



Refrigerant 22 (R22)

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Supplement

Mexichem Fluor Chemical Safety Data Sheet for ARCTON 22. Issue 1:04/10.

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1. About this Publication

These instructions have been prepared according to the following standards:

BS 4884: Technical Manuals:

Part 1: 1992 Specification for Presentation of Essential

Information.

Part 2: 1993 Guide to Content.
Part 3: 1993 Guide to Presentation.

BS 4899: User's Requirements for Technical Manuals:

Part 1: 1991 Content. Part 2: 1992 Presentation.

BS 4899 is based on the principles of BS 4884.

BS 5378 : Part 2 : 1982 Safety Signs.

1.1. Safety Warnings and Symbols

The system of safety warnings and symbols is based on BS 5378: Part 2: 1982 Safety Signs and BS 4884: Technical Manuals: Part 1: 1992 Specification for Presentation of Essential Information.

A WARNING

This denotes an immediate hazard with a high likelihood of personal injury or death if instructions, including recommended precautions, are not followed. There is also a potential risk of damage to the product, process or its surroundings.

A CAUTION

This draws attention to instructions which must be complied with to avoid damage to the product, process or its surroundings.

NOTE: draws attention to important additional information.

1.2. Units of Measurement

Quantities are expressed in SI units or SI derived units.

1.3. Terminology

Terminology, abbreviations and acronyms are those currently in use throughout the refrigeration and air conditioning industry.

1.4. Ordering Extra Copies

Extra copies of these instructions can be obtained from J & E Hall International. For contact details go to www.jehall.com.

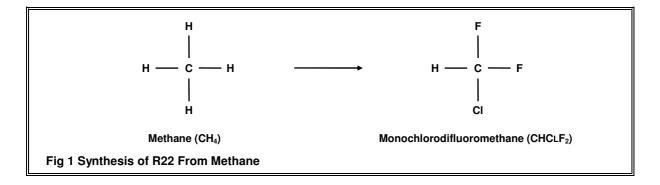
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2. Introduction

The refrigeration system to which these instructions refer is charged with refrigerant 22 (R22), one of a group of compounds collectively known as halocarbons (halogenated hydrocarbons, commonly referred to as hydrochlorofluorocarbons (HCFCs).

R22 is synthesized from methane by replacing three of the hydrogen atoms in the methane (CH_4) molecule with two fluorine and one chlorine atom, producing monochlorodifluoromethane ($CHCIF_2$), refer to Fig 1. For a full list of properties refer to 19. Properties of R22.



R22 is marketed under several different trade names:

- ARCTON 22 by INEOS Fluor.
- FREON 22 by Du Pont Chemicals.
- ISCEON 22 by Rhone-Poulenc Chemicals.

2.1. Physical Characteristics

R22 is non-flammable, non-explosive, non-corrosive, stable, and although it does not support life, is virtually a non-toxic compound. If there is leakage, it has practically no effect on foodstuffs or other materials which would normally be exposed in a refrigerated or air conditioned environment. However, for the reasons discussed in 2.2, R22 must never be deliberately allowed to escape into the atmosphere and every precaution must be taken to keep accidental leakage to a minimum; refer to 8. Leak Prevention.

2.2. Hazard to Health

R22 can, under certain conditions, create hazardous concentrations in enclosed spaces; refer to 14. General Safety Considerations. For this reason it is very important that exposure levels in the workplace are kept to a practicable minimum and certainly within the recognised threshold limit value of 1,000 parts per million (ppm) based on an 8 hour day, 40 hour week.

While HCFC refrigerants such as R22 have a much lower ozone depletion potential compared with chlorofluorocarbon (CFC) refrigerants, this is still significant compared with the zero ozone depletion potential of HFC refrigerants. HCFC refrigerants also contribute towards global warming and are classed as fluorinated greenhouse gases covered by the Kyoto Protocol.

Under no circumstances should refrigerant be deliberately vented to atmosphere, within the European Community it is illegal to do so; refer to 11. Recovering Refrigerant Charge.

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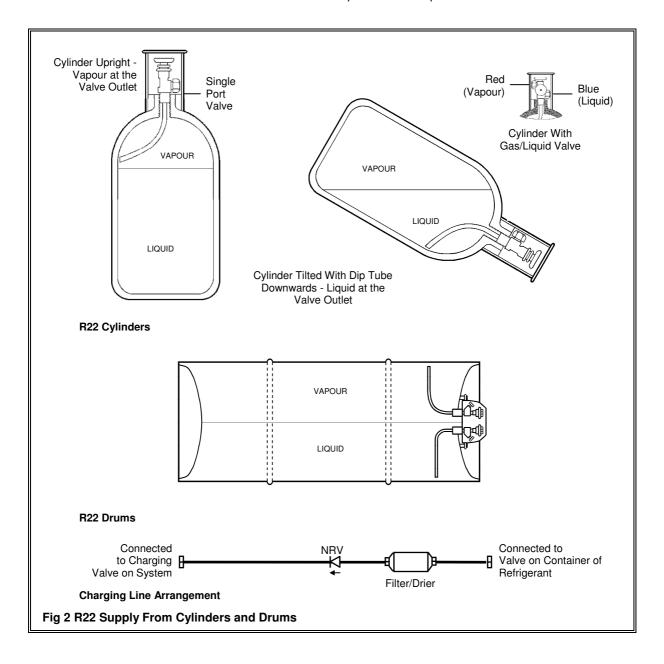


3. R22 Containers: Supply From Cylinders and Drums

Cylinders of R22 are usually fitted with either a 'single port' valve, or a 'gas/liquid' valve with two ports: one coloured red and labelled 'vapour' and one coloured blue and labelled 'liquid'.

