

**HALON 1211: USES, RESTRICTIONS, AND REPLACEMENTS**

**Revision:** 4/95  
**Process/Product:** Fire extinguishing with Halon 1211 alternative streaming agents  
**Process Code:** N/A  
**Substitute for:** Halon 1211  
**Waste Stream:** N/A  
**Applicable EPA Hazardous Waste Codes:** N/A  
**Applicable EPCRA Targeted Constituents:** Halon 1211 (Bromochlorodifluoromethane)

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**Introduction:** Halon 1211 is a widely used fire suppression and explosion protection agent applied primarily as a streaming agent. It has been, for example, the fire extinguishing agent of choice for portable fire extinguishers in C-130 aircraft. However, it also has one of the higher ozone depletion potentials of any compound; thus, its production has been halted as of 1 January 1994, and its use is being curtailed until existing supplies are exhausted. However, Halon 1211 is still approved for use, but only in mission-critical applications:

- Ship- and shore-based crash, fire, and rescue
- Flightline firefighting
- Limited use for training activities

Existing installations of Halon 1211 that are not considered mission critical must switch to an approved acceptable alternative so that non-mission-critical applications can be decommissioned and allocated to the Halon reserves' stockpile at the Defense Logistics Agency (DLA) Halon bank. Furthermore, procurement of replacement stocks of Halon 1211 for mission critical uses must also come from the DLA Halon bank, since its production has already been phased out and purchase of new product is now impossible. Conservation of Halon 1211 is still necessary to preserve existing supplies until replacement products and systems can be implemented. Routine testing of systems for proper operation with the Halon product is discouraged. Actual use should be restricted to real incidents requiring fire suppression.

The large domestic stockpile of relatively inexpensive reclaimed Halon 1211 is expected to last a number of years. However, technical challenges have hindered product development of Halon 1211 substitutes. Several drop-in replacements are being studied, but are not yet approved for substitution.

**Description:** Halon 1211 is a brominated, chlorinated fluorocarbon (CF<sub>2</sub>ClBr) used primarily for fire suppression and explosion prevention. Because it is

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a severe ozone-depleting substance, there is a serious effort to phase out its use by developing and finding qualified substitutes. The EPA has developed a list of acceptable alternatives as an initiative of its Significant New Alternatives Policy (SNAP) program, though none of the alternatives is a universal drop-in replacement for Halon 1211. The substitutes are only acceptable subject to specific use conditions as cited in 40 CFR 82, Appendix A to Subpart G, "Substitutes Subject to Use Restrictions and Unacceptable Substitutes." (Non-halocarbon systems are considered "alternative technologies" and are also subject to EPA SNAP review.) Therefore, it is critical that any alternatives' applicability be verified, given the long list of qualifications and use conditions to which each alternative is subject. The variation in use conditions is often a result of physical property differences. A substitute compound may not be as effective in extinguishing a fire, and so a higher concentration of the extinguishing agent is required. Higher gas concentrations also increase the sensitivity of personnel to cardiotoxicity and reduce available oxygen content, limiting their use.

Acceptable substitutes, deemed "approved" alternatives to Halon 1211 use as a streaming agent, as determined by the SNAP program are:

- HBFC-22B1 (FM-100) for non-residential uses only, an interim substitute at best since its high ozone depletion potential qualifies it for phased-out production by January 1, 1996.
- Carbon dioxide.
- Dry chemical - potassium bicarbonate, Monnex™, sodium bicarbonate; smaller particles are more effective at extinguishing fires.
- Foam.
- HCFC Blend B (Halotron 1), for non-residential uses only.
- HCFC Blend C (NAF P-III), for non-residential uses only.
- HCFC Blend D (Blitz III), intended for large outdoor non-residential applications only.
- HCFC-123, for non-residential general uses only; not yet approved as a streaming agent.
- HCFC-124 (DuPont FE-241), for non-residential uses only. HCFC use as substitutes should be considered interim because HCFC production is scheduled for phaseout early next century and could be accelerated.
- Perfluorohexane ( $C_6F_{14}$ ) (PFC-614 or CEA-614), allowed by SNAP where no other agent is technically feasible. Perfluorohexane is regarded as an acceptable alternative only for a couple of military applications.
- Surfactant Blend A (Cold Fire™).
- Water.

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Note: Since the SNAP-approved alternatives for Halon 1211 have narrow use limits, extreme care must be taken when converting, retrofitting, or redesigning Halon 1211 systems.

