REFRIGERATION & AIR CONDITIONING CFC and HCFC Phase Out:

Advice on Alternatives and Guidelines for Users

DETR
Environment
Transport
Regions

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Contents

Glossary of terms

CFC	chlorofluorocarbon
ODS	ozone depleting substances
HCFC	hydrochlorofluorocarbon
ODP	ozone depletion potential
HFC	hydrofluorocarbon
GWP	global warming potential
HC	hydrocarbon

Aim of this Guide

This Guide provides details of how the new EC Regulation 2037/2000 on ozone depleting substances (ODS) will affect manufacture and use of refrigeration and air-conditioning equipment. The Guide is aimed at all key parties in the refrigeration and air-conditioning market including users, designers, equipment manufacturers, installation contractors and maintenance contractors.

This Guide has been published as one of a set of four booklets addressing the new EC Ozone Regulation. The other booklets include a general guide on the EC Regulation and two further detailed guides addressing the solvents and fire fighting markets.

Users of CFC (chlorofluorocarbon) and HCFC (hydrochlorofluorocarbon) refrigerants need to be aware of a number of significant changes to the previous phase out regulations. The aim of this Guide is to outline these changes and to help users decide on appropriate action plans. Details of how to obtain further help are also given at the end of this booklet.

Summary of the new EC Regulation

The new EC Regulation on ozone depleting substances, EC 2037/2000 applies from 1st October 2000, upon which date the previous regulation, EC 3093/94, is repealed. Highlights of the new EC Regulation, which in some cases goes beyond the requirements of the Montreal Protocol, include:

- New bans on the supply[1] and use[2] of CFCs, halons, 1,1,1 trichloroethane, carbon tetrachloride, hydrobromofluorocarbons and bromochloromethane. These bans apply from 1st October 2000 for most applications, although certain delays and exemptions apply. The bans on these substances apply to both virgin and recycled material.
- Significant revisions to the controls on use[2] of HCFCs. This adds a number of new controls to those specified in the previous EC Regulation. HCFCs will not be allowed to be used in new equipment from 1st January 2001 (with some exemptions) and servicing HCFC systems will be restricted to the use of recovered/reclaimed refrigerant from 1st January 2010 - 31st December 2014. All the major end use sectors for HCFCs are subject to new use controls.
- Tougher requirements regarding the recovery of ozone depleting substances from products and equipment and to prevent leakage from systems.
- A ban on the supply of ozone depleting substances in disposable containers (except for essential uses).
- A revised timetable for the supply[1] of HCFCs. The timetable is designed to match the new HCFC end use controls. Some cuts come into effect in 2001 and there will be a substantial cut by 2003. No virgin HCFCs can be supplied after the end of 2009.
- A ban on the import of products containing ozone depleting substances. This is immediate for all ozone depleting substances except HCFCs - the specific HCFC use control dates also introduce import bans for those products and equipment which they cover.
- A ban on the export of virgin and recycled CFCs and halons and products containing them, although certain exemptions apply.
- A new timetable for the phase out of EU production of HCFCs.

1 In this booklet, the word 'supply' is used to describe the supplying or making available to third persons, against payment or free of charge, of controlled substances or products containing controlled substances covered by EC Regulation 2037/2000. It is referred to as "placing on the market" in the EC Regulation.

2 Use is defined in EC Regulation 2037/2000 as the utilisation of controlled substances in the production or maintenance, in particular refilling, of products or equipment or in other processes except for feedstock and processing agent uses. Running an existing CFC appliance, without maintenance, would NOT qualify as use.

Impact of the EC Regulation on Refrigeration

The key elements of the new EC Regulation as they apply to the European refrigeration and air-conditioning market are now described. New rules that were not in the previous EC Regulation are highlighted.

a) Supply and Use Controls for CFC[3] Refrigeration Systems

New controls on supply and use of CFCs will have immediate effect on the refrigeration and air-conditioning market. From 1st October 2000 there is a ban on supply of CFCs. From 1st January 2001 there will be a ban on the use of these refrigerants for the maintenance of existing equipment. The only exemption to this ban will be for certain existing military applications, where the ban does not come into force until the end of 2008.

These new controls will have a very significant impact on users that still have CFC refrigeration systems. With the exception of leak free domestic sized systems it will become impractical to operate CFC systems after the beginning of 2001. Owners of such systems must take immediate steps to prepare for CFC replacement.

b) HCFC Use Controls, New Equipment

The previous EC Regulation already had a number of end use controls that are repeated in the new EC Regulation. This means there is already a ban on the use of HCFCs in the manufacture of new equipment for the following applications:

- non-confined direct evaporation systems
- domestic refrigerators and freezers
- motor vehicle, tractor and off-road vehicle or trailer air conditioning systems[4]
- road public-transport air-conditioning
- rail transport air conditioning applications
- public and distribution cold stores and warehouses
- equipment of 150 kW and over shaft input

3 In this Guide, reference to CFCs includes Refrigerant 13B1, which is a Halon.
4 Except for military uses where the ban applies from 31 December 2008.

