Eliminating Dependency on Halons

Case Studies

United Nations Environment Programme
Division of Technology, Industry and Economics
Energy and OzonAction Unit
OzonAction Programme

Multilateral Fund for the Implementation
of the Montreal Protocol

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PREFACE

Technical innovations in fire protection methods have contributed to great reductions in risk to human life, business, government, national security and cultural heritage, especially during the second half of the 20th century. The development and widespread adoption of effective, safe and affordable chemical fire protection agents such as halons have significantly helped to increase fire safety worldwide.

Unfortunately, what is good for fighting fires is not always good for the environment. In the case of halons, their long atmospheric lifetimes and high ozone destruction potential makes them extremely damaging to the stratospheric ozone layer, which protects humans, animals and plants from the damaging effects of ultraviolet solar radiation. Recognizing the danger posed by the continued use of these fire fighting agents, the world community through the Montreal Protocol has agreed on a schedule to phase out halons.

How can countries ensure effective fire protection while at the same time eliminating dependency on halons to protect the ozone layer? Developed countries have already made significant progress towards meeting this goal, as evidenced by their phase out of halon production by January 1994. Developing countries (known as "Article 5 countries") now have to meet the challenge of freezing their halon consumption by January 2002, reducing it by 50% by January 2005 and totally phasing out by January 2010. Action towards meeting these targets must begin now.

These case studies will help Article 5 countries to meet these compliance targets by learning how other countries and organizations have approached and addressed different aspects of halon management. The topics range from the adoption of alternatives in different sectors (aviation, electronic facilities, military) to how a country organized a network of stakeholders and institutions to steer the halon phase out (Poland) to the experience of specific organizations in different aspects of halon management (NASA, Alang shipbreaking yard). Additionally, guidance is provided on key issues such as decommissioning halon systems.

Although specifically written for National Ozone Units (NOUs) within the government, the guide is also designed to be used by other members of the fire protection community, including public fire services, fire equipment vendors, halon users, insurance companies, customs officials, and NGOs.

Through its International Recycled Halon Bank Clearinghouse, UNEP supports the development of national and regional strategies for the management of halons, including emissions reduction and ultimate elimination of their use, as requested by the Parties to the Montreal Protocol through their Decision X/7 (November 1998). This document is part of a halon management series, which also includes the Self Help Guide for Low Volume Consuming Countries. These and other halon resources are available at www.uneptie.org/ozonaction.html

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HALON USE, ALTERNATIVES AND INVENTORY MANAGEMENT BY THE AVIATION SECTOR

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 halons are amongst the most demanding uses of the agents, and require every one of their beneficial characteristics. Particularly important are 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; and the weight and space requirements of the agent and associated hardware (the typical incremental cost in fuel alone of carrying an additional kilogram of weight is estimated at US$16,000 per annum, the world commercial transport fleet numbers some 32,000 aircraft, and each can have anything from a few to several hundred kilograms of halon on board). Also significant are short and long term damage to 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; installed cost of the system and maintenance cost over its life. It is no surprise, therefore, that it is an area that is proving technically difficult to satisfy - and that in the meantime many aviation applications are generally accepted as "critical" in accordance with the terms of Decision VII/12 by reference to the criteria set out in Decision IV/25.

Most of the approaches to identifying viable replacements, at least for commercial applications, are being co-ordinated by an International Halon Replacement Working Group

(IHRWG) led by the US Federal Aviation Administration, together with the European Joint Airworthiness Authorities and Transport Canada. The Group meets about three times per year, and the meetings are open to all interested parties: major airframe manufacturers and several airlines and military organisations as well as a number of research bodies and agent and equipment manufacturers are regular participants. The overall aim is to ensure a level of safety equivalent to that currently provided by halon: but most prior specifications were defined by reference to the halon system itself rather than to a prescribed level of fire suppression performance, so it has first been necessary to determine by test, usually at full scale, what the existing performance levels are, so that equivalent requirements and certification acceptance criteria can be defined for replacement agents.

The current status of the search for replacements is set out below according to the various specific application areas: in some cases, technically acceptable replacements are now available, but in several, work to find a suitable approach is still in progress. Until this is successful, it will continue to be necessary to conserve and recycle halon to support existing aircraft systems; this approach is being actively pursued by a number of airlines and equipment suppliers. In the meantime, most airlines, air forces, airframe manufacturers and system suppliers have introduced policies to minimise discharge testing, introduce simulants for the purposes of training, and tighten maintenance procedures to reduce emissions during servicing and due to inadvertent discharges.

Applications

Engines

Airworthiness regulations require a fire protection system to be fitted to engines and auxiliary power units of commercial air transports; the use of halon is not mandated, but in practice all such aircraft are protected in this way, and the same applies to many military aircraft. A copious fuel supply, high airflows and low temperatures render many non-halon agents inadequately effective.

An experimental programme has been conducted at Wright Paterson Air Force Base, supported by the US Air Force and the FAA and overseen by the IHRWG, to evaluate the available alternatives; and additional work is in progress at the FAA Technical Center. The preferred halocarbon solution is HFC-125; a number of new US military programmes have already adopted this approach, and design codes and certification approaches are due for publication shortly. However, this will incur a significant weight and space (and therefore cost) penalty, making it unlikely to be adopted for retrofit and unattractive compared with recycled halon even for new designs. Meanwhile there is continued interest in the use of FIC-13I1 for this application, although doubts persist regarding its potential toxic impact on maintenance staff. Research work is also in progress on pyrotechnic gas generators.

Cargo Bays

The majority of cargo bays are located in the lower fuselage beneath the passenger compartment, isolated from it by fixed fireproof liners. In dedicated freight aircraft the main deck is also used for cargo. In "combi" aircraft, cargo occupies part of the main deck, separated from the passenger accommodation by a movable partition.

Rapid and effective agent dispersion throughout a tightly packed, possibly containerised, cargo bay is a key and demanding consideration. Cargo fires typically involve quantities of Class A (smouldering) combustibles, and existing halon systems do not extinguish such fires, but merely suppress them at a level which does not threaten the airframe, flight systems, passengers or crew; aircraft qualified for extended operations may be as much as three flying hours from the nearest adequately equipped airport, and after an initial burst of halon to knock down the fire, a continuing slow discharge is bled into the protected areas to maintain a suppressing concentration against the diluting effects of ventilation and leakage until a safe landing can be achieved. The withdrawal of CFC aerosol propellants in favour of propane and butane introduces a further threat of explosive fire resulting from the potential for thermal over-pressurisation failure of such aerosol cans in smouldering luggage followed by ignition of the gases released. Livestock may be transported in these bays, and the agent selected should not pose an unacceptable toxic hazard. Finally, although the direction of airflow is designed to be exclusively from the passenger compartment into the cargo bay, reverse leakage is known to occur, and its likelihood is increased by the disruptions associated with a fire; thus traces of agent or of its decomposition products should not pose an unacceptable toxic hazard to passengers.

Airworthiness Regulations require a fire protection system to be fitted in larger cargo bays of commercial air transports; the use of halon-1301 is not mandated, but the advisory

documentation which accompanies the regulations describes the methods of designing, testing, and certifying this agent; in practice all such aircraft are protected in this way, and the same applies to most military aircraft which have compartments of this kind. Smaller bays (<1,000ft ^{3}) may currently rely on sealing to contain a fire by oxygen starvation, but recent incidents are likely to lead to a new requirement to fit protection systems in these smaller bays too. The Airworthiness Authorities aim to ensure that design codes and certification approaches are available for at least one non-halon agent in time for implementation of the requirement, but as this will probably incur a significant weight and space (and therefore cost) penalty, it may not be widely adopted for retrofit and could be unattractive compared with recycled halon even for new designs.

An experimental programme is in progress at the FAA Technical Center, overseen by the IHRWG, using full scale representations of aircraft fuselages, to assess the available alternatives, embracing water mist and pyrotechnically generated aerosols as well as new halocarbons including HFC-125, HFC-227ea and FIC-13I1.

Lavatory Compartments

Airworthiness Regulations require a fire protection system to be fitted in the waste paper bins in lavatory compartments of commercial air transports; the use of halon is not mandated, but in practice all such aircraft are protected in this way. A performance specification for a replacement system has been agreed by the IHRWG and a test protocol defined. Using these, suppliers of such systems have completed the necessary test work to demonstrate compliance and are now offering systems based on some of the new halocarbons. The rather poor performance of halon in this application means that the new approaches carry substantially no weight or space penalty.

Portable Extinguishers

Portable extinguishers are required to be carried on board all commercial air transports above a certain passenger capacity. The vast majority of the incidents in which they are used are readily addressable by a suitably rated standard hand extinguisher, but there are documented instances of "hidden" fires in areas inaccessible in flight which have been extinguished successfully using halon-1211 while it is likely that other agents would have failed. Rare though these occurrences are, they could have led to loss of the aircraft and its occupants, and for this reason halon-1211 "or equivalent" is mandated in Airworthiness Regulations. A programme of work, sponsored by the UK Civil Aviation Authority, overseen by the IHRWG, and performed by Kidde International Research, has led to the development of a defined test method which will allow portable extinguishers already having a suitable conventional rating to be assessed for their effectiveness against representative "hidden" fires.

A further special requirement in aviation is the hijack or terrorist threat. Work is in progress at the FAA Technical Center to define a representative and reproducible standard based on a petrol-soaked aircraft seat fire.

The responsibility for fire extinguishing action in all these scenarios rests with the cabin crew, who undergo regular training (using halon simulants) to maintain the necessary skills. An agent less effective than halon-1211 will have a reduced tolerance of less skilled users and its adoption is therefore likely to necessitate more intensive and extensive training but at the same time to result in a reduced certainty of success in extinguishing a fire.

A final complex issue is the toxicity, both of the agent and of any decomposition products, when necessarily used in a confined space, probably with delayed egress. In the case of the existing halon-1211 extinguishers, it has been possible almost to ignore this issue as the toxic hazard generated by burning cabin furnishings dramatically exceeds that from the agent and its decomposition products. This may not be the case with a replacement.

Airworthiness regulations require fire protection systms to be fitted to engines and auxiliary power units of commercial air transports. Halons are extensively used worldwide for these and other critical aviation applications. Halon banking is required for such uses where alternatives do not yet exist.

Dry Bays

This application is unique to military aircraft. Its aim is to protect the bays located between fuel tanks and the outer skin of the aircraft against fire and explosions resulting from combat damage.

An experimental programme is in progress at Wright Paterson Air Force Base, supported by the US Air Force and Navy, to evaluate the available alternatives. The preferred halocarbon solution is HFC-125; a number of new US military programmes have already adopted this approach. Work is also in progress on pyrotechnic gas generators for this application, and these devices have also been selected on some new programmes.

Fuel Tank Inerting

This application is unique to a few existing military aircraft. Its aim is to inert the head spaces of fuel tanks prior to entering a battle zone to protect against the risk of explosion following combat damage. Investigation of possible replacements for halon is planned by the US Department of Defense but has yet to commence. It is possible that the agent selected for dry bay protection may be applicable.

Flightline

Protection of aircraft and their occupants while on the ground, for instance during preparation for flight, was traditionally ensured by the provision of halon-1211 wheeled appliances in the ramp area. Most operators have already replaced these with foam, dry chemical or carbon dioxide extinguishers, depending on the particular needs and circumstances.

Halon Banks

It is clear from the foregoing that halon will continue to be needed for several aviation applications, probably for a considerable period of time. Even if new designs adopt new agents and approaches, retrofit of existing aircraft and those now being built to current designs is unlikely. The life expectation of these aircraft is thirty years or more.

At present, the halon demands of aviation are readily met by recycling agent being withdrawn from applications in other industries. This source of supply will be dramatically reduced, perhaps to the point of non-existence, long before the aircraft now being built and fitted with halon systems are retired. Those airlines, air forces and other users who have not already done so are strongly advised to consider whether the installed stocks of halon they own in non-flying applications are sufficient to meet their long term needs; to ascertain that these installed stocks are being properly managed to ensure they are redirected to be available for critical needs when they are in due course decommissioned; and to determine whether it is necessary to procure and store additional agent now, while it is relatively easy to do so, to meet long term critical demands.

It is important, both in order to be consistent with this policy and to maintain their status as suitable purchasers and responsible users of recycled halon, that airlines, air forces, airframe manufacturers and system suppliers continue to implement policies which eliminate or minimise discharge in testing, training, and maintenance.

Conclusions

The aviation industry remains highly active in the search for replacements for halon, and in the meantime has eliminated or dramatically reduced emissions in testing, training and maintenance. Significant progress has already been achieved and, in some applications, technically acceptable replacements are available and have been, or are in the process of being, implemented. However several of the areas where halon is used in aviation present unique and demanding technical challenges. An active programme of work to find suitable approaches for these remaining areas continues, co-ordinated for the commercial aviation industry by an International Halon Replacement Working Group open to all interested parties.

Until these projects reach successful conclusions, new aircraft being built will be reliant on halon for their fire protection and Airworthiness. Support for these and existing aircraft will continue to necessitate recycling, conservation and banking of halon, probably for their expected life of some thirty years; airlines, air forces and other users are strongly recommended to review their policies on discharge minimisation and on banking and their preparedness for this long-term need.

SAFETY IN HALON DECOMMISSIONING

Introduction

Decommissioning is the process of removing a halon system from service. This must be done in order to recover the halon so it can be made available for other uses. As a logical and natural outcome of the decision to phase out production in Non-Article 5 countries, the rate at which halon systems are being decommissioned is increasing around the world. This is because recycled halon is now the only source for the remaining Essential Uses in Non-Article 5 countries, and in most Article 5 countries as well. Because safety is such an important aspect of decommissioning, it is becoming a more significant issue for the fire protection industry as more systems are being removed so their halon can be used elsewhere.

Halons are pressurised gases. Therefore, the cylinders containing them are under pressure and must be handled with great care. If the pressure is released in an uncontrolled way, the cylinder will become a projectile and can cause serious injury or death to people working on the cylinder, or to bystanders. It is of utmost importance that proper safety procedures be followed at all times when handling halon cylinders. There are basically two ways halon bottles can become dangerous. One is by damaging the valve and the other is to activate the discharge mechanism. It can be easy to accidentally activate these bottles, and cause serious injury or death. In Canada last year, a service technician was killed while preparing to remove halon from a cylinder. His death occurred because proper safety procedures were not being followed. In the US, the Fire Suppression Systems Association (FSSA) has received a number of reports of incidents involving cylinders that accidentally discharged in an uncontrolled way when they were being removed from service or during handling. In all cases, the cause was improper handling of the cylinders by untrained and unqualified people.

Today, the remaining needs for halons in all Non-Article 5 countries, and most Article 5 countries is being met with recycled halon. This halon becomes available to the market when an owner of a halon system removes the system from service and makes the halon available to another buyer. Before the phase out when halon was widely available, halon systems were decommissioned at a much slower pace than is occurring today. With the process taking place so much more frequently, the temptation to hire untrained and inexperienced people is increasing. This situation can occur when the market demand for service professionals exceeds the capacity of the local industry, or because of a need to acquire halon quickly.

Halon systems components have been manufactured for over 20 years, in many places around the world, and by many different companies. As a result, many different types and models of valves and activation mechanisms are installed on halon cylinders. Because of this, it can be difficult to know exactly how a particular valve mechanism works, or the proper procedures for safe decommissioning. This can even be true for professionals who may not have encountered a particular design before. Ideally, the people who decommission a system should be those who installed and serviced it, however this is not always possible.

In any case, the procedures outlined in the Operations and Maintenance Manuals, Owners Manuals, Service Manuals, etc., that are provided by the manufacturer for the specific type of equipment installed must be followed. Some of the key steps that would be considered as mandatory in any procedures manual are detailed below:

Secure Cylinders

Before any steps are taken to disconnect any piping from a halon cylinder, it must first be firmly secured to an immovable object. If this is not done, and the valve becomes damaged, the cylinder could become a projectile. Cylinders connected to installed systems are usually adequately secured to a system manifold.

Disable Actuation Devices

Once the cylinder is firmly secured, the first step in decommissioning is to disable the actuation devices so the cylinder cannot accidentally fire. The actuation device triggers the valve to open. The valves holding the pressure in the cylinder are designed such that when activated, they go from a fully closed to fully open position instantly, and the cylinder will be fully emptied in approximately 10 seconds. When this happens, the cylinder depressurises rapidly. If the cylinder is not safely secured in place when this occurs, it will become a projectile. This is why the first thing the technician must do when decommissioning (after securing to an immovable object) is to disable the actuation mechanism.

Actuation mechanisms can be either electrical, pneumatic or mechanical. However, simply disconnecting the device from its electrical or pneumatic source is not enough to deactivate the device. In the case of pneumatic systems, there is usually a small pin exposed that must be covered with a safety cap. Failure to do this could result in accidental discharge. On electrically activated valves, disconnecting the electrical leads to the solenoid valves is acceptable. However, if the electrical connection is to an explosive initiator, it is very important to remove the initiator. This is a very important safety practice, because static electricity can cause the explosive to detonate, firing the valve. These actions must be taken before any further dismantling is done.

Install Anti-Recoil Devices

At this point, it is now safe to carefully disconnect any discharge piping from the discharge port. Immediately upon disconnection of the piping, an anti-recoil device must be installed.

The anti-recoil device prevents the cylinder from becoming a projectile in the event the cylinder activates or if the valve becomes damaged. Most fire suppression system cylinders are furnished with valve outlet anti-recoil devices, and in some cases cylinder protection/safety caps. DO NOT disconnect cylinders from the piping system, or move or ship the cylinders if the anti-recoil devices or safety caps are missing.

Obtain these parts from the Distributor or the Manufacturer. These devices are provided for safety reasons, and must be installed at all times, except when the cylinders are connected to the piping system, or being filled. All control heads, pressure operating heads, initiators, discharge heads, or other type of actuation devices must be removed; and anti-recoil devices or safety caps must be installed before disconnecting the cylinders from the system piping.

Fire suppression system equipment varies according to manufacturer, therefore it is important to follow the instructions and procedures provided in the manufacturer's manuals. Decommissioning should only be undertaken by qualified fire suppression system service company personnel.

