Significant New Alternatives Policy Program
Fire Extinguishing and Explosion Prevention Sector

Risk Screen on Substitutes for Halon 1301
Total Flooding Systems in Normally Occupied and Unoccupied Spaces

Substitute: ATK OS-10

This risk screen does not contain Clean Air Act (CAA) Confidential Business Information (CBI) and, therefore, may be disclosed to the public.

1. Introduction

Ozone-depleting substances (ODS) are being phased out of production in response to a series of diplomatic and legislative efforts that have taken place over the past decade, including the Montreal Protocol and the Clean Air Act Amendments of 1990 (CAAA). The U.S. Environmental Protection Agency (EPA), as authorized by Section 612 of the CAAA, is developing a program to evaluate the human health and environmental risks posed by alternatives to ODS. The main purpose of EPA's program, called the Significant New Alternatives Policy (SNAP) program, is to identify acceptable and unacceptable substitutes for ODS in specific end uses.

EPA's decision on the acceptability of a substitute is based largely on the findings of a screening assessment of potential human health and environmental risks posed by the substitute in specific applications. EPA has already screened a large number of substitutes in many end uses within all of the major ODS-using sectors, including refrigeration and air conditioning, solvent cleaning, foam blowing, aerosols, fire suppression, adhesives, coatings and inks, and sterilization. The results of these risk screens are presented in a series of Background Documents that are available in EPA's docket.

The purpose of this risk screen is to supplement EPA's Background Document on the fire suppression and explosion protection sector (hereinafter referred to as the Background Document, EPA 1994). This risk screen discusses potential human health and environmental risks posed by the ATK OS-10 system when used as a replacement for Halon 1301 for use as a total flooding system in normally occupied and unoccupied spaces.

The OS-10 system produces post-activation products mainly consisting of gases and some particulates. The pre-activation products are summarized below in Table 1-1 and the post-activation products in Table 1-2.

Table 1-1: Composition of ATK, Prior to Activation

Constituent	Chemical Formula	CAS #	% of Total by Weight
Gas Generant[a]			
Ignition Material			

[a] The submitter notes that [] will be added to the generant once full production begins. It will be []% of the total by weight. []

Table 1-2: Composition of ATK, Post-Activation

Constituent	Chemical Formula	CAS #	% of Total by Weight
Gaseous			
Water Vapor	H_2O	7732-18-5	
Nitrogen	N_2	7727-37-9	
Particulate			

* The percentages in this table are based on the amount of matter that is discharged from the system and do not take into account the material remaining in the generator as residue.

OS-10 systems consist of gas generators that are intended to be used either singly or as several grouped together in a casing that also contain the controls for the firing sequence, a heat management portion and a particulate filter. Each generator contains [] pounds of the pre-activation mixture of chemicals (see Table 1-1). The generator includes a pyrotechnic igniter and a diffuser through which the hot gas is released. A single gas generator is capable of extinguishing a heptane fire in a volume of 220 cubic feet with a safety factor of 1.3 on the agent quantity (ATK 2008a).

OS-10 systems are intended to be used in a variety of commercial, industrial, and marine applications including protection of data centers, shipboard machinery spaces, and telecommunication facilities. Applications also include the protection of selected spaces in aircrafts, ships, and vehicles. (ATK 2008a)

To ensure that use of OS-10 in the applications listed above will not pose unacceptable risks to workers or the general public, worst case occupational exposure (during manufacturing, installation and maintenance, and post-activation clean up) and general population analyses were performed. Consumer exposure modeling was not performed because no consumer applications are proposed for this system.

The remainder of this risk screen is organized as follows:

- Section 2 of this report summarizes the results of the risk screen for OS-10;
- Section 3 presents atmospheric modeling;
- Section 4 discusses occupational exposure during manufacturing, installation, and maintenance;
- Section 5 discusses exposure at the end-use;
- Section 6 assesses risks associated with general population exposure; and
- Section 7 assesses the emissions of volatile organic compounds.

2. Summary of Results

ATK OS-10 is recommended for SNAP approval as a total flooding device in normally occupied and unoccupied spaces. Section VIII of the Occupational Safety & Health Administration (OSHA) Technical Manual (OSHA 1999) should be consulted for information on selecting the appropriate types of personal protective equipment (PPE) to be worn by personnel involved in the manufacture, installation, maintenance or clean-up of OS-10. It is expected that level C of the levels of protection presented in the

Manual will provide appropriate protection (see Appendix A for a description of level C protection). The risk screen indicates that the use of the proposed substitute will be less harmful to the atmosphere than the continued use of Halon 1301. Additionally, the risk to the general population is expected to be below levels of concern for non-cancer risks. EPA recommends that use of this system should be in accordance with the safe exposure guidelines for inert gas systems in the latest edition of NFPA 2001, specifically the requirements for residual oxygen levels, and should be in accordance with the relevant operational requirements in NFPA Standard 2010 for Aerosol Extinguishing Systems.

