MONTREAL PROTOCOL
ON SUBSTANCES THAT DEPLETE
THE OZONE LAYER

UNEP

REPORT OF THE
HALONS TECHNICAL OPTIONS COMMITTEE

DECEMBER 2014

VOLUME 2

2014 SUPPLEMENTARY REPORT #1

CIVIL AVIATION

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Preface

The December 2014 HTOC Report consists of three volumes:

Volume 1: 2014 Assessment Report

Volume 2: 2014 Supplementary Report #1 – Civil Aviation

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

Supplemental Report #1, *Civil Aviation*, expands on the abbreviated information contained in the main body of the 2014 Assessment Report of the UNEP Halon Technical Options Committee (HTOC), which briefly introduces the subject of *Civil Aviation* and refers the interested reader to this document. In the 2010 Assessment Report *Civil Aviation* was covered with other sectors that continue to rely on halons, such as *Military*, *Pipelines and Oil and Gas Facilities*, *Merchant Shipping* and other *Commercial*, *Industrial* and *Agricultural sectors*. These sectors have moved to alternatives for virtually all new applications, with only legacy systems still relying on halons, whereas *Civil Aviation* continues to rely on halon for almost all fire protection systems in new civil aircraft produced today. The HTOC believed that important information for the Parties regarding *Civil Aviation* was getting lost amongst the other information. Thus, the Committee felt this topic could be best covered by a separate Supplemental Report. By this approach, those having a particular interest in the use of halons and the progress with their replacement in *Civil Aviation* can access a self-contained document addressing those issues.

1.0 Introduction

Although the incidence of in-flight fires is low, the consequences in terms of loss of life are potentially devastating, and the use of halon to help guard against such events has been extensive. Aviation applications of halon are among the most demanding uses of the agents, and require every one of their beneficial characteristics. Particularly important are the following:

- Dispersion and suppression effectiveness, which must be maintained even at the low temperatures encountered at high altitude.
- Minimal toxic hazard to the health and safety of ground maintenance staff and also of passengers and flight crew, who could be exposed to the agent and any decomposition products for periods as long as several hours.
- Weight and space requirements of the agent and associated hardware.

Also significant are short- and long-term damage to aircraft structure or contents resulting from the agent or from its potential decomposition products in a fire; avoidance of clean-up problems; suitability for use on live electrical equipment; effectiveness on the hidden fire; and the installed cost of the system and its maintenance over its life.

While alternative methods of fire suppression for ground-based situations have been implemented, the status of halon in the civil aircraft sector must be viewed in three different contexts: existing aircraft, newly produced aircraft of existing models, and new models of aircraft. All of them continue to depend on halon for the majority of their fire protection applications. Given the anticipated 25–30 year lifespan of a newly produced civil aircraft, this dependency could continue beyond the time when recycled halon is readily available. The civil aviation industry must look either to their own stockpiles of halon or to the limited amounts of recycled halon available on the open market to avoid grounding aircraft because of a lack of appropriate fire protection. In the four years since the last Assessment Report, it appears that the aviation industry has made limited efforts to begin stockpiling halon.

Decision XV/11 was the first of several Decisions that authorized representatives of the Ozone Secretariat and the Technology and Economic Assessment Panel and its HTOC to work with the International Civil Aviation Organization (ICAO) on the development of a plan of action that would eventually lead to the elimination of the need for halons on board civil aircraft. The HTOC has worked closely with ICAO bodies to develop resolutions to require a scheduled halon replacement in certain applications where alternatives were available.

2.0 Estimated Halon Usage and Emissions

The halon 1301 and halon 1211 installed base estimates for mainline and regional aircraft were developed using activity data and fleet assumptions. In order to estimate the current and projected fleet, estimates were made from Airbus' and Boeing's Global Market Outlook reports (Airbus 2013; Boeing 2013).[1] It was assumed that the remaining portion of the estimated 2014 fleet consists of regional aircraft[2]. The market breakdown of the mainline versus regional fleet after 2014 is assumed to be proportionate to the number of mainline versus regional deliveries in 2013 (CAPA accessed February 2014; The Flying Engineer access February 2014). Table 1 below outlines the current and projected worldwide fleet.

