

Halons Technical Options Committee

2018 Assessment Report

Volume 3

Montreal Protocol
on Substances
that Deplete the
Ozone Layer

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**MONTREAL PROTOCOL
ON SUBSTANCES THAT DEplete
THE OZONE LAYER**

**REPORT OF THE
HALONS TECHNICAL OPTIONS COMMITTEE
DECEMBER 2018**

VOLUME 3

**2018 SUPPLEMENTARY REPORT #2
GLOBAL HALON, HCFC, AND HFC BANKING**

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on Substances that Deplete the Ozone Layer**

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Halons Technical Options Committee

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Preface

The December 2018 HTOC Report consists of three volumes:

Volume 1: 2018 Assessment Report

Volume 2: 2018 Supplementary Report #1 – Civil Aviation

Volume 3: 2018 Supplementary Report # 2 – Global Halon, HCFC, and HFC Banking

Supplemental Report #2, *Global Halon, HCFC, and HFC Banking*, expands on the abbreviated information contained in the main body of the 2018 Assessment Report of the UNEP Halons Technical Options Committee (HTOC), which briefly introduce the subject of *Global Banking* and refer 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. Additionally, space restricted the number of country reports that could be included; 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. One final point, the name and scope of this report has changed to reflect the inclusion of HCFC and HFC banking due to the production phase-out of HCFCs and the phasedown of HFCs under the Montreal Protocol.

1.0 Introduction

The total amount of fire extinguishing agents that are installed or banked in fire protection systems far exceeds the yearly amount that is emitted (discharged). This simple fact led to the concept that recovery, recycle/reclaim and re-deployment of fire extinguishing agents from decommissioned or retrofitted systems could be a large part of the responsible management of existing fire extinguishing banks and would also serve to reduce the need for new production. This led initially to what was referred to as halon banking and the agents that were in them became referred to as the halon bank. This concept of properly managing the bank of fire extinguishants is also true for the hydrochlorofluorocarbon (HCFC) and hydrofluorocarbon (HFC) agents as well.

For the purposes of this Report, “banking” is considered to be all functions both physical and virtual that involve the use, recovery, recycling, reclamation, transfer, storage, and disposal of all halons, HCFCs, and HFCs used for fire protection. A facility or organisation can either perform the banking function physically as a “physical” bank with agent actually stored and maintained in specific locations, or they can act as a clearinghouse where agent users can be facilitated in turning-in agent and/or obtaining agent. Virtual banking is a clearinghouse whereby agent transfer is facilitated between users. A bank is defined as all of the fire extinguishing agents contained in fire extinguishing cylinders and storage cylinders within any organisation, country, or region. Likewise, the ‘global bank’ is all of the agent presently contained in fire equipment plus all stored at distribution or recycling centres, fire equipment companies, users’ premises, etc., i.e., it is all of the fire extinguishing agent produced to date that has yet to be emitted or destroyed.

While halon banking is the only source of halon to service equipment*, there is still limited ongoing production of HCFCs to service new equipment in non-A5 parties (Decision XXX/2) and the production, while under a phase-out schedule, is still on-going for new and existing systems in A5 parties. As a result of the Kigali amendment, beginning in 2019, HFC production phase-down begins in non-A5 parties although at only a 10% reduction. Thus, the three different classes of fire extinguishing agents, halons (Annex A group II), HCFCs (Annex C group I), and HFCs (Annex F), are in differing maturity levels for banking.

Halon banking is quite mature and continues to be a critical part of the management of halons as the only source of halons for both new and existing systems. As such, there is a lot more known about halon banking, and global and regional supplies. Halon users exist in most countries and include commercial aviation, the military sector, and some applications in banking, telecommunications and computer rooms, oil & gas, etc. The use of halons will 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 and for the foreseeable future there still are no drop-in replacements. Halon banking is a critical part of the management of halons and is essential for the remaining uses that must continue to rely upon them.

* Recycled halons are the only source for the new installations in military and more significantly for civil aviation.

Likewise, as the phase-downs proceed further for HCFC and HFCs and a heavier reliance is needed on banking to provide agents to support systems, more information on their bank management is expected to be available to the HTOC and reported in its 2022 and 2026 Assessment Reports (as requested for HCFCs in Decision XXX/2). For now, the little information that is available on HCFC and HFC banking is provided in Chapter 2 of this report. Since much more is known on halon banking, it is covered extensively in Chapters 3 and 4 for halon 1211 and 1301, and halon 2402 respectively. Nevertheless many, if not all, of the good practices that led to successful halon banks will be applicable to other HCFC and HFC fire extinguishing agent banks in the future.

All halon, HCFC and HFC fire protection users must be made aware of the cessation of halon and phase-out of HCFC and the phasedown of HFC production and the need to cease emitting these agents. Parties must develop fire extinguishing agent bank programmes even if it is simply a guidance document utilized by the National Ozone Unit (NOU) to educate users and facilitate halon use. Bank programmes need to be accessible to all users and recyclers 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 particularly halon becomes scarcer, there is a significant risk of unscrupulous vendors and users filling cylinders with contaminated or counterfeit halon. This group could in turn sell this contaminated halon as fit-for-purpose agent, thereby creating non-functioning halon systems in remaining applications such as commercial aircraft or military armoured vehicles. 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 generate hazardous combustion by-products. It is therefore essential that reliable banking operations are established with testing and certification of the agents.

Many parties have halon banking programs that are fully operational. The early halon production phase-out schedule imposed on the non-Article 5 (non-A5) 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-A5 parties.

A United Nations Environment Programme (UNEP) study conducted in 2008 found that the Countries with Economies in Transition (CEIT)s and A5 parties were in many cases still struggling to establish halon banks or to set up protocols for participation in regional halon banks. Currently, there still remains a need in many parties to implement regulations, procedures, and/or programs to facilitate the effective management of remaining halon inventories. In most 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. Because of the length of time over which the Montreal Protocol has been functioning, there is now a loss of institutional knowledge compounding lagging efforts to conduct accurate halon surveys, identify remaining users, and plan/provision for long-term requirements.

2.0 HCFC and HFC Banking

Like halons, HFC and HCFC fire protection agents can be recovered from decommissioned fire protection systems and extinguishers and reused. For HFCs, this practice is fairly common in non-A5 parties that have an established halogenated gaseous fire extinguishing agent recycling industry. Unlike halons, where recovered agent is used in both new fire protection equipment and to service existing fire protection equipment, recovered HFCs are used mostly to service existing equipment and are not commonly used in new fire protection systems or extinguishers. This may change in the future as the phasedown of HFC production and consumption proceeds. The use of HCFCs in fire protection is much smaller than the use of HFCs and more regionally specific, and as of now recovery of HCFCs from fire protection equipment is somewhat limited. This may change as the phase-out of HCFC production and consumption proceeds.

The HTOC has begun gathering information on the recycling and banking activities of HFCs and HCFCs in the fire protection sector globally. The following is a regional summary of those activities to-date.

2.1 African Countries

The only halon recycling and bank management activities known to the HTOC in Africa are in the country of South Africa which has been included in this and previous HTOC reports. It is the HTOC's opinion that since there has been no halon banking activity with the exception of South Africa, there is unlikely to be banking of alternatives to halon.

2.2 Asia-Pacific Region

There are no known plans for bank management or recycling of HCFCs or HFCs in Indonesia, Malaysia, Philippines, Thailand, or Vietnam. They are still using HCFCs as the fire extinguishing agent for portable fire extinguishers (HCFC-123). They are primarily using HFC-227ea and CO₂ in their fixed fire systems. The annual quantities of both HCFC-123 and HFC-227ea used by these countries are known from surveys conducted as part of the preparation for ratification of the Kigali Amendments.

