MONTREAL PROTOCOL
ON SUBSTANCES THAT DEPLETE
THE OZONE LAYER

UNEP

REPORT OF THE
HALONS TECHNICAL OPTIONS COMMITTEE
DECEMBER 2014

TECHNICAL NOTE #2 – REVISION 2
HALON EMISSION REDUCTION STRATEGIES

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Preface

Technical Note #2, *Halon Emission Reduction Strategies*, replaces the chapters on this subject that have been part of previous Assessment Reports of the UNEP Halon Technical Options Committee (HTOC). Future reports, including the 2014 Assessment Report, will contain an abbreviated chapter that briefly introduces the subject of *Emission Reduction Strategies* and refers the interested reader to this document. The HTOC elected to take this approach as much of the information, while important to understand when developing strategies for reducing emissions from halons, has largely been reported in prior editions of Assessment Reports. The *Halon Emission Reduction Strategies* chapter of each edition of past Assessment Reports contains important updates on evolving technologies and procedures, but the updates usually form only a small portion of the chapter content. As such, it was deemed by the HTOC to make the *Emissions Reductions Strategies* a stand-alone document for reference purposes. By this approach those having particular interest in the procedural and technical aspects of the *Emissions Reductions Strategies* can access a self-contained document addressing those issues. One final note – the emission reduction strategies apply equally well to the halocarbon alternatives to halon and as climate change has joined ozone depletion in the environmental package of concern to the Parties, the HTOC encourages the readers of both the Assessment Reports and this document to integrate these strategies into their operations, policies, and guidelines when employing halocarbons for fire suppression.

1.0 Introduction

Releasing halon into the atmosphere is fundamental to the process of flame extinction and enclosed space inertion. However, these necessary emissions use only a small proportion of the available supply of halon in any year. Most countries have discontinued system discharge testing and discharge of extinguishers for training purposes resulting in emission reductions in some cases of up to 90%. Additional and significant reductions of halon emissions can be realised by improving maintenance procedures, detection and control devices, etc. as outlined in this Technical Note.

It is becoming apparent that there are a number of non-technical actions that should be taken which have been shown to be equally important to the aforementioned technical actions. Non-technical steps include development of Codes of Conduct, implementing Awareness Campaigns, workshops, and training, Policies, and legislating regulations and ensuring enforcement. Halon Emissions Reduction Strategies are a combination of “responsible use” and political regulatory action.

Emission reduction strategies are discussed in detail in the ten following areas:

- Alternative Fire Protection Strategies
- Halon Use Minimisation
- Maintenance Program
- Detection Systems
- Hazard and Enclosure Review
- Personnel Training and Documentation

- Halon Transfers and Storage
- Halon Discharging
- Awareness Campaigns and Policies
- Decommissioning, Transportation, and Destruction

2.0 Alternative Fire Protection Strategies

Do not use halons in new fire protection applications or new designs of equipment. Alternatives are available for virtually all applications with very few exceptions, e.g., some aircraft applications. Clearly halon emissions can be reduced if halon is no longer employed as the fire protection agent. In determining whether or not a halon protection system should be retained or removed, a risk assessment should be performed.

Good engineering practice dictates that, where possible, hazards should be designed out of facilities rather than simply providing protection against them. Active fire extinguishing systems, which perform the same function as halon systems **SHOULD NOT** BE CONSIDERED AS THE ONLY ALTERNATIVE TO HALON SYSTEMS. A combination of prevention, inherently safe design, minimisation of personnel exposure, passive protection, equipment duplication, detection, and manual intervention should be considered as follows:

1. Prevention

   Where there is a low probability of fire and that probability can be reduced to acceptable proportions by procedures and diligence, the need for protection can be minimised. Where it is not possible to reduce the chance of fire/explosions sufficiently, then a combination of prevention and other measures such as sensitive fire/gas detection and manual intervention may be considered as acceptable protection.

2. Inherently Safe Design

   It may be possible to eliminate the need for protection by ensuring that either all the equipment in the area is not combustible, or that inventories are sufficiently small such that there is no immediate threat to life or vital equipment before evacuation of the area and manual intervention can take place.

3. Minimisation Of Personnel Exposure

   Where the only threat to life is within the protected area, the need to man the area may be minimised by the segregation of the hazardous equipment from the areas requiring access. Similarly, evacuation strategies and routes may be arranged to ensure that personnel can evacuate before a fire reaches a scale which can threaten life.

4. Passive Protection

   Vital equipment may be safeguarded with passive fire protection materials to ensure its survivability, or by location in a protective enclosure. This may not be possible where the inherent risks are within the equipment itself.

5. Equipment Duplication

   Vital equipment may be duplicated so that the loss of one item does not affect the system availability. However, since secondary equipment may also be exposed to hazards, duplication may not protect the total system from all hazards.