The new EC Regulation introduces further use controls. The use of HCFCs will be banned for the manufacture of new equipment in all refrigeration and air-conditioning applications from 1st January 2001 except for 2 temporary exemptions:

- the ban is delayed until 1st July 2002 for fixed air-conditioning equipment with a cooling capacity of less than 100 kW.
- the ban is delayed until 1st January 2004 for reversible air-conditioning/heat pump systems.

This is another significant new control. HCFC 22 is still a popular refrigerant in new equipment. Users will need to specify an alternative refrigerant in most new systems.

c) HCFC Use Controls, Existing Equipment

New controls are being introduced related to the use of HCFCs in the maintenance of refrigeration and air conditioning systems manufactured prior to the relevant manufacture ban. There will be a ban on the use of virgin HCFCs from 1st January 2010 and a ban on the use of all HCFCs, including recycled materials, from 1 January 2015.

d) Recovery & Destruction

With immediate effect, all ozone depleting substances used in refrigeration and air conditioning equipment must be recovered during servicing and maintenance of equipment or prior to dismantling or disposal of equipment. After 1st January 2001 recovered CFCs must be destroyed by an environmentally acceptable technology. Recovered HCFCs can either be destroyed or can be re-used until 2015.

This rule will apply to domestic refrigerators and freezers on disposal after 1st January 2002.

e) Leakage Prevention

The new EC Regulation strengthens requirements for the prevention of leakage of ozone depleting refrigerants from systems.

All precautionary measures practicable must be taken in order to prevent and minimise leakage.

An important new rule is that fixed equipment containing ozone depleting substances, which has a refrigerating fluid charge greater than 3 kg, must be checked annually for leakage.

To ensure that recovery and leakage issues are properly dealt with by refrigeration technicians the EC Regulation calls for each Member State to set a minimum qualification level for all personnel servicing and maintaining equipment and handling refrigerants. This must be done by the end of 2001.

The leakage prevention rules have been considerably strengthened. Refrigeration system owners and maintenance contractors will need to take significant steps to comply with the new rules.

f) Trade Controls

A number of controls on international trade outside the EU will influence the import and export of refrigeration and air-conditioning products that contain ozone depleting substances.

The import and placing on the market of refrigeration equipment containing CFC refrigerants is prohibited unless the equipment was manufactured before 30 September 2000.

Products and equipment containing HCFCs can be imported until the relevant use control dates described in Paragraph (b) above take effect. After those dates imports of products and equipment containing HCFCs are prohibited, unless the products were manufactured before the relevant use control date.

The export of refrigeration equipment containing CFCs is prohibited.

The HCFC use controls described in this booklet do not apply to the use of HCFCs for the production of products for export to States Party to the Montreal Protocol where the use of HCFCs is still permitted, until 31st December 2009. After that date the export of products and equipment containing HCFCs is prohibited.

Exports of HCFCs to any state not party to the Montreal Protocol shall be prohibited from 1 January 2004.

Which Refrigerants are affected?

a) CFCs (chlorofluorocarbons)

One of the most significant new rules in the EC Regulation relates to the immediate ban on the supply[5] of CFCs and the CFC use[6] ban that applies from 1st January 2001 for maintenance and servicing of refrigeration and air-conditioning equipment.

The commonly used CFC refrigerants that will be affected by these bans are:

CFC 11	CFC 12	CFC 502

All other CFCs are also affected. The only other CFCs likely to be found in refrigeration or air-conditioning systems are:

CFC 13	CFC 113	CFC 114
CFC 115	CFC 500	CFC 503

The CFC rules also apply to halons when used as refrigerants. This affects just one further refrigerant:

R 13B1

b) HCFCs (hydrochlorofluorocarbons)

Only two HCFCs are likely to be used in new refrigeration or air-conditioning systems. These are:

HCFC 22	HCFC 123

Several refrigerant blends containing HCFCs have been introduced as CFC alternatives. These blends will be subject to the same rules as pure HCFCs. The HCFC blends currently on the market include:

R401A	R401B	R402A	R402B
R403A	R403B	R406A	R408A
R409A	R409B	R411B	

5 In this booklet, the word 'supply' is used to describe the supplying or making available to third persons, against payment or free of charge, of controlled substances or products containing controlled substances covered by the EC Regulation 2037/2000. It is referred to as "placing on the market" in the EC Regulation.

6 Use is defined in EC Regulation 2037/2000 as the utilisation of controlled substances in the production or maintenance, in particular refilling, of products or equipment or in other processes except for feedstock and processing agents uses. Running an existing CFC appliance, without maintenance, would NOT qualify as use.

