



# HALON RECYCLING CORPORATION

## Halon 1301 Use in Civil Aviation: Guidance for Reducing Emissions and Contamination During Servicing and Maintenance



## Summary

Halons are ozone-depleting fire suppression chemicals widely used in aerospace for over 50 years. Halon production for fire protection largely ended in 1993 and was banned worldwide in 2010. All halons available for use today are from finite, recycled stocks. Halon 1301 (bromotrifluoromethane, CF<sub>3</sub>Br) is currently used on commercial aircraft to protect engine nacelles, cargo compartments, and auxiliary power unit (APU) compartments.

Most halon emissions from commercial aviation occur during the servicing of aircraft fire protection systems. During this process, Halon 1301 is being contaminated with other chemical agents due to poor practices, resulting in significant losses of Halon 1301. To avoid future halon shortages and possible aircraft grounding, this must be corrected immediately. The following is industry best practice to achieve this aim.

## Recommended Practices to Minimize Emissions and Contamination

### Transportation

- Do not purposely vent halon for shipping, handling, or any other reason
- Properly deactivate or cap the explosive squib prior to shipping
- Follow all national and international regulations for shipping pressurized cylinders

### Transfer Between Cylinders to Avoid Emissions

- Do not disconnect fire bottles, cylinders, or hoses until all halon has been fully evacuated
- Only use closed-loop equipment designed to transfer Halon 1301 per manufacturer instructions
- Clearly label cylinders for halon use with correct, specific placarding
- Leak-check and properly maintain all equipment at manufacturer-recommended intervals
- Ensure that the re-welding of discharge ports after servicing is done properly

### Transfer Between Cylinders to Avoid Contamination

Recyclers report that much Halon 1301 received from airlines and MROs is contaminated with other chemical agents to the point it requires distillation, which is costly and results in large Halon 1301 losses.

- All transfer equipment including pumps, hoses, recovery tanks and bulk tanks should be used for the transfer and storage of Halon 1301 only
- Do not use equipment to transfer or store Halon 1301 that has been used with any other chemical
- Recover all Halon 1301 into 120 kg (250 lb.) size or smaller cylinders to minimize contamination
- Ensure all cylinders are filled with Halon 1301 that meets ASTM D5632-17 Type II
- Sequester contents of all low-rate discharge cylinders as they contain methanol

## Introduction

Halons are highly effective fire and explosion suppression agents that have been used for special hazard fire protection since the 1960s. Halons are also potent ozone-depleting and global warming substances whose production for fire protection uses was phased out worldwide in 2010 under the Montreal Protocol. All halons available for use today are from recycled stocks.

Despite the phase out of production, halons continue to be needed in several important applications where alternatives are not yet available including military, oil and gas, and commercial aviation. A recent Montreal Protocol report estimates that Halon 1301 will be needed in commercial aviation for another 40 years and that the supply of recycled Halon 1301 could be exhausted before then<sup>1</sup>.

For these reasons it is critical that the world's existing halon resources be carefully managed. Every kilogram of halon that is prevented from being unnecessarily emitted, contaminated, or destroyed is a kilogram of halon that will be available for servicing halon systems in the future.

This document sets forth the background for how the Civil Aviation sector can protect the future of aviation fire protection by following best management practices in the servicing of aviation fire suppression systems and their Halon 1301 contents.

## Halon Recycling and Banking

Used halons become available in most cases when a fire suppression system or extinguisher is decommissioned. The recovery and recycling of the existing halons is key to minimizing unnecessary emissions and provides an environmentally sound pathway for halons to be directed to important uses until acceptable alternatives are developed.

The world's halon needs are supplied by halon recyclers. Halon recyclers are responsible for transporting decommissioned halon systems to their facilities; testing for contaminants; consolidating halon into storage cylinders; recycling the halon with equipment to remove contaminants and return it to the appropriate specifications; testing to certify that it meets specifications; and shipping the certified halon to the customer<sup>2,3</sup>. The process of certifying halon quality is of great importance to halon users, and all halon users are urged to make certain that the substance they are purchasing meets the specification required for their use.