6. Detection

   Early detection could allow isolation and manual intervention before a fire reaches a size which can cause major damage or threaten life.

7. Manual Intervention

   Critical examination of the fire hazards may show that, where codes permit, a manual response using agents other than halons is acceptable when trained fire teams can react within a short time.

Performing an overall Risk Assessment, taking into consideration fire protection strategies, allowable down time, backup equipment & documentation, backup services, etc., will help in determining the optimum fire protection strategy. A thorough analysis may also provide documentation necessary for obtaining insurance.

3.0 Halon Use Minimisation

When protection against fire or explosion hazards with halon is considered vital, the following practices should be observed to minimise the use of halon systems, and thus reduce emissions potential:

1. Local Application

   Local application systems should be used where the primary fire hazards within an area can be identified and effective protection achieved with less agent than a total flood design would require.

2. Reserve Systems

   Reserve systems should only be installed when:

   - There is a confirmed immediate need to restore fire protection.
   - Recharge supplies are an unacceptable transport time away.

   If it is feasible to do so, consideration should be given to leaving reserve supplies unconnected, which can help avoid unwarranted release of the reserve supply. If possible, keep reserve agent in a single large storage tank to reduce the risk of accidental release and minimise the chance of leaking. Note, if the reserve halon is on site in a system of cylinders rather than a single large storage tank, then the chances of leaking and accidental discharge is increased by approximately the number of cylinders. Where there are no on-site capabilities for the storage and transfer of halon agent, or a contractor nearby with the capabilities, then consideration should be given to placing all reserve cylinders in an enclosure c/w caps or plugs installed in the discharge connection and installing an automatic halogen leak detector with remote and/or local alarms, or placing them on load cells and monitoring them for material loss.

3. Extended Discharge

   All possible means to maintain extinguishing concentration from an initial discharge, such as stopping air movement, closing openings, installing system-actuated dampers or shutters, etc., should be explored before considering an extended discharge. Extended discharge systems should be avoided as they normally require more halon than the initial discharge.

4. Zoned Systems

   Where it is technically feasible, protection of several separate zones by a single halon bank using total or partial discharge should be considered.

4.0 Maintenance Program

Attention to maintenance programs can add years to a halon bank by reduced emissions. This represents money saved in two ways. It minimises the need to purchase recycled halon, and it prolongs the useful life of the existing fire protection system. Once emissions are minimised, funding for system replacement can be planned over longer periods, for example over the life of the program/equipment. Cost payback from maintenance, manufacturer improvements, and more frequent servicing can be realised almost immediately. A maintenance program includes; upgrading equipment to utilise improvements and new technology, scheduling equipment replacement, proper design, regular maintenance, and regular system checks.

1. Upgrade Equipment

   Upgrade halon equipment to minimise leaks, prevent accidental discharges, and minimise false alarms/discharges. In some cases, the same equipment (with minor modifications) can be used for the halon replacements. In most cases, the alarm/detection system can be reused after halon system removal regardless of the method of fire protection. Thus upgrades to equipment represent a natural progression in an operation and maintenance program.

2. Scheduled Equipment Replacement

   A well-developed maintenance program will include scheduled equipment replacement, based on the expected life of the equipment. The equipment life may be based on manufacturer's recommendations, local or national regulations, or previous history. Planning for replacement provides a basis for forecasting long term funding requirements.

3. Design and Regular Maintenance

   In some cases, inadvertent discharges represent the largest source of halon emissions, and they can often be eliminated through improved maintenance and/or system redesign.

   Inadvertent discharges are mostly attributed to:

   - Automatic detectors responding to transient changes in environmental conditions (e.g., humidity and airborne dust).

- Electronic unreliability or poor circuit protection from outside interference, e.g., lightning.
- Design not conforming to manufacturer's recommendations or Listing.
- Irregular and/or inadequate personnel training.
- Inadequate maintenance procedures and documentation.
- Accidents during system servicing or testing (see note below).

Note: Reductions in false releases during maintenance of detection systems have been observed when electrical isolation switches are incorporated in protection system designs. Such devices prevent equipment from being returned to service while still in an alarm condition.

4. Regular System Checks

System checks and maintenance should be done on a frequent and regular basis. System cylinders should be visually inspected on a monthly basis for obvious damage to the cylinders, valves, leak detectors, etc. The contents of cylinders should be checked every six months to monitor losses. (Note: There are a number of methods for checking the quantity of halon in a cylinder. Check with the manufacturer for the optimum method.) Valves, hoses, manifolds, and fittings should be inspected at the same time using a local halon sensor such as those used to check refrigeration systems for leaks. Cylinders should only be replaced if more than 5% by weight of the initial contents has been lost or will be lost by the next service. Minor losses within this 5% can often be tolerated and will minimise unnecessary losses incurred in the process of rectifying such leaks. Bar coding methods have been successfully employed to record and track halon quantities and equipment condition.