Despite the SNAP list of more than a dozen approved alternatives, there are some relatively simple and logical guidelines to follow, as outlined by the Navy CFC/Halon Clearinghouse for prudent selection of non-mission critical alternatives:

- Dry chemical is the best choice alternative; it is an inexpensive and readily available product, it is environmentally benign (zero ozone depletion potential [ODP] and zero global warming potential [GWP]), and it is safe for use in either unoccupied or occupied areas, having low toxicity. Dry chemical units are also relatively simple to operate and to maintain. However, dry chemical is not a clean agent, and may cause some collateral damage to certain types of equipment. Substitution with dry chemical is recommended.
- Carbon dioxide (CO<sub>2</sub>) is the preferred clean agent. CO<sub>2</sub> has a zero ODP and, although a greenhouse gas, all commercially available CO<sub>2</sub> is a by-product of industrial processes like fermentation or natural gas production; thus, secondary use does not add to carbon dioxide's global warming impact. Although discharge of CO<sub>2</sub> can cause a static charge, the presence of a fire is considered a much more significant ignition source. CO<sub>2</sub> extinguishes fires primarily by smothering. It is heavier than air and tends to cover fuel sources, displacing air, and thus oxygen. Furthermore, since CO<sub>2</sub> is discharged at atmospheric pressure, its temperature upon sublimation (vaporization directly from the solid state to the vapor state) is about -110 degrees F. The low temperature of the vapor provides a cooling effect that also helps extinguish the fire. Substitution with CO<sub>2</sub> is recommended where a clean agent is needed.
- Foam wetting agents can also be considered, but they require water for dispersion and, therefore, have more narrow application. Surfactant Blend A is a wetting agent that may find broader application as a Halon 1211 substitute than some of the conventional foams.
- Water systems are also approved under SNAP, but uses are limited to fixed systems or stations.
- Perfluorocarbon (PFC) alternatives should be used only for applications where no other approved substitute will work. Although PFCs have zero ODP, are reasonably effective extinguishing agents, and also have low toxicity, they can produce toxic decomposition products during an actual fire. Furthermore, they are very expensive and have the highest GWPs of any of the approved substitutes. Use of PFCs is discouraged, although there

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may be some application for command/control systems.

- Hydrochlorofluorocarbons (HCFCs) are at best interim substitutes. HCFCs have non-zero ODPs (albeit an order of magnitude or more below Halon 1301) and non-zero GWPs. In addition, HCFCs are already scheduled for phaseout, and the established time frames could be accelerated at any time. Substitution to any of the HCFCs is not recommended.
- Hydrobromofluorochlorocarbon 22B1 (HBFC-22B1), though listed on SNAP, hardly qualifies even as an interim substitute, since it is scheduled for a production ban as of 1 January 1996. It was included on the CFC phaseout schedule because its ODP is on the same order as those of the CFCs. Substitution to HBFC-22B1 is not recommended.

Some of the qualities that make for a good extinguishing streaming agent, which Halon 1211 possesses and is desirable in other compounds:

- Forms a low level of combustion by-products that are thought to hinder the combustion mechanism, effectively extinguishing flames.
- Has a relatively low vapor pressure, only partially vaporizing upon discharge, so its liquid stream can be projected much farther than if it had vaporized totally. In contrast, carbon dioxide does not have the reach of Halon 1211, making CO<sub>2</sub> a somewhat inferior streaming agent.
- Is a cleaning extinguishing agent and does not leave a residue.

Reduced visibility can be a problem with both halocarbon and non-halocarbon extinguishing agents. Fog or snow (in the case of CO<sub>2</sub>) formation and condensation of moisture in the air can sometimes produce a persistent fog. Nevertheless, the risk of reduced visibility is low, since ventilation is typically adequate to quickly disperse most fogs, and also only a small amount of agent is normally applied.

Each and every alternative for any application should be carefully reviewed for applicability to the use conditions. For example, an aqueous foam can not be used for explosion protection. For the halocarbon alternatives, oxygen displacement and cardiotoxicity are primary concerns. The main factors to weigh when considering conversion to a Halon 1211 alternative are the following:

- 1) Are there non-halocarbon alternatives that would work for the application, such as dry chemical, carbon dioxide, or foam?
- 2) Is the candidate substitute EPA SNAP approved?
- 3) Has the candidate substitute been tested by a nationally recognized testing organization such as Underwriters

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- Laboratories (UL) or Factory Mutual (FM)?
- 4) Is it necessary that the candidate substitute conform with the National Fire Protection Association Standard for Clean Agent Extinguishing Systems (NFPA Standard 2001)?
  - 5) Does the candidate substitute have zero ozone-depletion potential and low global-warming potential? If not, it may also be targeted for replacement sometime in the future; for example, any HCFC substitute will eventually be phased out over the next 20 years per the Montreal Protocol on ozone depleting substances.
  - 6) Is the existing equipment compatible with the candidate substitute? If not, what are the performance compromises, costs, and retrofit requirements?