The concept of "halon banking" is now a commonly used term. The accepted definition of a "halon bank" represents the total available amount of halon that is presently located in existing equipment, being the installed base, in addition to the halon already reclaimed from decommissioning activities and held in storage pending other future uses. A halon bank therefore is not necessarily a physical bank, it instead can be a managed inventory, such as inventories that airlines and MROs manage.

## Halon 1301 Use on Commercial Passenger Aircraft

Halon 1301 (bromotrifluoromethane,  $\text{CF}_3\text{Br}$ ) is a gaseous agent that is safe for occupied spaces and used mainly in total flooding fire suppression systems. Historically, the largest single user of Halon 1301 has been the electronics industry. The protection of vital electronics facilities such as computer and telecommunications rooms were estimated to account for 65% of Halon 1301 use. Halon 1301 has also been used extensively for military applications, ships, oil production, and electric power generation.

Halon 1301 is used on commercial passenger and freighter aircraft to protect engine nacelles, cargo compartments and auxiliary power unit (APU) compartments. Extensive research and testing are ongoing to identify and certify halon replacements for all these applications. International Civil Aviation Organization (ICAO) standards and European Union (EU) regulations require new aircraft designs to use halon replacement agents now or in the near future<sup>4,5</sup>. EU regulations will require retrofit of all halon systems on aircraft by 2040. Despite these actions, the civil aviation fleet will require Halon 1301 to maintain aircraft for many years to come.

## Emissions of Halons from Civil Aviation

A 2014 report from a Federal Aviation Administration (FAA) Halon Aviation Rulemaking Committee (ARC) estimated that the amount of Halon 1301 being used to service aircraft worldwide was higher than previous estimates<sup>6</sup>. This determination was made based on data collected from halon recyclers, aviation fire protection equipment manufacturers and aviation MROs. If correct, it would represent an emission rate in the range of 7-8% per year, which is much higher than for most other halon applications. Understanding and minimizing the release rate of Halon 1301 is critical for the aviation industry. If the rate is 2-3%, recycled Halon 1301 global supplies may support the fleet over their lifetime. A rate of 7-8% would exhaust global Halon 1301 supplies much earlier.

### Onboard Emissions

Emissions of Halon 1301 from systems while in service onboard the aircraft can occur in the following ways:

- Use on a fire
- Release in a false alarm
- Accidental discharge
- Leaking cylinders

Recent improvements in smoke detectors have significantly reduced false alarms in cargo compartments, and data shows that release of halon from fires and accidental discharges is infrequent. As such, release rates from onboard fire protection systems are thought to be low, probably in the 1% range.

Aviation halon bottles are high-quality, specialized cylinders that are hermetically sealed and new bottles should not leak. However, servicing the bottles requires removing a discharge port to evacuate the cylinder and welding it back on prior to refilling the cylinder with halon after servicing. If not done properly, these secondary welds can be a source of leaks.

## Transportation

Aviation halon bottles are sometimes removed from the aircraft and shipped directly to an MRO or recycler for servicing. These bottles are pressurized cylinders with an explosive squib activation device that must be properly deactivated prior to shipping. In addition, there are national and international regulations that specify how pressurized cylinder should be shipped. If shipped properly there should be no emissions during shipment.

Due to regulatory requirements, shipping aviation halon bottles can be costly and time consuming and there have been anecdotal reports of bottles being purposely evacuated of halon to ease shipping requirements. **Do not purposely vent halon under any circumstance. It is damaging to the environment, prohibited by national laws and regulations, and severely undermines efforts to minimize emissions and extend the life of the halon bank.**

Halons have a high monetary value, so purposely venting them is equivalent to throwing money away.

## Transfer Between Cylinders

When halon is transferred from one cylinder to another there is the potential for some halon loss. Additionally, some loss is inevitable from the removal of oils, moisture, and solids during the recycling process. Such losses are usually limited to 1-2% by weight if properly maintained transfer equipment and procedures are used.