If the single port valve is fitted, with the cylinder in the upright position (valve at the top) refrigerant vapour will be available at the valve. To obtain liquid refrigerant the cylinder must be inverted. If the gas/liquid type valve is fitted, with the cylinder in the upright position vapour will be obtained at the red 'vapour' outlet and liquid at the blue 'liquid' outlet from an internal dip pipe.

Drums of R22 are usually fitted with two 'single port' valves located at one end of the drum. These valves are fitted with dip pipes so that with the drum horizontal and the valves on the vertical axis refrigerant vapour can be drawn from the top valve and liquid from the bottom valve.



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3.1. Verifying the Contents of the Container

Before charging begins, it is essential to verify the contents of the container of refrigerant to avoid contaminating the system. Also, charging with the wrong substance can, under certain circumstances, cause an explosion or other accident.

Cylinders and drums containing R22 are labelled and coloured to identify their contents. The label fixed to the container should always be used as the primary method of identification; for further details refer to J & E Hall International engineering standard 10 001 Identification of Industrial Gas Cylinder Contents.

A WARNING

The contents of cylinders or drums must NEVER be checked by smell. If there is any doubt as to the contents, refer the cylinder pressure and the ambient temperature surrounding the cylinder to the pressure/temperature relationship for the suspect refrigerant; refer to Table 5.

4. Substitution of the System R22 Refrigerant Charge

Substitution of the system refrigerant charge for another refrigerant **MUST NOT** be made without the approval of the authority concerned, the manufacturer, the installer or other competent person, and the user.

5. Personnel Permitted to Work on R22 Plant

It is essential that only authorised and competent personnel are allowed to work on the refrigeration plant. A permit to work system should be introduced when the plant is commissioned and rigorously enforced thereafter.

Within the UK, registration on the Air Conditioning and Refrigeration Industry Board (ACRIB) Refrigerants Handling Register indicates adequate training has recently been received.

Any person rendering assistance or under training must be supervised by the authorised competent person who has responsibility for safety.

6. Before Charging Refrigerant into the System

Charging can be divided into two parts:

- The provisions which must be made before charging takes place.
- The charging procedure itself.

Carry out the provisions described in 6.1 to 6.5 before refrigerant is charged into the system.

6.1. New Plant or After Repair or Modification to an Existing Plant

Check the following:

- The plant has been installed to specification and in accordance with the certified drawings. Piping is complete, including relief valve vent lines piped to a safe location.
- System strength and leak testing has been completed and the appropriate pressure certificates issued; refer to Part D: Strength and Tightness Testing in Section 1 of the plant instruction manual.

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 The system has been dehydrated by evacuation; refer to Part E: Evacuation and Dehydration in Section 1 of the plant instruction manual.

If the plant is under vacuum and it is required to add the system lubricating oil charge, use the vacuum to suck the oil into the system; refer to Part E: Evacuation and Dehydration in Section 1 of the plant instruction manual.

- · All relevant insulation has been completed.
- All relevant electrical safety systems have been installed and tested.
- All relevant documentation is available to those personnel
 who are responsible for charging the plant (usually the
 commissioning engineers). This must include the plant
 specification and system design note, and certified copies of
 the refrigeration circuit diagram(s) and electrical wiring
 diagram(s).

In accordance with BS EN 378-2: 2009 Part 6.3, the complete installation should be inspected by a competent person immediately before it is put into operation for the first time. This inspection must be documented.

6.2. Plant Located Indoors

If the plant is located indoors, the plant room must be effectively ventilated in case large quantities of refrigerant should accidentally escape. Open doors and windows as required. If ventilation fans are available, these should be switched on.

Smoking and the presence of other naked flames, for example gas space heaters, must be prohibited while charging takes place.

6.3. Safety of Personnel

Protective clothing, goggles, gloves, etc. must be worn by all personnel carrying out the charging procedure; refer to 15. Safety Equipment.

6.4. Charging Line

The charging line must be fit for purpose.

The charging line should be kept as short as possible. **DO NOT** use a home-made charging line made up from fittings and odd lengths of pipe. Invest in a flexible, steel-braided charging line from a reputable manufacturer.

A non-return valve must be fitted in the charging line to prevent backfilling if the system pressure becomes higher than the cylinder pressure; refer to Fig 2. Back-filling is most likely to occur when charging refrigerant into the HP side of the system.

6.5. Preventing Moisture Entering the System

Air or moisture can enter the system during the charging process unless adequate precautions are taken. Besides using the correct method of connecting cylinders of refrigerant to the system, as described under 6.4. Charging Line, the possibility of moisture ingress can be eliminated by using a refrigerant filter/drier located in the charging line before the non-return valve; refer to Fig 2. This precaution is especially important if the plant is fitted with a semi-hermetic compressor.

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7. Charging Refrigerant

A WARNING

Personnel who are going to charge the system must possess a permit to work certificate to show they are authorised and competent to work on the plant and are fully aware of the potential hazards involved.

If this publication relates to a plant supplied by J & E Hall International, these instructions should be read along with procedures specific to the plant; these are described in Part G: Charging With Refrigerant in Section 1 of the plant instruction manual.