Table 1: Mainline and Regional Fleet Estimates (2014-2030)

Year	2014	2020	2025	2030
Total Mainline Fleet	18,313	23,509	27,839	32,170
Total Regional Fleet	2,699	3,465	4,103	4,741
Total Worldwide Fleet	**21,012**	**26,974**	**31,942**	**36,911**

To estimate the number of installed halon systems per aircraft, activity data for engine nacelles, cargo compartments, APUs, lavatory extinguishing (lavex) systems, and handheld applications from previous analyses were used, as well as feedback from airframe manufacturers. These "activity data" were used in turn to estimate the installed halon base across the commercial aviation fleet.

The assumptions by halon 1301 application type are as follows: the engine nacelle application assumes one halon bottle per engine; the baggage/cargo application varies according to flight

[1] These estimates do not specifically include Russian-built aircraft.

[2] Commercial Rotary and Business Aircraft, depending on size, have halon 1301 systems and halon 1211 hand portables installed. The quantities are smaller than the commercial and regional transport aircraft but nonetheless, have the same issues for the airframers and operators.

distance and estimated cargo space;[3] the APU application assumes one bottle per aircraft; and the lavex application assumes one bottle per regional aircraft.[4] of the total kilograms installed.

Table 2 below outlines the estimated contribution of each halon 1301 application and airframe category to the total halon 1301 installed base, presented as a percentage of the total kilograms installed.

Table 2: Percentage of the Halon 1301 Installed Base by Halon Application and Airframe Category

Airframe Category	Engine Nacelle	Cargo	APU	Lavex	Total
Mainline	32%	49%	5%	~ 0%	87%
Regional	4%	9%	0.74%	0.02%	13%

Using this bottom-up approach, it is estimated that there is approximately 1.5 million kg of halon 1301 installed across the mainline and regional fleet, as presented in Table 3.

Table 3: Estimated Installed Base of Halon 1301 in Commercial Aircraft Worldwide (kg)

Total Halon 1301 Applications	2014	2020	2025	2030
Total Installed	1,500,000	1,850,000	2,200,000	2,500,000

The assumption for the halon 1211 handheld application is two bottles per mainline aircraft and one bottle per regional aircraft. Due to the uncertainty surrounding the use of halon 1211 in handheld fire extinguishers beyond 2016, the halon 1211 analysis in Table 4 considers two scenarios: a business as usual scenario and a best-case scenario. The business as usual scenario assumes the continued use of halon 1211 in handheld fire extinguishers through 2030. The best-case scenario assumes that mainline airframe manufacturers will implement halon-alternative handheld fire extinguishers in all aircraft new deliveries by December 31, 2016, and in the European Union retrofit of all existing aircraft by December 31, 2025.[5]

Table 4: Estimated Installed Base of Halon 1211 in Commercial Aircraft Worldwide (kg)

Total Halon 1211	2014	2020	2025	2030
Total Installed: Business As Usual Scenario	197,000	252,000	299,000	345,000
Total Installed: Best-Case Scenario	197,000	211,000	183,000	150,000

[3] The installed halon in the baggage/cargo section of the aircraft varies depending on the aircraft type and maximum distance to the closest airstrip at any point during the flight. When a fire is detected, there is an initial halon release into the cargo space. The halon continues to be released at a slower rate to maintain halon levels until the plane can safely land at the closest airstrip.

[4] Lavex systems no longer use halon 1301 in mainline aircraft (HTOC 2010).

[5] The best-case scenario assumes that Boeing and Airbus aircraft represent 100% of the mainline fleet, and the Airbus fleet will be subject to the European retrofitting mandate by the end of 2025.

