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Review of Annex VI of Regulation (EC) No 1005/2009 on substances that deplete the ozone layer, with regard to the critical uses of halons

Background note to the Members of the Committee established under the Regulation, summarizing the review process, stakeholder consultations, analysis and conclusions (Revised April 2010)

Contents

1 Introduction

1.1 The halogenated hydrocarbons known as the halons, primarily halon 1301 ($CBrF_3$), halon 1211 ($CBrClF_2$) and halon 2402 ($CBrF_2CBrF_2$), have proven to be very effective, clean, gaseous fire extinguishants and explosion suppressants, with a range of advantageous properties that resulted in their widespread adoption. Their effectiveness is largely due to the presence of bromine in their composition, which has a catalytic quenching effect on combustion processes. Unfortunately, the bromine also acts as a significant catalyst in the destruction of ozone in the stratosphere. The halons are, in fact, the most potent ozone-depleting substances (ODSs). Consequently, their production has been phased out under the Montreal Protocol.

1.2 A range of new clean alternative extinguishants and fire protection technologies has been, and continues to be, developed to supplement traditional extinguishants (such as foams and chemical powders) to address the fire protection needs which have, in the past, been met by the halons. One or more of these alternatives has been found to be, or will likely be, suitable for all but a few fire protection applications. Consequently, halons can be, and have been, replaced at relatively low cost in many applications. However, whilst all of the current alternatives have particular advantages, they also have one or more disadvantages. For example, they are often less effective on a weight-for-weight basis and toxicity of the extinguishants or their breakdown products may be a barrier to their adoption where persons need to be present in a protected space. As a result, further development of alternative substances and fire protection technologies is needed for some applications where it is not yet technically and economically feasible to replace the halons and for which, consequently, the halons continue to be necessary. In the Member States of the European Union and some other countries, these applications are termed "critical uses". The critical use applications vary with time, as alternatives are developed, and with location, due to the varying circumstances and fire protection practices in different countries.

1.3 In Member States of the European Union, the halons are listed as controlled substances in Group III of Annex I to Regulation (EC) No 1005/2009[1] on substances that deplete the ozone layer ("the Regulation"). Article 5(1) of the Regulation prohibits their production and Article 13(1) restricts their use[2] to certain critical use applications as set out in Annex VI to the Regulation. It also prohibits use of halons for non-critical halon applications; non-critical halon extinguishers and fire protection systems must be converted to alternatives or decommissioned[3]. Critical use applications can only be maintained using stocks of recovered, recycled and reclaimed halons from decommissioned extinguishers and fire protection systems or from authorised storage facilities. The Regulation also requires users of halons and owners and operators of equipment and facilities that require them to take all practicable precautionary measures to minimize emissions of the halons to the atmosphere and to recover them for recycling, reclamation, reuse or destruction when an extinguisher or fire protection system is decommissioned.

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:286:0001:0030:EN:PDF

[2] The term "use" has a defined meaning in the Regulation, which relates to the act of maintenance – the filling, refilling or topping-up – of, for example, an extinguisher with a halon. A "use of halon" in common language is often taken to mean the discharge of a halon extinguisher to extinguish a fire, or it describes the type and purpose of the extinguisher or the existence or the installation of an extinguisher. In this note, it is the intention that "use" has the first meaning; the description, occurrence, or fitting of the halon extinguisher or fire protection system is termed variously as "application", "implementation" or "installation". A critical use of halon would, therefore, be a use for the purpose of maintenance or installation of a halon critical use application as listed in the Annex.

[3] The ban on use of halons for non-critical applications, and the requirement for non-critical halon extinguishers and fire protection systems to be decommissioned, became effective from 31 December 2003, in accordance with Regulation (EC) No 2037/2000, the predecessor of the current Regulation.

1.4 Halon applications that are considered to be critical by Member States are found mainly in the following sectors: defence (primarily in ships and submarines, armoured vehicles, military aircraft and command centres), civil aviation (aircraft and airports); oil, gas and petrochemicals; and nuclear power. Halon fire protection systems remain in service also in some commercial cargo vessels, in communications facilities and in the Channel Tunnel infrastructure and railway rolling stock.

1.5 Article 13(2) of the Regulation requires the Commission to review the Annex VI. Pursuant to this requirement, the Commission has reviewed the current use of halons in Member States and the availability and implementation of alternative extinguishants and fire protection technologies, in consultation with the principle stakeholder groups. It concluded that Annex VI of the Regulation should be amended by describing each permitted critical use application in more detail, by establishing cut-off dates for all critical use applications in new equipment and facilities, and by establishing end dates for all critical use applications in all equipment[4] and facilities. The proposed changes reflect the latest technical developments in the areas of fire protection, notably the increased availability and implementation of alternative extinguishants or fire protection technologies, the progress in halon replacement made by Member States' governments and the industries concerned, and the varied technical, economic, logistical and regulatory barriers to halon replacement that exist across the different user sectors.

1.6 The Montreal Protocol's Scientific Assessment Panel calls on Parties[5] to reduce the remaining exempted uses of ozone depleting substances, including the uses of halons. Whilst production of halons for fire protection purposes has been phased out and continued uses are maintained with existing stocks or halon "banks", reducing halon emissions[6] by setting cut-off dates and end dates for those continued uses will play an important part in the recovery of the ozone layer. The proposed changes are therefore in line with the objectives of the Montreal Protocol and the Regulation and reflect the fact that halon use cannot continue indefinitely.

1.7 For the owners and operators of equipment and facilities that require halons, and the undertakings that recover, recycle, reclaim and supply halons to maintain the critical use applications, the draft new Annex VI will provide a more certain long-term regulatory framework within which to function, and will facilitate the planning for, and funding of, conversion or replacement programmes for the applications concerned. The changes should also reduce the potential for future shortages in availability of recycled or reclaimed halons for the critical uses as existing stocks are depleted. The Regulation provides two important safeguards to ensure that compliance does not result in excessive costs or adverse impacts on the operation of the equipment or facilities concerned. Article 13(2) requires the Commission to keep the new Annex VI under review to take account of progress, and Article 13(4) allows the Commission to authorise case-by-case derogations from the cut-off dates and end dates.

1.8 The draft new Annex VI, as agreed by the Committee on 23 March 2010, is reproduced at Appendix A. A copy of the current version of Annex VI is at Appendix B. Appendix C shows the correlation between the two. Appendix D lists, for each critical use application, examples of alternative substances or technologies that have been, or could potentially be, implemented for those applications.

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[4] The term "equipment" relates to the location of the halon extinguisher or halon fire protection system, and not to the extinguisher or fire protection system or its component parts.

[5] Scientific Assessment Panel 2006 report, executive summary, available at: http://ozone.unep.org/Assessment_Panels/SAP/Scientific_Assessment_2006/index.shtml.

[6] Estimated for all Member States to be approximately 500 ODP-tonnes per year.

2 The process related to the present review

The mandate for the present review

2.1 The Commission began its present review of halon critical uses in 2006 in accordance with Article 4(4)(iv) of Regulation (EC) No 2037/2000 of the European Parliament and of the Council on substances that deplete the ozone layer[7], which required the Commission to "review the Annex VII of critical uses of halons to that Regulation and, if necessary, adopt modifications and, where appropriate, time frames for phase out of critical use status, taking into account the availability of suitable alternative substances and technologies that are acceptable from the standpoint of environment and health". During the review, the Regulation (EC) No 2037/2000 was recast as Regulation (EC) No 1005/2009 and the review continued in accordance with Article 13(2) of Regulation (EC) No 1005/2009. The Annex VII to Regulation (EC) No 2037/2000 did not change, but became Annex VI to the Regulation (EC) No 1005/2009. The review therefore results in a proposal for amendments to the Annex VI of the (recast) Regulation (EC) No 1005/2009, by means of a Commission Regulation.

2.2 The draft new Annex VI will be adopted in accordance with the regulatory procedure with scrutiny of the European Parliament referred to in Article 25(3) of the Regulation, with the favourable opinion of a qualified majority of Member States in the Committee.

The objectives of the present review

2.3 The aims of the review of Annex VI were to:

(a) Facilitate a common understanding and interpretation across Member States of which halon applications constituted critical use applications;

(b) Ensure that all current critical use applications were included;

(c) Ensure that non-critical applications were excluded;

(d) Set a clear, realistic and achievable timetable for the conversion or replacement of all critical use applications;

(e) Provide a longer-term regulatory framework in which owners and operators of equipment and facilities that relied upon halons, and the suppliers of the halons, could operate.

Evidence and expertise supporting the present review and the draft new Annex VI

2.4 The Commission contracted consultants, ICF International, to study halon use and replacement and recommend improvements to the current Annex VI. The study focused initially on military applications but then considered also halon use and replacement in civilian applications.

2.5 Experts from Member States' defence ministries were consulted by ICF and provided information in support of the study. Opportunities were also provided to military experts to comment on the content and conclusions of the final ICF report[8] and to provide their comments on

[7] Official Journal of the European Communities, L 244, 29.9.2000, p.1

[8] *Review of halon Critical Uses specified in Annex VII of Regulation (EC) No 2037/2000 on substances that deplete the ozone layer*, European Commission, June 2007.

the emerging conclusions of the review. The Commission consulted relevant civilian stakeholder groups for their views on relevant recommendations, which were taken into account in developing the draft new Annex VI. Appendix E lists the organisations that were consulted. Finally, the Commission took into account the annual reports on halon critical uses submitted by Member States as a requirement of Article 14(4) of Regulation (EC) No 2037/2000, the reports of the UNEP Halons Technical Options Committee[9], progress made under the auspices of the United States Federal Aviation Administration's International Aircraft Systems Fire Protection Working Group, initiatives on halon replacement by the International Civil aviation Organisation, and information from other assessments and sources.

2.6 Member States' Committee representatives provided their preliminary views on emerging conclusions in the run-up to the presentation of the Commission draft and written comments on that draft. These comments were considered in the preparation of an amended draft which was presented to Member States at the end of 2009. Further comments were invited and these formed the basis for the final discussions of the Committee on 23 March 2010.

Terminology adopted for the present review

2.7 To deliver on the objectives of the review, notably to enable the setting of appropriate cut-off dates and end dates that reflect the level of technical and economic difficulty that halon replacement represents, the critical use applications[10] have been described in more detail according to the different types of application that exist.

2.8 For the draft new Annex VI, the critical use applications have been described first in terms of the category of equipment or facility concerned. All known halon applications could be allocated to eleven such categories:

(1) Military ground vehicles: Halons protect large numbers of armoured fighting vehicles such as tanks and personnel carriers, but the term "military ground vehicle" was most widely understood by defence experts of Member States;

(2) Military surface ships: Halons protect many larger warships and support vessels of Member States' navies, but also smaller vessels such as landing craft of other services of the armed forces, and the term "military surface ship" encompassed all such vessels;

(3) Military submarines: Halons protect machinery and other spaces of a few submarines operated by some Member States' navies;

(4) Aircraft: Halon extinguishers and fire protection systems protect virtually all military and civil aircraft and helicopters. It was found to be unnecessary (and indeed would have been problematic) to distinguish between them for the purposes of the new Annex VI. Although military and civil aircraft face different operational constraints and risks, and the former have additional halon systems as a result, the technical, logistical, regulatory and other issues that must be addressed in replacing the halons are similar;

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[9] A comprehensive description of current halon applications is available in the 2006 Assessment Report of the Technology and Economic Assessment Panel's Halons Technical Options Committee, available at: http://ozone.unep.org/teap/Reports/HTOC/2006_HTOC_Assessment_Report_2006.pdf.

[10] See also footnote 2.

(5) Oil, gas and petrochemicals facilities: Halons continue to be necessary for the safety of a few oil, gas and petrochemicals industry facilities where there is a risk of escape of flammable liquids and gases;

(6) Commercial cargo ships: Halon fire protection systems continue to protect some older cargo ships flagged to several Member States, though the majority of such uses are not consistent with the current description of the critical use application in the Annex;

(7) Land-based command and communications facilities: Halon extinguishers and fire protection systems protect a range of facilities operated by both governments (defence and civilian ministries) and commercial telecommunications companies;

(8) Airfields and airports: Halon extinguishers continue to be used for the protection of aircraft on the ground or for providing an emergency response to aircraft crashes at some military airfields and civil airports;

(9) Nuclear power and nuclear research facilities: Halons continue to be necessary to ensure the safety of some nuclear power stations and research reactors;

(10) Channel Tunnel. Halons continue to be used for applications protecting Channel Tunnel trains and some, primarily underground, technical facilities;

(11) Other applications: Halon portable extinguishers are utilised in a few miscellaneous applications by fire-fighters and police forces, primarily for the protection of personnel from flammable liquid projectiles during civil order disturbances.