Unusually high loss rates can occur, however, if cylinders and hose lines are not fully evacuated prior to disconnect. There have been anecdotal reports where service technicians, to save time, disconnect fire bottles prior to complete evacuation when the back pressure in the receiver cylinder increases above that of the source cylinder, and the evacuation process slows down. An easy solution to this problem is to obtain more empty receiver cylinders, so that connections can be switched to a lower-pressure receiver cylinder when the backpressure builds up. **Disconnecting fire bottles prior to full evacuation for any reason is the same as purposely venting halon and should not be done under any circumstance.**

## Contamination with Other Chemicals

Recyclers are reporting that a significant percentage of the Halon 1301 they receive from airlines and MROs is contaminated with other chemical agents. These include refrigerants such as HFC-134a and HCFC-22 and other fire protection agents such as Halon 1211, HFC-227ea, HFC-125, and HFC-236fa. Although the exact causes of this contamination are not fully understood, the following reasons are speculated:

- Transfer of Halon 1301 from a fire bottle into a recovery or bulk tank that either contains or has been used to store refrigerants or other fire protection agents besides Halon 1301
- Using the same recycling equipment such as pumps and hoses to transfer multiple agents

Halons contaminated with other chemical agents cannot be returned to specification using standard recycling equipment. Instead, they must be sent for distillation to separate out the other chemicals, which is a costly process that results in a significant increase in loss rates. Depending on the level of contamination and the physical properties of the other chemicals, loss rates as high as 20-30% have been reported. Therefore, it is critical that airlines and MROs take steps now to stop contaminating halon during the transfer process.

If an aviation fire bottle or other cylinder containing Halon 1301 is suspected of being contaminated and cannot be verified by the MRO, immediately segregate cylinders and contact a halon recycler for testing.

## Methanol

Cargo compartment fire protection systems have high-rate discharge bottles that release halon quickly to knock down or extinguish the fire and low-rate discharge bottles that release halon slowly to maintain an adequate concentration for the duration of the flight. Methanol is sometimes introduced as an additive to Halon 1301 to prevent the freezing of water from condensation during the low-rate discharge. As a result, methanol is frequently identified as a contaminant in Halon 1301 recovered from aviation fire protection systems. Like the other chemicals listed above, removing methanol from Halon 1301 requires distillation. To avoid contaminating Halon 1301 from other sources with methanol, transfer the halon from the low-rate discharge bottle into separate, dedicated tanks.

## Recommended Practices

### Transportation

- **Do not vent halon or evacuate halon from the fire bottle prior to shipping!**
- Properly deactivate or cap the explosive squib prior to shipping.
- Follow all national and international regulations for shipping pressurized cylinders.

### Transfer Between Cylinders to Avoid Emissions

- **Do not disconnect fire extinguisher bottles, cylinders, or hoses until all the halon has been evacuated for any reason!**
- Only use closed-loop equipment that is designed to transfer Halon 1301 in accordance with manufacturer's instructions.

- Designate and clearly label cylinders for halon use with appropriate placarding. Indicate the specific product in the container (such as Halon 1301).
- Check and properly maintain transfer equipment at recommended intervals to ensure it has no detectable leaks.
- Ensure that the re-welding of discharge ports after servicing is done properly to avoid future leaks.

## Transfer Between Cylinders to Avoid Contamination

- All transfer equipment including pumps, hoses, recovery tanks and bulk tanks should be used for the transfer and storage of Halon 1301 only.
- Do not use equipment to transfer Halon 1301 such as pumps and hoses that have been used to transfer any other chemical agent and do not transfer Halon 1301 in bulk tanks that have been used to store any other chemical agent.
- If possible, utilize recovery cylinders of 120 kg (250 lb.) size or smaller to minimize potential contamination.
- When refilling aviation fire bottles after servicing, make sure you are using Halon 1301 from a cylinder whose contents carry an independent laboratory certification indicating the Halon 1301 meets ASTM D5632-17 Type II.
- If the Halon 1301 from the low-rate discharge bottles in the cargo compartment contains methanol, it should be transferred and stored in a separate, clearly marked cylinder to prevent the contamination of methanol-free Halon 1301 stocks with methanol.

## References

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<sup>1</sup> [HTOC Assessment Report 2018 \(Volume 1\)](#)

<sup>2</sup> [Halon 1301: ASTM D5632](#)

<sup>3</sup> [Halon 1211: ASTM D7673](#)

<sup>4</sup> [ICAO/Safety/Ops/Ops Section/Halon Replacement](#)

<sup>5</sup> [EASA: Halon replacement in the aviation industry](#)

<sup>6</sup> [FAA Halon Replacement Aviation Rulemaking Committee, 12/1/2014](#)