An example of the importance of a maintenance program is illustrated through reports like the following. The manager of a national halon bank reported that 90% of the halon discharges were a result of "dirty smoke detectors and bad maintenance operations". The experience of HTOC members is this is a typical example seen world-wide. It is imperative in cases where halon is still being used that considerable effort be given to developing better maintenance methods for the equipment. Improved discharge system reliability is achieved through enhanced maintenance procedures and/or replacement with new technology. <u>Development of a maintenance program should be done in parallel with performing a risk assessment of the facility and operations</u>. **Once a risk assessment has been performed on an operation, the fire protection needs are then determined**. In cases where automatic fire detection or suppression is determined necessary, maintenance becomes a significant and integral part of the risk management.

5.0 Detection Systems

Automatic halon systems go hand in hand with sensitive detection systems. **Poor design and improper maintenance of sensitive detection systems will almost always result in unwanted halon releases.** It is therefore essential that:

1. Systems components should not be mixed.

Systems assembled from a mixture of components from different manufacturers should be avoided unless the fire and/or gas control panel manufacturer takes responsibility for the overall system.

2. Halon is released only after positive confirmation of fire.

   Automatic release circuits should be designed to operate only after at least two detectors on independent circuits have confirmed a serious incident.

   Where the Authority Having Jurisdiction permits, and in facilities that are occupied continuously by trained personnel, the use of Closed Circuit Television (CCTV) flame detectors will allow trained personnel to remotely, visually confirm the existence of a fire within a predetermined time when alerted by pop-up video. If no fire exists, then release of halon can be inhibited. Newer technology called video smoke & fire detection or video smoke detection (VSD) can provide even faster response than CCTV alone as it utilises computer software to analyse the smoke pattern for quicker identification.

   Where the Authority Having Jurisdiction permits, in protected areas that are occupied continuously by trained personnel, consideration should be given to manually activated systems rather than automatic.

3. Equipment chosen conforms to internationally or nationally accepted specifications.

   Equipment chosen should conform to internationally or nationally accepted specifications incorporating suppression of airborne and electrical interference. For example, BS7273 2006 covers the electrical actuation of total flooding extinguishing systems, and was introduced to improve the reliability of control systems to reduce the likelihood of accidental discharges, see reference [1]. One of the major requirements is that the circuit design and equipment construction should be such that the system should not discharge because of the failure of a single component or the short circuiting of two current paths. In addition the equipment must be protected from EMI (cellular phones, etc.), e.g., EC Directive 2004/108/EC, see reference [2].

4. Existing detection systems are upgraded to take advantage of the latest technology.

   Experts in the field have determined that fires produce different types of stimulation that can be detected by sensors, e.g., molecular gases, condensed-phase aerosols, heat conduction, electromagnetic radiation, and acoustic waves. As a result there are a number of ways the fire can be detected. An example of upgraded technology in this area would be the use of early warning air sampling smoke detection systems. These types of systems employ a laser based light source, see reference [3] for an example. Owing to particle size discrimination, a laser based light source requires no air intake filter which can clog over time and desensitise the system. In addition, a laser based light source requires no maintenance and no replacement on a periodic basis. Other examples are infrared optical sensors which have an advantage over sensors that depend on sunlight or operate in the ultraviolet range because they cannot be blinded by smoke or obscured by oil or other substances. Consequently, they are less likely to produce false alarms. Sensors using optical signal processing also achieve very rapid response times.

   Addressable detectors and control panels should be employed wherever possible. Such systems enable exact location of the fire event to be made resulting in faster attendance with first aid fire fighting. Addressable systems are now no more expensive than earlier conventional systems. More sophisticated systems are also available where a combination of analogue detectors and control equipment can, in addition to identifying event location, compensate for detector deterioration and advise when sensor maintenance is required or the system is tending towards a false alarm. This can be either automatically corrected or manually through the service company, see reference [4].

5. Trained service personnel are employed.

   User and service company personnel should be fully familiar with the system operation and the equipment fitted, and should have undergone product/system training with the supplier.

6.0 Hazard and Enclosure Review

Monitor and control the hazard. Check for enclosure modifications or changes to the configuration of the protected space. Halon system removal or redesign will likely be required where walls have been repartitioned, moved, the contents of the enclosure have been changed significantly, etc. During these types of changes it is also important to review impacts to the protection system which may include changes in the environmental control system. It is usually necessary to modify the halon system when heating, ventilation and/or air conditioning systems (HVAC) are added to the protected zone. Check with local/national fire regulations and manufacturers recommendations for specific requirements, which will include requirements to connect controls of the halon system into the HVAC system for automatic shutdown where the HVAC is not dedicated to the protected enclosure.