2.9 Each category of equipment or facility has been subdivided according to the purpose of the halon extinguisher or fire protection system. For many categories of equipment or facility, the halon applications serve a range of purposes, protecting against fire or explosion in different high risk compartments, locations or circumstances. The feasibility of replacement or conversion of these extinguishers or systems may be different for each of the applications, so they should be identified and described separately.

2.10 The majority of the critical use applications are intended for the extinguishing of fires. However, in one or two cases (in the F-16 fighter aircraft, in some petroleum industry facilities and in a few cargo ships), the halons are required for pre-emptive inerting of compartments or spaces to *prevent* fire or explosion. Since inerting systems[11] usually require a higher concentration of halons per unit volume of protected space, and because the majority of the gaseous alternatives are inherently less effective inerting agents on a weight or volume basis than the halons, the implementation of halon alternatives for inerting applications is potentially more challenging than for extinguishing applications and they should therefore be distinguished.

2.11 Some protected spaces that are normally-occupied or normally-unoccupied have also been distinguished. The inherent toxicity of some gaseous alternatives at their design concentration, the properties of not-in-kind alternatives such as powder extinguishants, and the potential levels of hazardous combustion by-products, may preclude the adoption of some alternatives in a normally-

[11] An inerting system is one that is designed to prevent the initiation of combustion of a flammable or explosive atmosphere by means of the addition of an inhibiting or diluting agent. It is activated by or after the detection of a flammable or explosive atmosphere or to prevent a fire or an explosion occuring. An extinguishing system is one designed to eliminate combustion after it has been initiated, and it is activated by or after the detection of smoke, flame or heat.

occupied space without substantial redesign of the equipment or facility concerned. The number of options for a normally-occupied space may therefore be more limited and the modifications necessary to accommodate them may be more substantial. The two types of application should therefore be distinguished.

2.12 The critical use applications have then been further subdivided by describing them in terms of the type of fire extinguisher concerned. Portable halon extinguishers (whether hand-held or wheel-mounted) have been distinguished from fixed halon fire protection systems because, generally, it is significantly easier (technically and economically) to replace halon portable extinguishers than fixed halon fire protection systems. This is normally because the distribution pipe work associated with halon systems might need to be modified or replaced, and this may entail additional engineering work within the protected space which can, in some cases, be substantial.

2.13 Finally, each critical use application has been described in terms of the type of halon, whether halon 1301, halon 1211 or halon 2402. The type of halon chosen for any particular application will usually depend upon its physical properties and toxicity, and the historical production and marketing patterns across different Member States. Halon 1301 has been the extinguishant of choice for the majority of fixed fire extinguishing systems and for all inerting systems; it was rarely chosen for portable extinguishers because of its poor "streaming" properties. Halon 1211 has been the extinguishant of choice for some fixed fire extinguishing systems protecting smaller, normally-unoccupied compartments or spaces, particularly in older equipment, and for the large majority of portable extinguisher applications. Halon 2402 was the extinguishant of choice in older military equipment and aircraft of former Soviet Union design and construction. The type of halon does not significantly affect the feasibility of replacing the fire protection system or extinguisher concerned, which is dependent more upon the nature and properties of the protected space and the fire risks that are present.

2.14 In determining the practicality of setting a phase out timetable for the critical use applications it was found necessary to distinguish new equipment and new facilities from existing equipment and existing facilities and those that are, or will be, built to an existing design that required halons[12]. Because, at present, a greater quantity of alternative gaseous extinguishant is often required for effective fire extinguishing performance, the additional or larger cylinders necessary can more easily be accommodated when designing and building equipment or facilities to incorporate them. Conversion or replacement of halon systems in existing equipment or facilities (often termed "retrofitting") can be significantly more difficult (technically and economically) if sufficient space is unavailable, if additional weight is unacceptable, or if opportunities for re-engineering of the protected space are limited. For non-gaseous alternatives, different issues may arise, but substantial modifications (for example to extinguishant distribution systems) may be necessary to convert an existing system. The distinction is reflected in the draft new Annex VI by means of cut-off dates for halon critical use applications in new equipment and new facilities and end dates for critical use applications of halons in all equipment and facilities that have been designed and built with halon extinguishers and fire protection systems.

2.15 The current applications of halons are discussed below, in these terms. The definition of some of the terms, in particular concerning "new equipment" and "new facilities", was found to be both complex and crucial in the development of the draft new Annex VI. These aspects are discussed in more detail in Section 4 (paragraphs 4.5 – 4.8).

[12] Reference to "existing" in this note is intended to include equipment that is in the process of, or will be, manufactured to an existing design that incorporates halon extinguishers or fire protection systems. It is also intended to include equipment that is procured second-hand even though it may be "new" to the owner or operator.

2.16 In considering the feasibility of halon replacement, the Commission considered that alternatives were available if one or both of the following conditions was met:

(a) Marketed alternative substances or technologies had been implemented for the application concerned in a range of types of equipment or facility in one or more Member State or elsewhere;

(b) Marketed alternative substances or technologies had been demonstrated to perform as well as or better than the halons for the application concerned.

3 Assessment of current halon applications and the availability of alternative substances and technologies

Overview of current halon applications in Member States

3.1 Halon applications in Member States are summarised in Table 1, which shows the estimated installed quantities in metric tonnes in 2005/6, based upon Member States' reports and the ICF study.

3.2 The most significant applications, in terms of installed quantities (but not necessarily in terms of quantities used or emitted to the atmosphere) are in military vehicles, naval vessels, civil aviation and commercial shipping. However, there is also a significant quantity installed in a range of other applications that are considered by Member States to be covered by the current Annex VI.

Current halon applications and the availability of alternative substances and technologies, by category of equipment or facility

Military ground vehicles (Category 1)[13]

3.3 This category of equipment describes the largest single installed quantity of halons. The halons are found in three separate applications:

Engine compartment fixed systems (1.1);

Crew compartment fixed systems (1.2); and

Crew compartment portable extinguishers (1.3).

3.4 All are fire extinguishing applications. Most of the halons are installed in engine compartment systems (1.1), with fewer vehicles fitted with crew compartment fixed systems (1.2) or portable extinguishers (1.3). The crew compartment fixed systems are usually rapid response detection and discharge systems intended to prevent an explosion in the event of ignition of flammable vapours in the compartment. In many vehicles used in combat, crew must be able to remain in the vehicle during and after extinguishant discharge and the vehicle must, wherever possible, be able to continue its mission.

[13] The number in brackets associated with each application correlates with its description in the draft new Annex VI, as outlined in Appendix A to this document.

Table 1 - Estimated installed quantities (in metric tonnes) of halons in EU Member States[14]					
Applications	**Halon 1211**	**Halon 1301**	**Halon 2402**	**Total[15]**	**Percentage**
Military applications					
Ground Vehicles	200	125	20	**345**	28%
Surface Ships	10	270	1	**280**	23%
Submarines	–	5	–	**5**	<1%
Aircraft	20	15	2	**35**	3%
Other military[16]	15	50	1	**65**	5%
Civil applications					
Aircraft	30	140	1	**170**	14%
Oil/Petrochemical	–	20	–	**20**	2%
Cargo Ships	–	135	40	**175**	14%
Command and communications facilities	–	15	5	**20**	2%
Other civil[17]	10	115	–	**125**	10%
Total[7]	**285**	**890**	**70**	**1245**	100%

3.5 Alternative extinguishants are now available for all critical use applications in new designs of military ground vehicles and the Commission is not aware of any vehicles being developed with halon systems on board. The alternatives most commonly adopted are fluorocarbon or dry chemical extinguishants. Some Member States have replaced, or are replacing, halons in engine compartments (1.1) and portable extinguishers (1.3) on existing vehicles and some Member States have deactivated crew compartment halon systems (1.2) in some existing vehicles. Retrofit of existing systems and extinguishers is therefore likely to be feasible in most cases, given reasonable

[14] Data in Table 1 are based upon those reported for 2005 in the ICF Study, footnote reference (8), except for cargo ships and the oil/petrochemical sector, which are based upon data reported for 2006 by Member States. The figures reported here should be regarded as indicative only. Data for 2007 and 2008 were also taken into account. Whilst these present a similar picture, the quantities installed in cargo ships have reduced significantly as a result of continued efforts by Member States to ensure compliance and the quantities installed in aircraft and some military applications have increased with improved reporting.

[15] Data in Table 1 are rounded so totals may differ from the sum of their components.

[16] The applications included in Table 1 under "other military" are primarily those in military command centres and at military airfields and are described further in paragraphs 3.35 – 3.42.

[17] The applications included in Table 1 under "other civil" are primarily those at civilian airports and nuclear power stations, those that protect the Channel Tunnel, and portable extinguishers utilised by police forces. They are described in more detail in paragraphs 3.39 – 3.49.

time for implementation as part of planned refit programmes. However, in a few cases it may not be feasible to retrofit crew compartment fixed systems or portable extinguishers because of the potential hazards to crew from release of alternative extinguishants in the very confined spaces involved and in these cases halons may be necessary until the end of life of the vehicles concerned. Some Member States reported that it would not be feasible for them to replace halons in engine compartment systems, especially in older vehicles of ex-Soviet design, because of space constraints within the compartments.

Military surface ships (Category 2)

3.6 This category of equipment represents the second largest installed quantity of halons. There is a large number of different applications, depending upon the type of ship and varying naval architecture standards across Member States. The applications have been described as follows, although not all applications exist in all vessels or in all Member States:

Normally-occupied machinery space fixed systems (2.1);

Normally-unoccupied engine space fixed systems (2.2);

Normally-unoccupied electrical compartment fixed systems (2.3);

Vessel command centre fixed systems (2.4);

Fuel pump room fixed systems (2.5);

Flammable liquid storeroom fixed systems (2.6); and

Portable extinguishers used to protect aircraft in ship hangar spaces and maintenance areas (flight line extinguishers) (2.7).

3.7 All are fire extinguishing applications. Whilst operational procedures vary in different Member States, in a significant number of cases military ship machinery spaces and command centres must be able to continue to function during combat, with crew remaining in place and able to perform their duties during and after the discharge of the extinguishant. In other cases, these spaces may be evacuated during discharge of the extinguishant but the relatively low toxicity of halon 1301 allows a quick return of personnel to their posts.

3.8 Alternatives are now available for all critical use applications in new military surface ships and the Commission is not aware of any vessels being designed or built with halons on board. The alternatives most commonly adopted are fluorocarbons, water spray, foam and carbon dioxide. A few Member States have replaced, or are replacing, halons in the critical use applications in some existing vessels. Fluorocarbons and foam systems have been most commonly adopted in these cases. More generally, it should now be possible to replace halon portable extinguishers in the hangar spaces or aircraft maintenance areas of existing vessels (2.7) with minimal re-engineering of the protected spaces. Retrofit of halon systems in normally-occupied spaces of existing vessels with relatively low fire risks, such as command centres (2.4), or smaller normally-unoccupied spaces such as engine spaces (2.2), fuel pump rooms (2.5), flammable liquid storage compartments (2.6) and electrical compartments (2.3), is considered to be feasible, given reasonable time for the implementation of alternatives as part of planned refit programmes. Retrofit of systems protecting the machinery spaces of vessels that must remain occupied during combat (2.1), and which face high fire risks from release of flammable liquids due to equipment failure or battle damage, is likely

not yet to be feasible in many cases. This is because of constraints related to space or weight, the performance and safety of available alternatives, or other engineering obstacles.

Military submarines (Category 3)

3.9 A few Member States operate military submarines with halon systems that protect:

Machinery spaces (3.1);

Command centres (3.2);

Diesel generator spaces (3.3); and

Electrical compartments (3.4).

Because of the vessels' enclosed environment, halons are not ideal and alternative fire protection methods have often been adopted. The number of vessels and the total installed quantities and emissions of halons are small.

