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Education and Culture DG
Lifelong Learning Programme

Guidance, Tools and Training for Refrigerant Containment

Refrigerant Emissions and Leakage Skills for Europe

Guide to good leak testing

Guidance Notes

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Training

E-learning: see training guide TMG and visit the website for further details

www.realskillseurope.eu

Guidance Notes and Software Tools are available as FREE downloads

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Guide to good leak testing

REAL SKILLS EUROPE (**R**efrigerant **E**missions **A**nd **L**eakage **Skills** for **Europe**) is a project that offers practical assistance to everyone involved in purchasing, designing, installing, servicing, maintaining and owning refrigeration, air conditioning or heat pump equipment, to help them reduce leaks. It is run by a team of 8 partner organisations in 7 EU countries*.

This Guidance Note is one of a series of publications developed by the project team (see front cover). Also available are a Carbon Emissions/ Cost Calculator and F-Gas Logging Tool and an e-learning training scheme for those who wish to develop a more detailed understanding of the topic and to develop specialist skills in refrigerant containment.

A leak of 1 kg of refrigerant can cause the same environmental damage as driving a van 16,000 km.

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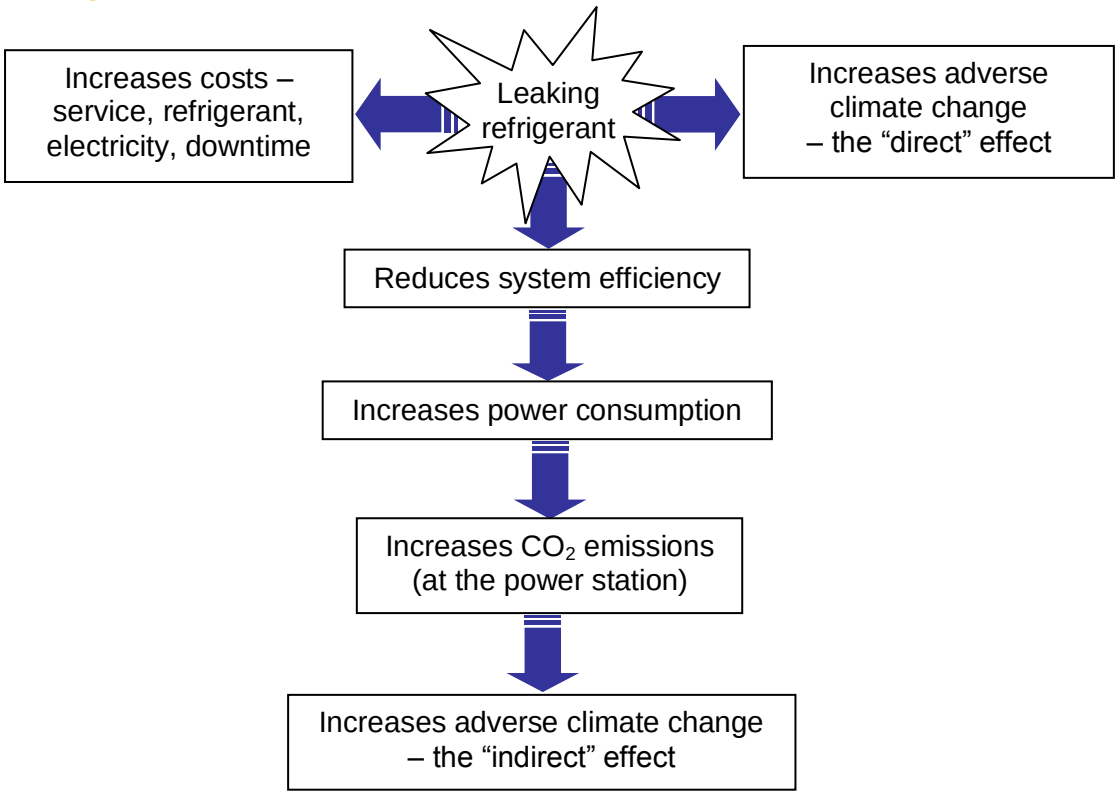
Guide to good leak testing

Commercial and industrial refrigeration, air conditioning and heat pump systems leak too much refrigerant into the atmosphere – leaks of up to 30% of the charge during a year are not uncommon. Leak rates do not have to be this high. Adherence to best practice in service, maintenance leak testing and repair can significantly reduce refrigerant losses. This guide shows you how.