3.0 Halon Banks

At present, the halon demands of aviation are being met by recycling agent withdrawn from applications in other industries. This source of supply will be dramatically reduced, and may even be exhausted, long before the aircraft now being built and fitted with halon systems are retired.

Civil aviation OEMs and operators who have not already done so are strongly advised to:

- Consider whether the installed stocks of halon they own are sufficient to meet their long-term needs (taking into account the possibility that contaminated halon may have penetrated their own stocks),
- Ascertain whether these stocks are being properly managed to ensure they are available for their needs,
- Determine whether it is necessary to procure and store additional agent now, while it is relatively easy to do so, to meet long-term demands, and
- Continue to implement policies that eliminate or minimize discharge in testing, training, and maintenance.

4.0 Status of Halon Replacement Options

Halons are used for fire suppression on civil aircraft in:

- Lavatory trash receptacle extinguishing systems;
- Handheld extinguishers;
- Engine nacelle/auxiliary power unit (APU) protection systems; and
- Cargo compartment extinguishing systems.

All new installations of fire extinguishing systems for engines and cargo compartments use halon 1301, and all new installations of handheld extinguishers use halon 1211. With the exception of lavatory trash receptacles, there has been no retrofit of halon systems or portable extinguishers with available alternatives in the existing worldwide fleet of aircraft.

Key to the acceptance of one or more of the approved substitutes has been their ability to demonstrate fire extinguishing performance equivalent to halon in specific applications. As such, substitutes for halons in civil aviation fire extinguishing systems are evaluated and approved according to the relevant Minimum Performance Standards (MPS) and testing scenarios developed by the International Aircraft Systems Fire Protection Working Group (IASFPWG). The status of the development of these MPS for the above applications and the alternatives tested to these MPS are discussed below.

4.1 Lavatory Trash Receptacle

Halon 1301 has historically been used in lavex systems, which are designed to extinguish trash receptacle fires in the lavatories of pressurised cabins. Trash receptacles are required to be installed with a lavex system that automatically discharges into the container in the event of a Class A fire (i.e., involving paper materials). All lavex systems using halon alternatives must meet the Minimum Performance Standard (DOT/FAA/AR-96/122) that includes the ability to extinguish a Class A fire and in the case of discharge, not create an environment that exceeds the chemical agent's no observable adverse effect level (NOAEL).

A finalised MPS for lavex systems was completed in February 1997. Research and testing has shown that there are suitable alternative suppression systems (using HFC-227ea or HFC-236fa) available for this application that are "a drop-in" replacement from a space and weight perspective, meet the toxicological requirements, and cost the same or less than the halon systems being replaced. Data from one lavatory extinguisher manufacturer shows that the vast majority of new production aircraft are now installed with non-halon systems. In addition, several airlines are replacing existing halon 1301 lavex systems with these halon-free alternatives during scheduled maintenance operations.

4.2 Handheld Extinguishers

All handheld extinguishers intended to replace halon 1211 extinguishers must meet the Minimum Performance Standard (DOT/FAA/AR-01/37) to ensure their performance and safety. These standards require that any handheld extinguisher for aviation use be listed by UL or an equivalent listing organisation. To be listed, the extinguisher must be able to disperse in a manner that allows for a hidden fire to be suppressed and does not cause any unacceptable visual obscuration, passenger discomfort, and toxic effects where people are present.

The MPS was published in August 2002. As of 2003, three halon alternatives, HFC-227ea, HFC-236fa and HCFC Blend B, have successfully completed all of the required handheld UL and MPS tests and are commercially available. These alternatives have increased space and weight characteristics, and environmental concerns of global warming for the two HFCs and production phase-out for HCFCs under the Montreal Protocol for the HCFC blend. Qualification and installation certification by airframe manufacturers and regional authorities is needed prior to airline use. Based on these issues, airframe manufacturers have chosen not to pursue qualification and installation certification for these alternatives.

