Department for Environment, Food and Rural Affairs

General Guidance

Guidance: F Gas and Ozone Regulations

Information Sheet GEN 3: Markets & Equipment

April 2012

Contents

1 Introduction 1

2 Summary of Key Markets 1

3 Regulatory Obligations 1

4 Market Overviews and Alternative Fluids and Technologies 3

1 Introduction

This Information Sheet provides a general description of the main uses of Fluorinated greenhouse gases (F gases) and Ozone Depleting Substances (ODS). It is intended to help end users identify whether they are using these fluids and, hence, whether they are affected by either or both the EU F gas and Ozone Regulations.

The Information Sheet also provides some brief information about alternative fluids or techniques that could be used in place of F gases or ODS.

Please refer to Information Sheet GEN 1 for a glossary of terms and acronyms, GEN 2 for a detailed list of F gases and ODS, to GEN 4 for listing and links to all relevant regulations and Information Sheet GEN 5 for guidance on estimating refrigerant charge.

2 Summary of Key Markets

The main markets in which F gases and ODS are used are summarised in Table 1. It is important to review the whole table carefully to identify any possible uses of F gas or ODS in your organisation. Further details about each of the market sectors are given in Section 4 of this Information Sheet.

3 Regulatory Obligations

There are obligations in the F gas Regulation (EU Regulation 842/2006) and the Ozone Regulation (EU Regulation 1005/2009 (EC 2037/2000 has been revoked and replaced by EC 1005/2009)) that affect many of the sectors listed in Table 1. In some cases the obligations lie with the owner / operator of the equipment. In other situations the obligations lie with third parties, such as equipment suppliers, maintenance contractors and waste handling companies.

The following is a summary of uses and sectors affected:

- **Stationary Refrigeration and Air-conditioning** - Users of these systems have numerous obligations to prevent leakage of F gas refrigerants, especially for any equipment containing 3 kg or more of refrigerant. RAC systems using hydrochlorofluorocarbons (HCFC) refrigerants such as R22 need to address a ban on the use of this refrigerant which comes into force in 2010 for virgin refrigerant and in 2015 for recycled fluid. There are also many obligations that apply to RAC system suppliers and maintenance contractors, especially related to the use of appropriately qualified personnel and certification of companies.

- **Fire Protection** - users of fire protection systems have many similar obligations related to leakage prevention and use of qualified personnel and certification of companies.

- **Mobile Air-Conditioning, Solvent Cleaning & Switchgear containing sulphur hexafluoride** – the obligations for these sectors are more limited in scope – mainly relating to proper recovery of gas during maintenance and at end of life and use of appropriately qualified personnel.

- **Bans** - A number of sectors are affected by bans on F gas usage; these include novelty aerosols, one component foam, magnesium die casting and non-refillable containers.

- **Other sectors** - Some sectors such as electronics manufacture, foam blowing and aluminium smelting have no specific obligations under the Regulations, but all users should be aware that emissions of F gases are very harmful to the environment and should be making all practical and economically feasible efforts to reduce emissions.

Table 1 F Gas and ODS End Use Markets

	End Use Sub-Sector	Currently use F Gas	Currently use ODS
Stationary refrigeration and air-conditioning (RAC) systems	Industrial refrigeration	✓	✓
	Commercial refrigeration	✓	✓
	Domestic refrigeration	✓	×
	Building air-conditioning	✓	✓
	Heat pumps	✓	✓
Mobile refrigeration and air-conditioning (MAC) systems	Mobile air-conditioning in cars	✓	×
	Mobile air-conditioning in vans	✓	×
Other transport refrigeration and air-conditioning	Other transport air-conditioning	✓	✓
	Refrigerated transport	✓	✓
Fire protection systems (FP)	Stationary fire protection systems	✓	×
	Portable fire extinguishers	✓	×
High voltage switchgear containing sulphur hexafluoride (SF_6)	Electricity supply industry	✓	×
	Factory based switchgear	✓	×
Aerosols	Technical aerosols	✓	×
	Novelty aerosols	✓	×

