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Halon emission reduction strategies

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Halon emission reduction strategies

1. Introduction

Releasing halon into the atmosphere is fundamental to the process of flame extinction and enclosed space inertion. However, these necessary emissions only use 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 realized by improving maintenance procedures, detection and control devices, etc. as outlined in this Technical Note.

Emission reduction strategies are discussed in detail in the eight 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

2. Alternative Fire Protection Strategies

Apply halon to critical uses <u>ONLY</u>. Do not install or use halon where alternatives can be employed. Clearly halon emissions can be reduced if halon is not employed as the fire protection agent in the first place. In all cases, in determining whether or not a halon protection system is required or should be 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:

i) 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.

ii) 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 critical equipment before evacuation of the area and manual intervention can take place.

iii) 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.

iv) Passive Protection

Critical equipment may be protected by direct protection 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.

v) Equipment Duplication

Critical 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.

vi) Detection

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

vii) 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. Halon Use Minimisation

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

i) 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.

ii) 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 minimize 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 is no on-site capabilities for the storage and transfer of halon agent nor a contractor nearby with the capabilities, then consideration should be given to placing all reserve cylinders in an enclosure and installing an automatic halogen leak detector with remote and/or local alarms.

iii) 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.

iv) 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. 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 produce or purchase 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 utilize improvements and new technology, scheduling equipment replacement, proper design, regular maintenance, and regular system checks.

i) 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.

ii) 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.

iii) 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 (i.e. humidity, airborne dust, etc.).
- Electronic unreliability or poor circuit protection from outside interference.
- 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.

iv) 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.

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. Development of a maintenance program should be done in parallel with performing a Risk Assessment of the facility and operations. 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. 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:

i) Systems components not be mixed.

Systems assembled from a mixture of components from different manufacturers, none of whom takes overall responsibility, should be avoided.

ii) Halon be 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.

iii) Equipment chosen conforms to internationally accepted specifications.

Equipment chosen should conform to internationally accepted specifications incorporating suppression of airborne and electrical interference. BS7273 1990 covers the electrical actuation of total flooding extinguishing systems, introduced to improve the reliability of control systems to reduce the likelihood of accidental discharges [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.) to EC Directive 89/336/EEC [2].

iv) Existing detection systems be upgraded to take advantage of the latest technology.

Experts in the field have determined that fires produce five different types of stimulation which can be detected by sensors; 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 [3]. Because of particle size discrimination, a laser based light source requires no air intake filter which can clog over time and desensitize the system. In addition, a laser based light source requires no maintenance and no replacement on a periodic basis. Another example 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.

Wherever possible addressable detectors and control panels should be employed. Such systems enable exact location of the fire event to be made resulting in faster attendance with first aid fire fighting. Addressable systems are rapidly becoming no more expensive than early 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[4].

v) Trained service personnel be employed.

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

6. 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. 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 system user be informed of the proper operation of the system and cautioned on 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 utilized or a maintenance servicing contract, always insist on trained and licensed service engineers.

Risk Management includes establishing good system documentation and maintenance procedures. Ensure there is documentation to follow in performing system maintenance and system checks. 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, utilize a computer database for tracking quantities and component failures.

8. 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 recognized standards organization 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 connects, 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 leak tested to twice its normal pressure prior to its initial use, 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.

Current 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 thereby enhancing recycling possibilities. Halon 1211 recovery systems with an efficiency of 98% and halon 1301 recovery systems with efficiencies >96% are readily available today [5]. The UK Fire Industry Council has issued a Code of Practice covering the recovery of halons [6]. The following tables list types of halon recovery equipment and manufacturers:

Table of Halon 1211 Recycling, Recovery, and Reclamation Equipment Manufacturers

Type	Product Name	Manufacturer	Country
Halon 1211	Halon 1211 Recovery System	AES Nitron 45 Creamery Way Exton, PA 19341 U.S.A. Tel: + (1) 215 524 8800 Fax: + (1) 215 524 8807	USA
Halon 1211	Recovery and Conditioning for Halon (REACH)	Walter Kidde Aerospace, Inc. 4200 Airport Drive, N.W. Wilson, NC 27893 U.S.A. Tel: + (1) 919 237 7004 Fax: + (1) 919 237 8533 **or** Kidde International Belvue Road, Northolt Middlesex UB5 5QW United Kingdom Tel: + (44) 181 845 7711 Fax: + (44) 181 845 4304	USA United Kingdom
Halon 1211	Defender 2000/M-1	FRC International, Inc. 6150 Merger Drive Holland, OH 43528 U.S.A. Tel: + (1) 419 867 8990 Fax: + (1) 419 867 3279	USA
Halon 1211	Model HR-1	Getz Manufacturing 1525 SW Adams Peoria, IL 61602 U.S.A. Tel: + (1) 309 674 1723	USA

