



**Institute of Refrigeration**

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## R22 Phase out - guidance for owners and users of refrigeration equipment

### 1. EU Regulation 2037/2000 on ozone depleting substances

The Ozone Regulation came into force in 2000 and it has already banned the use of ozone depleting HCFC refrigerants such as R22 in new systems. R22 remains a very common refrigerant in existing systems used by many air conditioning and process engineering users. The Regulation will ban the use of R22 as a “top-up” fluid for maintenance between 2010 (for virgin fluid) and 2015 (for recycled fluid). This is of crucial importance for many companies and means that all users of R22 and other HCFC systems need to consider alternative refrigerants or the purchase of new equipment.

You should also be aware of the **F-Gas Regulation** which is more recent, coming into force in July 2006. It relates to the use of HFC refrigerants such as R134a and R404A. It imposes various obligations on the operators of refrigeration plant using HFC refrigerants that apply from July 2007 to minimise potential leakage, but not restrict its use.

The Guide is aimed at users of equipment who are not refrigeration experts. A Glossary is included in Appendix I to explain acronyms and technical terms. You may find it useful to discuss the issues in this Guide with your refrigeration plant maintenance contractor.

### 2. Refrigerant Types

Type	Refrigerant Examples*			Comments
		Ozone	F-Gas	
HCFC	Pure fluids: <b>R22</b> , R123, R124, R141b, R142b	✓	✗	R22 is very common in air conditioning plant and food factories
HCFC Blends <u>with</u> HFCs	Blends: R401A, R401B, R401C, R402A, R402B, <b>R403A, R403B, R408A</b> , R411B	✓	✓	HCFC blends were introduced in mid-1990s to help with CFC phase out. Most HCFC blends <u>also contain HFCs</u> , so these refrigerants are affected by <u>both</u> Regulations.
HCFC Blends <u>with</u> <u>no</u> 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: <b>R134a</b> , R32, R125	✗	✓	HFCs have been used since 1995 as alternatives for CFCs and HCFCs
HFC Blends	Blends: <b>R404A, R407C, R410A</b> , 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	<b>Ammonia (R717)</b> , CO <sub>2</sub> (R744), Hydrocarbons (e.g. Propane)	✗	✗	Ammonia is quite common in the food industry and is not affected by these Regulations.
Trade Names	<i>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)</i>			

\* The more commonly used refrigerants are shown in bold

### 3. Other obligations of the Ozone Regulation

- a) The quantity of virgin HCFCs that can be sold in the EU is restricted. For example, in 2008 the amount available for sale will only be 25% of that available in 2001.
- b) Operators of HCFC refrigeration systems must take “all precautionary measures practicable” to prevent leakages. Any system containing more than 3 kg of HCFC refrigerant must be checked annually for leakage, by suitably qualified personnel. Any HCFC refrigerant removed from a system during maintenance or at end of life must be properly recovered for re-use, recycling or destruction.

### 4. Planning for the Phase Out of R22 and Other HCFC Refrigerants

Recommendations to users of R22 and Other HCFCs	
1.	<u>Start planning for HCFC Phase Out now.</u> This will ensure you have time to consider the most appropriate options and will enable you to minimise the cost implications. It will also give you time to properly budget for any investments required.
2.	Ensure you are complying with the leakage and recovery obligations (see (f) above). Most food industry plants contain more than 3kg, so you need to check for leaks.

It is important that R22 users begin to plan for the phase out of R22. There is little time available before the 2009 phase out date. It is dangerous to rely on the 2014 phase out date for recycled R22 because:

- The date might be brought forward by 2 or 3 years during the review process.
- There is no guarantee that sufficient supplies of recycled R22 will be available.