7.0 Personnel Training and Documentation

Where on-site maintenance will be performed, it is essential that the personnel performing the service be properly trained. It is equally important that the halon 1301 system user be competent in the proper operation of the system and aware of activities that could result in an unwanted discharge. Both groups should be educated on ozone depletion issues and the impact of halon releases, as well as the restrictions on future supplies. Encourage participation rather than demand compliance.

Where on-site maintenance personnel are not available, the user should take out a maintenance contract. Whether on-site personnel are utilised or a maintenance servicing contract, always insist on competent and licensed service personnel. Maintenance personnel should be properly trained for servicing halon system cylinders and hand-held extinguishers (both 1211 and 1301) such that moisture and other contamination are not introduced (essential to prevent cylinder corrosion and/or loss of agent due to contamination).

Risk Management includes establishing good system documentation and maintenance procedures. Ensure there is documentation to follow in performing system maintenance and system checks, and all maintenance activities are logged. Review it thoroughly and periodically to see that it correctly addresses the specific equipment on-site and is not a generic copy. Install proper warnings, labels, and instructions on-site, for example post signs on the walls of areas protected by halon systems stating "This area is protected by Halon, Contact xxx prior to performing modifications to this enclosure". Track quantities of halon in service, storage, and emitted to determine areas where emissions can be reduced, as well as, to identify halon needs.

Where large quantities of halon are in service, utilise a computer database for tracking quantities and component failures.

8.0 Halon Transfers and Storage

The component of halon emissions related to halon transfers can be substantially reduced by the use of approved filling rigs. Any operation relating to a high pressure gas must conform to the appropriate safety standards in line with all relevant local, national, and international regulations. The equipment used must be certified by a recognised standards organisation and be compatible for halon use.

Environmental and operator safety dictates that all filling procedures should be conducted by trained, and preferably licensed, personnel. Filling operations should be carried out in a well-ventilated area with all safety relief valves from the rig connected to a containment/recovery system. All equipment, particularly flexible connections, should be checked at monthly intervals for signs of deterioration. To avoid corrosion problems, it is essential that the halon not be allowed to come into contact with water. The filling rig must be tested in accordance with local/country regulatory requirements and constantly monitored for leaks during the filling operation. During filling and recovery operations, overall loss of halon should be minimised and under no circumstances should it exceed 5%.

It is recommended that all new portable fire extinguishers or system cylinders be leak tested at all welds, valves, fill points, fittings, burst discs and other cylinder closures before and after being filled with halon. Any units that show signs of leaking should be connected immediately to a recovery rig and the contents transferred into the recovery container. The cylinder/valve should be rebuilt and the leak located and eliminated. Newly filled cylinders should not be accepted unless they are certified as having total leak rates below 0.5% by weight per annum of the initial halon fill.

Most safety standards require that portable halon extinguishers be emptied and refilled at regular intervals. This permits the operation of the appliance to be checked, and allows the cylinder to be inspected for signs of corrosion and to be subjected to pressure testing. In the past, frequently the halon was released to the atmosphere. **Clearly such practices must be banned, and all discharging accomplished using approved recovery rigs.**

Recovery rigs should be operated so as to avoid contaminating halon supplies. Cylinders containing halon should be emptied by pressurising with dry nitrogen or by use of positive displacement pumps. Vapours should be recovered if possible. Halons should never be mixed as this would significantly limit recycling possibilities. Halon 1211 recovery systems with an efficiency of >98% and halon 1301 recovery systems with efficiencies >96% are readily available today, see reference [5]. Table 1 provides an up-to-date list of halon recycling and reclamation equipment manufacturers known to the HTOC. Both the Kidde unit and the Neutronics unit utilise step down refrigeration for nitrogen separation, a process which results in large reclamation units that are not considered portable. HTOC members are neither endorsing the use of the more portable units nor are they critical of the larger units, but rather we are pointing out a challenge encountered by some of the Parties to managing a national halon banking operation.