	One component foam (OCF)	✓	×
	Metered dose inhalers (MDI)	✓	×
Specialised uses	Magnesium smelting	✓	×
	Electronics manufacture	✓	×
	Solvent cleaning	✓	✓
	Military Applications	✓	✓
	Rigid insulating foam manufacture	✓	×
	By-product from aluminium smelting	✓	×
	By-product from R22 manufacture	✓	×
Less common uses	Double glazing	✓	×
	Car tyres	✓	×
	Cosmetics	✓	×
	Laboratory and scientific applications	✓	×

4 Market Overviews and Alternative Fluids and Technologies

4.1 Stationary Refrigeration and Air-Conditioning (RAC) Systems

RAC systems are used in all parts of the economy; this is the largest single market where F gases and ODS are used. The sector includes:

- Refrigeration – in which products and spaces are held at temperatures below ambient.
- Air conditioning – in which buildings and other occupied spaces are cooled to a comfortable ambient temperature.
- Heat pumps – in which waste heat is collected at a low temperature and delivered as useful heat energy at a temperature above ambient.

All three of these types of system can be based on similar equipment. The most common is electrically driven "vapour compression refrigeration". The refrigerants used in such systems are often hydrofluorocarbons (HFCs), which are F gases or hydrochlorofluorocarbons (HCFCs) which are ODS. There are many different types of fluids in use – see Information Sheet GEN 2 for a comprehensive list.

Historically many stationary refrigeration systems gave rise to significant F gas and ODS emissions through leakage during normal use and venting during maintenance or at end of life. The Regulations are intended to improve containment, so preventing emissions, by ensuring that leakage rates are reduced and that all refrigerant is recovered during maintenance and at end of plant life. Better plant design, construction and maintenance should enable emission rates to fall significantly.

There are a number of alternative refrigerants available that should be considered whenever new plants are being purchased.

- For larger industrial refrigeration and air-conditioning systems **ammonia** is a well established refrigerant which can provide a high efficiency system. Ammonia has a zero Global Warming Potential (GWP) and Ozone Depleting Potential (ODP); hence it is an excellent refrigerant from the climate change and ozone perspective. However, ammonia is highly toxic and slightly flammable, so it is not suitable in all situations.

- For very small systems **hydrocarbons** such as iso-butane have become well established. Well over 100 million hydrocarbon refrigerators and freezers are in operation in Europe – these typically contain under 100 grammes of refrigerant. Hydrocarbons have a very low GWP and a zero ODP. However, the high flammability of hydrocarbons makes them difficult to use if the system charge is much above 1 kg, unless the refrigeration system is in a safe location.

- There is growing interest in using **carbon dioxide** (CO_2) as a refrigerant. CO_2 has been used successfully in small systems (e.g. Coca Cola display cabinets), in larger commercial refrigeration systems (e.g. in supermarkets) and in some industrial applications. CO_2 has a very low GWP and a zero ODP. However, CO_2 systems run at much higher pressures than a conventional refrigeration system and this creates a number of technical barriers.

4.2 Mobile Air-Conditioning (MAC) and Transport Refrigeration

There is widespread use of Mobile Air-conditioning (MAC) in cars and light vans. These systems all use HFC 134a as the refrigerant. Historically MAC systems tended to leak quite badly, although the best modern designs are much less prone to leakage than older systems.

The use of MACs will be affected slightly by the EU F gas Regulation and more significantly by a further piece of legislation, the MAC Directive (EU Directive 40/2006). Under the EU F gas Regulation car maintenance companies will need to ensure their personnel hold an appropriate qualification and that refrigerant is always properly recovered during servicing, maintenance and at end of life. Under the MAC Directive the use of HFC 134a in new vehicles will be banned between 2011 and 2017 (the ban affects new “vehicle types” as they are introduced after the beginning of 2011). The ban requires that the refrigerant used in a MAC system has a GWP below 150. Fluid suppliers have been investigating low GWP alternatives to R134a that will meet the needs of the MAC

Directive. The Honeywell/Dupont refrigerant HFO-1234yf is the new refrigerant chosen to replace R134a in the automotive market.