Applications of CFC and HCFC Refrigerants

Some of the typical applications of CFCs and HCFCs are described in this section. For CFCs emphasis is given to the applications that are most likely to still be using CFCs.

CFC 11 is mainly used in large chillers for air-conditioning or certain industrial applications. A reasonable number of CFC 11 chillers are still operating in the UK.

CFC 12 is used for a wide variety of refrigeration and air-conditioning applications. All domestic refrigerators and freezers built before 1994 used CFC 12. Many are still in use. Similarly CFC 12 is used for many other small hermetic systems such as retail display cases, icemakers etc. CFC 12 is used in many medium and large sized systems in commercial and industrial refrigeration.

CFC 502 is usually used in low temperature commercial and small industrial cooling installations (e.g. supermarket frozen food systems, small cold stores and small blast freezers). In the UK CFC 502 became scarce quite quickly after the 1995 phase out of CFC production, so it is believed that there are relatively few CFC 502 systems still in use.

Other CFCs listed on Page 7 are used for less common applications. CFC 13 and CFC 503 are used in very low temperature cascade systems (e.g. at below -70^{o}C). CFC 114 and CFC 500 are occasionally used in large water chillers. CFC 115 is rarely used by itself - it is one of the fluids used in the refrigerant mixture CFC 502.

HCFC 22 is a very commonly used refrigerant. It is widely used in commercial, industrial and air-conditioning systems. It is currently used in many applications that can not be manufactured using HCFCs after 1st January 2001. It is also the most likely refrigerant to be used in the air-conditioning and heat pump applications that can be manufactured for slightly longer with HCFCs (see Paragraph (b) on Page 4 of this booklet).

HCFC 123 is a relatively unusual refrigerant in the UK. It was introduced as an alternative for CFC 11 in large air-conditioning water chillers following CFC production phase out in 1995.

The various HCFC blends were introduced as alternatives to CFC 12 and CFC 502. The majority of usage of these blends has been in the conversion of existing CFC equipment. The HCFC blends have also been used in new systems, built after 1995, but it is now relatively unusual for HCFC blends to be used in new systems.

Refrigerant Names and Trade Names

The names used for refrigerants can often be confusing. In the description opposite of applications and the list on Page 7 a prefix CFC or HCFC has been used. This is helpful as it clarifies what type of refrigerant is being referred to. Unfortunately, the prefixes are often not used - they are replaced with a trade name or the prefix "R". Hence CFC 12 may also be R12 or Arcton© 12 or Forane© 12. The list below shows the most common trade names. Some of these are used for different refrigerant types (e.g. Forane© is used for CFCs, HCFCs and HFCs (hydrofluorocarbons)) whereas others are more descriptive (e.g. Klea© is only used for HFC refrigerants).

Arcton©	Care©	Freon©	Forane©	Genetron©
Greencool©	Isceon©	Klea©	Solkane©	Suva©

How should you respond to ODS Phase Out?

Establish Which Refrigerants You Are Using

The first step is to identify whether you are affected by the new EC Regulation. All refrigeration and air conditioning systems should have a label showing what type of refrigerant is being used. If you cannot identify the refrigerant ask your equipment supplier if he has a record. If necessary, you can ask a qualified refrigeration engineer to come and identify the refrigerant. This may require a sample to be taken for analysis.

If you are using a refrigerant listed on Page 7 you must ensure that you comply with the appropriate parts of the new EC Regulation. CFCs users must take immediate action. If you are using HCFC or HCFC blends in existing systems, then be aware that you will need to replace them in the future. Immediate steps must be taken to prevent or minimise leakage of both CFCs and HCFCs.

Identify Your Ownership Category

Your detailed response to the new EC Regulation will depend on the type of equipment you own. There are two key categories:

CATEGORY 1

Small self-contained units that are mass-produced in a factory using hermetically sealed compressors. For example, domestic fridges and freezers, small retail displays, "through the wall" air conditioners. Category 1 systems are usually leak free for the whole of their working life.

CATEGORY 2

Small, medium and large systems using more complex items of refrigeration equipment and usually requiring some on-site systems assembly and refrigerant filling. Category 2 systems are susceptible to refrigerant leakage and often require regular maintenance. Typical examples range from pub cellar coolers, small cold stores, remote condensing units in grocery shops and split system air conditioners to much larger plants such as supermarket central systems, industrial systems and water chillers.

Assess the Strategic Importance of Your Refrigeration Systems

Your response to CFC/HCFC phase out will depend on how critical refrigeration is to your business. For example, if a plant failure could halt production or sales, your phase out plans must take a very high priority. Conversely, if you own a small air conditioning system in an office, you may feel that you can afford to be without it for a while and therefore respond by replacing the unit as and when it fails.

Take Appropriate Action

If you own Category 1 equipment the following section explains the simple actions you should take. The remainder of this booklet gives more extensive advice for Category 2 owners.