Testing of a "low GWP" and "near-zero ODP" unsaturated HBFC known as 3,3,3-trifluoro-2-bromo-prop-1-ene or 2-BTP that has the potential of lower space and weight impact compared to other alternatives, continues. The agent manufacturer has provided a submission under the US Significant New Alternatives Policy (SNAP) program and a Pre-manufacturing Notice (PMN) under the Toxic Substances Control Act (TSCA), both of which are required before commercialisation can begin within the US. If approved in the US, this agent could be commercialised in the next few years to meet aviation needs for a handheld extinguisher replacement for in production aircraft after December 31, 2016 and may be a possible candidate for evaluation in engine nacelles/APUs as well.

ICAO, in working paper A37-WP/67 reported that the airframe manufacturers and the International Air Transport Association (IATA) requested additional time (until 2016) to thoroughly test and validate a halon replacement agent for hand-held fire extinguishers, which is reported to be neither a greenhouse gas nor an ozone depleting substance. The International Coordination Council of Aerospace Industries Associations (ICCAIA) and IATA also indicated that should the halon replacement agent not be available by 2016, the aircraft manufacturers have agreed to put into service the current, approved hand-held halon fire extinguishing agents in order to meet the 2016 timeframe. In working paper A37-WP/197, the ICCAIA agreed with the dates presented by ICAO in working paper A37-WP/67.

4.3 Engine and APU Compartment

Halon 1301 is typically used in engine nacelles and APUs to protect against Class B fires. The requirements of fire suppression systems for engine nacelle and APUs are particularly demanding, since these compartments contain fuels and other volatile fluids in close proximity to high temperature surfaces. HFC-125 has been used successfully as an alternative to halon for engine fire protection on US military aircraft developed since the early 1990s. In addition, HFC-125 is currently being developed for use on a military derivative of a large commercial aircraft (Boeing 767; military derivative KC-46). HFC-125 has increased space and weight characteristics that present installation concerns. Also, HFCs are considered high global warming chemicals and are now subject to phase-down (not a phase-out, but a limit to future production) in the European Union and Japan. Based on these issues, particularly the additional weight, airframe manufacturers have chosen not to pursue qualification and installation certification for HFC-125 in engines/APUs.

A finalised MPS for engine nacelle/APU fire protection will be published in a forthcoming FAA report, but a deadline for formal publication has not been defined as yet. Three potential replacement agents, HFC-125, FIC-13I1, and FK-5-1-12 were tested against a previous version of the MPS and halon 1301 equivalent concentrations were determined. An engine nacelle system using FK-5-1-12 was developed but it failed a US FAA required live fire test using a cold soaked fire protection agent to simulate low temperature use. Also, an engine nacelle system based on the use of a dry powder failed a required full scale test. At this time, the system manufacturer is carrying out further work to improve the performance of the dry powder system.

The civil aviation industry has come to the conclusion that they need to take a different approach to finding a halon 1301 replacement for engine and APUs. Instead of separate efforts, they are going to pool their resources to develop a single agent/approach and have formed the Engine/APU Halon Alternatives Industry Consortium (IC). The IC consists of aircraft OEMs, fire extinguishing suppliers & distributors, a chemical company, airline operators, an engine manufacturer, an aviation industry group and representation from the US military. The IC has mapped out a 3 phase approach: Phase I (administrative start-up) is scheduled to run until mid-to-late 2014. Phase II (requirements development) is estimated to be another 12 months (will commence once Phase I is complete) and Phase III (selection of the winning agent/approach) follows thereafter, but has no time-scale assigned as yet. The first task for the IC is to appoint an independent Managing Entity, to manage Intellectual Property (IP) rules and agreements which are needed before Phase II (Technical definition of the Statement of Work) can take place. Currently, the air framer team is still reviewing a Service Agreement and Statement of Work that will formally engage the Managing Entity for launch of Phase I activities.

