Department for Environment, Food and Rural Affairs

Guidance for Stationary Refrigeration & Air-Conditioning

Guidance: F Gas and Ozone Regulations

Information Sheet RAC 2: Usage

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This Information Sheet provides background information about the use of stationary refrigeration, air-conditioning and heat pump equipment (RAC systems) in organisations across Great Britain. We provide a description of the types of refrigerants used, describe key end user markets and discuss sources of emissions and options for reducing emissions through improved containment or use of alternative refrigerants (more information on alternatives is provided in Information Sheet RAC 7).

1 Types of Refrigerants

Many organisations are major users of refrigerants that are affected by both the EU F gas and Ozone Regulations. The following table lists the most common refrigerants used and shows which Regulations are relevant to each. A more comprehensive list of refrigerants is available in Information Sheet GEN 2.

Refrigerant	Type	EU F Gas Regulation	EU Ozone Regulation
R22	HCFC	✗	✓
R408A	HCFC + HFC Blend	✓	✓
R134a	HFC	✓	✗
R404A	HFC Blend	✓	✗
R407C	HFC Blend	✓	✗
R410A	HFC Blend	✓	✗
Ammonia	Natural	✗	✗
CO_2	Natural	✗	✗

2 Use of RAC Systems by Companies

Many organisations use RAC systems and this section describes some of the various uses by different sectors across Great Britain. Users of RAC systems will need to comply with the various obligations described in Information Sheet RAC 3.

2.1 Food Retail

The key RAC system applications are as follows:

- **Retail display cabinets with pack systems**

  Retail display cabinets are used for chilled and frozen food, via central "pack" systems. In large supermarkets these usually contain well above 100 kg of refrigerant in each system and some are above the 300 kg threshold requiring automatic leak detection to be fitted. The packs often serve "back of store" cold rooms as well as the retail displays. Most central pack systems use either HFCs (often R404A) or HCFCs (often R22). Systems of this type will be affected by many of the obligations in the F gas or Ozone Regulations.

- **Retail display cabinets with condensing units**

  In smaller stores it is common to find display cabinets connected to a remote condensing unit. These are smaller than pack systems, but are usually above the 3 kg threshold for regular leak testing and record keeping.

- **Integral retail display systems**

  Retail cabinets are sometimes fitted with "integral" refrigeration, where the whole refrigeration system is built into the cabinet (in the same way that a domestic refrigerator is configured). These are sometimes used alongside displays connected to a central pack e.g. for a branded product or a special display. Integral systems will usually be well below the 3 kg threshold, so are not subject to all the obligations. However, the rules on refrigerant recovery and use of qualified personnel still apply to small systems.

- **Retail Store Air-conditioning systems**

  Most retail stores also use air-conditioning systems in public areas of the store. Whilst these are usually much smaller than the central pack refrigeration systems they will often be well above the 3 kg threshold.

- **Non-HFC systems**

  A few companies have trialled central systems using either ammonia or hydrocarbon refrigerants, in conjunction with a secondary refrigerant. These systems are not in widespread use, but do not fall under the F gas or Ozone Regulations if no fluorinated gases (F gases) or ozone-depleting substances (ODS) are used. This also applies to recent installations using CO_2 as a refrigerant.

- **Distribution depot refrigeration**

  Regional distribution centres have large cold and chill stores. The use of ammonia is quite common in such installations and CO_2 is sometimes used. However, some depots use R22, which falls under the EU Ozone Regulations and some use HFC blends such as R404A, which falls under the EU F gas Regulation.

2.2 Buildings

- **Office air-conditioning**

All private and public sector organisations need to consider their use of refrigerants in RAC systems in the office buildings they occupy when undertaking their overall F gas and ODS assessments. Many office air-conditioning systems use ODS refrigerants (such as R22) or F gas refrigerants (such as R410A and R407C). These may be in the form of small split systems or larger chilled water systems.

- **Retail centres – air-conditioning systems**

Retail centres, such as shopping malls and outlet centres, will have air-conditioning such as small split systems and large, central systems - often using a chilled water secondary system (e.g. in centrally controlled parts of a shopping centre). Many systems use HFC refrigerants, and older ones might use HCFCs.

- **Retail stores – air-conditioning systems**

Large, non-food retail stores also have air-conditioning systems similar to those of retail centres - such as small split systems and large, central systems (e.g. in department stores). Small, non-food retail stores, such as high street shops and smaller chains, may use some refrigeration and air conditioning in small systems. Many systems use HFC refrigerants, and older ones might use HCFCs.

- **Hospitals, health centres and nursing homes (multiple systems)**

Hospitals are important users of refrigeration and air-conditioning equipment, due to both their size and some of the functions they need to perform. Typical cooling applications in a hospital may include general air-conditioning (for staff offices and wards), 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). Smaller sites, like health centres and nursing homes, may also have air conditioning. All these applications make widespread use of equipment that contains HFC or HCFC refrigerants which fall within the requirements of the EU F gas and Ozone Regulations.

