



# FLUORINATED GASES MANAGEMENT

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### Amendments to 192/14

Section	Change
	Editorial to align style with EIGA style manual
4.5.4, 4.5.5, 4.5.6, 4.5.7	Updates to reflect current legislation

NOTE Technical changes from the previous edition are underlined

## 1 Introduction

This publication is intended to provide guidance on the management of fluorinated gases and compliance with the EU regulation on fluorinated gases (F gases).

## 2 Scope and purpose

This publication provides information and guidance for EIGA members and specifically to directors, technical managers, company environmental specialists, operations and site managers and to national industrial gas associations on management of fluorinated gases.

This publication applies to the specification design, construction, installation, operation and maintenance of equipment containing F gases and the distribution and use of F gases and products containing F gases and specifically on the implementation of the F Gases Regulation enacted in May 2014 by Regulation (EU) No 517/2014 *on fluorinated greenhouse gases* [1].<sup>1</sup>

## 3 Definitions

For the purpose of this publication, the following definitions apply.

### 3.1 Publication terminology

#### 3.1.1 Shall

Indicates that the procedure is mandatory. It is used wherever the criterion for conformance to specific recommendations allows no deviation.

#### 3.1.2 Should

Indicates that a procedure is recommended.

#### 3.1.3 May

Indicates that the procedure is optional.

#### 3.1.4 Will

Is used only to indicate the future, not a degree of requirement.

#### 3.1.5 Can

Indicates a possibility or ability.

### 3.2 Technical definitions

#### 3.2.1 Carbon dioxide equivalent

Tonne(s) of carbon dioxide equivalent (CO<sub>2</sub>e), a quantity of greenhouse gases, expressed as the product of the weight of the greenhouse gases in metric tonnes and of their global warming potential.

#### 3.2.2 Fluorinated Gases

Gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF<sub>6</sub>) and other greenhouse gases that contain fluorine, or mixtures containing any of those substances as listed in Annex 1 and Annex 2 of Regulation 517/2014 [1].

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<sup>1</sup> References are shown by bracketed numbers and are listed in order of appearance in the reference section.

## 4 Fluorinated gases management

### 4.1 Background

Fluorinated industrial gases (F Gases, for example HFCs, PFCs and SF<sub>6</sub>) are widely used in common devices and applications such as refrigerators, air conditioners, insulation, medical aerosols and semiconductors. In the 1990s, after the Montreal Protocol entered effect, these gases were used to replace ozone-depleting substances such as CFCs [2].

However, the high Global Warming Potential (GWP) of these gases raised new environmental concerns and they were included among the six greenhouse gases identified by the Kyoto Protocol, along with carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) [3].

HFCs, PFCs and SF<sub>6</sub> are gases contained in the basket of gases whose emissions are controlled under the 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change. These gases are monitored within the EU under the monitoring directive and featured in a number of national action programmes in individual member states.

Fluorinated gases and gas mixtures are used for many common applications and in a wide variety of products. As part of the first phase of the ECCP (European Climate Change Programme) the EU Commission proposed a regulation on fluorinated gases which was adopted in 2006 as Regulation (EC) No 842/2006 *on certain fluorinated greenhouse gases* [4].

As this is a regulation and not a directive, the requirements are directly applicable to member states. The aim of the regulation was to contain, prevent and thereby reduce emissions of fluorinated greenhouse gases covered by the Kyoto protocol [3].

In December 2013, EU policymakers reached an agreement on a new F Gases Regulation to replace Regulation 842/2006, introducing wider control and a phase down of F Gas use [4]. The revised F Gases Regulation (EU) No 517/2014 was published in May 2014 [1].

This regulation applies from 1st January 2015, repealing the former regulation. The regulation sets minimum EU wide standards and is directly applicable to member states. However, member states are free to adopt more ambitious measures going beyond the regulation, for example introducing taxes at the member state level.

The revised regulation:

- includes a reduction in the amount of F Gases in the EU by 79% by 2030;
- includes further restrictions on the use of F Gases in refrigeration equipment so that the recharging during service and maintenance of existing refrigeration equipment, with a charge size of over 40 tonnes of CO<sub>2</sub>e and with a GWP of 2500 or more, will not be permitted from 2020 onwards; and
- introduces bans on certain products based on agreed GWP thresholds, there are no specific bans for industrial refrigeration other than a ban on the use of F Gases with a GWP of 2500 or more from 2020 as outlined in 11a of Annex III [1]. It should be noted, however, that this ban does not apply to equipment designed to cool products to temperatures below -50 °C.

The Commission is currently reviewing Regulation (EU) No 517/2014 [1]. Based on the results of a consultation process and the work of external experts, the Commission will draw up a joint evaluation and impact assessment to examine if and how it can further improve the regulation in the coming years. A Commission proposal for a new regulation is expected by the end of 2021.

### 4.2 Impact on EIGA members

EIGA members are both users and distributors of these gases so EIGA members may be impacted both for the purchase / use and sale of the F Gases and shall be aware, in particular, of the following:

- phase down of supply of HFCs;
- restrictions on marketing and use of equipment containing F-Gases, and of use of the gases for certain applications;
- requirements for service and maintenance;
- requirements for recovery of F Gases;
- need for monitoring of equipment (refrigeration units and electrical equipment) containing F Gases;
- reporting of information on F Gases (imports, exports, use, emissions, etc.);
- training requirements; and
- requirements for certification to purchase / use F Gases, but also to ensure customers are certified and the requirement to hold records to show this.