3.10 Alternative extinguishants or fire protection technologies are available for all critical use applications in new military submarines and the Commission is not aware of any vessels being designed or built with halon fire protection systems on board. No Member States have replaced, or are replacing, any halon systems in existing submarines. In all cases, retrofit of halon systems in existing submarines is considered not yet to be feasible. This is because of constraints related to space or weight; the performance and safety of the available alternatives; engineering obstacles which may be insurmountable if conversion requires the installation of a new system in a sealed hull; and high conversion costs for a very small environmental benefit. Use of halons is therefore likely to be necessary for these applications until the end of life of the vessels concerned.

Aircraft (Category 4)

3.11 Halon applications on aircraft comprise:

Cargo compartment fixed systems (4.1);

Crew compartment and cabin portable extinguishers (4.2);

Engine nacelle and auxiliary power unit fixed systems (4.3);

Fuel tank inerting fixed systems (military aircraft only) (4.4);

Lavatory waste receptacle fixed systems (4.5); and

Dry bay fixed systems (military aircraft only) (4.6).

3.12 Halon applications in military and civilian aircraft (both fixed-wing and rotary-wing) are broadly similar, technologically, though some differences and additional applications exist to counter the greater potential fire threats faced by combat aircraft. Because of the rationalisation of the aerospace industry, an industry and user desire for common standards, and the increasing tendency of military organisations to buy modified civil aircraft for pilot training and transportation of goods and personnel (or even to hire a service capability rather than to buy a fleet of aircraft),

military and civil aircraft are not differentiated in the draft new Annex VI. However, the status of halon replacement in the two areas is different and so each is described here in turn.

3.13 The fuel tank inerting (4.4) and dry bay (4.6) fixed systems are unique to military combat aircraft. The fuel tank inerting systems are confined, in Member States, to the F-16 fighter aircraft. The systems are activated by the pilot when the aircraft enters a combat zone. The halon is fed into the fuel tank and inerts the space above the fuel, preventing potential ignition of the fuel vapour if the tank is damaged. The halon is emitted to atmosphere when the fuel tank is refilled. In most Member States that operate this type of aircraft, the halon system is not activated during non-combat flights. Dry bay fixed systems are present on a range of combat and transport aircraft and helicopters. They protect the compartments that surround the fuel tanks, so that any fire caused by ignition of fuel leaking from those tanks is very rapidly extinguished.

3.14 In general, new military aircraft are being designed and built without halon portable extinguishers or fire protection systems. There are an important number of cases where halon extinguishers and fire protection systems continue to be installed in new aircraft being produced to existing or modified designs, or in accordance with civilian standards. Nevertheless, fluorocarbon alternatives, primarily HFC-125, HFC-227ea and HFC-236fa are available which meet the aircraft manufacturers' and operators' minimum performance standards for all applications except for the protection of cargo compartments (4.1), where research and development continues in collaboration with the civil aviation sector. However, for protection of cargo compartments, dry bays and fuel tanks in new military aircraft, alternative technologies and safety procedures exist so that an in-kind gaseous alternative extinguishant will usually no longer be necessary. No barriers exist to replacing the lavatory waste receptacle systems in new aircraft. Some additional costs and performance penalties may be incurred in replacing halon extinguishers in other applications.

3.15 There have been some reported instances of the replacement of halon portable extinguishers in existing military aircraft, but this is exceptional. There have been no reported cases of retrofit of any military aircraft fixed fire protection systems. However, replacement of halon portable extinguishers and lavatory waste receptacle systems in existing aircraft is considered to be technically and economically feasible, given reasonable time to complete the necessary design authority and regulatory approvals and the conversion work as part of routine maintenance programmes. Retrofit of engine nacelle, fuel tank inerting, dry bay or cargo compartment systems in existing military aircraft is considered not yet to be feasible. This is because of constraints related to space and weight, the performance and physical properties of the available alternatives, other engineering obstacles, and the absence of design and regulatory authority agreement, all of which may lead to disproportionate costs.

3.16 The quantities of halons installed in civil aircraft are the largest of all remaining civil applications of halons. Furthermore, the quantities are increasing in both absolute and relative terms because of the continual expansion in the volume of air traffic and the apparent lack of progress being made in halon replacement in comparison to other sectors.

3.17 Civil aviation is a highly regulated global business governed, *inter alia*, by the Chicago Convention, with common minimum standards established through the International Civil Aviation Organisation (ICAO). International agreement on the choices of alternatives to halons, and any initiatives for their introduction, is considered by industry representatives to be very important. Substantial technical challenges must be overcome for halons to be replaced in some applications and the potential costs of implementing alternatives are likely, in some cases, to be high. Replacement of halons requires certification of the alternatives for each aircraft type before implementation can begin. There are numerous different players – including aircraft manufacturers, fire extinguisher and fire protection system suppliers, aircraft operators, extinguishant suppliers and

aviation regulators – that must all act in a coordinated manner. These are all major barriers to progress, which has been limited, so far, to the development and agreement of minimum performance standards and the marketing of alternatives for two of the four aircraft applications. Without substantial further progress, the industry will remain reliant on finite and reducing supplies of halons for at least the next 50 years.

3.18 With few exceptions, new civil aircraft are still being designed and built with halon portable extinguishers and fixed fire extinguishing systems on board. However, two fluorocarbon alternatives (HFC-227ea and HFC-236fa) which meet sector-agreed minimum performance standards are currently commercially available for crew compartment and cabin portable extinguishers (4.2) and lavatory waste receptacle fixed systems (4.5). No technical or economic barriers exist to replacing the halon lavatory waste receptacle systems in new aircraft. At least one European aircraft manufacturer is now supplying new production aircraft with HFC-236fa lavatory extinguishing systems. Some additional costs would be incurred in replacing halon cabin portable extinguishers in new designs of aircraft. The current commercially-available alternative portable extinguishers that utilise these two substances are larger and heavier than the halon equivalent, and their adoption would likely require additional training for cabin crew. However, whilst they are considered by the Commission to be feasible options for this application, in the absence of any requests for certification by airlines or aircraft manufacturers, they have not yet been assessed and certified as providing the required level of safety for any type of aircraft. In the absence of a regulatory incentive, this "catch-22" situation is unlikely to change. Concerns have been expressed by aviation industry representatives that the additional weight of the extinguishers is unacceptable. The Commission is not persuaded that the additional weight would be significant, but other more effective extinguishants may also prove to be suitable alternatives if they were to be submitted for minimum performance standard testing.

3.19 Commensurate with the level of technical difficulty, and in the absence of a suitable policy framework, progress has been relatively slow in identifying suitable alternatives for halon fixed systems protecting engine nacelle and auxiliary power units (4.3) of new aircraft. A minimum performance standard has been developed which is suitable for international agreement for the engine and auxiliary power unit system, but this is under review with the intention of making it applicable to not-in-kind (i.e. non-halon-like) alternative technologies such as aerosols, inert gas generators and powders. Research and development therefore continues. However, there are a few promising candidate substances for this application and it is considered reasonable that one or more alternatives will be demonstrated to be suitable within one to two years for engine nacelle and auxiliary power unit fixed systems. At least one European aircraft manufacturer has stated that it intends to install an alternative extinguishant for the engine nacelle application in its next aircraft type which is currently under development. The alternative extinguishant has successfully completed each of the MPS tests and development of the agent delivery technology continues.

3.20 The identification and development of an alternative extinguishant or fire protection technology for the aircraft cargo compartment application (4.1) has proven, arguably, to be more difficult than for any other application. A series of fire tests has been developed to simulate the wide range of potential fires (involving flammable liquids or solids, caused by exploding aerosol containers, or whether smouldering and deep-seated or flaming) which must be contained (though not necessarily extinguished) for extended periods of up to several hours. However, agreement has not yet been reached on which tests should form part of the minimum performance standard requirement. No alternative substance or technology has yet been demonstrated to perform as well as halon 1301 in all the tests. One alternative, based upon fine water spray, has met the requirements for all but one test (for exploding aerosol cans), but a fire protection system based on this would come with a substantial weight penalty. Consequently, for the cargo compartment application, international agreement on the final form of the minimum performance standard and

further research and development of potential alternatives are necessary. Currently, therefore, alternatives are not yet available for new types of aircraft. However, there has been little effort devoted to this task in recent years and this situation is unlikely to change without a regulatory incentive.

3.21 The International Civil Aviation Organisation (ICAO) is in the process of mandating the replacement of halons in lavatories, portable extinguishers, engine nacelles and auxiliary power units in new aircraft being submitted for type certification "in the 2011 timeframe", in accordance with ICAO Assembly Resolution A36-12 of 2007[18]. The Resolution includes an additional requirement for the implementation in new production aircraft of alternatives for lavatory and portable extinguishers "in the 2011 and 2014 timeframes respectively". The ICAO secretariat held a coordination meeting at the beginning of December 2009 to review the feasibility and timetable for implementing the Resolution, through changes to the Annexes of the ICAO Standards and Recommended Practices (SARP). The meeting concluded that the Resolution should not be changed significantly and the timetable should broadly stand. However, because of delays in addressing this issue, the implementation of the Resolution for new aircraft being submitted for type certification, through changes to the Annex 8, would not be enforceable until November 2014, because of a three-year transition period enshrined in the Chicago Convention for this Annex. This delay would, therefore, be reflected in a change of the "2011 timeframe" for portable extinguishers and engine nacelles to a "2014 timeframe". After the meeting, the aviation industry, represented by the International Coordinating Council of Aerospace Industries Associations (ICCAIA), stated that it could accept a mandate to replace halon portable extinguishers in all new production aircraft from 2016, arguing that the extra two years would allow it to develop and introduce extinguishers based on 2-bromotrifluoropropene, which preliminary testing had indicated was more effective than the HFC alternatives. It is likely that this proposal will be accepted and the ICAO secretariat will amend the Annex 6 to the Chicago Convention to mandate the replacement of halons in lavatories of new production aircraft by November 2011, and in portable extinguishers in new production aircraft[19] by November 2016.

3.22 The concept of cut-off dates in the draft new Annex VI mirrors the ICAO Resolution's focus on new aircraft being submitted for type certification, but there are no equivalent measures in the Annex VI relating to "new production aircraft". The ICAO Resolution does not address the cargo compartment application, though the December coordination meeting concluded that ICAO should assess potential measures for this application also. The Commission's intention has been to align, where appropriate, the cut-off dates in the new Annex VI with the timetable for halon replacement in the ICAO Resolution. The Commission believes that it is technically and economically feasible for aircraft manufacturers to implement alternatives in line with the Resolution's timetable and has accepted cut-off dates of 2014 for the portable extinguisher and engine applications to align the likely ICAO and EU rules as much as possible.

3.23 The draft new Annex VI includes a cut-off date which would require the implementation of an alternative extinguishant or fire protection technology for the cargo compartment application in new aircraft being submitted for type certification after 2018. The Commission considers this to be necessary in order to incentivise research and development work for this important application. Progress will be monitored closely and the date will be kept under review.

3.24 The European Aviation Safety Agency (EASA), the authority responsible for regulating the European civil aviation industry and for the airworthiness certification of aircraft flown by

[18] ICAO Resolution A36-12 can be viewed at: http://www.icao.int/icao/en/assembl/a36/docs/A36_res_prov_en.pdf.

[19] Aircraft being manufactured to an existing type certification.

European airlines[20], is supportive in principle of a draft new Annex VI along these lines, based upon the ICAO Resolution and with the additional cut-off date for the cargo compartment application in new designs of aircraft, provided the alternative substances or technologies can deliver an equivalent (or better) level of safety and provided the cut-off dates are kept under review to take account of progress in the development and implementation of alternatives.

3.25 There have been some reports that some airlines are replacing lavatory waste receptacle halon systems in existing civil aircraft with fluorocarbon (HFC-236fa and HFC-227ea) alternatives when the systems are subject to routine maintenance. Wider implementation of alternative lavatory extinguishers based upon these substances would face no significant barriers, since they are comparable in cost, performance, weight and volume. Replacement of halon lavatory waste receptacle systems in existing aircraft is therefore considered to be technically and economically feasible, given reasonable time to complete the necessary certifications and implement the replacements as part of routine maintenance activities.

3.26 There have been no reported cases of retrofit of halon portable extinguishers in existing civil aircraft. The commercially-available alternative HFC-based portable extinguishers are heavier and bulkier than the halon extinguishers. Their implementation in existing aircraft would therefore likely require modifications to mounting brackets or, in some cases, locations. However, these are considered not to be insurmountable barriers and replacement of halon portable extinguishers in existing aircraft is considered to be technically and economically feasible, given reasonable time to complete the necessary certifications and implement alternatives as part of routine maintenance activities. Furthermore, other alternatives, not yet commercialised, show promising performance potential and, if found suitable, may reduce any space, weight, or cost penalties.