Australia: There is no HCFC banking (from fire sector applications). Replenishment capabilities exist by way of accessing service providers that can offer recycling/reclamation services or swapping to alternative agents. Despite the implementation of an HFC phase down in Australia, there is no urgency to transition away and replace HFCs found in fire protection systems as there is sufficient supply in the country and access to recycling/reclamation services. The industry is also promoting the consideration of alternatives should be well-thought-out, especially during a ten yearly pressure testing of cylinders, during facility upgrades or changes, when there is a change in the fire risk of the protected area or following a discharge.

China: China is planning to include HFCs in their "halon" management and recycling work.

Japan: There are companies who are reporting on installation and recovery of HFCs, but they do not yet provide details on recovery and storage methods. Because HFC systems are relatively new compared to halons, they report there are not many recovery records yet.

India: A regulation was passed in India in 2014 banning the import of HCFCs and limiting their use in many applications. India now has a bank management plan in place to address the phase-out of HCFCs. Multi-lateral Fund support was provided in 2017 to assist India in moving forward the phase-out dates for HCFCs from 2040 to 2025. There is currently no known recycling of HCFCs, HFCs, or FK. India is still in a transition state and is installing the recommended HFCs and FKs as required. They are in a discovery/planning phase for banking of HFCs and will follow with other fire extinguishing alternatives at a later date.

Pacific Island Countries (PIC): The PIC (12) except for Fiji and Papua New Guinea (PNG) have developed a regional HCFC Phase-Out Management Plan (HPMP). Stage 1 of the HPMP is aimed at 35% by 2020 (although some countries are already well in advance of that). They are currently considering Stage 2 of the HPMP. Fiji is also following the 2007 phase-out schedule for HCFCs. PNG decided to accelerate its phase-out to 2025 which is slightly in advance. In terms of banking, these PICs are not progressed and would likely need assistance with the management of their banks to ensure adequate supplies for meeting their critical needs.

2.3 Central Asia and Caucasus Region

Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan: There are no HCFCs in use and no HCFC banking from fire protection sector applications. There is no urgency to transition away and replace HFCs in fire protection systems as there is sufficient supply in the countries and access to recycling/reclamation facilities. The market situation in the countries promotes a slow decrease in the usage of HFCs in the fire protection sector due to availability of alternative technologies having competitive prices.

2.4 Eastern Europe

Belarus, Moldova, Russia, Ukraine: There are no HCFCs in use and no HCFC banking from fire protection sector applications. There is no urgency to transition away and replace HFCs in fire protection systems as there is sufficient supply in the countries and access to recycling/reclamation facilities. In addition to this, Russia has its own production of HFC-125 and HFC-227ea to satisfy the demand of fire protection sector (prices for recycled and newly produced HFCs are comparable). The market situation in the countries promotes a slow decrease in the usage of HFCs in the fire protection sector due to availability of alternative technologies having competitive prices.

2.5 Latin American Countries

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.

Colombia: HCFC-123 is widely used in portable fire extinguishers in Colombia; however, the civil aviation and ozone office are actively pursuing more environmentally friendly replacements. The NOU hosted an international conference in 2018 for all sectors regulated under the Montreal Protocol and a national workshops in 2019 for the military and for civil aviation on alternatives to HCFCs and HFCs.

2.6 Middle East

There are no reported HCFC or HFC recycling/banking operations underway in the Middle Eastern Countries.

Egypt: There are currently no known recycling operations for HCFCs, HFCs, FK, or PFCs. The Egyptian Environmental Affairs Agency (EEAA) with UNIDO conducted workshops in August and November to discuss the feasibility of establishing recycling facilities. Such operations are not expected to be on-line before the year 2022.

2.7 North America

HFC recycling is common and is performed by the primary halon recycling companies. The U.S. Defense Logistics Agency recycles HFCs for military uses. In addition, recovery and reuse of HFCs occurs at the distributor level. The Halon Alternatives Research Corporation (HARC) has developed a recycling code of practice for halogenated clean agents, which is referenced in the NFPA 2001 standard. Data from HARC's HFC Emission Estimating Program (HEEP) shows that in recent years about 75% of the HFCs used to service existing fire protection equipment in the U.S. comes from recycling as opposed to new production. Recovery of HCFCs from fire extinguishers is occurring, however reclamation is complicated by proprietary agent composition restrictions.

2.8 Western Europe

It is presumed there is some HFC recycling occurring in most of Western Europe as management plans were well established for halons.

Germany: TEGA – Technische Gase und Gasetechnik GmbH based in Würzburg and part of the Irish DCC Group, offer services for the recovery and recycling of refrigerants, without specifying an application for the same agents in the fire protection sector.

Italy: There is no HFCs/HCFCs banking from fire sector applications; replenishment capabilities exist by way of accessing directly service providing companies that can offer recycling/reclamation services or swapping to alternative agents. Many undertakings declare on their own websites to provide the service of collection and of recovery HFCs/HCFCs, but they do not specify details on recovery and storage methods. Hudson Technologies Europe srl (HTE) is able both to reclaim HFCs/HCFCs throughout a patented and proprietary technology of distillation (Hudson Technologies, USA) and recycle HFCs/HCFCs by the proprietary ZugiBeast® equipment designed and built for solving refrigerants contamination problems (moisture reduction, removal of residue particles, oil decontamination). Furthermore, HTE is fitted with a quality control lab which provides quality control inspections on the reclaimed HFCs/HCFCs to ensure that they meet or exceed the applicable normative requirements.

Sweden: There are no installations of HCFCs in the fire sector, so banking is not needed. There is no HFC banking underway; however, there is at least one company that may be reclaiming/recycling HFCs from fire equipment/systems. It is presumed there may be some fire protection companies who are storing bulk HFC, from decommissioned systems, at their facility properties.

United Kingdom: A-Gas in Europe, part of the A-Gas Group, offer services for the recovery and reclamation of used HFC fire suppressants (HFC-23, HFC-227, HFC-125) and halons (halon 1301, halon 1211). The used agent separation facilities contain “Bespoke Technology” designed, commissioned, and built in-house. A-Gas laboratories provide analysis and related services to ensure the quality of all products; the analysis test results will indicate identity and purity, along with problems with oil residue, moisture, acidity, and composition against the U.S. National Institute for Standards and Testing (NIST) libraries. The laboratory services also include the analysis of halons 1301 and 1211 in accordance with ASTM D5632-08 Type I / II and ASTM D7673-10 Type I / II respectively.

It is the conclusion of the HTOC that parties who have not implemented halon management programmes (or organized recycling) are unlikely to be recycling or managing other halogenated fire extinguishing agents. In all of those cases, there are no reported activities for HFCs and HCFCs.

Countries/regions who have more recently begun working on halon banking such as Colombia, Egypt, and India, have indicated awareness of the need to bank HFCs and HCFCs and are at various levels in the planning stages as reported above.

Parties with well-established halon bank management programmes such as Australia, Japan, and the U.S. (and in most cases the largest remaining users) have already incorporated HFCs into their bank management operations.

Independent recyclers mentioned in previous reports, such as members of the Halon Recycling Corporation, are recycling HFCs.

3.0 Halon 1211 and 1301 Banking

As stated above, halon banking programmes are well established in the non-A5 parties that need them (and many now include HCFCs and HFCs). Therefore, the majority of parties reported on in this section are A5; however, for the 2018 revision, reports from a few non-A5 parties have been included.