A safety cap is a device to prevent recoil. It is simply a cap that is secured over the discharge port to disperse a sudden release of halon and prevent the cylinder from becoming a projectile. It is important that the caps designed and manufactured for the specific model of valve be used. This is because the threads are not standardised, and if the wrong size is used they may not hold the pressure of the halon release.

If the proper manufacturers caps cannot be obtained, pipe caps, plugs or plates can be substituted, but must be installed correctly. If pipe caps, plugs or plates are used, at least four opposing holes must be drilled in the cap, plug or plate so that in the event of a discharge, the pressure is dispersed in a way that balances the forces exerted on the cylinder. Anti-recoil device safety caps, plugs or plates must always be properly installed before handling the cylinders.

Packing Cylinders for Shipment

Complying with the above safety practices is paramount before removing any cylinders from the mounting position. Once the safety devices are in place, cylinders can be moved with relative safety. However, it is always important to remember that these are high pressure compressed gas cylinders, and must be handled according to all the safety procedures applicable to any other high pressure gas cylinder. At this point, with the actuating mechanism removed or disabled and the anti-recoil device correctly installed, the cylinder may be moved to the location where the halon will be removed. Sometimes the halon is removed on site, but usually the cylinders are secured onto pallets or packed in crates and shipped to a central point.

Receiving Shipped Cylinders

At the receiving point for the cylinders, there are a number of safety procedures that must be followed. When opening the shipping container, a "halon sniffer" should be used to determine if there has been an accidental discharge or leakage during transit. If there is a reading, people should move away and allow any heavy concentrations of halon to dissipate.

Technicians should then look carefully at each cylinder to determine which one of the following devices is present:

- Burst disk/initiator
- Mechanical/cutter valve
- Shraeder valves/pilot check valves

If there is no initiator present and the safety cap is in place, the cylinder may be safely unloaded and stored.

If the burst disk/initiator valve is present, look for initiators and safety caps and proceed as follows: If the initiator and safety cap are both in place, the cylinder may be carefully unloaded, but the initiator must be disabled immediately by a qualified technician. It is important not to discharge any static electricity to the initiator or the initiator wiring during unloading. This could cause the valve to discharge,

If the initiator is in place and there is no safety cap in place, first connect an electrical ground strap to the cylinder, the vehicle the containers were shipped in, and the person unloading the cylinder. Then install an anti-recoil device (safety plug, plug or plate) over the outlet, taking care not to release any static electricity to the initiator or its wiring. After the anti-recoil device is installed, the initiator must be immediately disabled by a qualified technician.

If the valve is of the mechanical/cutter type, look for the safety caps/plugs and proceed as follows:

If the cutter mechanism is removed and the safety cap is in place, or if the cutter mechanism is in place with a safety cap or plug in place, the cylinder may be safely unloaded and stored.

If the cutter mechanism is in place and no safety plug is installed, DO NOT INSTALL A SAFETY PLUG. Make sure the cylinder is secured to a pallet, and is handled in a safe manner. Cutter valves are activated by a sharp edge that cuts into the disk sealing the cylinder opening. Be careful that the cylinder and pallet are not hit hard against anything since this could cause the cutting edge of the mechanism to cut into the disk and discharge the cylinder. Hold the cylinders in a safe location until a qualified technician can take action.

If the valve type has a Shraeder core, look for safety caps and proceed as follows:

- If the safety caps are installed and the release valve or mechanism is secured, the cylinder may be safely unloaded and stored.
- If the safety cap is not in place and the release mechanism is not secured, install the appropriate safety caps and secure the release mechanism before unloading the cylinder.

The procedures for actually removing the halon differ depending on the type of valve the cylinder has connected. There are many different types, manufactured by many different companies around the world.

Measures to Improve the Safety of Decommissioning

The Halons Technical Options Committee recommends fire protection industry associations, regulatory agencies of government with cognisant authority, and system manufacturers work together to make sure only qualified people work on halon systems, and that all necessary literature for the safe decommissioning be made widely available throughout the industry, anticipating a greater than usual demand for this information.

Owners of halon systems wishing to make the halon available to other buyers should first turn to the company that installed the system originally, or the company that provided service to the system to have the system decommissioned. If these companies are no longer available, a company with experience with the specific system should be contacted. HTOC suggests that the following options might form some appropriate guidelines:

For Consideration by Governments

Governments that regulate their domestic fire protection industries should be aware that decommissioning will be taking place much more frequently than they have in the past. Governments can use the same methods they now use to communicate regulatory requirements to industry to increase awareness about the importance of safety during decommissioning, and to distribute technical information. It would also be prudent at this time to review the adequacy of existing rules and regulations governing the qualifications of people who perform this work and the procedures to be followed, and make adjustments as necessary.

For Consideration by Halon System Owners

It is in the interest of the halon system owners that the removal of the system proceed without incident. Once the decision to sell halon has been taken, the owner should first determine whether a halon bank is operating in their country. This information can usually be obtained from the ozone protection, or Montreal Protocol unit of the national government's environment ministry, department, or agency. The halon banking organisation may also be able to locate a buyer, arrange for testing of the material to protect both buyer and seller, negotiate a price, and identify companies competent to remove and recycle the halon.

For Consideration by Repository Operators, Halon Recyclers, and Halon Service Professionals

Be aware of the increasing pace of halon decommissioning. Develop awareness and training materials for use by the industry. The guide to different valves and some of the safety information in this report would serve as a good start to awareness material targeted to the service professionals. In a number of countries in which halon banks operate, a surcharge has been placed on the halon transactions brokered. Such a scheme could finance the development, publishing and distribution of such safety material for the industry.

For Consideration by All Interested Groups

The US Department of Defense through their ODS Reserve Program Office has assembled a halon system valve types and safety issues manual. The ODS Reserve Office has kindly agreed to make this manual available on a case by case basis to parties engaged in the decommissioning of halon systems. In addition, they have volunteered to expand this document as additional technical information is submitted by other companies, individuals, or fire protection organisations. The Halon Technical Options Committee would appreciate it if fire protection professionals reading this report would submit technical information on cylinders, valve assemblies and actuators not included in this manual so they may be added to future updates. Please send information and requests for to the following address:

US Department of Defense ODS Reserve (DSCR-RP)
Defense Supply Center Richmond
8000 Jefferson Davis Highway
Richmond, VA 23297-5100
www.denix.osd.mil/denix/Public/News/DLA/Halon/hal1.html

LEARNING FROM THE PAST - THE KEY TO ACHIEVING RELIABLE FIRE PROTECTION USING GASEOUS FIRE EXTINGUISHING AGENTS

Introduction

The phase out of halon-1301 production and serious limitations on future availability motivated many large users to examine their existing halon systems. From these examinations and the common errors that were uncovered we learned several important lessons that can help us to apply the new generation of gaseous fire extinguishing agents.

Common errors that were found in the halon systems examined included:

- Design errors
- Installation errors
- Errors after installation
- Maintenance errors

Major lessons learned included:

- Enclosure integrity is critical to achieve effective fire protection using gaseous fire extinguishing agents
- Changes to the protected space, including configuration changes, must be evaluated as an integral part of ongoing maintenance procedures
- Very careful attention must be given to the design, installation and maintenance of the detection and control system, including ancillary functions.

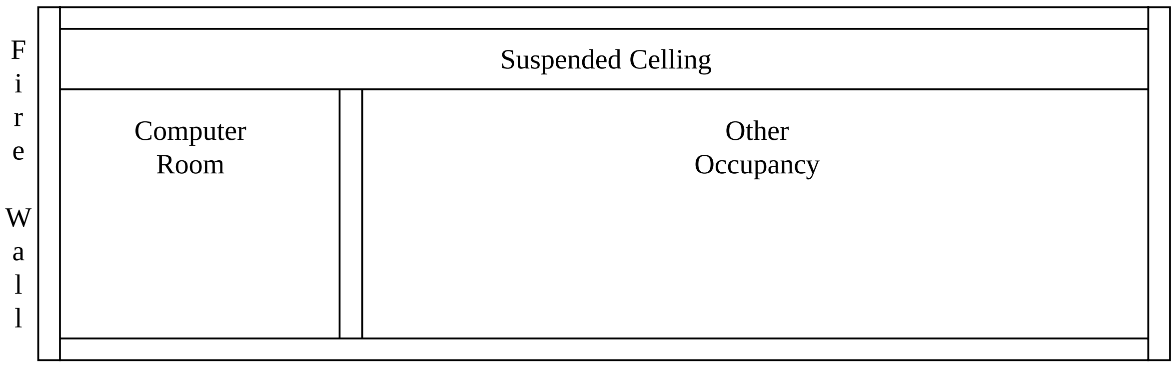
Design Errors

Design error - the hazard enclosure

Gaseous fire protection systems are individually engineered to achieve a concentration by volume of the extinguishing gas within a protected enclosure. It is believed that the halocarbon alternatives to halon extinguish fires heat absorption at the point of combustion. In general a fire requires a continuous supply of heat to remain self-propagating for as long as the fuel supply lasts. However with this current generation of halocarbon alternatives heat from the combustion reaction is absorbed by the agent and used to break the fluorine bond within the molecule of the extinguishing agent. It is important that this is done quickly to lessen the creation of unwanted by-products including hydrogen fluoride. It is also important that the concentration by volume of the extinguishing agent within the protected enclosure be sufficient to extinguish the fire but not exceed allowable concentration limits for human exposure. For most of the halocarbon alternatives this requires a precise design within a narrow minimum and maximum design concentration. The minimum and maximum design concentrations are much more restrictive than those that were typical for halon-1301.

The hazard enclosure (walls, floor and ceiling) must be constructed to contain the extinguishing gas. Failure to contain the design quantity could result in failure to extinguish the fire. As well, gaseous fire extinguishing systems are only capable of extinguishing fires that originate within an enclosure. Fires that start outside the protected enclosure and burn into the enclosure cannot be extinguished because the fire destroys the capability of the enclosure to allow the extinguishing concentration of the gas to be achieved.

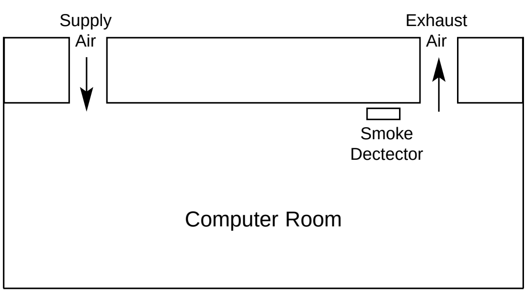
The walls, floor and ceiling of the protected enclosure must be constructed to adequately contain the gas concentration necessary to extinguish fire and prevent an external fire from quickly breaching the enclosure. As such the walls, floor and ceiling must be constructed as fire separations using materials that have been tested to allow them to be used with confidence to create a fire separation. Simple suspended ceilings do not offer reliable means to contain the gas or prevent a fire from reaching the enclosure. Yet examinations of many halon protected enclosures showed that in a great many cases this basic requirement was overlooked. The following diagram illustrates the problem. In the diagram please note that the wall between the computer room and the other occupancy terminates at the suspended ceiling a this results in a connected space above the ceiling that could allow loss of the gas or provide a path of fire from the other occupancy to quickly invade the computer room.



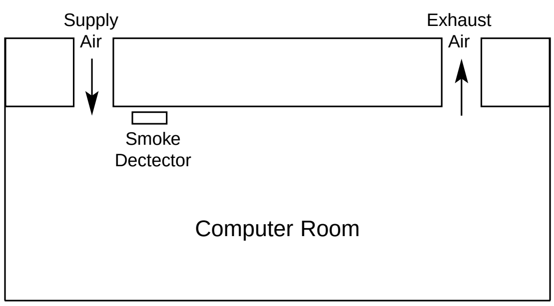
Section View

Design error – incorrect smoke detector locations

Gaseous fire protection systems are often used to protect high value equipment because the gases used do not cause secondary damage to the protected equipment. As a result it is appropriate to discharge the extinguishing gas when the fire is very small, even before flames appear. In order to achieve this automatically fire detection devices that can detect smoke or the invisible products of combustion are often used to control the release of the fire extinguishing system. The types of detectors often referred to as optical smoke detectors (visual smoke) and ionization smoke detectors (products of combustion) rely upon air movement to carry smoke particles or very small product of combustion particles to the detection device. These detectors should not be located close to fresh air supply points as the fresh air supply will prevent smoke or combustion particles from entering the device and therefore unable to detect a fire. These types of fire detectors should be located between the fresh air supply and the return air exhaust, preferably closer to the return air exhaust location. The following diagram illustrates this concern.



Section View Proper Smoke Dectector Location

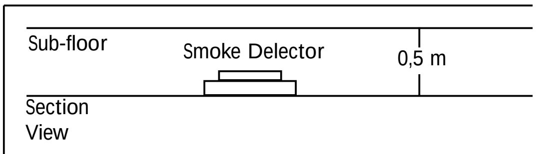


Section View Improper Smoke Dectector Location

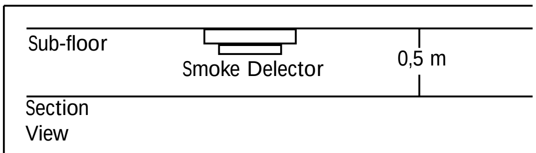
Installation Errors

Incorrect smoke detector placement

In many computer rooms the sub-floor space is used for running interconnecting cables between various computer equipment modules. As smoke rises it is always preferred to mount a smoke detector at the highest point. However in a sub-floor it is easier to mount the detectors on the floor facing up. This is not a good practice because the ability to detect fire is degraded and the detectors are more likely to become contaminated with dirt and dust, further reducing their effectiveness. The following diagram illustrates this point.



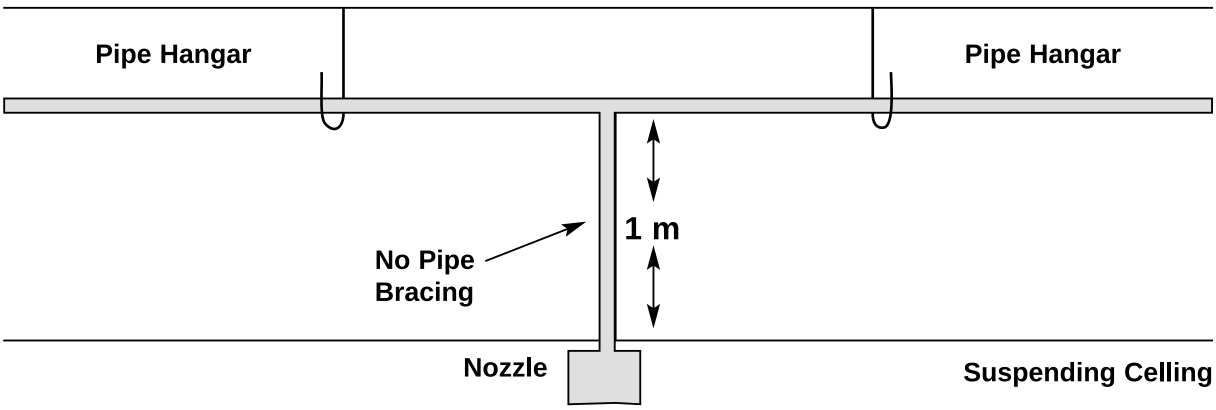
Improper Mounting Installation



Proper Mounting Installation

Distribution piping not adequately secured

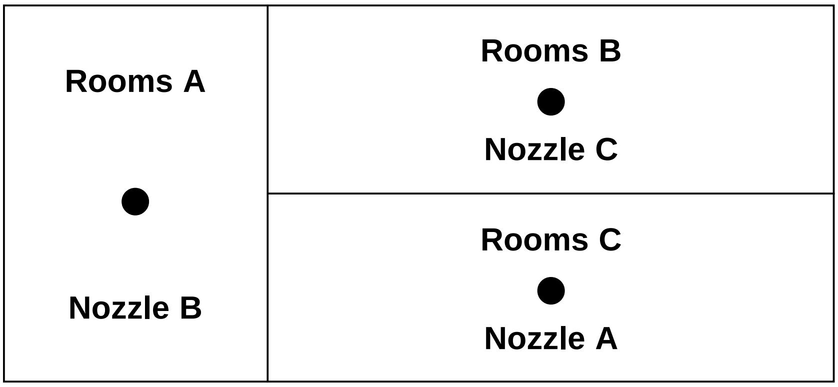
Halon systems and halocarbon alternative fire protection systems are designed to achieve extinguishing concentration within the protected enclosure very quickly. This very fast discharge is necessary to reduce extinguishing time and reduce the creation of toxic by-products created during the extinguishing process. As a result very high flow rates of the extinguishing agent are carried by the distribution piping system. It is very important that the piping system be adequately secured to prevent undue pipe movement during discharge of the fire protection system. Excessive pipe movement can result in a hazard to people and equipment within the protected space. A special problem occurs when pipe must drop up to 1 meter for enclosures where there is a suspended ceiling to reach the discharge nozzle. Examination of typical halon installations revealed that these pipe drops were often not secured properly. Pipe bracing must be provided for all pipe sections to prevent hazardous movement during discharge. The following illustrates this typical problem.



Section View

Incorrect nozzles installed

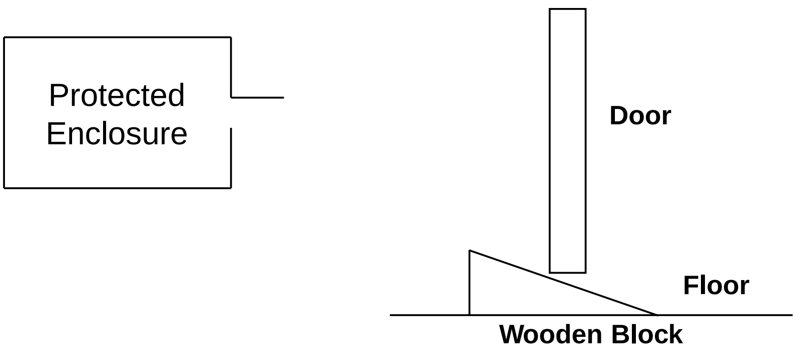
The discharge nozzles used with gaseous fire extinguishing systems are precisely drilled with the exact size orifice necessary to achieve the flow rate required for an individual application. Although nozzles may look alike, the size of the orifice is the governing factor as to how much extinguishing agent will flow from the nozzle. Where a single gaseous fire protection system is used to protect two or more enclosures simultaneously it is very important that the specific nozzle fabricated for the enclosure be installed within the enclosure. As nozzles with different size orifices may fit the same distribution pipe size care must be exercised to ensure that the correct nozzle for the enclosure is installed. The following illustration portrays this problem.