- **School and University air-conditioning and refrigeration**

There is relatively little use of F gases in most schools. However, there may be some air-conditioning installed in larger modern schools and it is more likely to be found in universities, especially in large buildings. Also most schools and universities will have refrigeration systems for catering facilities and within universities there will be some specialist uses of refrigeration and air conditioning, particularly in laboratories, such as chilled rooms. Most systems use either HFCs or HCFCs.

2.3 Manufacturing

- **Food and Drink**

  Many food & drink manufacturing facilities rely heavily on refrigeration to cool and store products. Key sectors include meat, poultry and fish processing, chilled and frozen foods, confectionary, dairy, brewing and cold stores. A wide variety of equipment is used ranging from small cold rooms to very large freezing systems. HCFC 22 is still in common use and HFCs such as R134a and R404A are widely used. Some larger systems use ammonia.

- **Chemical**

  Some chemical processes are required to operate below ambient temperatures and others are exothermic and require heat removal. Gas liquefaction, vapour condensation and maintenance of reaction temperatures are all important examples of the requirement to avoid excessive temperatures via refrigeration systems. This industry sector possesses some very complex refrigeration systems employing a variety of refrigerants including both HCFCs and HFCs.

- **Electronics**

  In the production of electronic components the maintaining very specific temperature and humidity conditions are crucial. The maintenance of optimum manufacturing environments relies on the use of large air-conditioning systems.

- **Engineering**

  Refrigeration is used in various engineering applications, such as mould cooling. It may also be required for machine cooling (e.g. hydraulic power packs). Generally, it is used where the process temperature required would be lower than that capable of being achieved by the use of cooling water or air-blast cooling.

3 Sources of F Gas and ODS Emissions

There are four main sources of F gas or ODS emissions from RAC systems:

1) **Gradual leakage during normal operation.** There are many potential leak locations, especially on larger systems that have numerous joints, valves and compressors. If leakage is slow it can go unnoticed for long periods and result in direct emissions of F gases or ODS and poor refrigeration plant performance which often leads to wasted energy.

2) **Catastrophic leakage during normal operation.** It is not uncommon for a major failure to occur and for a system to lose all refrigerant in a short time period, e.g. a

refrigerant pipe burst. On a large system this can lead to a significant loss of refrigerant.

3) **Emission during plant maintenance.** If a refrigeration plant component needs to be replaced during maintenance it may be necessary to remove some or all of the refrigerant from the system. Some years ago refrigerant was simply vented to the atmosphere. This is now illegal. To avoid refrigerant loss during maintenance it is vital that personnel have suitable recovery equipment and are properly trained in accordance with the requirements set out in the relevant Regulations.

4) **Emissions at end of plant life.** It is vital to properly recover refrigerant from older plants during decommissioning, using recovery equipment and appropriately trained personnel.

4 Options for Reducing F Gas and ODS Emissions

Complying with the EU F gas and Ozone Regulations will help reduce greenhouse gas emissions. Refrigerant leakage is costly in both financial and environmental terms – it makes sense to address the leakage problem. To achieve the lowest possible loss of refrigerant an organisation should consider taking the following steps:

4.1 Only purchase plant that is "leak tight"

There is a lot that can be done at the design stage to minimise leakage. The key is to design the pipework carefully (to avoid stress related failures) and to use connections that remain leak free in all modes of operation. This approach does require attention to detail and may involve a small amount of extra capital cost. However, the extra investment will pay-off if the plant remains free of leaks. Designing the plant to hold the minimum quantity of refrigerant reduces the loss in the case of a catastrophic leak. Ensure that personnel are appropriately qualified to install equipment – minimum qualifications apply for both installation, servicing and maintenance of F gas containing equipment, see RAC 5 for details.

4.2 Ensure regular leak checks and take action to repair leaks

Both the F gas and Ozone Regulations set down minimum requirements on leak testing that are a key obligation. Make sure that leaks are repaired promptly and properly by appropriately certificated personnel. See Information Sheet RAC 3 for details on frequency of leak testing.

4.3 Address the "rogue" plants

It is quite common to find that the 80/20 rule applies – i.e. that 80% of annual leakage comes from only 20% of the refrigeration systems. It is therefore advisable to identify your rogue plants and spend more effort on them to ensure that problem components are replaced and that leaks are reduced. It is suggested that you increase the leak test frequency on these plants until the problems are solved.

4.4 Ensure you maintain complete records

Data, such as rate of leakage and the cause of previous leaks, makes management of leakage problems easier and more effective. For advice on keeping records see Information Sheet RAC 6.