### 4.3 Summary of the regulation

The regulation on F Gases applies to fluorinated greenhouse gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF<sub>6</sub>) and preparations containing these substances as listed in Annex I of the regulation (see Appendix 1) [1].

Annex 2, F Gases (see Appendix 2) has requirements for reporting only [1].

The scope of the regulation covers F Gases in stationary applications such as refrigeration equipment, air conditioning and heat pump equipment, including their circuits, as well as fire protection and high voltage electrical equipment and mobile equipment such as refrigeration equipment in vehicles or trailers.

The main points in the regulation are:

- supply phase down for F Gases;
- revised leak detection requirements, based now on CO<sub>2</sub>e; and
- inclusion of SF<sub>6</sub> switchgear in leak detection requirements.

### 4.4 Objectives of the regulation

The F Gases regulation aims to further reduce projected F Gases emissions. It is composed of the following elements:

- phase down of F Gases use;
- restrictions on the use of F Gases in service and of refrigeration equipment;
- restricting the marketing and use for number of applications where containment is not feasible or the use of fluorinated gases is deemed inappropriate;
- improving the monitoring and verification of F Gases emissions;
- improvement in containment and recovery of F Gases;
- certification for persons handling and using F Gases; and

- reporting on the production, importation, export, recycling and destruction to strengthen the monitoring of emissions.

#### 4.5 Summary of requirement

This is a regulation not a directive, so the requirements are directly applicable to member states.

Article 3 includes a general duty to prevent and minimise leakage with mandatory inspections for leakages defined in Article 3, with a requirement to repair equipment without undue delay.

Article 4 defines the requirements for leakage detection, subject to thresholds based on the CO<sub>2e</sub> of the contained gas. Leakage detection is required unless the equipment contains less than 10 tonnes CO<sub>2e</sub> and is hermetically sealed.

Article 5 defines the requirements for the leakage detection systems.

Article 6 covers record keeping.

Article 8 covers requirements to recycle, reclaim or destroy F Gases.

Articles 7 and 11 implement controls of production and phase down and use restrictions of some F Gases in certain applications such as SF<sub>6</sub> in magnesium die casting and vehicle tyres. The use prohibitions and restrictions are set out in Appendix 4.

Article 10 covers training. Member states will be required to establish programmes to provide for the training and certification of personnel involved in making inspections for leakage and for those involved in the recovery, recycling, reclamation and destruction of F Gases.

Article 12 covers labelling of F Gas equipment when placed on the market.

Article 13 covers control of use, including restrictions on use for service and maintenance.

Article 19 covers reporting by producers, importers and exporters of total production / import / export by gas for production and imports; applications in which it is used as well as estimated emissions and quantities recovered, recycled and destroyed; for quantities more than 1 tonnes CO<sub>2e</sub> per annum.

##### 4.5.1 Prevention of emissions of fluorinated greenhouse gases (Article 3)

The intentional release of fluorinated greenhouse gases into the atmosphere shall be prohibited where the release is not technically necessary for the intended use.

Operators of equipment that contains fluorinated greenhouse gases shall take measures which are technically and economically feasible to minimise leakage of fluorinated greenhouse gases.

Where a leakage of fluorinated greenhouse gases is detected, the operators shall ensure that the equipment is repaired without undue delay, and where the equipment is subject to leak checking under Article 4 the repair needs to be checked by a certified person within 1 month.

##### 4.5.2 Leak checks (Article 4)

Article 4 requires that operators of the following equipment that contains F Gases in quantities of 5 tonnes or more CO<sub>2e</sub> and not contained in foams shall ensure that the equipment is checked for leaks:

- stationary refrigeration equipment (a);
- stationary air conditioning equipment (b);
- stationary heat pumps (c);

- stationary fire protection equipment (d);
- refrigeration units of refrigerated trucks and trailers (e);
- electrical switchgear (f); and
- organic Rankine cycles (g).

Except for:

- hermetically sealed equipment that contains f-gases in quantities of less than 10 tonnes CO<sub>2</sub>e, provided the equipment is labelled as hermetically sealed;
- electrical switchgear:
  - with tested leakage of less than 0.1% per year and labelled accordingly;
  - equipped with a pressure or density monitoring device; and
  - that contains less than 6 kg F gases.

Under the former regulation the thresholds for determining the frequency of leak checks were at 3 kg, 30 kg and 300 kg of F Gases. The thresholds are now at 5 kg, 50 kg and 500 tonnes CO<sub>2</sub>e. Therefore, the charge size thresholds will vary by refrigerant gas and respective GWP as detailed in Table 11. This will lead to some systems being categorised differently. Operators of systems using gases with GWP more than 1666 may find that they need to carry out more frequent leak checks, and those with systems using gases with GWP less than 1666 can find that they can carry out less frequent checks. It should be noted that most systems will continue to have the same requirement, listed in Appendix 3.

Leak detection frequency for typically used refrigerants is shown in Appendix 4.