3.1 African Countries

To-date, the HTOC has been able to obtain status on only one country in Africa. All past attempts at contacting ozone offices have not been successful. Recent attempts at contact resulted in one request for assistance in gathering information on halons in their African country. It is not clear to the HTOC whether the offices in Africa are staffed or there are 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 recognized 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 containerized 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 tonnes 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 tonnes (mostly halon 1301, of uncertain purity). Since 2010 however, returns have reduced substantially (being only a total of 3.3 tonnes 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 failed the purity 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 needs 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 South Africa is thus presently uncertain.

The previous HTOC Assessment Report stated that a destruction facility had been identified in Johannesburg. This facility has since closed, and currently there is no local capability authorized 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 A5 parties, 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 needs, (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.

3.2 Asia-Pacific Countries

Australia: The National Halon Bank was established in 1993 and is administered by the Department of the Environment and Energy. Its day-to-day management is contracted to a gas management specialist company. The National Halon Bank is a dedicated facility that continues to accept halon 1211 and halon 1301 surrendered for disposal by business and the community. The bank has recovery and reclamation equipment on hand and has access to its contractor's ISO 17025 accredited laboratory for the full testing of halons to recognized international standards.

Recycled or reclaimed halon is stored in bulk pressure vessels and subject to continuous environmental monitoring for the detection of leaks.

The bank is the primary supplier of halons to those uses considered essential namely civil aviation and, from time to time, the Australian Defence Force, that continue to rely on halon. Requests for supply are administered in accordance with the criteria established in the Ozone Protection and Synthetic Greenhouse Gas Management Act 1989.

The Australian Halon Management Strategy sets out how Australia will treat the management of Australia's halon stocks in the lead up to their ultimate phase-out. The Department is in the process of reviewing the Australian Halon Management Strategy and policy on the import and export of used ozone depleting substances and synthetic greenhouse gases. The Department has taken a precautionary view on the disposal of used halon. Only used halon that is in excess of Australia's needs is available for export. Only recovered halon that is considered too contaminated to be brought back to specification is destroyed. Australia has facilitated the movement of used halon between countries.

Currently the National Halon Bank has a stock pile in the order of 262 tonnes (Halon 1211 – 94 tonnes, Halon 1301 – 168 tonnes). Even though the Australian phase-out has been successful, it is difficult to accurately substantiate what remains in installed banks. A report on Australia's essential use requirements was prepared in 2012, another report is planned for 2018. These reports will inform the prospects and possible timeframes for transition of remaining civilian halon uses; how long a strategic stockpile of halon will be required and the quantity of halon likely to be required for remaining non-defence essential uses.

There is an acknowledged need for halon banking in Australia, with a centralized facility seen by many industry participants as the most efficient way of managing supply and purity. The Department of the Environment and Energy currently performs periodic reviews of how halon banking is managed in Australia.

China: The Foreign Economic Cooperation Office (FECO) recently signed a contract with the Office under the Ministry of Public Security (MPS) to function as the national halon management office and to maintain a database on halon 1211 and 1301 installed, collected, and stored in China. The MPS is responsible for national fire safety and certification of fire equipment. The MPS is essentially the halon bank programme office. They are in the process of

setting up a halon recycling website. The contract has been awarded to a Chinese institute and the contract has been signed. The department in charge of the day-to-day operation of the halon management center has been appointed and has established a small working group within the department for long-term management of the halon banking activities. Developing a halon database is part of the activities. The MPS and FECO have conducted a couple of workshops over the past 4 years to create awareness. A survey on halon installed in fire extinguishing systems and portable fire extinguishers and collected by fire equipment companies and fire brigades covering several provinces, was completed in 2016. While conducting this survey, some recycling companies were identified. One of the companies, located in Shanghai, has been active in the collection of halon from fire extinguishing systems on board ships. All of the identified recycling activities are now part of the national halon management programme. The halon management system and activities were planned to have been completed by December 2018 but have been delayed (due to a number of reasons) and are now expected to be completed by 2021. There are some ongoing and planned studies that will be conducted including the following three surveys:

- The China National Ship-Recycling Association was hired in 2017 to undertake a survey of halons installed onboard ships. The survey has not yet been completed.
- A contract was signed in 2018 with the Civil Aviation University of China to determine the quantities of halons installed on aircrafts and at airports, as well as the annual use and future demand, taking into account the rapidly growing civil aviation in China.
- A survey on halons still installed in key provinces in China is planned to improve understanding on amount of halon 1211 and 1301 still installed in China.

Halon 1211: A halon 1211 recycling facility was established in the 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 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 was no longer in operation due to the lack of demand for recycled halon 1211. There was still sufficient stock of halon 1211 available for sale from a former producer (approximately 2,000 tonnes with annual sales of 20 tonnes), which contributed to the closure of the recycling facility. The hazardous waste regulation was also a barrier as none of the fire equipment companies were willing to spend time and money in order to obtain a HW license. It appears that a result of the availability of the newly produced halon and the HW legislation was 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 recently planned to restart the halon 1211 recycling centre in Guangdong; however, the company decided not to move ahead for some of the same reasons as previously cited. First, the amount of halon 1211 is expected to be very limited because the hand-held extinguishers more than 10 years old must be retired, and the last one was probably sold prior to the time when the fire extinguisher manufacturer completed the phase-out of halon 1211 (year 2010) and converted to other alternatives. Second, the quantity of halon 1211 which might still be available would not be sufficient to justify the activity. Third,

the past experiences regarding collected halon 1211 were that it was contaminated, e.g. mixed with other chemicals, and could only be reclaimed through distillation. Finally, with the large stock of halon 1211 still available at the former producer of halon 1211, the price of recycled halon 1211 would be more expensive than buying it from the former halon 1211 producer.

It is still 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. FECO signed a contract with the former producer, who is still holding the stock of halon 1211 (stock about 2,000 tonnes), to ensure that halon 1211 is stored safely. The company is now part of the halon management activities and is reporting stocks and sales. It is also planned that a halon 1211 storage area/facility will be established, instead of the present storage, utilizing a large number of 600 kg to 1,000 kg cylinders. It is still under discussion if all or only part of the halon 1211 should be stored for future use and the rest be destroyed or converted to other chemicals.

Halon 1301: It was reported in 2010¹ that China was in the process of setting up a halon 1301 reclamation facility with assistance from the MLF; however, the facility had not yet been established as of the writing of the 2014 HTOC Assessment Report. China produced halon 1301 until the end of 2009 and therefore did not see a need for reclamation capabilities until after production cessation. In 2014, China estimated there was sufficient halon 1301 installed nationwide to make a halon 1301 recycling facility viable; however, it was unknown at that time whether a former halon 1301 producer had stocks of halon sufficient to undermine the 1301 recycling operations as had occurred with the 1211 operations. Several high throughput halon 1211/1301 reclamation units had been purchased and delivered to China; however, in 2014 it was not known who, if anyone, was operating those units.

As of 2018, the regulatory issue surrounding halon being classified as a hazardous waste has been resolved, and the halon banking and recycling activities have restarted. FECO signed a contract with a company who set up a halon 1301 recycling centre. The company has a small stock of halon 1301, which is now also managed under the national halon management activities.

The department that will be in charge of the day-to-day operation of the halon management center has been appointed and has established a small working group within the department for long-term management of the halon banking activities. Developing a halon database is part of the activities.

A halon 1301 recycling facility has been set up and started operation in Zhejiang Province. While the facility has the capability of processing up to 50 tonnes per annum of Halon 1301, as of September 2018, they had collected, recycled, and stored 1.5 tonnes at the recycling facility.

A second halon 1301 recycling company has been identified in Shanghai and is expected to be part of the Chinese halon banking system. The company has collected some halon 1301 from existing users and from ships. The Shanghai recycling company has also collected halon 1301 from dismantled halon 1301 systems in Shanghai and the provinces of Jiangsu and Zhejiang.

