UK IMPLEMENTATION OF FLUORINATED GREENHOUSE GASES AND OZONE-DEPLETING SUBSTANCES REGULATIONS

Market Intelligence and Risk-Based Implementation Model

November 2007

EXECUTIVE SUMMARY

This report identifies the key UK end-user markets affected by the fluorinated greenhouse gas (F-Gas) and ozone depleting substances (ODS) Regulations and defines the relative importance of these markets in terms of proportions of total emissions of F-Gases and ODS. For each market it provides a detailed analysis of the end-user organisations and identifies significant markets in terms of F-Gas emission reduction potential, which is important because F-Gases are potent greenhouse gases and are widely used in the UK. [Section 3 to Section 6]. A number of case studies are also provided to illustrate the types of F-Gas and ODS equipment that might be found in different types of end-user organisation [Section 7].

On the basis of this intelligence, recommendations are set out for implementation of the Regulations in the UK [Section 10]. They adhere to a better regulation approach and primarily focus on sectors that offer the greatest F-Gas emission reduction potential. A series of overarching principles underpin the recommended risk-based implementation model, which include:

- The need for a national information campaign that covers the requirements of the Regulations and is targeted at affected sectors and organisations in order to promote compliance.

- The Environment Agency, the Scottish Environment Protection Agency, the Environment and Heritage Service and councils should regulate businesses for which they currently have responsibility under another regulatory regime. Where there is dual regulatory responsibility, the relevant national authority will take responsibility.

- The focus for regulators should be on those major emitters of F-Gases where significant reductions are possible, working where appropriate through national organisations and/or businesses to agree protocols on compliance with the Regulations.

The report identifies the needs of relevant regulators to enable them to effectively implement the Regulations [Section 8] and specifies possible information dissemination routes to best inform different types of end-user organisation about their obligations [Section 9].

The report also recommends setting up a “central team” to help develop and deliver information to end users as part of the national information campaign and to support the relevant regulators.

1. INTRODUCTION

LACORS (the Local Authorities Coordinators of Regulatory Services) is working with Defra (the Department for Environment, Food and Rural Affairs) and the devolved administrations to develop a risk-based implementation model for the EU Regulations on fluorinated greenhouse gases (F-Gases) and ozone depleting substances (ODS) – "the Regulations". This report provides market intelligence information related to end users of F-Gases and ODS and, on the basis of this information, sets out options for risk-based implementation of the Regulations. The report is based on work carried out by consultants Enviros and Environmental Health Matters – overseen by LACORS – during the period April to September 2007.

1.1 Project Objectives

The aims of this project are:

1) To identify the key markets in the UK with end-user companies and organisations affected by the F-Gas and ODS Regulations.

2) To define the relative importance of these markets in terms of proportions of total emissions of F-Gases and ODS.

3) For each market, to provide an appropriate and suitably detailed analysis of the end-user organisations.

4) To use this information to design a risk-based implementation model.

5) To identify the needs of relevant regulators to enable them to implement the Regulations.

6) To specify information dissemination routes to inform different types of end-user organisation about their obligations.

2. KEY ASPECTS OF THE F-GAS AND OZONE REGULATIONS

In this section we summarise the key aspects of each Regulation to identify activities that may require regulation. In Section 2.3 we have summarised regulatory issues that are common to both the F-Gas and the ODS Regulations.

2.1 F-Gas Regulation

The relevant Regulation is "EC Regulation No 842/2006 on certain fluorinated greenhouse gases" (www.berr.gov.uk/files/file30123.pdf). In this report this will be referred to as the F-Gas Regulation. The Regulation is intended to reduce emissions of fluorinated greenhouse gases through (a) better containment, (b) recovery after use and (c), in a few special cases, product bans. The Regulation was published in May 2006. Many of the important Articles come into effect in July 2007.

2.1.1 What Are F-Gases?

The F-Gases include 3 families of fluorinated chemicals that have very high global warming potential (GWP). The GWPs are typically between 1,000 and 20,000 times higher than that of CO_2. The "Kyoto basket" of gases is summarised in Table 2.1. The F-Gases are highlighted in bold. HFCs and PFCs represent families of fluorocarbons, hence the range of GWPs shown in the table. SF_6 is a single substance.

Table 2.1 Gases in the Kyoto Protocol

	Gas	GWP	% of GWP Weighted UK Emissions*
	CO_2	1	85.2%
	Methane	21	7.0%
	N2O	320	6.2%
F-Gases	**HFCs (hydrofluorocarbons)**	**140 to 11,000**	**1.3%**
	PFCs (perfluorocarbons)	**6,000 to 10,000**	**0.1%**
	SF_6 (sulphur hexafluoride)	**23,900**	**0.2%**

* UK Emissions in 2004 based on 100 year GWPs. Note, GWP weighted emissions = tonnes of gas emitted multiplied by the GWP

As shown in Table 2.1, the total level of GWP weighted emissions is actually quite low compared to the other 3 Kyoto gases – in 2004 F-Gases represented only 1.6% of total UK emissions. However, the GWP of the F-Gases are much higher than the other GHGs, hence it is important that emissions from existing applications are minimised and that these gases are not used in new equipment unless absolutely necessary.

F-Gases are specialised man-made chemicals. Appendix 1 provides information about the F-Gases that are covered by the Regulation. The uses of F-Gases are discussed in detail in Section 3 of this report.

In many cases the F-Gas is used as a "working fluid" e.g. as a refrigerant in a refrigerator. In this situation, emissions through leakage are undesirable for the end user as well as for the environment. Hence, the F-Gas Regulation concentrates on preventing such leakage emissions.

Some uses are emissive in nature. For example, HFCs are used as aerosol propellants – it is inevitable that the F-Gas will be emitted when the aerosol is used. Where possible emissive uses have been banned, but in some cases there is no viable alternative and marketing of the product is permitted.

2.1.2 F-Gas Containment

Article 3 of the F-Gas Regulation concerns containment of F-Gases during the "end use phase" of a product lifecycle. The article specifically targets F-Gas users with stationary applications [1] in 2 market areas:

- Refrigeration, air-conditioning and heat pump equipment (in this report these will be referred to as RAC applications)
- Fire protection systems

If F-Gases are used in these applications the operator must adhere to the requirements shown in Table 2.2.

The first obligation is a "catch-all" requirement that has the caveat "using all measures which are technically feasible and do not entail disproportionate cost". From a regulatory perspective this might be very difficult to interpret for plants below 3 kg. Also, leakage from these small plants is generally very low, so they present little risk. It is recommended that plants below the 3kg threshold are not targeted in the risk-based implementation model.

The obligations at or above 3kg are clearly defined and depend on the size of system as shown in Table 2.3. It is these systems that should be the target of the regulatory system put in place.

1 Stationary applications exclude refrigerated transport, car air-conditioning and portable fire extinguishers

Table 2.2 Containment Obligations in Article 3

Obligation for Stationary RAC and Fire Protection Applications	Applicability (for systems using F-Gas)
Take steps to prevent F-Gas leakage and repair detected leakage as soon as possible	All stationary systems
Regularly check for leakage	Stationary systems 3kg and above or, for stationary hermetically sealed systems, 6kg and above [2]
Repair any leaks found and recheck for leaks within 1 month	Stationary systems 3kg and above or 6kg and above [2]
Keep certain records about refrigeration plant that uses F-Gases	Stationary systems 3kg and above
Fit automatic leak detection system	Stationary systems 300kg and above

Table 2.3 Leak Testing Frequencies

Frequency	Normal systems	Hermetically sealed systems
None	<3 kg	<6 kg
Annual	3 kg to 30 kg	6 kg to 30 kg
6-monthly*	30 kg to 300 kg	30 kg to 300 kg
Quarterly*	>300 kg	>300 kg

* Half this frequency if fitted with automatic leak detection

2 The threshold is 3 kg for most systems, but is increased to 6 kg for a "hermetically sealed system". This is defined as: "a system in which all refrigerant containing parts are made tight by welding, brazing or a similar permanent connection which may include capped valves and capped service ports that allow proper repair or disposal and which have a tested leakage rate of less than 3 grams per year under a pressure of at least a quarter of the maximum allowable pressure".

2.1.3 F-Gas Recovery

Article 4 of the F-Gas Regulation concerns recovery of F-Gases during servicing of equipment or at the end of the product lifecycle. The article specifically targets F-Gas users with stationary applications in 6 market areas:

- Refrigeration, air-conditioning and heat pump equipment
- Fire protection systems
- Systems using F-Gas solvents
- High voltage switchgear using SF_6
- Non-refillable containers
- Mobile air-conditioning units

If F-Gases are used in these applications the operator must ensure that the gases are not vented to atmosphere during servicing or decommissioning at the end of life. F-Gases recovered must be sent for recycling, reclamation or destruction. There are no size thresholds defined, so the rule applies to equipment with <3kg.

The Article also contains a catch-all clause that requires recovery of F-Gases contained in other products and equipment, including mobile equipment unless it is serving military operations. This is subject to the caveat “to the extent that it is technically feasible and does not entail disproportionate cost”.

2.1.4 Training and Certification

Article 4 of the F-Gas Regulation concerns the training and certification related to activities specified in Articles 3 and 4 (on Containment and Recovery). Companies carrying out these activities and their personnel will require appropriate training and certification. The EC and Member States have not yet agreed what the training and certification requirements are. Defra is planning to introduce an interim definition of training requirements that will apply in 2007/8. This will be updated when there is further information available from the EC.

2.1.5 Product and Use Bans

Articles 8 and 9 of the F-Gas Regulation concern certain bans on use and of products containing F-Gases. The key bans are summarised in Table 2.4.

Table 2.4 Use and Product Bans

Use or Product Ban	Date of Ban	Comments
F-Gases used in footwear	July 2006	Main manufacturers have already stopped using SF_6 in training shoes.
SF_6 for filling car tyres	July 2007	Not common in UK
F-Gases in non-refillable containers	July 2007	Important ban on containers used to supply F-Gases to end users. This ban does not apply to aerosols.
HFCs and PFCs used in direct evaporation refrigeration	July 2007	Not common in UK
PFCs in fire protection systems	July 2007	Not common in UK
F-Gases used in double glazing	July 2007	Not common in UK. July 2008 for non-domestic applications.
F-Gases in one component foams	July 2008	Except when required to meet national safety standards.
SF_6 for magnesium die casting	January 2008	Except for annual use <850 kg
HFCs used in novelty aerosols	July 2009	Novelty aerosol applications are defined in Section 3.2.5.

Many of the products and applications shown in Table 2.4 have little environmental impact in the UK. For example, the use of SF_6 in car tyres and double glazing was accepted practice in one or two other EU countries but the market was virtually non-existent in the UK. The items marked “not common in UK” in Table 2.4 should not require much attention in the implementation model.

2.1.6 Reporting

Article 6 places obligations on manufacturers and importers/exporters of F-Gases to report data to the EC on an annual basis. It applies to companies who make or import/export more than 1 tonne of F-Gases per year.

2.1.7 Labelling

Article 7 requires certain types of equipment containing F-Gases to be labelled. This includes:

- Refrigeration, air-conditioning and heat pump equipment
- Fire protection systems
- High voltage switchgear using SF_6
- Containers used to transport F-Gases
- All F-Gas containers

2.1.8 Background Information on F-Gas Regulation

Further useful information about the Regulation is available on the internet and via the following links in particular:

A copy of the Regulation: www.berr.gov.uk/files/file30123.pdf

Detailed guidance about the Regulation:
www.berr.gov.uk/files/file31943.pdf

FAQs: www.berr.gov.uk/files/file34640.pdf

Guidance on refrigeration applications:
www.berr.gov.uk/files/file34176.pdf

2.2 Ozone Regulation

The relevant Regulation is "EC Regulation No 2073/2000 on substances that deplete the ozone layer" (www.berr.gov.uk/files/file29106.pdf). In this report this will be referred to as the Ozone Regulation. The Regulation is intended to reduce emissions of ozone depleting substances (ODS) through (a) better containment, (b) a reduction of the total amount of ODS that can be sold and (c) bans on placing ODS on the market for specific products and applications. The Regulation was published in 2000. Most of the obligations have been in force for a number of years.

2.2.1 What are the Relevant ODS and Markets?

The Ozone Regulation refers to a number of ODS, most of which are already completely banned (except for a few well monitored essential uses). ODS that are already phased out in the UK include CFCs and Halons.

From the perspective of this project it is the obligations that apply to HCFCs (hydrochlorofluorocarbons) that are of relevance. The use of HCFCs in all new equipment and products was completely banned between 2000 and 2004 (in a series of steps linked to application). This leaves a "residual" market of older equipment containing HCFCs that requires on-going maintenance.

Whereas the end-user markets for F-Gases are relatively complex (these are described in Section 3), the residual HCFC market is now restricted to refrigeration and air-conditioning equipment that was installed before the ban on new systems (which was between 2000 and 2004). Appendix 1 provides information about the ODS that are covered by the Regulation.

2.2.2 Outstanding Obligations Under the Ozone Regulation

Many of the obligations in the Ozone Regulation came into effect several years ago and no longer require regulation. These obligations have led to the complete phase out of gases such as CFCs and Halons. In the HCFC market it has also led to the complete phase out of HCFC use in some historically important markets such as the blowing of rigid polyurethane foam and for use as industrial cleaning solvents.

The residual market for HCFCs relates to servicing the "bank" of HCFCs in existing refrigeration and air-conditioning equipment. Operators of HCFC equipment in these markets are required to:

a) Take "all precautionary measures practicable" to prevent leakages.

b) Any system containing more than 3 kg of HCFC refrigerant must be checked annually for leakage, by suitably qualified personnel.

c) Any HCFC refrigerant removed from a system during maintenance or at end of life must be properly recovered for re-use, recycling or destruction.

d) Use of virgin HCFCs for maintenance will be banned from 31/12/2009.

e) Use of recycled HCFCs for maintenance will be banned from December 31st 2014. This date is subject to a review to be completed in 2008. This means that recycled HCFCs may be phased out earlier than the end of 2014.

There is significant similarity between these obligations and some of the F-Gas Regulation obligations:

- Item a) is a "catch-all" obligation to prevent leaks on plants with HCFCs, but it will be hard to regulate for very small equipment.
- There is a 3 kg threshold for mandatory annual leak checks, although the frequency does not increase for larger systems.
- As with F-Gases, refrigerant recovery during servicing and at end of life is mandatory on all sizes of equipment.
- As with F-Gases, qualified personnel are required to do leak checks and all refrigerant handling tasks. Unlike F-Gases the minimum training and certification requirements are properly specified by Defra. Refrigerant handlers must have the City & Guilds 2078 qualification or the CITB Refrigerant Handlers qualification.

Unlike the F-Gas Regulation, there is a clear and imminent timetable for the complete phase out of HCFCs in the residual market. Regulatory officers will need to understand the implications of the phase out rules prior to the end of 2009.

2.2.3 Background Information on Ozone Regulation

Further useful information about the Regulation is available as follows:

A copy of the Regulation: www.berr.gov.uk/files/file29106.pdf

General Guidance on the Regulation
www.berr.gov.uk/files/file29100.pdf

Guidance on refrigeration applications:
www.berr.gov.uk/files/file29101.pdf

2.3 Regulatory Issues

Many of the regulatory issues related to both the F-Gas and Ozone Regulations can be summarised via the following questions:

a) **Are end users adhering to the obligations on containment and recovery?** For F-Gases these obligations include regular leak checks, refrigerant recovery, record keeping, use of automatic leak detection systems on larger systems and use of qualified personnel for these tasks. For HCFCs the obligations are a "sub-set" of those for F-Gases.

b) Are product manufacturers adhering to placing on the market bans on products? There are a relatively small number of manufacturers involved in making the products that will be banned under the F-Gas Regulation (see Table 2.4, e.g. novelty aerosol manufacturers must phase out use of HFC propellants). There are a small number of SF_6 suppliers who could be monitored to ensure banned uses are not receiving supplies (e.g. magnesium smelters where there is an SF_6 ban). Also, there are a small number of HCFC suppliers who could be policed under the Ozone Regulation to ensure that virgin supplies are not sold after the end of 2009.

c) Are end users adhering to placing on the market bans on products and use? It may also be necessary to check that end users are adhering to the bans. For F-Gases this refers to a list of fairly unusual uses that can be regulated either through a small number of product manufacturers or through a fairly small number of specialist end users or retailers. For HCFCs this is a much wider issue that will affect many thousands of refrigeration and air-conditioning end users in industrial, commercial and public sector organisations.

d) Are maintenance contractors adequately qualified? The containment and recovery activities for both the F-Gas and Ozone Regulations require properly qualified staff. Regulation via

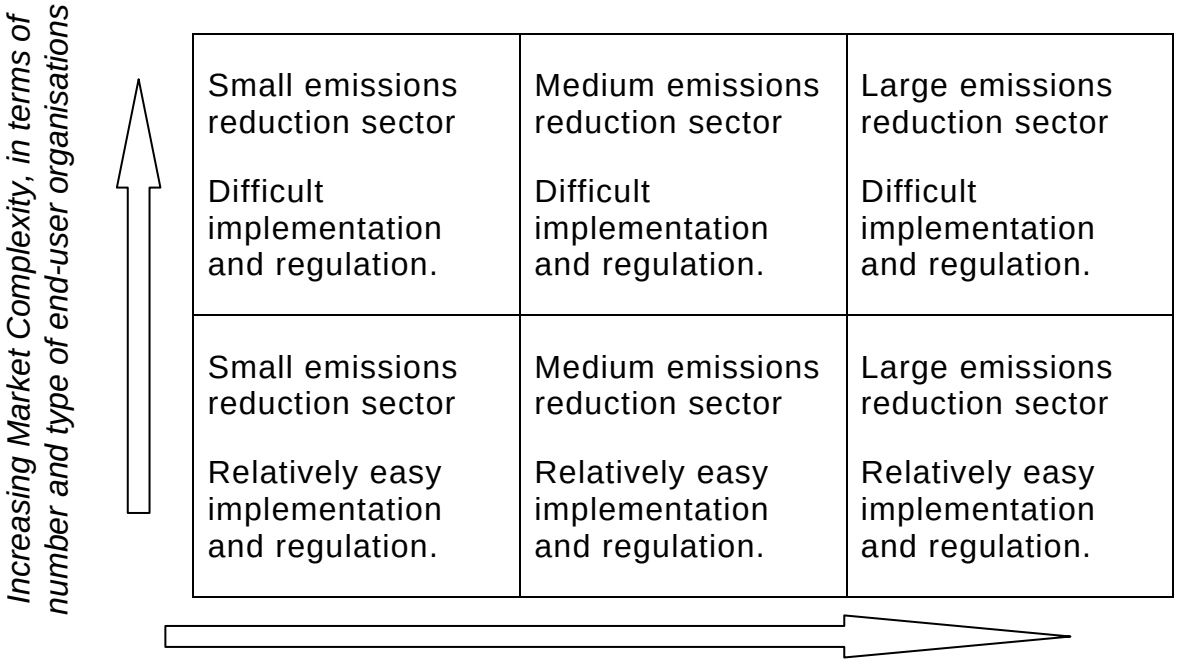
contractors may facilitate end-user compliance, particularly for small end users.

e) **Are F-Gas manufacturers and importers meeting the reporting obligation?** A small number of companies manufacture or import F-Gases. They will be obliged to provide data on annual sales to the European Commission.

All of these regulatory issues depend on establishing a good knowledge of end-user markets and of suppliers of products and services into these markets. The end users of F-Gases and ODS involve a large number of organisations and a very large number of individual user sites. The complexity of some end-user markets will make implementation and regulation of the Regulations quite difficult.

To make the implementation process manageable it is vital to sub-divide the markets into appropriate sectors. A sectoral approach will allow the implementation mechanism to be adapted to each sector. In general terms the market sectors will fall into one of the broad categories shown in Figure 2.1.

Figure 2.1 General Categories of End Use



Note that the sector size is defined in terms of potential to reduce emissions not in terms of absolute level of emissions. This is because some markets have a high level of emissions, but only a small emission reduction potential. From the implementation perspective it is best to target those sectors where the emission reduction potential is greatest.

These categories are best illustrated with examples:

a) **Large/easy: supermarkets.** This is a very large sector for both ODS and F-Gas emissions (supermarkets are major users of both refrigeration and air-conditioning equipment). However, there are a relatively small number of organisations that own most supermarkets, hence it will be easy to reach these companies.

b) **Medium/difficult: building air-conditioning.** This is probably the most challenging sector because of the widespread use of air-conditioning systems with more than 3 kg of refrigerant. Almost every type of building could have air-conditioning systems that are affected by the F-Gas Regulation (e.g. shops, restaurants, hotels, offices, hospitals etc.) or by the Ozone Regulation. Even domestic dwellings could be affected.

c) **Small/easy: fire fighting systems.** This is a low emissions sector. There are a relatively small number of end users and a very small number of system suppliers, so it should be relatively easy to characterise this sector.

d) **Small/difficult: small hermetic refrigeration systems.** In terms of emissions this is a small sector because the type of system used have very low annual leakage and few systems are >3kg. Hence the sector represents a low risk. However, the market is large and complex in terms of number and types of organisation using this equipment.

Sections 3 to 5 of this report provide an in-depth analysis of the end user and supplier markets to help inform the development of the implementation model. We have used the categories introduced above to define the characteristics of each market sub-sector. Six categories are used as follows:

- L/E Large emission reductions, easy to define market
- L/D Large emission reductions, difficult to define market
- M/E Medium emission reductions, easy to define market
- M/D Medium emission reductions, difficult to define market
- S/E Small emission reductions, easy to define market
- S/D Small emission reductions, difficult to define market

The choice of emission reduction category has been based on the following:

- L (large) is for emission reduction potential of >500 ktonnes CO_2 (e)
- M (medium) is for emission reduction potential between 100 and 500 ktonnes CO_2 (e)
- S (small) is for emission reduction potential of <100 ktonnes CO_2 (e)

The choice of “market complexity” category (easy or difficult) is more subjective. A sector is considered easy to target if a relatively small number of organisations can be targeted to regulate a large proportion

of the emission reduction potential. For example in the supermarket sector, the 10 largest companies represent over 90% of financial turnover and can be expected to represent a very high percentage of emissions. Difficult sectors would require lots of organisations to be targeted.

Where the monitoring of imported products is important we have allocated a “difficult” market complexity category. For example there is a ban on one component foam, which is all imported into the UK. This can potentially be imported by many companies in both the wholesale and retail building trades. It has been assumed that regulation at the point of importation (via HM Revenue and Customs) will not be easy to achieve, because products can arrive freely from other EU countries.

Identification of the relevant category for each market sector is a useful input to the design of a phased implementation programme. Initially the programme can concentrate on the L/E area which will provide the best “environmental returns”. Regulation in smaller or more difficult areas can follow in later stages of the implementation programme.

3. OVERVIEW OF END-USER MARKETS AND EMISSIONS

3.1 F-Gas Markets

As discussed in Section 2.3, the end users of F-Gases and ODS involve a large number of organisations and a very large number of individual user sites. A useful starting point to understand the user markets is to review the UK F-Gas emissions inventory in conjunction with obligations in the F-Gas Regulation.

The main end-use emissions of F-Gases are shown in Table 3.1. This table is based on the most recent UK inventory of F-Gas emissions[3]. We have included forecast emissions data for both 2005 and 2010, to show the likely trend over the early years of the implementation programme. The sectors specifically targeted in Articles 3 and 4 of the F-Gas Regulation have been shaded in grey.

Table 3.1 F-Gas Markets and Emissions

Type of End Use	F-Gas Emissions ktonnes CO_2 equiv		% of F-Gas Emissions	
	2005	2010	2005	2010
Stationary refrigeration	3,555	2,872	26.8%	25.0%
Fluid manufacture	2,223	1,084	16.8%	9.4%
Medical aerosols	1,516	1,393	11.4%	12.1%
Mobile air-conditioning	1,459	1,651	11.0%	14.4%
General Aerosols	1,442	1,515	10.9%	13.2%
Magnesium production	860	741	6.5%	6.5%
Foam blowing	563	867	4.3%	7.6%
High voltage switchgear	522	507	3.9%	4.4%
Fire protection	358	375	2.7%	3.3%
Aluminium production	170	120	1.3%	1.0%
One component foam	111	128	0.8%	1.1%
Electronics production	99	84	0.7%	0.7%
Solvent cleaning	46	107	0.3%	0.9%
Other	320	37	2.4%	0.3%
Total	**13,244**	**11,481**	**100%**	**100%**

3 AEAT Report for Defra, Emissions and Projections of HFCs, PFCs and SF_6 for the UK and Constituent Countries, June 2004

3.2 Review of Complexity of Each Market

In this section we provide a brief overview of each row in Table 3.1. We include a discussion of market sub-sectors where relevant and of implementation options. Further more detailed market data is given in Sections 4 and 5 of this report.

3.2.1 Stationary Refrigeration

27% of 2005 F-Gas emissions

Only major market for ODS use and emissions

End-use regulation category: various (see Table 3.2)

F-Gas emission reduction potential: 1,000 to 1,600 ktonnes CO_2 equiv

The emissions referred to for "stationary refrigeration" includes emissions from stationary refrigeration, air-conditioning and heat pump systems. The 3 categories are usually treated together because the technologies involved are very similar. Further details about these types of system are given in Section 4. Note, that this emissions category in Table 3.1 excludes mobile air-conditioning which is itemised separately and discussed in Section 3.2.4 below. It is important to recognise that it is common for stationary refrigeration, air-conditioning and heat pump systems to use either HFC (F-Gas) or HCFC (ODS) refrigerants. In a few cases systems use refrigerant blends with both HFC and HCFC constituents.

This sector is the largest single source of F-Gas emissions, representing nearly 27% of the 2005 total. It is one of the end uses specifically targeted in both Article 3 and 4 of the F-Gas Regulation. It is the only significant end use affected by the Ozone Regulation. This is a sector of great importance in the implementation process.

The sector can be subdivided into a number of major sub-sectors for analysis. This is done from an end-user perspective in Section 4. The UK emissions inventory uses a number of sectors which form a useful starting point for understanding the important sub-sectors of this market. These are shown in Table 3.2.

Table 3.2 shows that supermarkets are the dominant sub-sector, representing over half of emissions. The data shows that, from the implementation perspective, supermarkets, industrial refrigeration and building air-conditioning are the most important sub-sectors. It should be noted that transport refrigeration is not "stationary" refrigeration, hence it is not specifically targeted by Article 3 of the F-Gas Regulation (even for refrigerant charge above 3 kg). However, it might be affected by the recovery clause in Article 4.