3.27 Retrofit of engine nacelle and cargo compartment halon systems in existing civil aircraft, or those aircraft that are being, or will be, produced to existing type certificates, is considered not yet to be feasible. This is because there are no alternative substances or technologies on the market that have yet been demonstrated to meet performance and other requirements for current aircraft types. Constraints related to space and weight, the performance, toxicity and physical properties of current alternative extinguishants, other engineering obstacles, and the absence of manufacturer and regulatory authority approval would all likely preclude their implementation. Without further development of alternative substances or technologies, use of halons for fire extinguishing systems in civil aircraft for these applications may be necessary until the end of life of the aircraft concerned.

3.28 The major aircraft manufacturers and aviation fire protection companies are researching and developing better alternative extinguishants and fire protection technologies, and in some cases

[20] The Regulation and the Annex VI would be applicable to aircraft that are:

(a) registered in the Community; or

(b) registered in a third country and used by an operator for which a Member State ensures oversight of operations

in accordance with Article 4 of Regulation (EC) No 216/2008 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:079:0001:0049:EN:PDF).

The Annex VI would, in essence therefore, be applicable to aircraft manufactured for and operated by Member States' airlines, but would not apply to most aircraft operated by non-european airlines flying aircraft into and out of the Member States.

submitting them for testing by the regulatory authorities[21]. This work may deliver additional options in the medium term.

3.29 ICAO recognises that much more needs to be done on halon replacement in civil aircraft and in the Resolution A36-12 mentioned above has urged its member states to advise aircraft manufacturers, airlines, chemical suppliers and fire-extinguishing companies to move forward at a faster rate in implementing halon alternatives in handheld extinguishers, lavatories, engine nacelles and auxiliary power units. However, there is currently no ICAO or other international initiative that specifically mandates halon replacement in existing aircraft fleets. EASA is, however, supportive in principle of the end dates as set out in the draft new Annex VI, provided alternative substances or technologies delivering an equivalent (or better) level of safety can be implemented in time and provided, therefore, that the end dates are kept under review to take account of progress.

Oil, gas and petrochemicals facilities (Category 5)

3.30 Halon fire extinguishing and inerting systems were widely adopted in oil, gas and petrochemical production and processing facilities to protect both normally-occupied and normally-unoccupied spaces where there was a risk of fire and explosion from the release of flammable hydrocarbon gases and liquids. Both types of system are safety-critical and adequate time must be allowed for replacement. The industry has made significant progress in halon replacement such that remaining use and installed quantities of halons are now relatively small.

3.31 Alternatives are available for all critical use applications in new facilities, which are not being designed or built with halon systems. The industry in most Member States has replaced, or is replacing, halons in many fire protection applications in existing facilities. Replacement of all remaining halon systems is considered to be feasible, given sufficient time to complete conversion work. However, in a few instances, retrofit of both extinguishing and inerting systems in existing facilities may not be economically feasible, notably for a few remaining installations that are close to the end of their economic lifetime. The halon fire protection systems may be necessary until the end of life of the facilities concerned.

Cargo ships (Category 6)

3.32 Historically, halon fire extinguishing systems have protected machinery spaces and engine compartments of passenger and cargo ships and, to a much lesser extent, inerting systems have protected certain compartments of ships that carry flammable liquids, gases and fine particulate materials (6.1). Cargo ship inerting system applications are now likely to be rare. Those that protect normally-occupied spaces, as described in the current Annex VI, will be rarer still and may no longer exist. The Commission and many Member States have maintained the view that fire extinguishing systems in machinery spaces and engine compartments of cargo ships are not critical use applications, but a few Member States have interpreted the Annex VI description wrongly to include such systems. Consequently, there is still a quantity of halons installed in machinery and engine space fire extinguishing systems on cargo ships registered in a few Member States. Such systems should have been decommissioned by the end of 2003 and infringement proceedings are underway in several cases where engine room fire extinguishing systems have not yet been converted.

3.33 Non-halon extinguishants and fire protection technologies are available for all new cargo ships, whether for inerting or extinguishing applications. For inerting applications, alternative

[21] The latest initiatives and status of collaborative alternatives work for the aviation sector are reported by the Federal Aviation Administration at: http://www.fire.tc.faa.gov/systems.asp.

technologies that minimise the potential for build-up of explosive atmospheres are now routinely adopted. For extinguishing applications, the most commonly adopted alternative is carbon dioxide but HFCs such as HFC-227ea and fine water spray systems are also being installed. New cargo ships are not being designed or built with halons because the International Maritime Organisation's SOLAS Convention[22] has prohibited halon fire extinguishing systems in new vessels since October 1994.

3.34 The majority of Member States have replaced all halon fire extinguishing systems in existing vessels. Conversion or replacement of any remaining systems is considered to be feasible and, since this application is not a critical use, should be completed at the earliest opportunity to ensure compliance. Retrofit of remaining inerting systems is likely to be more challenging, and may not always to be feasible because of constraints related to space, performance and safety of the available alternatives and the economic viability of conversion of these older vessels. Halon inerting systems may therefore be necessary until the end of useful life of the vessels concerned.

Land-based command and communications facilities (Category 7)

3.35 Command centres and communications facilities operated by military and civil authorities and communications companies, which Member States consider to be essential for national security, have often been equipped with halon portable extinguishers and fixed fire protection systems. The applications which remain can be described as:

Portable extinguishers protecting normally-occupied spaces (7.1);

Fixed systems protecting normally-occupied spaces (7.2); and

Fixed systems protecting normally-unoccupied spaces (7.3).

3.36 Some Member States have reported that portable extinguishers in some computer facilities comply with this description. The Commission would disagree. Halon system applications in this category range from protecting computer rooms in command centres to protecting electronics cabinets in radio communications towers. None of the applications is an inerting system, and though many protected spaces *can* be occupied at certain times, they are not in *normally*-occupied spaces. It can be argued, therefore, that most of the remaining applications of halons in these facilities do not strictly match the current description of the critical use application in the Annex VI. There has been considerable variation amongst Member States in the rigour with which the term has been interpreted.

3.37 Alternatives are available to meet fire protection needs in new command and communications facilities. The Commission is not aware of any new facilities which are now being designed or built with halon fire protection systems. Many Member States have replaced halon portable extinguishers and fire protection systems in the above applications in existing facilities, but an important quantity still remains in applications which it is now considered feasible to convert, given reasonable time. The magnitude of the challenge ranges from portable extinguishers (7.3) where minimal barriers to replacement exist, to fixed systems in normally-occupied spaces (7.1) where substantial economic barriers may exist.

3.38 There is normally no difference in the feasibility of conversion between military- and civilian-operated facilities and so the draft new Annex VI does not differentiate between them.

[22] International Convention for the Safety of Life at Sea (SOLAS), "Fire extinguishing systems using Halon 1211, 1301 and 2402 and perfluorocarbons shall be prohibited", Regulation 10, Paragraph 4.1.3, Chapter II-2.

However, the conversion of some underground military command centre fixed systems may potentially be difficult and expensive. Furthermore, at least one Member State has reported that it has a very large number of military command centres protected by halon systems, the conversion programme for which was not scheduled for completion until 2025.

Airfields and airports (Category 8)

3.39 Some military and civil airfields and airports are equipped with halon 1211 portable (including vehicle- and wheel-mounted) extinguishers to extinguish fires resulting from aircraft crashes or on aircraft undergoing maintenance or being prepared for flight. These applications can be described as:

On crash rescue vehicles (8.1); and

Portable extinguishers protecting hangars and maintenance areas (8.2).

3.40 New crash rescue vehicles (8.1) and portable extinguishers (also known as flight line extinguishers, especially at military airfields) (8.2), are available with suitable alternative extinguishants. Halons are not now necessary in these applications, though there has been at least one recent instance of procurement of new crash rescue vehicles equipped with halon extinguishers at a civil airport. In most Member States, the replacement equipment utilises foam, carbon dioxide or dry chemical extinguishants.

3.41 Conversion of existing crash rescue vehicles fitted with halon extinguishers would result in some additional cost, but is considered to be feasible given reasonable time for implementation.

3.42 The replacement of halon 1211 military flight line extinguishers is considered by a few Member States to be problematic. Some combat aircraft with engine afterburners are prone on start-up to flash ignition of flammable liquids that have pooled in the engine nacelles. The military requirement is that such fires are rapidly extinguished so that the aircraft can continue its take-off and mission. The certification of suitable alternatives by the aircraft manufacturer, especially when that manufacturer is outside the EU, is cited as a particular barrier to progress. However, it is considered that clean agent alternatives are available to meet this requirement, given reasonable time to verify their suitability and performance and obtain the necessary design authority approvals.

Nuclear power and nuclear research facilities (Category 9)

3.43 The majority of halon extinguishers considered by a few Member States to be critical under the current definition "*for the making inert of spaces where there may be a risk of dispersion of radioactive matter*" relate to conventional halon fire extinguishing systems protecting control rooms and computer rooms of nuclear power stations. There are also some examples of research reactors which have halon fire extinguishing systems in control rooms or reactor spaces. None of these systems is known to be an inerting system. An amended description is therefore proposed:

Systems protecting spaces where necessary to minimise risk of dispersion of radioactive matter (9.1).

3.44 Alternative extinguishants are available for all new nuclear facilities and the Commission is not aware of halon extinguishers being installed for this application. The majority of existing nuclear power station halon systems have been, or are being, converted to fluorocarbon or inert gas extinguishants. It is considered feasible to convert those that remain, given reasonable time for the

work to be completed as part of routine maintenance procedures and taking due account of the importance of the halon systems for the safety of the facilities concerned.

The Channel Tunnel (Category 10)

3.45 Halon systems protect some technical facilities within the Channel Tunnel and the power cars and shuttle wagons of the freight and passenger trains that use it. The systems can therefore be described as:

Systems protecting technical facilities of the Channel Tunnel (10.1); and

Systems protecting the power cars and shuttle wagons of Channel Tunnel trains (10.2).

All other halon systems and portable extinguishers that were installed in facilities and rolling stock connected with the Channel Tunnel have been replaced by the companies concerned. Halons are no longer necessary in new trains and new technical facilities and no new systems are being procured.

3.46 The replacement of the halon systems that protect the technical facilities of the Channel Tunnel, many of them underground, is considered to be feasible given reasonable time. Inert gas and fluorocarbon extinguishants may be the most suitable options. Suitable alternatives have not yet been identified for the power car and shuttle wagon applications on existing rolling stock, because of constraints related to space and the performance and physical properties of potential alternatives. Further research and reasonable time may therefore be necessary to identify and implement a replacement.

Other applications (Category 11)

3.47 Other halon critical use applications reported by Member States can be described as follows:

For initial extinguishing by fire brigades where essential to personal safety (11.1); and

Portable extinguishers intended for protection of persons by military and police personnel (11.2).

3.48 There has been considerable variation amongst Member States in the rigour with which the current definition "*in fire extinguishers essential to personal safety and used for initial extinguishing by fire brigades*" has been interpreted. The majority of applications reported under this definition relate to the airfield and airport applications (8.1) and (8.2) as described above. However, there is continued use of extinguishers in some Member States for applications which the Commission and many other Member States consider no longer to be critical use applications. An example is the use of portable halon extinguishers to extinguish fires at pit-stops at motor racing circuits. It is proposed that the application in the current Annex VI is retained as (11.1) for a limited period to allow reasonable time for halon extinguishers for these miscellaneous applications to be replaced in the Member States concerned.

3.49 Some police and other security personnel in a few Member States carry halon 1211 belt-mounted portable extinguishers for protection of persons (11.2) in circumstances where they may come under attack from flammable liquid projectiles such as "Molotov cocktails". One Member State has reported that its police authority has not yet been able to identify a suitable alternative for this application. However, alternatives such as dry chemical, foam or fluorocarbon extinguishers, though not providing an ideal combination of properties, may prove to be suitable options and could be introduced relatively quickly after appropriate training of personnel.