Response for Category 1 users

If you only own Category 1 equipment then your response to CFC/HCFC phase out can be quite simple. Refrigeration systems in this category are very reliable and often run for up to 20 years without requiring maintenance. In these circumstances your actions should be to:

a) Continue running your existing plant until it reaches the end of its useful life.

b) Make an appropriate contingency plan in case the system breaks down and loses its charge of CFC/HCFC (see Page 12).

c) Plan how you can safely dispose of an old system without illegally venting refrigerant to the atmosphere (many local authorities have facilities for dealing with domestic sized systems).

The nature of an appropriate contingency plan will depend on the type of equipment you own and the strategic importance of your systems. You should contact your equipment supplier, refrigeration contractor or Trade Association to discuss what options are available. Some typical contingency plans will be:

- Ensuring you can quickly purchase a new system using an ozone-friendly refrigerant. For example, if you own a domestic refrigerator, it will be possible to buy a new one "off the shelf".
- Agreeing with a contractor that if you have a breakdown the system can be repaired and then topped up with the original type of refrigerant (only for HCFCs) or a retrofillable alternative. A number of HCFC or HFC blends can be used to retrofill CFC 12 and CFC 502 hermetic systems. Category 1 plants contain only a small amount of refrigerant, so the cost need not be excessive even if the price of HCFCs rises considerably.

Remember:
If you are using CFC-containing equipment they can be used until they require servicing.

BUT
They cannot be topped up with CFC refrigerant after 31 December 2000.

Response for Category 2 users

If you are a Category 2 user then a carefully structured approach should be adopted. There is a wide range of technical solutions that can be applied to achieve ozone depleting substance phase out. In some cases the best line of action is quite clear, but in most instances there are competing options that require assessment.

It is likely that the most cost-effective solution will involve a combination of several different activities such as purchase of new plant or conversion of some existing plant. This Guide describes a step by step approach to help you ensure that all relevant options are properly assessed.

It should be noted that the structured programme of activities is particularly important for those users who own a number of refrigeration systems. Owners of a single large plant will generally have fewer options to consider.

If you are in a large organisation it is important that senior level commitment is given to CFC/HCFC phase out and that someone is made responsible for undertaking the steps described below:

Step 1 - Equipment Identification

How many systems do you own?

What type of hardware is used?

What refrigerant is used?

How old is each plant?

Step 2 - Issues to Consider

Environmental issues
Ozone Depletion Potential & Global Warming Potential

Financial issues
Climate change levy & energy efficiency

Waste
Refrigerant & equipment disposal

Health & safety issues

Step 3 - The Alternative Approaches

Which technical options will prove most practical and have the lowest financial impact?

Step 4 - Implementation

Ensure that a structured implementation programme will meet phase out dates and minimise costs.

Step 1 – Equipment identification

Before assessing your technical options it is important to know the type of equipment and refrigerant that is used in each plant that you own, as this will have a direct impact on the choices available.

REFRIGERANT

Identify the type of refrigerant being used (see list of refrigerants affected by the EC Regulation on Page 7).

SIZE

It is important to note the size of each plant, as this may affect the technical option to be adopted. An appropriate measure of size is compressor motor power (kW or HP).
Examples are given in the table below:

Size	Rating	Examples
Very small	<0.25 kW	Domestic systems
Small	1 to 10 kW	Small retail systems or air conditioners
Medium	10 to 50 kW	Cold storage, food retail and air conditioning
Large	>50kW	Industrial applications, supermarket systems, large air-conditioning

COMPRESSOR HOUSING AND TYPE

The type of compressor used in a refrigeration system has a strong influence on conversion opportunities. The common varieties include reciprocating, screw and centrifugal. The motor/compressor housing is particularly important. Very small and small systems use "hermetic" compressors, which are housed in a welded metal shell. Conversion options for hermetics are slightly limited. Larger compressors are "semi-hermetic" (motor/compressor in a flanged casing) or "open" (separate motor and compressor). These are often easier to convert than hermetics.

AGE OF PLANT

Note the age and life expectancy of the plant as this will influence whether it is worthwhile converting the plant or replacing it with a new one.

MATERIALS COMPATIBILITY

Various materials used in a refrigeration system can affect conversion options. If you are considering conversion to a different refrigerant fluid, you must establish the types of lubricating oil, rubber seals and metals that are used. New fluids must be chemically compatible with these materials.

COOLING REQUIREMENT

It is also worth noting what type of load is being cooled (and at what temperature level) as this can have an impact on future options.

Step 2 – Issues to consider

The ozone depleting refrigerants affected by this EC Regulation are being phased out because of their impact on the global environment. When identifying a response to the EC Regulation it is important to consider a range of environmental, financial, safety and other practical issues to ensure that the response is cost effective and appropriate.