Table 1: Halon Recycling and Reclamation Equipment Manufacturers

Type	Product Name	Manufacturer	Country
Halon 1211 Halon 1301 Halon 2402	REcovery And Conditioning for Halon (REACH™) System REACH REACH	Kidde Aerospace Inc. 4200 Airport Drive, N.W. Wilson, NC 27896 USA Tel: + 1 252 237 7004 Fax: +1 252 246 7185 **or** Kidde Graviner Ltd. Mathisen Way, Colnbrook Slough Berkshire, SL3 0HB United Kingdom Tel: +44 (0)1753 683245 Fax: +44 (0)1753 685126 URL:www.kiddegraviner.com	USA United Kingdom
Halon 1211 Halon 1211 & 1301 Halon 2402	Defender M-1 (Military) Defender C-1 (Commercial) Defender C700 (Commercial) Defender CM700M1 (Military) Defender C2402 NOTE: The MARS unit must be purchased with the Defender units to perform halon reclamation. MARS is a nitrogen separator.	A-GAS RemTec International 1100 Haskins Rd. Bowling Green, Ohio 43402 USA Tel: 800-372-1301 Fax: 419-867-3279 URL: www.remtec.net	USA
Halon 1211 Halon 1301	Halon 1211 Recovery System Halon 1301 Recovery System NOTE: The “Filtration System” must be purchased with these units in order to *RECYCLE* halon and the “Nitrogen Separator” must also be purchased to *RECLAIM* halon.	Getz Manufacturing 540 S Main Street North Pekin IL 61554, USA Tel: (309) 382-4389 Fax: (309) 382-6088 Web Site: www.getzmfg.com	USA
Halon 1211 and 1301	Halon 1211 & 1301 Reclamation Unit	Neutronics, Inc. 456 Creamery Way Exton, PA 19341 Tel: (610) 524-8800 Fax: (610) 524-8807 URL: www.neutronicsinc.com	USA

In the past it has been common practice to install redundant or backup halon systems on-site for providing immediate protection once the primary system has discharged. This is no longer an encouraged practice. Where backup systems are not necessary, they should be removed from service and the halon recovered. The proliferation of relatively inexpensive, high efficiency halon recovery systems makes it easier to increase the longevity of an individual's halon bank. Good practice dictates halon should not be stored in system size cylinders if possible and should **never** be placed or stored in cylinders not intended for halon use. (*The manager of a national halon bank reported finding halon stored in improper cylinders resulting in slow leaks.*) By recovering all on-site halon that is not in use for fire protection purposes, the risk of accidental discharge or agent leakage is minimised. The halon can be recovered into large storage tanks and the tanks monitored for leaks.

The following practices should be observed:

- Store halon reserves in bulk storage where possible rather than in individual cylinders.
- Recover surplus halon from systems and appliances.
- Transfer and Store halon in system cylinders, extinguishers, and storage cylinders designed for halon use.
- Inspect and test (where appropriate) all cylinders prior to filling with halon.
- Provide good storage conditions for both in service systems/cylinders and backup systems or bulk agent, and install leak detection for storage atmospheres.

9.0 Halon Discharging

The discharging of halon systems and portable fire extinguishers for testing, training, and other non-fire related procedures is a cause of unnecessary emissions that can easily be avoided. The HTOC committee believes that discharge testing using halons has been eliminated in most if not all countries; however, several Parties did not respond to HTOC requests for information, and therefore their policies regarding halon management are unknown.

1. Systems

   <u>Do not</u> perform discharge tests using halon under <u>any</u> circumstances. The Committee recommends that any existing regulations which mandate such tests should be amended. A principal emission control measure adopted by the fire protection community has been the reduction of halon 1301 full discharge tests by utilising several alternative procedures to ensure operational readiness of a system. These procedures are incorporated in the most recent edition of NFPA 12A, *Halon 1301 Fire Extinguishing Systems*, see reference [6]. The reasons for discharge tests using halon 1301 were to check enclosure integrity, distribution and concentration of agent, movement of piping supports and piping, and detector/control device functions.

   To address enclosure integrity a test, known as a "door fan" test, is conducted. The test uses air pressure, developed with a fan and measured with calibrated gauges, to determine the ability of an enclosure to hold the halon 1301 concentration. The calculations to interpret the gauge readings into halon 1301 hold time are usually performed with a small computer.

To address the other items, fire protection equipment standards play an important role. For example, UL 1058, *Standard for Halogenated Agent Extinguishing System Units*, see reference [7], provides an indication of the level of reliability for the proper operation of detector/control devices, guidelines for the proper installation of nozzles to achieve sufficient agent distribution, and a test for verifying a manufacturer's flow calculation methodology. Only systems with complex piping arrangements should require additional agent distribution testing. If you must test, use a surrogate gas.

Although the exact decrease in emissions, caused by the reduction in discharge testing using halon 1211, halon 2402, or halon 1301, is not known, it was estimated through the modelling of emissions and inventories to exceed 3500 MT per annum. The Committee therefore believes that eliminating discharge testing on a global basis should continue to be enforced for halon and encouraged for all in-kind halon alternatives. This change in practice has not shown to cause a major impact on protection system integrity.