Some larger vehicles such as coaches, trains and agricultural vehicles also use HFC MAC systems. These are not explicitly affected by the MAC Directive or the EU F gas Regulation, except that F gases should be recovered by appropriately qualified personnel.

Refrigerated transport is in widespread use, e.g. refrigerated lorries and vans, refrigerated containers and refrigerated rail wagons. These all use HFC or HCFC refrigerants. Any HCFC systems are subject to the phase out of HCFCs which began in January 2010. HFC systems are currently not explicitly covered by the EU F gas Regulation. However, both HCFC and HFC refrigerants should be recovered by appropriately qualified personnel.

4.3 Fire Protection Systems

F gases are used as fire fighting agents in certain specialised applications e.g. for buildings protecting valuable items or critical plant or machinery such as electronic systems serving computer centres and telecoms, data warehouses, clean rooms, industrial process control rooms, petrochemical factories. Various HFCs are effective as fire fighting agents in fixed systems including HFC 227ea, HFC 125 and HFC 23. In addition, HFC 236fa is sometimes used in portable fire extinguishers.

Historically these types of applications were built using halons. These have a very high ozone depleting potential (ODP) and have already been banned under the EU Ozone Regulation, with the exception of some critical military uses, see EU Regulation 744/2010 for details of permitted critical uses of halons.

HFCs are selected when they are considered the most cost effective and practical option. However there are various alternatives that can be considered. An effective fluoro-ketone is available which has a GWP of less than 1 and zero ODP. Alternative technologies such as water spray systems can also be considered for certain applications.

4.4 Switchgear

Switchgear containing sulphur hexafluoride (SF_6) is used in electricity transmission and distribution systems at power stations, sub-stations and, occasionally, at end user premises where there are safety or space constraints that mean that air insulated switchgear is not a suitable alternative. SF_6 is a much better insulant and spark quenching gas than air, which is why switchgear with SF_6 has become increasingly popular and cost effective during the last 20 years.

Smaller switches are often hermetically sealed and are not prone to leakage. However, some switches, especially older ones, are built using numerous seals and can be prone to leakage. Users should ensure that “leaky” switches are repaired properly to minimise emissions.

Under the EU F gas Regulation there are obligations related to SF_6 recovery during equipment maintenance and at end of life. Any personnel involved in carrying out SF_6 handling, including gas recovery, must be properly qualified.

There is no alternative to SF_6 other than air insulated switchgear. However, if new equipment is being purchased it is possible to buy switches with very good seals that should not leak during normal use.

4.5 Aerosols

Historically many aerosols were sold using chlorofluorocarbon (CFC) propellants – indeed, these represented over 75% of emissions of ozone depleting substances during the 1980s. When the ozone problem was discovered, the use of CFCs for aerosols was quickly phased out. Many markets moved to propellants such as hydrocarbon and DME (dimethyl ether) as these were much cheaper than the new HFC alternatives such as HFC 134a. However, the high flammability of hydrocarbons and DME makes them unsuitable in some applications.

Technical aerosols are used in certain special applications such as air dusters for electronics maintenance and lubricant sprays for engineering maintenance. These are often used in enclosed locations where there is a risk of ignition – HFC propellants remain popular in such applications.

Novelty aerosols include applications such as “silly string”, artificial snow and decorative paints. These required non-flammable propellants as they might be used close to a source of ignition. Under the EU F gas Regulation the use of HFCs in novelty aerosols has been banned since July 2009.

One Component Foam (OCF) is a specialised type of aerosol that produces a spray of quick setting foam that is widely used in the professional and DIY construction industry (e.g. for filling gaps around window and door frames). OCF was widely used with HFC propellant as a large volume is often discharged in a short time and this was considered a safety risk. However, a lot of OCF is made using hydrocarbon or DME propellants, without any apparent safety issues. Under the EU F gas Regulation the use of HFC propellants in OCF has been banned since July 2008.

Metered Dose Inhalers (MDIs) are a specialised aerosol used in medical applications to dispense certain drugs (e.g. asthma inhalers). Historically these used CFC propellants and they became the last major source of CFC emissions as phase out could only happen slowly because of the complex process of reformulating a drug with a new propellant. Drug companies spent many years proving that MDIs with HFC propellants were non-toxic and effective. The CFC phase out is now complete in Europe, but most MDIs have moved to HFCs. This use will continue to be allowed under the EU F gas Regulation. Drug companies are using alternatives such as DPIs (dry powder inhalers) but these are not always as effective as MDIs.