Ozone Depletion

Clearly a key issue is whether to select a response that involves an ozone depleting refrigerant. The most potent ozone depleting refrigerants - CFCs - cannot be used in any response. However, in some circumstances HCFCs can still be considered. From an environmental perspective HCFCs are best avoided. Nonetheless, for existing CFC systems an important option is to retrofill with an alternative refrigerant and in some situations the most practical retrofill will be with an HCFC blend. This may be a reasonable response for older equipment that will be replaced by 2010 but should be avoided if the plant is still likely to be operating after this date.

As far as new equipment is concerned use of HCFC refrigerants is a very limited option - from 1st January 2001 most new equipment cannot be built with ozone depleting refrigerants. However, there are

two short exemptions for new equipment: the ban on HCFCs is delayed until 1st July 2002 for fixed air-conditioning equipment with a cooling capacity of less than 100 kW and until 1st January 2004 for reversible air-conditioning/heat pump systems. These delays allow equipment manufacturers more time to develop alternative systems. Purchasers of new equipment are **strongly advised to use non-HCFC systems in these applications** if appropriate systems can be purchased.
Any new HCFC equipment purchased in the next 2-3 years is likely to still be operational in 2010, after which time use of virgin HCFCs for refrigeration system maintenance will be prohibited.

Global Warming

The other key environmental issue that must be considered is global warming (also referred to as climate change). There are two distinct aspects to global warming in respect of refrigeration and air-conditioning equipment. These are refrigerant selection and energy efficiency.

REFRIGERANT SELECTION

Hydrofluorocarbons (HFCs) are a family of refrigerants that have been specifically developed to provide alternatives to CFCs and HCFCs. They have many of the favourable characteristics of CFCs especially those of zero flammability and zero toxicity. However, HFCs are powerful greenhouse gases that are identified in the Kyoto Protocol (the international agreement to limit emissions of greenhouse gases). Purchasers of refrigeration systems should try to minimise emissions of global warming refrigerants. This can be done either by:

- minimising leakage of HFC refrigerants to the lowest practical level
- or by using low Global Warming Potential refrigerants such as ammonia or HCs (hydrocarbons)

ENERGY EFFICIENCY

The major part of greenhouse gas emissions from refrigeration and air-conditioning systems is related to the electricity used to operate them. Generation of electricity leads to CO_2 emissions from power stations. On average about 85% of greenhouse gas emissions from UK refrigeration systems relates to the energy related CO_2 and only 15% relates to emissions of high Global Warming Potential refrigerants.

Clearly it is essential that purchasers and operators of refrigeration systems consider all potential environmental impacts, including the energy efficiency of their equipment.

As well as helping the environment, improved energy efficiency may lead to considerable financial savings. The Climate Change Levy on business use of energy being introduced on April 1st 2001 will add to the importance of maximising energy efficiency.

Control of Emissions & Waste Disposal

Waste CFCs and HCFCs are already controlled by the waste management controls in the Waste Management Licensing Regulations 1994 and the Environmental Protection Act 1990. The relevant provisions are sections 33(1)(c) and 34 of the 1990 Act, which are designed to ensure that waste travels only along legitimate routes towards proper disposal or recycling without harm to the environment or health.

Section 33 prohibits the disposal and recovery of waste in a manner likely to cause pollution of the environment or harm to human health. The duty of care imposed under section 34 requires all producers and holders of waste (except householders) to take all reasonable steps to keep the waste safe and ensure it is treated lawfully. Anyone concerned with controlled waste must ensure it is managed properly, recovered or disposed of safely; and must only transfer it, with a description of the waste, to someone who is authorised to receive it. Those authorised to receive controlled waste are registered waste carriers or brokers, local authority waste collectors and waste operations with a waste management licence or registered exemption from licensing.

It is possible that some waste ODS may be "special waste" and so subject to more stringent disposal arrangements than most other wastes. Special rules also apply to their import and export. You should contact your local Environment Agency office for further information.

Under the new EC Regulation:

- all precautionary measures practicable must be taken to prevent and minimise leakages of HCFC and other ozone depleting refrigerant gases
- any fixed equipment with a refrigeration fluid charge greater than 3 kg must be checked annually for leakage

- minimum qualifications will be defined for people who handle refrigerants and ensure that they are disposed of in an environmentally responsible manner
- during servicing and maintenance of refrigeration and air-conditioning equipment any ozone depleting substance must be recovered for destruction, by an environmentally acceptable technology, or recycled or reclaimed (this will apply to domestic fridges and freezers from 1st January 2002)
- prior to dismantling or disposal of refrigeration, air-conditioning and heat pump equipment any ozone depleting substance must be recovered for destruction, by an environmentally acceptable technology, or recycled or reclaimed (this will apply to domestic fridges and freezers from 1st January 2002)

Health and Safety Issues

Although there are no specific regulations relating to the selection and use of refrigerants, these activities fall within the scope of more general Health & Safety legislation. The Management of Health and Safety at Work Regulations 1999 (Management Regs.) requires all risks at work to be assessed and prevented, or, where this is not reasonably practicable, adequately controlled. These risks could include the risk from handling the refrigerant and the risk from the use of a refrigeration system.