5 Dealing with Phase Out of R22

If you are using R22 or another HCFC refrigerant (see Information Sheet GEN 2 for more information of refrigerant fluids) then you need to consider a plan for phase out in addition to ensuring low levels of leakage from existing plants. The phase out of HCFCs for refrigeration applications will occur in two steps:

Virgin HCFC phase out: Since 31st December 2009 you have not been allowed to use virgin HCFCs for plant maintenance (even if you bought the fluid before this date). You are allowed to use recycled or reclaimed HCFCs, see RAC 8 for definitions of recycled and reclaimed HCFCs and details of what you are allowed to do with each. You can only purchase reclaimed HCFCs and there is no guarantee that supplies will be available at a reasonable price.

Recycled/reclaimed HCFC phase out: After 31st December 2014 you cannot use recycled/reclaimed HCFCs for plant maintenance.

The best phase-out option depends on the age and efficiency of existing equipment. If your plant is old, unreliable or inefficient it is best to consider plant replacement. If the plant still has some years of useful life then it may be possible to retrofill with a “drop-in” replacement refrigerant. Your 3 main options are to:

1) **Replace the whole plant with a new system.** This is the most expensive option, but enables you to minimise leakage and maximise energy efficiency.

2) **Change the refrigerant to a suitable alternative.** This is much cheaper than a new plant, but you will still have to make additional investment to ensure leakage is minimised and reliability and efficiency maximised.

3) **Delay a decision until nearer the 2014 final phase-out date.** This is initially the easiest option, but it is only delaying the decision and it is a high risk strategy, as recycled/reclaimed HCFCs might be in short supply.

See Information Sheet RAC 8 for more details on options for dealing with the HCFC phase out.

6 Alternative Refrigerants for RAC Systems

The ideal way of reducing F gas or ODS emissions to zero is to use an alternative refrigerant, such as CO_2, ammonia or hydrocarbons. These three refrigerant types have all been used in RAC systems. However, before you invest you must take care that your alternative design is cost effective and has the lowest “overall carbon footprint”. Refrigeration plants give rise to two main types of greenhouse gas emissions:

Firstly: Direct emissions of refrigerants such as F gases through leakage.

Secondly: “Indirect” emissions of CO_2 from the power station supplying the plant with electricity.

For most refrigeration plants it is the energy related CO_2 emission that is the dominant part of the overall carbon footprint. Hence, it is essential that a system with an alternative refrigerant is equal to or better than an HFC system in terms of energy efficiency. A brief summary of the advantages and disadvantages of each refrigerant type is shown below.

Refrigerant	Advantages	Disadvantages
HFC	Widely used Non-toxic and non-flammable	High GWP (Global Warming Potential). Equipment containing HFCs has historically had high levels of leakage; however this is not an intrinsic characteristic of the refrigerant.
Ammonia	Zero GWP	Highly toxic and flammable. Must be used with secondary refrigerant, which can lead to poor efficiency.
CO_2	Zero GWP (net) Good potential for heat recovery Good potential for energy efficiency	Operates at very high pressure. Little practical experience in service companies. Additional costs associated with energy efficiency optimisation.
Hydrocarbon	Low GWP	Highly flammable. Must be used with secondary refrigerant, which can lead to poor efficiency.

The brief section here on alternatives is supplemented by Information Sheet RAC 7 which provides a fuller discussion about the subject of alternatives.

7 Energy Efficiency

In many organisations RAC Systems can account for a significant percentage of the total energy costs. The steps necessary for compliance with the EU F gas and Ozone Regulations provide an ideal opportunity to assess the energy efficiency of your RAC systems. If HCFC systems have to be replaced or retrofitted, this is particularly important.

Typical issues to consider are:

- Load reduction (e.g. better time and temperature controls);
- Plant operating conditions (e.g. reduce head pressures);
- Secondary loads (e.g. chilled water pumps);

- Part-load operation (e.g. compressor controls and variable speed drives).

For further guidance, see the Carbon Trust website and guides such as “GIL120 - Air conditioning Fact Sheet”.

7.1 Energy Performance in Buildings Directive (EPBD) 2002/91/EC

The EPDB calls for regular inspection of heat pumps and of air-conditioning systems of an effective combined rated output of more than 12 kW in buildings.

These inspections must include an assessment of the air-conditioning efficiency and the sizing compared to the cooling requirements of the building. The accredited expert inspecting the systems must provide appropriate advice to the users on the alternative solutions and the possible improvements or replacement of the air-conditioning system.

For further information about EPBD inspections please contact the Department for Communities and Local Government.

The information in this document is intended as guidance and must not be taken as formal legal advice or as a definitive statement of the law. Ultimately only the courts can decide on legal questions and matters of legal interpretation. If you have continuing concerns you should seek legal advice from your own lawyers.