4 Conclusions of present Annex VI review

4.1 The review has shown that:

(a) There is some variation across Member States in the interpretation of which halon applications constitute critical use applications as listed in the current Annex and considerable variation in the rate of progress being made in the implementation of alternative substances and technologies;

(b) With few exceptions, halons are no longer necessary to meet fire protection needs in new designs of equipment and new facilities and alternatives can now routinely be implemented. However, halon extinguishers and fire protection systems continue to be necessary in some equipment that is, or will continue to be, produced to existing designs;

(c) In a range of existing equipment and existing facilities, halon extinguishers and fire protection systems in critical use applications have already, or are in the process of being, converted to, or replaced by, alternative substances or technologies;

(d) In some cases, both for new and existing equipment and facilities, halons in some critical use applications are not being replaced even though it is now considered to be technically and economically feasible to do so;

(e) In some existing equipment, the conversion or replacement of halons in some critical use applications remains particularly challenging and is considered not yet to be technically and economically feasible; and

(f) In the absence of a clear regulatory timetable for the conversion or replacement of halon extinguishers and fire protection systems, progress in the development and implementation of alternative substances and technologies is losing momentum.

4.2 It is intended, therefore, that the new Annex VI should describe each critical use application in more detail than before, quickly prohibit halon extinguishers and fire protection systems in new equipment and new facilities by setting appropriate cut-off dates, and prohibit over time halon extinguishers and fire protection systems in all equipment and facilities by setting appropriate end dates.

Draft new Annex VI

4.3 Taking into account the factors outlined in this note, especially the progress made to date in Member States, and the technical and economic feasibility of implementing alternative fire extinguishants and fire protection technologies, the Commission and Member States propose replacing the current Annex VI to the Regulation with the draft new Annex VI set out in Appendix A.

4.4 An overview of the phase-out timetable for all halon applications in the draft new Annex VI is presented in Appendix F.

Definition of "cut-off dates", "end dates", "new equipment" and "new facilities"

4.5 In the draft new Annex VI, the cut-off date for each critical use application is the date after which halons must not be used for the application concerned in new equipment and new facilities. In this context, the meaning of "new equipment" is not necessarily determined by the date when an item of equipment is produced, or comes into service or is procured, or by the date when a facility is completed, but should reflect the stage in the equipment procurement process or the design of the facility at which the structure and properties of the protected space are effectively fixed. This is particularly important for complex equipment with long development, marketing or fleet delivery periods, especially in the military and civil aviation sectors. Furthermore, a suitable definition of the cut-off date will vary with the type of equipment or facility and the different procurement processes concerned.

4.6 The Commission therefore proposes that new equipment is equipment for which, by the cut-off date, neither of the following events has occurred:

(a) signature of the relevant procurement or development contract;

(b) submission of a request for type approval or type certification to the appropriate regulatory authority.

Similarly, new facilities are facilities for which, by the cut-off date, neither of the following events has occurred:

(a) signature of the relevant development contract;

(b) submission of a request for planning consent to the appropriate regulatory authority.

A "procurement contract" would be a contract for the purchase of equipment and a "development contract" would be a contract for the design or development of a type of equipment or the design or construction of a facility.

4.7 Thus, if the procurement or development contract has been let, or the type approval or type certification or planning consent has been requested before the cut-off date, the use of a halon for the specified application in the equipment or facility concerned is considered to be a critical use until the corresponding end date. If the procurement or development contract has been let, or the type approval or type certification or planning consent has been requested after the cut-off date, the use of a halon for the specified application in the equipment or facility concerned is not considered to be a critical use. In most examples of equipment procurement, a development contract or a request for type approval or type certificate would precede the signing of a production contract. Consequently, any type of equipment developed or designed in accordance with a development contract signed before the cut-off date, or in accordance with a type certificate or type approval requested before the cut-off date, would be permitted to incorporate halon extinguishers or fire protection systems. The date at which a procurement contract for such equipment is signed is then not pertinent and items of equipment designed with halons can be procured and manufactured at any time, up to the relevant end date.

4.8 The end date is the date after which halons must not be used for the maintenance of halon extinguishers or fire protection systems in any equipment or facilities for the application concerned and, by which date, the fire extinguishers or fire protection systems containing halons must be decommissioned. Whilst "use" is defined in the Regulation in a way that covers, for instance, the

refilling of an extinguisher, this definition reflects the requirement of the Regulation that non-critical use applications must be decommissioned.

Definition of "normally-occupied" and "normally-unoccupied" spaces

4.9 Critical use applications protecting normally-occupied and normally-unoccupied spaces are differentiated in cases[23] where it is potentially more challenging to implement alternatives in fixed systems in the case of normally-occupied spaces. For the new Annex VI, a normally-occupied space is considered to be a space in which it is necessary for personnel to be present for most or all of the time in order for the equipment or facility to function effectively. For military applications, the occupancy status of the protected space would be that applicable during a combat situation. A protected space that is occupied for limited periods only, for example for the purposes of undertaking maintenance, and where the continual presence of personnel is not necessary for the effective functioning of the equipment or facility, is considered to be a normally-unoccupied space.

4.10 The distinction between the two types of space should normally be clear. However, some stakeholders have expressed uncertainty concerning the difference between a normally-occupied machinery space and a normally-unoccupied engine space on a military vessel (applications 2.1 and 2.2), since the terms engine space and machinery space are often used interchangably. In this case, in practice, the distinction will often be one of size, with a larger vessel having a normally-occupied machinery space, and a smaller vessel a normally-unoccupied engine space. Many warships will have normally-unoccupied engine spaces, such as diesel or gas turbine modules, contained within larger normally-occupied machinery spaces, each with their own dedicated halon systems. The end-dates will apply for each protected space accordingly.

Reasoning behind proposed cut-off dates and end dates for each critical use application

4.11 The proposed cut-off dates in the draft new Annex VI, after which use of halons for the listed applications in new equipment and new facilities is not considered to be a critical use, are:

> 2010[24], (with immediate effect) where alternatives are considered to be readily available and halon extinguishers or fire protection systems are no longer necessary or being specified;
>
> 2011, where alternatives are not yet always being specified but are considered to be readily available;
>
> 2014, where alternatives are not yet being specified but are considered to be available, given some time for equipment designs to be amended to accommodate them; and
>
> 2018, where alternatives are considered not yet to be available but which, allowing a reasonable period for necessary research, development and evaluation by regulatory authorities, should soon become available.

4.12 The cut-off dates reflect the current availability and feasibility of alternatives substances or technologies and whether new halon systems are still being procured. However, even where halon extinguishers or fire-protection systems might be permitted in new equipment and new facilities,

[23] Where a protected space is not explicitely described as "normally-occupied" or "normally-unoccupied", it can usually be assumed (for example with crew compartments or command centres) or the distinction has little significance in terms of the halon application or the feasibility of its replacement.

[24] All dates are effective from 31 December of the year concerned.

potential owners or operators should consider the need for conversion or replacement of the halon extinguishers or fire protection systems in line with the end dates and the fact that it is always easier to implement alternatives before the equipment or facility is built or comes into service.

4.13 The proposed end dates for the critical use applications are intended to allow sufficient time for completion of the large majority of conversion or replacement programmes where it is feasible to do so, and to motivate further development of alternatives where conversion or replacement of halon systems is still especially challenging. In a few cases, where conversion is not yet technically and economically feasible, end dates are intended to allow continued use of halons until the end of the useful life of the majority of the equipment or facilities concerned. Accordingly, the proposed end dates for the critical use applications are:

2013, where alternatives are considered to be readily available and there are low economic and logistical barriers to early replacement;

2016, where alternatives are considered to be available but there are low technical barriers and economic and logistical barriers to earlier replacement;

2020 and 2025, where some alternatives are considered to be available but certification requirements must often still be met and technical, economic and logistical barriers mean that implementation will likely be feasible only as part of routine maintenance programmes extending over a number of years;

2030 and 2035, where some alternatives are considered to be available, but certification requirements must usually be met and high technical and economic barriers mean that implementation will likely be feasible only as part of planned equipment refit or upgrade programmes extending over considerable periods; and

2040, where alternatives are considered not to be available, very high technical and economic barriers to replacement remain, and for which additional research and development are likely to be necessary to deliver suitable alternatives in time for implementation as part of routine maintenance, refit or upgrade programmes.

4.14 It is likely that the proposed 2030 and 2035 end dates, for some military vehicle and surface ship applications, will allow the majority of affected equipment to reach the end of its useful life without undergoing conversion. However, since alternatives have been implemented for these applications for a range of types of equipment in some Member States and elsewhere, opportunities for conversion of most such equipment during refit and upgrade programmes should arise during this period. The end dates should allow sufficient time for completion of halon replacement programmes for any existing equipment which is scheduled to remain in service after these dates.

4.15 The 2040 end date is considered to be appropriate for a few applications, on existing military surface ships, military submarines and aircraft, where technically and economically feasible alternatives have not yet been identified. It can reasonably be expected that, by 2040, a large part of the equipment concerned will have reached the end of its useful life. However, in particular for more modern aircraft which will remain in service beyond 2040, alternatives will need to be developed to enable the end date to be met for all applications. It is envisaged that, by that date, following further research and development of alternatives and developments in fire protection technology, it should be possible for alternatives to be implemented successfully.

Costs and benefits of the proposed changes to the Annex VI

4.16 Whilst stakeholders generally collaborated generously and constructively with the Commission in the present review process, few were in a position to provide detailed quantitative information that would be necessary for the Commission to conduct a formal impact assessment on the proposed changes to the Annex VI. In addition:

(a) The costs of halon replacement would vary considerably with each different type of equipment and for each Member State, and would depend on when and how the replacement work would be undertaken;

(b) Halon replacement programmes which have been undertaken have often been completed as part of routine equipment or facility development, maintenance or upgrade programmes and so costs of halon replacement have not been identified separately by the owners or operators;

(c) Many halon replacement programmes have not yet been initiated or costed, so there was no information available; and

(d) Overall costs of replacement programmes would depend on the number and extent of future derogations authorised by the Commission and changes resulting from future reviews of the Annex.

4.17 Consequently, the Commission focussed on a qualitative cost-benefit analysis because it was unable to quantify the implementation costs of replacing halon fire extinguishers and fire protection systems according to the proposed timetable in the new Annex VI.

4.18 More detailed cost information will become available as stakeholders develop and implement plans for compliance with the halon replacement timetable. Cost information will therefore form an important part of future requests for derogations or future reviews of the Annex. However, the draft new Annex was based upon the best information available at the time and in the knowledge that better information would likely not be forthcoming in the absence of the regulatory incentive provided by the new Annex VI.

4.19 The environmental benefits of the new Annex were equally difficult to quantify, because:

(a) Data on use and emissions of halons provided by stakeholders and Member States have been limited in detail and have varied considerably from year to year;

(b) The full extent of potential under-reporting of installed quantities, use and emissions was unknown;

(c) Conversion programmes necessary to ensure compliance will be implemented over potentially lengthy periods and the timetables for doing so have not yet been determined; and

(d) The environmental benefits of replacement programmes would depend on the number and extent of future derogations authorised by the Commission and changes resulting from future reviews of the Annex.

4.20 The new Annex VI will facilitate improved reporting on quantities of halons installed, used and emitted in future years, by more clearly distinguishing between the critical use applications.

This will allow better assessment of environmental benefits of any proposed changes as a result of future reviews of the Annex. However, the draft new Annex was based upon the best information available at the current time, recognising that the replacement of halons in the remaining critical uses would represent the final stages of the phase-out of halons and therefore costs could be relatively high unless safeguards were introduced. The flexibility provisions provide important means to ensure that costs are not excessive for the environmental benefits to be realised.

4.21 Other benefits that the new Annex would bring, though clear, are also difficult to quantify. They include:

(a) A significantly reduced risk of the need for production of halons to resume under an essential use exemption authorised by the Parties to the Montreal Protocol;

(b) Timely replacement of halon extinguishers and fire protection systems where alternatives are available, reducing demand for recycled or reclaimed halons, and supplementing the supplies of recycled or reclaimed halons necessary for the remaining long-term critical uses in the military and civil aviation sectors;

(c) A level playing field across Member States for the manufacturers of equipment and the developers of facilities requiring fire extinguishers or fire protection systems;

(d) A clearer legislative framework within which owners and operators of equipment and facilities can function; and

(e) Additional incentives for research and development of better fire extinguishants and fire protection technologies for all fire protection needs.