The choice of alternative refrigerants must take due account of the requirement to minimise fire risks and prevent or control operator exposure, including possible monitoring.

Step 3 – The alternative approaches

The best response to be adopted by owners of Category 2 equipment will depend on numerous site specific circumstances.

Broadly speaking there are three types of response for **existing equipment**, as follows:

a) Do nothing

This is not an option for owners of CFC equipment (except Category 1 systems - see Page 10).

For owners of HCFC systems this can be considered the "normal" response during the next few years. The new EC Regulation allows use of HCFCs for servicing existing equipment until 2010 for virgin HCFCs and 2015 for recycled HCFCs. Hence, there is no pressing need to convert or replace HCFC systems.

b) Keep existing equipment operational by retrofilling with an alternative refrigerant

This may be the most cost effective and practical option in many circumstances. It is likely to be relatively low cost and will cause least disruption to provision of cooling as retrofilling can usually be carried out relatively quickly.

However, retrofills may lead to reduced performance, either in terms of cooling capacity or energy efficiency. They give little flexibility of response e.g. if your current system is inefficient or oversized the retrofilled system will probably be no better. A retrofilled system may leak more than the original. If an existing system is old, inefficient, leaky or ill suited to its current task it may be more cost effective to consider plant replacement.

For CFC systems there may be a choice between HCFC or HFC blends for retrofilling. HFCs or other refrigerants with a zero Ozone Depletion Potential should be preferred whenever possible but HCFCs may be more practical in some circumstances (because of material and oil compatibility).

As stated in (a) above, there is no particular need to consider the retrofill of HCFC systems at this time.

c) Replace existing equipment with a new system

The most flexible response is to replace the old system. This allows you to carefully consider all aspects of refrigeration system selection to ensure you select a plant with minimum environmental impact and good energy efficiency.

If you are purchasing a new system it is strongly recommended that you carefully review the cooling load. Many refrigeration systems are unreliable and/or inefficient because they do not suit the cooling load. Do not assume that the cooling requirements are the same now as they were 20 years ago when the existing plant was installed!

Whenever you are considering **new equipment** (whether this is as response (c) above or simply because you have a new requirement for refrigeration or air-conditioning equipment), **do not forget the new rules regarding use of HCFCs**. For most applications you can no longer consider HCFC 22. As discussed on Page 15, you are advised to avoid HCFCs on those types of system temporarily exempt from the new equipment rule, if alternative options are available and cost effective.

What are the best alternatives to HCFC 22 in new systems? This is one of the most difficult considerations because some HCFC 22 alternatives are relatively new to the market. The main choices will be between HFC blends and hydrocarbons (for small and medium sized systems) and between HFC blends and ammonia (for larger systems). Currently the leading HFC blends being used to replace HCFC 22 are HFC 407C and HFC 410A. They both have some characteristics that make the move from HCFC 22 problematic for system designers (e.g. HFC 407C has a large "temperature glide" that makes it incompatible with some heat exchangers and HFC 410A operates at a considerably higher pressure than HCFC 22). These issues are being addressed and experience of using these fluids is growing quickly.

There are numerous refrigerants on the market that have been developed to address phase out of CFCs and HCFCs. Alternative refrigerants fall into 3 main groups:

- **HCFCs and HCFC blends –** these can provide a practical alternative to CFCs, although usage can only be transitional as HCFCs are ozone depleting and will be phased out in due course (1st January 2001 in most new equipment and 1st January 2010 for use of virgin HCFCs for maintenance). Most HCFC blends have been specifically developed to provide a low cost retrofill and are particularly useful in direct expansion (DX) CFC systems.
- **HFCs and HFC blends** – these can be used as alternatives for both CFCs and HCFCs. They have zero Ozone Depletion Potential. All pure HFCs and most HFC blends require use of synthetic lubricating oils in place of the more conventional mineral oils used for CFCs and HCFCs. This makes retrofill more expensive, but it is still a practical proposition in many situations. HFCs have a high Global Warming Potential (although lower than those of CFCs) and if they need to be used they must be used with care - every effort must be made to prevent/minimise leakage. However, the favourable properties of zero flammability and zero toxicity displayed by most HFCs makes them a popular alternative in both existing and new systems.
- **Ammonia and Hydrocarbons (HCs)** – these so-called "natural refrigerants" have excellent thermodynamic properties and can be used in certain systems. Ammonia can only be used in new equipment specifically designed for ammonia. It is highly toxic and slightly flammable. Hydrocarbons are highly flammable and should only be used in systems designed to cope with the flammability risk. As a general rule, hydrocarbons are viable alternatives in small systems (e.g. Category 1 systems as described on Page 10 and small Category 2 systems) and in larger systems remote from public access. HCs can only be used in existing systems if great care is taken to address safety issues. Ammonia is already a very popular refrigerant in the industrial sector where it is used in systems remote from public access. Materials incompatibility makes ammonia generally unsuitable for small vapour compression systems.