If you have not already done so read the provisions and precautions detailed in 6. Before Charging Refrigerant into the System. Then read through the following procedures before charging refrigerant.

7.1. Charging Procedure

These instructions are applicable to R22 supplied in cylinders or drums; cylinders of refrigerant are referred to in the following procedure; refer to 3. R22 Containers: Supply From Cylinders and Drums.

- (a) Verify the contents of the container of refrigerant; refer to 3.1. Verifying the Contents of the Container.
- (b) Check that the charging line is clean, dry and in good condition, free from any sign of damage; refer to 6.4. Charging Line.
- (c) The cylinder of refrigerant must be mounted on a suitable weighing device (scales) to determine the weight of refrigerant charged into the system. Secure the cylinder to prevent it falling off the scales.
 - It is recommended to keep a record of the quantity of refrigerant charged into the system and the quantity taken out; this information must be recorded in the plant log book.
- (d) When charging into an evacuated system, arrange the cylinder of refrigerant so that only vapour enters to break the vacuum; refer to Fig 2. Liquid should **NOT** be charged until the pressure has been raised.
- (e) Check that the charging valve on the system and the valve on the cylinder are both fully closed before unscrewing and removing the protective caps.
- (f) Note the orientation of the non-return valve in the charging line before connecting one end of the line to the cylinder valve and tightening the connection. Connect the other end of the line to the charging valve on the system.

A WARNING

Purging the charging line involves the release of refrigerant, sometimes liquid refrigerant. Adequate protective clothing must be worn, as described under 6.3. Safety of Personnel, to prevent injury to personnel. Depending on circumstances, it may be necessary to wear a respirator.

(g) Crack open the cylinder valve, then carefully slacken the connection at the charging valve to purge the line of air. As refrigerant begins to escape, retighten the connection and close the valve on the cylinder.

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Provided the charging line connections are gas-tight, open the charging valve, then gradually open the cylinder valve, allowing refrigerant to pass into the system. Always use the cylinder valve to control the charging process.

A CAUTION

When charging into an evacuated system, allow refrigerant vapour to enter gradually until system pressure has risen well above atmospheric pressure. If the refrigerant is permitted to enter too quickly, the very rapid cooling which will result may damage components.

- (h) How much of the total contents of the cylinder of refrigerant it is possible to transfer depends on the ambient temperature surrounding the cylinder. The lower the ambient temperature, the less refrigerant is induced to enter the system; also when charging vapour, the cylinder is itself cooled as the refrigerant evaporates.
- (i) More refrigerant can be persuaded to enter the system by raising the cylinder pressure, either by increasing the ambient temperature or by gently warming the cylinder.

A WARNING

On no account should the cylinder of refrigerant be heated by means of a naked flame. If required, warm the cylinder by standing it in, or spraying with, warm water. Alternatively, use a thermostatically controlled, electrically heated jacket around the cylinder. The water/jacket temperature should NOT exceed 50 °C.

 Containers of refrigerant, cylinders or drums, must be disconnected from the system immediately after charging has been completed.

On completion of charging, close the valve on the cylinder before closing the charging valve. Closing the valves in this order encourages the charging line to empty of liquid, however, liquid refrigerant may still be present in the line. Guard against this possibility by slackening the charging line connection at the charging valve and allowing any refrigerant to slowly vent to atmosphere before disconnecting the line.

Refit the protective caps to the charging valve and the cylinder valve to prevent accidental damage.

8. Leak Prevention

The majority of leaks can be prevented by correct installation and maintenance.

8.1. Installation

Refer to Part C: Installation in Section 1 of the plant instruction manual.

Information of particular relevance to leak prevention is detailed under Connecting System Components.

8.2. Maintenance

Refer to Part J: Maintenance in Section 1 of the plant instruction manual.

Information of particular relevance to leak prevention is detailed under Maintenance and Repair.

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9. Leak Detection

It is essential to identify and cure refrigerant leaks as soon as they occur; refer to Fig 3 Flow Diagram for Leak Detection and the following notes on each step of the leak detection procedure.

9.1. Step 1 Reason for Leak Check

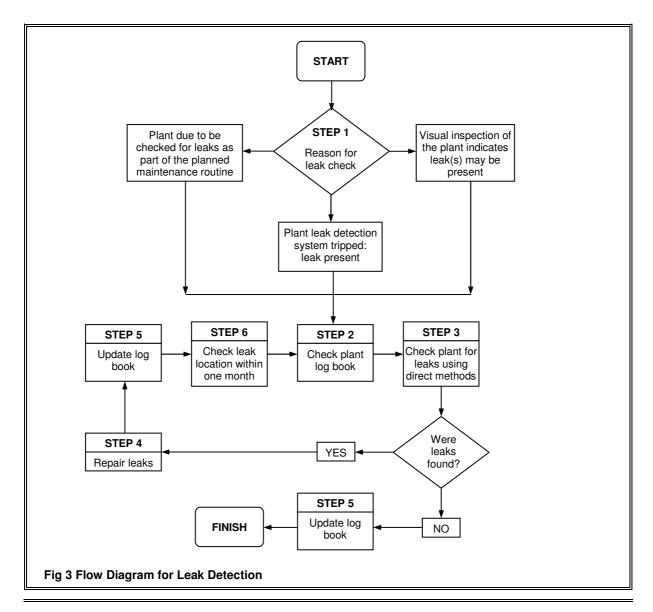
Checking the plant for leakage of refrigerant is usually prompted by one of the following:

- Routine visual inspection has identified a potential leak.
- It is necessary to check the plant for leaks as part of the planned maintenance schedule.
- The plant leak detection system (if fitted) has tripped.