Table 3.2 Stationary Refrigeration Sub-Sector Emissions

Sub-Sector	2005 F-Gas Emissions	F-Gas Emission Reduction Potential	% of 2005 F-Gas Emissions	End-Use Regulation Category[4]
	ktonnes CO_2 equiv			
Supermarket refrigeration	2,000	650 to 1,100	56%	L/E
Industrial refrigeration	600	150 to 210	17%	M/D
Air-conditioning	500	140 to 250	14%	M/D
Small commercial refrig.	250	40 to 60	7%	S/D
Transport refrigeration[5]	100	10 to 20	3%	S/D
Domestic refrigeration	60	3 to 5	2%	S/E
Non-domestic hermetic refrig.	50	3 to 5	2%	S/D
Total	3,565	1,000 to 1,600	100%	

We estimate that there is potential to reduce the emissions from stationary refrigeration by between 30% and 40% through better containment and recovery. This is equivalent to an emission reduction of between 1,000 and 1,600 ktonnes CO_2 equiv.

Further details about refrigeration markets are given in Section 4.

3.2.2 Fluid Manufacture

17% of 2005 F-Gas emissions

End-use regulation category: L/E (large/easy)

F-Gas emission reduction potential: 500 to 1,000 ktonnes CO_2 equiv

The large majority of these emissions are from 2 factories producing HCFC 22 and emitting HFC 23 as a by-product.

F-Gas emission from fluid manufacture is not specifically mentioned in the F-Gas Regulation, although the manufacturers should be targeted

4 These are the 6 categories introduced in Figure 2.1 (i.e. large, medium or small / easy or difficult)
5 Not "stationary" refrigeration but included here for simplicity

to ensure that losses during manufacture are minimised. This is an "L/E" sector. Regulation via the IPCC permits at the relevant factories might be appropriate.

We estimate that there is potential to reduce the emissions from HCFC22 manufacture by between 25% and 50% through better containment and recovery. This is equivalent to an emission reduction of between 500 and 1,000 ktonnes CO_2 equiv.

There are 2 further F-Gas issues linked to fluid manufacturers and importers. These are:

a) An obligation to report sales to the European Commission on an annual basis (for companies manufacturing or importing more than 1 tonne of F-Gas per year).

b) A ban on placing on the market of non-refillable F-Gas containers from July 2007. Regulation of fluid introduction into these containers in the UK will be easy as there are very few sites carrying out this activity. Regulation related to imported containers could be more challenging. The Mobile air-conditioning (MAC) servicing sector is one that historically has made use of small non-refillable containers containing HFC 134a.

Further details about fluid manufacturing are given in Section 5.2.

3.2.3 Medical Aerosols

11% of 2005 F-Gas emissions

End-use regulation category: S/E (small/easy)

F-Gas emission reduction potential: 15 to 30 ktonnes CO_2 equiv

This sector relates to emissions from "metered dose inhalers" (MDIs) which are a specialised form of aerosol. MDIs are used to administer certain drugs, usually for lung diseases, especially asthma.

Historically MDIs used CFC 12 as a propellant. Because of the difficulty and timescale involved in developing alternative formulations, MDI manufacturers were allowed to continue use of CFCs after phase out under the "essential use" exemptions. MDIs using HFC 134a were slowly introduced and these are now in widespread use. As MDIs are totally "emissive" in use (i.e. it is impossible to prevent emissions of the propellant) the only option for significant emission reduction would have been a ban. This was not found to be a practical or cost-effective option, hence the F-Gas Regulation does <u>not</u> target MDIs.

The UK is a major manufacturer of MDIs and there are substantial net exports from the UK. The small number of pharmaceutical companies making MDIs in the UK are an S/E category and could be targeted via Integrated Pollution Prevention and Control (IPPC) to ensure that they are making best efforts to minimise HFC use and to minimise emissions during the manufacturing and testing phases. Although total emissions from this sector are large, we have used the "S" category because the potential for emission reductions at manufacturing

facilities is small. More than 95% of emissions occur in the use and disposal phases of the life cycle of an MDI.

We estimate that there is potential to reduce the emissions from medical aerosols by 1% to 2% through better containment and recovery during MDI manufacture. This is equivalent to an emission reduction of between 15 and 30 ktonnes CO_2 equiv.

Further details about MDI markets are given in Section 5.3.

3.2.4 Mobile Air-Conditioning

11% of 2005 F-Gas emissions

End-use regulation category: M/D (medium/difficult)

F-Gas emission reduction potential: 75 to 150 ktonnes CO_2 equiv

MAC in all cars built after 1993 uses HFC 134a as the refrigerant. As the "boom" in car air-conditioning in the UK has occurred since the late 1990s and, as the typical life of a car is about 12 years, the vast majority of existing cars with air-conditioning use an HFC refrigerant.

MAC is an important source of F-Gas emissions because it is difficult to prevent leaks in the "harsh" conditions that MAC systems have to contend with. For this reason MAC is going to be subject to a ban on the use of HFC 134a (and other high GWP refrigerants). This is not via the F-Gas Regulation. A separate piece of EU Legislation[6] introduces this ban which will start to be introduced in 2011.

The MAC Directive only deals with the eventual ban of HFC 134a – it makes no reference to emissions from HFCs in existing MAC systems. Whilst the F-Gas Regulation makes no specific mention of MAC it is implicitly covered via the catch-all clause in Article 4 that requires refrigerant recovery during servicing and at end of life. This clause affects the car servicing and car scrapping sectors, which are quite complex in terms of numbers of sites and owners.

The overall emissions from MAC are "large" but the bulk of emissions occur via slow leakage during normal use or during damage in car accidents. The amount of emission reduction available through better recovery of HFCs during servicing is uncertain. It is probably less than 10% of the total emissions, on the border between small and medium categories. As this sector has a growing level of emissions (because of increasing use of MAC in new cars) we have categorised MAC as a "medium" opportunity. The car servicing and car scrapping sectors can therefore be categorised as "M/D".

We estimate that there is potential to reduce the emissions from MAC by 5% to 10% through better containment and recovery. This is equivalent to an emission reduction of between 75 and 150 ktonnes CO_2 equiv.

Further details about MAC servicing and vehicle scrapping markets are given in Section 5.4.

6 Directive 2006/40/EC relating to emissions from air-conditioning systems in motor vehicles

Article 10 of the F Gas Regulation tasks the European Commission with reviewing the effectiveness of the Regulation to prevent escape of F gas to the atmosphere. Article 10.1 requires the Commission to look at MAC in a range of motor vehicles. The Commission have to provide a report and any legislative proposals by 31 December 2007 which would need to be implemented by 31 December 2008. Any proposals on how the UK would implement this potential obligation would be subject to a consultation.

3.2.5 General Aerosols

11% of 2005 F-Gas emissions

End-use regulation category: M/E (medium/easy)

F-Gas emission reduction potential: 300 to 400 ktonnes CO_2 equiv

This sector is made up of all aerosols using HFC propellants other than MDIs.

Historically a large proportion of aerosols used CFCs as propellants. These were banned in the mid-1990s. As HFC propellants were much more expensive than CFCs, manufacturers tried to use alternatives. The majority of aerosol applications were considered suitable for hydrocarbon (HC) or dimethyl ether (DME) propellants. Most domestic aerosol products (e.g. polishes, hair sprays etc.) use HCs or DME.

However, both HCs and DME are flammable and these propellants were considered unsuitable for products where there was a high risk of fire. Two types of general aerosol use F-Gas propellants. These are:

- Technical aerosols used in places with an ignition source (e.g. lubricant aerosols used in certain factories).
- Novelty aerosols[7] (e.g. silly string, artificial snow for decoration) which are believed to represent a safety risk.

The F-Gas Regulation will allow the continued use of F-Gas propellants in technical aerosols, but will ban the use in novelty aerosols after July 2009. Ensuring that this ban is fully effective could have a significant impact on HFC emissions – the emission reduction potential is “medium”.

We estimate that there is potential to reduce the emissions from general aerosols by between 20% and 30% through implementation of the ban on novelty aerosols. This is equivalent to an emission reduction of between 300 and 400 ktonnes CO_2 equiv.

Regulation in this sector can be targeted via the very small number of UK manufacturers of novelty aerosols. It will be more difficult to target imports – some steps must be taken to ensure that banned products are not imported. A high proportion of the UK market is supplied by one manufacturer and there are a relatively small number of

7 ‘novelty aerosol’ means those aerosol generators marketed and intended for sale to the general public for entertainment and decorative purposes as listed in the Annex to Directive 94/48/EC

companies importing and retailing novelty aerosols, hence this sector is categorised as an "M/E" sector.

Further details about general aerosol markets are given in Section 5.4.

3.2.6 Magnesium Production

7% of 2005 F-Gas emissions

End-use regulation category: M/E (medium/easy)

F-Gas mission reduction potential: 300 to 600 ktonnes CO_2 equiv

The smelting of magnesium requires the molten magnesium to be protected from any atmospheric oxygen by a "blanket" of inert gas. SF_6 has been used for this purpose during the last 20 years.

The F-Gas Regulation bans the use of SF_6 for die casting in factories using more than 850 kg of SF_6 per year.

In the UK there are only a small number of magnesium die casting operations that are affected by this ban. They can be categorised as S/E.

The majority of UK SF_6 emissions from magnesium smelting is carried out at one UK factory producing magnesium billets. This factory does not do die casting. However, this factory could still be targeted for SF_6 emission reduction via IPPC. Because the historic use at this factory is high and they are already taking significant steps to reduce emissions (by using an alternative cover gas) the whole magnesium sector can be categorised as M/E.

It is interesting to note that the best alternative cover gas appears to be HFC 134a. Although this is also an F-Gas with a high GWP it is considerably better in environmental terms than SF_6, which has the highest GWP of all the F-Gases (23,900). The GWP of HFC 134a (1,300) is 18 times lower than that of SF_6.

We estimate that there is potential to reduce the emissions from magnesium production by between 30% and 60% through using SF_6 alternatives. This is equivalent to an emission reduction of between 300 and 600 ktonnes CO_2 equiv.

Further details about magnesium markets are given in Section 5.6.

3.2.7 Foam Blowing

4% of 2005 F-Gas emissions

End-use regulation category: S/E (small/easy)

F-Gas emission reduction potential: 20 to 40 ktonnes CO_2 equiv

Certain types of rigid foam, including polyurethane, PIR[8], phenolic and extruded polystyrene foams, can be made using HFCs as a blowing

8 polyisocyanurate

agent. The foam is usually made in sheet form or as blocks or pipe-sections and is mostly used for insulation purposes.

Historically there was a significant CFC usage for foam blowing. After CFCs were banned, some manufacturers used HCFCs for a short period, but these are already completely banned under the Ozone Regulation. Where insulation performance or fire resistance are of concern HFCs are now the preferred blowing agent, although much of the market has moved to alternatives such as HC blowing agents.

Foam bowing is not specifically mentioned in the F-Gas Regulation, although the manufacturers of foam could be targeted to ensure that losses during manufacture are minimised. This sector is "S/E" as there are only a small number of UK sites carrying out foam blowing.

We estimate that there is potential to reduce the emissions from foam blowing by between 5% and 10% through better containment and recovery during foam manufacturing. This is equivalent to an emission reduction of around 20 to 40 ktonnes CO_2 equiv.

Old buildings being demolished could contain foam that is blown with HFCs – and this should be recovered if costs are not excessive. However, HFCs have only been used in this role since 2003, hence this will not be a significant problem for many years. It is more likely that old buildings could have foam containing CFCs which could require recovery under the Ozone Regulation.

Further details about foam blowing markets are given in Section 5.7.

3.2.8 High Voltage Switchgear

4% of 2005 F-Gas emissions

End-use regulation category: S/E (small/easy)

F-Gas emission reduction potential: 50 to 80 ktonnes CO_2 equiv

SF_6 is used as an insulating gas in certain types of high voltage switchgear. SF_6 is a better electrical insulator than air and this allows "gas insulated" high voltage switches to be more compact than "air insulated" equivalents. This type of equipment is often referred to as gas insulated switchgear (GIS).

GIS is not targeted under the containment category of the F-Gas Regulation (Article 3) but it is specifically referred to in relation to gas recovery during servicing and at end of life (in Article 4). The end-user market is very concentrated (mainly the electricity supply industry) so this sector is categorised as S/E.

We estimate that there is potential to reduce the emissions from high voltage switchgear by between 10% and 15% through better containment and recovery. This is equivalent to an emission reduction of between 50 and 80 ktonnes CO_2 equiv. Further details about GIS markets are given in Section 5.8.

3.2.9 Fire Protection

3% of 2005 F-Gas emissions

End-use regulation category: S/E (small/easy)

F-Gas emission reduction potential: 20 to 40 ktonnes CO_2 equiv

HFCs are used as fire fighting agents in certain types of building fire protection systems. HFCs are an effective way of extinguishing fires without causing as much damage as would occur with water sprinkler systems. They tend to be used in specialised buildings serving computer and telecoms.

Historically Halons were used for this type of fire protection system. These were very powerful ODS and were banned under the Ozone Regulation. The market for fixed installations with HFCs is much smaller than the old market for Halons – many users have moved to alternative technologies.

The residual market is relatively small and the emissions only make up a small proportion of UK F-Gas emissions. Some emissions are inevitable i.e. if there is a fire the HFC agent is all emitted. There is only a small emissions reduction potential related to reduced leakage and recovery, as fire protection systems are inherently leak tight.

There are many end users in various different building categories making this a complex market from the end-user perspective. However, there are only a small number of gas suppliers and system installers, so it is believed that this market can be targeted relatively easily through the supply chain. It has been categorised S/E.

We estimate that there is potential to reduce the emissions from stationary refrigeration by about 5% and 10% through better containment and recovery. This is equivalent to an emission reduction of between 20 and 40 ktonnes CO_2 equiv.

Further details about fire protection markets are given in Section 5.9.

3.2.10 Aluminium Production

1% of 2005 F-Gas emissions

End-use regulation category: S/E (small/easy)

F-Gas emission reduction potential: 30 to 50 ktonnes CO_2 equiv

PFCs are emitted as a by-product of primary aluminium smelting. All of these emissions are from 2 companies at 3 sites.

Aluminium production is not specifically mentioned in the F-Gas Regulation, although the manufacturers of aluminium could be targeted to ensure that losses during manufacture are minimised. This is an “S/E” sector. Regulation via the IPCC permits and climate change agreements (CCAs) at the relevant factories might be appropriate.

We estimate that there is potential to reduce the emissions from aluminium production by between 20% and 30% through better control of the process to avoid PFC being emitted. This is equivalent to an emission reduction of between 30 and 50 ktonnes CO_2 equiv. Further details about aluminium markets are given in Section 5.10.

3.2.11 One Component Foam

1% of 2005 F-Gas emissions

End-use regulation category: M/E (medium/easy)

F-Gas emission reduction potential: 110 ktonnes CO_2 equiv

One component foam (OCF) is a specialised type of aerosol that is used in the construction industry. An OCF aerosol produces a foam that can be used to fill small gaps during construction e.g. around window frames. OCF is often made using HFC propellants to avoid a fire safety risk. When an OCF aerosol is used it is common to discharge the whole can or a large part of a can, which leads to a lot of propellant being discharged in a short period of time. Without good ventilation this could cause a flammability risk if HCs are used as a propellant. That being said, a significant proportion of the EU OCF market already uses alternative non-HFC propellants which are flammable.

The use of OCF in the UK is much lower than in some other EU countries. OCF aerosols are not currently manufactured in the UK. OCF is imported from manufacturers in the EU.

Under the F-Gas Regulation the use of HFCs for OCF will be banned from July 2008, except when required to meet national safety standards. It is believed that the UK has no safety standards that would allow HFC use to be continued after 2008. From an implementation perspective the key measure will be to ensure that importers, wholesalers and retailers are aware of the ban. This is categorised as M/E as it believed that the majority of OCF will be imported / sold by a fairly small number of importers, wholesalers and retailers.

We estimate that there is potential to reduce the emissions from OCF by 100% through full implementation of the proposed ban. This is equivalent to an emission reduction of around 110 ktonnes CO_2 equiv.

Further details about OCF markets are given in Section 5.11.

3.2.12 Electronics Production

1% of 2005 F-Gas emissions

End-use regulation category: S/E (small/easy)

F-Gas emission reduction potential: 10 to 20 ktonnes CO_2 equiv

The semiconductor manufacturing industry use PFCs and SF_6 as specialist gases for the production of semi-conductor wafers. Use and emissions are quite small.

Electronics production is not specifically mentioned in the F-Gas Regulation, although the manufacturers of semiconductors could be targeted to ensure that losses during manufacture are minimised. This sector is "S/E" as there are only a small number of UK sites carrying out semiconductor manufacturing.

We estimate that there is potential to reduce the emissions from electronics production by between 10% and 20% through better containment and recovery. This is equivalent to an emission reduction of between 10 and 20 ktonnes CO_2 equiv.

Further details about electronics markets are given in Section 5.11.

3.2.13 Solvent Cleaning

0.3% of 2005 F-Gas emissions

End-use regulation category: S/D (small/difficult)

F-Gas emission reduction potential: 5 to 10 ktonnes CO_2 equiv

HFC solvents are used to clean some products in certain manufacturing processes, e.g. high precision metal components, specialist glass components etc.

Historically various ODS including CFCs and 1,1,1, trichloroethane were widely used as cleaning solvents. These substances were banned under the Ozone Regulation and the majority of users adapted their processes to use alternative types of cleaning system (e.g. aqueous cleaning).

A small number of specialist users have moved to the use of HFC solvents. These are relatively expensive, which has a self-limiting affect on usage.

The total usage is small. The market is fragmented and will be difficult to characterise, hence the S/D classification.

We estimate that there is potential to reduce the emissions from solvents by around 10% to 20% through better containment and recovery. This is equivalent to an emission reduction of between 5 and 10 ktonnes CO_2 equiv.

Further details about solvent markets are given in Section 5.13.

3.2.14 Other Sources

2% of 2005 F-Gas emissions (falling to 0.3% by 2010)

End-use regulation category: S/E (small/easy)

F-Gas emission reduction potential: 300 ktonnes CO_2 equiv

A number of other end uses exist, although these only have small impact in the UK.

The most important historical "other use" was SF_6 in training shoes. This makes up most of the emissions from this sector shown in Table 3.1. The use of SF_6 in training shoes has now stopped (and is already banned under the F-Gas Regulation from July 2006). There will still be some emissions as old training shoes are disposed of. The reason for the significant fall in emissions from "Other Uses" (a drop 90%) is due to the phase out of training shoes.

Other uses also include SF_6 in car tyres and double glazing. It is believed that these markets have always been negligible in the UK. These applications will be banned under the F-Gas Regulation from July 2007.

There are no further implementation issues for existing "other uses", hence the S/E classification.

We estimate that there has already been a reduction in the emissions from training shoes by 100% through implementation of the SF_6 ban. This is equivalent to an emission reduction of around 300 ktonnes CO_2 equiv.

Defra needs to ensure that no further uses are allowed to come to market if these are avoidable. For example HFCs have been proposed for use in "self-cooling drinks cans", but manufacturers voluntarily agreed not to pursue this technology.

3.3 Summary of Regulatory Issues

Table 3.3 summarises key points from the analysis in Section 3.2 above. The grey shaded sectors are those with explicit obligations in Articles 3/4 of the Regulation.

Table 3.3 Summary of Regulatory Issues

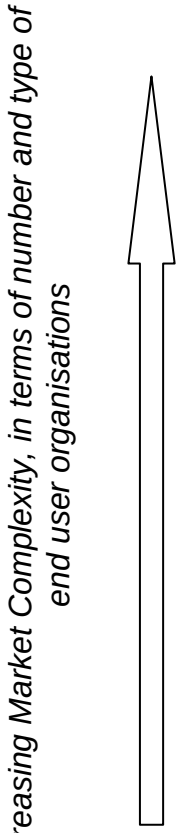
Type of End Use	% of 2005 F-Gas Emissions	F-Gas Emission Reduction Potential ktonnes CO_2 equiv	End-Use Regulation Category9	Comments
Stationary refrigeration	26.8%	1,000 to 1,600	Various	Vital sector – see Section 4 and Table 3.2 for more details of categories
Fluid manufacture	16.8%	500 to 1,000	L/E	Via IPPC10 for 3 sites
Medical aerosols	11.4%	15 to 30	S/E	Via IPPC for 4 sites
Mobile air-conditioning	11.0%	75 to 150	M/D	Difficult – thousands of small car servicing sites
General Aerosols	10.9%	300 to 400	M/E	UK production mainly at one site. Import control could be more difficult.
Magnesium production	6.5%	300 to 600	L/E	<10 sites
Foam blowing	4.3%	20 to 40	S/E	<10 sites
High voltage switchgear	3.9%	50 to 80	S/E	Targeted sector – mainly affecting electricity suppliers.
Fire protection	2.7%	20 to 40	S/E	Targeted sector – approach via maintenance contractors.
Aluminium production	1.3%	30 to 50	S/E	Via IPPC for 3 sites
One component foam	0.8%	110	M/E	Import control
Electronics production	0.7%	10 to 20	S/E	<20 sites
Solvent cleaning	0.3%	5 to 10	S/D	Targeted sector – but little use or emissions.
Other	2.4%	300	S/E	Main emitter already phased out
Total	**100%**	**2,400 to 4,150**		

9 These are the 6 categories introduced in Figure 2.1 (i.e. large, medium or small / easy or difficult)

10 IPPC – Integrated Pollution Prevention and Control

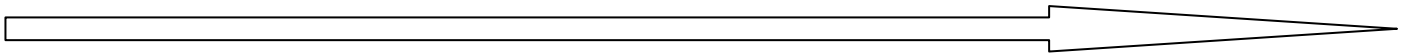
Figure 3.1 Categories of End Use

Emission reduction potential shown in brackets, ktonnes CO_2 equiv. Sectors underlined have ODS issues in addition to F-Gas issues.



Increasing Market Complexity, in terms of number and type of end user organisations

Small/Difficult Small commercial refrigeration (40 to 60) Non-domestic hermetic refrig (5 to 10) Solvent cleaning (5 to 10)	**Medium/Difficult** Industrial refrigeration (150 to 200) Building air-conditioning (150 to 200) Mobile air-conditioning (75 to 150)	**Large/Difficult**
Small/Easy HV Switchgear (50 to 80) Medical aerosols (15 to 30) Foam blowing (20 to 40) Aluminium production (30 to 50) Fire protection (20 to 40) Electronics production (10 to 20)	**Medium/Easy** General aerosols (300 to 400) Magnesium production (300 to 600) Training shoes (300) One component foam(110)	**Large/Easy** Supermarket refrigeration (650 to 1,100) Fluid manufacture (500 to 1,000)



Increasing Level of Potential to Reduce Sector F-Gas or ODS Emissions

4. REFRIGERATION, AIR-CONDITIONING AND HEAT PUMPS

4.1 Introduction

The markets for stationary RAC applications are the most complex and the most important from the perspective of implementing both the F-Gas and ODS Regulations. These markets are discussed in this section of the report. All other markets are discussed in Section 5 of this report.

The vast majority of refrigeration, air-conditioning and heat pump systems use the "vapour compression cycle" to provide cooling. This uses an electrically driven compressor to compress refrigerant vapour. The vapour is created in a heat exchanger that cools something down, referred to as an evaporator. The compressed vapour is then condensed – creating heat which is rejected in a heat exchanger called a condenser. In many cases, the refrigerant used in such a system is either an ODS or an F-Gas.

The Regulations refer to refrigeration, air-conditioning and heat pumps. In technology terms these use very similar (or sometimes identical) equipment. The difference between them is related to the application of the technology:

- **Refrigeration** refers to cooling below ambient temperature. This includes domestic refrigerators and freezers, retail displays, industrial process cooling and cold storage warehouses.
- **Air-conditioning** refers to cooling of a building to achieve an acceptable ambient temperature (and sometimes humidity control as well). This includes air-conditioning of domestic, commercial and industrial buildings.
- **Heat pumps** refer to refrigeration devices that are used to provide heat. The "cooling" in the evaporator is done to a waste heat stream and the heat rejected from the condenser is the "useful output" of a heat pump. This includes heating of buildings with heating only heat pumps and dual purpose heating and air-conditioning systems. It also includes industrial process heating via waste heat recovery.

Which Refrigeration and Air-Conditioning Systems Are NOT Affected by the Regulations?

It is important to recognise that not all RAC systems use ODS or F-Gas refrigerants. There are 2 groups of RAC equipment not affected by the ODS or F-Gas Regulations. These are:

a) Vapour compression systems with other refrigerants. These are quite common. Most domestic refrigerators and freezers are now made using hydrocarbon (HC) refrigerants. Many industrial refrigeration systems use ammonia as the refrigerant. Recently CO_2 has been introduced as a refrigerant into some applications including supermarkets, cold stores, industrial plants and small

retail displays. Any systems with HC, ammonia or CO_2 refrigerants are not affected by the ODS or F-Gas Regulations.

b) **Alternative refrigeration cycles.** Cooling can be carried out with alternative types of system that are not based on the vapour compression cycle. None of these alternative cycles use ODS or F-Gas refrigerants. The most common alternative is "absorption refrigeration" which is used in some domestic sized refrigerators (e.g. used in hotel rooms because they are very quiet or used in caravans/boats as they don't require electricity) and in some large air-conditioning systems. Another fairly common alternative is to use a "cryogenic material" such as liquid nitrogen or dry ice (frozen CO_2) to directly cool a product. Some cooling is carried out using an air cycle or a Peltier cycle although these are very unusual.

Which Refrigerants are Affected by the Regulations?

From an implementation perspective it is important to recognise what refrigerant is being used to identify the substance type. Appendix 1 provides details of all relevant F-Gases and ODS. Some refrigerants are used as pure fluids (i.e. a single pure chemical). Since the phase out of ODS began in the 1990s a number of refrigerant blends have been introduced. These are usually a "cocktail" of 3 pure fluids – the properties of the blend are designed to closely resemble the properties of a pure ODS that has been phased out. The most common refrigerants affected by the Regulations are shown in Table 4.1.

Table 4.1 Common ODS and F-Gas Refrigerants

ODS:	Pure fluids:	HCFC 22 (usually referred to as R22)
	Blends:	Various, including R403A, R403B, R408A
F-Gas:	Pure fluids:	HFC 134a (usually referred to as R134a)
	Blends:	Various, including R404A, R407C, R410A

See Appendix 1 for less common examples of ODS and F-Gas refrigerants.

It is important to note that most of the ODS blends (such as R408A) contain **both ODS and F-Gas components.** This means that they are affected by both Regulations.

4.2 Key End-Use Markets for Refrigeration and Air-Conditioning Systems

The key markets for RAC systems were introduced in general terms in Section 3.2.1, which showed the emissions from 7 sub-sectors of the market. Table 3.2 is repeated below for convenience.

Unfortunately, from an implementation perspective this categorisation is not very helpful as it is mainly based on refrigeration technology

types rather than end-use markets. There are 2 well described market sectors in Table 3.2:

- Supermarkets
- Domestic refrigeration

For these sectors it is possible to describe the nature of the market and to give clear examples of the types of RAC system used in each market.