#### 4.5.3 Leakage detection systems (Article 5)

The intentional release of fluorinated greenhouse gases into the atmosphere shall be prohibited where the release is not technically necessary for the intended use.

Operators of equipment that contains fluorinated greenhouse gases shall take measures which are technically and economically feasible to minimise leakage of fluorinated greenhouse gases.

Where a leakage of fluorinated greenhouse gases is detected, the operators shall ensure that the equipment is repaired without undue delay

Operators of the equipment listed in points (a) to (d) in 4.5.2 and containing fluorinated greenhouse gases in quantities of 500 tonnes of CO<sub>2</sub> equivalent or more, shall ensure that the equipment is provided with a leakage detection system. Operators of the equipment listed in points (f) and (g) in 4.5.2 and containing fluorinated greenhouse gases in quantities of 500 tonnes of CO<sub>2</sub>e or more and installed from 1<sup>st</sup> January 2017, shall ensure that this equipment is provided with a leakage detection system. In this condition if the equipment is listed in points (a) to (d) and (g) leakage detection systems are checked at least once every 12 months. Otherwise, they are checked at least once every 6 years

Leak detection system requirements are shown in Appendix 4.

#### 4.5.4 Inventory, recovery and record keeping (Article 6 and 9)

The first step is to provide an inventory of these gases, with inputs output and losses accounted for.

EIGA Doc 30, *Disposal of Gases* gives information on how to manage these gases for recycling or destruction [5].

The regulations enhance previous requirements for record keeping. Operators of equipment are required to be checked for leakages such that records will be required for each piece of equipment regardless of charge size.

Operators of equipment which is required to be checked for leaks pursuant to 4.5.2, shall establish and maintain records for each piece of such equipment specifying the following information:

- The quantity and type of fluorinated greenhouse gases installed.
- The quantities of fluorinated greenhouse gases added during installation, maintenance or servicing or due to leakage.
- Whether the quantities of installed fluorinated greenhouse gases have been recycled or reclaimed, including the name and address of the recycling or reclamation facility and, where applicable, the certificate number.
- The quantity of fluorinated greenhouse gases recovered.
- The identity of the undertaking which installed, serviced, maintained and where applicable repaired or decommissioned the equipment, including, where applicable, the number of its certificate.
- The dates and results of the checks carried out in 4.5.2.
- If the equipment was decommissioned, the measures taken to recover and dispose of the fluorinated greenhouse gases.

The regulations also introduce additional requirements for undertakings supplying fluorinated gases. They shall establish and maintain for at least 5 years records of relevant information on the purchasers of such gases, including the number of their certificate and quantities of fluorinated greenhouse gases purchased. These records shall be made available on request to the competent authority or Commission.

#### **4.5.5 Certification and training (Article 10)**

Anyone undertaking service, maintenance or leak checking (carrying out the tasks referred to in points (a) to (c) of Article 10(1)) shall be certified in accordance with Article 10(4) and (7) and shall take precautionary measures to prevent leakage of fluorinated greenhouse gases.

Companies carrying out the installation, servicing, maintenance, repair or decommissioning of the equipment listed in points (a) to (d) of Article 4(2) shall be certified in accordance with Article 10(6) and (7) and shall take precautionary measures to prevent leakage of fluorinated greenhouse gases.

Article 11(4) states that "*For the purposes of carrying out the installation, servicing, maintenance or repair of the equipment that contains fluorinated greenhouse gases or whose functioning relies upon those gases for which certification or attestation is required in Articles 10, F Gases shall only be sold to and purchased by undertakings that hold relevant (F Gases) certificates or attestations....or ...that employ persons holding a certificate or training attestation...*". This will impact a variety of applications as defined in Article 10, as summarised in Appendix 5.

The regulation defines compliance to the supply controls to be demonstrated via keeping records of details of certification in a customer sales database.

Therefore, it is important that EIGA members ensure that they are correctly trained and/or certified to purchase and use F Gases and that they ensure that their sales and record keeping processes are modified as necessary to ensure that they conform to responsible supply obligations as detailed in Articles 10 and 11(4).

The certification of individuals and companies needs to be checked and valid certificates kept.

Commission Implementing Regulation (EU) 2015/2066 and Commission Implementing Regulation (EU) 2015/2067 establish for the purpose of Regulation (EU) No 517/2014 on fluorinated greenhouse gases, minimum requirements and the conditions for mutual recognition for the certification of natural persons for [6, 7, 1]:

- installation, servicing, maintenance, repair or decommissioning of electrical switchgear containing fluorinated greenhouse gases or recovery of fluorinated greenhouse gases from stationary electrical switchgear (Implementing Regulation (EU) 2015/2066) [6]; and
- stationary refrigeration, air conditioning and heat pump equipment, and refrigeration units of refrigerated trucks and trailers, containing fluorinated greenhouse gases and for the certification of companies as regards stationary refrigeration, air conditioning and heat pump equipment, containing fluorinated greenhouse gases (Implementing Regulation (EU) 2015/2067) [7].

#### **4.5.6 Market restrictions and use of F Gases in new equipment (Article 11)**

Use of new F gases with GWP of 2500 or more is banned for stationary refrigeration equipment from 1<sup>st</sup> January 2020, except equipment intended for applications designed to cool products to temperatures below –50 °C.