5 Flexibility provisions and future reviews of the new Annex VI

Case-by-case derogations to accommodate exceptional challenges

5.1 It is expected that the majority of manufacturers, developers, owners and operators of equipment and facilities should be in a position to comply with the proposed cut-off dates and end dates in the new Annex VI. Nevertheless, it is acknowledged that, in some circumstances, this will not be the case.

5.2 The potential need for case-by-case derogations, in the form of extensions to the cut-off dates and end dates, is envisaged in Article 13(4) of the Regulation. This allows the Commission to take account of the varying circumstances of Member States and the different challenges presented by conversion of different types of equipment and facilities whilst avoiding a need for cut-off dates and end dates which set the standard at the lowest level achievable by all.

5.3 The Article 13(4) provision enables the Commission, following a request by the competent authority of a Member State, to assess and authorise time-limited extensions to the cut-off dates and end dates given in the new Annex VI. The derogations will be considered by the Commission and granted, with the agreement of the Committee, for specific cases where it is demonstrated that, despite reasonable efforts, no alternatives are available or can be implemented in time. However, the Commission would consider granting such a derogation in exceptional circumstances and where persuasive evidence was provided of substantial technical difficulties, excessive compliance costs, or adverse operational impacts (for example, the potential grounding or otherwise unnecessarily early retirement of equipment) for minimal environmental benefit. As an example, and without

prejudice to any such future assessments, equipment that is due for retirement from service shortly after the applicable end date would very likely warrant a derogation if its conversion would incur high costs for little environmental benefit.

5.4 The Commission will prepare, in consultation with Member States, a standard template for requests for derogations, probably along the lines of the current request form for exemptions authorising use of HCFCs. Whilst the template for derogation requests might be completed by the manufacturer, developer, owner or operator of the equipment or facility concerned, the request would need to be submitted by the competent authority following its preliminary assessment of the information provided and its endorsement that a derogation was necessary. If the Commission was persuaded, following its assessment and consultation with stakeholders as appropriate, that a derogation was justified, it would draft a Decision outlining the nature, scope and conditions of the derogation and present it to a meeting of the Committee for the opinion of Member States under the standing procedure. If the Committee gave a favourable opinion, the Decision would be adopted by the Commission and it would then be addressed to the Member State concerned.

5.5 The submission of late derogation requests would not be regarded favourably if the case was based primarily on there being insufficient time to complete a conversion programme that could, in fact, have been started earlier. Conversely, the Commission would also be unlikely to accept very early derogation requests, especially in relation to applications with the later end dates, on the basis that the owner or operator of the equipment or facility would not be able to demonstrate sufficient effort in identifying or implementing alternatives or be able to take into account the continued development of better or additional alternatives in the years ahead.

Future reviews of the new Annex VI

5.6 As required by Article 13(2) of the Regulation, the Commission will keep the new Annex VI, including the cut-off dates and end dates, under review, taking into account continued developments in the availability of technically and economically feasible alternative fire extinguishants and fire protection technologies and the progress being made in halon replacement in the Member States.

5.7 The Commission will consider future reviews at appropriate intervals and at the request of Member States. Such reviews should take place in advance of the principle cut-off dates and end dates to take account of the latest information regarding feasibility of compliance. The reviews should take place sufficiently far ahead of time to allow manufacturers or developers and owners or operators of equipment or facilities to adjust halon replacement plans if it became necessary to do so, but they should also allow sufficient time for these undertakings to demonstrate reasonable effort and progress and for research and development of additional alternatives to bear fruit.

5.8 In addition, in circumstances where derogations might otherwise be needed for many or all examples of a particular application by a significant number of Member States, the commission will review the end-date for that application, based on its own assessment and information from stakeholders and Member States. If any change is deemed necessary and agreed by Member States, the Annex VI will be amended and that change is then applicable for that particular application in all Member States. In such circumstances it would then not be necessary for derogations to be requested.

5.9 A tentative schedule for future reviews is outlined in Table 2. The Commission may change the dates and scope of future reviews, or undertake additional reviews, where it is appropriate to do so, based on information that becomes available from Member States or other sources and especially if additional and improved alternatives become available.

5.10 Because end dates may be brought forward as well as postponed as a result of future reviews, owners and operators of equipment and facilities should take advantage of all reasonable opportunities to replace or convert halon extinguishers or fire protection systems, especially during major or mid-life upgrades of equipment, and not wait until an end date approaches before taking action.

Table 2 – Suggested future reviews of the Annex VI[25]

Projected review periods	Projected focus of the review	
	Applications	**Cut-off dates and end dates**
2011-12	Aircraft (4.2, 4.3)	2014 cut-off dates
	Aircraft (4.1)	2018 cut-off date
	Command centres (7.2) Other (11.1, 11.2)	2013 end dates
2014-15	Aircraft (4.1)	2018 cut-off date
	Military vessels (2.7) Cargo ships (6.1) Airfields and airports (8.1, 8.2) Channel Tunnel (10.1)	2016 end dates
	Military vehicles (1.3) Aircraft (4.5) Oil, gas & petrochemicals facilities (5.1) Command centres (7.3) Nuclear power (9.1) Channel Tunnel (10.2)	2020 end dates
	Military vehicles (1.1) Military vessels (2.2)	2035 end dates
2019-20	Aircraft (4.2) Command centres (7.1)	2025 end dates
	Military vehicles (1.1) Military vessels (2.2)	2035 end dates
2024-25	Military vehicles (1.1) Military vessels (2.2)	2035 end dates
	Military vehicles (1.2) Military vessels (2.1) Military submarines (3.1, 3.2, 3.3, 3.4) Aircraft (4.1, 4.3, 4.4, 4.6)	2040 end dates
2029-30	Military vehicles (1.2) Military vessels (2.1) Military submarines (3.1, 3.2, 3.3, 3.4) Aircraft (4.1, 4.3, 4.4, 4.6)	2040 end dates

[25] The dates and scope of actual future reviews may differ from those indicated here.

6 Other issues

Status of hydrofluorocarbon (HFC) alternatives with a high global warming potential

6.1 Many of the alternative extinguishants identified during the review as suitable for replacing halons in the critical use applications are HFCs with a global warming potential (GWP) comparable to, or greater than, the halons. Table 3 compares the environmental properties of the halons with those of a range of potential alternative extinguishants, including the HFCs.

6.2 The new Annex VI will not stipulate or restrict the choice of halon alternative for any fire protection application. Ideally, alternatives with the lowest GWP that meet performance, safety and other requirements should be selected by the manufacturer, developer, owner or operator of the equipment or facilities concerned. Where a high-GWP HFC is the only suitable alternative currently available, other options should be considered that may prove to be suitable following further research and development and which could be implemented in time to meet the proposed end dates. If there are no foreseeable further options, the HFC should be implemented and measures taken to minimise use and emissions, in accordance with Regulation (EC) No 842/2006.

Table 3 – Environmental properties of halons and potential alternative substances[26]

Substance	ODP	Atmospheric Life (Years)	GWP_{100}
Halons			
Halon 1301	10	65	6900
Halon 1211	3	16	1300
Halon 2402	6	20	503
Alternative substances[27]			
HFC-23	0	260	14800
HFC-125	0	29	3500
HFC-227ea	0	33	3220
HFC-236fa	0	220	9810
FIC-13I1	0	0.005	1
FK-5-1-12	0	0.01	1
Inert gases	0	-	0
CO2	0	-	1

[26] Data are obtained from the Regulation, the Intergovernmental Panel on Climate Change Assessment Report No 4, or the HTOC Technical Note No 1, revision 3.

[27] This list of alternatives is indicative only and is not intended to be a comprehensive list of alternatives that are available.

6.3 Discussions related to potential controls on production of high-GWP HFCs, to discourage their widespread adoption as alternatives to the ODSs, are on-going both at the EU and international level. A possible "phase-down" of production – rather than a "phase-out" – features amongst the more interesting scenarios, because it is acknowledged that HFCs will continue to be needed for the foreseeable future in a number of applications or circumstances where other alternatives are not available. For as long as HFCs remain necessary as alternatives for the ODSs, including as alternatives for the halons, HFC production is expected to continue in order to meet supply needs.

The need for further research and development of halon alternatives

6.4 Further research is necessary to identify better alternative extinguishants or technologies for some fire protection applications in the military and civil aviation sectors. The Commission urges these sectors to continue their collaborative efforts, jointly with the fire protection and chemicals industries, to identify such alternatives and develop and validate them for implementation. The options for suitable fundamentally-new substances, with high fire extinguishing performance and a range of acceptable other properties, seem at present to be very limited. The potential market for such substances is also relatively small, and so the fire protection and chemicals industries may lack sufficient incentive to continue this work without a clear commitment to participation from potential customers in the critical use sectors.

6.5 There is also scope for the critical use sectors to work more urgently with the fire protection and chemicals industries to evaluate a range of promising chemicals and technologies that are currently at the development stage and available in trial quantities. Serious consideration should be given to the evaluation and implementation of such solutions where they are found to have advantages over the current commercially-available options, even where they may not have the full range of ideal properties. The critical use sectors should not wait for an ideal, halon-like, alternative to emerge before they undertake a more substantial effort to replace the halons.

6.6 Member States' governments should consider the active support of these research and development activities where it is appropriate to do so.

6.7 The European Commission can consider requests for funding of collaborative research projects to facilitate halon replacement in the sectors concerned. Fundamental research may be appropriate for consideration under programmes run by the Directorate General for Research and Technology. For example, research into improved replacements for halons in aircraft applications could be eligible for funding under Framework Programme 7 on Aeronautics, either on a safety or environmental basis, or the *CLEANSKY* Joint Technology Initiative which supports the development of breakthrough technologies that significantly improve the impact of the air transport on the environment. Near-to-market research may also be appropriate for consideration under the LIFE+ programmes run by the Directorate General for Environment. Further information on these programmes can be obtained from the Commission's websites[28].

[28] Further information on DG Research's funding policies and programmes can be found at: http://ec.europa.eu/dgs/research/index_en.html.

Details concerning the research Framework Programme FP7 on aeronautics can be found at: http://cordis.europa.eu/fp7/cooperation/transport_en.html and on *CLEANSKY* at: http://www.cleansky.eu/index.php?arbo_id=35.

Further information on DG Environment's LIFE+ programme can be found at: http://ec.europa.eu/environment/life/index.htm.

Ensuring adequate supply and quality of recycled and reclaimed halons

6.8 The draft new Annex VI envisages a prolonged period of continued use of halons, for some sectors such as defence and civil aviation until up to 2040 and possibly beyond. Although this situation may change as improved fire extinguishants and fire protection technologies are developed, Member States should continually remind those with a continuing demand of the need to ensure access to sufficient quantities of recycled and reclaimed halons for as long as they are likely to require them. Market availability of halons at the right price is not guaranteed, but depends on the balance between supply, from decommissioned or converted halon extinguishers and fire protection systems, and demand, from those undertakings with remaining critical use applications. There is already evidence that halon 1211 is in short supply within the EU, although quantities are currently available from elsewhere[29]. It is, however, likely that the cost of recycled and recovered halons will rise over time.

6.9 It is also important to ensure that the recycled and reclaimed halons on the market are of the required quality. The responsibility for this lies with the undertakings that recover halons from extinguishers and fire protection systems that are no longer needed in order to supply them to others, but the recipients of the halons should also satisfy themselves that the quality standard is being met, preferably by independent verification. Recycled or reclaimed halons should meet an appropriate standard, such as ISO 7201-1:1989 *Fire Protection – Fire extinguishing media – Halogenated hydrocarbons*, or equivalent. This standard sets out minimum purity and maximum contamination levels for halon 1301 and halon 1211 and the analytical procedures that should be used to determine the purity. If the standard is not adhered to, the effectiveness of the extinguishant and the associated hazards to persons cannot be predicted. All recovered halons should, therefore, be analysed and any quantities that do not meet the standard isolated until they can be recycled, reclaimed or destroyed. In the majority of cases, quality can be maintained by submitting the recovered halons to the basic recycling process that separates out the nitrogen propellant and filters the halon to remove water, particulates, non-volatile residues and acidic contaminants. The halon cylinders and extinguishers should also be properly maintained to minimise contamination of the halons as they are filled.