3. Atmospheric Modeling

This section presents an assessment of the potential risks to atmospheric integrity posed by the use of OS-10 as a total flooding system in normally occupied/unoccupied areas. The global warming potentials (GWP) of the gaseous post-activation products released upon activation of the fire suppressant are listed below in Table 3-1. All products have an ozone-depletion potential (ODP) of zero.

Table 3-1: GWPs of the Gaseous Post-Activation Products of OS-10

Constituent	GWP
H_2O	0[a]
N_2	0

NA Not available
Source: IPCC, 2001, unless otherwise noted.
[a]Although water vapor is a greenhouse gas, human activities are not thought to directly affect the average global concentration of water vapor (EPA, 2002). There is no IPCC published GWP for water vapor.
[b]Calm and Hourahan, 2007

The GWPs of post-activation products in OS-10 are well below the GWPs of previously SNAP-approved fire-suppression agents (e.g. HFCs and other high-GWP fluids). Accordingly, use of OS-10 is not expected to pose any significant adverse atmospheric impacts.

4. Occupational Exposure

The potential for personnel exposure during manufacture, installation maintenance, and cleanup are examined in this section. The discharge scenarios discussed are assumed to occur accidentally and not as the result of a fire.

4.1. Exposure During Manufacture

During manufacturing operations, workers may be exposed to [] while conducting various activities during the production process (ATK 2008a). Safeguards (i.e., PPE requirements) for each have activity been developed by ATK based on air samples collected during previous production runs of similar constituents. During production of OS-10, exposure levels of the various constituents are expected to be similar to those observed in the previous production runs (ATK 2008b). Therefore, the PPE used during the previous runs should be appropriate for use during OS-10 manufacture. ATK should continue to follow good workplace hygiene and should monitor concentrations of constituents present during manufacture once OS-10 production begins to ensure that the PPE are still sufficient.

4.2. Exposure During Installation and Maintenance

Installation and maintenance personnel should receive training so as to minimize the risk for accidentally discharging the system while performing installation or maintenance activities. If accidental dispersion of the system does occur while workers are in the protected volume, no significant adverse health effects should result if workers vacate the space during the five-minute egress time established by NFPA 2010 (NFPA 2006). Refer to Section 5 for a detailed discussion on exposure to the substitute during this five-minute period.

Users of the system should consider the installation of oxygen masks/tanks, safety showers and other treatment materials outside the room where people can reach them within five minutes in the event of accidental release.

4.3. Exposure During Cleanup

Testing data provided by the submitter do not indicate that there will be a significant amount of particulate left in the room post-release. Prior to cleanup, the air exchange rate in the room should be increased in order to aerate the space and reduce humidity. As clean-up operations may result in the re-circulation of dust particles, it is recommended that all workers entering the protected volume to clean-up after activation wear appropriate PPE. It is expected that level C of the levels of protection presented in the OSHA Technical Manual (OSHA 1999) will provide appropriate protection.

The contents removed from the protected volume should be disposed of according to federal, state and local regulations. When recommended safety precautions are followed, no significant adverse health effects should result.

5. Exposure At End-Use

When the ATK system is activated, gaseous compounds and particulate matter are emitted. The following sections examine exposures to the gaseous effluent, the components of the particulate matter and nuisance dust.

5.1. Exposure to Gaseous Effluent

Table 5-1 presents the concentrations of each gaseous effluent present after dispersion of the system, as determined in testing by ATK. The table also includes relevant toxicity limits for each constituent.

Table 5-1. Concentrations of Gaseous Effluent and Relevant Toxicity Limits

	ATK Test Levels	National Research Council Emergency Exposure Guideline Levels (EEGLs)	Immediately Dangerous to Life and Health (IDLH)[a]	Acute Exposure Guideline Levels (AEGLs)			
Gas	10 Minute TWA (ppm)	10 min (ppm)	30 min (ppm)	AEGL-2[b]		AEGL-3[c]	
				10 min	30 min	10 min	30 min

NA = Not Available

[a] IDLH values are defined as the maximum exposure concentration of a given chemical in the workplace from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects.