### 5. What are your options?

Option	Advantages	Disadvantages
1. <b>Replace whole plant</b>	<ul style="list-style-type: none"> <li>• New plant can be designed to have best energy efficiency.</li> <li>• New plant can meet your current and future cooling requirements and use the latest technology.</li> <li>• New plant will have 20 to 30 year life.</li> <li>• You can chose an alternative refrigerant such as ammonia, HCs or CO<sub>2</sub>.</li> </ul>	<ul style="list-style-type: none"> <li>• Most expensive option in terms of first cost.</li> <li>• Longest implementation time.</li> </ul>
2. <b>Modify plant to use a new refrigerant</b>	<ul style="list-style-type: none"> <li>• Fairly quick implementation.</li> <li>• Probably much lower capital cost than plant replacement.</li> </ul>	<ul style="list-style-type: none"> <li>• Efficiency might get worse.</li> <li>• Cooling capacity might fall</li> <li>• Not applicable to all plant designs.</li> <li>• Some risks of reliability problems.</li> <li>• Plant life not being extended.</li> </ul>
3. <b>Use existing plant with recycled HCFCs</b>	<ul style="list-style-type: none"> <li>• Easy zero capital cost option.</li> <li>• Avoids being an “early mover” – you can benefit from experience gained on other conversions.</li> <li>• New technology options could enter the market in next few years.</li> </ul>	<ul style="list-style-type: none"> <li>• Efficiency not being improved.</li> <li>• This Option only delays your response – Option 1 or 2 must be adopted by the end of 2014.</li> <li>• The 2014 date could be changed to an earlier phase out date.</li> <li>• There is no guarantee of recycled HCFCs being available at reasonable cost.</li> </ul>

The selection of the best option needs careful consideration and will be influenced by your company’s circumstances. In particular, if you are a company with lots of HCFC equipment at a number of sites then you can develop a corporate strategy that creates an appropriate mixture of all 3 options. As you begin to use Option 1 or 2 you can recover the old HCFC, have it reprocessed and create your own supplies to enable some use of Option 3.

## 6. The planning process

The following steps should be used in the planning process:

Step 1: Identify all equipment with HCFCs. An important step is to identify each individual system using HCFCs. Don't forget to check air-conditioning plants as well as process refrigeration and cold stores.

Step 2: Establish relevant information about each plant. For example:

- Quantity of refrigerant in the system.
- Historical records of amount of refrigerant used to top up the system (this gives an indication of leakage rates).
- Age of the system; estimate of original design life of the system.
- Cooling load details – e.g. size, temperature level and variability of each cooling load.
- Plant design details – e.g. compressor types and size, evaporator and condenser type, materials of construction (e.g. copper or steel pipes?), type of lubricating oil.
- Plant performance – is the plant efficient; does it meet your current and future cooling requirements?

Step 3: Evaluate Phase Out Options. For example:

**3.1 Age** – an old plant should be replaced, but a young plant might be suitable for modification to an alternative refrigerant. If a plant is already relatively old e.g. >15 years, then plant replacement is likely to be the best option.

**3.2 Performance** – if the plant is known to be inefficient, unreliable or unsuited to the current and future cooling loads then plant replacement is likely to be the best option.

**3.3 Plant design** – some plants are not well suited to refrigerant replacement. You should seek specialist advice.

**3.4 Plant already uses an HCFC Blend** – if the existing plant is using one of the HCFC blends shown in Table 1 (e.g. R403A) then it is likely that the plant has already been converted from a CFC such as R12 or R502. This is because the HCFC blends were specifically designed as CFC refrigerant replacement options – they were only occasionally used on new installations. If the plant has already been through one refrigerant replacement it is probably not practical to consider another!

**3.5 Avoiding HFCs** – many HCFC alternatives are based on HFC refrigerants, usually a blend. Some companies might wish to avoid making investments in HFC equipment as these come under the F-Gas Regulation. If you want to avoid HFCs by using refrigerants such as ammonia, HCs or CO<sub>2</sub> you will need to replace the existing plant.

## 7. Considering converting existing plant to use a new refrigerant?

First you must identify the options available to you. In almost all cases you will be evaluating the replacement of R22. You cannot convert to a completely different refrigerant like ammonia – the existing plant will be incompatible with this refrigerant. Your main options will be to use one of 3 categories of HFC refrigerant, i.e.:

- A pure HFC fluid such as R134a.
- An HFC blend that is often used in new systems, such as R407C or R404A.
- An HFC “Service blend” that has been specifically designed to be retrofilled into an existing R22 plant.