The table below summarises some of the popular refrigerant alternatives for replacement or retrofilling. Further information on these, such as the Ozone Depletion Potential and Global Warming Potential factors, is shown in Appendix A at the back of this Guide.

Popular Refrigerant Alternatives

Type of Alternative	Refrigerant Being Replaced			
	CFC 11	CFC 12	CFC 502	HCFC 22
HCFC Alternatives (retrofill or new)	123	401A 401B 409A 409B	402A 402B 403A 403B 408A 411B	N/A
HFC Alternatives (retrofill or new)	134a (new only)	134a 413A	404A 407A 407B 507	407C 417A 410A (new only) 134A (new only)
Other Alternatives (new plant only)	Ammonia	HCs Ammonia	HCs Ammonia	HCs Ammonia

Source: Refrigerant Manufacturers

Step 4 – Implementation

Before deciding on new refrigeration equipment to replace existing equipment you will need to consider the technical factors relevant to your operation:

- the feasibility of introducing new plant into your workplace,
- the cost implications for your company and
- the current and future environmental, health and safety legislation, controls and responsibilities.

Feasibility of Installing New Equipment

You need to identify and prioritise the technical factors that control the introduction of a refrigeration system. The refrigeration process should be viewed as a whole and the role of refrigeration examined, then your refrigeration needs (including both refrigerant gas and equipment) need to be appraised. Some suggested technical factors are listed, there may be others particular to your operation:

- environmental compatibility
- performance of the equipment
- health and safety issues
- trends in the rest of the industry
- flexibility of the system
- materials compatibility (corrosion, swelling etc.)
- fallback position (what is the likelihood that the refrigerant will need to be changed in the future and what is your strategy for this)
- maintenance/servicing - extent cost, availability of suitably trained technicians
- throughput of process, including cycle time
- availability (number of suppliers of equipment and refrigerant)
- future costs (energy cost, Climate Change Levy and waste disposal costs)
- ease of installation (availability of power, water, compressed air, nitrogen, steam etc.)

THE COST OF REFRIGERATION

When considering the best option, all costs throughout the plant lifetime should be considered. Historically, many refrigeration systems have been purchased with the main focus on first cost and little concern about on-going running costs. Key costs include:

- first cost i.e. capital and installation cost
- energy (including the new Climate Change Levy)
- maintenance & servicing (including consumables such as refrigerant, oil etc,)
- decommissioning costs

There are also indirect costs, which are much more difficult to quantify. Some factors affecting indirect cost are:

- product reliability
- disruption of existing process
- operator training (no alternative equipment can be installed without a period of learning)
- future costs connected with changes in environmental legislation

Useful information

Contacts

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Environment Agency office, telephone
0845 9333111

Literature

Environmental Protection Act 1990
HMSO Publications Centre
ISBN 0-10-544390-5

Environment Act 1995
HMSO Publications Centre
ISBN 0-10-542595-8

Management of Health & Safety at
Work Regulations
Approved Code of Practice 1999
ISBN 0717624889

Control of Substances Hazardous to
Health Approved Code of Practice (1999)
ISBN 0 717616703

Climate Change - The UK Programme
ISBN 0101491328
Available from HMSO Publications or
DETR on www.detr.gov.uk

Other New DTI / DETR Publications

GUIDANCE ON THE IMPACT
OF THE NEW EC REGULATION:

Overview of the New EC Regulation
URN 00/1153

Fire Fighting Applications
URN 00/1154

Solvent Applications including dry cleaning
URN 00/1155

The above booklets can be ordered from EC Logistics by Fax: 0870 150 2333, Tel: 0870 150 2500 or email your requests to: dtipubs@eclogistics.co.uk

References to the Regulation

The full text of the EC Regulation can be obtained from the DETR. Electronic versions can be obtained from the DTI web site http://www.dti.gov.uk/access/ozone.htm