[b] AEGL-2: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
[c] AEGL-3: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.
[d] No Rec: No recommendation due to insufficient data.
[e] AEGL values for [] are recommended due to the greater toxicity of [].

IDLH levels are developed to be protective of human health in the event of a 30-minute exposure. To supplement these values, AEGLs and EEGLs are also used, both of which provide more acute exposure scenarios (i.e., 10-minute exposure levels). These levels should be closer in magnitude to a 5-minute exposure limit, the expected maximum exposure time in case of accidental release. The main results are summarized below:

- Concentrations of [], [] and [] resulting from an accidental release are not anticipated to be problematic, based on comparison to AEGL and IDLH values.

- The concentration of [] is well below the AEGL-3 values (even at 30 minutes) and should not result in irreversible health effects in exposed individuals, although eye and mucus membrane irritation may result following exposure.

- It is not expected that exposure to the concentration of [] present after activation of OS-10 (i.e., [] ppm) for only 5 minutes will cause adverse effects. See Section 5.1.1 for a more detailed discussion regarding the exposure level of [].

Therefore, no adverse health effects are expected due to exposure to the gaseous effluents during the five-minute egress time established by NFPA 2001 (NFPA 2008).

5.1.1 []

[]

Table 5-2. Dose-Response Table of Levels of [] and [] Resulting from Treatment []

Dose Level of [] (ppm)	Maximum [] Level Recorded	Maximum [] Level Recorded (ppm)	Test subject	Time	Comments	Source
10-20			Adult	Up to 23 days	No detectable toxic effect, such as []	
80	4.6%	<4	Patients aged 1 day to 72 years	15 minutes		
80	9.4%		Adult	8 hours		
80	9.6%		Adult	108 hours		
80	11.9%	3	Term infants	No more than 14 days	[] and elevated [] levels were problematic only in this dose group	
80	14%		Adult	18 hours		
80	14%		Patients aged 1 day to 72 years	Maximum of 110 hours		
80	17%	3.5	Newborns with gestational age ≥ 34 weeks	12 hours		

Moreover, EPA has concluded "that for [], if the concentration is not high enough to be lethal due to [] formation, the animal recovers completely." Therefore, EPA does not recommend acute exposure guidelines level (AEGL) values for [] and instead recommends that AEGL values for [] be used for emergency planning for [], as conversion of [] to [] occurs and [] is more toxic than [] (EPA 2006).[1]

5.2. Exposure to Particulate Matter

Table 5-3 presents concentrations of particulate matter measured during testing conducted by ATK and relevant toxicity limits for the substances.

Table 5-3. Concentrations of Particulate Matter and Relevant Toxicity Limits

Particulate Compounds	Concentration at 5 minutes (mg/m^3)	OSHA mg/m^3 (TWA: 8hrs)	OSHA mg/m^3 (TWA: 15min)[a]
Acid Soluble Portion			
Water Soluble Portion			
Total Particulate			

[a] Assuming that all exposure takes place in the time span of 15 minutes, the 8-hour TWA can be converted to a 15-minute TWA using the following equation: 15-minute TWA (mg/m^3) = (8-hr TWA x 480 minutes)/15 minutes
[b] []
[c] NIOSH, 2007
[d] []
[e] []

At the levels reported by the submitter, the particulate matter should not be detrimental to human health. While exposure to the reported level of [] does not present toxicity concerns, given the irritating nature of the compound, further information on exposure to this compound is presented in Section 5.2.1.

Users of the system should consider the installation of oxygen masks/tanks, safety showers and other treatment materials outside the room where people can reach them within five minutes in the event of accidental release.

5.2.1 []

[]

Although contact with [] may be uncomfortable, there are no toxicity concerns with the post-activation levels. The submitter reports the concentration of [] will be [] mg/m^3 at five minutes. This level is well below the eight hour OSHA TWA of [] mg/m^3.

5.3. Exposure to Nuisance Dust

OS-10 contains a total particulate concentration at five minutes of [] mg/m^3 for all particulates. The nuisance dust OSHA PEL TWA is 15.0 mg/m^3 for eight hours and calculated as $480mg/m^3$ for fifteen

[1] AEGLs are intended to describe the risk to humans resulting from rare exposure to airborne chemicals.

minutes.[2] The nuisance dust level of ATK should not present a toxicity threat since room occupants will only be exposed to this dust level for five minutes; however, irritation during respiration or impaired visibility may occur.