The impact on EIGA members is that commonly used refrigerants such as R134a may continue to be specified for new plants, where they are intended to cool products below –50 °C.

Other market restrictions are listed in Appendix 3.

Service providers may not be aware of this exemption, where –50 °C exemption is to be understood not as that of the cold end of the cooling unit but as the temperature of the final intended product, for example –180 °C or lower for cryogenics.

In this sense, the following are examples of those eligible to exemptions:

- 5 °C or –20 °C cooling units on entering air into air distillation column; and
- 20 °C to –40 °C cooling unit on liquefier.

#### **4.5.7 Labelling (Article 12)**

Labelling regulations impact EIGA members that supply F Gases.

Article 12 states that “*Products and equipment that contain fluorinated greenhouse gases....shall not be placed on the market unless they are labelled*”.

Exact labelling requirements are dictated by Implementing Regulation (EU) 2015/2068 [8].

The information on a label shall stand out clearly from the background of the label and shall be of such size and spacing as to be clearly readable. The entire label and its contents shall be designed so as to ensure that it remains securely in place on the product or equipment and shall be legible under normal operational conditions, throughout the entire period during which the product or equipment contains fluorinated greenhouse gases.

Products and equipment, containing F Gases, shall be marked with a label containing the:

- text ‘Contains fluorinated greenhouse gases’;
- accepted industry designation for the fluorinated greenhouse gases concerned or, if no such designation is available, the chemical name; and

- quantity expressed in kilograms and in CO<sub>2</sub>e tonnes of fluorinated greenhouse gases contained in the product or equipment, or the quantity of fluorinated greenhouse gases for which the equipment is designed, and the global warming potential of those gases.

When equipment is pre-charged with, or when its functioning relies upon, fluorinated greenhouse gases and such gases may be added outside the manufacturing site and the resulting total quantity is not defined by the manufacturer, the label shall contain the quantity charged at the manufacturing site, or the quantity for which it is designed, and shall provide space on the label for the quantity added outside the manufacturing site as well as for the resulting total quantity of fluorinated greenhouse gases.

When the fluorinated greenhouse gases are intended to serve for certain uses, the following text shall be included in the label:

- '100% Reclaimed' or '100% Recycled', for reclaimed or recycled fluorinated greenhouse gases not containing any virgin fluorinated greenhouse gases. The address of the reclamation or of the recycling facility shall include its street address in the Union.
- 'Imported for destruction only': for fluorinated greenhouse gas quantities imported for destruction.
- 'For direct bulk export outside EU only', for fluorinated greenhouse gas quantities being supplied by a producer or importer to an undertaking for direct export in bulk out of the Union.
- 'For use in military equipment only', for fluorinated greenhouse gas quantities which are to be used in military equipment.
- 'For etching/cleaning in semiconductor industry only', for fluorinated greenhouse gas quantities which are to be used for etching and cleaning purposes in semiconductor industry.
- 'For feedstock use only', for fluorinated greenhouse gas quantities serving as feedstock.
- 'For MDI production only', for fluorinated greenhouse gas quantities intended for the delivery of pharmaceutical ingredients in metered-dose inhalers (MDIs).

#### **4.5.8 Control of use, service and maintenance restrictions (Article 13)**

The recharging during service and maintenance of existing refrigeration equipment, with a charge size of over 40 tonnes of CO<sub>2</sub>e and with a GWP of 2500 or more, will not be permitted from 2020 onwards.

Use of reclaimed gas for maintenance is authorised but those shall come from the concerned installation. Proof of this shall be kept.

This means refrigerants commonly used by EIGA members with GWP less than 2500, such as R134a, can therefore continue to be used freely. This minimises the impact on the environment by making sure we can maintain high energy efficiency of large industrial cryogenic installations.

This provision does not apply to equipment intended for applications designed to cool products to below -50 °C. In addition, reclaimed and recycled F Gases with a GWP greater than 2500 can still be used for the service and maintenance of existing equipment until 2030.

This means that other gases such as R507, with a GWP more than 2500, which were used as a replacement for ozone depleting substances, can also continue to be used, avoiding the high environmental and cost impact of equipment replacement.

#### **4.5.9 Market restrictions and quotas (Article 14 to 18)**

The regulation introduces a phase down of F Gases with a reduction in the amount of F Gases to be placed on the market in the EU by 79% by 2030; this will impact EIGA members who supply F-gas, as supplies will be restricted. Annex V indicates with a declining cap on supply starting in 2015. Quotas will be allocated based on historical sales in the period 2009 - 2012 (article 14/ Annex V).

Those producing or importing HFC F Gases from outside the EU need to apply to the Commission for quota allocations. List of concerned gases is in Appendix 1.

Unused quotas may be sold and traded.

#### 4.5.10 Reporting (Article 19)

Importers of HFC and PFC from outside the EU, exporters and producers are required to report data to the Commission on an annual basis, similar to the existing regulation. List of concerned products is in Appendix 2.

NOTE Reporting shall be done to both national authorities and to European authorities.

NOTE Not all countries with EIGA members are in the EU and import, export and reporting requirements will apply. for example from 1<sup>st</sup> January 2021 F gases sent from the EU to UK are exported from the EU and products sent from UK to EU are now imports.

## 5 References

Unless otherwise specified, the latest edition shall apply.