Unlike most chemicals, there are no federal reporting requirements for Halon 1211 in the event of a release to the atmosphere.

### **Materials**

#### **Compatibility:**

The HFCs and PFCs are very inert chemicals, and thus extremely stable, just like Halon 1211, especially in the absence of excess moisture. As a result, they are compatible with most metals, many plastics, and some elastomers, though they can cause swelling in a number of elastomers. Under normal conditions, these compounds will not degrade during long-term storage. In addition, they are essentially electrically non-conductive and do not leave residues after discharge. However, they do form a greater amount of toxic decomposition products than does Halon 1211, because higher concentrations of the alternatives are required to extinguish fires. In any case, specific compatibility questions should always be raised with the manufacturer.

**Safety and Health:** Dry chemical has a low order toxicity. Perfluorocarbons also have a low order toxicity, but care should be taken when handling any of the above-mentioned technologies. Proper personal protective equipment is recommended.

Consult your local Industrial Health specialist, your local health and safety personnel, and the appropriate MSDS prior to implementing any of these technologies.

#### **Benefits:**

Switching from Halon 1211 to an approved alternative will not reduce the amount of ozone-depleting chemical going into the environment. The reason is that Halon 1211 production has been stopped, and any material already existing will most likely be used for its originally intended purpose, since there is no method of converting it into another compound or destroying it. However, careful use of the material for only mission-critical applications will prolong its useful

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lifetime, and extend the time period over which the material enters the environment, thus lessening the immediate impact on the ozone layer. Because there is no universal drop-in replacement and many of the substitutes also have undesirable characteristics like non-zero ODPs and high GWPs, careful consideration of the choices is necessary in order to select the optimal alternative.

**Economic Analysis:** Use of pollution prevention funds for replacement of Halon fire extinguishing systems with non-Halon based systems is not authorized if the reason for conversion is that the existing system has reached the end of its life expectancy.

**Major Assumptions:** N/A

**Points of Contact:** Captain Robert Tetla  
Halon Replacement Program  
Occupied Areas  
Wright Laboratories (WR/FIVCF)  
DSN 523-3746, (904) 283-3746

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CFC, Halon, and Cylinder Technical Matters and Transportation  
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DLA Halon Bank  
(804) 279-4525

Factory Mutual Research Corporation  
(617) 762-4300 or 255-4980

Fire Equipment Manufacturers Association  
(216) 241-7333

Fire Suppression Systems Association

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(410) 931-8100

Halon Recycling Corporation  
(800) 258-1283, (202) 223-6166

National Association of Fire Equipment Distributors  
(312) 644-6610

National Fire Protection Association (NFPA)  
(800) 344-3555

Navy CFC and Halon Clearinghouse  
(703) 769-1883

Underwriters Laboratories  
(708) 272-8800

US EPA Stratospheric Ozone Information Hotline  
(800) 296-1996

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(202) 233-9193

Ms. Reva Rubenstein  
Toxicity Specialist  
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US EPA  
(202) 233-9155

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**Vendors:** DuPont Fluorochemicals  
(302) 992-2177  
Mr. Dan Moore  
Market Development Manager for Halon Replacements.  
DuPont manufactures HCFC 124 (C<sub>2</sub>F<sub>4</sub>HCl), DuPont brand name FE-241. DuPont is still evaluating several Halon 1211 replacements products. Another promising potential long term replacement is from the hydrofluorocarbon family, HFC-236 (C<sub>3</sub>F<sub>6</sub>H<sub>2</sub>), DuPont FE-36.

FireFreeze Worldwide, Inc.  
270 Route 46 East  
Rockaway, NJ 07866  
(201) 627-0722, Fax (201) 627-2982  
Manufacturer of Surfactant Blend A, brand name Cold Fire™ 302 Class A/B/D fire suppressing agent. Used in various concentrations with water (1 to 6% solution). Available in a hand held portable extinguisher at 6% concentration using compressed air as the propellant, or can be used with induction systems and proportioned at concentrations of 1 to 6%, depending on the type of fire.

3M Corporation  
3M Center Building  
223-6S-04  
St. Paul, MN 55144-1000  
(612) 736-6055, Fax (612) 736-7542  
Mr. John Schuster  
3M perfluorocarbons carry the designation CEA.

<b>Approving Authority:</b>	Approving authority is controlled locally and is not required by the major claimant.
<b>Note:</b>	This recommendation should be implemented only after engineering approval has been granted by cognizant authority.

Source(s): PA Technical Inquiries: 2287, 3188, and 3385.  
Lubiejewski, P. E., "Replacement of Halon 1301 Portable Fire Extinguishers on Board Naval Aircraft," Proceedings of the 1994 International CFC and Halon Alternatives Conference,  
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323, October 1994.