6. General Population Exposure

This section screens potential risks to the general population from exposure to ambient air releases of OS-10 constituents. Factory releases (occurring during manufacture) and on-site releases (those occurring at the end-use) are examined in this section. By following existing regulations, factory or on-site releases are not likely to pose a significant threat to ambient air, surface water, or solid waste. Consequently, use of OS-10 is not expected to pose significant risk to the general population.

6.1. Ambient Air

The submitter indicated no anticipated releases to the atmosphere at manufacture. On-site releases that result in the discharge of gases are not expected to pose a threat to the general public. ATK indicates that state of the art detection/control systems will eliminate unwanted discharges. Controlled discharge of nitrogen and water vapor to the atmosphere will occur. This will not pose a threat to the general public given the concentrations of these constituents naturally present in the atmosphere. Therefore, air emissions associated with the manufacture and use of OS-10 are not of concern to the health of the general population.

6.2. Surface Water

If all the solid waste settles onto the floor of the space and is removed from the site according to federal, state, and local requirements, the OS-10 components are not likely to settle into nearby streams or ponds.

6.3. Solid Waste

If all spilled and settled material in the manufacturing facility and all on-site releases are cleaned up and disposed of according to federal, state, and local requirements, no release to the environment is expected.

7. Volatile Organic Compound Analysis

The OS-10 constituents are not considered VOCs for purposes of local air quality.

8. References

ATK. 2008a. Significant New Alternatives Policy Program Submission to the United States Environmental Protection Agency, May 2008.

ATK. 2008b. Letter to Bella Maranion, U.S. EPA. 26 August 2008

Calm, James and Glenn Hourahan. 2007. "Refrigerant Data Update." *Heating/Piping/Air Conditioning Engineering*. 79(1): 50-64. January 2007. Available at < http://members.cox.net/jamesmcalmpubs2/Calm_Hourahan-Refrigerant_Data_Update-HPAC_Engineering-2007.pdf>.

[]

EPA. 2006. Acute Exposure Guidelines Levels (AEGLs) for []. October 2006. Available online at [].

EPA, 2002. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2000.*

EPA. 1994. Risk Screen on the Use of Substitutes for Class I Ozone-Depleting Substances: Fire

2 Assuming that all exposure takes place in the time span of 15 minutes, the 8-hour TWA can be converted to a 15-minute TWA using the following equation: 15-minute TWA (mg/m^3) = ($15 mg/m^3$ x 480 minutes)/15 minutes= **480 mg/m^3**

Suppression and Explosion Protection (Halon Substitutes). Stratospheric Protection Division. March 1994.

[]

IPCC, 2001. Third Assessment Report: Climate Change 2001: The Scientific Basis. International Panel on Climate Change. Available online at http://www.grida.no/climate/ipcc_tar/.

NFPA. 2008. NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems. National Fire Protection Agency.

NFPA. 2006. NFPA 2010: Standard for Fixed Aerosol Fire-Extinguishing Systems. National Fire Protection Agency.

NIOSH. 2007. NIOSH Pocket Guide to Chemical Hazards. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Publication No. 2005-149. September 2007.

OSHA. 1999. OSHA Technical Manual. Department of Labor. Occupational Safety and Health Administration. January 20, 1999. Available online at http://www.osha.gov/dts/osta/otm/otm_toc.html.

[]

[]

[]

Appendix A – Description of PPE Protection Level C

OSHA's Technical Manual (OSHA 1999) defines "level C" protection as follows:

> "Support Function Protective Garment (meets NFPA 1993)
> Full-facepiece, air-purifying, canister-equipped respirator
> Chemical resistant gloves and safety boots
> Two-way communications system, hard hat
>
> OPTIONAL: Faceshield, escape SCBA
>
> Protection Provided: The same level of skin protection as Level B, but a lower level of respiratory protection. Liquid splash protection but no protection to chemical vapors or gases.
>
> Used When: Contact with site chemical(s) will not affect the skin. Air contaminants have been identified and concentrations measured. A canister is available which can remove the contaminant. The site and its hazards have been completely characterized.
>
> Limitations: Protective clothing items must resist penetration by the chemical or mixtures present. Chemical airborne concentration must be less than IDLH levels. The atmosphere must contain at least 19.5% oxygen.
>
> Not Acceptable for Chemical Emergency Response"

Appendix A References

OSHA. 1999. OSHA Technical Manual. Department of Labor. Occupational Safety and Health Administration. January 20, 1999. Available online at http://www.osha.gov/dts/osta/otm/otm_toc.html.