9.1.1. Visual Inspection

It is recommended to check indirectly for potential refrigerant leaks by making a visual inspection of the plant once a week.

 Check for unusual noises or vibration, ice-formation and insufficient cooling capacity.



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- Check for oil leaks. To facilitate leak detection, it is good practice to keep the whole plant thoroughly clean externally. The presence of oil at a joint may well give early indication of a refrigerant leak, but unless the plant is kept clean this may pass unnoticed.
- Check for damage or corrosion to components, particularly at potential leakage points: joint faces, valves, flanges, instrument gauge lines etc.

Potential refrigerant leaks should be checked using the methods described in 9.3.

 Check for symptoms of undercharge. As R22 is practically odourless, small leaks may remain undetected until they adversely affect the running of the plant. For further details refer to Part I: Faults and Remedies in Section 1 of the plant instruction manual.

9.1.2. Planned Maintenance

The plant must be checked for leaks on a regular basis by certified personnel.

Newly commissioned plants should be checked daily for leaks during the first week or two of operation, and once a month thereafter.

The supplier of the plant cannot be held responsible for the replacement of refrigerant lost through incorrect or insufficient maintenance.

9.1.3. Plant Leak Detection System Tripped

The plant R22 leak detection system (if fitted) has tripped indicating that a leak is present.

The leak detection system should be checked and tested as required by the manufacturer, but at least once a year, for correct electrical operation and positive response to R22.

9.2. Step 2 Checking the Plant Log Book

The plant log book can be a valuable tool for identifying potential leaks. Check the following points:

- Is the plant running normally and achieving the design cooling duty?
- Have any faults occurred recently, especially repeat faults?
- When was the refrigerant charge last topped up? How much charge was added?
- When was the last time the plant was checked for leaks using the methods described in 9.3?

9.3. Step 3 Checking the Plant For Leaks

There are three standard methods of detecting leakage of R22:

- Halide test lamp.
- · Electronic leak detector.
- Soap and water.

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A popular method of detecting a leak of R22 is by using a test lamp. The lamp, which is similar to a small blow-lamp and burns propane gas or methylated spirits, has a length of flexible tube attached, through which air is drawn over the flame. The free-end of the tube is passed near to joints, valve glands and other areas where a leak may occur or is suspected. Any R22 escaping from the plant is sucked up the tube and decomposes in the lamp flame, changing the colour of the flame first to pale green then to a deep purple, depending on the magnitude of the leak and the concentration of the refrigerant. The lamp should not be used where heavy concentrations of R22 are suspected, especially in a confined space, as obviously the colour of the flame is affected the whole time, making the source of the leak impossible to find.

A WARNING

It is inadvisable to inhale the products of combustion; this would be inevitable if the lamp were used where a heavy concentration of R22 exists. In extreme cases a toxic, brown, acrid smoke will be given off; breathing this vapour is hazardous to health and must be avoided.

Until recently, it was common practice to use R22 as a tracer for strength and leak testing, part of the installation and commissioning procedure for all new refrigeration plant. A small percentage of the total system R22 charge was added to the system before raising the pressure to the required level with dry nitrogen. However, as it is not practical to recover the test charge afterwards, this method of leak testing **CANNOT** be recommended and should **NOT** be used - use soap and water solution instead; this method of leak detection is described below. For further details refer to Part D: Strength and Tightness Testing in Section 1 of the plant instruction manual.

Electronic leak detectors are very useful for those occasions where a leak is suspected but cannot be detected by other methods. These instruments are extremely sensitive and can detect leaks of a very minute order. They have the added advantage of employing a thin probe which may be inserted into places which are normally inaccessible; refer to 18. Suppliers of Leak Detection and Safety Equipment.

Electronic leak detectors and halide test lamps are sensitive to the presence of other hydrocarbons, notably the contents of certain fire extinguishers and the solvents in some jointing compounds. It is important to make quite sure that any reaction obtained is not coming from such a source.

As an alternative to using a test lamp or electronic leak detector, another effective method of leak detection is a mixture of soap and water mixed up to a good lather and applied, with a brush, to suspected points. Even quite small leaks can be detected by the bubbles which will form in the lather.

Leak detection must be carried out systematically. In a large installation mark each joint once it has been tested and passed to ensure that none are missed.

9.4. Steps 4 and 6 Repairing Leaks

All leaks must be rectified immediately they are discovered.

Before the leak is repaired, the part of the plant affected must be cleared of refrigerant and the charge recovered as described in 10. Opening Up the System and 11. Recovering Refrigerant Charge.

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Check the repair within in one month to make sure the leak has not reoccurred.

9.5. Step 5 Updating the Plant Log Book

The plant logbook must be completed as follows and signed:

- Date of leak check.
- Operatives name and certification ID number.
- Type of refrigerant.
- · Leak checking procedure used.
- · Repairs carried out and date.
- · Weight of refrigerant charged into the system.
- Weight of refrigerant recovered from the system for recycling.

10. Opening Up the System

Personnel who are going to open up the system must possess a permit to work certificate to show they are authorised and competent to work on the plant.



Opening up the system should only be carried out by competent persons who are fully aware of the potential hazards involved.