Table of Halon 1301 Recycling, Recovery, and Reclamation Equipment Manufacturers

Type	Product Name	Manufacturer	Country
Halon 1301	Model H1301	AES Nitron 45 Creamery Way Exton, PA 19341 U.S.A. Tel: + (1) 215 524 8800 Fax: + (1) 215 524 8807	USA
Halon 1301	Model ERS-130 Halon	Global Ozone Solutions, Inc. One Chestnut Street Nashua, NH 03060 U.S.A. Tel: + (1) 603 880 8365 Fax: + (1) 603 889 4206	USA
Halon 1301	HAL	Team Aer Lingus Sales Dublin Airport Ireland Tel: + (353) 1 705 2776 Fax: + (353) 1 705 6490	Ireland
Halon 1301	Recovery and Conditioning for Halon (REACH)	Walter Kidde Aerospace Inc. 4200 Airport Drive, N.W. Wilson, NC 27893 U.S.A. Tel: + (1) 919 237 7004 Fax: + (1) 919 237 8533 **or** Kidde International Belvue Road, Northolt Middlesex UB5 5QW United Kingdom Tel: + (44) 181 845 7711 Fax: + (44) 181 845 4304	USA United Kingdom
Halon 1301	Model HR-1301	Getz Manufacturing 1525 SW Adams Peoria, IL 61602 U.S.A. Tel: + (1) 309 674 1723	USA
Halon 1301	Halon Recovery System	Pacific Scientific HTL/KIN-TECH Division 1800 Highland Avenue Duarte, CA 91010 U.S.A. Tel: + (1) 818 359 9317	USA
Halon 1301	VaporSep system	Membrane Technology & Research, Inc. 1360 Willow Road Menlo Park, CA 94025 U.S.A. Tel: + (1) 415 328 2228	USA

Table of Halon 2402 Recycling, Recovery, and Reclamation Equipment Manufacturers

Type	Product Name	Manufacturer	Country
Halon 2402	Recovery and Conditioning for Halon (REACH)	Kidde International Belvue Road, Northolt Middlesex UB5 5QW United Kingdom Tel: + (44) 181 845 7711 Fax: + (44) 181 845 4304	United Kingdom

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 critical, 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. By recovering all on-site halon that is not used in critical, primary systems, the risk of accidental discharge or agent leakage is minimized. 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.
- Provide good storage conditions for both in service systems/cylinders and backup systems or bulk agent, and install leak detection for storage atmospheres.

9. Halon Discharging

9.1 Systems:

<u>Do</u> <u>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 - 1992, Halon 1301 Fire Extinguishing Systems [7]. 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 [8], 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. Similar requirements can be found in British Standards [9]. Only systems with complex piping arrangements should require additional agent distribution testing. If you must test, use a surrogate gas. SF_6 has been proposed as a candidate alternative to halon 1301 for such tests, but it should be noted that this gas has a high Global Warming Potential.

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 is believed to have been substantial. The Committee therefore believes that eliminating discharge testing on a global basis should be effected immediately and could be effected without major impact on protection system integrity.

9.2 Portable Fire Extinguishers:

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

The Committee believes that it may now be possible to virtually 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 only one is discharged. With the increase in awareness of the environmental problems associated with halon, many users are switching to CO_2, dry powder, or AFFF spray extinguishers. Thus, the demand for training in the use of portable halon extinguishers is rapidly declining. A pressurised water extinguisher system has been developed for the U.S. military for fire fighter training. The handling behaviour is similar to a halon 1211 system [10].

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 [10]. The U.K. military in conjunction with

the Civil Aviation Authority has also developed and utilises interactive video training [11]. 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 provides requirements for the construction and performance of portable halon type fire extinguishers [12].

10. 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 Technical Options Committee recommends the following:

- Reduce halon usage to critical applications only.
- Encourage the application of risk management strategies and good engineering design to take advantage of alternative protection schemes.
- Implement a regular maintenance program.
- Encourage users of automatic detection/release equipment to take advantage of the latest technology.
- Maintain enclosure integrity.
- 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.
- Utilize 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.

11. References

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3. Analaser by Fenwal, Kidde-Fenwal, Inc., 12 King James Court, Scotch Plains, New Jersey 07076, USA. Telephone (908) 322-8015, Facsimile (908) 322-2250.

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6. UK Fire Industry Council Code of Practice for Reclaiming Halon, 1993. 48A Eden Street, Kingston on Thames, Surrey, KT1 1EE UK. Telephone (44) 181 549 5855, Facsimile (44) 181 547 1564.

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8. Underwriters Laboratories Inc., UL 1058, Standard For Halogenated Agent Extinguishing System Units, Second Edition, 22 March 1991, ISBN 1-55989-024-X. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, Illinois 60062-2096, USA.

9. BS 5306: Section 5.1: "Halon 1301 Total Flooding Systems". British Standards Institute, 389 Chiswick High Road, London W44AL UK. Telephone (44) 181 996 7001.

10. Hughes Associates, Inc. Fire Science & Engineering, 3610 Commerce Drive, Suite 817, Baltimore, Maryland 21227-1652, USA. Telephone (410) 737-8677, Facsimile (410) 737-8688.

11. Civil Aviation Authority Fire Service Branch, Aviation House, South Area, Gatwick Airport, Gatwick, West Sussex, RH6 0YR UK. Telephone (44) 1293 573281, Facsimile (44) 1293 573999.

12. Underwriters Laboratories Inc., UL 1093, Standard For Halogenated Agent Fire Extinguishers, Fourth Edition, 11 October 1991, ISBN 1-55989-109-2. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, Illinois 60062-2096, USA.