¹ 2010 Assessment Report of the Halons Technical Options Committee

Amount not yet reported. There might be other private companies who have collected and stored halon 1301. If, and when, identified they will become part of the halon management system.

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 but soon after it ceased functioning. The information on the halon bank is being uploaded on the Indian National Science & Technology website and is expected to be available by the end of 2018. Indian regulations to control import and export of newly-produced halon came into force through a Government of India Gazette Notification (government of India) in 2014. Initially (2004–2007) some halon, approximately 1 tonne, was processed through the national halon banking facility, primarily for military organisations. Also, during that period, approximately 1 tonne 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 due to renovation work going on in the halon bank.

The renovation of the bank was completed in 2011 and the bank became operational. Since then the National Halon Bank has received 20 tonnes of decommissioned halon 1301 and 1 tonne of decommissioned halon 1211 in cylinders from the Air Force, Hospitality Sector, Power Sector, Oil & Gas Sector, Steel Plants and other Public Sector Undertakings. More recently, 1 tonne of halon 1301 and 2 tonnes of halon 1211 in system cylinders have been recovered from the previously cited sources. Reclamation and certification of the halons is currently underway.

It is still believed the military, as well as the power and oil sector, have developed their own halon management programmes and facilities. The military established their own storage in a limited scale and it is reported the military has no halon reclamation capability or quality control. The Indian Army is pursuing the National Halon Bank for assistance in recovery and reclamation operations.

In 2013, it was reported that India was having no difficulty in acquiring halons for their essential/critical needs. In 2014, India was reporting they had been recovering about 5 tonnes of halon 2402 and 25-30 tonnes of halon 1301 annually from shipbreaking in Alang; no halon 1211 had been 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 was unknown. It appeared that more recently some scrap dealers in Alang had been given permission to recover the halon for recycling in India or other countries “in a safe manner”. The National Halon bank, in their efforts to assess the overall criteria and latest practices for halon recovery and reclamation by the ship-breaking activities, provided this assessment in November 2018.

1. Quantities of halons recovered approximately from Ship-breaking in Alang is as follows:-
 - a. Halon 1301: 25 - 40 tonnes/annum

- b. Halon 1211: Less than 500 kg/annum
 - c. Halon 2402: 2-3 tonnes per annum
2. All ODS including halon is sent to the Ship-Owners/Reclamation Facilities via Transshipments.
 3. There are no known or documented evidence of any leakage of these halons at Alang.
 4. There are no projections available, Incoming Ships/Vessels come in various sizes and capacities. Approximately 120 vessels/annum come in for shipbreaking into approximately 60 ship breaking yards. “According to our experience only 5 to 8 percent of vessels contain halon.”

The following is a summary of some of the halon alternatives in use as of 2018;

- 1) floating roof tanks are being equipped with foam systems in place of halon 2402;
- 2) portable halon extinguishers have been replaced with dry powder extinguishants, where about 90% are now using not-in-kind halon alternatives, and approximately 10% are utilizing HFCs; and
- 3) most of the existing fixed systems have been replaced with FK-5-1-12 and HFC-227ea.

No halon is being used in the civil sector. The use of HCFCs in the civil and government sector have been completely replaced with HFCs, FK-5-1-12, and CO₂ where applicable.

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 in 2016 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 1301 for their armoured vehicles and were reported in 2014 to be in the process of developing banking to support this application as it is expected to be a long-term requirement. The naval ships have replaced their halon systems with HFC-227ea and/or water mist systems.

India has a Halon Bank Management Plan (HBMP) in place to address the phase-out of HCFCs. MLF support was provided in 2017 to assist India in moving forward the phase-out dates for HCFCs from 2040 to 2025.

The 2017 Gazette Notification for the Regulation and Control of ODS requires a 50% reduction of HCFCs and its blends from all applications including firefighting by 2020. Importation of newly produced HCFCs and its blends were no longer permitted 6 months following passage of this 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.

Indonesia: Garuda continues operating a halon banking facility.

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 tonnes 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 2010, the amount of halon 1301 installed in South Korea was presumed to be approximately 3,000 tonnes. As of 2018, the amount of halon 1301 installed in South Korea is still presumed to be about 2,500 tonnes even allowing for the amount vented into the atmosphere or reclaimed so far.

On a yearly basis, approximately 20–40 tonnes of recycled halon 1301 is recovered from existing facilities and is expected to come continuously for the next 20 years to come based on the historic data and expected life span of the existing fire extinguishing systems throughout the country.

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.

However, this regulation does not contain any enforceable measures against violations and, there is no database indicating how many halon systems are installed for critical users. The actual amount of recovered halon 1301 per year has fluctuated for the past decade and the actual inventory is consistently declining.

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 Korea Halon Banking System is estimated to be working in terms of providing a stable supply. The system has been providing efficient recovery management, quality control of the recovered halon agent, and preventing unintentional venting losses into the atmosphere. As the system is functioning and well-managed, critical users such as the military sector in Korea are also stably securing their needs at present.

New Zealand: New Zealand does not run its own Halon bank however it does have a collection system in place. Collected halon is exported to Australia for destruction. New Zealand makes use

of the Australian suppliers of recycled halon for critical needs. All imports are under permitted exemption and these are listed in an Annual Report to New Zealand's Parliament.

New Zealand has not done a complete assessment of future halon needs for critical needs and of possible future sources. Although applicants do have to provide justification of their need for halon when seeking permits, this does not give an overall view of future halon needs.

The Government provided funding for a Halon Recovery Programme starting in 2001. The programme continues to be run by the Fire Protection Association of New Zealand. The programme has had further funding from the Ministry for the Environment and has a current contract to collect and export to Australia refrigerant and including halons that will end shortly. Exports to Australia have been intermittent as collection takes time to accumulate shipment volumes.

Those needing halons from offshore or critical needs must obtain an exemption permit for the import. These permits include restrictions on use to ensure the halon is only used for critical purposes. New Zealand's use is restricted to a few aviation fire control uses. Access is usually from halon-held extinguishers in Australia, though some has come from the U.S. and other suppliers.

One of the airlines located in New Zealand does have some capacity to recover halon for reuse and they do source some of their needs from their own recycling.

3.3 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 was passed prior to 2014 in most Latin American countries prohibiting the import and export of halons (including recycled). This has created difficulties for some companies who provide servicing to the remaining users such as aviation and military.

A few parties have been working on their halon bank management or have implemented national strategies such as Argentina, Chile, Colombia, Brazil, and Venezuela. Halon banks are believed to still be in operation in Argentina, Brazil, Mexico, Venezuela, and Uruguay. Recycled halons can be sold only to refill fire systems installed in 'critical' uses. Chile and Colombia have conducted workshops with civil aviation, the military and police, and organizations in the fire sector within the past 4 years on halon awareness and more recently on HCFC/HFC management.

Argentina: In 1998 the Environment Secretariat established the Oficina del Programa del Ozono (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.

As of 2018, the national bank holds approximately 2 tonnes of halon 1301. The primary users are the Army, Aerolineas Argentinas (their flag carrier), and a telephone company. It is expected the telephone company will be replacing their halon 1301 system in the very near future with HFC-227ea and the halon will be sent to the national bank. In 2016, the Army required a halon 1301 system recharge (1500 kg) due to a discharge under fire conditions. The bank reported very small quantities of halons have been received in the past 2 years.

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 carried out with the assistance of 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 carry out the recycling. The halon banking was created and is managed by the company GESPI. Any need for recycled halon must be requested by the government Agency IBAMA, which is responsible for the halon importation licenses.