Before opening up the system to atmosphere, the section to be examined must be cleared of refrigerant and isolated as described under 11. Recovering Refrigerant Charge.

When isolating the part of the system to be opened up, under no circumstances should a non-return valve be used as an isolating valve, nor is it sufficient to rely solely on a stop valve for protection as it could be accidentally opened. If it is necessary to break into the system to remove major components or disconnect lengths of pipeline, then for complete protection use blank flanges or caps to seal off the open connections.

All vessels and pipelines should be thoroughly purged of refrigerant before they are opened up. Even after pumping down and purging, care must be exercised as pockets of gas may still remain.

Before starting operations likely to produce sparks or flame, welding for example, a 'cushion' of dry nitrogen should be introduced into the vessel or pipe if considered necessary. Nitrogen should be vented down to atmospheric pressure before burning or welding commences.

Take additional precautions, as necessary, to prevent a dangerous build up of refrigerant vapour.

11. Recovering Refrigerant Charge

Under the Environmental Protection Act 1990 and European Community Council Regulation 3093/94 it is illegal to vent refrigerant to the atmosphere. The EC regulation states that:

- All reasonable practicable precautionary measures shall be taken to prevent leakage of CFC's and HCFC's; refer to 8. Leak Prevention.
- CFC's and HCFC's shall be recovered for destruction or recycling/reclamation.

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11.1. Recovery Procedure

Before opening up the system, the section to be examined must be cleared of refrigerant and isolated.



Discharge of R22 in the atmosphere should be minimised. Every precaution must be taken to prevent accidental leakage.

Depending on the configuration of the system and the location of the section to be opened up, it is usually possible to run the compressor to transfer most of the refrigerant charge into another part of the system: the condenser, liquid receiver, suction separator or flooded evaporator.

However, it is important to remember that pumping down, as this procedure is referred to, cannot remove all the refrigerant charge. The remainder must be removed using a refrigerant recovery unit, or pumpout unit as it is sometimes called, to transfer refrigerant from the section to be opened into suitable drums or cylinders.

It is necessary to use the recovery unit to decant the whole of the refrigerant charge if the configuration of the system makes it impractical to pump down using the system compressor, or when the refrigerant is known to be contaminated.

The compressor lubricating oil is completely miscible with R22. Liquid refrigerant removed from the system will carry a certain amount of oil with it. This oil will contaminate the container used to store the charge, so further use of the container and its contents becomes questionable, especially if the system from which the refrigerant was transferred is suspected of containing moisture, acids or other contaminants. Accordingly, it is considered bad practice to recharge refrigerant taken from the system. Instead, return it to the supplier for recycling. The wording **CONTAMINATED WITH OIL** should be added to the description of contents marked on the outside of the recovery container; refer to 12. Disposal of Contaminated Refrigerant.

A CAUTION

Under no circumstances should heavily contaminated refrigerant, (for example, the result of a semi-hermetic motor burn-out) be recharged into the system; return to the supplier for safe disposal. Refer to 12. Disposal of Contaminated Refrigerant.

Containers of refrigerant, cylinders, drums or recovery cylinders, must never be overfilled. If this should occur, an increase in ambient temperature may make the container 'liquid full' and immediately cause a dangerous increase in hydrostatic pressure. For this reason, it is essential to check the amount of refrigerant charged into a container by weighing the container; the maximum permissible weight of refrigerant for the container must never be exceeded. How much refrigerant can be safely stored can be calculated from the equivalent water capacity which is stamped on the cylinder or drum.

It is important to keep a record of the quantity of refrigerant charged into the system and, if possible, the quantity taken out; record this information in the plant log book.

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12. Disposal of Contaminated Refrigerant

Contaminated refrigerant should never be recharged into the system or discharged into the environment. Large industrial suppliers of refrigerant, for example ICI, have their own recovery scheme whereby empty cylinders or drums are supplied free of charge so that recovered refrigerant can be returned to the supplier for safe disposal/recycling. Do not forget to clearly and permanently mark each container of refrigerant with its contents, for example, **RECOVERED R22**.

Mixed refrigerants cannot be reprocessed, instead a charge will be incurred to have them incinerated by a specialist company; for this reason, **DO NOT** mix refrigerants within the same recovery vessel. To avoid any possibility of cross-contamination, the refrigerant recovery unit should be reserved for recovering R22 only and **MUST NOT** be used with any other refrigerant.

13. Storage of Refrigerant

When not in use, valves fitted to cylinders or drums must always be sealed off with blank caps or flanges, using a suitable joint. This precaution is to prevent any refrigerant escaping past the valves, or if a valve should be inadvertently opened, refrigerant cannot escape and contaminate the surrounding area. The valve should be fitted with a guard to prevent accidental damage to the valve assembly.

Cylinders and drums of spare refrigerant must be stored outside the plant room in a separate storage area; refer to BS EN 378-4: 2008 Annex C Section C3. The store area should be cool, dry and well ventilated, located well away from flammable liquids or other fire risk, and positioned so that containers of refrigerant cannot be heated by direct sunlight or other heat sources. An appropriate sign, for example, **REFRIGERANT STORE - NO UNAUTHORISED ACCESS**, should be erected at the store entrance.

In the storage area, containers of refrigerant must be effectively secured to prevent them from falling. If containers of refrigerant are stored for long periods they must be inspected periodically for corrosion.