In this guide, key points are highlighted and include this symbol:

Anything which is a legal requirement is in *italic text*.

1. Why leaks matter



There is a legal obligation to reduce leaks and YOU are a key part of this

Under the European Fluorinated Gas (F Gas) Regulations and Ozone Depleting Substances (ODS) Regulations, we have to take measures to reduce leakage. These include:

- *Leak testing systems once every 12 months if the charge is 3kg or more (or 6kg for hermetic systems), once every 6 months for systems with more than 30 kg charge and once in every 3 months for systems with more than 300 kg charge.*
- *Logging refrigerant usage and leak tests / repairs.*
- *Being qualified to handle refrigerant.*

There is more detailed information on legal requirements throughout this guide.

It is illegal to top up a system with refrigerant without first finding and repairing the leak(s).

2. Leak testing

The table below lists the three most effective methods for finding refrigerant leaks:

Method	Effectiveness	Compliance
Leak detection spray / soapy water	Good for pinpointing leaks.	*Allowed under the F Gas Regulations.*
Electronic leak detector	Good for most leaks if the detector is used and maintained correctly (see Section 3 below). Make sure your detector is sensitive to the refrigerant type you are testing.	*Allowed under the F Gas Regulations* – the leak detector must have a sensitivity of 5 g/year and should be checked annually.
Fluorescent additive (injected into the system with oil and detected using an ultra violet lamp)	Can be an effective maintenance tool for quick leak testing. Can be messy. The additive must be cleaned off after a leak. Coalescent oil separators remove the additive so it does not circulate in the pipe work and components between the oil separator discharge and compressor suction.	*Allowed under the F Gas Regulations* if approved by the equipment manufacturer – the use of the additive voids warranty on some compressors.

Note: The ODS Regulations do not define leak test methods but the methods in this table and following sections can also be used to detect HCFC refrigerant leaks.

3. Getting the best out of your electronic leak detector

Electronic leak detectors are test instruments which need to be looked after, checked and maintained to ensure accuracy. Under the F Gas regulation it should be checked once a year. This is a minimum requirement – for optimum reliability they should be checked more frequently e.g. after 25 hours use (or according to the manufacturer's other guidance).

Avoid contaminating the detector with oil, and replace the filter (where fitted) regularly.

The two types of leak detector most commonly used, rely on different methods of detection:

- Heated diode detectors – the diode needs changing usually after 100 hours use. The photo shows a typical heated diode.

- Infra red (IR) detectors – the IR sensor needs changing less frequently.

Use a *reference leak* to check your detector is working correctly – just opening a cylinder or a connection on the system to check your detector is not accurate enough. The photo shows a simple calibrated reference leak that fits onto the cylinder valve. When the valve is opened the flow through the device is approximately 5 g / year. If your leak detector does not pick this up it needs servicing.

4. Pressure testing to find leaks

If you cannot find a leak using any of the methods above, you should recover the charge and pressurise with dry (oxygen free) nitrogen. A full procedure is available from the IOR (SES Good Practice Guide 24 – Pressurising installed systems with nitrogen to find leaks). The important points to remember when carrying out a tightness test are:

- A pressure of up to 10 bar g (150 psig) is usually sufficient to find leaks using a soap solution.
- Make sure your regulator is in good condition and does not have an output pressure significantly higher than you need (e.g. 10 bar g).
- Do not use a manifold with a sight glass to pressure test through. The photo shows a regulator, three-way gate valve and braded steel hose assembly which will minimise the hazard of using a high pressure gas.
- Ensure the regulator is closed (wound out, fully counter clockwise) when you fit it to the nitrogen cylinder – open it slowly when all the connections to the system are tight and the access valves are open.
- Make sure the cylinder is secure.

A trace of hydrogen (5% max. for safety reasons) or helium (10-30%) with the nitrogen will enable leaks to be found at a lower pressure. A suitable electronic detector must be used – your standard detector is not sensitive to hydrogen or helium. Nitrogen can be supplied with a trace of hydrogen (as shown in the photo) or helium specifically for leak testing.