The Brazilian government issued a document, “Instrucao Normativa No. 4” on February 14th, 2018 which reduces the importation of HCFC gases by 39.3% by the year 2020 and by 51.6% in 2021. For the years 2018 and 2019, a reduction of 16.6% had already been established.

Chile: In 2013, the UNDP, working closely with the Chile’s 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 critical 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 key areas to focus attention on to heighten awareness of halon phase-out 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 changed their systems to alternatives to halons and those considered as critical, are using recycled halons or their own stocks.

Legislation was passed in 2010 prohibiting the importation of pure halons, and allowing recycled halons with its corresponding authorization from the Ministry of Health (up to date, the NOU do not have information about imports of recycled halons).

The NOU has strongly recommended the use of recycled halons and has facilitated the collaboration between users, specially between those who are changing halons for alternatives and those who critically need halons.

Colombia: Colombia has a proactive ozone office which has implemented a comprehensive Awareness Campaign including conducting workshops, conferences, and training with the support of the UNDP for fire safety and engineering associations, recyclers, government organizations, and the military. Legislation was passed prohibiting the importation of halons, including recycled halons. It is uncertain at this time whether there are enough halons within Colombia for decommissioning to service critical users. The NOU is currently working on halon surveys to identify users and potential sources. There is no national halon bank; however, the NOU is considering setting up a national clearinghouse. A vendor in Bogotá who offers recycling of halons is working on setting up reclamation and certification for halons and the alternatives. The NOU is also following up on establishing a lab for analysis and certification of halons and alternatives.

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 tonne, so they decided not to establish a halon bank.

Venezuela: Venezuela received a halon reclamation equipment and a gas chromatograph in 1996 with assistance from the MLF. The Venezuelan government selected a commercial entity to operate the national halon bank; they have five branches in the country, one of which provides recycling and storage of halons. They have approximately 0.51 tonnes of halon 1301 in stock. Halon 1211 is not available locally, except in fire extinguishers in very few applications, such as small boats, small planes, and helicopters; therefore, exhausted fire extinguishers are being filled with a halon alternative. Halon 1301 is used to recharge fire protection systems in military and civil aviation, metro transport systems, and some oil tankers. Currently, the fire control system of the metro system has been converted with the use of the substitute HFC-227ea. Venezuela prohibits the import and export of halons.

The information on halons is for the exclusive use of FONDOIN, the Ministry of Popular Power for Ecosocialism, involved companies, and Tecnofuego.

The Venezuelan Industrial and Technological Restructuring Fund, FONDOIN, carries out the halon bank programme in Venezuela and contributes to the management of the activities related to other ODS. It also has a website, www.fondoin.gob.ve, where halon users can consult and establish links to buy, sell, or recycle halons. Since the bank is a commercial entity, this agreement gives them the opportunity to offer halon alternatives to system users. An agreement of this type has been formed by many countries that have engaged in a successful partnership of a government organization with the fire protection industry to allow for the elimination of halons while enriching the business for the business entity. In the case of Venezuela, the commercial entity has five branches that cover the Venezuelan market and serves a market of more than 100 small distributors and fire service companies. While the transfer of domestic banking operations from halons to a commercial entity provides a significant market advantage for the company, the

selection of this particular company with its smaller business network guarantees a much higher probability of halon collection and transition.

As for the operations of the banking systems, they do not buy contaminated halons. They perform a gas chromatography test of each cylinder/halon system before buying or receiving them as part of the payment of a new alternative fire extinguishing system.

They test the halon after having recovered it; however, they do not test stored halon unless a customer requires a certification. Most of its halon is stored in cylinders at a pressure of 56 kilos or 123 pounds. There are companies in other countries that will buy and "clean up" contaminated halons; however, cross-contaminated halons are a financial responsibility in Venezuela due to the ban on the export of halons.

The Ministry of People's Power for Ecosocialism and the Venezuelan Industrial Restructuring Fund, advocates, encourages, and supports the application of alternative halon systems. Currently in Venezuela the following gaseous fire extinguishing agents are used in fixed fire systems: Inert gas (N₂/Ar/CO₂), FK-5-1-12, and HFC-227ea.

3.4 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 MLF 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 Jordan.

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 recovery and reclamation 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.

Egypt: The Ministry of State for Environmental Affairs with the support of UNDP established the national halon bank on September 16, 2006. The halon bank was established through a cooperation protocol between the Ministry of State for Environmental Affairs and the Ministry of Military Production.

The national halon bank was inaugurated during the celebration of International Ozone Day in 2008. The Helwan Company for Engineering Industries was chosen as a governmental organization to manage and operate the halon bank, and it is the only official halon bank in Egypt. Full installation, operation, and training of the employees on how to recover and recycle halons was completed.

The purpose of the Egyptian halon bank is to cover the needs of the strategic sectors in the Egyptian market and build a strategic stock for critical applications including military, civil aviation, and the petroleum industry.

As per the Egypt State of the Environment report in 2016, the estimated total amount of halon imported prior to year 2000 was more than 850 tonnes. The majority of the imports were halon 1301 fixed extinguishing systems. There was a gradual reduction of imported halon 1301 each year until 2007, at which time imports reached zero tonnes and have remained zero.

Starting in 2006, the halon bank has been recovering halon 1301 from decommissioned systems in facilities. The amount of halon recovered each year has fluctuated and the inventory at the halon bank has decreased. There is no database on existing installed halon fire extinguishing systems, thus it is not possible for the halon bank to project the quantities that will become available in the future from decommissioning activities.

3.5 Western Europe

Sweden: No centralized halon bank was established in Sweden. The military maintains a bank for its own needs apart from all military aircraft that are serviced by a private company, SAAB Group. The military aircraft installed halon base is approximately 1000 kg. It appears there are no major commercial airlines based in Sweden; SAS is now jointly owned by the Nordic countries and its aircraft are serviced in Denmark. There is one known halon servicing company for aircraft in Sweden, the Saab Group, which provides services to some of them. In 2005, it was reported that some companies arranged halon banking operations for their customers; however, the HTOC is unaware of these halon banks if they are still in operation. Used halons are sent to the Swedish destruction facility Sydkraft SAKAB AB. The information gathered by the HTOC estimates that between 1998 and 2000, 10-15 tons of halon 1301 were sent to SAKAB AB for destruction. And, from 2002-2014 possibly 1000 kg per year of halon of 1211 and 500 kg of 1301 were sent for destruction. It is the HTOC's understanding that there are hardly any halons left in Sweden and therefore no halon is being sent for destruction. Recently there has been a reversal of the Swedish EPA rules prohibiting import/export of halons within the EU.

4.0 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 was commercialized 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, much of this equipment is 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 aircraft.

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, Tadjikistan, 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. Currently there is no apparent shortage of halon 2402 on a global basis, but regional shortages may arise as has been the case in the past.

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

4.1 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 parties 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. Typically, a contract is held between the buyer and seller which ensures spare parts, servicing, and sales. So, halon 2402 needs are likely being met through a contract with the manufacturer or seller.

4.2 Belarus

A small project 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 utilize recycling and reclamation equipment, the absence of centralized 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.

4.3 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 Global Environment Facility (GEF). Upon a request from the NOU 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 users 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 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 project, which was completed in June 2001.

Estimates indicate that 53 tonnes 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 40.3 tonnes installed in fire suppression systems on 40 ships, including 1.1 tonnes 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.

4.4 Central Asia: Kazakhstan, Kyrgyzstan, Tadjikistan, 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 tonnes 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 the United Nations Industrial Development Organization (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 tonnes 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 critical 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, storing any 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 three 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 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 tonnes 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 Federation. 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 Phase-Out of Ozone-Depleting Substances in Countries with Economies in Transition*, Volume Two: Country Reports, October 2009. pp 243–262).