For the remaining sectors it is necessary to identify key market sectors that make widespread use of RAC technologies. In many cases a given market uses several different kinds of refrigeration system. For example, restaurants might use building air-conditioning, small commercial refrigeration (e.g. a small walk-in cold store) and non-domestic hermetic refrigeration (e.g. bottle coolers).

Table 3.2 (repeated) Stationary Refrigeration Sub-Sector Emissions

Sub-Sector	2005 F-Gas Emissions	F-Gas Emission Reduction Potential	% of 2005 F-Gas Emissions	End-Use Regulation Category[11]
	ktonnes CO_2 equiv			
Supermarket refrigeration	2,000	650 to 1,100	56%	L/E
Industrial refrigeration	600	150 to 210	17%	M/D
Air-conditioning	500	140 to 250	14%	M/D
Small Commercial refrig	250	40 to 60	7%	S/D
Transport refrigeration[12]	100	10 to 20	3%	S/D
Domestic refrigeration	60	3 to 5	2%	S/E
Non-domestic hermetic refrig	50	3 to 5	2%	S/D
Total	3,565	1,000 to 1,600	100%	

To address this issue we have subdivided the emissions shown in Table 3.2 into a number of more easily defined market sectors and sub-sectors. These are summarised in Table 4.2.

There are 6 main sectors and 22 sub-sectors. The 6 main sectors include 3 of the categories shown in Table 3.2 i.e. industrial, domestic and transport refrigeration. The other main sectors are market facing

11 These are the 6 categories introduced in Figure 2.1 (i.e. large, medium or small / easy or difficult)

12 Not “stationary” refrigeration but included here for simplicity

sectors that use a combination of technology types. The main market sectors are Retail, Hospitality and Other Buildings. These use a combination of equipment from 3 main technology sectors i.e. building air-conditioning, small commercial refrigeration and non-domestic hermetic refrigeration.

Table 4.2 includes approximate estimates of emissions from each sector and sub-sector. It must be stressed that where these data are not explicitly extracted from Table 3.2 they are only approximate. No research has ever been done in the UK to give a detailed breakdown of F-Gas emissions from the 22 sub-sectors shown in Table 4.2 (the best data source is Table 3.2, using a different and less helpful categorisation). Although some of the figures are only approximate they are quite helpful for the development of a risk-based implementation mechanism, as they show the magnitude of emissions from each market. The data in Table 4.2 shows:

- The dominance of emissions from the supermarket sector. This is the only sector where a small number of organisations are responsible for a significant level of RAC emissions.

- The importance of food/drinks industry and the chemicals industry in terms of industrial emissions.

- The highly fragmented nature of the various commercial and building sectors.

In the tables following Table 4.2 we provide market information about each of the sub-sectors shown in Table 4.2. A standard template has been used to summarise the data to simplify use during the development of the implementation model. More detailed data is given in Appendix 2, including addresses of key organisations.

Table 4.2 RAC Market Sub-Sectors (excluding Mobile Air-Conditioning)

Market Sector	Sub-Sector	Approximate % of Stationary RAC F-Gas Emissions	See Details in Table Number
Retail (61%)	Supermarkets	56%	4.3
	Other food retail	3%	4.4
	Non-food retail	1%	4.5
	Shopping Malls	1%	4.6
Hospitality (7%)	Pubs / coffee shops	3%	4.7
	Restaurants / fast food	2%	4.7
	Hotels	1%	4.7
	Leisure facilities	1%	4.8
Other Buildings (10%)	Commercial offices	4%	4.9
	Central / Local Government	3%	4.9
	Health	2%	4.10
	Education	<1%	4.11
	Prisons	<1%	4.12
Industry (17%)	Food and Drink	6%	4.13
	Chemicals / Petrochemicals	6%	4.14, 4.15
	Cold Stores	3%	4.16
	Rubber and Plastics	<1%	4.17
	Printing	<1%	4.17
	Clean Rooms	<1%	4.17
	Other industry sectors	<1%	4.17
Domestic (2%)	Dwellings	2%	
Transport 13 (3%)	Refrigerated lorries and containers	3%	

13 Not “stationary” refrigeration but included here for simplicity

Table 4.3	Market Sector: Supermarkets

Market Description: This sector refers to food retail supermarkets. A supermarket is defined as having a floor area of >300 m^2. Most supermarkets owned by the big chains are between 2,000 and 6,000 m^2. The largest superstores can be up to 10,000 m^2. The retail market as a whole is worth £221 billion, has over 300,000 shops, and there are over 215,000 businesses. In 2007 the total food market is estimated at £72.8 billion. Supermarkets make up the majority of the food retail market and account for 56% of grocery sales in the UK. Most chains are national, although all have some regional concentration.

F Gas / ODS Uses: Supermarkets are major RAC users. At retail stores large "pack" refrigeration systems are used for the main retail displays and for holding cold stores. Air-conditioning is used in most stores. Various items of small hermetic equipment are also used. F-Gases are the dominant refrigerant (mostly R404A). Many supermarkets still use ODS (HCFC 22 and blends such as R408A). Supermarket companies also own large depots that include chilled and frozen storage. Some of these depots use ammonia refrigeration systems, but F-Gas and ODS refrigerants are also used.

The Main Players. The 4 largest Supermarket retailers are Tesco, Asda, Sainsburys and Morrisons (inc. Safeway). These have over 70% of the market share, they also have the largest stores, the vast majority are over 1,400 m^2. Other large retailers include: Aldi, Marks & Spencer, Somerfield (inc. Kwik Save), Waitrose, Iceland, Netto, Lidl, Farmfoods, and Co-op. There are also a few chains of wholesalers who also sell to the public, the largest of these are Makro (33 stores) and Costco (19 stores).

Market Share

Tesco- Turnover of £39 billion (2006); 1,898 stores; 2, 500,000 m^2 selling space

Asda- 260 stores

Sainsburys- Turnover of £16 billion (2006); 752 stores; 1, 700,000 m^2 of store space

Morrisons- Turnover of £12 billion (2006); 378 stores; 1,100,000 m^2 selling space

The top 11 supermarkets (% of supermarket market share in 12 weeks up to 25th February 2007): (they represent 92% of market)

Tesco	31.2%
Asda	16.8%
Sainsburys	16.5%
Morrisons	11.1%
Waitrose	4.0%
Somerfield	3.8%
Aldi	2.4%
Lidl	2.1%
Iceland	1.8%
Co-Op	1.6%
Netto	0.6%

Trade Bodies: The British Retail Consortium

Table 4.4	Market Sector: Other Food retail

Market Description: This is the food retail market in stores smaller than 300 m^2. There are over 50,000 convenience stores in the UK, which account for 20% of total UK grocery sales. Other stores including specialist shops account for an additional 8% of sales. This sector can be divided as follows:

Independent stores: This is a major part of the market, although there has been a decrease in stores that are completely independent, from 35,500 stores in 2000 to 25,893 stores in 2006.

Petrol Garage Forecourt Convenience stores are run by supermarkets, convenience store groups and oil companies. There are about 9,700 of these stores in the UK.

Specialist Retailer Chains: This includes greengrocers, butchers, bakers, farm shops and fishmongers. Sales in this sector have increased by 1% since 2000; this is compared to growth of 19% in Convenience stores and 26% in Supermarkets.

Convenience Multiples: Supermarkets have moved into the convenience market (e.g. Tesco has 1,150 small format convenience stores). These can be "accessed" via supermarket sector.

Symbol Groups: These are chains of small stores that operate as franchises. This will be difficult from an implementation perspective as the franchisee is the "operator" and is effectively an independent retailer. The number of convenience stores associated with co-operatives or symbol groups (e.g. Spar) increased by 87% between 2000 and 2006.

F Gas / ODS Uses: Mostly small refrigeration systems including both small hermetics and small split systems for retail displays and cold rooms. Also an increasing amount of small split system air-conditioning. Mostly HFC refrigerants, but some use of HCFC22 and HCFC blends on split systems.

The Main Players. Symbol groups are the largest part of this sector (by revenue), but independent retailers make up the largest number of stores. Market share (% of stores): Non-affiliated Independents 49.2%; Symbols 24.8%; Forecourts 17%; Co-operatives 4.4%; Multiples 4.6%. Market share (% of sales): Symbols 33.1%; Non-affiliated Independents 29.2%; Forecourts 15.1%; Multiples 12.4%; Co-operatives 10.3%.

Largest symbol groups, number of stores:		**Largest Forecourt retailers, number of stores:**	
Spar UK	2,724	Esso	631
Budgens/ Budgens Local/ Londis	2,087	Shell	611
Premier	1,900	Total	519
Lifestyle/ Scandia	1,440	BP	414
Costcutter	1,400	Tesco	406
Nisa Today's	1,040	Morrisons	274
Best in/ Best One	920	Sainsbury's	243
P&H Retail	710	Murco/EP	170
Key Store/Shop	342	Asda	164
VG/Vivo	102		

Trade Bodies: The British Retail Consortium; British Franchise Association; Association of Convenience Stores; The National Association of Master Bakers; National Federation of Meat and Food Trades; The Guild of Fine Food Retailers

Table 4.5	Market Sector: Non-Food Retail

Market Description

Non-food retail large*:*

Department stores- have estimated sales of £7 billion. Stores sell mainly clothing, cosmetics and home products. This sector comprises of a few companies with a relatively small number of stores.

DIY stores- market worth around £7.9 billion. Dominated by a few large chains.

Clothing – major chains

Non-food retail small: High street independent shops and smaller chains of all the sectors above. These sectors are extremely diverse with 175,000 businesses operating 275,000 outlets. Most of these will use little refrigeration or air-conditioning.

F Gas / ODS Uses: Mostly for air-conditioning loads including small split systems and some large central systems e.g. in Department stores. Many systems use HFC refrigerants and older systems might use HCFC22.

The Main Players.

DIY stores: The 4 largest chains have 80% of the DIY market.

Department stores: Debenhams, John Lewis and House of Fraser make up 54% of the Department Store sector.

The largest clothes retailers are M&S, Arcadia and Next, with strong competition at the “value end” of the market coming from supermarkets (see earlier)

Number of stores

DIY	B&Q	331 stores, 14.8% market share
	Homebase	310 stores
	Wickes	177 stores
	Focus DIY	250 stores
Department	Debenhams	90 stores
	House of Fraser	60 stores
	John Lewis	26 stores
Clothes	M&S	448 stores
	Arcadia	(includes Topman, Topshop and Burton) 2,000 stores
	Next	480 stores

Trade Bodies: The British Retail Consortium. For SMEs in this sector: British Shops and Stores Association (BSSA)

Table 4.6	Market Sector: Retail Centres

Market Description: This sector refers to shopping malls that have multi-retailer occupancy.

The International Council for Shopping centres divides this market into eight categories by size (from super-regional centre to outlet centre), but retail centres can be more simply divided into the following 3 broad groups:

Regional Shopping Centres/ Malls: Large, out-of-town shopping centres. There are relatively few of these, but each has a large amount of retail space. They often also include cinemas and restaurants.

Factory/ Designer Outlet Centre: There are around 30 in the UK, not all are typical under cover buildings.

Other Including Town/City Centre Shopping Centres: Most are on a smaller scale than out-of-town centres. This category includes roadside service stations.

F Gas / ODS Uses: Mostly for air-conditioning loads including small split systems and some large central systems e.g. in centrally controlled parts of a mall. Many systems use HFC refrigerants and older systems might use HCFC 22.

The Main Players. Many in-town and out-of-town shopping centres are owned by a small number of property investment companies. The largest of these are Capital Shopping Centres, Land Securities and PRUPIM (a subsidiary of Prudential). These three companies own, or partly own twelve of the seventeen large shopping centres listed below. The majority of Outlet Centres are owned by either McArthur Glen, Realm Ltd or Hermes.

The largest centres, by retail space (m^2):

Metro Centre, Newcastle	168,900
Trafford Centre, Manchester	148,720
Merry Hill, Birmingham	148,000
Bluewater Centre, London	144,000
Meadow Hall, Sheffield	132,800
Lakeside, London	130,340
Manchester Arndale	130,060
The Bullring, Birmingham	125,300
thecentre:mk, Milton Keynes	117,000
East Kilbride	107,100
The Eagle Centre, Derby	106,130
Braehead, nr Glasgow	98,470
The Mall@Cribbs Causeway	92,460
Victoria Centre, Nottingham	91,140
Eldon Square, Newcastle-U-Tyne	90,670

The largest Mall owners, by number and total retail space (m^2):

Capital Shopping Centres	14 / 1,151,200
Land Securities	30 / 1,100,000
PRUPIM	17
The Mall	23 / 738,000
Hammerson	6 / 482,500
British Land	7 / 475,000
Peel Holdings	810,000 (of retail, office, and industrial space)
Westfield	7 / 300,000
Lend Lease	4 / 300,000
Realm Ltd	12 / 160,000
McArthur Glen	7 / 153,500
Hermes Real Estate	22

Trade Bodies: British Council of Shopping Centres, International Council of Shopping Centres

Table 4.7	Market Sector: Hospitality

Market Description: Hospitality is split into four areas:

Pubs. There are around 58,000 pubs in the UK; approximately 16,000 are independent and the remainders are owned by a brewer or pub company. There are 10,000 "managed houses" where the owning company is directly responsible for the Regulations and 32,000 "tenanted houses" which are a type of franchise operation where the individual pub tenants would be responsible for the F-Gas Regulations.

Hotels. The budget hotel market is increasing and is made up of a few large chains of hotels. The higher end of the hotel market tends to have smaller chains, although there are some larger chains such as Hilton and Malmaison.

Coffee Shops. The sector is increasingly dominated by branded coffee shops; 3 chains make up about 60% of this market.

Restaurants. Independent restaurants are the most important group in this sector, 70% of businesses are owner operated.

F Gas / ODS Uses: There is a combination of small refrigeration systems (e.g. cellar cooling in pubs) and air-conditioning systems. Many small hermetic systems are used (e.g. in-line beer coolers, bottle cooler displays, ice making machines. Small split systems are used for larger loads including air-conditioning and large cellar coolers.

The Main Players.

Pubs: The main chains are listed below.

Hotels: Whitbread is also one of the main players in the hotel market, especially budget hotels. A list of the main companies and hotel chains are listed below.

Coffee Shops: Starbucks, Costa and Caffe Nero are the largest chains with 531, 415 and 300 coffee shops respectively. Costa is owned by Whitbread.

Restaurants: Whitbread is largest restaurant chain with more than 900 restaurants across a few large brands- Brewers Fayre and Beefeater, Pizza Hut, and TGI Friday's. The Restaurant Group has 284 restaurants across various chains e.g. Chiquito, Garfunkels, and Frankie & Benny's. Tragus Limited has 163 restaurants which are mostly Café Rouge (87) and Bella Italia (68).

Main Pub chains by number of pubs:

Punch Taverns	9,300
Enterprise Inns	8,600
Greene King	2,700
Wolverhampton & Dudley	2,400
Mitchells and Butler	2,000
Scottish & Newcastle	1,100
Avebury Taverns	800
JD Wetherspoons	700

Largest hotel chains by number in UK:

Whitbread 500 (mostly Premier Travel Inn)
Travelodge 316
Best Western >290
Intercontinental Hotel Group >200 (Holiday Inn / Express, Crowne Plaza Hotels)
Accor 90 (Novotel, Ibis, Sofitel, Mercure)
Hilton 70
Thistle Hotels 49
Millennium and Copthorne Hotels 19

Trade Bodies: British Hospitality Association, Northern Ireland Hotels Federation, Restaurant Association, European Catering Association (Great Britain), British Institute of Innkeeping, British Beer and Pub Association, Association of Licensed Multiple Retailers

Table 4.8	Market Sector: Leisure

Market Description: The leisure sector is divided into a few main areas:

Public Sector Leisure Centres. There are more than 4,400 swimming facilities in England, 72% are owned by local authorities or education sectors. There are also 3,738 public sport centres in the UK (2005), just under half are at education sites.

Private Health Clubs

Health clubs within workplaces, schools and Universities. The education sector is the fastest growing part of the leisure industry -73% of all public sector sports centres opened in 2003 were at educational sites.

Ice rinks and Snow domes. This is an important part of the leisure industry in terms of refrigerant use. There are approximately 68 Ice skating and Curling rinks in the UK, 4 snow domes and 7 more snow domes are currently being developed. Many temporary outdoor ice rinks are set up in the Winter.

F Gas / ODS Uses: Heat pumps at some swimming pools. Air-conditioning systems in Leisure Centres and private clubs. Large refrigeration systems for ice rinks and snow domes. Various refrigerants used including HFCs, HCFCs and ammonia for large systems e.g. in ice rinks.

The Main Players. Local authorities are the main providers of facilities in this sector. The main private companies are listed below. Most private clubs are part of large chains of health clubs; private companies also run many public sector centres.

Companies working for local authorities (LAs), managing swimming pools and leisure centres:

SLM Leisure	54 centres
Serco Leisure	work with 18 LAs
DC Leisure	118 LA sites
Greenwich Leisure Limited	>60 centres
David Lloyd Leisure	15 sites
Parkwood Leisure	>50 leisure centres
Leisure Connection	>80 centres

Private Leisure Companies, by number:

Fitness First	180
Curves Gyms	180
Living Well- part of the Hilton Group plc,	>85
Virgin Active	82
David Lloyd Leisure	59 (owned by Whitbread)
Esporta	54
Cannons	52
Lifestyle Fitness	38
Fitness Express	26 within hotels
Nuffield Proactive Health-	in-house gyms for over 100 companies
Snozone / X Leisure	

Trade Bodies: Fitness Industry Association

Table 4.9	Market Sector: Offices

Market Description: Offices account for 16.7% of non-domestic floor space in England. There is 99.5 million m^2 of office space in England and Wales.

Serviced Offices/ Business Centres – There are over 900 in the UK. It is quite a fragmented market, but the larger companies' market share is increasing.

Public Sector Offices– government office space totals more than 12.5 million m^2 in England, Scotland and Wales.

Real Estate Investment Companies – The 8 companies listed below have a total office space of about 5.6 million m^2.

F Gas / ODS Uses: Mainly air-conditioning. Most systems are either HFCs or HCFC22.

The Main Players.

Serviced Offices: The top 3 companies are Regus, MLS, and MWB. Together they have a 29% share of the serviced office market. The largest companies are listed below, but there are regional variations. For example, Bruntwood is not one of the largest companies, but it is the most significant in North West England. It has around 20% of the total office space in Manchester City Centre and over 450,000 m^2 in total.

Public Sector: Mapeley own and manage government and commercial properties. They have 2.3 million m^2 of commercial, retail and office space (1,683 properties). Its largest clients are HM Revenue and Customs (1.4 million m^2), Abbey (600,000 m^2) and IPS (18,500 m^2).

The largest occupier of government offices is the Department of Works and Pensions who have 2.5 million m^2, their offices are outsourced to Land Securities Trillium.

The Crown Estate has 954,000 m^2 of office space.

Real Estate Investment Companies: The main companies in this sector are British Land, Land Securities, and Hammerson.

Largest Serviced office providers (% of serviced office space):	
Regus	14% (106 centres)
MLS	8% (77 Offices)
MWB	7% (30 Offices)
Executive Offices	3% (27 Offices)
Abbey Business Centres	2% (13 Offices)
BEG	2% (10 Offices)
Stonemartin	2% (5 Offices)
First Base	1% (8 Offices)

Large Property Investors, by total office space (m^2):	
Land Securities Trillium	2,900,000
British Land	990,000
Land Securities	710,000
Hammerson	250,300
SEGRO	177,506
Great Portland Estates	162,720
Liberty International	160,600
Delancey	110,000
Hermes	107,100

Trade Bodies: British Council for Offices, Business Centre Association

Table 4.10	Market Sector: Health

Market Description: The main areas for health activity are Hospitals, Health Centres and Nursing Homes. Dentists, opticians and pharmacies are also part of this sector.

Hospitals. There are 872 NHS Hospitals and 460 private hospitals in the UK.

Nursing Homes. These are split into local authority residential care homes and private care homes. The numbers of local authority homes are reducing as the NHS have favoured paying for individuals at private homes.

GP Surgeries and Health Centres. There are also NHS walk-in centres (84 in England).

F Gas / ODS Uses: Main uses are in larger hospitals, with air-conditioning and specialised loads such as mortuary refrigeration and cooling of scanners. Smaller sites e.g. Health Centres may have air-conditioning. Most systems are either HFCs or HCFC22.

The Main Players: The largest organisation in this sector is, of course, the NHS. The NHS manages and owns the vast majority of health facilities in the UK, but there are private companies running Hospitals, Nursing homes and Health Centres. In 2001 there were 5,680 private nursing homes and hospitals (5,220 homes and 460 hospitals).

The NHS itself is one of the largest suppliers of private medical treatment. The largest private healthcare companies each have around 40 hospitals, which is less than the NHS but they tend to have more beds than the private NHS facilities.

Primary Health Properties PLC owns more than 75 healthcare facilities which it then leases out. Most of the properties are GP surgeries, but it also owns pharmacies, dentists and some Primary Care Trusts' buildings.

Private Healthcare companies by number of hospitals:

BMI Healthcare	49 (10 within NHS Hospitals)
Nuffield Hospitals	42
BUPA Hospitals	26
Capio Healthcare UK	22 hospitals, and 10 NHS Treatment Centres
Classic Hospitals	13
HCA International	6
Abbey Hospitals	5
Aspen Healthcare	3
The Hospital Management Trust	3
(NHS Private Patient Units	93)

Main Nursing Home/ Care Home Groups (with 100+ homes):

Anchor Trust

Barchester Healthcare Ltd

BUPA Care Homes

Craegmoor Healthcare Co Ltd

Four Seasons Healthcare Ltd

Milbury Community Services

Southern Cross Healthcare Ltd

Trade Bodies: The British Healthcare Trades Association, English Community Care Association, National Care Homes Association, British Medical Association, Registered Nursing Home Association (RNHA)

Table 4.11	Market Sector: Education

Market Description:

State Schools- Funded by Local Education Authorities (LEAs). In 2005 there were 8.3 million pupils attending all types of schools in the UK. There were a total of 25,335 schools in England (458 Nurseries; 17,642 Primary Schools; 3,385 Secondary Schools; 1,122 Special Schools; 447 Pupil Referral Units; 14 City Technology Colleges).

Privately-run state schools- Since 1997 private companies have been able to compete for contracts to run LEAs and provide support services. Private companies can now also run the schools themselves.

City Academies- There are 47 City Academies which are owned by commercial sponsors, but paid for by the LEA. Each sponsor must contribute £2million towards the school. The sponsor will have the majority of places on the board, and control over the way the school is run, it also owns the land and buildings.

Trust Schools- supported by a charity, but still funded by the LEA.

Independent Schools- Approximately 7% of pupils attend an independent school, of which there are around 2,250 in the UK. Some, but not most, are part of a chain of independent schools.

Universities- There are approximately 325 universities, colleges of higher education and further education colleges in the UK. They range in size from about 4,000 to 34,000 students. Higher Education Colleges can range from 450 to 13,000 students.

F Gas / ODS Uses: Relatively little use in schools. Air-conditioning might be used in large modern schools. Air-conditioning more likely in Universities, especially in large buildings. Some use of refrigeration systems for catering facilities. Most systems are either HFCs or HCFC22.

The Main Players.

Schools – local authorities are still the Main Players in Education, but examples of other organisations and companies in the Education sector are shown below.

Largest Universities – University of London, University of Wales, University of Central England, University of Manchester.

Examples of companies running state schools:	**City Academy Sponsors:**
Edisons Schools, Cambridge Education Associates, Serco, Nord Anglia, Atkins Education, OPM, VT Education, Equion, Jarvis, 3E's Enterprises	United Learning Trust- a Christian Charity involved with 13 Schools
	Emmanuel Schools Foundation- 2 Schools
	The Oasis Trust- 2 Schools
Large Chains of Independent Schools:	Individual businessmen e.g. Lord Harris of Peckham (3 Academies), and Arpad Busson
Gems - 12 Schools, Cognita- 32 Schools	

Trade Bodies: Girls' Schools Association, Independent Association of Prep Schools, Independent Schools Association, Boarding Schools Association, General Teaching Council

Table 4.12	Market Sector: Prisons

Market Description:

The prison sector covers local prisons, remand centres, training prisons, young offender institutes and open prisons. The prison population is currently numbers around 80,456 in England and Wales.

England and Wales- prisons are run by the HM Prisons Service, and overseen by the Ministry of Justice (since May 9th this year, before this it was the Home Office). There are 139 prisons; these are mostly publicly operated except for 11 privately operated prisons.

Scotland- the Scottish Prison Service manage the 16 Prisons in Scotland.

Northern Ireland- the Northern Ireland Prison Service is responsible for Northern Ireland's 3 Prisons.

F Gas / ODS Use.

Mainly refrigeration for catering facilities plus some air-conditioning. Most systems are either HFCs or HCFC22.

The Main Players.

Liverpool and Wandsworth Prisons are among the largest prisons, Wandsworth holds 1,416 prisoners.

Prison Operators and number of prisons:

HM Prison Service- 128 prisons- 4 in Wales, 13 in South West, 16 in South central, 11 in Kent and Sussex, 8 in London, 13 in Eastern, 15 in East Midlands, 13 in West Midlands, 13 in Yorkshire and Humberside, 14 in North West, 8 in North East.