Cylinders and drums containing refrigerant must be treated with care:

- · Keep away from heat.
- Do not drop.
- Ensure that blanked connections are tight.
- Never attempt to check the contents of a container by 'smell'.

14. General Safety Considerations

While R22 possess no unusually hazardous properties and is safe under normal conditions of handling and use; it does not support life. Inhaling high concentrations of the vapour, even for short periods, can depress the central nervous system and produce symptoms such as narcosis, lethargy, dizziness, a feeling of intoxication and a loss of co-ordination. Longer exposure may eventually lead to unconsciousness and could prove suddenly fatal due to oxygen deficiency.

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R22 vapour is heavier than air and tends to displace air upwards out of cellars, ships' engine rooms, etc., and tend to collect at ground level and fill pits and trenches. In static or poorly ventilated situations, the vapour may be slow to disperse so care must be exercised before entering any area where the presence of high vapour concentrations is suspected. Should accidental escape of refrigerant occur indoors, adequate fan assisted ventilation should be provided to dispense the vapour before entering the area, preferably by extraction at ground level. Where any doubt exists it is recommended that breathing apparatus be worn; refer to 15. Safety Equipment.

Anyone suffering from the effects of inhaling R22 vapour should be immediately moved to the open air. If high concentrations of vapour are inhaled at concentrations well above the threshold limit value, the heart may become sensitized to adrenaline, leading to cardiac irregularities and, possibly, cardiac arrest. This is particularly likely to occur if individuals are under physical or emotional stress. The use of adrenalin (epinephrine) or similar drugs to aid recovery **MUST** be avoided as they may *increase* the risk of cardiac arrhythmias and cardiac arrest. If the person is having difficulty breathing, administer oxygen. If breathing has stopped, apply external cardiac massage.

R22 is non-flammable, but will decompose if the vapour comes into contact with temperatures above approximately 300 $^{\circ}$ C (burning cigarettes, gas burners, electrical heating elements, etc.), forming acidic compounds such as hydrogen fluoride and hydrogen chloride. These compounds are very toxic have extremely harmful physiological effects on human beings, as well as being highly corrosive, causing rapid breakdown of electrical and mechanical equipment. Fortunately, the sharp acrid odour of the decomposition products gives an early warning of their presence.

Naked flame and smoking must be prohibited in the presence of refrigerant vapour, and all refrigerant must be purged from pipes or vessels before carrying out cutting or welding operations. If a halide test lamp is used for leak detection, remember that the heating or combustion effect will produce toxic by-products which could be dangerous if inhaled.

There is no hazard related to absorption through the skin, however, R22 has a low boiling point and liquid refrigerant in contact with human tissue will cause freezing and result in injuries similar to a burn. Avoid any possibility of spraying liquid or vapour onto the skin and into the eyes by wearing protective clothing, rubber gloves and goggles when loosening a connection on any part of the system in which refrigerant is confined. Freezing of tissues or eye fluids could otherwise result.

15. Safety Equipment

The following safety equipment must be available for use by personnel working on R22 plant.

- Goggles.
- · Rubber gloves.
- Protective suits.

For complete protection against liquid splashes, and some protection against concentrated vapour, it is recommended to wear a protective suit; this should be worn with gloves tucked inside the sleeves. Wear trousers outside boots.

Suits made from chlorobutyl proofed fabric are recommended as they retain their flexibility at lower temperatures than suits made from PVC proofed fabric and are less likely to crack.

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For emergency use in the event of accidental escape of R22 in a confined space, lifelines and full protective suits, including self-contained breathing apparatus (compressed air sets or similar), must be worn. For guidance and recommendations refer to BS EN 529: 2005 and J & E Hall International engineering standard 10 003 Guide to Gas Respirator Use and Maintenance.

Rescue equipment should only be used by trained personnel.

All safety equipment must be stored so that it is immediately accessible if there is an emergency. A competent person should be made responsible for ensuring that equipment is thoroughly examined at least once a month and a report of every examination should be kept.

16. Emergency and First Aid Procedures

Liquid R22 may cause freeze burns to the skin. If liquid or saturated vapour should enter the eyes, freezing of tissue and eye fluids may result. Very high concentrations can act as an anaesthetic and/or produce asphyxiation by limiting available oxygen, there is also the possibility of heart irregularities which can prove suddenly fatal (cardiac arrest).

Personnel responsible for first aid treatment should be made aware of the special problems associated with accidents related to the halocarbon family of refrigerants.

16.1. Inhalation

(a) Move the affected person into fresh air, well away from the source of the refrigerant leak.

If breathing has ceased, a competent person can apply mouth-tomouth resuscitation. If cardiac arrest has occurred, apply external cardiac massage. The use of adrenaline or similar sympathomimetic drugs **MUST** be avoided.

Summon medical attention **IMMEDIATELY**.

- (b) If the casualty has difficulty breathing, check the mouth and throat for any obstruction; a simple air-way can be inserted if required.
 - If the casualty has inhaled large quantities of vapour they should be given oxygen as quickly as possible by a competent person.
- (c) Remove all clothing contaminated with liquid or impregnated with concentrated vapour.
- (d) While waiting for medical attention, keep the patient still and warmly wrapped in blankets. When medical help arrives, inform the physician that the victim has been exposed to R22.

The anaesthetic effects of inhaling R22 vapour may not be immediately apparent. 24 hours medical observation is, therefore, recommended.