Errors after Installation

Doors blocked open

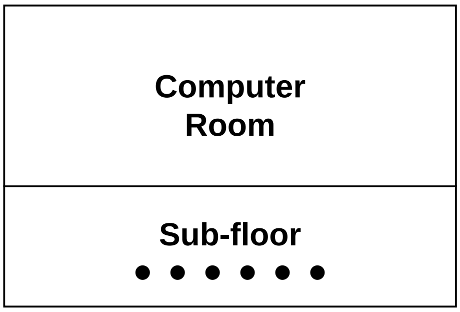
In order to easily carry equipment or supplies in or out of the protected enclosure a wooden wedge is sometimes used to keep the access door open. Very often these wedges a left and the door remains constantly open. However an open door defeats the capability of the enclosure to contain the fire extinguishing gas concentration and will likely result in failure to extinguish a fire should it occur. This is a very common error, illustrated in the following diagram.



Added openings and penetrations

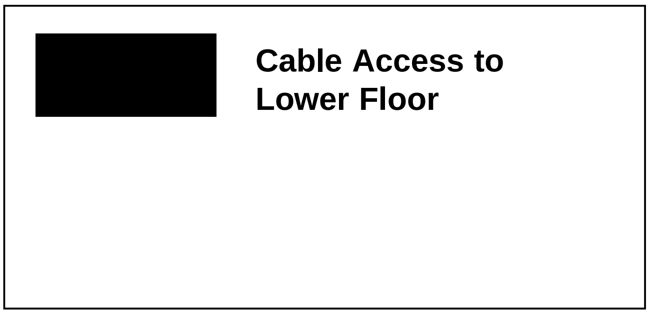
In computer rooms and other electronic equipment rooms it is often necessary to connect cables from equipment in the protected room to remote equipment located outside the room. Holes and penetrations for these cables must be tightly sealed to avoid loss of the extinguishing gas. However, the technicians that install new cables often do not understand the importance of sealing these cable penetrations and after a few months or years a large leakage area results. This can allow loss of the fire extinguishing gas and result in degradation of fire extinguishing capability.

Section View



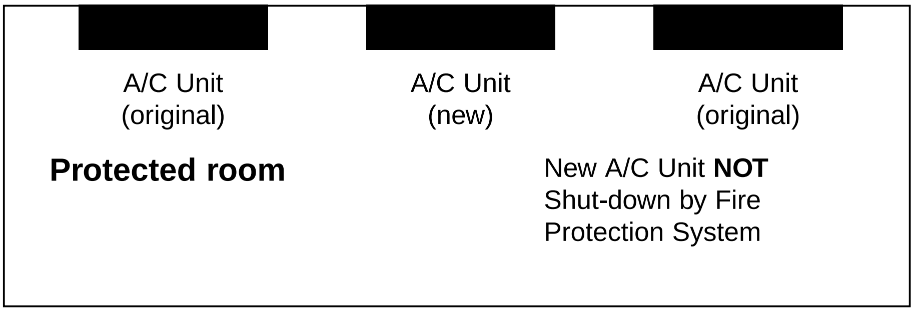
Cable Penetrations

Plan View



Added air conditioning equipment

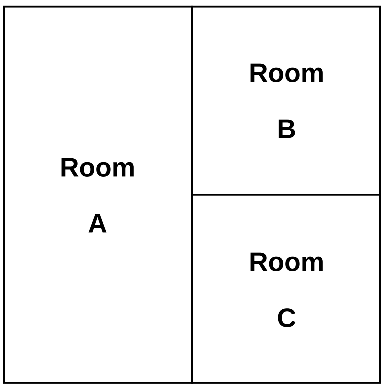
Electronic equipment rooms often require air conditioning equipment to remove the heat generated by the electronic equipment. Over time, as equipment is added, there may be a need for additional air conditioning equipment. It is very important that the new equipment is interlocked with the controls for the gaseous fire protection system to ensure that it shuts down automatically upon discharge of the fire protection system. Unless this is done the air conditioning equipment can quickly exhaust the extinguishing gas from the protected enclosure resulting in a failure to extinguish a fire. This issue is illustrated in the following diagram.



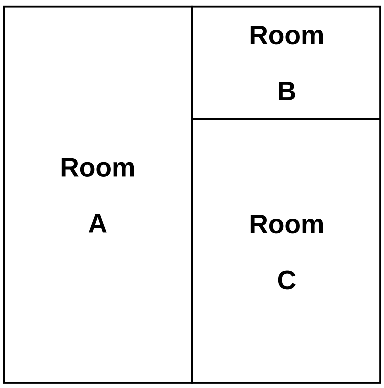
Plan View

Change in room configuration

In some cases operations within the protected spaces change and the enclosures are modified to accommodate the change in needs. This may be as simple as moving a partition wall. However, unless the gaseous extinguishing system is also modified a dangerous situation could occur. Discharge of the extinguishing gas into an enclosure made smaller could result in a gas concentration dangerous to people. Discharge of the extinguishing gas into an enclosure made larger may not result in an adequate concentration to extinguish a fire.



Original Room



Modified Room

Maintenance Errors

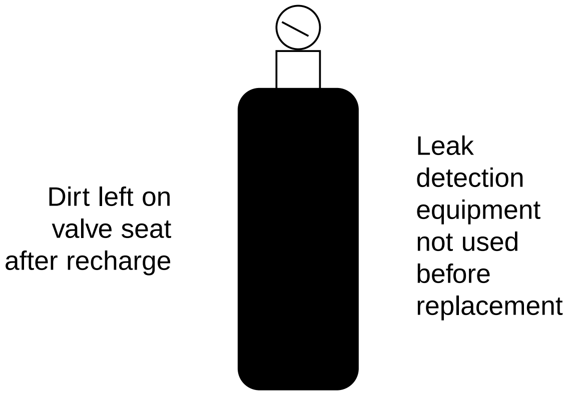
Failure to change electro-explosive devices

A common way to actuate a gaseous fire protection system is by means of a small electro-explosive device, often called a squib. These devices use a small amount of chemical to operate a valve or release a rupture disc allowing the extinguishing gas to enter the piping system and discharge into the protected enclosure. The chemical degrades with time and can become unreliable. As a result these devices most be changed on a schedule recommended by the equipment manufacturer. Although the time schedule may vary, five years is a typical usable life of a squib.

Electro-explosive devices do not last forever

Leakage after recharge

If a system has discharged to extinguish a fire or inadvertently due to some other cause there is usually an urgent need to recharge the gas cylinders as soon as possible. This urgent need is due to the fact that an important facility would be without fire protection until the gaseous system is operational again. This urgent need sometimes causes technicians to skip important procedures such as testing for very small leaks. However, over time, even small leaks can result in loss of the gaseous extinguishing agent.



New Errors to Expect

Exceed safe concentration

New generation gaseous extinguishing agents require much more precise engineering than halon-1301 did because the limits between the concentration required to extinguish a fire and the maximum allowable concentration that people should be exposed to are narrower. The following example illustrates this point:

For halon-1301 most fires were extinguished at a 5% concentration – the allowable upper exposure concentration for people was 10% - a 100% factor.

For HFC-227ea the recommended concentration for most electronic equipment rooms or computer rooms is 7.9% and the maximum allowable concentration that people should be exposed to is 9% a 14% factor.

Not achieve extinguishing concentration

The new generation halocarbon alternatives all require higher concentrations to extinguish fires than halon-1301. As more gas is required to be discharged into the protected enclosure leakage effects will also be greater.

Inadequate venting

As all of the new fire extinguishing gases require higher concentrations by volume it is also possible to overpressurize a very tightly built enclosure. This is especially true for inert gas extinguishing agents. A test of leakage from the enclosure should be conducted. The results of this test will assist in determining if the sealing of the enclosure is required or if additional venting is required to prevent structural damage when the extinguishing gas is discharged into the enclosed space.

Conclusion

Applying the new extinguishing gases adequately and safely requires attention to detail, more precise engineering and considerable care in installation and maintenance. In addition it is very important that a review of the fire protection system be conducted any time there is a change in the protected space. Those who design, install and maintain gaseous fire protection systems must pay much greater attention to detail than was necessary before in order to make a safe transition from halons. Those who operate facilities protected by the new gaseous fire extinguishing systems must receive the training necessary to ensure continued safe operation of the gaseous fire protection system.

MILITARY APPLICATIONS AND HALON MANAGEMENT

Introduction

By their nature, military weapons platforms and their support facilities present unique fire threats. Strategic military platforms (especially ground combat vehicles, ships, and high performance aircraft) not only represent significant financial investment but are characterized by a variety of fuels in a compact design where weight and space are critical. Fuel, weapons and personnel are often in close proximity to each other. Personnel safety is further compromised because evacuation is often not possible and maintaining continuity of operations is paramount, especially under combat conditions. Because halons are well suited for such an environment, halons have been the primary agent of choice for military organizations worldwide. In the search for halon alternatives, all of the problems faced individually by the other use sectors are inherent in total in military applications.

A general consensus has evolved internationally that continuation of certain military uses of halon is acceptable and justified because of the unique nature of military applications. However, responsible military organizations should not use this cloak of uniqueness to perpetuate a "business as usual" attitude. With the right to retain halon comes certain obligations. It is in this light that military organizations have exhibited leadership in demonstrating responsible stewardship of their halon assets. The necessary ingredients of a strategic plan to be followed by any military organization contemplating retention of halon include the following:

- Determining which halon uses have military essentiality. Retained uses must be justified not only by the nature of the fire threat but also by the lack of feasible fire protection alternatives.
- Decommissioning non-critical systems. The decommissioning process must include proper procedures to assure safety of personnel involved in the decommissioning as well as steps to minimize the potential for release of halon.
- Retaining of halon removed from non-critical systems to serve as a reserve to support critical uses. Proper management of this process should assure that sufficient halon is available to support retained systems without the need for production of new halon. An overriding objective must be to satisfy military halon needs by recycling and stockpile management rather than by reliance on an "essential use production exemption".
- Exhibiting responsible stewardship of the installed military base and reserve stocks. Proper system maintenance and leak detection, mandatory training, prohibitions on system discharge testing and training discharges must be enforced.
- Evaluating potential fire protection options and conducting basic and allied research in identifying environmentally safe and effective alternatives for military threats.
- Assuming responsibility for the ultimate safe disposal of military halon stocks in excess of requirements.

Like all aircraft, military aircraft are susceptible to fires in their engine nacelles (compartments). Halon-1301 has been widely used in this application. Armed forces around the world are actively searching for alternatives, such as this F/A-18E/F generator fire extinguishing system being evaluated at the US Naval Air Warfare Center Weapons Survivability Laboratory.

Scope of Military Halon Applications

Examples of military applications of halon-1301 total flooding systems include the following:

- Ground combat vehicle crew compartments
- Ground combat vehicle engine compartments
- Military aircraft engine nacelles and auxiliary power units
- Military aircraft dry bays
- Military aircraft fuel tanks for inertion
- Military aircraft cargo bays and lavatories
- Ship engine rooms, fuel pump rooms, generator rooms, and machinery spaces
- Ship flammable liquid storerooms
- Ship telecommunication, computer rooms, and command and control centers
- Submarine machinery spaces
- Engine rooms on boats and high speed craft
- Shore facility computer and telecommunication rooms
- Shore facility command and control centers
- Flight simulators
- Aircraft engine "hush" houses
- Hardened aircraft shelters
- High security tracking and listening posts
- Mobile vans used for telecommunications and computer operations
- Flammable liquid storage and fuel pump rooms
- Halon-1211 is typically used as a streaming agent for the following military applications:
- Portable fire extinguishers (buildings, aircraft, ships, tanks, misc. vehicles)
- Airport flight lines (aircraft parking, maintenance, and fueling areas)
- Airport crash vehicles

As indicated from the above list, military halon applications typically include either 1301 in total flooding fixed systems or 1211 in portables. There are some exceptions to these typical miltary applications of halon:

- Small fixed 1211 systems in engine compartments of ground combat vehicles,
- especially in Europe
- Small fixed 1211 systems in the engine compartments of small craft and boats
- 1211 total flooding sytems in gas turbine modules and diesel engine enclosures
- Limited use of 1301 in hand portables on certain military aircraft and ground
- combat vehicles
- Fixed halon-2402 systems in various military platforms in the Russian Federation

Unique Military Special Hazard Applications

While many of the military halon applications listed above are usages commonly found in the civil sector, there are certain unique applications where retention of halon is warranted due to mission criticality or the lack of an acceptable alternative. Three examples of those special uses (ground combat vehicle crew compartments, aircraft engine nacelles, and ship machinery spaces) are discussed below.

Ground Combat Vehicle Crew Compartments

The halon protecting the crew compartment in ground combat vehicles is delivered by a high speed detection and delivery system that can flood the compartment with halon-1301 in a fraction of a second. The system is designed for explosion suppression, which is essential for crew survival in battle scenarios since the crew compartment is surrounded by the vehicle fuel tanks. The threat is an enemy round penetrating the vehicle passing through the fuel tanks creating rapid atomization of fuel and a fuel/air explosion in the crew compartment. Due to space, weight and toxicity limitations there are no feasible backfit alternatives offering acceptable performance.

Military Aircraft Engine Nacelles

As with civil aviation, the challenge in identifying an alternative for halon-1301 is maintaining adequate dispersion and suppression effectiveness at the low temperatures encountered at high altitude while minimizing the toxic hazard to ground maintenance staff and flight crew. Weight and space limitations are especially acute in aircraft installations. Though extensive research is underway, no adequate halon replacement universally suited for backfit has yet to be identified. Because fire protection for engine nacelles is vital to the combat survivability of military aircraft, halon must be retained until a viable backfit agent emerges.

Ship Machinery Spaces

Ship propulsion machinery spaces are characterized by an array of fuel and lubricating oil piping under pressure. Over time, insulation and lagging tends to become oil saturated and residual fuel builds up in the bilges. Hot engine and machinery surfaces coupled with high temperature steam lines present a continual high potential for fire, particularly in the extreme stress environment of combat.. The presence of watch personnel in the spaces and the critical need to maintain propulsion capability during combat scenarios has made halon-1301 the agent of choice, especially when confronted with severe shipboard space and weight constraints. While research has produced acceptable alternatives for new construction, where preplanning in design can accommodate greater allocation of space and weight margins, no feasible replacement for halon-1301 has demonstrated feasibility of backfit. Hence, given the shortfall between halon-1301 and existing alternatives, existing halon systems will have to be supported for the remaining life of the affected vessels, or until a suitable retrofit agent is developed.

Removal of Halon from Non-Critical Military Uses

The continued availability of halon to support critical military uses as described above are based on the assumption that sufficient halon can be recovered from the decommissioning of non-critical systems. Clearly there are many military applications of halon where available alternative agents would provide acceptable performance. This is especially true where space and weight limitations are not present. Additionally, thorough analysis of the fire threats in existing halon protected spaces may identify areas where the installation of halon was not justified in the first place or where other fire protection strategies can offset the need for halon. Some actual examples of successful removal of halon from military applications are as follows:

- The removal of halon-1301 systems from many shore-based military computer facilities (including telecommunication and control rooms) has been facilitated by the installation of systems incorporating inert gases or one of the halocarbon gaseous chemical alternatives. In several cases, halon was removed without replacement due to the presence of water sprinklers.
- The need for halon-1301 protection for a raised floor area in a computer room was eliminated by the removal of under floor storage, the provision of a non-combustible floor system, and the installation of plenum-rated electrical cables.
- A scientifically-based threat assessment of a shipboard space containing sonar cables utilizing flammable acoustic transmission fluid confirmed that existing 1301 protection could be removed without significant increase in fire threat due to the lack of ignition sources, minimal quantities of fluid, and the high flash point of the acoustic medium.
- Halon-1301 has been removed from the engine compartments on many small non-combatant vessels and miscellaneous boats because the rooms were too small to be manned and thus amenable to carbon dioxide flooding.
- Halon portables were removed from ship electronics spaces, aircraft cabins, and small craft and replaced with carbon dioxide hand portables.
- Halon-1211 portables were removed from shore facilities where they served a role as multi-purpose extinguishers and were replaced by either ABC dry chemical extinguishers or a combination of water extinguishers and carbon dioxide extinguishers.
- Halon-1211 on airfield crash rescue vehicles was replaced with dry powder.
- Aircraft fuel tank inertion systems were deactivated during peacetime operations after a threat assessment concluded that the predominant hazard was limited to combat scenarios. This has significantly reduced halon consumption for these aircraft.
- By redesigning the fuel system on a combat helicopter, the fire frisk was sufficiently reduced so that a halocarbon alternative could be substituted for halon-1301 on an equal volume basis. 1301 bottles were replaced on a one-for-one basis thus eliminating any prohibitive space and weight penalty.

It is vital that these efforts to replace non-critical military halon uses be continued to provide a halon bank to support remaining critical needs.

Dedicated Military Halon Banks

In the years approaching the production phase-out of the halons, military policy-makers became concerned that the supply of halons needed to support critical military equipment may be compromised. These concerns were reinforced by the long lifetimes of modern military equipment, often 30 years or more, and the apparent difficulty in finding and fitting suitable alternatives. Some countries, usually those in which military uses of halon were relatively small, were content to rely upon the long term market availability of recovered and recycled material. However, larger organizations saw advantage to be gained in the careful management of their halon requirements and the recovery of halon where alternatives could be installed. Central facilities have, therefore, been established in several countries, with specifications ranging from the simple storage depot to sophisticated halon recovery, recycling, storage and distribution centers.

