

Department for Environment, Food and Rural Affairs

## General Guidance

### Guidance: F Gas and Ozone Regulations

#### Information Sheet GEN 5: Refrigerant Quantity

April 2012

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# 1 How much refrigerant is in the system?

If you have established that you are using an HFC refrigerant in a refrigeration system, the next step is to find out how much refrigerant is in the system. The key thresholds specified in the Regulation are as follows:

- All systems with less than 3 kg of HFC refrigerant are not covered by the obligation to carry out regular leakage checks and to keep records.
- Hermetically sealed systems with between 3 kg and 6 kg of HFC refrigerant are exempt from the obligation to carry out regular leakage checks. Examples of hermetically sealed systems include domestic refrigerators and small self-contained commercial systems such as bottle coolers, display cabinets and ice makers. Any system requiring on-site fabrication of refrigerant pipework is unlikely to fall in the hermetic category (even if it has a hermetic compressor).
- There are further thresholds at 30 kg and 300 kg which are used to define the regularity of leak testing required and the requirements for automatic leak detection. This is described in more detail in Information Sheet RAC 6 – Practical Guidance.

## 2 Doing it the easy way!

The easiest way to establish the amount of refrigerant in the system is to use data supplied by the manufacturer:

- Many refrigeration systems, especially small ones, have a Name Plate showing the amount of refrigerant.
- Alternatively, you may have a record of the amount of refrigerant in the documentation supplied when the system was installed.

On a Name Plate there will be a refrigerant name (which will enable you to establish whether the refrigerant is an HFC, using the lists in Information Sheet GEN 2) and also a refrigerant charge, shown in grams or kilograms. The name plate shown in Figure 1 shows the type of data you are likely to find. Half way down the right side of the label (inside the oval) it shows the refrigerant used is HFC (R134a) and the quantity is 0.05 kg.

Figure 1 Example Name Plate



Refrigerant name and quantity

### 3 Some Useful Rules of Thumb

In the absence of manufacturer's data you will need to make an estimate of the refrigerant quantity. There are five simple rules of thumb that can help:

**Rule 1: Small hermetically sealed systems fitted with a "domestic" 240 Volt 13 Amp plug will be well below the 6 kg limit.** This is a very important rule as it applies to millions of small systems. All domestic refrigerators and freezers fall into this category. So do many systems used in small shops (e.g. ice cream display cabinets, bottle coolers, small chilled or frozen food cabinets etc) in pubs / restaurants (e.g. "in-line" drink coolers, ice makers etc.), in offices (e.g. vending machines) and in other types of building.

**Rule 2: Most "split systems" will be above the 3 kg limit.** A split system is one with at least 2 major components located in different locations, connected by refrigerant pipework that is fitted by an installation contractor. For example, an air-conditioning system with a cooling unit inside a room and a "condensing unit" (consisting of various components including a compressor and a condenser) that is located remotely, usually outside the building. The components are interconnected by 2 refrigerant pipes, often made of copper. One or both of the pipes will be covered in insulation. Split systems are used for many refrigeration applications (e.g. cold stores, larger retail systems for supermarkets and large shops, industrial applications and air-conditioning in many types of building). The majority of split systems will use at least 3 kg of refrigerant.

**Exceptions to Rule 2:** Very small split systems that are "close coupled" e.g. an air-conditioning system serving a small room where the indoor and outdoor units are less than 5 metres apart could be below 3 kg. If a small split system is operated via a 240 Volt 13 Amp plug (see Rule 1), then it is more likely that the system has less than 3 kg – but only if the indoor and outdoor units are close coupled.

**Rule 3: Most air-conditioning water chillers will be above the 3 kg limit.** Water chillers for air-conditioning are factory built units where the components are located together in a fairly compact layout. They usually provide quite a large cooling duty and will be well over the 3 kg limit.

**Exceptions to Rule 3:** Very small water chillers, e.g. with a cooling duty below 15 kW might be below the 3 kg limit. Also, small units could be hermetically sealed, in which case the 6 kg threshold applies – a hermetically sealed water chiller providing less than 30 kW cooling might be below the 6 kg limit.

**Rule 4: A crude approximation is that the compressor motor kW equals the kg of refrigerant.** For example, a system with a 5 kW compressor motor might contain about 5 kg. This is only an approximation – the actual refrigerant charge depends on many different factors. However, it can be a useful screening test – e.g. a system with a 1 kW compressor motor is less likely to be above the 3 kg limit.

**Rule 5: Any system with a liquid storage vessel will contain more than 3 kg.** Some systems are fitted with a “high pressure liquid receiver” which is located under the condenser. They are usually quite large cylindrical vessels containing well over 3 kg. Other types of storage vessel are also used in other locations e.g. an evaporator surge drum or an intercooler for a 2-stage plant. Again these will almost always contain well over 3 kg.