16.2. Liquid Splashes or Concentrated Vapour on the Skin

(a) Use lukewarm water, not hot or cold, to thaw affected areas. Remove contaminated clothing, then wash affected areas with large quantities of fresh lukewarm water. If a body shower is available this can be used to advantage. This treatment should continue for at least 30 minutes.

Summon medical attention IMMEDIATELY.

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- (b) Apply a film of non-medicated ointment, such as petroleum jelly, to affected areas. If the exposed area is in a location where the presence of the ointment would be awkward, such as around the eye, apply a light bandage.
- (c) If no medical assistance is available, transfer the patient to a hospital casualty department.

16.3. Liquid Splashes or Concentrated Vapour in the Eyes

(a) Never rub the eyes. Immediately after contact, remove contact lenses, if worn, and irrigate the eyes using eye wash solution or distilled water, or fresh water preferably applied using an eye shower, forcing the eyelids open if necessary. This treatment should continue for at least 30 minutes.

Summon medical attention IMMEDIATELY.

(b) Continuing to irrigate the eyes until medical help arrives.

16.4. Ingestion

R22 swallowed accidentally will cause immediate severe freeze burn damage to the mouth, throat and gastro-intestinal tract.

DO NOT induce vomiting. Provided the patient is fully conscious, rinse out the mouth with water and give 200 ml to 300 ml (half a pint) of water to drink.

Summon medical attention **IMMEDIATELY**.

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17. References for Further Information

Organisation and Publication	Website
Air Conditioning and Refrigeration Industry Board (ACRIB)	www.acrib.org.uk
Safe Handling of Refrigerants.	
Guidelines for the Use of Halocarbon Refrigerants in Static Refrigeration and Air Conditioning Systems. ISBN 1-872719-13-9.	
American Conference of Government Industrial Hygienists (ACGIH)	www.acgih.org
Threshold Limit Values and Biological Exposure Indices 2001 (7th Edition). ISBN 1-882417-43-7. Also available on CD.	
British Standards Institution (BSI)	www.bsi-global.com
BS EN 529 : 2005 Guide to Implementing an Effective Respiratory Protective Device Programme. ISBN 0-580-46908-5.	
BS EN 378 : 2008 Refrigeration Systems and Heat Pumps. Safety and Environmental Requirements.	
Part 1: 2010 Basic Requirements, Definitions, Classification and Selection Criteria. ISBN 978-0-580-63661-5.	
Part 2: 2009 Design, Construction, Testing, Marking and Documentation. ISBN 978-0-580-62496-4.	
Part 3 Installation Site and Personal Protection. ISBN 978-0-580-53386-0.	
Part 4 Operation, Maintenance and Repair. ISBN 978-0-580-53387-7.	
DuPont Chemicals	www.dupont.com
Safety of DuPont Suva Refrigerants. Publication H-27350-9.	
Health and Safety Executive (HSE)	www.hse.gov.uk
EH64 Summary Criteria for Occupational Exposure Limits 1996 (plus supplements).	
Guide to the Pressure Systems and Transportable Gas Containers Regulations 1989 (Regulations Booklets). ISBN 0-717-60489-6.	
Her Majesty's Stationery Office (HMSO)	www.hmso.gov.uk
COSHH. Control of Substances Hazardous to Health Regulations 2002. Statutory Instrument 2002 No 2677. ISBN 0 11 042919 2.	
The Pressure Systems and Transportable Gas Containers Regulations 1989. Statutory Instrument 1989 No 2169. ISBN 0 110 98169 3.	
Health and Safety at Work Act 1974.	
INEOS Fluor	www.ineosfluor.com
Chemical Safety Data Sheet for ARCTON 22. Issue 6: 07/02.	
General Information: For the KLEA Range of Drums and Cylinders. Publication CP/11894/1Ed/13/999.	
Institute of Refrigeration	www.ior.org.uk
Safety Code for Compression Refrigerating Systems Utilizing Groups A1 & A2 Refrigerants (1999).	
Code of Practice for the Minimisation of Refrigerant Emissions from Refrigerating Systems.	
J & E Hall International	www.jehall.co.uk
Engineering standard 10 001 Identification of Industrial Gas Cylinder Contents.	
Engineering standard 10 003 Guide to Gas Respirator Use and Maintenance.	

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18. Suppliers of Leak Detection and Safety Equipment

Inclusion in these lists does not imply recommendation.

Company	Website	Telephone Number	Fax Number	
Ai Qualitek Ltd	www.ai-leaktest.com	01223-834420	01223-835050	
Anglo Nordic Burner Products Ltd	www.anglonordic.co.uk 020-8979-0988		020-8979-6961	
BOC Edwards	www.bocedwards.com	01293-528844	01293-533453	
Dean & Wood Ltd	www.dean-wood.co.uk	01372-378788	01372-386239	

Table 2 Suppliers of Leak Detection Equipment

		Web Site	Telephone Number	Fax Number
Arco Ltd	Chlorobutyl suits, hoods and gloves. Compressed air hoods and masks. Respirators. Self-contained breathing apparatus.	www.arco.co.uk	01482-222522	01482-218536
Draeger Safety UK Ltd	Entry suits. Self-contained breathing apparatus.	www.draeger.co.uk	01670-352891	01670-356266
Stenhouse Equipment (Safety) Ltd	Compressed air hoods and masks. Respirators. Self-contained breathing apparatus.	www.stenhouse.demon.co.uk	01482 329045	01482 226774