The military banks were established to support "critical use" equipment for its full operational life, or until alternative fire extinguishants could be fitted. Most organizations have used the HTOC Essential Use criteria, or something similar, to decide which equipment should be supported. It should be noted that the concept of banking brings with it inherent responsibilities which include careful management, leak monitoring, and safe decommissioning. Military organizations could be left with a liability if an ideal, retrofittable alternative was developed in the short term, or if legislation evolved such that continued use of halon became illegal. However, the importance of the materials is such that these risks were considered, in many cases, to be acceptable.

The halon banks operate in a manner similar to their financial equivalents. Managers of agreed "critical uses" have been allocated a quantity of material, with demands and returns debited and credited to their accounts. Initial allocations of material were based upon historical records of usage and expected remaining equipment life, with contingencies added to account for recycling losses and higher usage rates during wartime.

It was planned that, ideally, the bank accounts would be near zero when the last remaining halon-containing equipment was withdrawn from service. Many uncertainties exist which makes this situation an unlikely event. The strategic nature of the materials will have encouraged equipment managers to err on the safe side and overestimate the quantities needed. Since then, tight controls on the use of the halons, including the widespread recovery during maintenance and bans on training, have probably resulted in much lower demand from the banks than was originally predicted. Furthermore, the end of the Cold War has resulted in the major users reducing their defense expenditure and their equipment levels.

On the other hand, many users have found that the quantities of recoverable material in their organizations were less than predicted, leading to a possible “under-stocking” of accounts.

Although it is too early to be sure, it is probable that military banks will close with surplus material for disposal. At that stage, there is unlikely to be a market for the material, and so a potentially significant quantity will need to be destroyed by the most cost-effective means. The tight control over the material will ensure that little is accidentally vented. It is to be expected, therefore, that not all the halon banked for military uses will find its way into the atmosphere.

Each list of military "critical uses" should be updated periodically over time. In effect, the bank support will be provided until an application can be converted. Each military user is normally responsible for determining which applications are technically and economically feasible to convert and should be prepared to reassess the situation as alternative technologies and materials, and legislation, develop. Most users are aware that the banks exist to support the applications until they can be converted, and are not intended to support the halon systems indefinitely.

Retrofit Considerations

Three interconnected factors need to be addressed when an existing halon system is being considered for replacement: (i) is it technically feasible?; (ii) is it economically feasible?; (iii) is it practical within operational constraints? Each factor has a bearing on the others. Technically, the normal requirement is that the alternative fire protection system must provide a level of protection to personnel and equipment which is at least as good as that provided by the halon being replaced. Often, as with many other sectors, the first hurdle to overcome is the determination of the level of protection provided by halon. Many military standards prescribe a design concentration of halon that must be maintained in the protected enclosure for a certain period, without actually defining the system performance that is required. It has often been necessary to compare the performance of new alternatives against the halon baseline in purpose built rigs that simulate the range of conditions and hazards likely to be experienced by the equipment. A change in philosophy has become necessary whereby a minimum level of performance is specified against which compliance must be demonstrated.

Military equipment is designed to cope with a range of ambient conditions far greater than in any other sector, encompassing extremes of temperature, humidity, pressure, and air flow. These conditions can affect the performance and acceptability of any extinguishant. Furthermore, the risks to which the equipment is exposed are routinely greater, because of the equipment performance that is expected, its operating envelope, and the potential hazard from hostile forces. Paramount, in the face of all this, is the need to maintain operational capability. Evacuation of, or shutting down, the protected facility or equipment while a fire is being extinguished may not be an option in a combat situation.

In some circumstances, changes to operational procedures may remove the need for an automatic halon system. Manned intervention, with suitable portable extinguishers, may provide an acceptable level of protection. Otherwise, a replacement extinguishant must be considered. Most currently available in-kind gaseous alternatives are less effective, and so additional quantities need to be accommodated. Often, it will be necessary to not only provide additional agent cylinders but also improve the distribution system by redirecting pipework, increasing pipe diameters and adding nozzles. Most operational equipment is constructed within tight space and/or weight constraints, such that the necessary modifications are problematic.

If it is technically feasible to replace a halon system without sacrificing operational capability and safety, the economic feasibility must then be considered. It will rarely be cost effective for an equipment manager to replace the halon. The manager will often receive all the material he needs to re-supply or top-up the system free of charge from his military bank. The incentive to convert invariably results from a high level political decision, reinforced by concern that evolving legislation may restrict use of halons and force conversion anyway. There is the added constraint, perhaps more noticeable in recent years, imposed by the general reductions, world-wide, in defense expenditure resulting from the end of the Cold War. The funds for halon system replacement must usually be found from within existing, but shrinking, budgets.

The economic feasibility of conversion depends upon the predicted service life of the equipment. There is little justification in converting old equipment which is due for retirement. However, the opportunity to replace the halon may provide an additional incentive for replacing or upgrading the protected equipment.

The cost of conversion will depend significantly on whether the work can be accomplished during routine maintenance periods or whether a separate program is necessary. It is possible, especially if conversion is technically feasible only with major modifications to a protected enclosure, that the program will only be economically feasible at times of major equipment refit or upgrade, such as mid-life updates. The practical feasibility of undertaking a conversion program, in the light of the operational commitments of the equipment concerned, then becomes a critical factor. Deployment of equipment and associated maintenance, refit and upgrade schedules are often planned many years ahead and cannot readily be changed in peacetime. Thus, even if it is technically feasible to convert "critical use" equipment, it may not be economically justifiable, or practically acceptable, in the short term.

Military Research and Development Efforts on Halon Replacements

Initially, the military community gave a high priority to the assessment of commercially-available alternatives for use in the design of new weapons platforms.. This has resulted in acceptable systems for most new items of equipment for military applications. Laboratory-scale to full-scale testing has identified acceptable solutions for future military aircraft engine nacelles and dry bays, shipboard machinery and other spaces, and armored fighting vehicle engine bays, among others.

In nearly all cases, however, the identified alternatives will not enable the technically and economically feasible replacement of all current critical uses of halon. So the emphasis has shifted somewhat from assessment of current solutions to the support of research into better alternatives to enable conversion of current equipment. Military organizations have sponsored short, medium and longer term studies that have contributed significantly to understanding of the performance of fire extinguishants. However, an ideal alternative has not yet been found.

Needed is a halon-like gaseous or volatile liquid extinguishant with similar characteristics and performance. The US Department of Defense, in appreciating the magnitude of the challenge, has recently established an 8 year Next Generation Fire Suppression Technology Program. The goal is to find and demonstrate halon-1301 alternative technologies that are easily retrofittable into current military systems. Along the way, it will be necessary to gain a deeper understanding of some of the fundamental mechanisms of fire extinguishment, and also of the fire hazards and protection requirements of the military sector. A wide range of organizations from government, academia and industry will be involved.

The development of suitable replacements for halon-1211 in portable extinguishers is receiving relatively little attention, even though the quantity of halon-1211 in military applications is comparable to that of halon-1301. Commercially available alternatives have inferior performance, and/or questionable environmental characteristics. Future replacements for halon-1301 may prove equally suitable for the small fixed halon-1211 systems which are currently in use for the protection of unmanned engine compartments, especially in Europe. It is also possible that some of the chemicals which are rejected because of unsuitable physical properties may find a place as streaming agents. However, at present, there is still a need for more effective halon-like extinguishants to replace halon-1211 in airport crash fire fighting, in flight line applications, and in portables onboard aircraft, helicopters and armored fighting vehicles.

The world's militaries are also contributing to the necessary toxicity assessments and trials for many of the most promising alternatives. This work has been important in the wider appreciation of the hazards stemming from the use and breakdown of halocarbon extinguishants in fire situations, and measures that can be taken to minimize these hazards. The toxicity of halon alternatives is especially important to the military sector because of the greater possibility that personnel may be exposed to the agents during certain situations.

Conclusions

Military organizations have faced, and continue to face, significant difficulties in the replacement of halons in a large variety of applications. They have been instrumental in the development of alternative materials and the assessment of their performance, particularly for new designs of equipment. Where possible, existing military applications have already been converted to suitable alternatives. In other cases, improved procedures, changing requirements and alternative fire protection strategies have allowed the removal of halon without replacement by an in-kind alternative. Despite this progress, there are, still, military applications that can, and should, be converted.

There remains, however, a significant number of applications for which halon is currently, and for the foreseeable future, the only feasible option. These are mainly in applications where personnel safety, operational capability, weight, space and fire extinguishing performance are all dominant factors. Significant resources are being devoted to finding a long-term solution to these problem areas. Until alternatives can be found, these applications are being supported by the responsible management of halon stocks, often held at central locations, and often obtained by the recycling of materials recovered from non-critical applications. Because of this careful management, there is not considered to be any need for future Essential Use Production Exemptions for halons 1211 or 1301 for the military sector.

THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA) HALON MANAGEMENT PROGRAM

Introduction

NASA began an official halon phase out program in 1990. NASA has led the way in halon bank management and has participated in the search for halon alternatives. NASA representatives participate in technical committees of the National Fire Protection Association and United Nations Environment Program providing guidance on halon phase out and acceptance, design, installation, and maintenance of Halon Alternatives. This paper addresses some of the key issues that are leading the agency away from dependence on halons for fire protection.

The beginning of the program

Although the groundwork was being laid a year earlier, NASA officially began their Halon Phase-out Program in 1990. The program was comprehensive, in that it addressed all aspects of phase out and bank management; including defining "critical" for the agency, identifying critical uses, development of a plan to phase out non-critical systems, upgrading of critical systems and their hazard enclosures, establishment of recycling and storage, setting aside backup systems, upgrading of maintenance procedures and documentation, updating policies and fire protection guidelines for the agency, participating in the standards making process and decision-making process on both a national and international level, and participating in research and development programs for alternatives. Many of the aforementioned steps were accomplished in the first five years of the program. NASA is still underway with the phase out according to the original schedule. At the time the agency embarked upon this program, there were no alternatives available. All plans had to be made based on the possibility that alternatives would not be found along with the flexibility to adapt to alternatives if and when they did become available. The agency continues to participate in the regulatory process affecting halon use and replacements, as well as, participating in research and development to expand replacement options. The following three sections address specific aspects to NASA's past experience in phasing out halons, NASA's present fire protection activities, and NASA's future plans.

NASA's past experience with halon total flooding systems:

This section is split into three areas: 1) Lessons Learned, 2) Maintenance Issues, and 3) Documentation-Related Issues. The lessons learned and difficulties encountered will be the same for the use of any total flooding agent/system whether it is a first or second-generation halon replacement or an inert gas system. Before making a decision to install a total flooding system, the user and Authority Having Jurisdiction (AHJ) must be aware of the additional responsibilities, maintenance, and documentation associated with a total flooding gaseous system. Some of the more notable lessons learned are listed as follows:

<u>Lessons Learned</u>

- Although a hazard area is manned 24 hours per day, experience showed that the occupants may not evacuate the space nor apply/manually-activate a fire suppressant.
- Tape storage, in many instances, was not located in a separate hazard area from the "essential electronic equipment", and hazard areas were not always separated.
- Occupancies had changed, and a halon fire suppression system was no longer necessary for the hazard area.
- Hazard enclosures had been changed in size and configuration without modifying the halon system (rendering it insufficient or ineffective).
- Cylinders were below design fill levels (again rendering the system insufficient for the fire hazard) as a result of slow leaks.

- Many systems were not capable of suppressing a fire in their state and the state of the enclosure, thus giving a false sense of security.

Maintenance Issues

- Cylinders were from many different manufacturers, which made it difficult to maintain and stock adequate spares. The maintenance crew had to be trained on each different type of system and the training kept up-to-date. This is difficult to achieve and expensive to sustain. The cylinders, actuators, detection, and controls were outdated and more leaky and accident-prone. Upgrades were performed for those systems deemed "critical" by the agency.
- Softgoods must be replaced on a regular basis.
- Leak detection must be performed regularly during maintenance. Cylinder heads were found to be leaking into the manifold.
- Rewrite maintenance instructions to reflect each individual system. If a boilerplate is used, it is very likely accidental discharges will occur during maintenance.
- Establish critical spares. If a total flooding system is deemed essential, and the investment is made, then a standby replacement bank should be an integral part of that system (unless the user can afford the down-time necessary to recharge the system).
- Fan pressurization testing can be very useful in determining the enclosure leakage and to verify the design agent concentration. Kennedy Space Center's (KSC) experience has been mixed with regard to the fan pressurization test. Some users do not like it; it "appears" disruptive to their operations. The rooms with raised floors and drop ceilings were the most difficult to locate leaks and seal up. In many cases the configurations of the rooms around the hazard area were not conducive to the fan test as the control of doors and pressures in adjacent spaces would skew test results. In addition, it is difficult to maintain a trained crew to perform the tests.
- Make sure the owner has the means to perform or contract adequate maintenance. A total flooding system is a large investment. It is NASA's policy that total flooding systems for electronic areas should be secondary fire suppression systems with wet pipe sprinklers as the primary for total loss control. In many cases funding was not available for both, and the primary system became the total flooding system. This put the entire facility at risk. NASA is a government agency (self-insured) and should have had a primary wet-pipe sprinkler system first.
- The total flooding system must be tied into the HVAC system and/or appropriate dampers installed to isolate the enclosure.

Documentation-related Issues

- Ensure the agent/system is UL Listed or FM Approved and listed in the NFPA Standards.
- Replacement lifetime should be considered along with occupancy plans. Perform life cycle cost analysis before making final selection.
- Stay informed of changes in NFPA standards: become involved.
- Ensure maintenance documentation is in place and reflects each individual system.
- Provide awareness and training to users on the system.
- Label hazard enclosure walls, floor, and ceiling (i.e. "Do not modify or make penetrations without contacting responsible fire protection engineer").
- Maintain control of the agent. Bar coding of cylinders has been useful in tracking changes in agent quantities on an annual basis. Data entry occurs during maintenance. Accidental or unnecessary loss can cause a great deal of downtime (which translates to unnecessary expense) and large sums of money for some of the replacement agents.

NASA's present plans for facility fire protection

NASA has implemented procedures to minimize leakage and accidental discharges as outlined above. These procedures are applicable to any total flooding system and have resulted in significant cost savings and a minimization of impact to the users. As the agency moves forward with its phase out of halon there are a number of activities that are important both to the phase out program and the optimization of a successful fire protection program. Some of these key activities are listed below:

- Maintain accurate, up-to-date documentation including NASA's and Agency Center's Fire Protection Standards that address applications not covered in NFPA Standards.
- Ensure the fire department is aware of the special applications; response time must be adequate if a secondary system is not used. At the Kennedy Space Center the response time is less than four minutes.
- Install wet pipe sprinklers as primary protection for major loss control. NASA is self-insured meaning that any fire loss must be absorbed within the existing annual budget allocation.
- In the case of special electronic equipment rooms or facilities, a secondary system like a total flooding clean agent can be installed if the contents are high value and funds are available and/or the application of water could cause loss of life or loss of vehicle (space shuttle).
- Install advanced fire detection systems, etc. Types of detection systems in use at KSC include Spot Heat, Spot Smoke, Beam, Aspiration, Linear Wire, Heat, Ultraviolet Flame Detectors and Ultraviolet/Infrared Flame Detectors.
- The agency does not have plans to install any of the halon replacements currently available.
- Most NASA Centers have personnel for on-site engineering, maintenance, and operations. Fire inspectors conduct daily walk downs and Fire Protection Engineers perform Fire Risk Surveys on every major facility on a periodic basis. A Fire Risk Review Board, consisting of upper management, reviews fire protection deficiencies and they decide to either fund the solutions or make the programmatic decision to accept the risk. In addition, Fire & Safety Engineers from each NASA Center meet annually for technical interchange.
- Fundamental Fire protection engineering is practiced at all NASA Centers. This includes utilizing fire retardant materials, separating hazards, building in redundancy, backing up electronic data on a regular basis, etc.

The future of fire protection without halon at NASA facilities

NASA is proceeding with a sound plan for facility-based fire protection by practicing good fire engineering fundamentals, participating in the decision-making and standards-making processes, staying abreast of the latest technologies available, and participating in research and development of advanced fire suppression. NASA's halon phase out is proceeding on schedule as a result of grounding ourselves in solid fundamental fire protection practices. The future begins now with the following steps being taken by the agency:

- Modifications to the "Firing Rooms" in the Launch Control Facility at the Kennedy Space Center consist of double-interlock pre-action sprinkler systems with smoke aspiration systems for early warning and gaseous portable extinguishers for early response.
- The agency will continue to invest in research and development for halon alternative options.
- NASA plans to stay involved in the standard's making process and decision making process; this involvement allows the agency to influence its future and stay abreast of changes in halon replacement options.
- NASA plans to team up research and development efforts with the Department of Defense to address special needs.

As halon alternatives continue to evolve, NASA will continue to evaluate their applicability and adapt its fire protection program to incorporate them as appropriate.

The Space Shuttle Discovery atop the Mobile Launch Platform at NASA's Kennedy Space Center. While KSC has a significant need for fire protection for valuable vehicles, equipment and facilities such as these, it minimized its halon use to a very few critical uses through its comprehensive facility-wide halon management programme.

THE HALON SECTOR IN POLAND
A CEIT SUCCESS STORY

Introduction

Poland has been a Party to the Montreal Protocol since 1990, prepared its Country Program for Implementing the Montreal Protocol in 1995-96, ratified the London and Copenhagen Amendments in 1997 and to date has been in full compliance with the Montreal Protocol provisions.

Poland is considered to be a "Country with Economy in Transition" (CEIT), i.e. one of the nations of Central and Eastern Europe that have recently undergone a process of major structural, economic and social change, resulting in severe financial and administrative difficulties for both government and industry.

Control measures related to the halon sector have been implemented partly through regulations and partly through voluntary programs, with limited costs. This was possible due the country's efforts to build awareness among different target groups involved in the process, including policy makers as well as technical experts from different sectors. One of the main reasons Poland chose this approach was because there was a shortage of funds available to individual enterprises and the government.