6.10 Whilst routine halon analysis on recovery and prior to sale, combined with careful management of stocks and maintenance of halon extinguishers and fire protection systems, should ensure supplies of recycled and reclaimed halons meet the required standards, this cannot always be assumed. Supplies of contaminated halons have found their way onto the global markets, recently including the EU. In the latter case, mainly concerning halon 1211, there is evidence that contamination has occurred with other halocarbons, notably halon 2402 and CFC, HCFC and HFC refrigerants. Contaminants have also included the (flammable) hydrocarbon isobutane. The analytical methods set out in ISO 7201-1:1989 may not be sufficient to characterise such contamination and other methods of analysis may be necessary. Furthermore, recycling is likely not to be effective in such cases and reclamation would be necessary. This more expensive process may not be commercially viable at current price levels and destruction of the contaminated halons is then the only option. If contamination becomes more widespread, supplies of halons for the critical uses may be compromised.

6.11 Those responsible for equipment and facilities with critical use applications of halons should keep both of these factors in mind in determining their halon replacement strategy, alongside the requirements of the Regulation and the new Annex VI.

[29] Import and export of halons (and halon extinguishers and cylinders) across EU boundaries are subject to licensing by the European Commission and are permitted only for critical uses. Import of halons is also subject to the importers having an annual quota allocation from the Commission.

Appendix A – Draft new Annex VI to Regulation (EC) No 1005/2009

CRITICAL USES OF HALONS					
APPLICATION				**CUT-OFF DATE** (31 December of the stated year)	**END DATE** (31 December of the stated year)
CATEGORY OF EQUIPMENT OR FACILITY	**PURPOSE**	**TYPE OF EXTINGUISHER**	**TYPE OF HALON**		
1. On military ground vehicles	1.1 For the protection of engine compartments	Fixed system	1301 1211 2402	**2010**	**2035**
	1.2 For the protection of crew compartments	Fixed system	1301 2402	**2011**	**2040**
	1.3 For the protection of crew compartments	Portable extinguisher	1301 1211	**2011**	**2020**
2. On military surface ships	2.1 For the protection of normally-occupied machinery spaces	Fixed system	1301 2402	**2010**	**2040**
	2.2 For the protection of normally-unoccupied engine spaces	Fixed system	1301 1211 2402	**2010**	**2035**
	2.3 For the protection of normally-unoccupied electrical compartments	Fixed system	1301 1211	**2010**	**2030**
	2.4 For the protection of command centres	Fixed system	1301	**2010**	**2030**
	2.5 For the protection of fuel pump rooms	Fixed system	1301	**2010**	**2030**
	2.6 For the protection of flammable liquid storage compartments	Fixed system	1301 1211 2402	**2010**	**2030**
	2.7 For the protection of aircraft in hangars and maintenance areas	Portable extinguisher	1301 1211	**2010**	**2016**
3. On military submarines	3.1 For the protection of machinery spaces	Fixed system	1301	**2010**	**2040**
	3.2 For the protection of command centres	Fixed system	1301	**2010**	**2040**
	3.3 For the protection of diesel generator spaces	Fixed system	1301	**2010**	**2040**
	3.4 For the protection of electrical compartments	Fixed system	1301	**2010**	**2040**

Appendix A – Continued

CRITICAL USES OF HALONS					
APPLICATION				**CUT-OFF DATE** (31 December of the stated year)	**END DATE** (31 December of the stated year)
CATEGORY OF EQUIPMENT OR FACILITY	**PURPOSE**	**TYPE OF EXTINGUISHER**	**TYPE OF HALON**		
4. On aircraft	4.1 For the protection of normally-unoccupied cargo compartments	Fixed system	1301 1211 2402	**2018**	**2040**
	4.2 For the protection of cabins and crew compartments	Portable extinguisher	1211 2402	**2014**	**2025**
	4.3 For the protection of engine nacelles and auxiliary power units	Fixed system	1301 1211 2402	**2014**	**2040**
	4.4 For the inerting of fuel tanks	Fixed system	1301 2402	**2011**	**2040**
	4.5 For the protection of lavatory waste receptacles	Fixed system	1301 1211 2402	**2011**	**2020**
	4.6 For the protection of dry bays	Fixed system	1301 1211 2402	**2011**	**2040**
5. In oil, gas and petrochemicals facilities	5.1 For the protection of spaces where flammable liquid or gas could be released	Fixed system	1301 2402	**2010**	**2020**
6. On commercial cargo ships	6.1 For the inerting of normally-occupied spaces	Fixed system	1301 2402	**1994**	**2016**
7. In land-based command and communications facilities essential to national security	7.1 For the protection of normally-occupied spaces	Fixed system	1301 2402	**2010**	**2025**
	7.2 For the protection of normally-occupied spaces	Portable extinguisher	1211	**2010**	**2013**
	7.3 For the protection of normally-unoccupied spaces	Fixed system	1301 2402	**2010**	**2020**
8. At airfields and airports	8.1 For crash rescue vehicles	Portable extinguisher	1211	**2010**	**2016**
	8.2 For the protection of aircraft in hangars and maintenance areas	Portable extinguisher	1211	**2010**	**2016**

Appendix A – Continued

CRITICAL USES OF HALONS					
APPLICATION				**CUT-OFF DATE** (31 December of the stated year)	**END DATE** (31 December of the stated year)
CATEGORY OF EQUIPMENT OR FACILITY	**PURPOSE**	**TYPE OF EXTINGUISHER**	**TYPE OF HALON**		
9. In nuclear power and nuclear research facilities	9.1 For the protection of spaces where necessary to minimise risk of dispersion of radioactive matter	Fixed system	1301	**2010**	**2020**
10. In the Channel Tunnel	10.1 For the protection of technical facilities	Fixed system	1301	**2010**	**2016**
	10.2 For the protection of power cars and shuttle wagons of Channel Tunnel trains	Fixed system	1301	**2010**	**2020**
11. Other	11.1 For initial extinguishing by fire brigades where essential to personal safety	Portable extinguisher	1211	**2010**	**2013**
	11.2 For the protection of persons by military and police personnel	Portable extinguisher	1211	**2010**	**2013**

Notes

(1) "Cut-off date" means the date after which halons must not be used for fire extinguishers or fire protection systems in new equipment and new facilities for the application concerned.

(2) "New equipment" means equipment for which, by the cut-off date, neither of the following events has occurred:

(a) signature of the relevant procurement or development contract;

(b) submission of a request for type approval or type certification to the appropriate regulatory authority.

(3) "New facilities" means facilities for which, by the cut-off date, neither of the following events has occurred:

(a) signature of the relevant development contract;

(b) submission of a request for planning consent to the appropriate regulatory authority.

(4) "End date" means the date after which halons shall not be used for the application concerned and by which date the fire extinguishers or fire protection systems containing halons shall be decommissioned.

(5) "Inerting" means preventing the initiation of combustion of a flammable or explosive atmosphere by means of the addition of an inhibiting or diluting agent.

(6) "Cargo ship" means a ship that is not a passenger ship, is over 500 tons gross weight, and embarks on an international voyage, in accordance with the definition of these terms in the Safety of Life at Sea (SOLAS) Convention. The SOLAS Convention defines a "passenger ship" as "a ship that carries more than twelve passengers" and an "international voyage" as "a voyage from a country to which the present Convention applies to a port outside such country, or conversely".

(7) A "normally-occupied" space means a protected space in which it is necessary for persons to be present most or all of the time in order for the equipment or facility to function effectively. For military applications, the occupancy status of the protected space would be that applicable during a combat situation.

(8) A "normally-unoccupied" space means a protected space that is occupied for limited periods only, in particular for undertaking maintenance, and where the continual presence of persons is not necessary for the effective functioning of the equipment or facility.

Appendix B – Current Annex VI to Regulation (EC) No 1005/2009

Note: the letters in (brackets) have been added here to aid the comparison in Appendix C between the current version of Annex VI and the draft new version in Appendix A.

Critical uses of halon

Use of halon 1301:

(A) — in aircraft for the protection of crew compartments, engine nacelles, cargo bays and dry bays, and fuel tank inerting,

(B) — in military land vehicles and naval vessels for the protection of spaces occupied by personnel and engine compartments,

(C) — for the making inert of occupied spaces where flammable liquid and/or gas release could occur in the military and oil, gas and petrochemical sector, and in existing cargo ships,

(D) — for the making inert of existing manned communication and command centres of the armed forces or others, essential for national security,

(E) — for the making inert of spaces where there may be a risk of dispersion of radioactive matter,

(F) — in the Channel Tunnel and associated installations and rolling stock.

Use of halon 1211:

(G) — in military land vehicles and naval vessels for the protection of spaces occupied by personnel and engine compartments,

(H) — in hand-held fire extinguishers and fixed extinguisher equipment for engines for use on board aircraft,

(I) — in aircraft for the protection of crew compartments, engine nacelles, cargo bays and dry bays,

(J) — in fire extinguishers essential to personal safety used for initial extinguishing by fire brigades,

(K) — in military and police fire extinguishers for use on persons.

Use of halon 2402 only in Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia:

(L) — in aircraft for the protection of crew compartments, engine nacelles, cargo bays and dry bays and fuel tank inerting,

(M) — in military land vehicles and naval vessels for the protection of spaces occupied by personnel and engine compartments,

(N) — for the making inert of occupied spaces where flammable liquid and/or gas release could occur in the military and oil, gas and petrochemical sectors, and in existing cargo ships,

(O) — for the making inert of existing manned communication and command centres of the armed forces or others, essential for national security,

(P) — for the making inert of spaces where there may be a risk of dispersion of radioactive matter,

(Q) — in hand-held fire extinguishers and fixed extinguisher equipment for engines for use on board aircraft,

(R) — in fire extinguishers essential to personal safety used for initial extinguishing by fire brigades,

(S) — in military and police fire extinguishers for use on persons.

Use of halon 2402 only in Bulgaria:

(T) — in aircraft for the protection of crew compartments, engine nacelles, cargo bays and dry bays, and fuel tank inerting,

(U) — in military land vehicles and naval vessels for the protection of spaces occupied by personnel and engine compartments.

Appendix C – Correlation between the current Annex VI and the draft new Annex VI

Note: The letters in the first column refer to the descriptions of each critical use application in the current version of Annex VI, as reproduced in Appendix B. The numbers in the second column refer to the descriptions of each critical use application in the draft new Annex VI, as reproduced in Appendix A.

Critical use application in the current Annex VI (Appendix B)	Corresponding critical use application in the draft new Annex VI (Appendix A)	Comments
A, I, L, T	4.1 – 4.6	There is a direct correlation, with no significant changes to the descriptions of the critical use applications.
B, G, M, U	1.1 – 1.3 2.1 – 2.7 3.1 – 3.4	The current, repeated, description is divided into the separate categories of "military ground vehicles", "military surface ships" and "military submarines" and each critical use application is described in more detail.
C, N	5.1 6.1	The critical use applications covered by the current description are divided into separate categories. Fire protection systems protecting "oil, gas and petrochemicals facilities" may be both inerting and extinguishing systems protecting both normally-occupied and normally-unoccupied spaces. Since the proposed cut-off dates and end dates are the same for all these applications, a single, broader, desciption is used. For "commercial cargo ships", the description "making inert" may be relevant for a few vessels and is retained (fire extinguishing systems protecting engine spaces on cargo ships are not considered to be critical use applications). The description "military" is deleted because military critical use applications are described separately in categories 1-3.
D, O	7.1 – 7.3	There is a direct correlation, but current critical use applications are described in more detail. The current description "making inert" is inappropriate because it does not apply to any applications reported by Member States under the current description. The term "making inert" has therefore been replaced with "for the protection of …".
E, P	9.1	There is a direct correlation, but current critical use applications are described in more detail. The current description "making inert" is inappropriate because it does not apply to any applications reported by Member States under the current description. The term "making inert" has therefore been replaced with "for the protection of …". No examples of halon 2402 fire protection systems have been reported for this application.
F	10.1, 10.2	There is a direct correlation, but current critical use applications are described in more detail and limited to fixed fire protection systems. The applications are subdivided to accommodate different end dates for facilities and rolling stock.
H, Q	4.2, 4.3	There is a direct correlation, with portable extinguishers and engine fire protection systems described as separate applications but with no significant changes to the description.
J, R	8.1, 8.2 11.1	The current broad description is retained as 11.1 with an end date allowing a limited period for replacement of the extinguishers in some Member States . The majority of critical use applications reported by Member States under this description relate to airport and airfield applications, which are more precisely defined as 8.1 and 8.2.
K, S	11.2	There is a direct correlation, with no significant changes to the description of the critical use application. No examples of halon 2402 extinguishers have been reported for this application.