Serco- 4 (Ashfield, Doncaster, Dovegate, Lowdham Grange)

GSL- 3 (Altcourse, Rye Hill, Wolds)

United Kingdom Detention Services- 3 (Bronzefield, Forest Bank, Peterborough)

G4S Justice Services- 1 (Parc)

Trade Bodies:

Prison Officers Association

<table>
<tr><th>Table 4.13</th><th colspan="2">Market Sector: Food and Drink Manufacturing</th></tr>
<tr><td colspan="3">Market Description: The food and drink sector is the largest industrial user of refrigeration. There are round 2,000 medium and large food / drink factories in UK plus several thousand smaller facilities. Main sectors using refrigeration include:
Primary processing: Red meat, poultry, fish, fruit and vegetables
Secondary processing: Chilled and frozen foods, ready meals, bakery products, dairy products, ice cream, chocolate and confectionary, margarine
Drink manufacture: brewing, cider, soft drinks, milk</td></tr>
<tr><td colspan="3">F Gas / ODS Use. Major refrigeration facilities for raw material storage, product cooling and freezing and finished goods storage. Air-conditioning for production areas. HCFC22 still in use. HFCs common. Ammonia quite common on large systems.</td></tr>
<tr><td colspan="3">The Main Players. A significant proportion of food is manufactured by a small number of major multi-national companies. Many of these are large users of refrigeration. There are climate change agreements (CCAs) in place for 17 different sub-sectors of the food and drink industry. These form an ideal starting point for identifying locations of food factories. Large companies from CCA sectors are shown below.</td></tr>
<tr><td>FDF: All the companies below have UK sales in excess of £1 billion p.a)
Unilever
Associated British Foods
Premier (now including RHM)
Northern Foods
Masterfoods
Nestle
Cadbury-Schweppes
Coca Cola
Greencore
H. J. Heinz
Salvesens
Uniq
Kerry Foods
Burtons Foods
Youngs Bluecrest
McCain Foods</td><td>BMPA The largest UK red meat companies are:
Anglo Beef Products
Fairfax Meadow
Weddel Swift
Dawn Holdings
Cranswick
Tulip International
Adams Pork Products

BPC The largest UK poultry meat companies are:
Grampian
Bernard Matthews
Deans Foods
Faccenda
Moy Park</td><td>Dairy UK
Milk processing is dominated by three companies –see market shares below
Arla Foods 43%
Robert Wisemans 35%
Dairy Crest 22%
Dairy products are also made by Express, The Cheese Company, Milk Link and
Glanbia

BBPA The following have 80% of the brewing market
Anheuser Busch
Carlsberg
Coors
InBev UK
Scottish Courage</td></tr>
<tr><td colspan="3">Trade Bodies: Numerous TAs. Key TAs with CCAs are: Food and Drink Federation (FDF), British Meat Processors Association (BMPA), British Poultry Council (BPC), British Beer and Pub Association (BBPA), Dairy UK (DUK)</td></tr>
</table>

<table>
<tr><td>Table 4.14</td><td colspan="3">Market Sector: Chemicals and Pharmaceuticals</td></tr>
<tr><td colspan="4">Market Description: The chemicals sector is the second largest industrial user of refrigeration. There are around 300 medium and large chemical factories in UK plus around 500 smaller facilities. Main sectors using refrigeration include:
Bulk chemicals (including industrial gases)
Speciality chemicals
Pharmaceuticals</td></tr>
<tr><td colspan="4">F Gas / ODS Use. Major refrigeration facilities for product cooling. Also air-conditioning for production areas and clean rooms (e.g. in pharmaceuticals). All types of refrigerant used. Lots of HCFC22 still in use. HFCs common. Ammonia used on large systems, although not that common in chemicals sector.</td></tr>
<tr><td colspan="4">The Main Players. A significant proportion of chemicals are manufactured by a small number of major multi-national companies. Many of these are large users of refrigeration. There are climate change agreements (CCAs) in place for 300 chemical sites in the UK, via the CIA. This CCA forms an ideal starting point for identifying locations of chemical plants. Large companies from CCA sectors are shown below. Figures in brackets are the latest sales of the UK company as reported in the UK R&D Scoreboard.</td></tr>
<tr><td>Bulk:
BP Chemicals*
Shell Chemicals*
Ineos (£3,560m)
Huntsman Tioxide (£,2880m)
Lucite International (£780m)
Croda Chemicals (£306m)
Dupont (£302m)
Brunner Mond (£160m)
Also:
Dow Chemicals
Solvay
Kemira
BOC Linde
Air Products
(* Sales are reported under oil & gas and do not include separate figures for chemicals operations).</td><td>Speciality
ICI (£5,812m)
Johnson Matthey (£4,756m)
British Vita (£959m)
Yule Catto (£556m)
Syngenta (£475m)
Ciba Speciality Chemicals (£445m)
Avecia (£407m)
Elementis (£399m)
BASF (£361m)
Sun Chemical (£316m)
Akzo Nobel (£257m)
Wide range of other firms e.g.:
Akcros Chemicals
Invista
FMC Chemicals
Rohm & Hass
Pentagon Chemicals
Robert MacBride</td><td colspan="2">Pharmaceuticals
Glaxo Smith Kline (£21,660m)
Astra Zeneca (£13,950m)
Eli Lilly (£1,999m)
Merial (£1,152m)
Pfizer (£979m)
Shire (£932m)
Johnson & Johnson (£923m)
American Home Products (£757m)
Roche (£589m)
Merck Sharp & Dohme (£386m)</td></tr>
<tr><td colspan="4">Trade Bodies: Chemical Industries Association (CIA)</td></tr>
</table>

Table 4.15	Market Sector: Oil, Gas and Petrochemicals

Market Description: The industry is divided into two main sectors:

Upstream oil & gas production from the UK Continental Shelf (UKCS)

Downstream oil & gas processing including refining and the production of bulk petrochemicals

F Gas / ODS Uses: Large refrigeration systems used for product cooling and processing. HCFC22 in common use. Also HFC refrigerants. Some unusual refrigerants such as ethylene used within petrochemical processes.

The Main Players.

Upstream Oil & Gas Production: There are 277 offshore oil & gas installations on the UKCS comprising: 88 fixed oil platforms, 18 floating oil platforms and 171 gas platforms. The platforms are operated by around 30 companies consisting mainly of the major oil & gas multinationals such as BP, British Gas, ConocoPhillips, Chevron, ExxonMobil, Perenco, Shell and Total. There are also a number of smaller operators such as BHP Billiton, Burlington, CNR, Talisman and Tullow. A complete list of operators and addresses is available.

Downstream Oil & Gas Processing: There are 12 oil refineries in the UK – 8 major facilities which are involved in distillation, reforming and cracking of petroleum and 5 other facilities which are involved in distillation only. The major facilities are operated by oil & gas multinationals such as BP, Conoco, ExxonMobil, Shell and Total and by Ineos Refining which now operates the Grangemouth refinery (see below).

National Grid owns and operates the National Transmission System for natural gas throughout Great Britain. This includes four LNG storage facilities located at Avonmouth (near Bristol), Dynevor Arms (South Wales), Partington (near Manchester) and Glenmavis (Strathclyde). Due to the growing trend to import gas considerable investment in gas storage facilities is in development and/or planning including LNG facilities at South Hook, Pembroke (Dragon), Teesside and Canvey Island.

A wide range of chemicals are produced downstream of the oil refineries including olefins, aromatics and bulk plastics. The key sites in the UK are also operated by major multinationals such as BP, ConocoPhillips, Huntsman, Ineos Olefines and Shell

Upstream Oil & Gas Production: main operators and % of platforms.

Shell (18%)
BP (14%)
ConocoPhillips (12%)
Perenco (12%)
Talisman (6%)
ExxonMobil (4%)
Total (3%)
HRL (3%)
Tullow (2%)

UK Refinery Processing Capacity: sites, operators and % total distillation capacity Fawley, ExxonMobil (18%)
Stanlow, Shell (13%)
Lindsey Oil Refinery, Total (12%)
Killingholme, Conoco (11%)
Pembroke, Texaco (11%)
Grangemouth, Ineos Refining (11%)
Coryton, BP (10%)
Milford Haven, Murco (6%)
North Tees, Petroplus (5%)

Trade Bodies: UK Oil & Gas Association (UKOGA). UK Petroleum Industries Association (UKPIA). Chemicals Industry Association (CIA).

Table 4.16	Market Sector: Cold Stores
Market Description: The cold storage sector relates to the bulk storage of frozen and chilled foods in "stand-alone" cold storage warehouses. Food manufacturing sites sometimes have on-site cold storage facilities – these are not included in this sector. Chilled and frozen products are usually shipped to a cold store before being delivered to supermarkets and other retailers. Some cold storage is "long term" i.e. the products are stored for many weeks before dispatch. Other cold stores are "distribution stores" with a rapid turnaround of product. The major supermarket chains all own chains of distribution stores.	
F Gas / ODS Use. Major refrigeration facilities for maintaining the temperature in cold or chill stores. Also some product freezing equipment at some cold store sites. Lots of HCFC22 still in use. HFCs common. Ammonia commonly used on large systems.	
The Main Players. The main players split into 2 groups: (a) Specialist cold storage and logistic companies and (b) Supermarket distribution centres.	
Specialist Cold Store Operators TDG Salvesen Logistics Associated Cold Stores Innovate Logistics Harry Yearsley Gist Norrish Fylde Cold Stores Reed Boardall Turners	**Supermarket cold stores** Sainsburys Tesco Asda Morrisons Cooperative Group
Trade Bodies: Cold Storage and Distribution Federation (CSDF)	

Table 4.17	Market Sector: Other Industrial Sectors

Market Description: A very large proportion of refrigeration used in industrial sectors is used in the food & drink, chemicals & petrochemicals and cold storage sectors. These probably represent nearly 90% of industrial refrigeration and air-conditioning applications.

Other sectors using refrigeration or air-conditioning include:

Plastics manufacturers – plants carrying out injection moulding often use water chillers to provide cooling to the moulding machines.

Rubber processing – certain processes require refrigerated cooling. Some are quite unusual and process specific e.g. the manufacture of some types of foam mattresses uses low temperature refrigeration systems.

Printing – some large printing machines require water chillers to provide cooling.

Clean rooms – clean rooms in facilities such as semi-conductor manufacturing require large air-conditioning systems.

There is no large scale and consistent use of refrigeration outside the sectors discussed above, although a few unusual processes will make use of refrigeration.

F Gas / ODS Use. Most of the systems used in these sectors will utilise either HFC or HCFC refrigerants. Ammonia is only occasionally used on large systems.

The Main Players. See Table 5.12 for semiconductor companies.

Plastics and Rubber	**Printing**
A diverse sector. The DTI (now the Department for Business, Enterprise and Regulatory Reform) notes 6, 315 plastic processors of which 2,315 are in building ware. Major companies include: BASF BP Dunlop Hydro Polymers Ineos Vinyls Shell Wavin	In 2002, there were 17,620 printing companies. These are mainly small firms – around 90% employ fewer than 20 people and only about 500 employ more than 50. The top five companies involved in the sector by size are: De La Rue Chesapeake Williams Lea British Polythene Industries St Ives

Trade Bodies: British Printing Industry Federation (BPIF); British Plastics Federation (BPF); British Rubber Manufacturers Association (BRMA); National Microelectronics Institute (NMI)

5. OTHER END-USER MARKETS

5.1 Introduction

In Section 4 we have concentrated on the complex and very important refrigeration and air-conditioning markets. In this Section we provide data about all the other end-use sectors discussed in Section 3.

As in Section 4 we have used a standard template to summarise the data to simplify use during the development of the implementation model. Further more detailed data is given in Appendix 2, including addresses of key organisations. The sectors reviewed in this Section are summarised in Table 5.1. The 3 shaded rows in the table indicate the markets specifically identified in Articles 3 and 4 (Containment and Recovery) of the F-Gas Regulation.

Table 5.1 Other End-Use Markets

Type of End Use	F-Gas Emissions, 2005 ktonnes CO_2 equiv	Details found in Table No:
Fluid manufacture	2,223	5.2
Medical aerosols	1,516	5.3
Mobile air-conditioning	1,459	5.4a and 5.4b
General Aerosols	1,442	5.5
Magnesium production	860	5.6
Foam blowing	563	5.7
High voltage switchgear	522	5.8
Fire protection	358	5.9
Aluminium production	170	5.10
One component foam	111	5.11
Electronics production	99	5.12
Solvent cleaning	46	5.13

Table 5.2	Market Sector: Fluid Manufacture
Market Description: The market can be characterised into 3 different sub-sectors: Manufacture of F-Gas or ODS: there are only 3 UK facilities doing this and one of these is due to close during 2007. Distribution, cylinder filling and recovery / reprocessing. there are 5 UK facilities that use bulk supplies of F-Gas (sourced from UK manufacture or imported) and provide a filling and blending service to supply cylinders and other containers to the various markets. Some of these facilities also handle recycled ODS and F-Gases. Wholesalers: A number of wholesalers supply cylinders from the main distributors to contractors and end users.	
F Gas Emissions. There is the potential for emission from the manufacturing process or cylinder filling / handling operation. There are no specific obligations under the F-Gas Regulation, but minimising emissions, especially from the 1 remaining HCFC22 manufacturing site (Ineos at Runcorn) is important in terms of the overall UK F-Gas emissions inventory.	
The Main Players. The key emissions will come only from the Ineos site at Runcorn, which emits HFC23 as a by-product of HCFC 22 manufacturing. Other players are summarised below.	
Manufacture Ineos Fluor, Runcorn, making HCFC22 and HFCs 134a and 125. F2 Chemicals, Preston, making PFCs Rhodia, Avonmouth, making HCFC 22, but due for closure.	
Distributors Harp, Pontypridd, packing refrigerants, aerosol propellants and foam blowing agents BOC Immingham, packing refrigerants and other special gases. National Refrigerants, Birmingham, packing imported refrigerants. A-Gas, Bristol, handling imported refrigerants, foam blowing agents and other products including SF_6. Gower Chemicals Limited, Swansea packing imported refrigerants. Great Lakes Chemicals, packing fire fighting HFCs	**Wholesalers** Dean and Wood Climate Centre BOC HRP IDS United Refrigeration
Trade Bodies: Chemical Industries Association (CIA); British Refrigeration Association (BRA)	

Table 5.3	Market Sector: Medical Aerosols

Market Description:

This market relates to the manufacture of metered dose inhalers (MDIs). Note, the use of MDIs is totally emissive and can only be avoided by banning the use of F-Gas propellants in MDIs. Such a ban was not considered cost-effective or practical. There are small opportunities to reduce emissions at MDI manufacturing facilities. These relate to losses during the filling process and recovery of F-Gas from MDIs used for testing purposes at the manufacturing site.

The UK is a major exporter of MDIs, hence our manufacturing sites are large. There are xx manufacturing sites in the UK owned by 2 companies.

F Gas Emissions.

Most MDIs are now filled using HFC 134a as the propellant. Some use of CFC12 may still be allowed under the essential use exemptions in the Ozone Regulation.

The Main Players.

All manufacturing is carried out by 4 major pharmaceutical manufacturers at 5 plants.

MDI Manufacturers

Glaxo SmithKline

Astra Zeneca

3M

INyX Pharma

Trade Bodies:

International Pharmaceutical Aerosol Consortium (IPAC)

British Aerosol Manufacturers Association (BAMA)

Table 5.4a	Market Sector: Mobile Air-Conditioning: Car Maintenance/ Repair

Market Description: There are a number of different types of business car maintenance: (a) Authorised/ Franchised repair shop, (b) Independent Workshop for one brand, (c) Independent Workshop for several brands, (d) Quick repair outlet, and (e) Autocentre chains.

There are an estimated 35,000 maintenance and repair outlets in the UK. The value of the sector was around £6.13 billion in 2004 (service market £2.64 billion, mechanical repair market £3.5 billion). Many of these outlets do MAC repairs and servicing.

F Gas Emissions. All MAC systems have used HFC 134a as the refrigerant since 1993. Leakage can occur during use, during servicing and at the end of vehicle life. There are no obligations under Article 3 (containment) but there are obligations for recovery during servicing and at end of life. This responsibility will fall to car servicing companies, who will need to use proper recovery equipment and employ adequately trained technicians. Historically this sector has made widespread use of HFC from non-refillable containers, that will be banned from July 2007.

The Main Players

Franchised dealers and independent garages have the major share of the market. Fast-fit and Autocentre outlets have seen a decline in their market share. There is a split in the type of car being serviced at these outlet types. Franchises deal with the majority of new cars while independents work on most older cars.

There are approximately 6,000 authorised repairers, and 29,000 independent businesses. The top 5 makes of new car registrations in 2006 were Ford, Vauxhall (GM), Volkswagen Audi Group, Peugeot, and Renault; this will roughly correspond with the companies who have the most authorised repairers. Other important franchises include Toyota, Nissan, Honda, and BMW,.

The main Autocentre/ Quick-repair outlets are listed below.

Autocentre/ Quick-repair centres and number of outlets		**Market share of different outlets (% of total outlets)**
Kwik fit	672	Independent Garage workshops 55%
Rapid Fit	>300	Franchised Dealers 25%
Centres		Fast-fit outlets 17%
Nationwide Autocentres	225	Other outlets 3%
National Tyres and Autocare	> 200	
Arnold Clark Service Centres	118	
Formula One Autocentres	47	

Trade Bodies: Society of Motor Manufacturers and Traders; Motor Vehicle Repairers Association; Retail Motor Industry Federation; Scottish Motor Trade Association; Vehicle Builders and Repairers Association. It is estimated that a third of car maintenance businesses are not a part of a trade association

Table 5.4b	Market Sector: Mobile Air-Conditioning: Car Dismantlers

Market Description: There are approximately 2 million waste vehicles produced annually. As a hazardous waste they need to be de-polluted prior to recycling, shredding etc. Since the End-of-life vehicle regulations (2003) all car dismantlers must now have a licence to deal with waste vehicles.

There are a total of 1,553 vehicle dismantlers who are affiliated to trade associations and a further 2,500 who are not members.

F Gas Emissions: HFC 134a must be recovered from old cars with MAC systems to prevent illegal venting.

The Main Players

Most Authorised Treatment facilities (ATF) are owned by small independent businesses, but there are companies working as part of networks in order to obtain contracts from the large manufacturers. Most motor manufacturers have contracts with ATFs through 2 networks- Cartakeback and Autogreen.

Caretakeback has contracts with manufacturers including Alfa Romeo, Aston Martin, Audi, Bentley, Citroën, Fiat, Ford, Jaguar, Lamborghini, Land Rover, Mazda, Nissan, Peugeot, Renault, Rover, Volkswagen and Volvo.

Autogreen has contracts with Kia, Honda, Porsche, Chevrolet, Daihatsu, Toyota, BMW, DaimlerChrysler, Vauxhall and Saab.

Large vehicle dismantlers:	**Networks of vehicle dismantlers:**
European Metal Recycling Ltd- 40 ATFs, 200,000 cars/year	Cartakeback- more than 200 ATFs
Sims Group UK- 22 ATFs	Autogreen
Universal Salvage-11 ATFs, 100,000 cars/year	European Metal Recycling Ltd- >300 companies
Charles Trent Ltd- 5 ATFs, 45,000 cars/year	NSG- > 40 companies, 100,000 cars/year
Century Salvage sales Ltd- 5 ATFs, 30,000 vehicles/year	Nationwide Auto Salvage Amalgamation- 25 companies
	Sims Group UK- network of approved ATFs who are not contracted to manufacturers (recycleyourcar.co.uk)

Trade Bodies:

Motor Vehicle Dismantlers Association;

British Metals Recycling Association;

Institute of Vehicle Air-Conditioning

British Vehicle Salvage Federation

Autorecyclers Association

Table 5.5	Market Sector: General Aerosols
Market Description: The general aerosols market has 3 relevant parts: (a) Aerosols using non-F-Gas propellants, (b) Technical aerosols using HFC propellants and (c) Novelty aerosols using HFC propellants. Only the novelty aerosol market is affected by the F-Gas Regulation – with a ban coming into force from July 2009.	
F Gas Emissions. The emissions from novelty aerosols will be completely prevented providing that the ban is effective. Preventing imports may prove to be a key aspect of implementation.	
The Main Players. There is only 1 manufacturer of novelty aerosols in the UK – Goodmark in Gwent. All other novelty aerosols are imported. There is little focus in the retail market. Novelty aerosols include products such as silly string, artificial snow and decorative paints. These are sold in a wide range of retail establishments including Department Stores, DIY stores and Garden Centres. It is not easy to identify major players in the retail markets.	
Trade Bodies: British Aerosol Manufacturers Association (BAMA)	

Table 5.6	Market Sector: Magnesium Manufacture
Market Description: Magnesium manufacturing includes the primary processing of magnesium alloys which are cast into billets and the secondary processing of magnesium alloy components using die casting and sand casting techniques	
F Gas Emissions. Magnesium processing requires the use of an inert "cover gas" to prevent molten magnesium reacting with the oxygen in the air. SF_6 is the most commonly used cover gas. This has the highest GWP of any greenhouse gas – it is 23,900 times more powerful than CO_2. SF_6 will be banned as a cover gas for magnesium die casting from January 2008, except for small die casters using less than 850 kg of SF_6 per year. Note, other forms of casting are not specifically targeted by this ban.	
The Main Players. Magnesium Elektron, in Manchester is the largest magnesium processing company in the UK and emits a significant proportion of the SF_6 from this industry. However, Magnesium Elektron is not a die caster, hence is not directly affected by the F-Gas Regulation. All other magnesium processing companies in the UK are much smaller. Those involved in die casting and sand casting are shown below. It is uncertain that any of these companies use >850 kg SF_6 per year for die casting.	
Die casters Magnesium Castings, C. E. Marshall, Willenhall Dynacast, Alcester Norfran, Bridgenorth	**Sand casters** Aeromet, Sittingbourne UK Racing Castings, Kent
Trade Bodies: Cast Metals Federation Non-Ferrous Alliance (NFA)	

Table 5.7	Market Sector: Foam Blowing

Market Description:

This market relates to the blowing of rigid foams using HFCs as the blowing agent. This type of foam is used in various insulation applications including flat panels (e.g. for wall/floor insulation), metal clad panels (e.g. for cold store walls) and shaped sections (e.g. pipe insulation). The main types of insulation blown with HFCs include: extruded polystyrene (XPS), polyurethane (PU), polyisocyanurate (PIR) and phenolic foams.

F Gas / ODS Emissions.

Some F-Gas is emitted during the manufacturing stage of the life cycle. These emissions are not specifically targeted by the F-Gas Regulation, although some emission reduction may be possible. Manufacturing emissions are very high for XPS foams. The losses during PU, PIR and phenolic foam manufacture are much lower. There are slow emissions during the "use phase" of the life cycle, but these are impossible to prevent if HFC blown foam is used. There is a residual amount of HFC left in the foam at the end of useful life. In principle this is affected by the "catch-all" requirement for F-Gas recovery in Article 4 of the Regulation, although recovering foam during building demolition may be prohibitively expensive.

It is important to note that from the 1960s to 2003, these foams were blown with ODS blowing agents including both CFCs and HCFCs. It is foam blown with ODS that is more likely to be encountered during building demolition during the next 20 years.

Foam manufacturers are trying to use non-HFC alternatives such as HCs (for PU foams) and CO_2 (for XPS), although HFCs have advantages in terms of insulation effectiveness and low flammability.

The Main Players.

There are only 4 main manufacturers of HFC blown foam as shown below.

XPS Foam	PU, PIR and Phenolic Foam
Dow	Kingspan
Knauf	Celotex

Trade Bodies:

British Rigid Urethane Foam Manufacturers Association (BRUFMA).

European Diisocyante & Polyol Producers Association (ISOPA)

Table 5.8	Market Sector: High Voltage Switch Gear (The Electricity Supply Industry)

Market Description:

The Electricity Industry uses SF_6 insulated switch gear in three main activities, all involving very high voltage electricity:

Electricity Generation.

Transmission. This is the high-voltage transmission network.

Distribution – The Distribution Network Operators (DNOs) are the owners and operators of the network that bring electricity from the high-voltage transmission Network to end users.

F Gas Issues SF_6 switchgear is used in high voltage substations and will be used by electricity generators, and in electricity transmission and distribution. Gas insulated switch gear (GIS) uses SF_6 as an insulating gas. During maintenance of GIS it is necessary to remove the SF_6 to gain access. Proper recovery of the SF_6 is a requirement of Article 4 of the F-Gas Regulation, which makes specific mention of this sector.

The Main Players. There are four Transmission licence holders in the UK. There are eight DNOs in the UK

There are over 2,000 generating stations in the UK. However, a large number of these are very small. The 40 largest power stations produce around 80% of UK power output..

The four transmission companies are:

National Grid, NIE, Scottish Power and Scottish & Southern

The eight DNOs are:
CE electric
Central Networks
EdF
NIE
Scottish Power
Scottish & Southern
United Utilities
Western Power

The top 10 generators by installed capacity accounted for nearly 80% of total capacity in 2005. These are as follows:

British Energy	15%
RWE Npower	12%
E On	12%
Scottish & Southern	12%
Scottish Power	8%
EdF	6%
Drax	5%
BNFL	3%
Centrica	3%
iPM Energy	3%

Trade Bodies: Energy Networks Association (ENA, for the transmission and distribution sector).

Association of Electricity Producers (AEP, for electricity generation).

Table 5.9	Market Sector: Fire Protection
Market Description: This market relates to the use of HFCs for fixed fire fighting systems. Certain HFCs provide a very effective method of extinguishing fires whilst creating minimum damage to the premises and equipment where the fire occurs. For this reason HFC systems are used to protect high value equipment and goods that would be damaged by water. Most applications relate to protecting electronic systems e.g. computer centres and telecoms. The end-use market is quite fragmented, consisting of specific buildings that require this approach to fire protection. The supply and servicing market is highly specialised and only consists of a small number of companies. The market can be better accessed through the supply side rather than via end users.	
F Gas Emissions. Fire protection systems using HFCs are specifically targeted via Articles 3 (containment) and Article 4 (recovery) of the F-Gas Regulation. Also there is a ban on the use of PFCs for fire protection, from July 2007. It is believed that no PFCs are currently used for fire protection in the UK.	
The Main Players. End users: not possible to identify any very dominant users – the market is highly fragmented. Supply and service companies: there are a small number of main players as shown below.	
Fire Protection Supply / Maintenance Companies Tyco Fire & Integrated Solutions (also own ADT Fire and Security Systems and Wormald Fire Systems) Kidde Fire Protection (also own Chubb Fire) Siemens Building Technologies Surefire Systems Fike Protection Systems LPG (Spain) Honeywell	**HFC Suppliers** Great Lakes Chemicals Dupont
Trade Bodies: British Fire Protection Systems Association (BFPSA) Fire Industry Association (FIA) British Approvals for Fire Equipment (BAFE)	

Table 5.10	Market Sector: Aluminium Production

Market Description:

This market relates to the primary smelting of aluminium.

F Gas Emissions.

During the smelting process PFCs are sometimes emitted as a by-product. This is an undesirable operating condition but it does occur on a regular basis in many type of aluminium smelter. There is no specific mention of this source of emissions in the F-Gas Regulation, but the small number of producers could be targeted via Integrated Pollution Prevention and Control (IPPC) regulations to achieve best practice.

The Main Players.

There are only 2 UK companies that have aluminium smelting facilities. They operate 3 sites in the UK. Details are shown below.