## 4 Doing a proper estimate of refrigerant charge

To more accurately estimate the amount of refrigerant in a system you need to collect data about key components in the system and build a “refrigerant inventory”. BIS/Defra have developed a spreadsheet tool that can be used to help with this process.

Refrigerant in a system is either in the form of liquid or vapour. The liquid is about 50 times denser than the vapour – so to estimate the refrigerant charge we need to find out how much liquid is in the system (the extra for vapour will only add 1 or 2% to the total). The refrigerant liquid can be found in the following places:

- In the evaporator – the heat exchanger providing the cooling.
- In the condenser – the heat exchanger where heat is rejected.
- In the liquid line – the pipe connecting the condenser to the expansion valve.
- In any storage vessels – e.g. a liquid receiver under the condenser or a surge drum linked to the evaporator.

In the compressor – a small amount of liquid is often dissolved in the compressor lubricating oil.

Figure 2 shows a very simple refrigeration system without any storage vessels. The red shading shows where liquid is located.

Figure 3 shows a slightly more complex system with a high pressure liquid receiver.

Figure 4 shows a complex industrial plant with multiple heat exchangers, a high pressure liquid receivers and a low pressure surge drum.

The amount of liquid in the liquid line and in storage vessels is specific to the actual layout of pipework and the size of vessels installed. The only way of establishing the refrigerant charge is to do calculations based on pipe and vessel dimensions.

The amount of liquid in the evaporators and condensers depends on the type of heat exchanger used and the size of the cooling load.

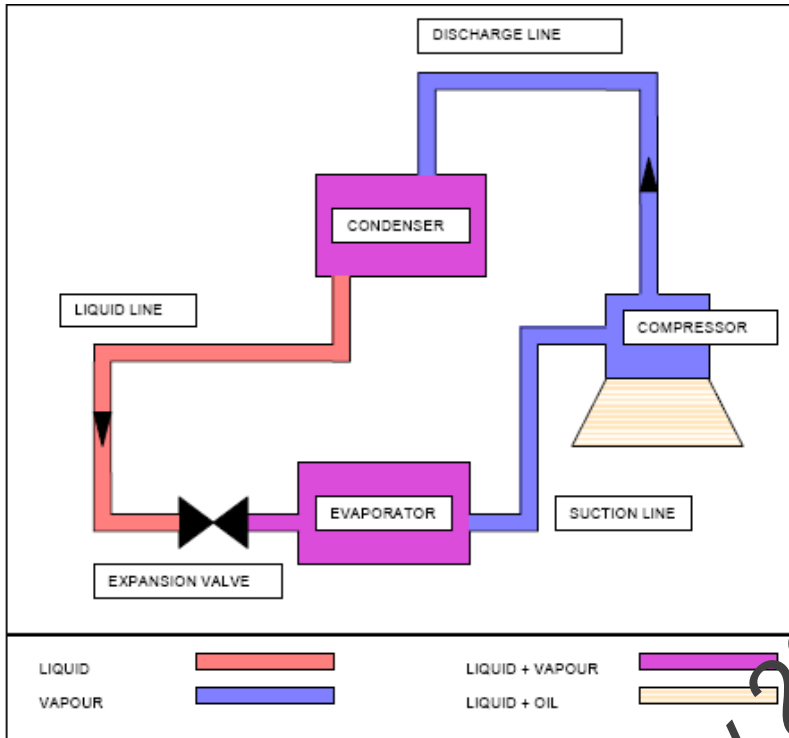
## 5 Using the Refrigerant Charge Calculator Spreadsheet

Research with equipment suppliers has identified the amount of refrigerant used in different components – these have been used to develop the Refrigerant Charge Calculator spreadsheet.

To use the spreadsheet tool you will need to enable the macros and you must supply the following information:

- The type of evaporators (e.g. finned air cooler) and condensers (e.g. evaporative).
- The length and diameter of the main liquid line.
- The dimensions of liquid storage vessels.
- The type of compressors (e.g. reciprocating).
- The overall system size (either in terms of cooling duty or compressor power) and the cooling temperature level.
- The type of refrigerant used.
- The spreadsheet then calculates an estimate of the refrigerant charge for a system. The outputs include:
  - The total charge of the system, in kg.
  - The amount of F gas in the system, in kg. Note, in many cases this will be equal to the total charge, but some refrigerant blends include components that are not F gases. This could affect your assessment of size threshold e.g. a plant with a total charge of 5 kg of R403B only contains about 2 kg of F gases, which is below the important 3 kg threshold.
- A summary of the obligations that apply from the EU F gas and Ozone Regulations.