Appendix D – Potential alternative extinguishants and technologies[30] for the halon critical use applications

Category of equipment or facility	Purpose	Potential alternatives for new equipment and new facilities	Potential alternatives for equipment and facilities constructed with halon extinguishers	Estimated cost of converting or replacing halon extinguishers[31]
1. On military ground vehicles	1.1 For the protection of engine compartments	HFC-125 HFC-227ea HFC-236fa FK-5-1-12 dry chemical	HFC-227ea HFC-236fa FK-5-1-12 inert gas dry chemical	€€
	1.2 For the protection of crew compartments	HFC-236fa HFC-227ea + dry chemical water + potassium acetate	HFC-236fa	€€€
	1.3 For the protection of crew compartments	HFC-236fa HFC-227ea FK-5-1-12	HFC-236fa HFC-227ea FK-5-1-12	€€
2. On military surface ships	2.1 For the protection of normally-occupied machinery spaces	HFC-227ea fine water spray HFC-227ea + fine water spray foam FK-5-1-12 CO_2	HFC-227ea fine water spray HFC-227ea + fine water spray foam FK-5-1-12	€€€€
	2.2 For the protection of normally-unoccupied engine spaces	HFC-227ea CO_2 dry chemical fine water spray	HFC-227ea CO_2 dry chemical fine water spray	€€
	2.3 For the protection of normally-unoccupied electrical compartments	HFC-227ea	HFC-227ea	€€
	2.4 For the protection of command centres	HFC-227ea inert gas fine water spray	-	€€
	2.5 For the protection of fuel pump rooms	HFC-227ea HFC-227ea + water spray	HFC-227ea	€€
	2.6 For the protection of flammable liquid storage compartments	HFC-227ea	HFC-227ea	€€
	2.7 For the protection of aircraft in hangars and maintenance areas	HFC-236fa FK-5-1-12 foam CO_2	HFC-236fa FK-5-1-12 foam CO_2	€

[30] These alternatives have been identified in the ICF study, by HTOC, or by Member States as potential or actual alternatives to the halons for the applications concerned. The list is indicative only and is not a comprehensive list of the options that are available. The indicated alternatives will not be suitable in all examples of the applications concerned nor in all Member States where different safety standards and operating procedures will apply. The inclusion of an alternative extinguishant or technology in this table, or its order relative to any other, does not constitute any endorsement of its suitability for any particular application.

[31] Estimated costs are qualitative, based upon the ICF study, HTOC 2002 Assessment Report (http://ozone.unep.org/teap/Reports/HTOC/HTOC2002.pdf, p5) and information provided by Member States and stakeholders: € = minimal or low cost; €€ moderate cost; €€€ = potentially high cost; €€€€ = very high cost.

Appendix D – Continued

Category of equipment or facility	Purpose	Potential alternatives for new equipment and new facilities	Potential alternatives for equipment and facilities constructed with halon extinguishers	Estimated cost of converting or replacing halon extinguishers
3. On military submarines	3.1 For the protection of machinery spaces	Inert gas foam fine water spray	-	€€€€
	3.2 For the protection of command centres	Inert gas foam fine water spray	-	€€€€
	3.3 For the protection of diesel generator spaces	Inert gas foam fine water spray	-	€€€€
	3.4 For the protection of electrical compartments	Inert gas foam fine water spray	-	€€€€
4. On aircraft	4.1 For the protection of normally-unoccupied cargo compartments	OBIGGS[32] water spray + inert gas	-	€€€€
	4.2 For the protection of cabins and crew compartments	HFC-227ea HFC-236fa	HFC-227ea HFC-236fa	€€
	4.3 For the protection of engine nacelles and auxiliary power units	HFC-125 FIC-13I1 FK-5-1-12	-	€€€€
	4.4 For the inerting of fuel tanks	OBIGGS fire suppression foam[33]	-	€€€€
	4.5 For the protection of lavatory waste receptacles	HFC-227ea HFC-236fa HFC-236fa + dry chemical	HFC-227ea HFC-236fa HFC-236fa + dry chemical	€
	4.6 For the protection of dry bays	OBIGGS inert gas generator pyrotechnically-generated aerosol	-	€€€€
5. In oil, gas and petrochemicals facilities	5.1 For the protection of spaces where flammable liquid or gas could be released	foam inert gas fine water spray HFC-227ea	foam inert gas fine water spray HFC-227ea	€€

[32] On-board inert gas generating system. This technology has mainly been developed and adopted for military aircraft.

[33] The fuel tanks are filled with an open-cell polymer foam that prevents flame propogation.

Appendix D – Continued

Category of equipment or facility	Purpose	Potential alternatives for new equipment and new facilities	Potential alternatives for equipment and facilities constructed with halon extinguishers	Estimated cost of converting or replacing halon extinguishers
6. On commercial cargo ships	6.1 For the inerting of normally-occupied spaces where flammable liquid or gas could be released	HFC-227ea	HFC-227ea	€€€
7. In land-based command and communications facilities critical to national security	7.1 For the protection of normally-occupied spaces	HFC-227ea inert gas portable extinguisher	HFC-227ea inert gas portable extinguisher	€€
	7.2 For the protection of normally-occupied spaces	CO_2 dry chemical foam water HFC-227ea	CO_2 dry chemical foam water HFC-227ea	€
	7.3 For the protection of normally-unoccupied spaces	HFC-227ea CO2 inert gas fine water spray water sprinkler	HFC-227ea CO2 inert gas fine water spray water sprinkler	€€
8. At airfields and airports	8.1 For crash rescue vehicles	CO_2 dry chemical foam	CO_2 dry chemical foam	€€
	8.2 For the protection of aircraft in hangars and maintenance areas	CO_2 dry chemical foam HFC-236fa FK-5-1-12	CO_2 dry chemical foam HFC-236fa FK-5-1-12	€
9. In nuclear power and nuclear research facilities	9.3 For the protection of spaces where necessary to minimise risk of dispersion of radioactive matter	HFC-227ea HFC-236fa FK-5-1-12 CO2 inert gas fine water spray	HFC-227ea HFC-236fa FK-5-1-12 CO2 inert gas fine water spray	€€
10. In the Channel Tunnel	9.4 For the protection of underground technical facilities	HFC-227ea HFC-236fa FK-5-1-12 CO2 inert gas fine water spray	HFC-227ea HFC-236fa FK-5-1-12 CO2 inert gas fine water spray	€€
	9.5 For the protection of power cars and shuttle wagons of Channel Tunnel trains	HFC-227ea HFC-236fa FK-5-1-12	-	€€€
11. Other	9.1 For initial extinguishing by fire brigades where essential to personal safety	CO_2 dry chemical foam water	CO_2 dry chemical foam water	€
	9.2 For the protection of persons by military and police personnel	dry chemical foam	dry chemical foam	€

Appendix E – Principle stakeholders consulted during the review

Defence sector

Member States' defence ministries, through the EU Member States' Defence Environmental Network (DEF*NET*) and Member States' Committee representatives

Civil aviation sector

European Aviation Safety Agency (EASA)
Association of European Airlines (AEA)
Aerospace and Defence Industries Association of Europe (ASD)
International Coordinating Council of Aerospace Industries Associations (ICCAIA)
UNEP Halons Technical Options Committee (HTOC)

Oil, gas and petrochemicals sector

International Association of Oil and Gas Producers (OGP)
Oil Companies' European Association for Environment, Health and Safety in Refining and Distribution (CONCAWE)
European Petroleum Industry Association (EUROPIA)
International Petroleum Industry Environmental Conservation Association (IPIECA)
The European Union of the Natural Gas Industry (EUROGAS)
Technical Association of the European Natural Gas Industry **(**Marcogaz**)**

Commercial shipping sector

Oil Companies International Marine Forum (OCIMF)
European Community Shipowners' Associations (ECSA)
International Marine Contractors' Association (IMCA)
Committee of Professional Agricultural Organisations, General Confederation of Agricultural Cooperatives in the European Union (Copa-Cogeca)

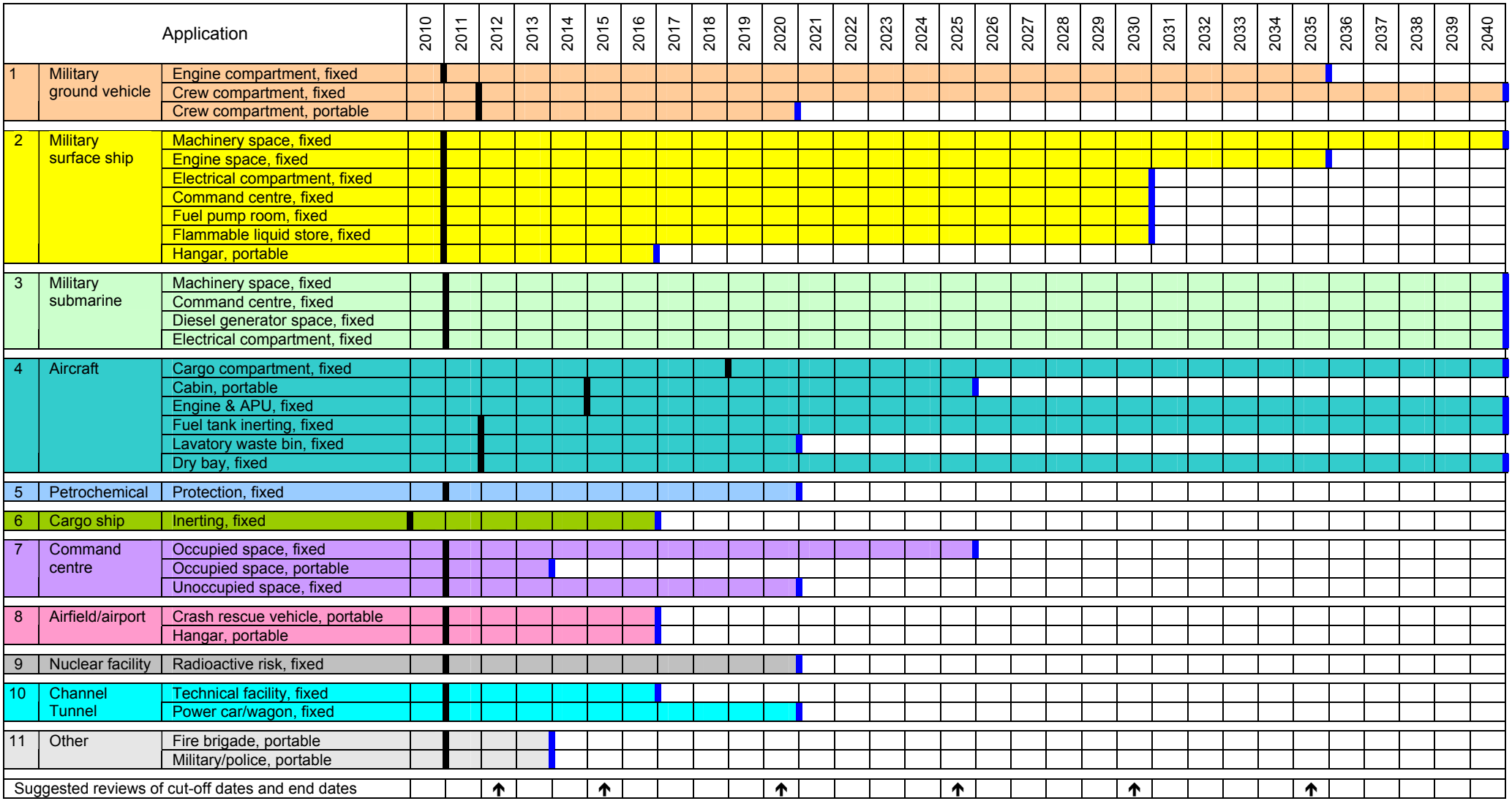
Nuclear power sector

European Atomic Forum (FORATOM)

Channel Tunnel

Eurotunnel
Eurostar UK Ltd
Société Nationale des Chemins de Fer Belges (NMBS/SNCB)
Société Nationale des Chemins de Fer Français (SNCF)

Appendix F – Overview of halon critical use phase-out timetable in draft new Annex VI



Note: Left-most heavy vertical bar (black): cut-off date for critical use for new equipment and new facilities; right-most heavy vertical bar (blue): end date for critical use for all equipment and facilities; solid coloured horizontal bar: use of halons for listed equipment and facilities is permitted.