Aluminium Smelting Companies

Alcan Smelting and Power UK, with 2 smelters at:

Lynemouth Smelter

Lochaber, Fort William

Anglesey Aluminium Metal Limited, with 1 smelter at:

Penrhos Works, Holyhead

Trade Bodies:

Aluminium Federation (AF)

Table 5.11	Market Sector: One Component Foam
Market Description: This market relates to a specialised type of aerosol used to create polyurethane foam that is used in the construction industry. The foam is usually applied in gaps such as those around window and door frames.	
F Gas Emissions. One component foam (OCF) often utilises an HFC which acts as both the aerosol propellant and the foam blowing agent. HFCs in OCF will be banned under the F-Gas Regulation from July 2008.	
The Main Players. There are no UK companies that manufacture OCF aerosols in the UK. All OCF used in the UK is imported. The import market is fairly fragmented. OCF is sold by DIY stores and by wholesalers to the building trade. The builders merchant sector is much more fragmented than the DIY sector – but there are some national chains as shown below OCF is also available via the internet.	
DIY Chains (see Table 4.5 for more details) B&Q Homebase Wickes Focus DIY	**Trade Wholesalers (number of outlets)** Travis Perkins 750 Jewson 460 Build Centre 200 (part of Wolseley plc also own plumb centre etc) Build base 125
Trade Bodies: British Aerosol Manufacturers Association Builders Merchants Federation	

Market Sector: 5.12	Microelectronics (Semiconductor Manufacture)

Market Description: The industry is divided into following main sectors:

Integrated Device Manufacture (IDM): Vertically integrated companies (e.g. Intel) involved in all or most parts of the semiconductor supply chain including supply and processing of semiconductor materials, integrated circuit (IC) design, photolithography mask making, silicon wafer fabrication ("foundry" plant) and IC device assembly and test. These companies operate their own foundry plants but rely on third party suppliers for specialist equipment and services (e.g. electronic design automation tools).

Fabless: A fabless company is one which designs and markets its own semiconductor devices but has no foundry plant or wafer production capability – most of its manufacturing is contracted out to a third-party foundry. These firms focus on the value-added functions of design and marketing without incurring the expense of running state-of-the-art manufacturing facilities. An intermediary step between the IDM and Fabless models is called "Fablite" where the company owns its own foundry and wafer making capability but has a policy of outsourcing part of its manufacturing to third parties.

Design and Manufacturing Services: These firms are involved in the provision of design and/or manufacturing services as sub-contractors to other firms in the industry.

Supporting Industries: These include the **merchant foundries** which provide manufacturing facilities for the industry and a range of firms which operate smaller clean-rooms for development, mask-making and tool development. It also covers those involved in the provision of advanced software design tools (EDA firms) and a variety of contract design houses.

The most important sectors of the industry in the context of F-Gases are likely to be the IDMs and merchant foundries.

F Gas Issues:

PFCs and SF_6 used in the production of semiconductors. Large air-conditioning systems with HFC and HCFC refrigerants for clean rooms.

The Main Players. There are 11 mainstream manufacturing foundries in the UK with about 20 to 30 other smaller clean room facilities for development, characterisation, mask-making and tool development. The NMI (see below) has 19 member firms listed as IDMs and another 9 listed as foundries and/or manufacturers. The IDMs and foundries are spread around the UK. In terms of IC design skills the main clusters are in Scotland ("Silicon Glen"), Cambridge ("Silicon Fen") and Bristol ("Silicon Gorge").

Main manufacturing plants

Freescale Semiconductor, East Kilbride
Seagate Technology, Londonderry,
Filtronic, Newton Aycliff
Zetex, Oldham,
Zarlink Semiconductor, Swindon
International Rectifier, Newport
National Semiconductor, Greenock
Atmel North Tyneside, Newcastle
NXP Semcionductor, Stockport
Bookham, Caswell
X-Fab, Plymouth

Trade Bodies : National Microelectronics Institute (NMI)

Table 5.13	Market Sector: Solvent Cleaning
Market Description: Fluorinated solvents have been used for many years to clean certain components used in manufacturing industry e.g. electronic circuit boards, high precision metal components (used in sectors like aerospace) and optical components. Historically there was a large ODS market, especially for CFC 113 and 1,1,1 trichloroethane. HFCs are not particularly good solvents, hence the majority of the historic market has moved to non-F-Gas products such as “not-in-kind” cleaning systems (e.g. aqueous) or alternative organic solvents such as HFEs (hydrofluoroethers).	
F Gas Emissions. F-Gas solvent recovery is identified as a specific obligation under Article 4 of the F-Gas Regulation.	
The Main Players. There are few users and the market is highly fragmented.	
Trade Bodies: None that focus on the use of solvents.	

6. SUMMARY OF KEY ORGANISATIONS

6.1 Introduction

In Sections 4 and 5 we have provided details of key organisations in around 30 different market sectors and sub-sectors. In this Section we have identified those individual organisations that might have the greatest impact on F-Gas emissions. The list of key organisations provides a useful input to the design of an implementation system.

The number of organisations that will be affected by the F-Gas Regulation is very high. We have estimated that there could be in excess of 750,000 non-domestic sites that own equipment that will be affected by the F-Gas Regulation. The vast majority of these are very small F-Gas users. For example, an independent pub using beer cooling equipment or a single shop using some air-conditioning equipment. At the other extreme are a very small number of organisations that either:

- Have high emissions at a single industrial site.
- Have a large estate with significant emissions across all the sites within a single organisation.

6.2 Analysis

We have analysed the possible emission reduction potential from key organisations. The results are summarised in Tables 6.1. For each sector we have estimated the total emission reduction potential (based on data given in Section 3) and identified the approximate number of key organisations. We have then estimated what percentage of the total reduction potential can be achieved by the key organisations. This provides an estimate of the emission reduction that can be “accessed” via each key organisation.

It should be noted that for some sectors the estimates are reasonably accurate (e.g. in fluid manufacture and magnesium there are only a few dominant organisations in each sector). For the lower emission sectors (e.g. hospitality and “other food retail”) the estimates are only approximate, but the conclusions that can be drawn for the purposes of understanding the difficulties of implementation remain valid.

Table 6.1 shows that the sectors fall into 3 distinct bands:

- 68% of the emission reduction potential can be “accessed” via the top 20 key organisations.
- The next 11% can be accessed via the next 140 key organisations.
- The next 1% can be accessed via the next 120 key organisations.

The table shows a clear “law of diminishing returns”. Getting much beyond the level of “access” equivalent to 80% coverage of the emissions reduction potential will require regulation of many thousands of organisations.

Table 6.1 Analysis of Key Organisations

Sector	F-Gas Emissions, 2005	F-Gas Emission Reduction Potential*	No. Key Orgs	F-Gas Reductions Accessed		F-Gas Reduction per Org	
	ktonnes CO_2 equiv			%	ktonnes CO_2		
Supermarkets	2000	1100	11	90%	990	106	20 organisations, 68% of emission reduction potential
Fluid Manufacture	2220	1000	3	95%	950	317	
Magnesium	860	600	5	95%	570	200	
General Aerosols	1450	400	1	75%	300	300	
OCF	110	110	8	75%	90	11	140 organisations, 11% of emission reduction potential
Food/Drink Industry	350	140	40	60%	84	2	
Chemical Industry	250	100	40	80%	80	2	
GIS	520	80	16	75%	60	4	
Aluminium	170	50	2	100%	50	25	
MDI	1520	30	4	100%	30	8	
MAC	1460	150	20	20%	30	1	
Fire	360	40	5	50%	20	4	
Foam	560	40	4	50%	20	5	
Other buildings	360	110	40	10%	11	0.3	120 Organisations, 1% of emission reduction potential
Electronics	100	20	11	50%	10	0.9	
Hospitality	250	90	20	10%	9	0.5	
Other Retail	70	30	30	20%	6	0.2	
Other Food Retail	110	40	10	10%	4	0.4	
Solvents	50	10	10	20%	2	0.2	
Total	12,770	4,140	280	80%	3,310		

* Maximum estimated potential emission reduction

6.3 Top 20 Organisations

Sector	Organisations	IPPC*	Comments
Supermarkets 11 organisations	Top 11: Tesco, Asda, Sainsbury's, Morrisons, Waitrose, Marks & Spencers, Somerfield, Aldi, Lidl, Co-op, Netto	No	Top 4 companies represent 75% of potential from supermarkets. They own around 3,300 stores.
Fluid Manufacture 3 organisations	Ineos Fluor, Rhodia, F2 Chemicals	Yes	Ensure BAT destruction of by-product HFC 23 emissions. No specific F-Gas Regulation requirements.
Magnesium 5 organisations	Magnesium Elektron, Norfran, Magnesium Castings, C. E. Marshall, Dynacast	Some	Maximise use of SF_6 alternatives. No specific F-Gas Regulation requirements at Magnesium Electron, although this is by far the largest emitter in the group.
General Aerosols 1 organisation	Goodmark (GAC UK Ltd)	No	Also need to monitor imports of novelty aerosols to regulate HFC ban.

* Key site/s have Integrated Pollution Prevention and Control (IPPC) processes

6.4 Next 140 Organisations

Sector	Organisations	IPPC*	Comments
OCF 8 organisations	4 DIY companies (B&Q, Homebase, Wickes, Focus DIY) and 4 builders merchants (Jewson, Travis Perkins, Buildcentre, Buildbase)	No	Monitor imported products via these organisations to regulate HFC ban
Food/Drink Industry 40 organisations	Largest companies from the following CCAs : FDF (food and drink), BMPA (red meat), BPC (poultry), Dairy UK, BBPA (brewing), CSDF (cold stores)	Some	Food sector CCAs are good source of data and access to key organisations and sites.
Chemical Industry 40 organisations	Largest companies from the following CCAs: CIA (chemicals), BCGA (air liquefaction). Also oil, gas and petrochemical producers.	Most	Chemical sector CCA is good source of data and access to key organisations and sites.
GIS 16 organisations	Power stations, transmission companies and local distribution companies.	No	Most GIS equipment is owned by the power generation industry.
Aluminium 2 organisations	Alcan, Anglesey Aluminium	Yes	Ensure BAT avoidance of PFC emissions. No specific F-Gas Regulation requirements.
MDIs 4 organisations	Glaxo SmithKline, Astra Zeneca, 3M, INyX Pharma	Yes	Recover HFC from test samples. Minimise manufacturing emissions.
MAC 20 organisations	Car dealerships, car service networks and car dismantlers.	No	Minimise emissions during servicing and at end of life
Fire 5 organisations	Tyco Fire & Integrated Solutions, Kidde Fire Protection, Siemens Building Technologies, Surefire Systems, Fike Protection Systems	No	Target end users via these 5 large installers / maintainers
Foam 4 organisations	Dow, Knauf, Kingspan, Celotex	Some	Minimise manufacturing emissions. Recover from scrap product. No specific F-Gas Regulation requirements.

* Key site/s have Integrated Pollution Prevention and Control (IPPC) processes

6.5 Next 120 Organisations

Sector	Organisations	IPPC*	Comments
Other Buildings 40 organisations	Largest companies from building sectors including: offices, health, education and leisure.	No	Emissions are mostly from air-conditioning systems. Some buildings may have HFC fire protection systems.
Electronics 11 organisations	11 semiconductor manufacturing facilities	Yes	Processes might include use of PFCs and SF_6. Factories will also have large air-conditioning systems for clean rooms.
Hospitality 20 organisations	Largest companies from hospitality sectors including: pubs, hotels, restaurants and coffee shops.	No	Emissions are mostly from small air-conditioning systems and small refrigeration systems.
Other retail 30 organisations	Largest companies from other retail sectors including: DIY, department stores, clothing, shopping malls	No	Emissions are mostly from small air-conditioning systems.
Other Food retail 10 organisations	Largest companies from convenience store symbol groups and petrol forecourts.	No	Emissions are mostly from small air-conditioning systems and small refrigeration systems.

* Key site/s have Integrated Pollution Prevention and Control (IPPC) processes

6.6 UK Distribution of the Key 180 Organisations

For reference, Table 6.2 below shows the number of organisations, within the group of 280 with the largest F-Gas emission reduction potential, that are based in each of the countries of the UK.

Table 6.2 National Split of Organisations with Largest Emission Reduction Potential in the UK

Country	Top 20	Next 140	Next 120
England	18	126	102
Wales	2	1	1
Scotland	0	12	6
Northern Ireland	0	1	2
Other (not UK)	0	3	0

6.7 Public Sector Organisations

It is useful to summarise which parts of the public sector use F-Gases and will need to comply with the Regulation. Referring to the 19 end-use sectors summarised in Table 6.1, only 3 end-use sectors will involve public sector organisations:

a) **Other buildings**. This is the key category for the public sector and it involves mainly the use of air-conditioning and, in some building types, refrigeration systems. The most important categories of building are as follows:

   i. Offices, used throughout the public sector and especially in central and local government.

   ii. Health sector buildings, especially large hospitals which make extensive use of both air-conditioning and refrigeration.

   iii. Leisure facilities, including swimming pools, leisure centres and ice rinks that are under local authority control.

   iv. Education facilities that may require air-conditioning systems. This will mainly apply to universities, although some schools may make limited use of air-conditioning. Small refrigeration systems will be used for catering facilities in these establishments.

   v. Prisons. These may make limited use of air-conditioning and will require refrigeration for catering.

b) **Fire protection**. A small number of public sector buildings are likely to make use of HFC fire protection systems. These will be in some of the building types listed above.

c) **Mobile air-conditioning**. Vehicles owned by public sector organisations might make use of MAC systems.

6.8 Research Activities

The implementation activities will benefit from various items of focussed research to clarify the emission reduction potential in a small number of key sectors. This work is required to update some of the work done by Enviros and AEA Technology in the 1998 and 2003 F-Gas emissions inventories. The key activities are as follows:

a) **Supermarkets.** This is the sector with the greatest emission reduction potential. It is quite important that regulatory officers have some knowledge of the average levels of leakage so that they can identify good and bad performing sites and organisations. Such data may be difficult to obtain immediately, without the voluntary support of the major supermarkets. However, detailed research could be carried out during the first two years of the Regulation, using the records which each organisation is obligated to keep. An important option to reduce emissions from supermarket

refrigeration will be the more widespread use of alternative refrigerants that will completely eliminate HFC emissions. The most likely possibility in this respect is the use of CO_2 which several supermarkets are currently trialling.

b) **Fluid manufacture**. The emission reduction potential in this sector is partly dependant on the "automatic" reductions that will occur due to the closure of one HCFC 22 manufacturing plant and the reducing demand for HCFC 22 (linked to the Ozone Regulation). The remaining potential mainly relates to the performance of the HFC 23 incinerator at the remaining HCFC 22 manufacturing plant. It will be useful to re-evaluate the level of emissions expected after the closure of the Rhodia plant and to agree the BAT level of emissions from the Ineos plant. It will also be worthwhile to research the level of emissions from the F2 PFC plant and from the 10 major cylinder filling and recycling facilities and refrigerant wholesalers.

c) **Magnesium production**. The use of HFC 134a as an alternative cover gas for SF_6 is a comparatively recent option. A review of the drivers and barriers to the widespread uptake of this technology and other alternatives will provide a useful basis for re-evaluating the emission reduction potential from this sector.

d) **General aerosols and OCF**. These sectors are both subject to a use ban that will provide significant emission reductions if it is successfully introduced. Both markets make use of imported products (especially OCF, where there is no UK manufacturing). Establishing contact with the key organisations that import and/or retail these products is a vital step towards ensuring that the product bans are effective.

e) **Aluminium, foam, and MDIs.** These are all sectors without specific obligations in Articles 3 and 4 of the F-Gas Regulation. They also have a small number of organisations to target in an implementation programme. It will be useful to establish a dialogue with these sectors/organisations to agree the level of emission reduction potential that is achievable.

7. CASE STUDIES

In this section of the report we provide a description of the types of F-Gas and ODS equipment that might be found in five different types of end-user organisation. All five case studies concentrate on the use of refrigeration and air-conditioning systems, as these markets are the most complex from the perspective of understanding implementation issues.

7.1 Supermarkets

The supermarket sector is a major user of refrigeration and also makes use of a significant amount of air-conditioning. Both ODS and F-Gas refrigerants are in common use. There is very little use of other refrigerants, although supermarket companies are currently trialling CO_2 systems, which could revolutionise the use of refrigeration if the trials prove successful.

The majority of RAC equipment in supermarket companies will be found at the stores. In addition, very large refrigeration systems are used at distribution depots. The majority of stores in the major supermarkets are "large format" e.g. between 2,000 and 10,000 m^2. In addition there are an increasing number of smaller "convenience stores" (<300 m^2) owned and operated by the large supermarket companies. The types of refrigeration system used at these small format stores is slightly different to that used in larger sites.

Large Format Stores

The main refrigeration loads in a store relate to the retail display cabinets. In addition there is a refrigeration load for "back of store" cold rooms that are used for temporary storage before the goods are put on display. Most large supermarkets will have around 100 retail display cabinets and 4 cold rooms. These are split into 2 distinct temperature levels i.e. chill (+1 to +8 ^oC) and frozen (-18 to -25 ^oC).

The main loads are usually served by "pack systems". Each pack serves a number of display cases and might also serve some cold rooms. A typical arrangement is 4 independent packs, 2 for chilled loads and 2 for frozen loads. Each pack will include extensive refrigerant pipework used to connect the compressor/condenser systems with the display cases. The compressor systems for each "pack" are often located together in a single plant room, with air cooled condensers located nearby (usually outside). Alternatively some supermarkets use smaller packs located on rooftops as close as possible to the actual display cabinets they serve. Packs vary considerably in size. Many will have between 200kg and 400 kg of refrigerant. All packs are likely to be above the 30 kg threshold and some will be above the 300 kg threshold. Note, each pack is an independent refrigeration system, so each is treated separately from the perspective of the F-Gas threshold. Older packs might use HCFC

22. All packs installed from around 2000 onwards will use HFC refrigerants, typically HFC 404A. A handful of stores use ammonia, CO_2 or hydrocarbon refrigerants for the main refrigeration system – but these are less than 1% of the current market. A move to greater use of CO_2 is quite likely during the next few years.

Some loads are served by small hermetic systems. These are stand alone systems that plug into a single phase 13 amp electrical circuit. Many are similar to domestic equipment e.g. larder fridges used to store ingredients in an in-store bakery or small freezers used to display ice cream. Some of the retail display cabinets might not be connected to the main pack systems – instead they are served with small hermetic systems. In all cases these small systems will contain less than 3 kg of refrigeration. In almost all cases they will use HFC refrigerants, especially HFC 134a. Some older systems might use HCFC 22.

Most stores also use air-conditioning systems. There are 3 main types used in supermarkets:

- Small split systems (sometimes referred to as cassette units) can serve a localised area of a store. These will typically contain between 2 kg and 10 kg of refrigeration. Hence some very small split systems will fall below the 3 kg threshold but most will be in the 3 to 30 kg band. Older systems might use HCFC 22 and newer ones will use HFCs, especially HFC 407C and HFC 410A.
- Larger split systems (sometimes referred to as unitary systems or DX systems) can serve much larger areas via air handling units. Most of these will fall in the 30 to 300 kg band, although smaller and larger exceptions are possible. Older systems might use HCFC 22 and newer ones will use HFCs, especially HFC 407C and HFC 410A.
- Water chillers. These produce chilled water that is circulated to air handling units to provide air-conditioning. Again most of these will fall in the 30 to 300 kg band, although smaller and larger exceptions are possible. Older systems might use HCFC 22 and newer ones will use HFCs, especially HFC 407C and HFC 134a.

Small Format Stores

Small format stores will not have large pack systems. The loads are quite similar to a large store i.e. chilled and frozen displays, small cold rooms and air-conditioning.

The smallest stores will make extensive use of small hermetic refrigeration (all <3 kg). Lager ones will use “condensing units” that each serve a few display cases. These are similar to pack systems but much smaller. Typical refrigerant charge will be in the range of 10

to 50 kg. Older systems might use HCFC 22 and newer ones will use HFCs, especially HFC 404A.

Air-conditioning will usually be provided by small split systems (see above).

Distribution Depots

Distribution depots will have large warehouse facilities kept at three temperature levels: ambient, chilled and frozen.

In almost all cases these will be served by a large central refrigeration plant, usually a "2-stage" system that can efficiently provide cooling at both chill and frozen temperature levels. Most stores are based on pumped circulation systems, where the cold refrigerant liquid is pumped to coolers in each part of the warehouse that needs cooling. The refrigerant charge depends on the size of store but will usually be above 300 kg. Ammonia is often used, which is not affected by either the ozone of F-Gas Regulation. HCFC 22 is also common in older stores.

7.2 Pubs

Pubs represent a good example of a sector with a large number of premises, each with just a few small RAC systems. These will use either HCFC or HFC as their refrigerant and many will qualify for the F-Gas Regulations.

The amount and type of refrigeration systems depend on the size of pub. Small pubs (typically serving only drinks and cold snacks) require refrigeration for cellar cooling, the inline cooling of drinks served "on tap" and for glass-fronted display cabinets (for chilled bottles). In addition, larger pubs (typically those serving food) are also likely to have some air-conditioning for customer and/or kitchen areas and may also have a walk-in chill for food storage.

These applications and likely refrigeration equipment are summarised in the table below and described in more detail underneath.

Nearly all the systems will contain either HFC or HCFC refrigerants. A small (but growing) number of new hermetic systems may contain hydrocarbon refrigerants[14].

14 Hydrocarbon refrigerants are now standard in new domestic fridges, and they may become used more widely in small commercial fridges.

Cooling Application	Typical Equipment	Refrigeration System Type	Refrigerant Charge
Cellar cooling	Refrigeration systems with separate internal fan-coil units and external compressor-condenser units	Split	Most, but not all systems will contain over 3 kg of refrigerant charge
In-line drink chillers	Water-cooled packaged chillers	Hermetic	These units are hermetic systems, with less than 1 kg charge
Bottle coolers	Glass-fronted chilled display cabinets	Hermetic	These units are similar to domestic fridges, using hermetic systems, with less than 1 kg charge
Air-conditioning	Cassette-style comfort cooling units, or	Split	Typically 2 to 10 kg
	Roof-top unitary air-handling units	Non-hermetic	Usually over 3 kg
Chilled food stores	Commercial refrigerators, or	Hermetic	Less than 1 kg
	Walk-in Chill Rooms, with split refrigeration systems	Split	Some may contain over 3 kg

Cellar Cooling – Most pubs will store barrels of beer in a chilled room, traditionally located in the cellar but this may now be anywhere on the premises. The room is usually kept at between 12 and 18°C. In the chilled room, the air is cooled by an internal evaporator unit, comprising of a heat-exchanger coil and one or more fans. This is connected by two refrigerant pipes to a compressor-condenser unit, located outside. The nameplate on the compressor-condenser unit should indicate the type and amount of refrigerant gas. Older units are likely to use HCFC 22, while more recent systems may use HFC 404A or HFC 407C. The charge shown on the nameplate may be less than 3 kg, but this will not include the charge in the internal unit or the interconnecting pipes. If this is the case, we recommend using the Department for Business, Enterprise and Regulatory Reform (BERR) – formerly DTI – Refrigerant Calculator to assess the total system charge, in order to confirm whether the system must comply with the F-Gas Regulations.

In-line Drink Chillers – Draught beers are cooled further just prior to serving using in-line chillers. These are small, packaged chillers (the size of a large suitcase) and contain water-cooled, hermetic refrigeration systems with very small charges (typically less than 1 kg). They do not fall within the F-Gas Regulations. However, the water cooling circuits are usually piped to external fan-coil heat-exchangers which can be mistaken for external compressor-condensing units. They can be identified by the lack of any compressor.

Bottle Coolers – These are usually glass-fronted chilled display cabinets for bottled beers and soft drinks. They are similar in size and construction to domestic fridges, with hermetic refrigeration systems

with small charges, usually less than 1 kg. They do not fall within the F-Gas Regulations.

Cassette Air-Conditioning Systems – Medium-sized pubs may provide cooling for customer areas using wall or ceiling-mounted cassette-style air-conditioning units, similar to those found in small offices. These may be recessed into false ceilings or hidden in ducts. They are connected via refrigerant pipes to compressor-condenser units, located outside (often on the roof). Common refrigerants in use are HFC 407C or HFC 410A, but some older units may use HCFC 22. The external units should display the refrigerant and the unit charge on a label. The smallest units may display less than 3 kg, but this may not include the charge in the pipes (especially if longer than about 10 m), which should be included in assessing the total system charge.

Unitary Air-Conditioning Systems – Some larger pubs may provide heating, cooling and ventilation using an air handling unit (AHU), often located on a flat-roof, with ducts to connect the return and supply air to the rooms, and to draw in fresh air. These AHUs may contain an integral (or unitary) refrigeration system, or may be served by a separate, remote compressor-condenser unit. These systems may use either HFC or HCFC refrigerants and are almost certain to contain more than 3 kg. Furthermore, they are unlikely to use a hermetic system and so will need to comply with the F-Gas Regulations.

Walk-In Chill Stores – All pubs serving food will need somewhere cold to store fresh food. Smaller ones may have commercial refrigerator-cabinets, which use hermetic refrigeration systems with small charges (not in the F-Gas Regulations). Larger food-serving pubs however are likely to have a small walk-in chill store. This will be served by a refrigeration system similar to a beer cellar system described above, comprising of an internal fan-coil evaporator and an external compressor-condenser unit. The total system charge must be assessed from the total of these two units plus the interconnecting pipework. They may contain either HFC or HCFC refrigerants.

7.3 Hospitals

Hospitals are important users of refrigeration and air-conditioning equipment, due to both their size and their critical requirements. Typical cooling applications in a hospital may include general air-conditioning (for wards and staff offices), specialist air-conditioning (for operating theatres or IT/communications rooms), equipment cooling (e.g. for X-ray machines), general refrigeration (for mortuary rooms and canteen catering) and specialist refrigeration (for vaccine and tissue stores and cryogenic applications). All these applications may use equipment that contains sufficient HFC refrigerant to fall within the requirements of the F-Gas Regulations. Depending on the choice of different refrigeration options, there may very many systems. A large

hospital may have many hundreds of systems (most, but probably not all, of which will need to comply with the F-Gas Regulations).

Note: Large hospital sites may be shared by more than one organisation (e.g. an NHS Trust and an MRC research facility). Each organisation may own and maintain its own building services, including refrigeration and air-conditioning systems.

The types of typical refrigeration systems found in hospitals are described below.

Central Air-Conditioning Systems

Most large hospital buildings will have a ducted ventilation system that provides heating, cooling and fresh air throughout the building. Conditioned air will be blown around the ductwork system by fans in "air handling units" (AHUs) located in central plant rooms or perhaps outside (often on the roof). These AHUs are likely to contain a filter section, a fan section, a heating coil (served by hot water) and a cooling coil (served typically by chilled water). There may also be small in-duct cooling coils at the point of discharge into each room, to give individual control of room temperature. The chilled water will be supplied from a separate chiller plant - it is this that may contain an F-Gas refrigerant.

Chiller plants may either be packaged units or site-installed equipment.

The *packaged chillers* are factory-assembled on a single steel frame, sized to be delivered on a lorry, and need the minimum of site installation work. If located outside, this will contain the whole refrigeration system (the compressor, evaporator, air-cooled condenser and all associated controls) within a weatherproof unit. A nameplate should indicate the type and amount of refrigerant in the system. If located inside, it will be connected to an external condenser by refrigerant pipework. In this latter case, allowance must be made for the extra charge in the remote condenser and any associated vessels and pipework.