Table 3 Suppliers of Safety Equipment

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19. Properties of R22

QUANTITY	PROPERTY					
	Chemical name	Chlorodifluoromethane				
Identifiers	CAS number	000075-45-6				
identillers	EC number	200-871-9				
	UN number	1018				
	Chemical formulae	CHCIF ₂				
	Appearance	Colourless gas				
	Molecular weight	86.48 kg/kmol				
	Molar mass	17.031 g/mol				
	Density at 15.0 °C and 1.013 bar (gas)	0.73 kg/m ³				
	Specific gravity at 21.0 °C and 1.013 bar	0.597				
	Melting/freezing point	-160.0 °C (113 K)				
	Boiling point at 1.013 bar	-40.8 °C (232 K)				
Properties	Specific heat of liquid at 30 ℃	1.40 kJ/kg K				
	Specific heat of vapour at 30 ℃	0.636 kJ/kg K				
	Density of saturated vapour at boiling point	4.69 kg/m³				
	Latent heat of vaporisation at boiling point	233.1 kJ/kg				
	Vapour pressure at freezing point	0.0608 bar abs				
	Critical temperature	96.0 ℃				
	Critical pressure	49.8 bar abs				
	Critical density	0.526 kg/l				
	Solubility of R22 in water	0.060 % at 25.0 ℃, 0.15 % at 30.0 ℃				
	EU classification	Dangerous to the environment (N) Central nervous system depressant, Carc Cat 3				
	R phrases	R59				
	S phrases	S23, S24, S25, S59				
Hazards	Flash-point (closed cup)	102 °C				
	Auto-ignition temperature	632 °C				
	¹ Toxicity classification	Group A1 (lower toxicity)				
	¹ Flammability classification	No flame propagation				
	Occupational exposure limit (TWA value)	1000 ppm v/v - 8 hour				
Environmental	¹ Ozone depletion potential relative to R11 (R11 = 1)	0.055				
	^{1,2} GWP relative to R744 (CO ₂) (R744 = 1)	1500				
In accordance wit Global Warming F	h BS EN 378-1 : 2010 Annex E. Potential, 100 year time horizon.					
Table 4 Propert	ies of R22					

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Темр ℃	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
-50	-0.37	-0.40	-0.43	-0.46	-0.49	-0.52	-0.54	-0.57	-0.59	-0.62
-40	0.03	-0.01	-0.06	-0.10	-0.15	-0.19	-0.23	-0.26	-0.30	-0.34
-30	0.62	0.55	0.49	0.42	0.36	0.30	0.24	0.19	0.14	0.08
-20	1.43	1.34	1.25	1.16	1.08	0.99	0.91	0.84	0.76	0.69
-10	2.53	2.40	2.28	2.16	2.05	1.94	1.83	1.73	1.63	1.53
0	3.96	3.80	3.65	3.49	3.34	3.20	3.06	2.92	2.78	2.65
Темр ℃	0	1	2	3	4	5	6	7	8	9
0	3.96	4.13	4.30	4.47	4.65	4.83	5.01	5.20	5.40	5.60
10	5.80	6.01	6.22	6.44	6.66	6.89	7.12	7.36	7.60	7.85
20	8.10	8.36	8.62	8.89	9.16	9.44	9.73	10.02	10.31	10.62
30	10.92	11.24	11.56	11.88	12.21	12.55	12.90	13.25	13.60	13.97
40	14.33	14.71	15.09	15.48	15.88	16.28	16.69	17.10	17.52	17.95
50	18.39	18.83	19.28	19.74	20.21	20.68	21.16	21.64	22.14	22.64
60	23.15	23.67	24.19	24.72	25.26	25.81	26.36	26.93	27.50	28.08
70	28.66	29.26	29.86	30.47	31.09	31.72	32.35	33.00	33.65	34.31
80	34.98	35.66	36.35	37.04	37.75	38.46	39.18	39.91	40.65	41.40
90	42.15	42.92	43.69	44.48	45.27	46.07	46.88	47.70	48.53	49.37
100	50.22	51.07	51.94	52.82	53.70	54.59	55.50	56.41	57.33	58.27
Table 5 R22 Pressure/Temperature Relationship (bar g/°C)										



20. Sample Log Sheet

Table 6 shows an sample log sheet for compliance with the F Gas Regulations. A log of this type must be kept for each individual refrigeration plant that contains more than 3 kg of HCFC refrigerant.

General Information					
Plant Name		Refrigerant R22	Quantity of Charge (kg)		
Plant Location		1			
¹ Plant Operator					
² Operator Contact					
Plant Manufacturer			Year of Installation		
Cooling Loads Served					
Refrigerant Charge Adde	d				
Date	³ Engineer	Quantity Added (kg)	Reason for Addition		
Refrigerant Charge Remo	oved				
Date	³ Engineer	Quantity Removed (kg)	Reason for Removal. What Was Done With Recovered Refrigerant?		
Refrigerant Leak Tests					
Date	³ Engineer	Test Result	Follow-up Action Required		
Follow-up Actions					
Date	³ Engineer	Related to Test on	Action Taken		
Testing of Automatic Lea	k Detection System (if fitte	ed)			
Date	³ Engineer	Test Result	Comments		
² Contact details for the C	ne company operating the pla Operator's nominated person competence; identify both th	responsible for compliance	with the F-Gas Regulations. f the technician carrying out the work, plus		

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Table 6 Sample Log Sheet For Compliance With the F Gas Regulations



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