protocol".

Atmospheric Lifetime: The total atmospheric lifetime or turnover time of a trace gas is the time required to remove or chemically transform approximately 63% (i.e., $1-1/e$) of its global atmospheric burden as a result of either being converted to another chemical compound or being taken out of the atmosphere by a sink.

Consumption: Production plus imports minus exports of controlled substances.

Countries with Economies in Transition (CEITs): States of the former Soviet Union, and Central and Eastern Europe that have been undergoing a process of major structural, economic and social change, which has resulted in severe financial and administrative difficulties for both government and industry. These changes have affected most areas of community life, as well as implementation of international agreements such as the phase out of ODS in accordance with the Montreal Protocol. CEITs include both Article 5 and non-Article 5 countries.

Country Programme (CP) A national strategy prepared by an Article 5 country to implement the Montreal Protocol and phase out ODS. The Country Programme establishes a baseline survey on the use of the controlled substances in the country and draws up policy, strategies and a phase out plan for their replacement and control. It also identifies investment and non-investment projects for funding under the Multilateral Fund.

Decommissioning: Decommissioning is the physical process of removing a halon system from service. This must be done to recover the halon so that it can be made available for other uses. Effective decommissioning requires knowledge of good practices related to technical procedures and safety measures.

Essential Use: In their Decision IV/25, the Parties to the Montreal Protocol define an ODS use as "essential" only if: "(i) It is necessary for the health, safety or is critical for the functioning of society (encompassing cultural and intellectual aspects) and (ii) There are no available technically and economically feasible alternatives or substitutes that are acceptable from the standpoint of environment and health". Production and consumption of an ODS for essential uses is permitted only if: "(i) All economically feasible steps have been taken to minimise the essential use and any associated emission of the controlled substance; and (ii) The controlled substance is not available in sufficient quantity and quality from existing stocks of banked or recycled controlled substances, also bearing in mind the developing countries' need for controlled substances".

Halon: The halon terminology system provides a convenient means to reference halogenated hydrocarbon fire extinguishants. Halogenated hydrocarbons are acyclic saturated hydrocarbons in which one or more of the hydrogen atoms have been replaced by atoms from the halogen

series (that is, fluorine, chlorine, bromine, and iodine). By definition, the first digit of the halon numbering system represents the number of carbon atoms in the compound molecule; the second digit, the number of fluorine atoms; the third digit, the number of chlorine atoms; the fourth digit, the number of bromine atoms; and the fifth digit, the number of iodine atoms. Trailing zeros are not expressed. Unaccounted for valence requirements are assumed to be hydrogen atoms. For example, bromochlorodifluoromethane – CF_2BrCl - halon 1211.

Halons exhibit exceptional fire-fighting effectiveness. They are used as fire extinguishing agents and as explosion suppressants.

Halon 1211: A halogenated hydrocarbon, bromochlorodifluoromethane (CF_2BrCl). It is also known as "BCF". Halon 1211 is a fire extinguishing agent that can be discharged in a liquid stream. It is primarily used in portable fire extinguishers. Halon-1211 is an ozone depleting substance with an ODP of 3.0.

Halon 1301: A halogenated hydrocarbon, bromotrifluoromethane (CF_3Br). It is also known as "BTM". Halon 1301 is a fire extinguishing agent that can be discharged rapidly, mixing with air to create an extinguishing application. It is primarily used in total flooding fire protection systems. Halon 1301 is an ozone depleting substance with an ODP of 10.

Halon 2402: A halogenated hydrocarbon, dibromotetrafluoroethane ($C_2F_4Br_2$). Halon 2402 is a fire extinguishing agent that can be discharged in a liquid stream. It is primarily used in portable fire extinguishers or hand hose line equipment, and fire protection for specialised applications. Halon 2402 is an ozone depleting substance with an ODP of 6.0.

Halon Bank: A halon bank is all halons contained in fire extinguishing cylinders and storage cylinders within any organisation, country, or region.