Site-installed chiller systems are usually found in plant rooms and consist of separate compressors, heat exchangers, a remote condenser (located outside), interconnecting pipework and associated electrical controls. There should be labels indicating the type of refrigerant gas used. With luck, the maintenance personnel will have a design manual which may indicate the total system charge (when first installed). Otherwise an assessment must be carried out based on the volumes of vessels, heat exchangers and interconnecting pipework.

All these chiller plants for central air-conditioning systems can be expected to contain more than 3 kg of charge, most will contain more than 30 kg and the largest systems may contain over 300 kg.

Cassette-style Air-Conditioning Systems

In addition to (or in the absence of) a central ducted air-conditioning service, there may be a number of cassette-style "comfort cooling" units, similar to those found in small offices. It is possible that there may be a very large number of these units. Rising expectations of a comfortable working environment and the large amounts of electronic equipment in hospitals can lead to a proliferation of these small air-conditioning units.

The smallest systems consist of one or two small wall-mounted indoor units, connected by refrigerant pipework and cables to a single external compressor-condenser unit (mounted on the ground or bracketed off a wall). The type and charge of gas should be indicated on the external unit's nameplate. If the interconnecting pipework is less than about 10 m, then this will be the total system charge[15] and this may be less than 3 kg. If the pipework is longer, then an allowance must be made for the extra charge. This would need to be confirmed by a site survey.

Larger cassette-style systems consist of many (up to about 10) internal units connected up to one or more external units. These systems (sometimes called VRV or VRF systems) will hold more than 3 kg of charge.

Specialist Air-Conditioning Systems

Specialist air-conditioning requirements for critical applications (e.g. Operating theatres or IT server rooms) may be served by the central system or one or more dedicated air-conditioning systems. These may be either ducted AHU systems (with an associated refrigeration plant) or cassette-style systems, similar to those described above.

Equipment Cooling

Some medical machinery (e.g. X-Ray machines and MRI scanners) typically require some form of cooling. This is usually provided by a dedicated water chiller. These are usually packaged chillers, with integral air-cooled condensers similar to those serving the air-conditioning systems. The common refrigerants are HFC 134A, HFC 407C, HFC 404A and HFC 410A. The charge is likely to be over 3 kg.

Some equipment also requires very low temperature cooling (e.g. some MRI scanners), which use liquid nitrogen to cool superconducting magnets. These systems do not hold F-Gas refrigerants.

15 The external units of these split cassette-style air-conditioning systems are usually supplied “pre-charged” from the factory, along with the internal unit and a standard length of interconnecting pipework. If the distance between the units is not too great, then the pipes are connected up on-site, evacuated of air and then the gas is released into the system. If extra pipework is needed, then an appropriate amount of extra gas will be added to compensate for the extra pipe volume.

General Refrigeration Systems

General refrigeration requirements in a hospital may include cooling for mortuary rooms and for canteen chill stores. These will usually be served by split direct-expansion refrigeration systems, consisting of one or more internal fan-coil evaporators and an external compressor-condenser unit. They may contain either HFC or HCFC refrigerants and (for all but the smallest units) will hold more than 3 kg of charge.

Specialist Refrigeration Systems

A hospital may also use specialist refrigeration equipment for very low temperature applications. These are usually small units (typically low-temperature storage cabinets) with integral, hermetic refrigeration systems carrying less than 3 kg of charge. However larger units with non-hermetic refrigeration systems holding more than 3 kg of charge may exist. They may use HCFC, HFC or hydrocarbon refrigerants.

7.4 Schools and Further Education

Whilst hospitals represent a very complex user of both refrigeration and air-conditioning systems, it is useful to be aware that there is relatively little use of such systems in schools. Large universities may represent a slightly more complex user.

Schools

Most primary and secondary schools will make minimal use of air-conditioning systems. Some may have small split systems to cool specialist equipment such as computers, but this remains relatively unusual. It is very unusual for a school to make use of a centralised air-conditioning plant.

Schools will make use of refrigeration equipment for their catering facilities although in most cases these are relatively small-scale systems, most of which hermetically sealed systems and fall below the 6 kg size threshold for regular leak testing.

Schools that have an indoor swimming pool might make use of a heat pump system to heat the water all the space around the pool. This would usually be based either on an HCFC or HFC refrigerant and would be well above the 3 kg size threshold. Systems of this type will be relatively unusual.

Further Education

Some further education facilities, especially large universities, will make greater use of air-conditioning and refrigeration systems than schools.

Large university buildings may require air-conditioning of lecture theatres, laboratory facilities and specialist IT equipment. In certain cases this air-conditioning will be provided by large-scale central systems either based on water chillers or direct expansion cooling associated with air handling units. In all cases such equipment would be well above the 30 kg size threshold and in many cases the systems could even exceed the 300 kg threshold. Both HCFC and HFC refrigerants might be used for these systems.

The refrigeration requirements in catering facilities for universities will often be much larger than those in schools, because of the number of students being served and also the residential nature of many university establishments. As with schools, much of the catering equipment will be hermetically sealed and below the 6 kg threshold; however there is a greater likelihood of larger systems such as walk-in cold rooms that would be above the 3 kg threshold for regular leak testing.

Some universities will have specialist facilities linked to engineering or scientific research laboratories that require unusual and perhaps large refrigeration or air-conditioning systems. These would need to be checked on a case-by-case basis.

7.5 Food and Drink Manufacturing

The food and drink manufacturing sector represents one of the largest users of industrial scale refrigeration systems. The following sub-sectors of the food and drink manufacturing industry all make widespread use of industrial refrigeration:

- brewing of beer and cider
- milk processing and dairy products
- soft drinks
- meat, poultry and fish primary and secondary processing
- chilled and frozen fruit and vegetables
- chilled and frozen ready meals
- chilled and frozen bakery products and sandwiches
- ice cream manufacture
- confectionery manufacture
- margarine and vegetable oil processing
- pet food manufacture

Most factories making these products will make use of a number of refrigeration and air-conditioning systems. It is not uncommon for a single site to have more than 50 separate systems. Many of these systems will fall under the F-Gas or Ozone Regulations. Some food manufacturers operate many factories in the UK, and therefore a single organisation might be responsible for several hundred systems that are affected by the Regulations. Some of these systems may be quite large, containing several tonnes of refrigerant. For this reason, large multi-site food manufacturing companies may be of great importance in terms of implementation of the Regulations.

7.5.1 Refrigerants in Common Use

Recent research amongst food manufacturers show that R22, an HCFC, is the most commonly used refrigerant, in terms of number of systems. Since 2000, the Ozone Regulation has prevented the use of R22 in any new systems and the industry has widely adopted HFC refrigerants in place of R22. It is also quite common to find ammonia used as the refrigerant on large systems in food and drink factories. Ammonia falls outside the scope of either the F-Gas all the ozone regulations.

7.5.2 Types of Refrigeration and Air-Conditioning System in Food Factories

A wide variety of different system types may be encountered in food manufacturing facilities. The types of system used will often influence the way in which the Regulations may affect the end user. The following categories provide an indication of the variety of system that might be encountered in food factories:

Category 1: Catalogue Systems

This category covers very small systems, typified by a simple “comfort cooling” split system for an office. Category 1 includes the following types of equipment:

a) Integral systems in “domestic style” fridges or freezers, as exists in some site canteens and development kitchens. The refrigerant charge is typically around 0.5 kg or less. These systems are almost always hermetically sealed and hence will normally fall well below the 6 kg size threshold for regular leak testing.

b) Small “comfort cooling” split systems, comprising of an Outdoor unit (containing compressor and condenser) and an Indoor unit (containing evaporator coil and fans). These units are nearly always supplied in matched pairs, with the outdoor unit pre-charged with refrigerant gas. Refrigerant charge is usually around 2 to 5 kg. Hence, this type of system could fall below the 3 kg threshold for regular leak testing or, in many cases, could be slightly above the threshold.

c) Larger “comfort cooling” systems, comprising of a single Outdoor unit and multiple Indoor units. Total refrigerant charges are

typically between 5 and 10 kg. These systems are designed primarily for office buildings.

Unlike most other categories, all new “Catalogue” Systems will arrive on-site pre-charged with refrigerant.

Category 2: Commercial Systems

This category of system can serve a wide range of applications, from chill and frozen stores, to blast chillers and freezers, and factory area cooling systems. The key difference from “Catalogue” units is their degree of bespoke specification. While the individual compressor-condensing units are almost always factory assembled (to a standard range), the evaporator is chosen separately (from a wide range of suppliers) to match the specific application, and the remaining system components (e.g. expansion device & controls) are also specially selected and assembled on site. The refrigeration contractor-installer has the key design role for the whole system.

This category includes the following types of refrigeration systems:

a) “Condensing Units” – comprising of compressor(s), condenser, receiver and controls. The condenser is usually an air-cooled coil and fan, but may be a water-cooled shell & tube heat exchanger.

b) Similar to (a) but when the condenser is located externally, remote from the compressor-receiver set.

These are all direct expansion systems, most with thermostatic expansion valves (TEVs), but a few with electronic expansion valves (EEVs). Category 2 systems all use HCFC or HFC refrigerants with charges of typically 5 to 50 kg.

Category 3: Packaged Chillers

This category comprises standard factory-built glycol and water chillers. All refrigerant circuits are built in the supplier’s factory – only water and electrical connections are required when these packages are installed. They are often skid-mounted with weather-proof enclosures for external locations.

Refrigerant charges lie typically between 20 to 200 kg, of HCFCs or HFCs. In most cases these systems are charged with refrigerant at the manufacturer’s factory.

Category 4: Industrial DX Systems

These are similar to “Commercial” systems, but they are larger systems designed and built for each application, often with multiple compressors, remote condensers (air-cooled or evaporative) and piped up on-site to evaporator fan-coil units located in the cold space. They are direct expansion systems, with either TEVs or EEVs. Refrigerant charges may be large, depending on the application, but usually lie between 30 to 300 kg, of HCFCs or HFCs.

Category 5: Industrial Flooded Systems

These systems usually serve larger duty applications, such as blast freezers or pump-circulation factory cooling systems. Their key characteristics include the large volume of liquid refrigerant (100 kg to several tonnes).

This category includes:

a) Very large pump-circulation refrigeration systems containing many tonnes of refrigerant. These can serve multiple evaporators in many different locations. Two-stage systems can serve evaporators at both frozen and chilled temperatures.

b) Slightly smaller (but still with large refrigerant charge, >100 kg) pump-circulation systems dedicated to just one application – usually a blast chiller or blast freezer.

c) Flooded systems with gravity-fed heat exchangers located below the low pressure suction vessel.

The common factor of all these systems is the flooded low pressure vessel, containing refrigerant liquid and gas under equilibrium at the saturated pressure and temperature. This type of arrangement has many advantages for large refrigeration systems, but it does introduce significant difficulties if refrigerant replacement is required. Most ammonia refrigeration systems fall into the flooded category.

Category 6: "Specials"

This category includes any other system not covered by the other main categories. For example, systems using CO_2 as the refrigerant are beginning to become of interest. Also there may be specialised system configurations such as the LPR (low pressure receiver) system that is supplied by one particular manufacturer.

7.5.3 An Example of Systems in a Large Food Manufacturing Organisation

A typical food manufacturing company is likely to have a number of systems in all the categories described in the section above and may make use of many different types of refrigerant.

During the implementation process it will be useful to review the number of systems in different categories and also the quantity of different refrigerant types used in these categories. It is worth noting that there is an obligation under the F-Gas regulation to keep records about the size and type of refrigeration systems that use HFC refrigerants. If an end-user company is unable to provide a breakdown of overview information about their systems it is likely that they are not complying with this aspect of the Regulation.

Tables 7.1 and 7.2 below show examples of such overview information for a fictitious food manufacturing company. The information given would be representative of a food manufacturing company owning around 10 large manufacturing sites making a chilled or frozen food product.

Table 7.1 "Fictitious Foods Group" – Number of Systems

Category	Refrigerant Type			Total	%
	HCFC	HFC	NH_3		
Catalogue	30	20		50	25%
Commercial DX	40	30		70	35%
Packaged Chiller	10	6	5	21	11%
Industrial DX	25	15		40	20%
Industrial Flooded	4		6	10	5%
Special	4	5		9	5%
Total	113	76	11	200	100%
%	57%	38%	6%	100%	

Table 7.2 "Fictitious Foods Group" – Quantity of Refrigerant (kg)

Category	Refrigerant Type			Total	%
	HCFC	HFC	NH_3		
Catalogue	100	70		170	1%
Commercial DX	200	60		260	1%
Packaged Chiller	900	600	1,000	2,500	8%
Industrial DX	6,000	2,000		8,000	25%
Industrial Flooded	5,000		15,000	20,000	62%
Special	500	700		1,200	4%
Total	12,700	3,430	16,000	32,130	100%
%	40%	11%	50%	100%	

It is interesting to note that, in this example, the 3 smallest categories represent about 70% of the number of systems but only about 10% of the total quantity of refrigerant. The risk of large leaks is much greater from the large systems that could leak many hundreds of kg of refrigerant if there was a "catastrophic" leak.

8. TRAINING REQUIREMENTS FOR REGULATORY OFFICERS

The training requirements for regulatory officers will depend on the approach adopted for the implementation model and options for this are set out in Section 10 of this report.

8.1 Specialist Industrial processes

Specialist knowledge of the following types of emissions will be required by regulators of these industries:

a) **Fluid manufacturing emissions**. Training will be mainly related to understanding the emission reduction potential from HCFC 22 and HFC manufacture which takes place at only three UK sites. Training should also include other types of processes used at gas bottling and gas recycling plants. There are around 10 UK sites in these categories.

b) **Magnesium emissions**. Training will be mainly related to the use of alternative cover gases (i.e. replacement of SF_6 with HFC 134a, SO_2 or other gases). Also could cover BAT techniques to minimise the use of cover gas. There are around seven UK sites using SF_6 in magnesium operations.

c) **Aluminium, electronics, foam, and MDIs**. The emissions from these small sectors are quite specialised. Training for regulatory officers will be required to understand the nature of emissions to allow effective engagement with around 20 key organisations to create a process to minimise emissions in a cost effective way.

8.2 General Aerosols and One Component Foam

The key actions relate to identifying importers, wholesalers and retailers to ensure that these organisations are adhering to the relevant use bans. Implementation via 10 or 20 such organisations will access the majority of the emission reduction potential. Training requirements relate mainly to methods of identifying key organisations and ensuring good import control.

8.3 Other Sectors

Other key sectors with training requirements for those regulators dealing with them include:

- All stationary refrigeration and air-conditioning sectors including supermarkets, industrial refrigeration and all forms of building air-conditioning and refrigeration.
- Servicing of mobile air-conditioning (MAC) systems in cars.
- Fire protection systems.
- GIS systems used in high voltage electricity transmission.

As already outlined previous sections, these are highly dispersed markets involving tens of thousands of different organisations and hundreds of thousands of individual sites.

It is worth noting that the use of GIS in high voltage applications is a fairly dispersed market with hundreds of separate sites that will not generally fall under IPPC (e.g. electricity sub-stations). However, the application is highly specialised and will require specific training for regulatory officers.

8.3.1 Training Requirements, Refrigeration, Air-Conditioning and MAC

Regulatory officers will need training that addresses some of the following:

- **Refrigeration and air-conditioning fundamentals** – some background about how refrigeration systems work and the key markets using F-Gas refrigerants will be very helpful.
- **Refrigerant types** – regulatory officers must be aware of the three general categories of refrigerant i.e. HFCs (which fall under the F-Gas Regulation), HCFCs (which fall under the Ozone Regulation) and non-fluorocarbons such as ammonia and CO_2 which do not fall under either regulation.
- **Obligations under the F-Gas and Ozone Regulations** – it is essential that all the obligations described in Section 2 of this report are well understood.
- **Making use of refrigeration system records** – the obligation in the F-Gas Regulation to keep records about all equipment over 3 kg refrigerant charge will prove a vital part of the implementation process. Regulatory officers can ask organisations they are focusing on to submit written information based on these records. If a good set of records is received it is reasonable to assume that the Regulation is being complied with. Those organisations that cannot submit good records are likely to be non-compliant in a number of ways and may require a site visit. It is important that regulatory officers fully understand the types of record must be kept and are able to interpret records that are submitted to them.
- **Size thresholds** – some of the obligations in the Regulations are dependent on the amount of refrigerant in the system. It is important that regulatory officers understand how to assess the amount of refrigerant charge in the system.
- **Typical leakage rates** – to be able to interpret data in the records it is important that regulatory officers have a reasonable understanding of the typical rate of leakage that occurs in different types of refrigeration and air-conditioning system. Being aware of benchmark figures will help officers assess

whether a company is being negligent in its efforts to reduce rates of leakage.

- **Leak testing** – it may be necessary to check that leak tests are being carried out properly and that repairs are being instigated when it is appropriate. Regulatory officers should be aware of different ways to carry out manual leak tests and also the different types of equipment available for automatic leak detection.
- **Refrigerant recovery** – regulatory officers must have some understanding of the type of equipment used to recover refrigerant and the subsequent options for reuse, recycling, reclaim or destruction.
- **Minimum qualifications** – it will be necessary to check whether personnel involved in refrigerant handling operations on behalf of a particular end user are properly qualified. Regulatory officers will need to be fully familiar with the types of qualification available and the form of proof that the qualification has been achieved.
- **Market specialisation** – it would be logical for some regulatory officers to specialise in particular parts of the refrigeration and air-conditioning market as it is so large and complex. Supermarkets are a vital specialist area as these represent such a large proportion of the emission reduction potential in the sector with only around 10 key organisations. If an officer is to work effectively with a supermarket refrigeration specialist they must be well informed about the types of system used in a typical supermarket. Other markets that deserve some degree of specialisation include (a) industrial refrigeration, (b) building air-conditioning and (c) MAC.

8.3.2 Training Requirements, Fire Protection Systems

Fire protection systems based on HFCs are used in certain specialist applications where the use of alternative systems such as water sprinklers would potentially cause too much damage when a fire is being extinguished. Many of the training requirements fall into similar categories to those described in 8.3.1 above. The details are not repeated below; we simply make reference to the refrigeration section above. Regulatory officers working on the fire protection systems will need to understand:

- **Fire protection fundamentals** – in particular, the different types of fire protection systems available for use in buildings and the reasons why each type might be chosen.
- **Obligations under the F-Gas Regulations** – see 8.3.1.
- **Making use of fire protection system records** – see 8.3.1
- **Typical leakage rates** – see 8.3.1. It is also necessary to understand the way that fire detection systems are used to

automatically set off the HFC flow. A large proportion of HFC in emissions in this type of system can be caused by false alarms that accidentally release gas when there is no fire.

- **Leak testing** – see 8.3.1. In the fire protection market systems already require regular testing of system effectiveness for fairly obvious safety reasons. Regulatory officers need to fully understand the existing testing requirements, which will often be sufficient to also meet the requirements of the F-Gas Regulation.
- **Fluid recovery** – see 8.3.1. In general, engineers working on fire protection systems do not need to recover fluid whilst working on site, which is quite different from the refrigeration and air-conditioning markets. Regulatory officers should be aware that the normal practice is to return complete cylinders to a factory where recovery can take place in more controlled circumstances.
- **Minimum qualifications** – see 8.3.1.

8.3.3 Training Requirements, GIS

Gas insulated switchgear uses SF_6 inside high voltage switches. SF_6 is a better insulator than air and the use of GIS enables high voltage switches to be much smaller than they would be using air as an insulant. Most GIS is used by the electricity supply industry at power stations and at sub-stations in the electricity distribution network. Some large industrial companies might also have sufficiently high voltage systems to make use of GIS.

Some of the training requirements fall into similar categories to those described in 8.3.1 above. The details are not repeated below; we simply make reference to the refrigeration section above. It should be noted that there are no obligations for GIS in Article 3 of the F-Gas regulation, which refers to leak testing and record keeping. The only obligation is in relation to gas recovery during maintenance and at end of life.

Regulatory officers working on GIS will need to understand:

- **GIS fundamentals** – in particular, the different types of high-voltage switch and the way that SF_6 is used.
- **Obligations under the F-Gas Regulations** – see 8.3.1.
- **Understanding fluid recovery** – see 8.3.1.
- **Understanding minimum qualifications** – see 8.3.1.

9. INFORMING END USERS OF THEIR OBLIGATIONS

An important role for Defra and the devolved administrations is to ensure that end users are well informed about their obligations under the F-Gas and Ozone Regulations. It is reasonable to suggest that those organisations involved in the implementation of the Regulations will be in a good position to help Defra and the devolved administrations with an ongoing process of information dissemination.

9.1 Existing Information

Defra has created a range of good information material that is available on the Defra and BERR websites. This material includes a lot of useful material about obligations under the F-Gas and Ozone Regulations together with helpful documents such as "frequently asked questions" and specialised guidance for users in the refrigeration and air-conditioning sectors.

The existing information provides a very good starting point for the dissemination of information to relevant end users. Relatively little extra work is required to produce new information - the key issue is to ensure that the information is disseminated to the correct people.

It is recommended that short sector-specific summary sheets are made available. These can be used to highlight the key obligations for a specific type of end user and act as a “signpost” to other existing sources of information.

9.2 Existing Contacts Network

Defra has already established a good communication network with key stakeholders through the regular meetings held at the BERR conference centre. Defra can make use of its extensive mailing list to this group to reach many senior "influencers".

However, it should be noted that those people on this mailing list only include a relatively small number of end-user organisations. It is necessary to reach a very large number of end-user organisations to achieve good levels of information dissemination.

It is recommended that the existing network should still be a focal point and is an excellent forum to get advice about how to best reach a wider audience.

The regulatory bodies need to use a variety of methods to ensure that the wider audience is properly informed. This can be based on:

- The major emitting organisations identified in this market intelligence study (the “top 20” and the “next 140”).
- The other end-user organisations identified in this study (the database produced during this project includes over 400 organisations.

- Using trade associations to disseminate information to relevant groups.
- Using Climate Change Agreement databases to reach the industrial users.
- Placing articles in relevant trade press.

9.3 Building on the Risk-Based Implementation Model

From an implementation perspective it is clearly vital that the actual organisations that need to meet obligations under the Regulations must be well informed about these obligations. This mainly includes end-user organisations of equipment such as refrigeration, air-conditioning and fire protection systems although it is worth noting that it also includes organisations such as fluid manufacturers that need to meet the annual reporting obligations.

Reviewing the analysis in Section 6 of this report it is clear that a relatively small number of organisations can be targeted to ensure that the biggest emitters are well informed about their obligations. The key organisations that should be targeted in this way have been described in Section 6 and contact information has been provided in the spreadsheet of organisations that support this report. The information provided in this database of organisations includes around 400 end-user organisations that represent over 80% of the emissions reduction potential. A campaign targeted at these organisations should prove very helpful.

9.4 Reaching End Users via Trade Associations

Concentrating on the 400 targeted organisations is a practical and effective approach but it does not fulfil the Government's obligations to reach a much wider audience.

As discussed in Section 6, there are many thousands of organisations that need to receive information about the Regulations to ensure that those organisations that are relatively small emitters are also doing their best to meet their obligations.

The best way of making contact with such organisations will be to encourage a wide variety of trade organisations to inform their membership about the new obligations. As part of the research presented in Sections 4 and 5 of this report we have identified over 100 trade organisations that could prove very helpful in the dissemination process. Contact details for each of these trade organisations are provided in the spreadsheet of organisations that support this report.

The organisations identified fall into the following groups:

- Industry sector trade associations whose members include the end users that need to receive information.

- Specialist trade associations whose members include contractors operating in the refrigeration and air-conditioning markets and in the fire protection system market.

The regulatory bodies should use both these types of trade association to get the widest possible level of information dissemination. The industry sector trade associations can circulate information directly to end-users. The specialist trade associations have indirect access to end-users who will be clients of their members. Ensuring that contractors working in the relevant industry sectors are well informed about the Regulations will help end users receive information and understand their obligations.

9.5 Information Dissemination Through Climate Change Agreements

The industry sector trade associations include bodies such as the Food and Drink Federation (FDF) that is very active in the food manufacturing sector. The FDF is responsible for operating a Climate Change Agreement (CCA) on behalf of companies in the food manufacturing sector. A CCA is an agreement set up between eligible industry sectors and Defra. It provides the financial incentive of a climate change levy discount in return for a legally binding target to save energy. Because the financial incentive is very strong the uptake of CCAs is very high in eligible sectors.

The FDF CCA includes nearly 1000 food manufacturing sites. The FDF hold a completely up to date list of contacts at all the sites, as they need to coordinate an annual process of data collection from each site in the CCA. Many of the sites are not actually members of the FDF, so the CCA database is actually far more useful than simply using the membership list of the trade association. It would be in the interest of all the CCA participants to receive information about the F-Gas and Ozone Regulations and it would be logical that FDF would be happy to use their mailing list to disseminate information.

It is worth noting that the list of site addresses in all CCAs is published on a HM Revenue and Customs website. This could be used as a mailing list for information dissemination, although the published list does not include an individual contact. The CCA trade associations coordinate communication between Defra and each participant – hence their mailing lists are much more useful as they include the name of the person responsible for the CCA.

In Section 4 we identified that the food & drink manufacturing industry and the chemical, pharmaceutical and petrochemical industry were the main users of industrial refrigeration systems. The majority of large sites in these industries have a CCA and can be contacted through the CCA networks. The printing and electronics sectors, which are also users of refrigeration and air-conditioning systems, also have a CCA. The spreadsheet of organisations indicates which of the trade associations are responsible for a CCA.

9.6 Information Dissemination Through Trade Press

The spreadsheet of organisations also includes contact details for three refrigeration and air-conditioning magazines that are widely read by engineers in these sectors. These magazines can be encouraged to publish regular information about obligations in the Regulations.

9.7 Information Dissemination via Refrigeration Contractors

It is important to recognise the importance of reaching end users of refrigeration and air-conditioning equipment in a wide range of end-use markets. The refrigeration contracting industry will be a good way of reaching smaller end users. The key contacts are trade associations such as the British Refrigeration Association (BRA) and the Heating and Ventilation Contractors Association (HVCA). Contact details for these associations is included in the spreadsheet of organisations referred to in 9.4 above.

The Air-Conditioning and Refrigeration Industry Board (ACRIB) act as an umbrella organisation over a number of trade associations including BRA and HVCA. ACRIB are already taking active steps to make sure that engineers working in the industry are fully aware of the various obligations in the F-Gas and Ozone Regulations. It is recommended that the regulatory bodies liaise closely with ACRIB to maximise the effectiveness of this information dissemination route.