2. Portable Fire Extinguishers

   Do not discharge manually operated halon fire extinguishers for training purposes.

   The Committee believes that it is now possible to eliminate this source of halon emissions. Discussions within the industry suggest that fire training organisations are now only demonstrating the use of portable halon extinguishers and have stopped using them during training. Thus, where three or four extinguishers may have been discharged in the past, now none are discharged during training sessions. With the increase in awareness of the environmental problems associated with halon, many users are switching to carbon dioxide, dry chemical, Aqueous Film Forming Foam (AFFF), Water Mist, or other acceptable zero or low ozone depleting substance (ODS) clean agent extinguishers. Thus, the reliance on the use of portable halon extinguishers has significantly declined. A pressurised water extinguisher system has been developed for the US military for fire fighter training. The handling behaviour is similar to a halon 1211 system, see reference [8].

   Video demonstrations of halon 1211 appliances in use compared to alternatives would assist in building user confidence without the actual use of halon 1211 in every training session. Interactive video training has also been developed for US military applications and can be developed for most other needs, see reference [8]. The UK military in conjunction with the Civil Aviation Authority has also developed and utilises interactive video training, see reference [9]. Therefore, it is reasonable to assume that the use of halon 1211 for training purposes can be virtually eliminated.

   Similar to the halon system cylinders, UL 1093, *Standard for Halogenated Agent Fire Extinguishers*, see reference [10], provides requirements for the construction and performance of portable halon type fire extinguishers.

10.0 Awareness Campaigns and Policies

This section covers non-technical steps that can be taken to reduce halon emissions. These steps have been shown to be as important as the technical steps discussed in the previous sections of this chapter in achieving halon emission reductions. The non-technical steps are discussed only briefly in this section; however, references within this section are provided at the end of this chapter and should be consulted for in depth coverage of each subject. The HTOC, various governments, and the fire protection community have worked diligently to provide guidance documents on all aspects of halon phase-out. The value of the references should not be underestimated.

Non-technical actions for halon emission reduction strategies are discussed in the following order:

- Policies, Regulations, and Enforcement
- Awareness Campaigns
- Standards and Code of Practice
- Record keeping

The intent in this section is to trigger some ideas on existing strategies that can or have been demonstrated to enhance country programmes while reducing halon emissions. It is not possible to provide comprehensive lists or information in this Technical Note as the options are extensive and specific aspects should be tailored to the country-specific conditions and needs.

10.1 Policies, Regulations, and Enforcement

Policies should be in place to meet the country obligations under the Montreal Protocol. Each country has a National Ozone Unit (NOU) tasked with implementing policies, programs, and regulations in support of those obligations under the articles of the Montreal Protocol specific to their country. Some countries have elected to utilise the concept of a Steering Group to formulate plans for ODS phase-out, to draft policies and regulations, and to provide periodic oversight. This is especially effective where resources are limited and actions might otherwise be delayed. It also serves to involve those entities directly affected by the phase-out. It is advisable that a Steering Group be made up of stakeholders from the following sectors, see reference [11]:

- Public fire service
- Fire equipment trade association
- Insurance company
- Halon user company
- Environmental advocacy groups (NGOs)
- Environment Ministry
- Customs officials
- Defence ministry

The Steering Group can be tasked to put forward a plan for halon management by the NOU or other responsible government agency. The NOU should initiate the revision of regulations to eliminate requirements for discharge testing and provide needed assistance to authorities having jurisdiction, especially in those cases where such testing is mandated by local regulations that are outdated or otherwise unnecessary. The NOU should also introduce regulations requiring the recovery, recycling, and reclamation of the halons.

While penalties can increase venting of halon and black market trading, many halon bank managers have cited lack of enforcement of halon control regulations as limiting the success of their operations. Without enforcement and incentives, national halon banking functions, especially those operated by industry or commercial entities, are unlikely to be financially viable. Several national halon bank managers have reported to HTOC members little or no activity in halon recycling which they attributed directly to lack of policies, regulations, and enforcement. In those cases, the bank either shuts down or the recycling operators will need retraining in the event decommissioned halon does become available.

10.2 Awareness Campaigns

Emission Reductions can be achieved by implementing a comprehensive Awareness Campaign. This can include any or all of the following: workshops, training, brochures, television commercials, website, newsletters directly or through fire protection equipment/service providers, fire protection and trade publications, etc.

Involve the stakeholders, who include the NOU delegate, Ministry of Environment, halon users, code enforcing authority, military branches, maritime and airline industries, research and testing laboratories, and the fire protection community. In all countries one or more of the following organisations exist and comprise the fire protection community:

- National fire service
- National standards writing organisation
- National building and fire code organisation
- National fire protection association
- Trade association of fire equipment companies
- Fire insurance companies

Awareness Campaigns should address a description of halons and their uses, environmental concerns related to the ozone layer, key goals and deadlines in the Montreal Protocol, country-specific policy and regulations on ODS, recycling requirements, alternatives and options, points of contact in government and the fire protection community, and answers to Frequently Asked Questions such as “what do I do with my halon 1211 extinguisher?”