Halon consumption in Poland

Halons were imported from the USSR/Russian Federation and Western European countries. Halons were never produced in Poland. The majority of these halons, and halon-based fire equipment, was imported in the late 1980s. This means that the halon systems and other halon-based fire equipment installed in Poland is relatively new. The consumption level for the base year of the Montreal Protocol control schedule (1986) was 3,600 ODP tones. This includes import of halon-1301, halon-1211 and halon-2402 in bulk and fire-fighting equipment, including portable equipment containing halons, was imported. Halon-1211 and halon-1301 were imported from Western Europe, while halon-2402 was imported from the USSR (in relatively small quantities), mostly for military equipment. It can be assumed that in that period the import of halons into Poland peaked. As of January 1994 import of new halons has been banned in accordance with the Copenhagen Amendments.

Infrastructure of the fire protection sector in Poland

Before 1989-1990 there were several large national companies producing fire protection equipment and extinguishing media, including halon systems and portable fire equipment. There were also a number of small private companies distributing and servicing fire protection equipment, including distribution of halon-based fire equipment and bulk halons. In 1989 major structural, economic and social changes began in Poland, which affected most areas of the economy, including the fire protection sector. In the following years, national companies were privatised, and many changed the types of equipment they produced. Several new private companies were also formed. At the beginning of the transformation process, most industries experienced a negative effect due to the demise of the traditional economic structure and their sudden exposure to international competition. Lack of established position in the market, aggressive expansion of new enterprises as well as aggressive competition did not create a good platform for co-operation. Thus, Polish companies producing, distributing and servicing fire-fighting equipment have yet to create an effective trade association. Importantly, insurance companies are not yet significantly involved in the fire protection sector. The process has started, however it is still at an early stage.

Although the Polish economy is progressing and is one of the best developed of the CEITs, funds available to finance the extensive activities required to convert to non-ODS technologies in individual companies and government are very limited.

Halon users structure

Halon use in Poland was not regulated or mandated by either insurance or fire protection codes. 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-1301 have been used in Poland in fixed systems. A small amount of halon-1211 is also in use in fixed and semi-fixed systems for unoccupied areas.

Halon-1211 has mainly been used in portable fire equipment. 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.

The following sectors are the largest halon users:

- military;
- shipping industry and sea transport;
- aviation;
- gas and oil industry;
- telecommunication;
- land -based transportation (mainly trains);
- power industry;
- financial sector (banks);
- protection of historical buildings;
- community documentation archives, etc.

Geographically, halon equipment is located throughout the country.

Network of institutions and organisations

In many developed European countries and North America, the institutional structures dealing with ODS are well established, and quite a large number of individuals are involved, including consultants from industry. In Poland, however, because of a lack of financial resources existing institutions must be used to build the network structure.

To date four institutions are involved with implementing the measures necessary to maintain compliance with the control measures of the Montreal Protocol related to halons:

- Ministry of Environmental Protection, Natural Resources and Forestry (MEP);
- State Fire Service Headquarters (SFSHQ);
- Science and Research Centre for Fire Protection (SRCFP); and
- Ozone Layer Protection Unit (OLPU).

The MEP is the governmental authority generally responsible for creating environmental protection policy, and responsible for implementation of the Montreal Protocol in Poland. Dealing with ODS phase out issues has been the responsibility of the Department of Air and Land Protection of the MEP, which is also responsible for national regulations in this regard.

The State Fire Service Headquarters (SFSHQ), working under the Ministry of Internal Affairs and Administration, is the national authority responsible for the fire fighting and rescue system, as well as the national fire protection strategy. As in most countries, the responsibility for implementation of fire protection measures is the owner's. The State Fire Service is not a user of halons. SFSHQ has been involved in the process of developing the phase-out strategy in the halon sector in Poland, an the request of the Ministry of Environmental Protection, via the Ministry of Internal Affairs and Administration (MIAA).

The SRCFP is a research facility working on projects related to fire and rescue services and fire protection system, associated and revised by the SFSHQ, financed by the budget, via the MIAA. According to the Polish law, all fire protection equipment and extinguishing media have to be certified and approved before reaching the market. SRCFP is the sole authority in Poland responsible for certification procedures and approval of fire protection equipment and extinguishing media, including halons and their replacements. Apart from certification and research projects, SRCFP also deals with standardization issues in the fire protection sector.

The OLPU was established in the Industrial Chemistry Research Institute on 1 July 1995 by the Ministry of Industry and Trade (MIT), under the agreement between the MIT and the MEP, to facilitate the ODS phase out process. OLPU's responsibilities include: collecting data and controlling ODS consumption, making recommendations for “import licensing permits", cooperating with industry in implementing the Montreal Protocol, and making recommendations for new legislation required to ensure compliance with the Protocol. The OLPU addresses all ODS except halons, which are under the supervision of the SFSHQ.

The above-mentioned institutions work cooperatively in solving particular issues, however, SFSHQ and its co-operation with the SRCFP, has been to date the key for implementation of the halon sector provisions of the Montreal Protocol.

Although the network looks impressive, it is worth mentioning that the number of people continuously involved in the process is very limited. For halon-related issues, there is one person dealing with subject in the MEP and one person at the SFSHQ, two in OLPU and one or more (depending on the particular issue) in the SRCFP. Others are involved on an ad hoc basis for particular activities, such as organising symposiums, training etc.

Building awareness

<u>Starting point</u>

Building awareness of the consequences of the Montreal Protocol decisions related to halons, among all the interested parties involved is the starting point, because it allows:

- Data gathering for formulating plans and measures to be taken;
- Preparation for implementing them , including technical, regulatory as well as financial steps;
- Creation of adequate policy in regard to new technologies;
- Pre-planning for future steps.

Building awareness requires professionals to be involved in the process, not only among policy makers, but also among people knowledgeable in the technical aspects related to the specific sector. Many governments of western countries have contracted consultants or consulting companies from the fire protection sector to assist in this role. However, such activities require additional funds and in most cases such funds are very limited or not available in Poland.

There are at least two factors that have influenced the solutions chosen in Poland:

- Limitation of funds;
- Lack of partners in institutions such as fire protection association or insurance companies.

Therefore, for developing strategy for implementation of the Montreal Protocol control measures related to the halon sector, MEP choose the appropriate central institution responsible for fire protection as a partner. SFSHQ became involved in the work process in 1994, and also participated in the work of the Polish delegation at all meetings of the Montreal Protocol where halon issues have been discussed. In 1993, Barbara Kucnerowicz-Polak was nominated as the Polish expert from SFSHQ to work with the UNEP Halon Technical Options Committee. This appointment created positive feedback.

Membership in the HTOC provided an opportunity to learn about specific issues related to:

- Implementation of Montreal Protocol decisions;
- New technologies available, their advantages and disadvantages, experience from practical of use;
- Halon phase-out problems in different countries and regions and possible options to solve them;

- Halon bank management, experience from different countries;
- Halon availability for critical use in different countries from existing halon banks;
- Economic impact and organisational aspects related to the specific issues; and
- Technical, organisational and economic aspects of the implementation of the Montreal Protocol in the halon sector.

Membership also provided a unique opportunity for consultation with international experts in the field, on individual issues while solving specific problems. That link continues to be a great support for the halon clearinghouse duties that the SFSHQ has started to undertake in Poland.

The Polish expert provides the HTOC with information on the specific situation in Poland and other CEITs to ensure that the specific issues of importance are fully considered by the HTOC.

Due to financial constraints, CEIT experts very often do not attend events on subject, such as symposiums, workshops, exhibitions or working groups meetings organised all over the world. However, to play an important role in building awareness in their country they should have access to international sources of information. HTOC membership facilitates that process.

Important activities related to building awareness

Problems related to the halon phase out became "hot" in 1994, when the Copenhagen Amendments entered into force, and the import of halons into Poland ceased. At that time MEP invited the SFSHQ, via MIAA, to co-operate. This was the starting point of building awareness among all interested parties involved in the halon sector. The most important activities are described below:

Meeting of decision makers from different sectors

A meeting was organised by the SFSHQ at the beginning of 1994. The participants included representatives of the Ministry of Transportation and Sea Economy, Ministry of Industry and Commerce, Ministry of Defence, Ministry of International Trade etc. Representatives of the SFSHQ and MEP presented the current status of the Montreal Protocol decisions regarding the halon sector, and discussed short, medium and long-term activities which required planning in that regard. Conclusions of the meeting were directed to the appropriate Ministers.

HTOC meeting and Seminar in Poland

On the invitation of the SFSHQ an HTOC meeting was organised in Poland in June 1994. The meeting itself was an opportunity to introduce the work of the Committee to decision-makers. It was also an important opportunity for the local fire protection community to learn from international experts, at the lowest possible cost because the members of the HTOC were already in Poland to attend their committee meeting. That opportunity was taken and an International Workshop on Problems Related to Halon Phase out, was organised by the SFSHQ, with financial support from the MEP and UNEP.

The programme of the Workshop includes, inter alia:

- Montreal Protocol decisions related to halons and national legislation implemented in that regard in different countries;
- Steps taken in Poland in that regard;
- Halon bank management in different countries
- Alternative technologies;
- Halon recovery and recycling;
- Halon-1301 use limitation in Defence sector using US examples.

All stakeholders of the halon sector in Poland (halon users, fire protection companies, insurance companies, fire engineers – fire protection systems reviewers, system designers, representatives of the decision makers) were invited and about 100 participants attended. Sixteen representatives from other CEITs attended as well, with the financial support of UNEP.

No policy can be effectively implemented if there is no clear message as to what technical steps must be taken to support the policy. Therefore, apart from the information related to the necessary policy, technical information was included in the program of the workshop and made available to the fire protection community. Simultaneous translation into Polish and Russian was provided. Also materials based on the HTOC report were prepared, edited and translated into Polish and Russian to maximise accessibility in CEIT countries.

It should be highlighted that this was the first time materials in Polish and Russian presenting issues related to the Montreal Protocol implementation in halon sector in a more complete way were available. Most materials on the subject are only available in English, and therefore their usefulness to CEITs is very limited. It could be assumed that the range of persons that used these materials was much wider then only the participants. There were faxes and telephone calls from CEITs asking about the possibility of receiving these materials that confirmed the widespread interest and distribution.

The symposium was also the first step of creating an informal clearinghouse, as members of the Polish fire protection community and users started to communicate with SFSHQ about their problems and seek information.

Training course on alternatives to halon-based technologies

The general scope of the training was to assist fire protection engineers to gain an adequate knowledge of the technical issues necessary to adequately evaluate hazards and apply alternative technologies.

The high market demand after halon imports were stopped, brought an avalanche of products which are not always of a proper quality, or suitable for the hazards to be protected. Moreover, some products caused concern regarding their environmental impact. Those products were often presented as excellent halon replacements. However, none of the variety of products offered to date has the same unique properties as halons. Therefore, the selection of an adequate alternative solution is a complicated process and has to take into consideration many factors, including safety and environmental factors. The choice must be based on deep knowledge of both the nature of the hazard to be protected and protection technologies - and it requires reliable, objective expertise.

A training course on Alternative Extinguishing Technologies - Halon Use Reduction was organized in 1998 by the Supreme Headquarters of the State Fire Service. It was one of 8 sub-projects funded by the Global Environmental Facility (GEF) via the World Bank to be implemented in Poland within the framework of the national strategy for phasing out substances that deplete the ozone layer.

The program of the course included:

- New fire extinguishing technologies, in terms of both their proper selection and the design of systems;
- Engineering necessary to apply alternative extinguishing systems;
- Fire detection and early warning systems in controlling extinguishing systems appropriate discharge;
- Polish legal regulations and organizational and technical issues related to the certification and testing of fire protection products;
- Critical use of halons and safety maintenance of the halon systems.

The training course was conducted at the SRCFP and included live demonstrations of some of the alternatives. The lecturers were all leading fire protection experts: two from the USA, two from Canada and two from Poland.

The participants were 68 engineers involved in fire protection, including the largest halon users - representatives of government departments including national defense, transport and economy, as well as individual companies, including distribution and servicing companies. Fire protection engineers and fire prevention experts and from the State Fire Service, lecturers from fire service colleges, employees of certifying institution and representatives of design offices. Participants received training materials translated into Polish and a set of NFPA standards concerning the subject of the course.

The course was of the "train-the-trainer" kind; of the participants, 6 facilitators were selected to meet the further needs of Poland in providing similar training.

Publication of a guideline on alternatives to halon-based technologies and other halon related issues

As was mentioned previously, most of the technical materials on the subject are available in English, and thus their perception among stakeholders is limited. Therefore, MEP decided that guidelines, in Polish, should be edited and made available widely. The guidelines were developed in 1998, based on newest information from the HTOC reports, HTOC technical notes, and other technical documents.

They include the following chapters:

- Alternative technologies for fixed fire protection systems:
- New technologies, their advantages and disadvantages, toxicology aspects as well as environmental impacts, and providing information about relative costs.
- Substitutes for halon portable equipment;
- Practical applications of alternative technologies;
- Alternatives for specific uses, e.g. ground transportation military and civil, aviation, oil and gas industry, etc.
- Alternatives and fire extinguishing equipment approved in Poland
- Certification procedures, related regulations and standards as well as the alternatives already approved in Poland.
- Critical halon uses;
- Conditions for the use to be determined as critical, recovery and recycling aspects and national and international regulations to import related to essential/critical use halon.
- Halon emission reduction strategies;
- The basis for safe for environment halon system maintenance, minimisation of halon use, choosing appropriate detection systems to avoid unwanted halon releases, instructions related to testing and training, etc.

The guidelines are directed at halon and alternatives users making final decisions with regard to the solution chosen, fire protection engineers and system reviewers, distributing and servicing companies, and other stakeholders from different target groups.

The guidelines were developed with financial support from National Fund for Environment Protection and Water Management.

Other activities conducted in Poland to build awareness about the halon phase out:

- Organising local and sector meetings, seminars and symposiums for different target groups;
- Publishing articles in newspapers and professional journals such as Fire Protection, Environment or Law and Environment.
- Publishing news on halon sector in the Bulletin on Ozone Layer Protection, edited periodically by the OLPU with financial support from National Fund for Environment Protection and Water Management. Special edition directed on halon sector was issued in 1997.
- Editing brochure containing substantial information on the consequences of ozone destruction and the Montreal Protocol provisions, directed to public. The brochure was developed by the OLPU and distributed to young people by the education system (schools).

US EPA awards and UNEP award presented to the Polish expert was also a special occasion for presenting halon sector problems, steps to be taken and build awareness on them widely in the public. The occasion attracted the interest of the media and gave an opportunity to present information on the subject.

Other activities taken to date, Outcome from building awareness

Clearinghouse

The clearinghouse, which has been functioned in the SFSHQ, not only facilitates contact between halon owners and buyers, but is also the centre for information on technical and environmental issues related to halon phase out.

Collected materials, such as a list of approved alternative technologies, the HTOC reports and HTOC Technical Notes, other materials provided by HTOC members e.g. output from sector working groups such as aviation or miltary, as well as materials collected at symposiums, in particular the International Conference on Ozone Protection Technologies are the source, and are provided to interested parties. The contact with stakeholders seeking information or advice is very important in building awareness and initiating implementation of control measures in individual companies or sectors. From the other side it is also an excellent source of feedback information from the fire protection sector and users, e.g. on recovery and recycling activity, halon prices, balance between supply and demand, and other practical problems. That information is provided to responsible authorities and has been used for review of strategies and development of further steps to be taken in that context.

The clearinghouse also plays a role in supporting critical needs by networking with national halon owners as well as international halon sources (banks) and the UNEP DTIE clearinghouse in Paris.

Halons inventory

Using the network of local fire service units a halon inventory was developed in 1994-95 and again in 1997. A questionnaire was used and asked the following:

- the type and quantity of halon in existing systems, including fixed and semi-fixed systems;
- the quantity of halons in portable equipment, if the amount exceed 50 kg in one facility;
- the type of hazard being protected;
- type and age of the equipment;
- expected time of decommissioning and/or changing for alternatives.

Additional efforts were undertaken to gather the same information in specific sectors (defence, transportation, industry etc). Data received were analysed and verified and basic register of halon users has been prepared. This is important step towards monitoring of halon stock and transfer.

It should be noted that there are no regulations requiring the registration. Although such regulations were considered, there was a real concern that strict regulations could promote the possibility of halon venting to the atmosphere.

Halon use limitation and the implementation of alternative technologies

From the beginning SFSHQ started direct co-operation with the SRCFP on reducing halon use in new systems, introducing alternative technologies, and limiting introduction into the market environmentally unacceptable or questionable technologies.

Traditional non-halon fire protection technologies as well as clean agent replacements have been promoted in Poland to reduce halon use.

As previously mentioned all extinguishing media and fire fighting equipment requires approval from the SRCFP before reaching the market. To date the following new technologies were certified and approved: HFC, PFC, inert gases. Water mist technology is in the process of certification. An important issue in that context is to stop or limit consumption of environmentally unacceptable or unsound alternative technologies. There are no regulation to date, however by building awareness on environmental aspects of new technologies and the possible economic consequences of poor choices and in co-operation with all institutions involved, it was possible to prevent HCFC introduction to the fire protection sector in Poland. HCFC-based halon replacements are not approved and are not present in the Polish market. PFC-based use has also been limited.

As a result of the SRCFP position regarding approval of new halon systems, in the last 4 years no new halon system has been introduced into the market.

Safe halon system maintenance

The campaign to create awareness on the importance of the safe halons systems maintenance as well as the need to eliminate tests, and training to reduce halon emissions, was performed by the SFSHQ and local fire services.The Prevention Offices of the State Fire Service organised a campaign during the last few years to review the technical standards of the existing systems by during last years. Special attention on that subject was also put during seminars and training, and in publications. In particular, recently-prepared guidelines include a special chapter highlighting this problem and giving technical recommendations.