4.4 Cargo Compartments

In passenger aircraft the cargo compartments are typically located below the passenger cabin, or occupy both the main and lower deck on freighter aircraft. Note, in freighter aircraft only the lower deck is protected with halon; the main deck is deemed too large (it can be up to six times larger than the lower deck) and would require excessive amounts of halon 1301. Fire control typically is effected by depressurising the main deck cargo compartment, reaching the landing site and landing as quickly as possible before the fire re-establishes itself. One large freight carrier has reportedly developed a foam system for additional fire protection for the main deck. In the case of a fire in the lower deck cargo compartment, a rapid discharge of halon is deployed into the protected space to suppress the fire, which is followed by a discharge that is released slowly to maintain a concentration of halon to prevent re-ignition. The slow discharge is maintained until the plane has landed to protect against any reduction in the concentration of halon caused by ventilation or leakage.

Cargo compartment fire suppression systems must be able to meet the requirements of four fire tests required in the Cargo Compartment Minimum Performance Standard last updated as DOT/FAA/TC-TN12/11. The system must be able to suppress a Class A deep-seated fire for at least 30 minutes and a Class A fire inside a cargo container for at least 30 minutes. The system must be able to extinguish a Class B fire (flammable liquid such as jet fuel) within 5 minutes, and prevent the explosion of a hydrocarbon mixture, such as found in aerosol cans. In addition, the system must have sufficient agent/suppression capability to be able to provide continued safe flight and landing from the time a fire warning occurs, which could be in excess of 350 minutes, depending on the aircraft type and route planned.

To date, there have been no cases of halon 1301 replacement with an alternative agent in cargo compartments of civil aircraft. All halocarbon agents that have undergone the exploding-aerosol-can test have been shown to cause an undesired increase in the test compartment pressure if discharged at a concentration below which the agent will suppress a fire or deflagration event. The cargo MPS now requires that pressure increase not occur upon application of a suppressant agent in a quantity less than that needed to suppress a fire or deflagration event. On this basis, all halocarbons tested so far have been found to be unacceptable. A combination of water mist and nitrogen has been tested to and met the requirements of the current MPS. Commercial development of a water mist/nitrogen cargo fire suppression system is in the early stages.

The ICCAIA has formed the Cargo Compartment Halon Replacement Working Group (CCHRWG) to begin to coordinate a single industry effort to find an alternative to halon 1301 in cargo bays.

The CCHRWG are trying to develop a recommended date for replacing halon 1301 in cargo compartments to fulfil a request made during the last General Assembly, in 2013 in Resolution A38-9, to report back to ICAO by December 2015 a date when a mandate to replace halons for new airworthiness type certificates could be instituted in cargo bays. This will be taken up at the next ICAO General Assembly meeting in 2016. There are two main elements that feed into this roadmap: estimation of a likely timescale to accomplish this and a single consolidated list of requirements. Some progress has been made on the list of requirements, but defining the timescale with fidelity is problematic. Current best estimates are that it will take somewhere between 3½ and 6 years to transition from proof of concept to a point where a type certificate can be applied for. However there are other factors / unknowns to consider including the lack of a comprehensive list of agents / systems, the need to obtain regulatory approval for any new agents, and possibly the need to develop new measurement methodologies for any novel agent or system. Furthermore, depending on the nature of the agent / system chosen, the FAA MPS may need to be rewritten, which would impose further delays.

4.5 Crash Rescue Vehicles

In addition to onboard civil aircraft applications, halon 1211 is used in some Aircraft Rescue and Fire Fighting (ARFF) or Crash Rescue vehicles on airport ramps. FAA CERT Alert 95-03 approved HCFC Blend B as a halon replacement for this application in the United States. Since 1995 a significant number of U.S. airports have installed such systems. However, because HCFC Blend B is an ODS, national regulations may limit its use for this application in other countries.