- [1] Regulation (EU) No 517/2014 *on fluorinated greenhouse gases*, [www.europa.eu](http://www.europa.eu).
- [2] The Montreal Protocol, [www.unenvironment.org](http://www.unenvironment.org).
- [3] The Kyoto Protocol, [www.unfccc.int](http://www.unfccc.int).
- [4] Regulation (EC) No 842/2006 *on certain fluorinated greenhouse gases*, [www.europa.eu](http://www.europa.eu).
- [5] EIGA Doc 30, *Disposal of Gases*, [www.eiga.eu](http://www.eiga.eu).
- [6] Implementing Regulation (EU) 2015/2066 *establishing, pursuant to Regulation (EU) No 517/2014 of the European Parliament and of the Council, minimum requirements and the conditions for mutual recognition for the certification of natural persons carrying out installation, servicing, maintenance, repair or decommissioning of electrical switchgear containing fluorinated greenhouse gases or recovery of fluorinated greenhouse gases from stationary electrical switchgear*, [www.europa.eu](http://www.europa.eu).
- [7] Commission Implementing Regulation (EU) 2015/2067 *establishing, pursuant to Regulation (EU) No 517/2014 of the European Parliament and of the Council, minimum requirements and the conditions for mutual recognition for the certification of natural persons as regards stationary refrigeration, air conditioning and heat pump equipment, and refrigeration units of refrigerated trucks and trailers, containing fluorinated greenhouse gases and for the certification of companies as regards stationary refrigeration, air conditioning and heat pump equipment, containing fluorinated greenhouse gases*, [www.europa.eu](http://www.europa.eu).
- [8] Implementing Regulation (EU) 2015/2068 *establishing, pursuant to Regulation (EU) No 517/2014 of the European Parliament and of the Council, the format of labels for products and equipment containing fluorinated greenhouse gases*, [www.europa.eu](http://www.europa.eu).

## Appendix 1 – Fluorinated gases Annex 1

Substance			GWP <sup>1)</sup>
Industrial designation	Chemical name (Common name)	Chemical formula	
Section 1: Hydrofluorocarbons (HFCs)			
HFC-23	Trifluoromethane (fluoroform)	CHF <sub>3</sub>	14 800
HFC-32	Difluoromethane	CH <sub>2</sub> F <sub>2</sub>	675
HFC-41	Fluoromethane (methyl fluoride)	CH <sub>3</sub> F	92
HFC-125	Pentafluoroethane	CHF <sub>2</sub> CF <sub>3</sub>	3500
HFC-134	1,1,2,2-tetrafluoroethane	CHF <sub>2</sub> CHF <sub>2</sub>	1100
HFC-134a	1,1,1,2-tetrafluoroethane	CH <sub>2</sub> FCF <sub>3</sub>	1430
HFC-143	1,1,2-trifluoroethane	CH <sub>2</sub> FCHF <sub>2</sub>	353
HFC-143a	1,1,1-trifluoroethane	CH <sub>3</sub> CF <sub>3</sub>	4470
HFC-152	1,2-difluoroethane	CH <sub>2</sub> FCH <sub>2</sub> F	53
HFC-152a	1,1-difluoroethane	CH <sub>3</sub> CHF <sub>2</sub>	124
HFC-161	Fluoroethane (ethyl fluoride)	CH <sub>3</sub> CH <sub>2</sub> F	12
HFC-227ea	1,1,1,2,3,3,3-heptafluoropropane	CF <sub>3</sub> CHF <sub>2</sub> CF <sub>3</sub>	3220
HFC-236cb	1,1,1,2,2,3-hexafluoropropane	CH <sub>2</sub> FCF <sub>2</sub> CF <sub>3</sub>	1340
HFC-236ea	1,1,1,2,3,3-hexafluoropropane	CHF <sub>2</sub> CHF <sub>2</sub> CF <sub>3</sub>	1370
HFC-236fa	1,1,1,3,3,3-hexafluoropropane	CF <sub>3</sub> CH <sub>2</sub> CF <sub>3</sub>	9810
HFC-245ca	1,1,2,2,3-pentafluoropropane	CH <sub>2</sub> FCF <sub>2</sub> CHF <sub>2</sub>	693
HFC-245fa	1,1,1,3,3-pentafluoropropane	CHF <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub>	1030
HFC-365mfc	1,1,1,3,3-pentafluorobutane	CF <sub>3</sub> CH <sub>2</sub> CF <sub>2</sub> CH <sub>3</sub>	794
HFC-43-10mee	1,1,1,2,2,3,4,5,5,5-decafluoropentane	CF <sub>3</sub> CHFCH <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>	1640
Section 2: Perfluorocarbons (PFCs)			
PFC-14	Tetrafluoromethane (perfluoromethane, carbon tetrafluoride)	CF <sub>4</sub>	7390
PFC-116	Hexafluoroethane (perfluoroethane)	C <sub>2</sub> F <sub>6</sub>	12 200
PFC-218	Octafluoropropane (perfluoropropane)	C <sub>3</sub> F <sub>8</sub>	8830
PFC-3-1-10 (R-31-10)	Decafluorobutane (perfluorobutane)	C <sub>4</sub> F <sub>10</sub>	8860
PFC-4-1-12 (R-41-12)	Dodecafluoropentane (perfluoropentane)	C <sub>5</sub> F <sub>12</sub>	9160
PFC-5-1-14 (R-51-14)	Tetradecafluorohexane (perfluorohexane)	C <sub>6</sub> F <sub>14</sub>	9300
PFC-c-318	Octafluorocyclobutane (perfluorocyclobutane)	c-C <sub>4</sub> F <sub>8</sub>	10 300
Section 3: Other perfluorinated compounds			
	Sulphur hexafluoride	SF <sub>6</sub>	22 800
<sup>1)</sup> Based on the Fourth Assessment Report adopted by the Intergovernmental Panel on Climate Change, unless otherwise indicated.			