Two new Polish standards that address this issue are being implemented. Both standard are based on European standards:

- EN 27201-1: Fire protection. Fire Extinguishing Media – Halogenated hydrocarbons. Part 1: Specification for halon-1211 and halon-1301, and
- EN 27201-2: Fire protection. Fire Extinguishing media – Halogenated hydrocarbons, Part 2: Code of practice for safe handling and transfer procedures

Supporting critical users needs

To date critical users needs are supported by recovered and recycled halons from national sources or by contacting European halon banks (see clearinghouse activity). An important problem is that there are no halon reclamation facilities in Poland. For individual enterprises, with limited funds, investment such as reclamation equipment is too expensive and there is no guaranty that costs can be recovered. Therefore, financial support from other resources is necessary to begin this process. Currently the problem is being evaluated by the MEP and resources to support such facility are sought.

Problems in establishing the appropriate legislation dealing with ODS phase out.

Poland is an example of a country without a separate legal Act covering all ODS-related issues.There are no legal documents corresponding to the US Clean Air Act that could easily be amended to introduce ODS related legislation, without creating an entirely new law.The only existing Act which might be considered for adaptation for this purpose is the Act on Protection and Modelling of the Environment, however it is far too general and changes would be very difficult and time consuming.

Therefore, until Poland prepares a more basic Act or is obliged to follow the regulations of the European Commission, the only feasible way to deal with the legislation necessary to implement the Montreal Protocol provisions, is step by step introduction of single governmental decrees and other regulations covering particular areas.

In the halon sector, such activity started in 1992 when the first regulation concerning certification of fire fighting equipment was issued As a result, the SRCFP was able to decide to not issue certificates for new halon extinguishers and not re-issue existing certificates when their validity was over. This eliminated halon use in new portable fire equipment and significantly limited use of halon extinguishers in Poland. Based on regulations concerning the shipbuilding industry, a ban on the use of halons on new ships was introduced in 1992, and was extended to other ODS in 1994.

In some sectors requirements for using halon-based equipment were changed to non-halon solutions, e.g. requirements for airports.

1994 Ministerial Decree

In 1994 the first Ministerial Decree implementing controls of import and export of all Ozone Depleting Substances was introduced. A second decree is based on an Act of Parliament dealing with international trade. Ministry of Economy Decree (MOE, 1997) provides:

1. Import and export of all the ODS from the Montreal Protocol parties is under control, and requires permits. Permits are issued by MOE based on recommendations from the OLPU, and in the case of halons, from the SFSHQ. Special provisions are provided for recycled halons.
2. Import and export of all ODS from non-Parties to the Montreal Protocol is banned. Another regulation which is useful in implementation appropriate control measurements is a Decree based on the "polluter pays principle". Fees for emissions of:
   - CFCs and halons (CA. US$ 30.0/KG)
   - HCFCs (CA> US$ 0.1/KG)

<u>Legislation in preparation:</u>

Ban on placing on the market certain groups of products containing selected ODS (CFCs, Halons, HCFCs)

- in aerosols - CFCs, HCFCs
- in fire extinguishers – halons and HCFCs
- in foams - CFCs, HCFCs
- in R&AC equipment, parts of R&AC equipment or products containing R & AC equipment - halons and CFCs

Parliament Act on Ozone Protection and Decree of Ministry of Economy, allowing its execution

Generally that project follows most of the requirements contained in EC Council Regulations. The following issues are addressed in the proposed Act:

- Bans and limitations of production, import and export of controlled substances;
- Bans, requirements and limitations concerning use of controlled substances;
- Ban of testing halon-based equipment, with halon emission;
- Responsibilities of the halon owners for its safe for environment handling and storage;
- Recommendations for effective halon recovery and recycling;
- Critical uses;
- Fees;
- Sanctions.

[1] Ban on foams does not concern thermal insulation and integral skin foams (follows EC Council regulation 3093/94).

[2] Ban on R&AC equipment and related products concerns also products to be used with CFCs and halons products (follows decision IX/9 of the Montreal Protocol). A possible problem expected is related to qualification of banned products by customs officers.

FIRE PROTECTION OF VITAL ELECTRONIC EQUIPMENT FACILITIES

Introduction

This "Case Study" resulted from numerous site visits to important electronic equipment facilities. The visits were always due to concerns regarding the essentiality of a halon system. In most cases, although thefacility would be considered as critical, the halon system would not of provided the degree of fire protection capability expected. This case study examines the basis for fire protection for important electronic equipment facilities and discusses ways to avoid the most common mistakes.

Risk evaluation

The purpose of fire protection measures is to reduce risk to acceptable levels in a cost-efficient manner. For critical electronic equipment facilities begin by considering the following factors:

- Life safety aspects of the function (e.g., process controls, air traffic controls);
- Fire threat of the installation to occupants or exposed property;
- Economic loss from loss of function or loss of records; and
- Economic loss from the value of the equipment

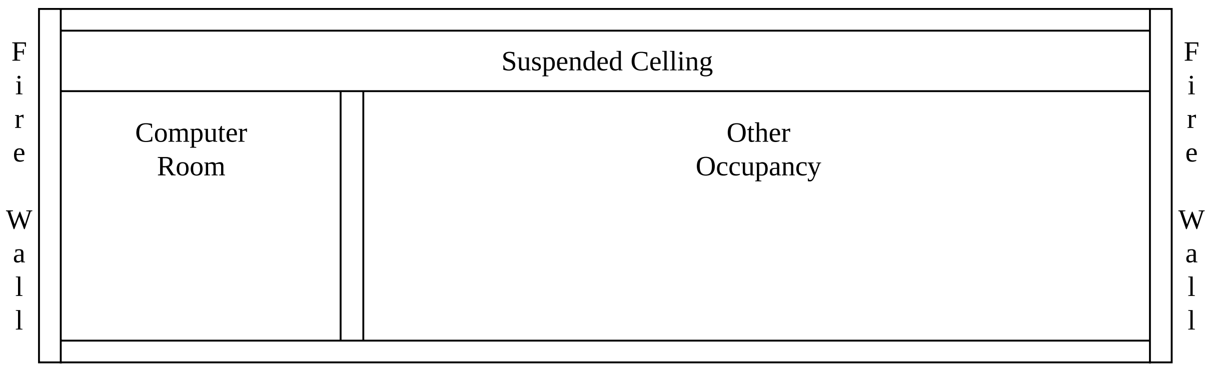
Location within the building

To reduce the risk of water damage from fire-fighting operations or other sources of water, the area should be located above grade. As well, the area should not be located above, below, or adjacent to areas or other structures where hazardous processes are located. Control rooms that must be located in proximity to industrial processes should be provided with adequate additional protective features, such as pressurization to prevent flammable gases or combustible dusts from entering the space, emergency fire shutters to provide fire resistance to glass viewing areas, etc.

High-speed printers and paper forms bursting equipment should be housed in fire rated enclosures, separate from other electronic equipment. The air handling system for high-speed printers and forms bursting equipment should be separate from the air handling system for other electronic equipment. Otherwise, fine paper dust generated from the printing operations will build-up on underfloor cables, filter media and equipment electronics, resulting in a significant fire risk.

General construction requirements

The facility should be housed in a fully sprinklered building of non-combustible construction. The area should be separated from other occupancies within the building (including atria or other open-space construction) by fire-resistant rated construction. The fire resistance rating should be commensurate with the exposure but not less than one hour. The fire-resistant rated enclosure(s) should extend from the structural floor to the structural floor above or to the roof.



Section View **A common problem - incomplete fire separations**

Very few building codes require a fire separation between an electronic equipment room and other occupancies within the building because these types of facilities are not seen to pose an increased risk to building occupants. From a life safety standpoint this is an acceptable risk, however from a property protection standpoint, it is likely that the adjacent areas pose an increased threat to the electronic equipment facility because it is unlikely that the fire prevention measures in the surrounding area would be as stringent as those for the electronic equipment area. Typically, modern office building design does not require internal load-bearing walls. This is done to allow maximum flexibility for tenant utilization of the space.

Common practice is to simply erect partition walls from the floor slab to the suspended ceiling. However, partition walls do not provide any fire resistance rating and cannot be considered as a fire separation between occupancies. An additional problem is the fact that the enclosure is not capable of reliably containing a gaseous fire extinguishant as it is open at the top. It is estimated that over 50% of the halon protected electronic equipment facilities in North America have inadequate fire separations as shown in the sketch.

Interior construction materials

Non-combustible materials should be used wherever possible. Special care should be taken to ensure that sound absorbing materials and wall and ceiling finishes are noncombustible. Exposed cellular plastics should not be used in construction.

Lay-in floor panels should be noncombustible or if they have a wood core, the core must be covered in steel. Lay-in floor panels must be easy to keep clean and be easily removed in a fire emergency to gain access to the sub-floor.

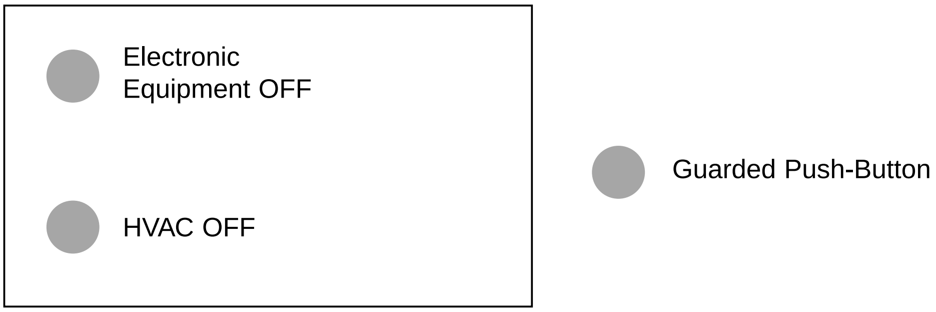
Electrical power wiring

The branch circuit supply conductors to receptacles or field wired equipment should be provided with mechanical protection. This could be by means of rigid metal conduit or by use of mineral insulated cable. Interconnecting cables and wiring between units, power cords, plugs and connectors should be considered as part of the computer system and should be certified as suitable for installation on the floor or under a raised floor.

Electric power emergency disconnect

A means should be provided to disconnect all power to all electronic equipment in the electronic equipment/data processing area from a single control. There should also be a similar means to disconnect power to all dedicated Heating, Ventillating and Air Conditioning systems (HVAC) serving the equipment room and area. Operation of the emergency HVAC shut-down control should also cause all required fire/smoke dampers to close automatically.

The controls for these disconnect means should be grouped and identified and should be readily accessible at the principal exit doors. A single means to control both the electronic equipment shutdown and the HVAC emergency shutdown would also be acceptable.



Typical Emergency Shut-down Station

Drainage

The structural floor should incorporate provisions for drainage from domestic water leakage, sprinkler operation, coolant leakage, or fire fighting operations.

Raised floors

The underfloor area is normally used to supply conditioned air to equipment and is also used as a raceway for cables. The underfloor area should not be used to supply conditioned air to any other area.

The structural supports for the raised floor should be of noncombustible material. The lay-in floor panels should also be of noncombustible material. Wood or similar core material for the lay-in floor panels that is encased on the top and bottom with sheet, cast, or extruded metal, with all openings or cut edges covered with metal would also be acceptable.

Tools, such as vacuum lifters, needed to provide access to the underfloor space should be located in the room and their location(s) should be well marked.

Electric cable openings in the floor should be made smooth or otherwise be protected to minimize the possibility of damage to the cables.

Electronic equipment

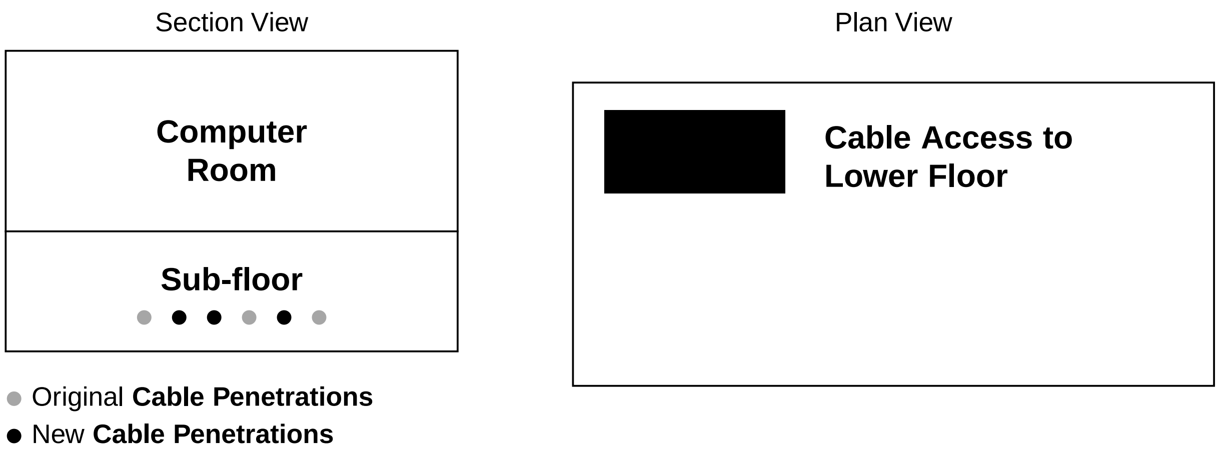
Each individual unit should be constructed in such a way that by limiting combustible materials, or by use of non-combustible enclosures, fire is not likely to spread beyond the unit where the source of ignition is located.

Where air filters are provided for individual pieces of equipment the filters should be certified for use with electronic equipment. The air filters should be arranged in such a way that they can be readily removed, inspected, cleaned or replaced when necessary. The filters should be inspected and cleaned on a regular basis to ensure that there is an adequate supply of air to prevent overheating of the equipment.

Openings

<u>Cable openings</u>

The structural enclosure for the electronic equipment room should be constructed using fire rated assemblies. It is important that cable openings or other penetrations be fire stopped with a certified fire-stopping material. The fire stopping material should have a certified fire resistance rating equal to the fire resistance rating of the wall, floor or ceiling where the penetration has occurred.



Other openings

Where any openings (e.g. pass-throughs or windows) are installed in any fire-rated wall, each opening should be equipped with an automatic fire-rated shutter. The shutter should close automatically by the presence of either fire or smoke on either side of the wall in which it is installed.

As well, the fire shutter should close automatically upon operation of any automatic fire protection system provided to protect the equipment room or adjacent area.

Materials and equipment permitted in the area

Paper stock, inks, unused recording media and other combustible materials within the electronic equipment room should be restricted to the absolute minimum necessary for efficient operpation. Any such material that must be kept in the electronic equipment room should be kept in totally enclosed metal file cases or cabinets.

The space beneath the raised floor should not be used for storage purposes. As well, cable that is no longer required should be removed from the underfloor area.

Waste paper and other combustible waste should be removed from the electronic equipment room on a regular basis. Waste receptacles should be of the self-extinguishing type.

Protection of records

As a minimum, all vital and important records should be duplicated and the duplicates stored at a remote location that would not be exposed to a fire involving the original records. Duplicate records should be stored in vaults having a minimum fire resistance rating of 2 hours. The duplicate records storage vault should only be used for storage of records. All other operations such as splicing, repairing, erasing, duplicating, cataloging, etc., should be prohibited in the storage vault.

A written plan and schedule should be established and followed to manage the back-up of vital and important records. The plan and performance should be reviewed every three months.

Emergency and recovery procedures

The following plans and procedures should be developed and implemented:

- Emergency fire plan
- Damage control plan
- Recovery procedures plan

Emergency fire plan

The emergency fire plan should be a written plan that has been approved by management. All new employees should be trained to perform any duties they may have under the plan and all employees should be part of an annual full scale test of the plan.

Damage control plan

The damage control plan is intended to pre-plan for damage minimization against other perils such as windstorms, long term power loss, water damage, etc. The geographic location of the facility should be carefully considered when considering other perils. The damage control plan should also be a written plan that has been approved by management. All new employees should be trained to perform any duties they may have under the plan and all employees should be part of an annual full-scale test of the plan.

Recovery procedures plan

Recovery procedures could include the procedures necessary to restore operations after electrical outages or anomolies, from water damage or other physical damage. Again the geographic location of the facility should be cafefully considered when considering appropriate recovery procedures. The recovery procedures plan should also be a written plan that has been approved by management. Lists of contacts for outside contractors or vendors that will be required to assist, as part of the plan, should be maintained continuously with current information.

Automatic fire protection systems

Automatic fire detection systems

A smoke detection type automatic fire detection system should be installed and maintained in accordance with a nationally recognized standard. Automatic detection devices should be installed in the following locations:

- at the ceiling level throughout the area
- below the raised floor; and
- above the suspended ceiling

Where interlock and shut-down devices are provided (e.g. emergency power off, and emergency HVAC shut down) the electrical power to the interlocks and shut down devices should be supervised by the fire alarm control panel. As well, all fire protection systems should be supervised by the fire alarm system. The alarms and trouble signals of the automatic fire detection system, the sprinkler system and if provided the gaseous extinguishing system should be arranged to annunciate at a constantly attended location.

Automatic fire sprinkler system

As previously indicated an automatic sprinkler system should be provided to protect the building housing the electronic equipment facilities and the rooms containing the electronic equipment. The sprinkler system should installed in accordance with the requirements of a nationally recognized installation standard. Sprinkler sub-systems protecting the electronic equipment areas should be valved separately frm other sprinkler systems. The sectional valve should be located outside and immediately adjacent to the protected space.

Type of automatic sprinkler system

A conventional wet-pipe sprinkler system should be used in conjunction with the automatic fire detection system previously discussed. Pre-action systems have often been used in electronic equipment facilities due to fear of water damage. However, other sources of water such as domestic water systems are far more likely to cause water damage than a sprinkler system and an analysis of pre-action system raises reliability concerns.

Type of system	A failure of the	Results in
Separate sprinkler and detection systems	Detection system	No alarm transmitted. Sprinkler system continues to operate.
	Sprinkler system	No automatic fire extinguishing capability. Fire alarm system not impaired
Pre-action system	Detection system	Total failure. No fire extinguishing capability. No fire alarm capability.
	Sprinkler system	No automatic fire extinguishing capability. Fire alarm system not impaired

Gaseous fire extinguishing systems

Gaseous fire protection systems are not a substitute for any of the previously discussed fire protection measures and they are not an equivalent to a water sprinkler system. Gaseous fire protection systems should be considered where implementation of all of the previously discussed measures and procedures have been implemented and further risk reduction is still considered necessary.