5.0 ICAO Activities

The HTOC continued to work with ICAO on the amendments to Annex 6 – Operation of Aircraft, and Annex 8 – Airworthiness of Aircraft, of the Chicago Convention that needed to be approved to meet the agreed upon mandated dates in Resolution A37-9. The amendments were adopted by the Council of ICAO on June 13, 2011. The Amendments mandate halon replacement as follows:

- in lavatory fire extinguishing systems used in aircraft produced after December 31, 2011;
- in hand-held fire extinguishers used in aircraft produced after December 31, 2016; and
- in engine and auxiliary power unit fire extinguishing systems used in aircraft for which application for type certification will be submitted after December 31, 2014.

It is important to note that these changes to ICAO standards are not requirements. States are expected to try as best as possible to meet these standards but they are allowed, and do, file "differences" which explain how they will not meet the standards, in part or whole. This means that they can and will continue to use halons or allow the use of halons past these dates.

In further compliance with Resolution A37-9, the HTOC worked with ICAO to develop a questionnaire to gain insights into the availability of halons to support civil aviation needs. The questionnaire was distributed to all ICAO Contracting States on May 28, 2012.

An analysis of the responses found a notable lack of responses from States (Parties) where the HTOC believes there could be a significant bank of halons and where filling of civil aviation bottles now occurs. Although some States have determined their supplies, some did not know how much halon they had. While some States believed that there is enough halon, it is unclear how this was determined. Other responses demonstrated that the civil aviation halon needs in some States depend on the availability of halon in the States supplying their aviation industry.

At the 38th General Assembly in 2013, Resolution A38-9 directed that the ICAO Council shall report to the next ordinary session of the Assembly (2016) on a timeframe for the replacement of halon in cargo compartment fire suppression systems. As noted previously, ICCAIA has established the CCHRWG to develop a recommended timeframe to be reported back to ICAO by December 2015 so that the item will be taken up at the 39th General Assembly in 2016.

6.0 European Union

The European Union banned all non-critical uses of halons in 2003. Critical uses are listed in the current Annex VI to Regulation (EC) No. 1005/2009. All current on-board uses of halons in aviation are included on the critical use list under the EC regulation. Annex VI was revised in 2010 as per Commission Regulation (EU) No 744/2010 of 18 August 2010) which contains "cut-off dates" for the use of halons in new designs of equipment or facilities and "end dates" when all halon systems or extinguishers in a particular application must be decommissioned (i.e. 'retrofit'; see Table 5 below). Engine nacelle and cargo compartment applications in new type designs are subject to Regulation (EU) No 744/2010 in the European Union. This differs from the approach that was supported by HTOC for the ICAO resolution, which focuses on eliminating the use of halon in new production aircraft and new designs only. Important safeguards have however been put in place in Regulation (EC) No 1005/2009 to avoid adverse impacts on safety and excessive costs: there are provisions for case by case derogations and for periodic reviews of the annex in order to account for the technological progress and the technical feasibility in terms of retrofit. The European Aviation Safety Agency (EASA) intends to publish a Notice of Proposed Amendment (NPA) around the end 2014, based on rulemaking task RMT.0560, where 'forward fit' (i.e. ICAO approach for new production aircraft) is expected to be proposed. The NPA might also provide some information on the legal provisions necessary to obtain case-by-case derogations.

Table 5: Aviation Halon Phase Out Dates in EC Reg. 1005/2009 Annex VI

Purpose	Type of Extinguisher	Type of Halon	Cut-off Date: Application for New Type Certification	End Date: All Halons Decommissioned
Normally unoccupied cargo compartments	Fixed system	1301 1211 2402	2018	2040
Cabin and crew compartments	Portable extinguisher	1211 2402	2014	2025
Engine nacelles and APU	Fixed system	1301 1211 2402	2014	2040
Inerting of fuel tanks	Fixed system	1301 2402	2011	2040
Lavatory waste receptacles	Fixed system	1301 1211 2402	2011	2020
Protection of dry bays	Fixed system	1301 1211 2402	2011	2040