**Figure 2 Simple Refrigeration System**



**Figure 3 Simple Refrigeration System with HP Liquid Receiver**

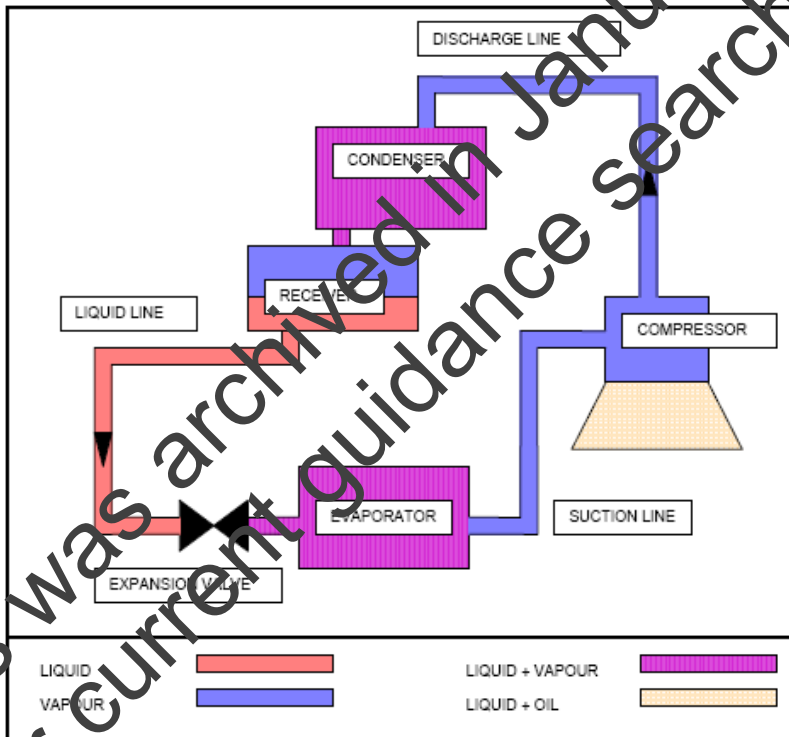
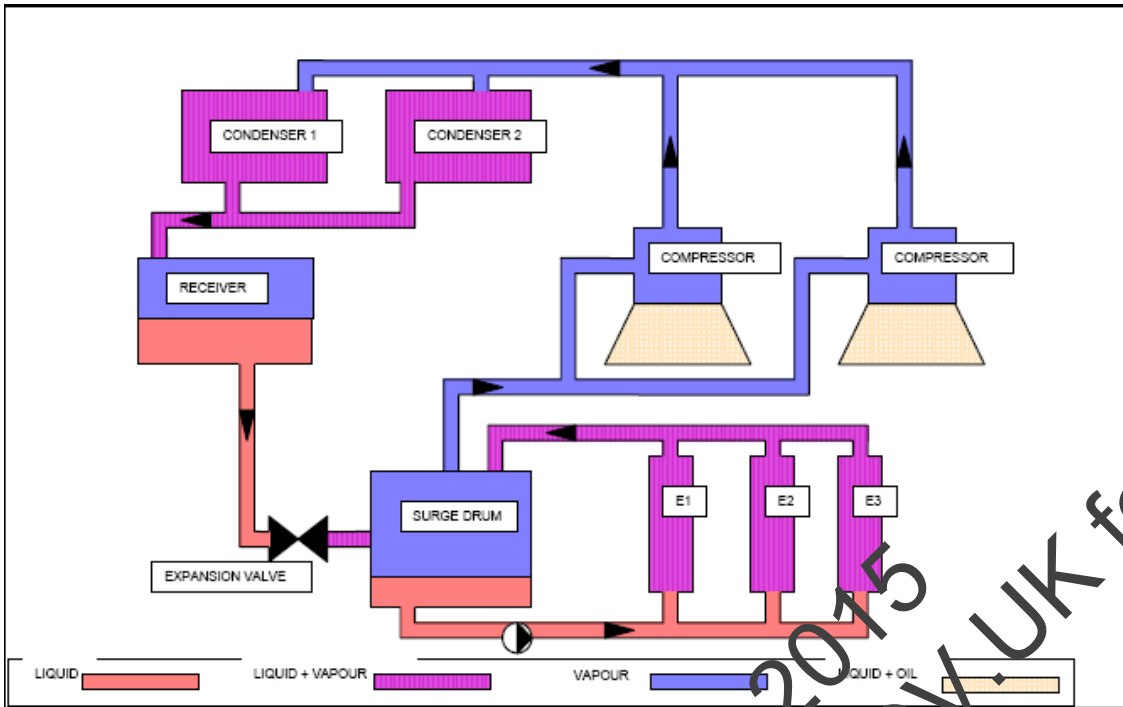


Figure 4 Complex Industrial Plant



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