In those countries where there is still no comprehensive halon management programme, no national halon bank, and no clearinghouse, it is quite likely there are halon installations that are inappropriate for the application and should be replaced with an alternative, see reference [11]. Workshops and Training are an excellent way to implement an Awareness Campaign while meeting with the fire protection community.

10.3 Standards and Codes of Practice

The fire protection community should:

- Adopt or develop technical standards on the design, installation, testing, and maintenance of extinguishers and fire suppression systems both for halons and their alternatives.

- Ensure users have training in place for the occupants and site manager of a halon protected enclosure.
- Develop or adopt a Code of Practice, see references [11–15]:
    - Target groups may include insurance, system manufacturers and distributors, fire protection system operators, service technicians, and state fire services.
    - Enforce the standards and codes. Various methods of enforcement may include command and control measures (e.g., regulations), market-based measures (e.g., taxes or permits) or voluntary agreements. Command and control approaches, the most common approach, require an effective legal framework and enforcement.
    - Incorporate standards and Codes of Practice in regular training. National training workshops should teach and explain the Code of Practice.

The fire protection industry has a goal of reducing the risk to people and property from the threat of fire while minimising non-fire emissions of fire protection agents. With the aim of ensuring both of these goals are achieved, the fire protection industries in many countries have developed or adopted a Voluntary Code of Practice (VCOP) that is intended to focus the industry's efforts on minimising emissions of gaseous fire protection agents, see reference [11]. The VCOP is distributed throughout the fire protection community and members are encouraged to voluntarily follow the emission reduction strategies. The following are typical strategies outlined in a VCOP:

1. Regulations and Standards: Follow applicable technical standards for the agent.
2. Emissions: Minimise emissions during storage, handling, and transfer.
3. Equipment: Utilise equipment appropriate for the agent and maintain it regularly according to step 1.
4. Discharge Testing: Eliminate discharge testing of halon and minimise discharge testing for all replacement agents to "essential" tests only.
5. Decommissioning, Servicing, and Disposal: Prohibit venting or release of agent to atmosphere, recycle or destroy agent, follow manufacturer instructions for operation and maintenance of recycling equipment, and assure purity of agent.
6. Technician Training: Require that technicians who test, maintain, service, repair or dispose of halon containing equipment are trained regarding responsible use to minimise unnecessary emissions, see reference [14]. Training should include:
    - Explanation of why training is required (trained technicians prevent emissions).
    - Overview of environmental concerns with halons and alternatives (ozone depletion, long atmospheric lifetimes, high GWP).
    - Review of relevant regulations or standards concerning halons and alternatives.
    - Specific technical instruction relevant to individual facilities (manufacturer manuals, training materials, references, and resources available to technicians).
7. Communications and Outreach: Ensure dissemination of information designed to minimise emissions and enable phase-out of halons.
8. Record keeping and Reporting: Develop a verifiable data tracking system on stockpiles, installed base, transfers, and emissions.

In most countries, fire equipment distributors belong to an industry association or are registered with a government agency. That agency or the government agency responsible for ODS phase-out could develop a Code of Practice (COP) and require compliance with the COP, in which case it would not be called voluntary. Requiring compliance would assure compliance with recognised and acceptable levels of safety and quality, thereby reducing liability concerns and building confidence in the viability of recycled material. This is very important where international transfers are concerned to ensure compliance with the provisions of the Basel Convention, see reference [12].

There are Codes of Practice available in many countries. It may be that another country's Code of Practice is suitably applicable to your situation and can be translated and adopted. Several countries have successfully used this method for example Georgia as reported in chapter 4 of the 2010 HTOC Assessment Report.

10.4 Record Keeping

Record keeping should be an integral part of managing halons from the system user to the national halon bank. Record keeping can include any or all of the following:

- User should have accurate information on site regarding system/extinguisher manufacturer, service provider, drawings, specifications, maintenance schedule, operator manual, etc., see reference [13] for an extensive list.
- Users, service providers, halon recycling facilities, and national banks should all implement inventory control, maintain detailed halon transfer records, and emissions data. This provides insight into why leaks or discharges occur, better long range planning for transition to alternatives, proactive capabilities for managing reserves, improved financial planning, and better enforcement of applicable regulations.
- Service providers and fire equipment distributors should keep records of customers' installed base, replenishment rates, and decommissioning plans especially where there is no national halon bank and no clearinghouse. This is also a tool to forecast future halon needs, surplus halons that will become available, and for assisting in the emissions quantifications.