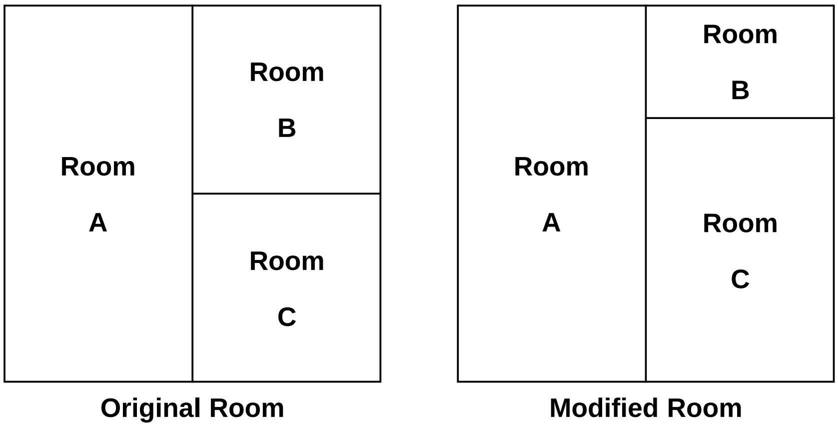
Gaseous agents, considered as appropriate for normally occupied areas are:

- inert gas mixtures (extinguish fires by oxygen reduction)
- some halocarbon agents (likely extinguish fires by heat absorption)

Gaseous agents are not suitable for partial protection applications such as sub-floors only.

If a supplementary gaseous fire protection system is to be installed, all spaces within the fire rated compartment should be protected simultaneously. For example, the sub-floor, equipment room and interstitial space above the suspended ceiling. In all cases gaseous extinguishing agent fixed systems are designed to achieve a required concentration by volume of the gaseous extinguishing agent within the protected space. It is very important that the enclosure be constructed to contain the gas. It is also very important that there are no changes to the size of the enclosure unless the quantity of gas is also changed to suit the new configuration.

Changes to the protected space, including configuration changes must be evaluated as part of an ongoing maintenance effort.



In the example shown, unless the gaseous agent system had been modified when the enclosure sizes were changed it is likely that a high concentration, dangerous to occupants, would result in Room B and a concentration too low to extinguish fire in Room C would result. This dangerous type of situation involving gaseous extinguishing agents was found in numerous vital electronic equipment facilities surveyed.

Enclosure integrity is critical to achieve effective fire protection sing gaseous fire extinguishing agent systems. Changes to the protected space can seriously affect the capability of the gaseous extinguishing agent and/or pose a serious threat to occupants if a very high concentration is achieved in a space that has been reduced in volume.

More than a choice of extinguishing systems

Although fire incidences are quite low, site inspections of numerous existing facilities has indicated that current fire protection levels were usually much lower than the facility operator realized.

In may cases these evaluations were triggered by environmental concerns regarding halons. In over 50% of the cases the halon system would not of performed to meet the original design criteria due to changes in the facility. As well, other practical fire protection measures had not been implemented due to a misplaced confidence in the ability of the halon system to handle any fire threat.

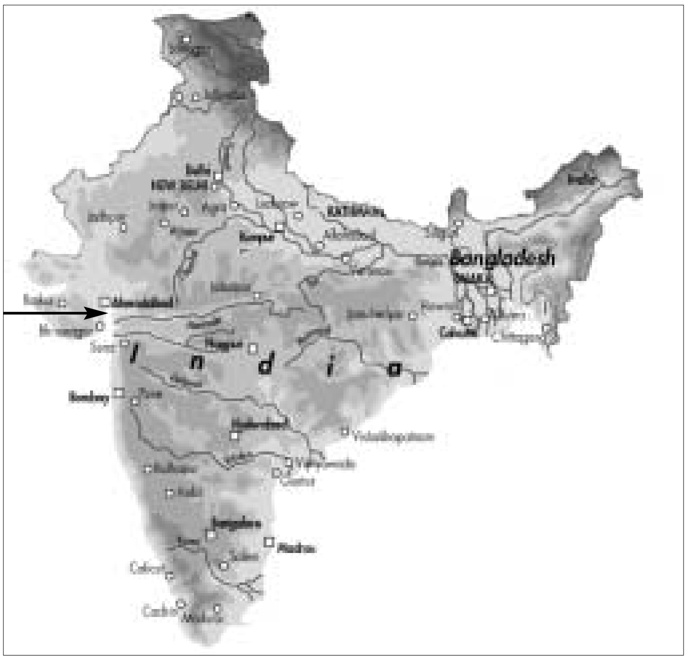
Is it time to check the fire protection of your vital electronic facilities?

HALON RECOVERY DURING SHIP-BREAKING OPERATIONS IN INDIA

Introduction

The ALANG ship-breaking yard, located at Porbander Coast of Gujarat, India is the largest in the world. The yard is strategically situated at a point on the seacoast with very calm seas that is suitable for anchoring very large ships.

Ship breaking started in the early 1980's in this small region of India with 4 to 5 shipyards processing 5 to 10 ships per year. By 1996 there were 160 yards in operation spread over 10 km of coast. Currently it is estimated that over 120 ships are usually in the process of being broken and an average of 350 ships are processed annually by the industry.There are other major ship breaking facilities in China, Pakistan and Bangladesh, although they have much lower capacity than India at present.



When any facility that is equipped with halon reaches the end of useful life the halon should be recovered, refurbished and made available for an essential or critical use. This reduces the need for newly produced halons and can assist in attaining an early phase out of global halon production. In many countries there are significant sources of halons suitable for recovery.

India is a major ship breaking country and has recognized the potential of recovering halons from ships that have reached the end of useful life. Halon systems were provided on many large ships for the protection of machinery spaces and spaces that contained flammable liquids. Recovered halons can be used within the country or exported after refurbishment.

The ship shown in the photograph was originally a 32000 MT oil tanker. Over 9 MT of halon-1301 were recovered from this ship. Commercial and military ships from all over the world are brought to the ALANG to be broken.

Typical Fire Protection Equipment Recovered

Most ships that are broken have been fitted with Carbon Dioxide systems for engine and machinery spaces. Tankers are usually equipped with foam fire fighting systems for the petroleum storage tanks and deck area, in addition to the gaseous system for the engine and machinery areas. Generally, ships constructed before 1975 were equipped with carbon dioxide systems. After 1975 ships were fitted with either carbon dioxide or halon-1301 systems. Ship breakers have found greater use of halon-1301 on naval ships than commercial ships. At present most ships being broken are older ships, constructed before 1960. The ship breaking yard attempts to recover and resell all items of value from the ships. The fire protection equipment recovered from the ships are typically sold to a sub-contractor who deals with life saving and fire fighting equipment from the broken ships. The sub-contractor, in turn, sells smaller parcels of equipment.

Types and sizes of ships

A variety of commercial and military ships ranging in size from 1500 MT to 55000 MT are broken. Oil tankers, bulk carriers, large passenger ships, ferries, frigates, aircraft carriers, research vessels and oil rigs were noted during the site inspection carried out by Mr. H.S. Kaprwan of the Defense Institute of Fire Research, a leading fire protection agency in India.

Of the 59 cylinders of halon-1301 recovered from the 32000 MT tanker, shown previously,

20 cylinders had been sold to a fire equipment company in Bombay. Of the 39 remaining cylinders, 5 were found to be empty and the remaining 34 were full. The sub-contractor had no specialized knowledge of halons or the means to recover or refurbish the halon contained in the cylinders. He was unaware that halons were capable of harming the Ozone Layer.

H.S. Kaprwan of the Defence Institute of Fire Research inspecting the area of the ship where the halon-1301 cylinders had been. Mr. Kaprwan is also a member of the UNEP Halons Technical Options Committee.

H.S. Kaprawan of the Defence Institute of Fire Research inspecting the area of the ship where the halon 1301 cylinders had been. Mr. Kaprwan is also a member of the UNEP Halons Technical Options Committee.

Estimated Quantities of Halons Recovered Annually

On average the ALANG yards break 350 ships per year. About 5% of the ships broken were originally equipped with halon fire protection systems. In 50% of the cases the halon cylinders have been removed before the ship was delivered to the breaking yard. The halon systems are typically of 1 tonne to 6 tonnes in capacity.

Typically 5% of the recovered halon cylinders are empty - as the result of leakage or discharge.

Currently about 30 tonnes of halon-1301 enters the Indian market from this source.

Future Prospects

It is expected that the quantity of halons recovered will steadily increase as newer halon equipped ships reach the end of their useful life. However, at present, there are no facilities in India to recycle or refurbish the recovered halon. At present the halon contained in the cylinders removed from the ships is transferred to other fire protection cylinders using simple procedures. Much lower recovery rates are obtained than would be possible using halon recycling equipment. As well there is presently no attempt to determine the quality of the recovered halon. A facility to refurbish and recycle the halon recovered from the ships would significantly increase the quantity of halon available from this source and assist India in meeting critical needs for applications such as aviation and mobile military equipment.

Conclusions

In India ship breaking has been identified as a viable source of recoverable halon-1301.

Experience has shown that identifying the major uses of halons in a country also serves to identify future sources of recoverable and recyclable halons. As protected facilities (like the ships discussed here) come to the end of their useful life, the halons that have been used to provide fire protection become available to fulfill essential needs. This is the basis of a halon management plan.

ANNEX 1: SOURCES OF ADDITIONAL INFORMATION

Publications

General information

Halon Management: Banking for the Future ◆
An "information kit" brochure that provides an introduction to the halon banking concept, describes how to obtain recycled halon through halon banks, describes the "essential use" concept", and provides contacts for national halon banks. (UNEP OzonAction Programme, 1994)

OzonAction Newsletter ◆
Each issue of this quarterly newsletter includes articles about the halon sector, such as technology updates, halon banking and halon management, halon sector projects approved by the Multilateral Fund, national policies and legislation related to halons, etc. (UNEP OzonAction Programme, quarterly).

Technical information

Eliminating Dependency on Halons: Self-Help Guide for Low Consuming Countries u
A guidebook to assist countries that consume small volumes of halons with the phase out of unnecessary halon uses, and the management of existing halon stocks to meet critical uses. The guidebook follows a seven step process that includes raising awareness, setting policies, ending unnecessary halon uses, managing a halon bank, and ending halon imports. Annexes include key technical guidance from the UNEP Halons Technical Option Committee, sample brochures that can be adapted to a local situation, overhead presentations for workshops, and much more. (UNEP OzonAction Programme, 1999).

Halon Technical Options Committee (HTOC) Reports and Technical Notes ◆
Reports produced and updated on a regular basis as part of the Montreal Protocol's technology assessment process, to inform decision-makers about the status of alternatives technologies, extinguishing agents and fire protection methods, as well as halon banking and halon management. Reports of particular interest:

- 1994 HTOC Report. Chapters 5 "Halon emissions reduction strategies", 6 "Halon recycling and bank management", 7 "Industry case studies" are especially helpful background about halon banking.
- 1998 HTOC Report. The state-of-the art in halon management, halon banking and halon alternatives. Particularly useful for halon banking are Sections 2.5 "Halon inventory management and recycling programmes", 2.6 "Case studies", and Chapter 4 "Responsible management of remaining halons".
- HTOC Technical Note Number 1: New Technology Fire Protection Alternatives for Fixed Halon Systems. Describes and compares the following total flooding gaseous alternatives: halocarbons (HCFC, HFC, PFC, FIC), inert gases (nitrogen, argon, nitrogen/argon blend, nitrogen/argon/carbon dioxide blend), water mist technologies, inert gas generators, fine particulate aerosols, streaming agents (HCFC, HFC, PFC).
- HTOC Technical Note Number 2: Halon Emission Reduction Strategies. Addresses the following topics: alternative fire protection strategies, halon use minimisation, maintenance programmes, detection systems, hazard and enclosure reviews, personnel training and documentation, halon transfers and storage, and halon discharging.
- HTOC Technical Note Number 3: Explosion Protection - Halon Use and Alternatives. Discusses how to minimize or avoid halon use when protecting spaces from explosion.

List of National Halon Banks ◆
Descriptions and contact information for public, private sector and military halon banks around the world. These focal points are available to help you obtain or trade recovered and recycled halons. For individuals wishing to learn about the different approaches to establishing and operating halon banks, these are the people whom you should contact. (UNEP OzonAction Programme, regularly updated)

List of Halon Recycling, Recovery and Reclaim Equipment Manufacturers ◆

A worldwide list of the manufacturers of halon recovery and recycling equipment, which is an essential component of a halon bank. (UNEP OzonAction Programme, regularly updated)

Safety Guide for Decommissioning Halon Systems ■

This is Volume 2 of the USEPA Outreach Report: "Moving Towards a World without Halon". It contains generic instructions for safe decommissioning of halon-1301 total flooding systems and manufacturer's specifications and instructions for handling specific equipment.

Halon Production and Consumption Data

April 1999 Report of the Technology and Economic Assessment Panel ▲

Latest global figures on halon production and consumption is found in this document under "Part III: Exports of Controlled Substances in Annex A and Annex B to the Montreal Protocol from Non-Article 5 Parties to Meet the Basic Domestic Needs of Article 5 Parties, Section 3: Balance Between Halon Production and Consumption" Data Reported by Parties under Article 7 of the Montreal Protocol. Year-wise figures on consumption and production of ODS, including halons ("Annex A, Group II" substances), for individual countries. (UNEP Ozone Secretariat, updated annually).

Trade Names of Chemical Products Containing Controlled ODS and Their Alternatives ◆

An information paper that provide commercial trade name of chemical products world-wide (including those related to halons and halon alternatives), name of the producer, chemical composition and indication of whether product has been discontinued. This paper supports the implementation of import and export licensing systems, which are mandatory for all Parties to the Montreal Protocol. The paper is designed to help NOUs, customs agencies and industry distinguish between imported chemical products containing ODS and those that contain non-ozone depleting alternatives, and to track and combat illegal imports. (UNEP OzonAction Programme, regularly updated)

Policy Information

Regulations to Control ODS ◆

A reference document designed for use by ODS officers and legal officers in Article 5 countries responsible for structuring and drafting of regulations to control and eliminate the use of ODS. It provides a brief overview of the structure and strategies in existing ODS regulations (including those related to halons and halon alternatives), which encompasses all governmental directives of a legally-binding nature. Also contains information about governmental guidelines, voluntary agreements and cooperation with industry, cooperation with industry associations, economic disincentives and labelling schemes. (UNEP OzonAction Programme, 1996)

Handbook for the International Treaties for the Protection of the Ozone Layer, 5th Edition ★

The handbook contains full texts of the Vienna Convention and the Montreal Protocol as adjusted and amended up to 1999. It also contains a useful summary of control measures to phase out ODS as well as all decisions adopted by the Parties to the Vienna Convention and the Montreal Protocol from 1989. (UNEP Ozone Secretariat, 2000).

Maintaining Military Readiness by Managing Ozone Depleting Substances: Guidelines for Armed Forces in Developing Countries ◆

A guide that assists armed forces in Article 5 countries with establishing and implementing their own programmes to manage and reduce use of ODS in accordance with their national obligations under the Montreal Protocol. Based on the lessons learned by developed countries' military services, the guide is written for military officials responsible for operations, facilities, and/or equipment that rely on ODS. It is targeted at personnel involved in environmental compliance/protection issues, as well as operation chiefs and managers whose responsibilities include weapons systems, support systems, and facilities that use ODS. (UNEP OzonAction Programme, 2000).

The above publications are available free-of-charge in electronic format from the following sources:

- ◆ OzonAction Programme web site
- ▲ TEAP web site
- ★ Ozone Secretariat web site
- ■ DENIX web site

Documents marked with ◆ ▲ ★ are also available for purchase in hardcopy from:

UNEP's Earthprint On-line Bookshop
(www.earthprint.com)

SMI (Distribution Services) Limited
P.O. Box 119
Stevenage, Hertfordshire
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Tel: (44) 1438-748111
Fax: (44) 1438-748844
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Email: secretariat@unmfs.org
www.unmfs.org
UNEP Ozone Secretariat

UNEP Ozone Secretariat
PO Box 30552
Nairobi
Kenya
Tel: (254 2) 623 855
Fax: (254 2) 623 913
Email: ozoneinfo@unep.org
www.unep.org/ozone/home.htm

Other organizations mentioned in this document

International Halon Replacement Working Group (IHRWG)
Ms. April Horner, Conference Coordinator
Federal Aviation Administration, Fire Safety Section
William J. Hughes Technical Centre
Building 287, AAR-422
Atlantic City International Airport, NJ 08405
United States
Tel: (1) 609-485-4471
Fax: (1) 609-646-5229
Email: April.CTR.Horner@tc.faa.gov
www.fire.tc.faa.gov/index.html?halwg.html&1

National Fire Protection Association (NFPA)
1 Batterymarch Park
P.O. Box 9101
Quincy, Massachusetts 02169
United States
Tel: (1-617) 770 3000 / 4543
Tel: (1-617) 984 7700 (en espagnol)
Fax: (1-617) 770 7777 (en espagnol)
Email: Custserv@NFPA.org
www.nfpa.org

US Department of Defense Ozone Depleting Substance Reserve
Mr. Ron Sibley, Program Manager
Defense General Supply Center
8000 Jefferson Davis Highway
Richmond, Virginia 23297-5230
United States
Tel: (1) 804-279-4525
Fax: (1) 804-279-4970

Web sites

Defense Environmental Network & Information eXchange (DENIX)
(www.denix.osd.mil/denix/Public/News/DLA/Halon/hal1.html)

Provides US Department of Defense personnel in the environmental security arena with timely access to environmental legislative, compliance, restoration, cleanup, and guidance information. It is intended to serve as a central electronic "meeting place" where information can be exchanged among environmental professionals worldwide. The "Safety Guide for Decommissioning Halon Systems" is available on DENIX.