5. Leak test procedure

Don't forget the following important points when leak testing:

- Review the F Gas log (see section 10) to check where leaks have been found previously.
- Choose the most appropriate method, for example - a quick sweep with an electronic leak detector followed by a leak detection fluid (soapy water) to pinpoint the leaks.
- Be methodical and take your time.
- Check the whole system, including
  - Fusible plugs and pressure relief valves and their vent lines
  - Couplers (e.g. for pressure switches and gauges)
  - Inside pressure switches (as in the photo) – beware live electrical connections
  - Service valve stem glands (and then cap them)
  - Schrader valves (tighten if necessary then cap them). Ensure the cap O-ring is in good condition (as in the photo) and the cap is tight
  - All flanges and joints
- If the suction pressure is low (e.g. below 1 bar g, 15 psig), it is better to increase the pressure to find leaks:
  - Simple condensing unit systems - switch them off (do not pump down)
  - Central plant – switch off as a last resort.

The first leak you find is usually not the only leak – check the whole system

Leak test frequency is covered by the Fluorinated Gas (F Gas) and Ozone Depleting Substances (ODS) Regulations:

- *Systems containing between 3 and 30 kg of HFC or HCFC refrigerant (or between 6 and 30kg for hermetic systems*) must be leak tested every 12 months;*
- *Systems containing more than 30 kg of HFC or HCFC refrigerant must be leak tested every 6 months*
- *Systems containing over 300 kg of HFC refrigerant must have permanent fixed leak detection.*
- *Systems containing over 300kg of HCFC refrigerant must be leak tested every 3 months*

If a leak is found it must be fixed as soon as possible (within 14 days maximum for systems containing HCFC refrigerants) and the system re-tested at the point of repair within one month.

* 'hermetically sealed system' means 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 (EC 842/2006 Article 2 Para. 11).

Know where leaks are likely to occur.
See REAL Skills Europe "Illustrated guide to 13 common leaks"

6. Reducing leakage

Many factors affect leakage:

- System design and the components used
- The type of joint and the quality of brazing
- How pipes are routed, supported and clipped
- Vibration elimination
- The quality of pressure testing during commissioning
- Standard of service and maintenance

You have the opportunity to reduce leakage when you are servicing or maintaining systems. Conversely, poor service and maintenance will increase the risk of leakage occurring. See the REAL Skills Europe Guide GN4 (Leakage Matters – the service and maintenance contractor's responsibilities) for more information.

Ensure ALL valves are capped.
Uncapped valves are a very common source of leakage.

To reduce leakage you should also:

- Check that pipes are not vibrating excessively and are not chafing - correct if necessary.
- Check pipe clips are adequate and in good condition - replace if necessary.
- When tightening flanges, tighten the bolts evenly and to the correct torque.
- When tightening flare nuts, use a torque wrench to achieve the correct torque:
  - ¼" (6.35mm) pipe, tighten to 14 to 18 Nm
  - 3/8" (9.52mm) pipe, tighten to 34 to 43 Nm
  - ½" (12.7mm) pipe, tighten to 49 to 61 Nm
  - 5/8" (15.9mm) pipe, tighten to 68 to 82 Nm.

- When replacing flared components, used flare solder adaptors rather than manually made flares. The photos show a standard flare solder adaptor and one specifically designed for expansion valves with a flare inlet.
- Do not leave line tap valves on systems (one cabinet manufacturer has found that 40% of line tap valves left on systems leak). Use the line tap to access the system to diagnose problem. If the system is short of refrigerant decant the remainder of the charge and replace the line tap with a Schrader before re processing the system.

For more information, see REAL Skills Europe Guide GN2 (Illustrated guide to 13 common leaks).

7. Refrigerant charging

The amount of refrigerant charge is important:

- Undercharged systems are less efficient, have higher running costs and might not be able to meet the load.
- Overcharged systems have greater potential leakage. In extreme cases, over charging will increase head pressure and reduce performance and efficiency. At higher ambient temperatures it may cause the system to cut out altogether.

Charging to a known weight is the most accurate method of achieving the correct charge - use this when possible, especially on systems without a receiver.

If you are charging to a full liquid line sight glass, ensure there is a load on the system, otherwise you may not charge enough refrigerant to meet a high load. Be aware that bubbling in the sight glass can also indicate that the liquid line filter drier is blocked or the condenser is significantly undersized or blocked.