4.5 European Union

In general, there is only a minor demand for halon 2402 in some Member States of the EU: 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 approximately 6.5 tonnes, 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 tonnes, while the stockpiled quantity for uses (deemed critical by Poland), export, or destruction more than doubled, changing from 1 tonne at the end of December 2008 to 2.8 tonnes 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 9.3 tonnes (slightly increased with respect to the previous year, 9.1 tonnes) while the total quantity of halon 2402 stockpiled for critical use/export/destruction in the same period resulted to be 4.2 tonnes, having doubled with respect to 2010. And in 2013, Poland reported having 9.5 tonnes of installed halon 2402 and 1.15 tonnes 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 quantity of halons reclaimed from 1994 to 2008 was 66 tonnes, which was much less than 2,900 tonnes estimated to have been installed as of 1994. Fajro had reserves of about 7 tonnes as of 2008. (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 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 tonnes. (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 centres 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, a Czech provider of fire extinguishing systems and portable equipment. 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 tonnes.

Estonia, Latvia, and Lithuania: Halon 2402 is the most widely used halon in these three parties and seems to have been used in blends as well as more conventionally as a single 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 finalize 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 1211, 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.

Some owners/operators of eight Estonian-flagged ships were fined for not decommissioning halon, which has encouraged them and other ship owners / operators 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 Estonian-flagged ships 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 1 shows the estimated status as of May 1999.

Table 1: Halon 2402 data for Estonia, Latvia, and Lithuania (1999)

Country	Installed capacity, tonnes	Yearly Consumption, tonnes
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 some recovery has taken place in the 2002-2008 time frame, as shown in Table 2 below. For example, in 2007 the Reclamation Centre recovered and recycled about 0.8 tonnes of halon 2402 when all of the halon in the TV tower (about 1.8 tonnes) was replaced with an alternative. The quantities of halon 2402 sent by Latvia to the Estonian halon bank are shown in Table 3. So far, Lithuania has not sent any halon to the bank, as negotiations on the price for the halon failed.

Table 2: 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 3: 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 tonnes of reclaimed halon were exported to India for Navy use 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 tonnes 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 tonnes.

In Latvia, firefighting use in 1995 was reported to be 5 tonnes of halon 2402. Once imports of halon systems stopped, the number of halon systems in the country dropped and consequently the annual use also reduced. Since 1993, some 45–50 large computer facilities protected by halon systems have been decommissioned. The annual use estimate for halon 2402 is 1.5 tonnes. Annual use of “BF-2” (a mixture of 37% halon 2402 and 63% ethyl bromide), 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 safety, 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 tonnes. 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 tonnes 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 tonnes 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 tonnes 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 tonnes of halon 2402 were banked in 2004, and 0.124 tonnes of halon 2402 was sold at the end of the year. In total, about 1.280 tonnes 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 tonnes. 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 tonnes) 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 2017, the Italian Ministry for the Environment and for the Care of the Land and the Sea reported zero halon 2402 in the country.

4.6 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 tonnes 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 because 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 (CF₃I). 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 tonnes of halon 2402 were recovered from ship breaking up until 2010. It is understood that 2-3 tonnes/year is still recovered and sold as scrap. In the 2014 HTOC Assessment Report, it was reported one vendor at Alang Shipbreaking Yard had received permission to get the halon managed through recycling in India or abroad. There have been no updates since that reporting.

4.7 Japan

Halon 2402 is mainly used for floating roof tank protection in the petrochemical industry. It was also used for explosion suppression, but these systems may have already been replaced. When replaced some of 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 159 tonnes as of March 2017. With respect to the amount of halon 2402 in ships, aircraft and the military, it was estimated to be 4 tonnes as of April 2008. Japan does not have any surplus halon 2402 to support other parties' needs.

4.8 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 918.9 tonnes in 2017. The main users are the military sector, Gazprom and other oil and gas companies. The market can be estimated as currently well balanced with no surplus available for outside markets. An average of 30 tonnes/year of halon 2402 were available as a free agent ready for purchase in a period from 2013 to 2017. Table 4 provides information on the Russian installed base, recycling, and emissions from 2007–2017.

Table 4: Changes in Russian Halon 2402 Bank

	2007	2009	2010	2011	2012	2013	2014	2015	2016	2017 ¹
Recycled amount, t	80.0	120.0	21.0	23.0	23.0	25.0	30.0	40.0	50.0	30.0
Annual offer of free agent, t	10.0	20.0	24.0	25.0	25.0	28.0	30.0	28.0	38.0	28.0
Emissions, t	8.0	10.0	1.6	3.0	2.2	2.0	3.0	3.8	3.5	3.0
Total bank, t	947.0	941.0	939.4	936.4	934.2	932.2	929.2	925.4	921.9	918.9

Note 1: Data obtained in January 2018

4.9 Ukraine

Ukraine is still 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. For the period 2005 to 2014, the total quantity of recovered, reclaimed and reused halon is close to about 3 tonnes of halon 2402. There is no available information on recycling after 2014.

At least one local company offered recycling and banking services to the market. Approximately 6-7 tonnes 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 tonnes. According to some Ukrainian experts, the current Ukrainian bank of halon 2402 can be estimated at 300–340 tonnes (1.5–2 times reduction in comparison with 2003). As shown in Table 5, the main users are the military sector, oil – gas industry, transport system and telecommunication facilities.

Table 5: Installed Halon 2402 in the major sectors in Ukraine

Sector	Halon 2402, tonnes
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 tonnes. 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 A5 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 the Phase-Out of Ozone-Depleting Substances in Countries with Economies in Transition*, Volume Two: Country Reports, October 2009. pp 223–242)

4.10 U.S.

There are no longer any known quantities of halon 2402 in the United States.

4.11 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 tonnes. An estimated reduction to 3.617 tonnes was anticipated for 2010.

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 National CFC and Halon Phase-out, December 2012).

In the past, Vietnam had difficulties sourcing halon 2402 for their petroleum industry and the military sector, but currently there are no signs indicating that the troubles in sourcing are still occurring.

5.0 Support for International Maritime Operations

In the mid-1970s passenger ships and tankers switched from carbon dioxide to halon 1301 as it was more cost effective. When the International Maritime Organization (IMO) banned the use of halons in new constructions in 1992, carbon dioxide once again became the agent-of-choice for these types of ships. However, from 1975 – 1993 (the last year that halon was allowed to be used under IMO rules), a significant amount of halon 1301 was installed in this sector.

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 SSE.1/Circular 2 (2014) and recently updated for this Report by the HTOC (through individual inquiries).

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, Gespi	Halon Receiving, Recharging, and Supply
Croatia	One Facility, VATRO-SERVIS	Halon Bank
Finland	Possibly, but Unverified	Virtual Halon Bank
France	Possibly Several facilities, but Unverified	Halon Recycling, Recovery, and Supply
Italy	One Facility, Safety, Hi-Tech	Halon Recycling, Recovery, and Supply
Norway	Possibly, but Unverified	Halon Recycling, Recovery, and Supply
Republic of Korea	Possibly, but Unverified	Halon Recycling, Recovery, and Supply
Russian Federation	Possibly, but Unverified	Halon Recycling, Recovery, and Supply
United States	Halon Recycling Corporation	Virtual Halon Bank

The need for halon for servicing in merchant shipping is rapidly diminishing and correspondingly, the number of facilities available for serving maritime halon needs is dwindling. The halon remaining in service is expected to reach zero between the years 2023 and 2033. For details on halon projections in maritime operations, see section 4.5 of the 2018 HTOC Assessment Report.