A significant issue is that most R22 systems operate with mineral lubricating oil, whilst many HFC refrigerants require polyol ester oil. It is time consuming and costly to change the oil in an existing system – the service blends are designed to avoid or minimise this problem.

Another important consideration is the difference between use of a pure fluid or a blend. Your existing R22 plant uses a pure fluid as the refrigerant. This means that evaporation and condensation take place at a constant temperature. Most HFC blends exhibit a characteristic called “temperature glide” – which means that evaporation and condensation takes place across a range of temperature instead of at constant temperature. For some plant designs a high temperature glide could cause problems and it would be inadvisable to replace the R22 with a new refrigerant blend with a high glide. In general this problem occurs on flooded and pumped circulation systems – which tend to be used on large plants such as blast freezers, cold stores and large liquid chillers. There is less of a problem with DX (direct expansion) systems – these can cope much better with a refrigerant with a temperature glide.

More details about the three main refrigerant conversion options are as follows:

1. Conversion using a pure HFC refrigerant. This is difficult because none of the pure HFCs have properties close enough to R22. The only realistic alternative is to use HFC R134a. This will require increasing the compressor capacity by about 30%. It may also require different lubricating oil and a number of non-metallic components to be changed (e.g. O-ring seals). To use R134a the plant will require significant modification, which will represent a large financial investment.

2. Conversion using an HFC blend that is often used in new systems. R407C is often used in new systems in place of R22, especially in direct expansion systems. It has properties that are quite similar to R22. It can also be used to convert an existing system. The use of R407C should require far less modifications than those described above for the use of R134a. However, it will be necessary to convert to a new type of oil and it may be necessary to change some seal materials. Other fluids that fall into this category include R404A and R507.

3. Conversion using an HFC "Service Blend". A number of refrigerants have been specifically developed to be easily retrofilled into existing R22 systems. As well as having similar thermodynamic properties they also are designed either to require no oil change or a single oil change. In many situations these blends can be used simply by removing the old refrigerant and refilling with the new one followed by a few simple adjustments to certain controls on the plant. In some situations some components may need replacing (e.g. seal materials). Special care must be taken with flooded systems because of the temperature glide exhibited by these blends. The main options available are Dupont Isceon Series (including MO29, MO59 and MO79) , Forane FX100, RS44 and RS52.

## **8. Considering moving to "Alternative" Refrigerants?**

Choosing the best option depends on the size of your cooling plant and the way in which refrigerant technology develops over the next few years.

1. Ammonia. If you have a *large plant* (e.g. a large cold store or freezing facility) then ammonia should be given careful consideration. Ammonia has been a popular refrigerant in the food and drink industry for many years, implying that it is already a cost effective option. In many situations it is possible to design a highly efficient ammonia plant. This will minimise your emissions of greenhouse gases. If you are replacing a relatively *small plant*, then ammonia can become a rather expensive option, because of the safety precautions required and HFCs would usually be more cost effective.

2. Carbon Dioxide. An interesting development in recent years has been the re-emergence of CO<sub>2</sub> as a refrigerant. This has been used successfully on a number of supermarkets, food processing and cold storage applications.

## **9. Sources of Further Information**

Air Conditioning and Refrigeration Industry Board

[www.acrib.org.uk](http://www.acrib.org.uk)

This is an umbrella body for the refrigeration industry, issues updates on key legislation.

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Institute of Refrigeration

[www.ior.org.uk](http://www.ior.org.uk)

Is the professional body for refrigeration and air conditioning engineers. We hold a list of consultants who can give expert advice and a number of technical and free non technical guides for users of refrigeration and air conditioning equipment produced for the Carbon Trust, for example on Procurement of new refrigeration plant and Choosing Contractors.

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British Refrigeration Association

[www.feta.co.uk](http://www.feta.co.uk)

Trade organisation for companies in the refrigeration and air conditioning industry.

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Department for Business, Enterprise and Regulatory Reform

Provides links to the ODS Regulation and Guidance

<http://www.berr.gov.uk/innovation/sustainability/ods/page29091.html>

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Department for the Environment, Food and Rural Affairs

Provides links to the F Gas Regulation and Guidance

<http://www.defra.gov.uk/environment/climatechange/uk/fgas/index.htm>

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