Charging to a pressure or frost line are not accurate methods of achieving the correct charge amount.

8. Records

Under the F Gas and ODS Regulations, a record must be kept for any system containing more than 3kg of HFC or HCFC (more than 6kg for hermetically sealed systems). The log should include:

- *Total Refrigerant Charge (not mandatory under the ODS Regulations)*
- *Refrigerant additions to the system*
- *Refrigerant removals from the system*
- *Leak tests*
- *Follow up actions*
- *Testing of automatic leak test systems where fitted*
- *(For systems using recycled or reclaimed HCFCs for service or maintenance): records of the undertakings that supplied the reclaimed gases and the sources of recycled gases**

This record can be a very useful source of information about leak points so that future leaks can be avoided. An example log sheet is included in section 10. There is a refrigerant logging spreadsheet tool at www.realskillseurope.eu which enables you to record refrigerant additions and removals, leak tests and repairs. It also provides a summary of the refrigerant usage (as a percentage of system charge) per system and its carbon equivalent.

9. Labelling

Equipment containing HFC and HCFC refrigerants must be labelled in accordance with the requirements of the F Gas and ODS Regulations. More information is provided in GN3 (Designing out leaks: design standards and practices).

*From 1 January 2010 only recycled or reclaimed HCFCs may be used to service and maintain RAC systems and from 1 January 2015 it will be illegal to use any HCFC to service RAC equipment (the use of virgin HCFC was banned after 31 December.2009).

10. EXAMPLE LOG SHEET FOR REFRIGERANT AND SYSTEM RECORDS			
General information			
Plant name			Reference no.
Location of plant			
Plant operator (name, address, telephone)			
Operator contact			
Cooling loads served			
Refrigerant type		Refrigerant quantity (kg)	
Plant manufacturer		Year of installation	
Refrigerant additions			
Date	Technician/company	Amount added, kg	Reason for addition
Refrigerant removals			
Date	Technician/company	Amount removed, kg	Reason for removal. What was done with recovered refrigerant?
Leak tests			
Date	Technician/company	Test result (including location and cause of any leaks identified)	Follow-up actions required
Follow-up actions			
Date	Technician/company	Related to test on	Actions taken
Testing of automatic leak detection system (if fitted)			
Date	Technician/company	Test result	Comments

11. Refrigerant Handling Qualifications and Certification

Commission Regulation EC 303/2008 establishes minimum requirements and the conditions for mutual recognition for the certification of companies and personnel as regards stationary refrigeration, air conditioning and heat pump equipment containing certain fluorinated greenhouse gases.

From 4 July 2011 all companies and individuals handling HFCs must be certified under Regulation EC 303/2008 (full certification)
(UK approved individual certification: City and Guilds 2079-11 to -14 or CITB J11 to J14 - for more information see http://www.acrib.org.uk/).

12. Useful Information

List of common HCFCs and HFCs

Type	Refrigerant examples (the most common refrigerants are in **bold** type)	EU Regulation	
		Ozone	F Gas
HCFC	**R22**, R123, R124, R141b, R142b	✓	✗
HCFC Blends	R401A, R401B, R401C, R402A, R402B, **R403A, R403B**, R406A, **R408A**, R409B, R411B	✓	✓
HFC	**R134a**, R32, R125	✗	✓
HFC Blends	**R404A, R407C, R410A**, R413A, R416A, R417A, R422D, R423A, R507, R508, FX100, RS44, RS45, RS52	✗	✓
Other/ Natural Refrigerants	**Ammonia (R717)**, CO_2 (R744), hydrocarbons (e.g. propane)	✗	✗

EC Regulations

- EC Regulation 842/2006 on certain fluorinated greenhouse gases. Referred to as the Fluorinated Gases (F Gas) Regulations which aim to reduce emissions of HFCs, PFCs and SF6 and whose key obligations came into force in July 2007.
- EC Regulation 1005/2009 (replacing 2037/2000) on substances that deplete the ozone layer. Referred to as the Ozone Depleting Substances (ODS) Regulations which phase out and control uses of ozone depleting substances and has been in force since 2000. HCFCs are the main type of substance still to be phased out under this Regulation.

UK F Gas support – for more detailed information about the practical application of the Regulations (downloadable information sheets and UK interpretation), visit http://www.defra.gov.uk/environment/quality/air/fgas/

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