6.0 Pathway to Halon, HCFC, and HFC Management and Banking

6.1 Banking Strategy

Halon, HCFC and HFC banking comprises but a portion of an overall Montreal Protocol compliance programme. The other features of a comprehensive programme should occur before a 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 halons, HCFCs, HFCs and alternatives to all of the agents)
- Survey installed capacities & establish database of halon, HCFC & HFC 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, HCFC & HFC Steering Committees
- Open discussions with the military, civil aviation, and other remaining users
- Plan for decommissioning of halon, HCFC & HFC 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 limited or 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
- Where possible replace discharged halon/HCFC/HFC systems with other forms of fire protection
- Require that all halon, HCFC and HFCs 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 regulations on halons/HCFCs/HFCs, 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 or other halocarbon agent transactions; e.g., turn in, reclamation, storage and reissue
- All used halon or other halocarbon agent is returned to the bank

- Deliver the type and quantity of halon or other halocarbon agent bottles where and when needed
- Bank provides clean halon or other halocarbon agent for applications, as needed
- Bank provides testing of halon or other halocarbon agent quality and certification
- Information available in the form of brochures, newsletter, website, phone, etc.

Recordkeeping 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 halons, HCFCs, and HFCs.

Options for setting up a (halogenated gaseous fire extinguishant) 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 or other halocarbon agent bank may be difficult to obtain in a government organisation.

Halon or other halocarbon agent 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 authorized 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 authorized users must be created and issues to those users should be made in approved quantities.

Halon or other halocarbon agent removed from service must be sent to the bank for reuse. Owners are not allowed to sell, trade, give away or dispose of the fire extinguishing agent. 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 agent. After encouraging and facilitating all possible sources to turn in their halocarbon agent, the Bank may then turn to commercial sources to obtain recycled agent. This can be expensive but should be considered to meet necessary requirements.

6.2 Agent Recycling Considerations

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

Safety is critical in the operation of a halocarbon agent bank. Workers must be fully trained to know and avoid common safety problems when dealing with compressed gas cylinders. Handheld 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 pressurized regardless of gauge reading.

Cylinders should always be chained down when being evacuated, moved 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 halocarbon agent cylinders needs to be fully trained to avoid accidents, which may be fatal.

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 halocarbons to specified level of vacuum
- Repackage into larger cylinders
- Clean the halocarbon agent to its specification
- Repackage for storage and issue
- Certify workers
- Use certified equipment
- Administer and produce dated and signed documentation that certifies the halocarbon agent has been decontaminated (certificate of analysis)

All incoming halocarbon agent must be tested. Cylinders may not contain what the label states. The agent may be contaminated and unsuitable for use. Always test before repackaging as small impurities can contaminate large amounts of otherwise good agent. All halocarbons 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 halocarbon agent, which is simply the collection and storage of the agent prior to disposal. The bank should provide, as a minimum, agent recycling which is the reuse of agent after a basic cleaning process of filtering and drying. In this case nitrogen should not be vented but rather processed through a recycling unit in order to capture as much of the agent as possible. The optimum services for the bank to provide are analysis of the gases contained within the cylinder, reclamation of the halocarbon agent followed by chemical analysis, and certification. Reclamation is recycling as previously defined followed by nitrogen separation in order to restore the agent to a minimum of purity as required by internationally recognized standards. Reclamation and certification are reviewed in detail for all halons and other gaseous fire extinguishing agents in the HTOC’s Technical Note #4., *Recommended practices for Recycling Halons and Other Halogenated Gaseous Fire Extinguishing Agents*.

https://ozone.unep.org/sites/default/files/Assessment_Panel/Assessment_Panels/TEAP/Reports/HTOC/technical_note4_2018.pdf

Certificates of analysis should be provided to users for both recycled and reclaimed halogenated fire extinguishing agents. Recycling/reclamation are core functions of a halogenated gaseous

fire extinguishing agent bank. Commercial recycling and reclamation machines are available on the market. Halon 1211, halon 1301, and halon 2402, as well as HCFCs and HFCs, 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 agent is found to be contaminated, then it will need to be cleaned using a distillation process.

6.3 Cylinders & Storage Containers

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

- Visual inspection
- Hydrostatic test
- Sand blast, prime, and paint the exterior
- Valve removal and insertion
- Valve rebuilding
- Clean interior
- Pressurize 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, halogenated gaseous fire extinguishing agents should be colour-tagged to denote new versus recovered, type and quantity, ready for issue or not, and owner. These agents should be kept between 20 and 100 degrees F (-7 and 38 degrees C). Cooler is better. All agents, cylinders, and operating equipment should ideally be housed within a conditioned space. Security measures should include fencing, motion sensors, and video cameras. Areas housing halocarbon 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 halocarbon from a leaking tank to an empty tank to avoid loss of the entire contents.

6.4 Summary

In summary, banking is one part of an overall halogenated gaseous fire extinguishing agent management program. Efforts to identify equipment using halocarbons, 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 authorized users for mission-critical applications only. Safety is paramount – unsecured agent cylinders can represent a significant safety hazard! Leak detection and physical security protect scarce, valuable fire extinguishing agents.

7.0 Current Situation

Note: the text in this chapter refers specifically to the current situation for halons. If lessons are not learned from these issues, the same problems will occur for HCFC and HFC fire extinguishing agents.

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) while simultaneously establishing a halon recycling program with the expectation that it be financially self-supporting. This has the added effect of eliminating the market for halon servicing. Another counterproductive policy has been 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 remaining ‘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 A5 parties where supportive infrastructure is in place. It is not working as well in the non-A5 parties. 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 National Ozone Officers (NOOs) changed or were unavailable for halon-specific issues). Many parties indicated they are experiencing severe financial restrictions. Some parties 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 critical users such as the military and gas producers set up their own internal recycling because there are no focal points or comprehensive national programmes. Because of the length of time over which the Montreal Protocol has been functioning, there is now a loss of institutional knowledge compounding lagging efforts to conduct accurate halon surveys, identify remaining users, and plan/provision for long-term requirements.

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 suppliers, or fire service companies, they have developed into international halon recycling centres on a strictly commercial basis and are now expanding to include all fire extinguishing halocarbons. 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.

As the length of time that the fire protection industry has been relying on banked and recycled halons increases, the chance of halons becoming contaminated increases each time the halon is recycled, 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 adulterated with other substances also increases thus further limiting the amount of halon globally available and increasing the amount of halon needing destruction.

Halon 1301 availability is diminishing rapidly, 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 production ceased 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.

8.0 Challenges

The text in this chapter refers specifically to challenges faced in setting up halon banking and recycling facilities. If lessons are not learned from these activities, the same problems will occur for HCFCs and HFC fire extinguishing agents.

The implementation of some of the halon banking and recycling projects in A5 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; the project was 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.
- The regional centre concept is difficult to implement; the transportation of halon or recycling equipment can be 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 or non-existent.
- 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 (e.g. import / export).
- 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.

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- Insufficient workshops and training and not including all stakeholders.
- Lack of Business Plan and/or lack of Halon Bank Management Plan

There was an unanticipated lag in the establishment of halon banking and management programs globally. Those countries which have implemented a form of banking program are able to utilize the same structure for the management and phase-out of HCFCs and phasedown of HFCs. Most countries have now implemented some form of legislation, but there is a need in many to readdress the policies due to over restriction of transboundary movement of recycled materials. Nonetheless, despite 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.

9.0 Conclusions

Halon and other halogenated gaseous fire extinguishing agent banking operations can play a significant role in ensuring the quality and availability of recycled agent, in managing production and consumption, and in assisting with emission data by providing regional estimates that should be more accurate than global estimates. Halon banking operations can easily be adapted to accommodate HCFCs and HFCs. National or regional banking schemes that maintain good records offer the opportunity to minimize 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, HCFC, and HFC banking schemes in order to ensure that the needs deemed critical by a party are met.