10. A RISK-BASED IMPLEMENTATION MODEL

10.1 Background

It is envisaged that implementation of the F-Gases and ODS Regulations will be carried out by local authorities and the Environment Agency in England and Wales, the Scottish Environment Protection Agency (SEPA) in Scotland and the Environment and Heritage Service (EHS) in Northern Ireland predominantly focusing on those premises for which they already have regulatory responsibilities. The implementation regime will be risk-based and will aim to comply with the Hampton principles of enforcement and inspection as far as practicable although it is recognised that there are difficulties in areas where there is no regulatory locus for either the Environment Agency/SEPA/EHS or local authorities. Fortunately the majority of these areas relate to premises that fall within the low risk area.

10.1.1 Hampton Principles of Inspection and Enforcement

Sir Philip Hampton carried out a review of inspection and enforcement in 2005 and set out a number of key principles which he felt regulators should adhere to. These have been adopted by the Government and are likely to be given statutory legitimacy as a result of the development of a Regulators' Compliance Code. The principles of inspection and enforcement that Hampton set out (and a sub-set of which are included in the Code) are as follows:

- Regulators, and the regulatory system as a whole, should use comprehensive risk assessment to concentrate resources on the areas that need them most
- Regulators should be accountable for the efficiency and effectiveness of their activities, while remaining independent in the decisions they take
- All regulations should be written so that they are easily understood, easily implemented, and easily enforced, and all interested parties should be consulted when they are being drafted
- No inspection should take place without a reason
- Businesses should not have to give unnecessary information, nor give the same piece of information twice
- The few businesses that persistently break regulations should be identified quickly, and face proportionate and meaningful sanctions
- Regulators should provide authoritative, accessible advice easily and cheaply
- When new policies are being developed, explicit consideration should be given to how they can be enforced using existing systems and data to minimise the administrative burden imposed

- Regulators should be of the right size and scope, and no new regulator should be created where an existing one can do the work
- Regulators should recognise that a key element of their activity will be to allow, or even encourage, economic progress and only to intervene when there is a clear case for protection
- As far as practicable the regulatory regime for the F-Gases and ODS Regulations should be Hampton compliant.

10.1.2 Rogers Review

The review carried out by Peter Rogers in 2007 of local authority environmental health and trading standards regulation set five national priorities for local authority regulation:

- **Air quality** (air quality, including regulation of pollution from factories and homes) – e.g. reducing air pollution
- **Alcohol licensing** (alcohol, entertainment and late night refreshment licensing and its enforcement) – e.g. protecting people from the effects of the misuse of alcohol through licensing
- **Hygiene of food businesses** (hygiene of businesses, selling, distributing and manufacturing food and the safety and fitness of food in the premises) – e.g. preventing food poisoning
- **Improving health in the workplace** – e.g. reducing the incidence of ill health and days lost arising from work activities in relation to musculo-skeletal disorders, stress and chemicals
- **Fair trading** (trade description/ trade marking/ mis-description/ doorstep selling) – e.g. protecting the vulnerable from scams and rogue traders
- **Animal and public health** (animal and public health, animal movements and identification; this priority is time limited) e.g. – ensures the control of animal disease

Although it is debatable whether the F-Gases and ODS Regulations fall within Rogers' definition of air quality as a priority area, they undoubtedly have an environmental impact – on the ozone layer and, most pressingly, contributing to climate change. It is also likely that the majority of premises that require F-Gas/ODS regulation, leaving aside those that will be regulated by the Environment Agency/SEPA/EHS will be regularly inspected as part of the regulatory regimes dealing with food safety, health and safety at work and air quality.

10.1.3 Draft Regulatory Enforcement and Sanctions Bill

The draft Bill seeks to establish the Local Better Regulation Office (LBRO), which is responsible for overseeing the regulatory activities of local authorities in terms of regulating businesses. It is suggested that the powers of LBRO may be extended to other regulatory areas at a later date.

The draft Bill also sets out the principles related to "primary authorities"; these are local authorities that agree with a business to be the primary authority for that business. It is proposed that when this has occurred then other regulatory authorities will require the approval of the primary authority before taking any enforcement action against the business in respect of outlets in their areas. This is an extension of the home/lead authority principle.

The Bill incorporates proposals that implement four recommendations from the Macrory Review – Regulatory Justice: Making Sanctions Effective – to make available to regulators an extended, more flexible and modern sanctioning toolkit that is better able to meet their needs in the Hampton world. The proposals for new enforcement powers will allow regulators to deal with non-compliance in a proportionate way – both with those businesses who need more support in their efforts to comply with the law, and with those who deliberately seek to gain an advantage by disregarding it.

The Environment Agency is a "designated regulator" within the Bill but not SEPA or EHS. Extension of the provisions to the devolved administrations will require their agreement.

It is also not yet clear if the F-Gases and ODS fall within the draft Bill as they had not previously been specifically mentioned within the designated enactments having been made under the provisions of the European Communities Act 1972.

10.2 Principles of Risk-Assessed Regulation and Current Models

It is essential that any risk-based implementation model takes heed of the regulatory priorities of the regulators that will be implementing the F-Gases and ODS Regulations. As far as possible, there needs to be a match in terms of the regulatory priorities in the different regimes. Where this is not possible, either due to the lack of an existing regulatory locus or a conflict of priorities, and there are major risks in terms of F-Gases and ODS, the methodology adopted needs to reflect this – for example, use of self regulation. Specific requirement under the Regulations, such as checks on inspections carried out by competent engineers, can be picked up in the course of routine inspections by the regulatory authorities.

Broadly there are two approaches to risk-based regulation:

a) Scoring systems that involve evaluation of a combination of factors such as current compliance and management practice to produce a risk-based score. These are often very dependent on the inspector's experience and judgment

b) Intelligence-led models that identify the businesses likely to be of high risk or where there is potential for most improvement and target these. There has been a tendency for these models to be built around limited information

Some examples of the current systems are given below.

10.2.1 Local Authorities

The central government study for the Retail Enforcement Pilot looked at the risk-assessed models of regulation used by local authorities. Relevant existing schemes used by local authorities exist for food hygiene (in the Code of Practice issued under the Food Safety Act 1990), food standards (in the Code of Practice issued under the Food Safety Act 1990), trading standards (LACORS), and health and safety (Health and Safety Executive/Local Authority Enforcement Liaison Committee (HELA)).

The aim of all the schemes is the prioritisation of inspection resources – the schemes identify inspection frequencies, with higher risk premises qualifying for more frequent inspections. In some instances, premises are so low risk that "alternative" approaches to programmed inspections can be used – for example, advice and education campaigns. All the schemes focus on the premises and define action required in relation to conditions in that premises.

The schemes commonly examine factors thought important in:

- Defining the level of hazard from the premises

- Defining the inspector's judgment and confidence in future compliance

Most schemes also examine existing compliance either as a separate factor (food schemes and LACORS' trading standards scheme) or in refining hazard from the premises into "risk" (health and safety scheme). The LACORS scheme also scores types of premises for hazard based upon the indicators of hazard it identifies.

These schemes are the product of the organisation's experience, attitudes and policy learning over many years. They incorporate the experience of regulatory officers. Although the evidence base of some of these schemes is incomplete, the factors included in these schemes have the advantage of being devised by the regulatory agencies.

10.2.2 Food Standards Agency

The Food Standards Agency is looking to introduce fundamental changes to the whole approach to food law regulation by local authorities. The aim is to provide local authorities with a suite of flexible interventions for improving business compliance.

To develop this work, the Food Standards Agency's Enforcement Division is leading a major policy review called the Changes to Local Authority Enforcement (CLAE) project.

10.2.3 Health and Safety Executive

The Health and Safety Executive (HSE) has devised an intervention matrix. This is sector-based and aims to enable top-down planning of intervention strategies differentiated by sector and size of business. A major difficulty it has experienced is identifying and evaluating the evidence on which such judgments are to be made. An evaluation of the evidence by the Health and Safety Laboratory concluded that the evidence is patchy, conflicting or missing.

The availability of detailed market intelligence information in respect of F-Gases and ODS is therefore key in developing the intervention process and should overcome such perceived shortcomings.

10.2.4 Environment Agency/SEPA/EHS

The Environment Agency and SEPA use the Operator and Pollution Risk Appraisal (OPRA) system to assess the risk associated with major industrial processes under industrial pollution regulation – specifically IPPC. Each site is scored according to the risk it poses to the environment, how that risk is controlled by the management systems in place, and the Operator Performance Appraisal (OPA). The sum of these gives the OPRA rating for overall risk to the environment. The Environment Agency and SEPA use these scores to prioritise the regulation and monitoring of sites. EHS has a standard inspection regime for all the larger/more complex “Part A” processes it regulates except for rendering plants which are inspected on a higher frequency.

Thousands of sites fall within the ambit of the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH). The HSE and the HSE Northern Ireland (HSENI) are the authorities responsible for implementation of REACH in the UK. The Environment Agency, SEPA and EHS will support HSE or HSENI in respect of chemicals that affect the environment. In this context they are taking an intelligence-led approach looking at the supply chain and the markets and have compiled a database of businesses that identifies those that pose a high risk and targets them through a national technical resource.

10.3 Regulatory Agencies for F-Gases and ODS Regulations

The potential regulatory agencies for the Regulations are as follows:

- The Environment Agency for England and Wales
- SEPA for Scotland
- EHS for Northern Ireland

Local authorities – environmental health and port health authorities for England, Wales, Scotland and Northern Ireland, and trading standards for GB

It is noted that there are differences between the regulatory regimes in England and Wales, and Scotland and Northern Ireland. Primarily these fall in the area of industrial pollution regulation. In England and Wales, the Environment Agency regulates "Part A1" processes and councils "Part A2" processes for multi-media emissions under IPPC; councils regulate "Part B" processes for emissions to air only under Pollution Prevention and Control (PPC). In Northern Ireland, EHS regulates "Part A" and "Part B" premises under IPPC and local authorities "Part C" premises (the equivalent of "Part B" in England and Wales). In Scotland, all premises, including what are termed "Part B" processes in England and Wales, are regulated by SEPA and local authorities have no involvement. These differences have a marginal impact on the risk-based approach to the implementation of the F-Gases and ODS Regulations – mainly in terms of who will regulate particular processes in different parts of the UK.

The systems for regulating food safety and health and safety at work are similar in all parts of the UK although both the Food Standards Agency and the Health and Safety Executive (HSE) have separate offices for the different countries of the UK (although in the case of HSENI, this is a separate entity from HSE, which has a GB-wide remit). Food safety is regulated exclusively by local authorities across the UK, whereas health and safety regulation is split between councils and HSE/HSENI. Trading standards is the responsibility of councils in GB but is currently delivered by central government in Northern Ireland. It is noted that there may need to be discussions with the relevant central government department in Northern Ireland if a key trading standards input is required in Northern Ireland as part of the implementation of the Regulations.

The F-Gas/ODS market intelligence work has confirmed the following:

- 68% of the F-Gas emission reduction potential can be "accessed" via the top 20 key organisations
- The next 11% of the F-Gas emission reduction potential can be accessed via the next 140 key organisations

- The next 1% of the F-Gas emission reduction potential can be accessed through the next 120 key organisations

- Getting much beyond this level of 80% coverage will require involvement of many thousands of organisations, illustrating the law of diminishing returns

Working from the Hampton principles, the focus for F-Gas/ODS regulation should be on the greatest risk – primarily in terms of emissions – and regulators should implement these Regulations as far as possible within the scope of their existing functions. It is therefore suggested that the regulators for the organisations that represent the top 80% of F-Gas emission reduction potential are as set out in Tables 10.1 to 10.4 below.

Table 10.1 Suggested Regulators for Sectors with the Top 68% F-Gas Emission Reduction Potential

Sector	Key Organisations	IPPC*	Suggested Regulator
Fluid Manufacture	3	Yes	Environment Agency/SEPA/EHS
Magnesium	5	Some	Environment Agency/SEPA/EHS
General Aerosols	1	No	Local authority trading standards for general retail and import of novelty products**
Supermarkets	11	No	Local authority

* Key site/s have Integrated Pollution Prevention and Control (IPPC) processes
** Appropriate for GB but noted that central government currently delivers trading standards services in Northern Ireland

A focus on these sectors at a national level through the 20 organisations with the greatest F-Gas emission reduction potential will result in a significant delivery of the regulatory agenda with relatively low effort. Section 6.3 in this report provides more detail on the organisations involved.

The next 140 organisations account for 11% of the F-Gas emission reduction potential and the table below indicates the sectors and the suggested regulatory agencies.

Table 10.2 Suggested Regulators for Sectors with the next 11% F-Gas Emission Reduction Potential

Sector	Key Organisations	IPPC*	Suggested Regulator
Aluminium	2	Yes	Environment Agency/SEPA/EHS
Metered Dose Inhalers	4	Yes	Environment Agency/SEPA/EHS
One Component Foam	8	No	Local authority
Gas Insulated Switchgear	16	No	Some may have local authority involvement through provision of catering but not all
Chemical Industry	40	Most	Environment Agency/SEPA/EHS
Foam	4	Some	No specific F-Gas requirements – recovery from scrap
Fire	5	No	Local authority
Food / Drink Industry	40	Some	Local authority
Mobile Air-Conditioning	20	No	Further discussion required (see Section 10.4)

* Key site/s have Integrated Pollution Prevention and Control (IPPC) processes

A focus on these 140 organisations at a national level either through the national regulatory agencies or local authorities using the home/lead authority approach provides a secondary focus for implementation and again will provide the best return on regulatory activity. Section 6.4 earlier in the report provides more detail on the organisations involved.

The stationary refrigeration and air-conditioning sectors have been broken down into sub-sectors previously in Table 4.2 although supermarkets and the food/drink industry – the main users of stationary refrigeration and air-conditioning – appear in the tables above. Table 4.2 is reproduced below (as Table 10.3) with an indication of the suggested regulator for each stationary refrigeration and air-conditioning sub-sector.

Table 10.3 Suggested Regulators for Stationary Refrigeration and Air-Conditioning

Market	Sub-Sector	Suggested Regulator
Retail (61%)	Supermarkets	Local authority
	Other food retail	Local authority
	Non-food retail	Local authority
	Shopping Malls	Local authority
Hospitality (7%)	Pubs / coffee shops	Local authority
	Restaurants / fast food	Local authority
	Hotels	Local authority
	Leisure facilities	Local authority except where local authority owned – self regulation
Other Buildings (10%)	Commercial offices	Local authority
	Central Government	Local authority where inspecting for food but otherwise self regulation
	Local Government	Self regulation
	Health	Local authority where inspecting for food but otherwise self regulation
	Education	Local authority where inspecting for food but otherwise self regulation
	Prisons	Local authority where inspecting for food but otherwise self regulation
Industry (17%)	Food and Drink	Local authority
	Chemicals / Petrochemicals	Environment Agency/SEPA/EHS
	Cold Stores	Local authority
	Other industry sub-sectors	Where Environment Agency/SEPA/EHS IPPC[16]/PPC[17], where not local authority
Domestic (2%)	Dwellings	Advice only from central government
Transport (3%)	Refrigerated lorries and containers	Associated with food businesses – mainly local authorities

16 IPPC – Integrated Pollution Prevention and Control

17 PPC –Pollution Prevention and Control

The market intelligence information presented earlier indicates that a further 1% of F-Gas emission reduction potential can be accessed through a further 120 organisations, the details of which are set out in Section 6.5 of this report. The table in Section 6.5 is reproduced below with a suggested regulator for each sector.

Table 10.4 Suggested Regulators for Organisations with the Next 1% F-Gas Emission Reduction Potential

Sector	Organisations	IPPC*	Suggested Regulator
Other Buildings	40	No	Local authority or self regulation
Electronics	11	Yes	Environment Agency/SEPA/EHS
Hospitality	20	No	Local authority
Other retail	30	No	Local authority
Other Food retail	10	No	Local authority

* Key site/s have Integrated Pollution Prevention and Control (IPPC) processes

This previous tables clearly demonstrate the law of diminishing returns and it is suggested that the regulatory effort be primarily focused on the top 160 organisations in terms of F-Gas emission reduction potential.

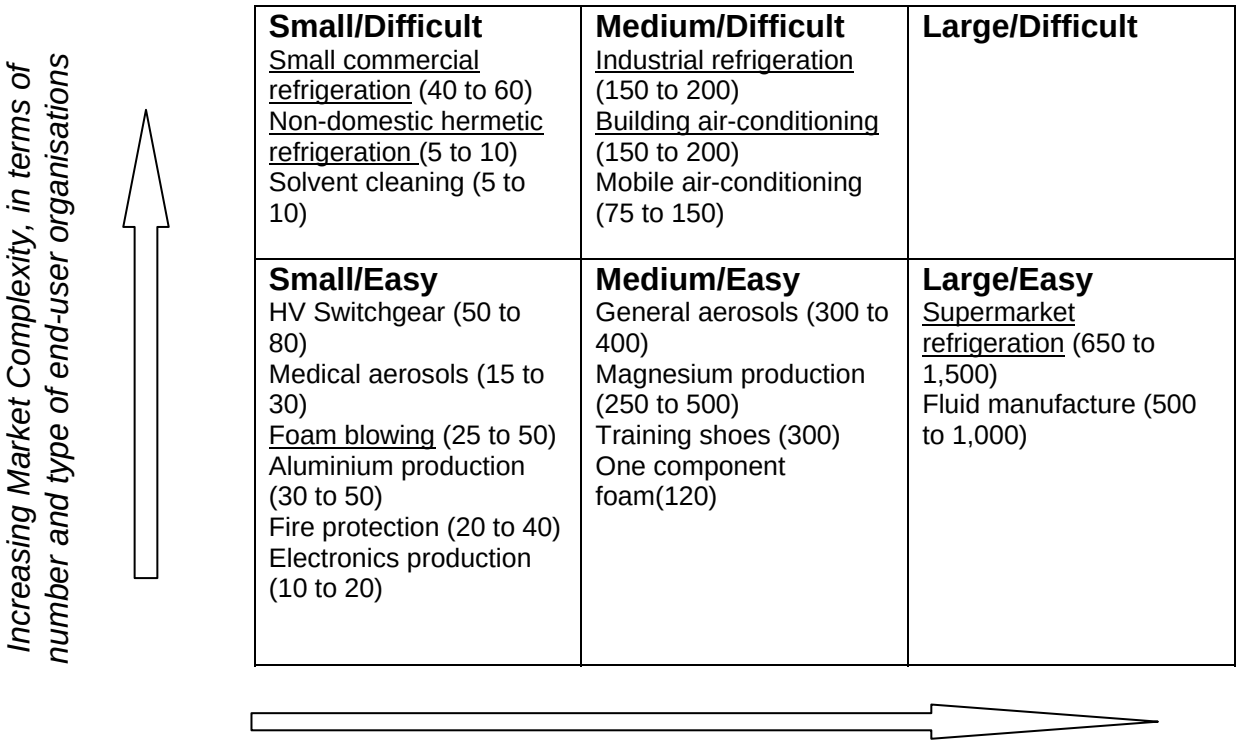
The tables indicate that there are sectors where neither the Environment Agency/SEPA/EHS nor local authorities are involved as regulatory authorities. The approach to implementation in these sectors is discussed in the next section.

10.4 Risk-Based Approach to the F-Gas and ODS Regulations

Figure 3.1 earlier in the report, reproduced again below (Figure 10.1), illustrates six broad end-use categories, to assist implementation of the Regulations, based upon the market complexity and the risk in terms of F-Gas emission reduction potential.

Figure 10.1 Categories of End Use

Emission reduction potential shown in brackets, ktonnes CO2 equiv. Sectors underlined have ODS issues in addition to F-Gas issues.



Note: that the sector size is defined in terms of potential to reduce emissions not in terms of absolute level of emissions. This is because some markets have a high level of emissions, but only a small emission reduction potential. From the implementation perspective it is best to target those sectors where the emission reduction potential is greatest.

A Hampton compliant model for implementing the F-Gases and ODS Regulations will have the following characteristics:

a) The risk factors will be defined by:

   i. The level of emissions and the potential to reduce emissions.

   ii. The level of management control within the sector – for example, a large supermarket chain is likely to have the ability to apply a national protocol for dealing with the F-Gas and ODS Regulations.

   iii. The complexity of the market – primarily focusing on few and comparatively well organised businesses as opposed to many and differentially organised businesses.

These factors have been defined throughout this report in the context of the six categories shown in Figure 3.1. This has been reproduced in this section as Figure 10.1 for ease of reference.

b) The implementation regime will be intelligence led. The approach is well founded as a result of the F-Gas/ODS market intelligence information that has been collected.

c) The Environment Agency, SEPA, EHS and local authorities should regulate in businesses for which they currently have responsibility under another regulatory regime – where there is a dual responsibility for example, food safety and national authority IPPC sites – the relevant national authority will take responsibility.

d) The focus for both the Environment Agency, SEPA, EHS and local authorities will be on those major F-Gas emitters where significant reductions are possible, working where appropriate through trade associations and/or with businesses – as appropriate – to agree protocols. It is recommended that local authorities will use the home/lead/primary authority principle to focus on head offices of relevant national companies – this is particularly relevant in the supermarket and other retail sectors – to agree protocols that will operate within their companies.

e) The priority will be to deal with the large or medium (in terms of F-Gas emission reduction potential) and easy (in terms of access to organisations) sectors first before moving onto the more difficult to access sectors.

f) Small F-Gas emission reduction potential sectors will primarily be dealt with by provision of information on the Regulations' requirements and subsequent requests for information on compliance – either written requests or requests during visits made by relevant local or national agencies in the course of other regulatory activity. It is recognised that for difficult to reach sectors, the large number and many different types of organisation in a sector is a major challenge for effective provision of, and requests for, information. Clearly it is desirable to facilitate compliance using targeted communications but if an organisation has knowingly not complied with the Regulations then formal enforcement should follow. Publicity of formal enforcement action may then help facilitate greater compliance elsewhere.

g) Central government, local authorities, educational establishments, the NHS and prisons will not have a regulatory authority for their buildings as there is no involvement of either the national environment agencies or local authorities in a regulatory capacity. In these cases, for buildings that require F-Gas and ODS regulation, it is suggested that the organisations will self regulate and report compliance to Defra/the devolved administrations as appropriate on an annual basis. It is noted that HSE/HSENI

regulate some of these areas for health and safety but following approaches to HSE, from a GB perspective, HSE stated that it was unable to play any role in F-Gas/ODS regulation because it does not see a good fit between its aims and responsibilities and the aims of these Regulations. The involvement of HSE and HSENI in implementing the Regulations has therefore not been pursued further.

h) Follow-up work or routine inspections by individual local authorities or national agencies will be on a checklist basis against the nationally agreed protocol when carrying out other inspections in sectors where significant emission reductions are anticipated. This work will be incorporated alongside other regulatory visits.

i) Follow-up visits will also take account of reports by appropriately qualified engineers indicating the dates and outcome of leakage tests, any servicing, maintenance or gas recovery undertaken.

The F-Gas/ODS market intelligence exercise has given a clear picture of the contribution that each sector makes to emissions, as well as the potential for emission reduction within each sector. Figure 10.1 above categorises each end-use sector in terms of risk defined as emission reduction potential and in terms of market complexity. Tables 10.1 to 10.4 suggest a regulator for the F-Gases and ODS Regulations for each sector in line with other regulatory responsibilities for each regulator.

There are a number of areas that are affected by the Regulations other than central government, local authorities, educational establishments, the NHS and prisons where no regulatory authority has been identified. These are in the areas:

a) Gas Insulated Switchgear – this relates to power companies, transmission companies and local distribution companies and is mostly owned by the power companies of which there are 16 organisations. Ofgem, the regulator of gas and electricity suppliers, already has a performance target for the reduction of SF_6, which is monitored through the pricing formula. It is therefore suggested that discussion with Ofgem, in addition to the companies themselves, could be part of the approach taken for this sector.

b) Mobile Air-Conditioning – this involves car dealerships, car service networks and car dismantlers minimizing emissions during services and at end of life. It involves 20 major organisations although the total numbers are probably in the thousands if account is taken of all the small car repair businesses and scrap yards. Local authorities will have some limited regulatory responsibility for car dealerships and car service networks under Health and Safety provisions but the majority of these will fall to the Health and Safety Executive in GB and to EHS in Northern Ireland. Car dismantlers are the responsibility of the Environment

Agency, SEPA or EHS. Further discussion will need to take place on the overall regulatory approach to this sector.

c) **Transport** – Local authorities will deal with the majority of these as they are related to food businesses. There will be a small number which are not food related and further discussions are needed to determine the overall regulatory approach to this sector.

d) **Industrial premises not inspected for food safety or under IPPC/PPC** (for example, some chemical manufacturing premises). Further discussions are needed to determine the overall regulatory approach to this sector.

10.5 Regulation of Specific F-Gas/ODS Requirements

Specific requirements in the Regulations for end users, maintenance contractors, manufacturers and importers have been set out earlier in this report and also the supplementary guidance on the F-Gas Regulation (Section 2.1.8). The obligations are reiterated below together with practical proposals for regulation against each one.

a) **Are end users adhering to the obligations on containment and recovery?** For F-Gases these obligations include regular leak checks, refrigerant recovery, record keeping, use of automatic leak detection systems on larger systems and use of qualified personnel for these tasks. For HCFCs the obligations are a “sub-set” of those for F-Gases.

   There are 6 main obligations in the F-Gas Regulation that will affect operators of stationary refrigeration, air-conditioning and heat pump equipment. The obligations are summarised in Table 2.2 earlier in this report. Further detail can be found in the supplementary guidance on the F-Gas Regulation (see Section 2.1.8).

   Compliance with all the obligations listed in Table 2.2 depends on the size and type of plant that is operated. The requirements to check for leakage and to keep records only apply to plant containing 3 kg or more of refrigerant (the leak checking obligation has a threshold of 6 kg for hermetically sealed equipment). However, the requirements to recover refrigerant and to use adequately trained staff applies to equipment of all sizes. Some parts of the F-Gas Regulation refer to “stationary refrigeration, air-conditioning and heat pump equipment”. This means that mobile systems used in cars (mobile air-conditioning) and in other forms of transport (e.g. refrigerated lorries or containers) are not subject to the regular leak testing and record keeping obligations.

The following has been identified as the proposed approach to be taken to implementation:

i. The organisations with the largest potential for F-Gas emission reduction fall into a number of clearly definable market sectors, which align with the sectors described in Table 6.1 of this report. Examples of important sectors include supermarkets, magnesium smelting, food and drink manufacturing, and the electricity supply industry. To maximise the effectiveness and consistency of the regulatory system, it is important that compliance protocols are set up at a national level, between the head offices of the companies in each sector and the relevant regulator – either a national agency or the appropriate lead/home authority – to suit the characteristics of each important sector. This is likely to be best achieved with a 4-step approach:

    - Step 1: Development of a draft protocol by the central support team (see Section 10.7.1), taking sector characteristics into account.