7.0 New Generation Aircraft

The civil aviation regulatory authorities should closely monitor and ensure that the testing and approval of alternatives for engine nacelle and cargo compartment applications is completed in the near-term for new airframe designs. New airframe designs should take into account these tested and approved alternative fire suppression agents and systems. However, this is not happening to date. The timing of the inclusion of the available halon alternatives in new aircraft designs remains uncertain, and unless the processes of designing, conforming, qualifying and certifying new extinguishing systems on civil aircraft are made a priority by the airframe manufacturers and approval authorities – and expedited accordingly – these are significant barriers to the transition away from halons and will place an increasing burden on the diminishing supplies of halons.

8.0 Conclusion

Halon alternatives that are not drop-in replacements, i.e., that weigh more and take up more space, are unlikely to be implemented by civil aviation airframe manufacturers. As such the Civil Aviation sector is likely to be reliant upon halons for the next 30 years and beyond. Having not secured sufficient halon stocks to meet their continuing needs, this sector is the least prepared to deal with diminishing halon supplies and, with the ultimate exhaustion of halon supplies, will most likely be the sector to request an Essential Use Nomination in the future.

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Appendix A: List of Acronyms and Abbreviations

2-BTP	3,3,3-trifluoro-2-bromo-prop-1-ene
APU	Auxiliary Power Unit
ARFF	Aircraft Rescue and Fire Fighting
CAPA	CAPA Centre For Aviation
CCHRWG	Cargo Compartment Halon Replacement Working Group
CO2	Carbon Dioxide
DOT	Department Of Transportation
EASA	European Aviation Safety Agency
EC	European Commission
EU	European Union
FAA	Federal Aviation Authority
GWP	Global Warming Potential
HBFC	Hydrobromofluorocarbon
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HTOC	Halons Technical Options Committee
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IC	Engine/APU Halon Alternatives Industry Consortium
ICCAIA	International Coordination Council of Aerospace Industries Associations
LAVEX	Lavatory Trash Receptacle Extinguishing
MPS	Minimum Performance Standards
NPA	Notice of Proposed Amendment
ODP	Ozone Depletion Potential
OEM	Original Equipment Manufacturer
PMN	Pre-manufacturing Notice
SNAP	Significant New Alternatives Policy
TEAP	Technology and Economic Assessment Panel
TSCA	Toxic Substances Control Act
UNEP	United Nations Environment Programme
US	United States

Appendix B: Definitions

Global Warming Potential (GWP): Global warming potential is defined as the cumulative radiative forcing effects of a gas over a specified time horizon resulting from the emission of a unit mass of gas relative to CO_2. The TEAP has proposed the following classification: High >1000, Moderate 300 – 1000, and Low <300, which has been used in this Assessment report.

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.

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

Hydrobromofluorocarbons (HBFCs): A family of chemicals related to halonss that contain hydrogen, bromine, fluorine, and carbon atoms. HBFCs are partly halogenated and have much lower ODP than halons.

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.

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.

Ozone Depletion Potential (ODP): A relative index indicating the extent to which a chemical product destroys the stratospheric ozone layer. The reference level of 1 is the potential of CFC-11 and CFC-12 to cause ozone depletion. If a product has an ozone depletion potential of 0.5, a given mass of emissions would, in time, deplete half the ozone that the same mass of emissions of CFC-11 would deplete. The ozone depletion potentials are calculated from mathematical models, which take into account factors such as the stability of the product, the rate of diffusion, the quantity of depleting atoms per molecule, and the effect of ultraviolet light and other radiation on the molecules. The substances implicated generally contain chlorine or bromine.

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

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

Production: The amount of controlled substances produced, minus the amount destroyed by technologies to be approved by the Parties and minus the amount entirely used as feedstock in the manufacture of other chemicals. The amount recycled and reused is not to be considered as "production".

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

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

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