4.6 Specialised industrial uses

Magnesium smelting requires the use of a "cover gas" to prevent molten magnesium reacting with the air. Sulphur hexafluoride (SF_6) has become a very popular cover gas in this industry. Under the EU F gas Regulation, the use of 850kg or more of SF_6 per year in magnesium die casting is banned. Other types of casting, such as sand casting, are not affected by the ban. However, there are alternatives such as HFC 134a or SO_2. Users of SF_6 should recognise that it is by far the most powerful greenhouse gas – with a GWP of 22,200 (this means that 1 kg of SF_6 emission is equivalent to 22,200 kg of CO_2) and they should make every effort to use alternatives if they are practically and economically feasible.

Electronics manufacture requires the use of various F gases for specialised processes such as silicon wafer etching. The gases used include perfluorocarbons (PFCs) and SF_6. There are no specific obligations in the EU F gas Regulation for users in this industry, although the main manufacturers have signed a voluntary agreement to ensure that emissions are minimised.

Solvent cleaning was historically carried out using certain ozone-depleting chemicals such as CFC 113 and 1,1,1,trichloroethane. These fluids were phased out some years ago under the Ozone Regulation. As an interim measure certain HCFC solvents were used, although these are also phased out in most applications. There was an exemption for certain high precision cleaning applications in the aerospace industry – that ran out at the end of 2008. HFCs are used in a few cleaning applications, although use is not widespread as they are expensive and not as effective as the CFCs and HCFCs that they are replacing. Various alternatives have been introduced such as alternative organic solvents or improved aqueous cleaning systems.

Military Applications. Both F gas and ODS are used in a wide variety of specialised niche applications within the military arena. It is important to note that the EU F gas Regulation applies to military applications. The only exception being that there is no requirement for recovery where the fluid is being used in mobile equipment in a "military operation".

Rigid insulating foam manufacture (e.g. polyurethane, polyisocyanate and phenolic foams) was historically carried out using CFC blowing agents. Again HCFCs were used as an interim solution but were phased out several years ago. Many manufacturers have adapted their processes to use hydrocarbon blowing agents. A small amount of the foam market has moved to HFCs, especially where low flammability is crucial. There are no specific obligations in the EU F gas Regulation related to manufacture of rigid insulating foam.

By-product from aluminium smelting. When aluminium is produced from ore in an electric arc furnace there is sometimes some "accidental" production of PFC gases as a by-product produced at the anode of the furnace. Aluminium companies are making efforts to minimise the circumstances in which PFC emissions might occur.

By-product from R22 manufacture. When HCFC 22 is manufactured there is a small proportion of HFC 23 in the output stream. Historically this was vented to atmosphere (as there is virtually no market for HFC 23). However, it was recognised that HFC 23 is a very powerful greenhouse gas and that venting is bad for the environment. Equipment can be installed at the manufacture plant that captures and destroys any HFC 23 emissions.

4.7 Less Common Applications

Double glazing was produced in some EU countries using SF_6 as an insulating gas between the panes of glass as it has very good sound proofing qualities. This has never been a popular option in the UK. This use of SF_6 was banned under the EU F gas Regulation for domestic applications in 2007 and was banned for all new windows from July 2008.

Car tyres for some luxury cars were filled with SF_6, to give a more comfortable ride. Again this has not been common in the UK and the application was banned under the EU F gas Regulation in 2007.

Cosmetics are occasionally formulated using small quantities of PFCs. This is still allowed under the EU F gas Regulation.

Laboratory and scientific applications. There are a number of minor uses of F gases in specialised scientific applications. For example SF_6 is used as an atmospheric tracer gas. These applications are still allowed under the EU F gas Regulation.

It should be noted that all the requirements of the EU F gas Regulation apply to these less common applications. Thus there is still a requirement for recovery of F gas after use from equipment in a laboratory for research purposes.