## Appendix 2 – Annex II Gases subject to reporting only

Substance		GWP <sup>1)</sup>
Common name / industrial designation	Chemical formula	
Section 1: Unsaturated hydro(chloro)fluorocarbons		
HFC-1234yf	CF <sub>3</sub> CF = CH <sub>2</sub>	4 Fn <sup>2)</sup>
HFC-1234ze	trans — CHF = CHCF <sub>3</sub>	7 Fn <sup>2)</sup>
HFC-1336mzz	CF <sub>3</sub> CH = CHCF <sub>3</sub>	9
HCFC-1233zd	C <sub>3</sub> H <sub>2</sub> ClF <sub>3</sub>	4.5
HCFC-1233xf	C <sub>3</sub> H <sub>2</sub> ClF <sub>3</sub>	1 Fn <sup>3)</sup>
Section 2: Fluorinated ethers and alcohols		
HFE-125	CHF <sub>2</sub> OCHF <sub>3</sub>	14 900
HFE-134 (HG-00)	CHF <sub>2</sub> OCHF <sub>2</sub>	6320
HFE-143a	CH <sub>3</sub> OCHF <sub>3</sub>	756
HCFE-235da2 (isofluorane)	CHF <sub>2</sub> OCHClCF <sub>3</sub>	350
HFE-245cb2	CH <sub>3</sub> OCHF <sub>2</sub> CF <sub>3</sub>	708
HFE-245fa2	CHF <sub>2</sub> OCH <sub>2</sub> CF <sub>3</sub>	659
HFE-254cb2	CH <sub>3</sub> OCHF <sub>2</sub> CHF <sub>2</sub>	359
HFE-347 mcc3 (HFE-7000)	CH <sub>3</sub> OCHF <sub>2</sub> CF <sub>2</sub> CF <sub>3</sub>	575
HFE-347pcf2	CHF <sub>2</sub> CF <sub>2</sub> OCH <sub>2</sub> CF <sub>3</sub>	580
HFE-356pcc3	CH <sub>3</sub> OCHF <sub>2</sub> CF <sub>2</sub> CHF <sub>2</sub>	110
HFE-449sl (HFE-7100)	C <sub>4</sub> F <sub>9</sub> OCH <sub>3</sub>	297
HFE-569sf2 (HFE-7200)	C <sub>4</sub> F <sub>9</sub> OCH <sub>2</sub> H <sub>5</sub>	59
HFE-43-10pccc124 (H-Galden 1040x) HG-11	CHF <sub>2</sub> OCHF <sub>2</sub> OCH <sub>2</sub> F <sub>4</sub> OCHF <sub>2</sub>	1870
HFE-236ca12 (HG-10)	CHF <sub>2</sub> OCHF <sub>2</sub> OCHF <sub>2</sub>	2800
HFE-338pcc13 (HG-01)	CHF <sub>2</sub> OCHF <sub>2</sub> CF <sub>2</sub> OCHF <sub>2</sub>	1500
HFE-347mmy1	(CF <sub>3</sub> ) <sub>2</sub> CFOCH <sub>3</sub>	343
2,2,3,3,3-pentafluoropropanol	CF <sub>3</sub> CF <sub>2</sub> CH <sub>2</sub> OH	42
bis(trifluoromethyl)-methanol	(CF <sub>3</sub> ) <sub>2</sub> CHOH	195
HFE-227ea	CF <sub>3</sub> CHFOCF <sub>3</sub>	1540
HFE-236ea2 (desfluoran)	CHF <sub>2</sub> OCHF <sub>2</sub> CF <sub>3</sub>	989
HFE-236fa	CF <sub>3</sub> CH <sub>2</sub> OCHF <sub>3</sub>	487
HFE-245fa1	CHF <sub>2</sub> CH <sub>2</sub> OCHF <sub>3</sub>	286
HFE 263fb2	CF <sub>3</sub> CH <sub>2</sub> OCH <sub>3</sub>	11
HFE-329 mcc2	CHF <sub>2</sub> CF <sub>2</sub> OCHF <sub>2</sub> CF <sub>3</sub>	919
HFE-338 mcf2	CF <sub>3</sub> CH <sub>2</sub> OCHF <sub>2</sub> CF <sub>3</sub>	552
HFE-338mmz1	(CF <sub>3</sub> ) <sub>2</sub> CHOCHF <sub>2</sub>	380
HFE-347 mcf2	CHF <sub>2</sub> CH <sub>2</sub> OCHF <sub>2</sub> CF <sub>3</sub>	374
HFE-356 mec3	CH <sub>3</sub> OCHF <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub>	101
HFE-356mm1	(CF <sub>3</sub> ) <sub>2</sub> CHOCH <sub>3</sub>	27