    - Step 2: Discussion of draft protocol with a representative group from the industry sector – facilitated via the relevant trade association if appropriate/possible – and if appropriate, representatives from the relevant regulator(s). For gas insulated switchgear, it is suggested that there is also preliminary discussion with Ofgem – see Section 10.4 for further details.

    - Step 3: Finalisation of an agreed national protocol.

    - Step 4: Bilateral meetings between each organisation and the relevant regulator (supported by the central team if appropriate) to agree an acceptable protocol for the organisation, based on the national protocol.

    Each national protocol is the likely to include the following elements:

    - An undertaking on compliance with the Regulations in all an organisation's premises (both F-Gas and ODS Regulations).

    - A database of systems within the company using F-Gases and ODS including location, type of system, quantity of F-Gases or ODS and systems with automatic leak detection.

- A summary of leak testing protocol, including frequency, qualifications of tester(s) and description of the leak checking process.
- A risk-based approach to dealing with leakages.
- Details of staff used for maintenance and leak checks including training and qualification.
- Details of arrangements for recovery of F-Gases during plant servicing and maintenance and at end of life.
- Details of any HCFCs currently being used in the company.
- If appropriate, information on how and when the ban on HCFCs will be implemented.
- Agreement on labelling requirements.
- Agreement on records to be kept at local level.
- An appropriate audit trail.

ii. Checks on record keeping at a local level – engineers' inspection reports to be retained at local level indicating date and outcome of any leakage checks or any gas recovery undertaken. This is not dissimilar to the approach taken to lift inspection under health and safety legislation where an inspection report is provided by a qualified lift inspector to indicate any requirements for works or that the installation is satisfactory. It would be helpful if a common format for an engineers' report could be agreed either through Defra or the professional/commercial associations. This is also reliant on agreement on the qualification requirements for engineers.

iii. Requests for information in respect of obligations – regulators may take the option of requiring confirmation of compliance with the Regulations by written request, possibly distributed with information in respect of other regulatory responsibilities.

b) Are product manufacturers adhering to placing on the market bans on products? There are a relatively small number of manufacturers involved in making the products that will be banned under the F-Gas Regulation (see Table 2.4, e.g. novelty aerosol manufacturers must phase out use of HFC propellants). There are a small number of SF_6 suppliers that could be monitored to ensure banned users are not receiving supplies (e.g. magnesium smelters where there is an SF_6 ban). Also, there are a small number of HCFC suppliers whose compliance

with the ODS Regulation could be checked – to ensure that virgin supplies are not sold after the end of 2009.

The arrangements for implementation under this obligation are time limited and relatively straightforward:

i. The small number of manufacturers can be regulated at a national level by the national agencies whilst dealing with other industrial pollution issues (mainly under IPPC). Requires maintenance of records of products being used to an agreed standard. There will also be a need to have a clear plan for phasing out any prohibited materials before the ban comes into effect.

ii. The largest user of SF_6 is Magnesium Electron, which is a magnesium smelter but not a die caster and therefore outside the strict definition within Regulations. There may be potential for this issue to be dealt with through the IPPC regime.

iii. Protocols should be agreed with the small number of suppliers through the national agencies in respect of phasing out of banned products.

iv. Manufacturers and suppliers records of supply should be available for relevant regulators to check.

v. The one area that may prove more difficult is the import of novelty aerosols and one component foam. It is not clear from the market intelligence what quantities are involved and it is therefore difficult to assign a priority. However these could be dealt with through trading standards checks at ports and in the retail sector as it is probable that the same importers will be importing toys and games which trading standards services routinely inspect. Some guidance on identification will be required.

c) Are end users adhering to placing on the market bans on products and use? It may be necessary to check that end users are adhering to the bans. For F-Gases this refers to a list of fairly unusual uses that can be regulated either through a small number of product manufacturers or through a fairly small number of specialist end users or retailers. For HCFCs this is a much wider issue that will affect many thousands of refrigeration and air-conditioning end users in industrial, commercial and public sector organisations.

The implementation arrangements will be broadly similar to the approach taken in relation to product manufacturers under b) above given the relatively small number of manufacturers and retailers, although there will be some differences:

i. The small number of manufacturers and specialist retailers have been identified and fall under a mix of national agency and local authority control. The home/lead authority approach will apply to those under local authority regulation.

ii. The ban on the use of virgin HCFCs for maintenance comes into effect on 31 December 2009 and the ban on the use of recycled HCFCs for maintenance on 31 December 2014. When these bans on HCFCs come into force they will have to be taken into account as part of the overall approach to F-Gases. It is suggested that as part of the protocols negotiated with major emitters that the issue of HCFC bans is included in the protocol.

d) Are maintenance contractors adequately qualified? The containment and recovery activities for both the F-Gas and ODS Regulations require properly qualified staff. It is likely that this will be regulated in a number of ways:

i. User-led oversight will be the primary means of regulation. Regulation via contractors may facilitate compliance, particularly for small end users.

ii. Trade, commercial, and professional bodies and associations should have an overview role.

iii. Regulators will only come into contact with this issue in respect of reports of inspections where these are supplied by businesses but could review stated qualifications as part of a checklist.

e) Are F-Gas manufacturers and importers meeting the reporting obligation? A small number of companies manufacture or import F-Gases. They will be obliged to provide data on annual sales to the European Commission. There is a question here as to who should be the competent authority for ensuring compliance. As there are a relatively small number of manufacturers and importers and most of the manufacturers are likely to be regulated by the national agencies, there is an argument for these agencies taking overall responsibility. However Defra will want an overview of the situation and may wish to consider the issue themselves.

10.6 Contact Details for Key Organisations

As part of the market intelligence exercise, work has been done on identifying contact details for the key 280 organisations which represent 80% of the emission reduction potential. This will enable the relevant regulator to identify and contact the appropriate organisation. LACORS has identified those organisations with a home/lead authority agreement (Appendix 4).

10.7 Other Implementation Issues

10.7.1 Central Team

It is recommended that a "central team" is established to help develop and deliver information to end users as part of a national information campaign and to support the relevant regulators – for example, assisting in the development of national compliance protocols and coordinating training.

The central team would use the risk-based model to inform their information provision to end users and support for the regulators. The top 20 organisations in terms of F-Gas emission reduction potential would be a priority for the team and the relevant regulators at the start of the implementation programme and would probably need on-going contact over the duration of the programme. A key initial area of work will be for the central team and the regulators to establish national compliance protocols with the top 20 organisations. The next 140 organisations would be a priority once the first 20 had agreed protocols in place. Subsequently the team's support work could move on to the next 120 and to a wide range of other organisations.

It should be noted that there would still be a need for some training for local authorities and the national agencies on the implementation issues (see below).

10.7.2 Training for Regulators

Using the implementation model set out above, requirements for training would fall into two areas:

a) **National agencies and home/lead authority specialist training**. This would be aimed at those officers who would be responsible for negotiating the national protocols with the key organisations in terms of emission reduction potential. It is estimated there would be at least 200 officers in this position and it is suggested that a two-day training course ideally run at several centres around the UK would be appropriate to help ensure that officers have a sufficient level of knowledge to carry out this role.

b) **Basic training for regulatory officers**. This would be designed to cover the basic principles of the legislation to enable national agency and council officers to carry out compliance checks under the F-Gas/ODS Regulations during ongoing regulatory visits to organisations (for example for PPC/IPPC, food safety, and health and safety). Further discussion with the local and national regulators is required to assess how many officers should receive this training to support effective implementation of the Regulation. It is suggested that the course would run for a full day, again ideally at several centres around the UK.

10.7.3 Helpline

The availability of a helpline to support local authorities and national agencies would facilitate consistency of approach. If the helpline was also open to businesses and other organisations potentially affected by the F-Gas/ODS Regulations, this would also assist the implementation process.

10.7.4 Website, Publicity and Literature

Website information will be a primary source of information and provision will have to be made for this to be established and updated – especially with frequently asked questions. A facility enabling businesses and other organisations potentially affected by the F-Gas/ODS Regulations to ask questions through a website would be helpful.

The level of publicity and the availability of literature for the introduction of the Regulations is a matter for Defra and the devolved administrations to decide upon but the more effective information – timely and well targeted – that can be provided, the more likely the regulatory system for F-Gas and ODS will be introduced successfully.

10.8 Conclusions

This final section of the report sets out a risk-based approach to implementing the F-Gases and ODS Regulations. It builds on the Hampton "better regulation" principles whilst recognising practical difficulties. It proposes the following principles/recommendations for implementing the Regulations (other options are in brackets and italics, although it should be noted that these additional options are not exhaustive and a variety of other options are possible for a number of the elements):

a) The implementation regime will be intelligence led – drawing on the market intelligence research set out in this report, which identifies those sectors where substantial reductions in emissions may be achieved.

b) The Environment Agency, SEPA, EHS and local authorities should regulate businesses for which they currently have responsibility under another regulatory regime – where there is a dual responsibility for example, food safety and national authority IPPC sites – the relevant national authority will take responsibility.

   (Option – all regulation to be done by national agencies using a specialist unit to promote consistency and reduce training requirements.)

c) The focus for both the Environment Agency, SEPA, EHS and local authorities should be on those major F-Gas emitters where significant reductions are possible, working where appropriate through trade associations and/or with businesses – as appropriate – to agree protocols on compliance with the Regulations.

   The greatest focus will be on the 160 organisations that have 79% of the F-Gas emission reduction potential at a national level and agreement of protocols for compliance with the relevant regulator – either the national agencies or local authorities. It is recommended that local authorities will use the home/lead/primary authority principle to focus on head offices of relevant national companies – this is particularly relevant in the supermarket and other retail sectors – to agree protocols that will operate within their companies.

   It is also recommended that a "central team" is established to support the relevant regulators in developing the national compliance protocols as well as helping to develop and deliver information to end users as part of a national information campaign.

   (Option – focus on just the top 20 organisations, which have 68% of the F-Gas emission reduction potential.)

d) The priority will be to deal with the large or medium (in terms of F-Gas emission reduction potential) and easy (in terms of access to organisations) sectors first before moving onto the more difficult to access sectors.

e) Small F-Gas emission reduction potential sectors will primarily be dealt with by provision of information on the Regulations' requirements and subsequent requests for information on compliance – either written requests or requests during visits made by relevant local or national agencies in the course of other regulatory activity. It is recognised that for difficult to reach sectors, the large number and many different types of organisation in a sector is a major challenge for effective provision of, and requests for, information. Clearly it is desirable to facilitate compliance using targeted communications but if an organisation has knowingly not complied with the Regulations then formal enforcement should follow. Publicity of formal enforcement action may then help facilitate greater compliance elsewhere.

   (Option 1 – no written requests for compliance information

   Option 2 – no requests for compliance information during other regulatory visits.)

f) Central government, local authorities, educational establishments, the NHS and prisons will not have a regulatory authority for their buildings as there is no involvement of either the national environment agencies or local authorities in a regulatory capacity. In these cases, for buildings that require F-Gas and ODS regulation, it is suggested that the organisations will self regulate and report compliance to Defra/the devolved administrations as appropriate on an annual basis.

(Option 1 – no requirement for returns.)

g) The overall regulatory approach in areas where it is not clear which regulator should take the lead – including gas insulated switchgear, mobile air-conditioning, transport and industrial premises not inspected for food safety or under IPPC/PPC – to be agreed following further discussions between Defra, the devolved administrations and other stakeholders.

h) Follow-up work or routine inspections by individual local authorities or national agencies will be on a checklist basis against the nationally agreed protocol when carrying out other inspections in sectors where significant emission reductions are anticipated. This work will be incorporated alongside other regulatory visits.

(Options – checking of engineers' reports only or no action.)

i) Follow-up visits will also take account of reports issued by appropriately qualified engineers indicating the dates and outcome of leakage tests, any servicing, maintenance or recovery undertaken. A common format of such reports to be agreed with professional/commercial associations.

j) Oversight of qualification requirements for engineers largely to be user led with some input from commercial, trade and professional bodies.

k) A targeted national information campaign is a crucial aspect of effective implementation of the Regulations. It is recommended that information dissemination to businesses and other organisations on the requirements of the Regulations is coordinated with the help of the central team – see also under c) above. Ideally this would include a helpline to deal with queries.

(Option 1 – website/email information only, without helpline.

Option 2 – website/email information plus information leaflets, without helpline.)

l) It is recommended that training is provided for national agency and local authority officers involved in developing national compliance protocols with key organisations – in terms of F-Gas

emission potential – and for an agreed additional number of national agency and council regulatory officers involved in ongoing regulatory visits to organisations (for example under PPC/IPPC, food safety, and health and safety regulation). See Section 10.7.2.

(Option 1 – training for officers in relevant national agencies if Option 1 under b) above is adopted.

Option 2 – training for all national agency and local authority officers involved in implementation.

Option 3 – no training provision.)

APPENDICES

1. GASES AFFECTED BY THE F-GAS AND OZONE REGULATIONS

Table A1 Refrigerant Types and Regulatory Impact

Type	Refrigerant Examples*	EU Regulation		Comments
		Ozone	F-Gas	
CFC	R11, R12, R502	✓	✘	These are already completely phased out - it is very unlikely to find these in use, except in very old domestic sized refrigerators.
HCFC	Pure fluids: **R22**, R123, R124, R141b, R142b	✓	✘	R22 is very common in air-conditioning and industrial refrigeration
HCFC Blends with HFCs	Blends: R401A, R401B, R401C, R402A, R402B, **R403A, R403B**, **R408A**, R411B	✓	✓	HCFC blends were introduced in mid-1990s to help with CFC phase out. Most HCFC blends also contain HFCs, so these refrigerants are affected by both Regulations.
HCFC Blends with no HFCs	R406A, R409A, R409B	✓	✘	These uncommon HCFC blends do not contain any HFC components, so are only subject to the Ozone Regulation
HFC	Pure fluids: **R134a**, R32, R125	✘	✓	HFCs have been used since 1995 as alternatives for CFCs and HCFCs
HFC Blends	Blends: **R404A, R407C, R410A**, R413A, R416A, R417A, R422D, R423A, R507, R508, FX100, RS44, RS45, RS52	✘	✓	HFC blends are used because the properties of pure HFCs do not suit all refrigeration applications.
Other	**Ammonia (R717)**, CO_2 (R744), Hydrocarbons (e.g. Propane)	✘	✘	Ammonia is quite common in industry and is not affected by these Regulations.
Trade Names	Trade names are sometimes used instead of an "R-number". The trade name is often used with the relevant R number (e.g. Harp 408A), but in some cases the trade name incorporates a completely different number (e.g. R 401A is also Suva MP39) Common trade names: Suva MP39 (R401A), MP66 (R401B), HP80 (R402A), HP81 (R402B) Isceon 69S (R403A), 69L (R403B) Dupont Isceon MO29 (R422D), 39TC (R423A), MO49 (R413A), MO59 (R417A), MO79 (R422A), MO89 Forane FX10 (R408A), FX56 (R409A), FX57 (R409B), FX100 (R427A) RS RS24, RS44 (R424A), RS45, RS52 (R428A) Greencool, Harp, Klea, Solkane			

* The more commonly used refrigerants are shown in bold

Table A2 Fluid Types in Other End-Use Sectors and Regulatory Impact

Type	Fluid Examples*	EU Regulation		Comments
		Ozone	F-Gas	
Fire Protection Systems				
Halon	Halon 1211, Halon 1301	✓	✘	Completely phased out. Halon 1211 was used for hand held fire extinguishers – some of these may still be found in the field. Halon 1301 was used for large fixed installations and should be fully removed from all systems.
HFC	Pure fluids: **R227**, R23	✘	✓	HFCs are used in some fixed fire protection systems as alternatives to Halon 1301
Foam Blowing Systems				
CFC	Pure fluids R11, R12	✓	✘	Completely banned for new foam, but will be found in older foam installed before 2000.
HCFC	Pure fluids R141b, R142b, R22	✓	✘	Completely banned for new foam, but will be found in older foam installed before 2004.
HFC	Pure fluids: **134a**, R245fa, R365mfc	✘	✓	Used for some new foam since HCFC phase out in 2003/4. Much foam now blown with alternatives such as hydrocarbons or CO_2.
Aerosols				
CFC	R12	✓	✘	Completely phased out
HFC	Pure fluids: **R134a**, R227	✘	✓	HFCs are used in some technical aerosols, novelty aerosols and for medical aerosols
Solvents				
CFC	R113	✓	✘	Completely phased out
HFC	Pure fluids: R365mfc, R4310	✘	✓	Very little use as solvents
Electronics				
PFC	R14, R116, R218	✘	✓	Used for microchip manufacture
SF_6	Pure fluids: **SF_6**	✘	✓	Used for microchip manufacture

* The more commonly used refrigerants are shown in bold

Table A2 (cont) Fluid Types in Other End-Use Sectors and Regulatory Impact

Type	Fluid Examples*	EU Regulation		Comments
		Ozone	F-Gas	
Magnesium Smelting				
SF_6	Pure fluids: **SF_6**	✘	✓	Cover gas for magnesium smelters
High Voltage Switchgear				
SF_6	Pure fluids: **SF_6**	✘	✓	Insulant in HV circuit breakers
Aluminium Smelting				
PFC	Pure fluids: R14, R116	✘	✓	By-product emission during smelting
R22 Manufacture				
HFC	Pure fluids: R23	✘	✓	By-product emission during chemical processing
Training shoes				
SF_6	Pure fluids: **SF_6**	✘	✓	Used as cushioning gas

* The more commonly used refrigerants are shown in bold

2. DETAILED MARKET SECTOR DATA

The research presented in Sections 4 and 5 included the collection of address information for key end-user organisations and trade associations.

The database of information has been entered into a spreadsheet that is available for use by Defra, the devolved administrations and ultimately the relevant regulators specifically in relation to the implementation of the F-Gas/ODS Regulations. This spreadsheet includes 5 worksheets with names and addresses of:

1) The top 20 organisations (in terms of F-Gas emission reduction potential)

2) The next 140 organisations

3) The next 120 organisations

4) A list of 394 organisations including the 280 key organisations as above and a further 114 organisations with significant F-Gas emission reduction potential

5) A list of 88 relevant trade associations and 3 trade magazines

3. GLOSSARY OF TERMS

CCA	Climate Change Agreement. Agreements between the UK Government and high energy intensity industrial sites to deliver reductions in energy use.
CFC	Chlorofluorocarbon. Family of chemicals that was historically used in various applications such as refrigeration, foam blowing, aerosols. Now completely banned under Ozone Regulation.
DME	Di-methyl ether. A fluid that can be used as an aerosols propellant.
F-Gas	Fluorinated gases in the Kyoto Protocol i.e. HFCs, PFCs and SF_6 (ibid.)
GHG	Greenhouse gas
GIS	Gas insulated switchgear – used in very high voltage electricity circuit breakers.
GWP	Global warming potential. This represents the "strength" of a gas in terms of impact on global warming – compared to CO_2 which has a GWP = 1.
HC	Hydrocarbon. Family of chemicals including propane, butane etc. These have been adopted as alternatives to ODS and F-Gases in some applications.
HCFC	Hydrochlorofluorocarbon. Family of chemicals used in various applications such as refrigeration, foam blowing, aerosols. Already phased out in many applications under Ozone Regulation. All applications will be banned in EU by 2015.
HFC	Hydrofluorocarbon. Family of chemicals used in various applications such as refrigeration, foam blowing, aerosols.
HFE	Hydrofluoroether. Family of chemicals that can be considered as HFC alternatives in some applications e.g. fire protection systems.

IPPC	Integrated Pollution Prevention and Control. Regulation of certain industrial processes in respect of emissions to a variety of media. UK implementation as a result of an EU Directive
MAC	Mobile air-conditioning. Air-conditioning in vehicles, especially in cars.
MDI	Metered dose inhaler. Medical aerosol used to dispense certain drugs (e.g. inhalers for asthma treatment).
OCF	One Component Foam. A specialised aerosol that is used in the construction industry.
ODS	Ozone depleting substance. Various chemicals, including CFCs and HCFCs that damage the ozone layer. Many are already completely phased out.
PIR	Poly-isocyanurate – a type of rigid foam used for insulation.
PFC	Perfluorocarbon. Family of chemicals used in a few unusual applications such as electronic chip manufacture and certain refrigerants.
PPC	Pollution Prevention and Control. Regulation of certain industrial processes in respect of emissions to air.
PU	Polyurethane – a type of rigid foam used for insulation.
RAC	Refrigeration, air-conditioning and heat pump equipment.
SF_6	Sulphur hexafluoride. An F-Gas. Used in a few unusual applications such as magnesium smelting and HV switchgear.
100 year GWP	GWP (ibid) can be measured against different time horizons. The 100 year timescale is commonly used for GWP figures quoted in Kyoto Protocol documentation.

4. HOME AND LEAD AUTHORITY AGREEMENTS

This Appendix shows whether or not a Home / Lead Authority Agreement is in place between local authorities and organisations with greatest F-Gas emission reduction potential

Sector	Company Name	Home/Lead Authority Agreement?
Fluid Manufacture	Ineos Fluor	No
	Rhodia	No
	F2 Chemicals	No
Magnesium – Billet Casting	Magnesium Elektron UK Operations	No
Magnesium – Die Casting	Magnesium Castings Ltd.	No
	C E Marshall Limited	No
	Dynacast (UK) Ltd	No
	Norfran Products Ltd	No
General Aerosols	Goodmark (GAC UK Ltd)	Yes
Supermarkets	Tesco	Yes*
	Asda	Yes
	Sainsburys	Yes
	Morrisons	Yes
	Waitrose	Yes*
	Somerfield Stores Ltd	Yes
	Aldi	Yes
	Lidl UK	Yes
	Iceland Foods Ltd	Yes
	Netto UK	Yes
	Marks & Spencer	Yes
OCF	B&Q	Yes
	Homebase	Yes
	Wickes	Yes*
	Focus DIY	Yes*
	Jewson	Yes
	Travis Perkins	Yes
	Buildcentre (Wolseley)	Yes
	Buildbase	Yes*
Food & Drink Manufacture	Unilever	Yes*
	Associated British Foods	No
	Premier (now including RHM)	Yes*
	Northern Foods	No
	Masterfoods	Yes*
	Nestle	Yes
	Cadbury-Schweppes	Yes*
	Coca Cola	Yes
	Greencore	Yes*
	H. J. Heinz	Yes
	Salvesens	No
	Uniq	Yes*
	Kerry Foods	Yes*
	Burtons Foods	Yes*
	Youngs Bluecrest	Yes

	McCain Foods	Yes
	Anglo Beef Products	Yes*
	Fairfax Meadow	Yes
	Weddel Swift	Yes*
	Grampian	Yes*
	Bernard Matthews	Yes
	Deans Foods	Yes
	Faccenda	Yes
	Arla Foods	Yes
	Robert Wisemans	Yes*
	Dairy Crest	Yes
	Express	Yes*
	The Cheese Company	Yes*
	Glanbia	Yes*
	Anheuser Busch	Yes*
	Carlsberg	Yes*
	Coors	Yes
	InBev UK	No
	Scottish Courage	Yes*
	TDG	No
	Salvesen Logistics	No
	Associated Cold Stores	No
	Innovate Logistics	No
	Harry Yearsley	Yes
	Reed Boardall	No
Chemicals	BP Chemicals	Yes*
	Shell Chemicals	Yes*
	Ineos	No
	Huntsman Tioxide	No
	Lucite International	No
	Croda Chemicals	No
	Dupont	No
	Brunner Mond	No
	Dow Chemicals	No
	Solvay	No
	Kemira	No
	BOC Linde	No
	ICI	Yes*
	Johnson Matthey	No
	British Vita	Yes*
	Yule Catto	No
	Syngenta	No
	Ciba Speciality Chemicals	No
	Avecia	No
	Elementis	No
	BASF	No
	Sun Chemical	No
	Akzo Nobel	Yes*
	Akcros Chemicals	No
	Glaxo Smith Kline	Yes
	Astra Zeneca	No
	Eli Lilly	No
	Pfizer	Yes

	Shire	No
	Johnson & Johnson	Yes
	American Home Products	No
	Roche	Yes
	Shell UK Ltd	Yes*
	BP plc	Yes*
	ConocoPhillips Ltd	Yes
	ExxonMobil	No
	Total UK Limited	Yes
	Centrica plc (HRL)	Yes*
	Murco Petroleum Ltd	No
	BG Group plc (British Gas)	Yes*
GIS	Scottish Power plc	No
	Scottish and Southern Energy	Yes
	National Grid	No
	Northern Ireland Electricity	No
	CE electric	No
	Central Networks	No
	EDF Energy	No
	United Utilities	Yes
	Western Power Distribution	No
	British Energy Group Plc	No
	RWE Npower	No
	E On UK plc	No
	Drax Group plc	No
	BNFL	No
	Centrica plc	Yes*
	iPM Energy	No
Aluminium	Alcan Smelting and Power UK	Agreement for 'British Alcan'
	Alcan Smelting and Power UK	Agreement for 'British Alcan'
	Anglesey Aluminium Metal Limited	No
MDIs	GlaxoSmithKline	Yes
	3m Drug Delivery Systems	Yes*
	Astra Zeneca	No
	INyX Pharma	No
MAC	Kwik-Fit (GB) Ltd	Yes*
	Nationwide Autocentres Ltd	Yes
	National Tyres and Autocare	No
	Arnold Clark Service Centres	Yes
	Formula One Autocentres	No
	Cartakeback.com Limited	No
	Autogreen	No
	National Salvage Group Ltd	No
	Nationwide Auto Salvage Amalgamation	No
	Sims Group UK	No
	European metal Recycling Ltd	No
	Charles Trent Ltd	No
	Century Salvage Sales Ltd	No
	Universal Salvage	No
	Ford	Yes
	Vauxhall (GM)	Yes
	Volkswagen Audi Group	No
	Peugeot	Yes

	Renault	Yes
	Toyota	Yes*
	Nissan	Yes*
	Honda	Yes
	BMW	No
Fire Protection	Tyco Fire & Integrated Solutions	No
	Kidde Fire Protection	Yes*
	Siemens Building Technologies	Yes
	Surefire Systems	No
	Fike Protection Systems	No
Foam	Dow Building Solutions	No
	Knauf Hartlepool Extruded Polystyrene Plant	No
	Kingspan Insulated Panels	No
	Celotex	No

Notes:

1) Home/lead authority agreements refer to entries within LACORS' home authority database covering trading standards (including food standards/labelling), food hygiene, and health and safety (through the LA-led 'Large Organisations Partnership Pilots') and HSE's Lead Authority Partnership Scheme database
2) The information on home/lead authority agreements presented was gathered from initial interrogation of the database cross-referenced against company details gathered by Enviros for the "top 20" organisations and the "next 120" organisations in terms of F-Gas emission reduction potential
3) "Yes*" indicates a home/lead authority agreement or agreements for a particular company but the company address (or addresses) listed for the agreement does not match the HQ address