Coordinate the development of a verifiable data tracking system on the emissions of halons and alternatives across the fire protection industry in your country.

Awareness Campaigns, Codes of Practice, Enforced Policies, and Recordkeeping are all essential tools to prevent further emissions of ozone depleting substances. A recent example of how these are needed was brought to the attention of the HTOC in 2010. *The manager of a national halon bank reported personal knowledge of halon cylinders being vented to make them lighter and easier to handle when decommissioning the systems. The manager emphasised the need to provide information to users, operators, and service technicians explaining the damage that is done to the ozone layer as a result of halon venting and discharges*. Continuing practices such as these are a reminder of the continued need to implement Awareness Campaigns and Policies on Responsible Halon Use.

11.0 Decommissioning, Transportation, and Destruction

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. Safety is an important aspect of decommissioning and transportation. 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 not only will it result in unwanted halon emissions, but more importantly it can become a projectile that can cause serious injury or death. Two ways this can occur is damage to the valve or activation of the discharge mechanism. Service technicians should always follow the manufacturer's guidelines for cylinder valve disassembly, see reference [15].

The rate of decommissioning has increased significantly as production of halon has ceased. As a result, there is the potential for a correlating increase in injury and unwanted emissions. Safe decommissioning guidelines are available from numerous sources and are applicable to all halon users, see references [11, 15, 16].

Transportation of halon occurs during decommissioning, servicing, and transfers to other users, vendors, banking facilities, or destruction facilities. It is important to develop guidelines and ensure they are properly followed so that halon is handled, transported, and stored in such a way that its physical property values are not degraded or emitted, see reference [16].

Destruction of halon is a final disposition option that should be considered only if the halons are cross-contaminated and cannot be reclaimed to an acceptable purity. There are several processes that have been identified as suitable for halon destruction by the Parties to the Montreal Protocol and they are discussed in HTOC Technical Note #5 (see also reference [14]). For up-to-date information on halon transportation and destruction refer to www.unep.fr/ozonaction under "Topics/Disposal & Destruction."

12.0 Conclusions

Avoidable halon releases account for greater halon emissions than those needed for fire protection and explosion prevention. Clearly such releases can be minimised. In reviewing reduction strategies, the UNEP Halons Technical Options Committee recommends the following:

- Do not use halon in new fire protection applications unless absolutely necessary.
- Take advantage of maintenance opportunities to replace existing halon systems or extinguishers with suitable alternatives where it is technically and economically feasible to do so.
- Encourage the application of risk management strategies and good engineering design to take advantage of alternative protection schemes.
- Implement a regular maintenance program.
- In protected areas that are occupied continuously by trained personnel, consideration should be given to manually activated systems or automatic systems that are activated via CCTV flame detectors.
- Encourage users of automatic detection/release equipment to take advantage of the latest technology.

- Verify system design and requirements when changes in hazard have occurred.
- Improve maintenance and system configuration documentation.
- Educate and train personnel on system characteristics.
- Introduce the use of halon recycling equipment to recover all surplus or reusable material.
- Utilise well-managed central storage for halon reserves and install automatic leak detection.
- Discontinue protection system discharge testing using halon as the test gas, and amend any existing regulations which mandate such testing.
- Discontinue the discharging to the atmosphere of portable halon extinguishers and system cylinders during equipment servicing.
- Discontinue the discharge of portable halon fire extinguishers for training purposes. Live fire training is important, but can be adequately done using simulants.
- Enact laws, develop policies, and ensure enforcement to support the managed phase-out of halons.
- Implement national Awareness Campaigns on all environmental concerns (ODS, GWP, Climate Change).
- Develop or adopt Technical Standards and Code of Conduct
- Develop database and implement record keeping on halon base, transfers, and emissions.
- Develop halon management plan – include end of useful (halon) life considerations.
- Ensure "Responsible Use" of halons using all of the tools from this chapter.

13.0 References

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14.0 List of Acronyms and Abbreviations

AFFF	Aqueous Film Forming Foam
BSI	British Standards institute
CCTV	Closed Circuit Television
COP	Code of Practice
GWP	Global Warming Potential
HTOC	Halon Technical Options Committee
HVAC	Heating, Ventilating, and Air Conditioning
NFPA	National Fire Protection Association
NGO	Non-Governmental Organization
NOU	National Ozone Unit
ODS	Ozone Depleting Substance
TEAP	Technology and Economic Assessment Panel
UL	Underwriters Laboratories Inc.
UK	United Kingdom
UNEP	United Nations Environment Programme
US	United States
VCOP	Voluntary Code of Practice
VSD	Video Smoke Detection