HFE-356pcf2	CHF2CH2OCF2CHF2	265
HFE-356pcf3	CHF2OCH2CF2CHF2	502
HFE 365 mcf3	CF3CF2CH2OCH3	11
HFE-374pc2	CHF2CF2OCH2CH3	557
	- (CF2)4CH (OH)-	73
Section 3: Other perfluorinated compounds		
perfluoropolymethylisopropyl-ether (PFPMIE)	CF3OCF(CF3)CF2OCF2OCF3	10 300
nitrogen trifluoride	NF3	17 200
trifluoromethyl sulphur pentafluoride	SF5CF3	17 700
perfluorocyclopropane	c-C3F6	17 340Fn <sup>4)</sup>
<p>1) Based on the Fourth Assessment Report adopted by the Intergovernmental Panel on Climate Change, unless otherwise indicated.</p> <p>2) GWP according to the Report of the 2010 Assessment of the Scientific Assessment Panel (SAP) of the Montreal Protocol, Tables 1-11, citing two peer-reviewed scientific references.</p> <p>3) Default value, global warming potential not yet available.</p> <p>4) Minimum value according to the Fourth Assessment Report adopted by the Intergovernmental Panel on Climate Change.</p>		

## Appendix 3 – Placing on the market prohibitions, Annex III

Products and equipment Where relevant, the GWP of mixtures containing fluorinated greenhouse gases shall be calculated in accordance with Annex IV, as provided for in point 6 of Article 2		Date of prohibition	
1.	Non-refillable containers for fluorinated greenhouse gases used to service, maintain or fill refrigeration, air-conditioning or heat-pump equipment, fire protection systems or switchgear, or for use as solvents	4 July 2007	
2.	Non-confined direct evaporation systems that contain HFCs and PFCs as refrigerants	4 July 2007	
3.	Fire protection equipment	that contain PFCs	4 July 2007
		that contain HFC-23	1 January 2016
4.	Windows for domestic use that contain fluorinated greenhouse gases	4 July 2007	
5.	Other windows that contain fluorinated greenhouse gases	4 July 2008	
6.	Footwear that contains fluorinated greenhouse gases	4 July 2006	
7.	Tyres that contain fluorinated greenhouse gases	4 July 2007	
8.	One-component foams, except when required to meet national safety standards, that contain fluorinated greenhouse gases with GWP of 150 or more	4 July 2008	
9.	Aerosol generators marketed and intended for sale to the general public for entertainment and decorative purposes, as listed in point 40 of Annex XVII to Regulation (EC) No 1907/2006, and signal horns, that contain HFCs with GWP of 150 or more	4 July 2009	
10.	Domestic refrigerators and freezers that contain HFCs with GWP of 150 or more	1 January 2015	
11.	Refrigerators and freezers for commercial use (hermetically sealed equipment)	that contain HFCs with GWP of 2 500 or more	1 January 2020
		that contain HFCs with GWP of 150 or more	1 January 2022
12.	Stationary refrigeration equipment, that contains, or whose functioning relies upon, HFCs with GWP of 2 500 or more except equipment intended for application designed to cool products to temperatures below – 50 °C	1 January 2020	
13.	Multipack centralised refrigeration systems for commercial use with a rated capacity of 40 kW or more that contain, or whose functioning relies upon, fluorinated greenhouse gases with GWP of 150 or more, except in the primary refrigerant circuit of cascade systems where fluorinated greenhouse gases with a GWP of less than 1 500 may be used	1 January 2022	
14.	Movable room air-conditioning equipment (hermetically sealed equipment which is movable between rooms by the end user) that contain HFCs with GWP of 150 or more	1 January 2020	
15.	Single split air-conditioning systems containing less than 3 kg of fluorinated greenhouse gases, that contain, or whose functioning relies upon, fluorinated greenhouse gases with GWP of 750 or more	1 January 2025	
16.	Foams that contain HFCs with GWP of 150 or more except when required to meet national safety standards	Extruded polystyrene (XPS)	1 January 2020
		Other foams	1 January 2023
17.	Technical aerosols that contain HFCs with GWP of 150 or more, except	1 January	

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when required to meet national safety standards or when used for medical applications	2018
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## Appendix 4 – Leak detection requirements

System F Gases contents	Leak Check Frequency (no leak detection system installed)	Leak Check Frequency (leak detection system installed)
500 tonnes (CO <sub>2</sub> e) or more	At least once every 3 months	At least once every 6 months
50 to 500 tonnes (CO <sub>2</sub> e)	At least once every 6 months	At least once every 12 months
5 to 50 tonnes (CO <sub>2</sub> e)	At least once every 12 months	At least once every 24 months