Appendix A – Refrigerant Names

Trade Names	ASHRAE Number	Type of Fluid	ODP	GWP	Safety* Classification	Manufacturer	Old Refrigerant
Forane© 123	R123	HCFC	0.02	90	B1	Atofina	R11
Forane© 124	R124	HCFC	0.022	470	A1	Atofina	R114
Forane© 134a	R134a	HFC	0	1300	A1	Atofina	R12
Forane© 141b	R141b	HCFC	0.11	600	A2	Atofina	R11
Forane© 23	R23	HFC	0	11700	A1	Atofina	R13, R503
Forane© 407C	R407C	HFC	0	1526	A1/A1	Atofina	R22
Forane© 410A	R410A	HFC	0	1725	A1/A1	Atofina	R22
Forane© 507	R507	HFC	0	3300	A1	Atofina	R502
Forane© 508B	R508B	HFC	0	11700	A1	Atofina	R13, R503
Forane© FX10	R408A	HCFC	0.02	2649	A1/A1	Atofina	R502
Forane© FX56	R409A	HCFC	0.05	1288	A1/A1	Atofina	R12
Forane© FX57	R409B	HCFC	0.05	1273	A1/A1	Atofina	R500
Forane© FX70	R404A	HFC	0	3260	A1/A1	Atofina	R502
Forane© FX80	None	HFC	0	2360	N/A	Atofina	R13B1
Care© 10	R600A	HC	0	3	A3	Calor Gas	R12
Care© 30	None	HC	0	3	A3	Calor Gas	R12
Care© 40	R290	HC	0	3	A3	Calor Gas	R22, R502
Care© 45	R1270	HC	0	3	A3	Calor Gas	R22, R502
Care© 50	None	HC	0	3	A3	Calor Gas	R22, R502
Suva© 23	R23	HFC	0	11700	A1	Dupont	R13, R503
Suva© 123	R123	HCFC	0.02	90	B1	Dupont	R11
Suva© 124	R124	HCFC	0.022	470	A1	Dupont	R114
Suva© 125	R125	HFC	0	2800	A1	Dupont	R22
Suva© 134a	R134a	HFC	0	1300	A1	Dupont	R12
Suva© 407C	R407C	HFC	0	1526	A1/A1	Dupont	R22
Suva© 410A	R410A	HFC	0	1725	A1/A1	Dupont	R22
Suva© 95	R508B	HFC	0	11700	A1/A1	Dupont	R13, R503
Suva© 404A	R404A	HFC	0	3260	A1/A1	Dupont	R502
Suva© HP80	R402A	HCFC	0.02	2250	A1/A1	Dupont	R502
Suva© HP81	R402B	HCFC	0.03	1964	A1/A1	Dupont	R502
Suva©MP39	R401A	HCFC	0.04	973	A1/A1	Dupont	R12
Suva©MP52	R401C	HCFC	0.03	760	A1/A1	Dupont	R12
Suva©MP66	R401B	HCFC	0.04	1062	A1/A1	Dupont	R12

Trade Names	ASHRAE Number	Type of Fluid	ODP	GWP	Safety* Classification	Manufacturer	Old Refrigerant
Genetron© AZ-20	R410A	HFC	0	1725	A1/A1	Honeywell	R22
Genetron© AZ-50	R507	HFC	0	3300	A1	Honeywell	R502
Greencool© 411b	R411B	HCFC	0.05	1500	A1	Greencool	R502
Klea© 407A	R407A	HFC	0	1770	A1/A1	ICI Klea	R502
Klea© 407B	R407B	HFC	0	2285	A1/A1	ICI Klea	R502
Klea© 407C	R407C	HFC	0	1526	A1/A1	ICI Klea	R22
Klea© 407D	R407D	HFC	0	1428	A1/A1	ICI Klea	R12
Klea© 410A	R410A	HFC	0	1725	A1/A1	ICI Klea	R22
Isceon© 39TC	None	HFC	0	1940	A1/A1	Rhodia	R12
Isceon© 49	R413A	HFC	0	1774	A1/A1	Rhodia	R12
Isceon© 59	R417A	HFC	0	1968	A1/A1	Rhodia	R22
Isceon© 69L	R403B	HCFC	0.03	3570	A1/A1	Rhodia	R502
Isceon© 69S	R403A	HCFC	0.04	2525	A1/A1	Rhodia	R502
Isceon© 89	None	HFC	0	3038	A1/A1	Rhodia	R13B1
Solkane© 134a	R134a	HFC	0	1300	A1	Solvay	R12
Solkane© 404A	R404A	HFC	0	3260	A1/A1	Solvay	R502
Solkane© 407C	R407C	HFC	0	1526	A1/A1	Solvay	R22
Solkane© 409A	R409A	HCFC	0.05	1288	A1/A1	Solvay	R12
Solkane© 410A	R410A	HFC	0	1725	A1/A1	Solvay	R22
Solkane© 507	R507	HFC	0	3300	A1	Solvay	R502
Ethane	R170	HC	0	3	A3	Various	R13
Iso Pentane	R601A	HC	0	3	A3	Various	R11
Pentane	R601	HC	0	3	A3	Various	R11

Notes:
HCFC blends usually contain both HCFC and HFC components. Both HCFC and HFC blends might also contain other components (e.g. HCs or PFCs).
*Safety classification based on nomenclature in BS 4434:1995

Source for GWP values:
Intergovernmental panel on Climate Change (IPCC) "Revised 1996 IPCC guidelines for National Greenhouse Gas Inventories", IPCC/OECD/IEA 1997

Key:
ODP - Ozone Depleting Substances
GWP - Global Warming Potential

www.dti.gov.uk/access/ozone.htm

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