10.0 References

ASTM D5632/D5632M-17, Standard Specification for Halon 1301, Bromotrifluoromethane (CF₃Br), ASTM International, West Conshohocken, PA, 2010, www.astm.org

ASTM D7673-10, Standard Specification for Halon 1211, Bromochlorodifluoromethane (CF₂BrCl), ASTM International, West Conshohocken, PA, 2010, www.astm.org

IMO SSE.1/Circular 2, “Halon Banking and Reception Facilities,” International Maritime Organisation, 27 October 2014, www.imo.org

UNEP Halons Technical Options Committee, Technical Note #4, *Recommended Practices for Recycling Halons and Other Halogenated Gaseous Fire Extinguishing Agents*, Revision 2, December 2018

UNEP Halons Technical Options Committee, *Assessment Report*, December 2018

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
DTIE	Division of Technology, Industry and Economics, part of UN Environment
EC	European Commission
EU	European Union
GEF	Global Environment Facility
HBMP	Halon Bank Management Plan
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HTOC	Halons Technical Options Committee
IMO	International Maritime Organisation
ISO	International Organisation for Standardisation
kg	kilogramme
MLF	Multilateral Fund
NOO	National Ozone Officer
NOU	National Ozone Unit
ODP	Ozone Depletion Potential
ODP tonnes	Weight of the ODS in metric tonnes multiplied by its ODP
ODS	Ozone Depleting Substance
PIC	Pacific Island Countries
PNG	Papua New Guinea
SOLAS	Safety of Life at Sea
TEAP	Technology and Economic Assessment Panel
tonne	Metric Tonne
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
U.S.	United States
USSR	Soviet Union

Appendix B: Definitions

Article 5 (A5) 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 were 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.

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

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

Clean Agent: An agent that is a gas or vaporizing liquid that leaves no residue after discharge.

Commission Regulation: *European Commission (EC)* is an institution of the *European Union*, responsible for proposing *legislation*, implementing decisions, upholding the *EU* treaties. A Commission regulation becomes law to all member states simultaneously

Consumption: Production plus imports minus exports minus destruction of controlled substances.

Controlled Substance: Any substance that is subject to control measures under the Montreal Protocol. Specifically, it refers to the ozone depleting substances substance listed in Annexes A, B, C or E or the global warming substances (HFCs) listed in Annex F of the Protocol, whether alone or in a mixture. It includes the isomers of any such substance, except as specified in the relevant Annex, but excludes any controlled substance or mixture which is in a manufactured product other than a container used for the transportation or storage of that substance.

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 A5 and non-A5 countries.

Country Programme (CP) A national strategy prepared by an A5 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.

Decision: A documented decision or action taken by the parties to the Montreal Protocol on Substances that Deplete the Ozone Layer.

Decommissioning: Decommissioning is the physical process of removing a fire extinguishing system containing a substance regulated under the Montreal Protocol from service. This must be done to recover the substance 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 minimize 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”.

Essential Use Nomination (EUN): A party’s request to obtain an Essential Use. Decision IV/25 of the 4th Meeting of the parties to the Montreal Protocol set the criteria and process for assessment of essential use nominations.

Feedstock: A controlled substance that undergoes transformation in a process in which it is converted from its original composition except for insignificant trace emissions as allowed by Decision IV/12.

General Assembly: The Assembly is an Organization's sovereign body.

Global Warming Potential (GWP): Global warming potential is defined as a cumulative radiative forcing effects of a gas over a specified time horizon resulting from the emission of a unit mass of gas relative to CO₂. The TEAP has proposed the following classification: High >1000, Moderate 300 – 1000, and Low < 300, which has been used in this Assessment report.

Halocarbons: Halocarbons are compounds derived from hydrocarbons, where one or several of the hydrogen atoms are substituted with chlorine (Cl), fluorine (F), bromine (Br), and/or iodine (I). The ability of halocarbons to deplete ozone in the stratosphere is due to their content of chlorine, bromine, and/or iodine and their chemical stability. CFCs, HCFCs and HFCs are examples of halocarbons.

Halocarbon Fire Extinguishing Agents: Halogenated hydrocarbon chemicals, including HCFCs, HFCs, PFCs, and FICs, that are used for firefighting applications. Each of these

chemicals is stored as a liquefied compressed gas at room temperature, is electrically non-conductive, and leaves no residue upon vaporisation.

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 ($\text{C}_2\text{F}_4\text{Br}_2$). 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 specialized applications. Halon 2402 is an ozone depleting substance with an ODP of 6.0.

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 and other halocarbon fire extinguishants (see TEAP).

Hydrochlorofluorocarbons (HCFCs): A family of chemicals related to CFCs that contains hydrogen, chlorine, fluorine, and carbon atoms. HCFCs are partly halogenated and have much lower ODP than the CFCs.

Hydrofluorocarbons (HFCs): A family of chemicals related to CFCs that contains one or more carbon atoms surrounded by fluorine and hydrogen atoms. Since no chlorine or bromine is present, HFCs do not deplete the ozone layer.

Inert Gases: Fire extinguishing agents containing one or more of the following gases: argon, carbon dioxide, and nitrogen. Inert gases have zero ODP and extinguish fires by reducing oxygen concentrations in the confined space thereby "starving" the fire.

Inert Gas Generator: A firefighting technology that uses a solid material that oxidises rapidly, producing large quantities of carbon dioxide and/or nitrogen. The use of this technology to date has been limited to specialized applications such as engine nacelles and dry bays on military aircraft.

Kigali Amendment: An amendment to the Montreal Protocol, taken at the twenty-eighth Meeting of the Parties in Kigali in October 2016. This amendment phases down HFC production step-wise by various amounts for A5 and non-A5 countries. The first step is a phase-down of 10% in non-A5 countries.

Member States: A *member state* is a state that is a member of an international organization or of a federation or confederation.

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 A5 parties.

National Ozone Officer (NOO): NOOs lead the A5-party's NOU. Typically they have a dedicated team that includes an Assistant Ozone Officer and other staff. The NOO is the focal points for implementation issues related to the Montreal Protocol.

National Ozone Unit (NOU): The government unit in an A5 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 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, that take into account factors such as the stability of the product, the rate of diffusion, the quantity of depleting atoms per molecule, and the effect of ultraviolet light and other radiation on the molecules. The substances implicated generally contain chlorine, bromine, and/or iodine.

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.

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

Phase Down: The reduction of production and consumption of the HFCs following the Kigali Amendment to the Montreal 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: To reprocess a fire extinguishing agent 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 specialized equipment usually not available at a servicing company.

Recovery: To remove the fire extinguishing agent 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: To extract the fire extinguishing agent from an extinguisher or system storage container and clean the agent for reuse without necessarily meeting all of the requirements for reclamation. In general, recycled agent has its super-pressurising nitrogen removed in addition to being processed to only reduce moisture and particulate matter.

Technology and Economic Assessment Panel (TEAP): An international body of experts established in 1990 as the technology and economics advisory body to the Montreal Protocol

Parties. The TEAP provides, at the request of Parties, technical information related to the alternative technologies that have been investigated and employed reduce, and where possible, eliminate use of ODS. The TEAP is one of three Assessment Panels; the other two being the Environmental Effects Assessment Panel (EEAP) and the Science Assessment Panel (SAP).

Total Flooding System: A fire extinguishing system that protects a space by developing the required concentration of extinguishing agent throughout the protected volume.

Water Mist: A firefighting agent that uses relatively small water droplet sprays to extinguish fires. These systems generate much smaller droplets than are produced by traditional water-spray systems or conventional sprinklers.