Product R-Number	Other Names	GWP	Leak Detection:	Leak Detection:	Leak Detection:
			5 tonnes (CO <sub>2</sub> e) kg threshold equivalent	50 tonnes (CO <sub>2</sub> e) kg threshold equivalent	500 tonnes (CO <sub>2</sub> e) kg threshold equivalent
23		14800	0.34	3.4	34
32		675	7.4	74.1	741
134a		1430	3.5	35.0	350
404A	SUVA HP62, Forane FX70	3922	1.3	12.7	127
407A	Klea 60	2107	2.4	23.7	237
407C	Klea 66, Suva 9000	1774	2.8	28.2	282
407F	Performax LT	1825	2.7	27.4	274
410A	Genetron AZ-20	2088	2.4	23.9	239
417A	ISCEON MO59	2346	2.1	21.3	213
422A	ISCEON MO79	3143	1.6	15.9	159
422D	ISCEON MO29	2729	1.8	18.3	183
423A	ISCEON 39TC	2280	2.2	21.9	219
424A	RS-44	2440	2.0	20.5	205
427A	Forane FX100	2138	2.3	23.4	234
R428A	RS-52	3607	1.4	13.9	139
434A	RS-45	3245	1.5	15.4	154
438A	ISCEON MO99	2265	2.2	22.1	221
442A	RS-50	1888	2.6	26.5	265
507A	Genetron AZ-50	3985	1.3	12.5	125
508B	SUVA 95	13396	0.37	3.7	37
MO89	ISCEON MO89	3805	1.3	13.1	131

## Appendix 5 – Leak detection systems

<b>F-Gas</b>
Operators of stationary refrigeration equipment containing fluorinated greenhouse gases in quantities of 500 tonnes CO <sub>2</sub> e of more shall ensure that the equipment is provided with a leakage detection system which alerts the operator or a service company of any leakage.

<b>Equipment Group</b>	<b>Leak Detection System Needs</b>	<b>Leak Detection System Check</b>
a) stationary refrigeration equipment b) stationary air conditioning equipment c) stationary heat pumps d) stationary fire protection equipment	Operators of stationary refrigeration equipment containing fluorinated greenhouse gases in quantities of 500 tonnes CO <sub>2</sub> e of more shall ensure that the equipment is provided with a leakage detection system which alerts the operator or a service company of any leakage	Leakage detection systems checked at least once every 12 months to ensure their proper functioning
e) refrigeration units of refrigerated trucks and trailers	No requirements	No requirements
f) electrical switchgear	Operators of stationary refrigeration equipment containing fluorinated greenhouse gases in quantities of 500 tonnes CO <sub>2</sub> e of more shall ensure that the equipment is provided with a leakage detection system which alerts the operator or a service company of any leakage	Leakage detection systems checked at least once every 6 years months to ensure their proper functioning
g) organic Rankine cycles	Operators of stationary refrigeration equipment containing fluorinated greenhouse gases in quantities of 500 tonnes CO <sub>2</sub> e of more shall ensure that the equipment is provided with a leakage detection system which alerts the operator or a service company of any leakage	Leakage detection systems checked at least once every 12 months to ensure their proper functioning

## Appendix 6 – Guideline on inventory of fluorinated gases

Fluorinated gases are generally released to the atmosphere in the following three types of situations:

- When they are packaged in various containers, such as aerosol spray cans. In this case what must be determined is the amount of gas consumed annually and which is not packaged.
- Either when equipment that operates with a fluorinated gas is refilled, such as large refrigeration systems for example, or when such a gas is used in an industrial process (such as SF<sub>6</sub> or PFC in the semiconductor industry) and it is difficult to recover them from the atmosphere. In this case, information concerning the amount of gas consumed is sufficient.
- In some industrial processes that involve a chemical reaction, such as the smelting of aluminium. In this case emissions are evaluated on the basis of measurements made by the manufacturer himself.

The various sources to be considered for each type of fluorinated gas and for each type of application are presented below:

### Hydrofluorocarbons or HFCs

The exact name of the HFC gases or mixtures used must always be indicated. This is because global warming potential may vary considerably depending on the type of HFC used. The various industries and applications for which HFC emissions are considered are:

Large refrigeration and air-conditioning systems emissions generally occur during maintenance operations and mainly when equipment is drained or refilled. A good idea of emissions is obtained if the operator of the equipment provides information concerning the frequency of refilling operations (once a year, every two years, etc.) and provides an inventory of the amounts of the HFC gases used and their type, as mentioned above.

### Perfluorocarbons or PFCs

PFC used in the semiconductor industry.

This includes PFC 116, PFC 14 and other types that the fab plant operator must indicate along with their global warming power. PFC gases are used to etch microprocessors. There is an international consensus that 72% of the PFC gases used by this industry are released to the atmosphere when no recycling or treatment system is used.

Since all of the gases used are by definition released to the atmosphere, the plant operator must indicate the amount of each PFC gas used each year and then multiply this amount by 72%.

### Nitrogen trifluoride (NF<sub>3</sub>)

Nitrogen trifluoride, the global warming potential of which is 8000 times that of carbon dioxide, is used for the same purposes as PFC. The emission coefficient is also the same. Plant operators must also indicate the amounts used each year.

### Sulphur hexafluoride (SF<sub>6</sub>)

The GWP of sulphur hexafluoride is 23 900 times that of carbon dioxide. A relatively small quantity may therefore have a substantial impact on global warming.

Sulphur hexafluoride emissions in magnesium foundries:

All of the sulphur hexafluoride used is released to the atmosphere. The foundry operator must indicate the total amount of sulphur hexafluoride used during the past year.