Halon Bank Management: A method of managing a supply of banked halon. Bank management consists of keeping track of halon quantities at each stage: initial filling, installation, "recycling", and storage. A major goal of a halon bank is to re-deploy halons from decommissioned systems. Halon banks can be managed by a clearinghouse, i.e. an office that facilitates contact between halon owners and halon buyers.

Halon Management Strategy: The Parties to the Montreal Protocol through Decision X/7 (November 1998) reinforced the need for a comprehensive strategy to manage halon stocks. They requested all Parties to “develop and submit to the Ozone Secretariat a national or regional strategy for the management of halons, including emissions reduction and ultimate elimination of their use”.

Halons Technical Options Committee (HTOC): An international body of experts established under the Technology and Economic Assessment Panel (TEAP) to regularly examine and report to the Parties on the technical options and progress in phasing out halon fire extinguishants (see TEAP).

Montreal Protocol (MP): An international agreement limiting the production and consumption of chemicals that deplete the stratospheric ozone layer, including CFCs, halons, HCFCs, HBFCs, methyl bromide and others. 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 the protocol to the Vienna convention.

Multilateral Fund (MLF): Part of the financial mechanism under the Montreal Protocol. The Multilateral Fund for Implementation of the Montreal Protocol has been established by the Parties to provide financial and technical assistance to Article 5 Parties.

National Ozone Unit (NOU): The government unit in an Article 5 Party that is responsible for managing the national ODS phase-out strategy as specified in the Country Programme. NOUs are responsible for, inter alia, fulfilling data reporting obligations under the Montreal Protocol.

Non-Article 5 Parties: Parties to the Montreal Protocol that do not operate under Article 5 of the MP.

Ozone Depleting Substance (ODS): Any substance with an ODP greater than 0 that can deplete the stratospheric ozone layer. Most of ODS are controlled under the Montreal Protocol and its amendments, and they include CFCs, HCFCs, halons and methyl bromide.

Ozone Depletion Potential (ODP): A relative index indicating the extent to which a chemical product destroys the stratospheric ozone layer. The reference level of 1 is the potential of CFC-11 and CFC-12 to cause ozone depletion. If a product has an ozone depletion potential of 0.5, a given mass of emissions would, in time, deplete half the ozone that the same mass of emissions of CFC-11 would deplete. The ozone depletion potentials are calculated from mathematical models, which 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 stratosphere, approximately 15 to 60 kilometres (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 most ultraviolet radiation, preventing it from reaching the earth.

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

Party: A country that has ratified an international legal instrument (e.g., a protocol or an amendment to a protocol), indicating that it agrees to be bound by the rules set out therein. Parties to the Montreal Protocol are countries that have ratified the Protocol.

Phase Out: The ending of all production and consumption of a chemical controlled under the Montreal Protocol.

Pre-Action Sprinkler: A sprinkler system whose pipes are normally dry and are charged with the extinguishing agent (e.g., water) only when the fire detection system actuates.

Production: The amount of controlled substances produced, minus the amount destroyed by technologies to be approved by the Parties and minus the amount entirely used as feedstock in

the manufacture of other chemicals. The amount recycled and reused is not to be considered as "production".

Reclamation of Halons: To reprocess halon to a purity specified in applicable standards and to use a certified laboratory to verify this purity using the analytical methodology as prescribed in those standards. Reclamation is the preferred method to achieve the highest level of purity. Reclamation requires specialised machinery usually not available at a servicing company.

Recovery of Halons: To remove halon in any condition from an extinguisher or extinguishing system cylinder and store it in an external container without necessarily testing or processing it in any way.

Recycling of Halons: To extract halon from an extinguisher or system storage container and clean the halon for reuse without meeting all of the requirements for reclamation. In general, recycled halon is halon that has its super-pressurising nitrogen removed in addition to being processed to only reduce moisture and particulate matter.