Halon Alternatives Research Corporation (www.harc.org)

HARC is a voluntary, non-profit trade association formed by concerned halon users and the fire protection industry to assist users of halons to redeploy the existing bank of halons from applications where alternatives have replaced halons, to those that still require halons. HARC facilitates halon recycling, helps determine critical use, acts as an information clearinghouse, and is a focal point for national/international halon recycling.

Halon Users National Consortium (www.hunc.org)

HUNC is a UK-based halon bank that assists members with legislative information and advises on halon purchase and sales, together with advice on alternative replacements.

National Fire Protection Association (www.nfpa.org)

NFPA is an international nonprofit organization whose mission is to reduce the burden of fire on the quality of life by advocating scientifically-based consensus codes and standards, research, and education for fire and related safety issues.

UNEP Technology and Economic Assessment Panel (TEAP) and Technical Options Committees (www.teap.org)

This site contains information about the background and current activities of the TEAP and HTOC, including reports, meeting schedules, members, etc.

Other web sites are listed under "Contacts".

ANNEX 2: GLOSSARY OF TERMS AND ACRONYMS

Article 5 countries
Developing countries that are Party to the Montreal Protocol whose annual calculated level of consumption is less than 0.3 kg per capita of the controlled substances in Annex A, and less than 0.2 kg per capita of the controlled substances in Annex B, on the date of the entry into force of the Montreal Protocol, or any time thereafter. These countries are permitted a ten year "grace period" compared to the phase out schedule in the Montreal Protocol for developed countries. The Parties in this category known as "countries operating under Article 5(1) of the Protocol." They are sometimes referred to simply as "developing countries".

Controlled substance
Any ozone depleting substance that is subject to control measures under the Montreal Protocol, such as a phase-out requirement. Specifically, it refers to a substance listed in Annexes A, B, C or E 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 Article 5 and non-Article 5 countries.

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

Critical halon applications
In their Decision VII/12, the Parties to the Montreal Protocol recommended that all non-Article 5 Parties "should endeavour, on a voluntary basis, to limit the emissions of halon to a minimum by: (a) Accepting as critical those applications meeting the essential-use criteria as defined in decision IV/25… (b) Limiting the use of halons in new installations to critical applications (c) Accepting that existing installations for critical applications may continue to use halon in the future (d) Considering the decommissioning of halon systems in existing installations, which are not critical applications, as quickly as technically and economically feasible (e) Ensuring that halons are effectively recovered (f) Preventing, whenever feasible, the use of halon in equipment testing and for training of personnel (g) Evaluating and taking into account only those substitutes and replacements of halon, for which no other more environmentally suitable ones are available (h) Promoting the environmentally safe destruction of halons, when they are not needed in halon banks (existing or to be created)…" (see also Essential use).

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

Decomposition products
When certain gases are used to extinguish a fire they break down (decompose) into a range of chemicals, some of which can be toxic. The types of decomposition products and the quantity produced depend on the chemical composition of the fire extinguishing gas.

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." (see also Critical halon application).

Fine solid particulate technology

A category of new fire fighting technologies to replace halons, that includes fine solid particulates, aerosols, and gelled halocarbon/dry chemical suspensions. These take advantage of the well-established fire suppression capability of solid particulates.

Fluoroiodocarbons (FICs)

A molecule that contains fluorine, iodine, and carbon atoms (in some cases FICs also contain hydrogen). FICs are highly-effective fire extinguishing agents and are alternatives to halons in some applications.

Halocarbons

Halocarbons are compounds derived from methane (CH_4) and ethane (C_2H_6), where one or several of the hydrogen atoms are substituted with chlorine (Cl), fluorine (F), and/or bromine (Br). These compounds are so called "partly halogenated halocarbons". When all the hydrogen atoms are substituted the compound is said to be fully halogenated. The ability of halocarbons depleting ozone in the stratosphere is due to their content of chlorine and/or bromine and their chemical stability. Fully halogenated halocarbons have much higher chemical stability (atmospheric lifetime typically 100-500 years) than partly halogenated halocarbons (atmospheric lifetime typically 1-20 years). CFCs, HCFCs and HFCs are examples of halocarbons.

Halocarbon fire extinguishing agents

Halocarbon chemicals used as alternatives to halons for fire fighting applications. These agents include HCFCs, HFCs, PFCs, and FICs. They share several common characteristics, including: all are electrically non-conductive, all are clean agents (vaporise readily and leave no residue), and all are liquefied gases or compressible liquids.

Halon

A halon is a bromochlorofluorocarbon (BCFC), a chemical consisting of one or more carbon atoms surrounded by fluorine, chlorine and bromine. Halons are fully halogenated hydrocarbons that exhibit exceptional fire fighting effectiveness. They are used as fire extinguishing agents and as explosion suppressants. Because halons are ozone depleting substances with high ODPs, they are controlled substances under Annex A of the Montreal Protocol. Their consumption and production is restricted and they will eventually be phased out worldwide.

Halon-1211

An halongenated 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 (see also Halon).

Halon-1301

An halongenated 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. (see also Halon).

Halon-2402

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

Halon bank

The total quantity of halon existing at a given moment in a facility, organization, country, or region. The halon bank includes the halon in fire protection systems, in portable fire extinguishers, in mobile fire extinguishers and the halon in storage (containers).

Halon bank management
A method of managing a supply of banked halon. Bank management consists of keeping track of halon quantities at each stage: initial filling, installation, "recycling", and storage. A major goal of a halon bank is to avoid demand for new (virgin) halons by re-deploying halons from decommissioned systems or non-essential applications to essential uses. Halon banks are usually managed by a clearinghouse, i.e. an office that facilitates contact between halon owners and halon buyers.

Halon management strategy
The Parties to the Montreal Protocol through Decision X/7 (November 1998) reinforced the need for a comprehensive strategy to manage halon stocks. They requested all Parties to "develop and submit to the Ozone Secretariat a national or regional strategy for the management of halons, including emissions reduction and ultimate elimination of their use". The strategies should address issues such as: "(a) Discouraging the use of halons in new installations and equipment (b) Encouraging the use of halon substitutes and replacements acceptable from the standpoint of environment and health, taking into account their impact on the ozone layer, on climate change and any other global environmental issues (c) Considering a target date for the complete decommissioning of non-critical halon installations and equipment, taking into account an assessment of the availability of halons for critical uses (d) Promoting appropriate measures to ensure the environmentally safe and effective recovery, storage, management and destruction of halons."

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)

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.

Implementing Agency
Under the Montreal Protocol, four international organizations designated to implement the Multilateral Fund. They are UNDP, UNEP, UNIDO and the World Bank.

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

Inert gas generator
A new fire fighting technology that replaces halons. Inert gas generators use a solid material that oxidizes 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.

International Halon Replacement Working Group (IHRWG)
A working group established in October 1993 that is developing minimum performance standards and test methodologies for non-halon aircraft fire suppression agents/systems in cargo compartments, engine nacelles, hand held extinguishers, and lavatory trash receptacles. Their objective is to determine if safe and effective substitute agents can be used to replace halon-1211 and halon-1301 in aircraft. The group develops certification criteria for approval of halon replacement agents and systems. The group is open to anyone in the international community in industry, government, and academia with an interest in aircraft halon replacement agents/systems. It meets three times per year.

International recycled halon bank management

Through their Decision IV/26, the Parties to the Montreal Protocol encouraged recovery, recycling and reclamation of halons in order to meet the needs of all Parties, particularly Article 5 countries. They also called upon Parties importing recovered or recycled halons to apply the essential-use criteria set out in the 1991 report of the Halons Technical Options Committee when deciding on the use of those substances. The purpose of these criteria is to minimize the use of halons in non-essential applications. The Parties also requested UNEP to function as a clearinghouse for information relevant to international halon bank management.

Low volume ODS-consuming countries (LVC)

Defined by the Multilateral Fund's Executive Committee as Article 5 countries whose calculated level of ODS consumption is less than 360 ODP tonnes annually.

Montreal Protocol

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

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

National ozone unit (NOU)

The government unit in an Article 5 country 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 countries

Developed countries that are Party to the Montreal Protocol. The Parties in this category are also sometimes unofficially known as "countries operating under Article 2 of the Protocol" or simply "developed countries".

Non-Party

Any country that has not ratified, acceded to, accepted or approved the Montreal Protocol (see Party). Article 4 of the Protocol restricts trade with non-Parties.

ODS officer

A member of a National Ozone Unit.

Ozone

A reactive gas consisting of three oxygen atoms formed naturally in the atmosphere by the association of molecular oxygen (O_2) and atomic oxygen (O). It has the property of blocking the passage of dangerous wavelengths of ultraviolet radiation in the upper atmosphere. Whereas it is a desirable gas in the stratosphere, it is toxic to living organisms in the troposphere.

OzonAction programme

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

Ozone depleting substance (ODS)

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

Ozone depletion

Accelerated chemical destruction of the stratospheric ozone layer by the presence of substances produced, for the most part, by human activities. The most depleting species for the ozone layer are the chlorine and bromine free radicals generated from relatively stable chlorinated, fluorinated, and brominated products by ultraviolet radiation.

Ozone depletion potential (ODP)

A relative index indicating the extent to which a chemical product may cause ozone depletion. The reference level of 1 is 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 weight of the product in the atmosphere would, in time, deplete half the ozone that the same weight of CFC-11 would deplete. The ozone depletion potentials are calculated from mathematical models, which take into account factors such as the stability of the product, the rate of diffusion, the quantity of depleting atoms per molecule, and the effect of ultraviolet light and other radiation on the molecules. The substances implicated generally contain chlorine or bromine.

Ozone layer

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

Ozone Secretariat

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

Party

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

Perfluorocarbons (PFCs)

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

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.

Reclamation of halons

As defined by the Parties to the Montreal Protocol in their Decision IV/24, "the re-processing and upgrading of a recovered controlled substance through such mechanisms as filtering, drying, distillation and chemical treatment in order to restore the substance to a specified standard of performance. It often involves processing "off-site" at a central facility."

Recovery of halons

As defined by the Parties to the Montreal Protocol in their Decision IV/24, "the collection and storage of controlled substances from machinery, equipment, containment vessels, etc., during servicing or prior to disposal."

Recycling of halons

As defined by the Parties to the Montreal Protocol in their Decision IV/24, "the re-use of a recovered controlled substance following a basic cleaning process such as filtering and drying. For refrigerants, recycling normally involves recharge back into equipment it often occurs 'on-site'".

Technology and Economic Assessment Panel (TEAP)

The TEAP is a standing subsidiary body of the Parties to the Montreal Protocol, comprising hundreds of experts from around the world and coordinated by UNEP. It was created under Article 6 of the Montreal Protocol ("Assessment and review of control measures"). That article requires a regular asessment of the control measures on the basis of available scientific, environmental, technical and economic information beginning in 1990 and at least every 4 years thereafter. The TEAP is responsible for reviewing and reporting to the Parties about: (a) the state of art of production and use technology, options to phase out the use of ODS, recycling, reuse and destruction techniques (b) economic effects of ozone layer modification, economic aspects of technology. The TEAP includes the Economic Options Committee and Technical Options Committees: Aerosols, Sterilants, Miscellaneous Uses and Carbon Tetrachloride; Flexible and Rigid Foams; Halons; Methyl Bromide; Refrigeration, Air-conditioning and Heat Pumps; Solvents, Coatings and Adhesives.

Total Flooding System

A fire extinguishing system that protects a space by developing a critical concentration of extinguishing agent.

Transitional substances

Under the Montreal Protocol, a chemical (e.g. HCFC) whose use is permitted as a replacement for ozone-depleting substances, but only temporarily due to the substance's ODP or toxicity.

Water mist

A halon alternative that uses relatively small droplet sprays under low, medium, or high pressure. to extinguish fires. These systems use specially designed nozzles to produce much smaller droplets than are produced by traditional water-spray systems or conventional sprinklers. Water mist systems are being actively developed due to their low environmental impact, ability to suppress three-dimensional flammable liquid fires, and reduced water application rates relative to automatic sprinklers. Applications to date include shipboard accommodation, storage and machinery spaces, combustion turbine enclosures, flammable and combustible liquid machinery areas, as well as light and ordinary hazard sprinkler applications.

ANNEX 3: ABOUT THE UNEP DTIE OZONACTION PROGRAMME

Nations around the world are taking concrete actions to reduce and eliminate production and consumption of CFCs, halons, carbon tetrachloride, methyl chloroform, methyl bromide and HCFCs. When released into the atmosphere these substances damage the stratospheric ozone layer — a shield that protects life on Earth from the dangerous effects of solar ultraviolet radiation. Nearly every country in the world — currently 172 countries -- has committed itself under the Montreal Protocol to phase out the use and production of ODS. Recognizing that developing countries require special technical and financial assistance in order to meet their commitments under the Montreal Protocol, the Parties established the Multilateral Fund and requested UNEP, along with UNDP, UNIDO and the World Bank, to provide the necessary support. In addition, UNEP supports ozone protection activities in Countries with Economies in Transition (CEITs) as an implementing agency of the Global Environment Facility (GEF).

Since 1991, the UNEP DTIE OzonAction Programme has strengthened the capacity of governments (particularly National Ozone Units or "NOUs") and industry in developing countries to make informed decisions about technology choices and to develop the policies required to implement the Montreal Protocol. By delivering the following services to developing countries, tailored to their individual needs, the OzonAction Programme has helped promote cost-effective phase-out activities at the national and regional levels:

Information Exchange

Provides information tools and services to encourage and enable decision makers to make informed decisions on policies and investments required to phase out ODS. Since 1991, the Programme has developed and disseminated to NOUs over 100 individual publications, videos, and databases that include public awareness materials, a quarterly newsletter, a web site, sector-specific technical publications for identifying and selecting alternative technologies and guidelines to help governments establish policies and regulations.

Training

Builds the capacity of policy makers, customs officials and local industry to implement national ODS phase-out activities. The Programme promotes the involvement of local experts from industry and academia in training workshops and brings together local stakeholders with experts from the global ozone protection community. UNEP conducts training at the regional level and also supports national training activities (including providing training manuals and other materials).

Networking

Provides a regular forum for officers in NOUs to meet to exchange experiences, develop skills, and share knowledge and ideas with counterparts from both developing and developed countries. Networking helps ensure that NOUs have the information, skills and contacts required for managing national ODS phase-out activities successfully. UNEP currently operates 8 regional/sub-regional Networks involving 109 developing and 8 developed countries, which have resulted in member countries taking early steps to implement the Montreal Protocol.

Refrigerant Management Plans (RMPs)

Provide countries with an integrated, cost-effective strategy for ODS phase-out in the refrigeration and air conditioning sectors. RMPs have to assist developing countries (especially those that consume low volumes of ODS) to overcome the numerous obstacles to phase out ODS in the critical refrigeration sector. UNEP DTIE is currently providing specific expertise, information and guidance to support the development of RMPs in 60 countries.

Country Programmes and Institutional Strengthening

Support the development and implementation of national ODS phase-out strategies especially for low-volume ODS-consuming countries. The Programme is currently assisting 90 countries to develop their Country Programmes and 76 countries to implement their Institutional-Strengthening projects.

For more information about these services please contact:

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About the UNEP Division of Technology, Industry and Economics

The mission of the UNEP Division of Technology, Industry and Economics is to help decision-makers in government, local authorities, and industry develop and adopt policies and practices that:

- are cleaner and safer;
- make efficient use of natural resources;
- ensure adequate management of chemicals;
- incorporate environmental costs;
- reduce pollution and risks for humans and the environment.

The UNEP Division of Technology, Industry and Economics (UNEP DTIE), with its head office in Paris, is composed of one centre and four units:

- The International Environmental Technology Centre (Osaka), which promotes the adoption and use of environmentally sound technologies with a focus on the environmental management of cities and freshwater basins, in developing countries and countries in transition.
- Production and Consumption (Paris), which fosters the development of cleaner and safer production and consumption patterns that lead to increased efficiency in the use of natural resources and reductions in pollution.
- Chemicals (Geneva), which promotes sustainable development by catalysing global actions and building national capacities for the sound management of chemicals and the improvement of chemical safety world-wide, with a priority on Persistent Organic Pollutants (POPs) and Prior Informed Consent (PIC, jointly with FAO).
- Energy and OzonAction (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition, and promotes good management practices and use of energy, with a focus on atmospheric impacts. The UNEP/RISØ Collaborating Centre on Energy and Environment supports the work of the Unit.
- Economics and Trade (Geneva), which promotes the use and application of assessment and incentive tools for environmental policy and helps improve the understanding of linkages between trade and environment and the role of financial institutions in promoting sustainable development.

UNEP DTIE activities focus on raising awareness, improving the transfer of information, building capacity, fostering technology cooperation, partnerships and transfer, improving understanding of environmental impacts of trade issues, promoting integration of environmental considerations into economic policies, and catalysing global chemical safety.

What is good for fighting fires is not always good for the environment. In the case of halons, their long atmospheric lifetimes and high ozone destruction potential makes them extremely damaging to the stratospheric ozone layer, which protects humans, animals and plants from the damaging effects of ultraviolet solar radiation. Recognizing the danger posed by the continued use of these fire-fighting agents, the world community through the Montreal Protocol has agreed on a schudule to phase out halons.

Developing countries face the challenge of ensuring effective fire protection while at the same time eliminating their reliance on halons to comply with the Montreal Protocol. These case studies help the process by showing how different organizations and countries has successfully approached and addressed various aspects of halon management. The case study topics range from the adoption of alternatives in different sectors, to how a country organized a network of stakeholders and institutions to steer the halon phase out, to the experience of specific organizations in different aspects of halon management. Additionally, guidance is provided on the key issue of decommissioning halon sytems.

Although specifically written for National Ozone Units (NOUs) within the government, this publication is also designed to be used by other members of the fire protection community, including public fire services, fires equipment vendors, halon users, insurance companies, customs officials, and NGOs.

It was developed as part of UNEP's Work Programme under the Multilateral Fund for the Implementation of the Montreal Protocol, in cooperation with the UNEP Halons Technicol Option Committee.

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