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TNO-report

Requirements for refrigerating systems pertaining to the Netherlands decree on substances that deplete the ozone layer

Reference number	93-103
File number	112325-24524
Date	March 1993
NP	

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Translation of the Dutch version of February 1992

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1 Decree on substances that deplete the ozone layer

The Netherlands decree on substances that deplete the ozone layer specifies, for the purpose of the implementation of Council Regulation 594/91/EEC dated 4 March 1991 on substances that deplete the ozone layer, a complete ban on the importation, production and marketing of CFC's and halogens. Consistent with the Council Regulation, this complete ban will come into force on 1 July 1997.

In addition to the implementation of the regulations specified in the Netherlands decree for the purpose of supervising the compliance with the regulations in this decree, the decree also stipulates explicit requirements for the use of substances causing ozone depletion such as refrigerants.

In the Netherlands decree refrigerating systems are defined as:

'movable or stationary systems of interconnected equipment and piping for the purpose of extracting heat, of which the total power of the compressors exceeds 500 watt and which contains substances or preparations causing ozone depletion that serve as refrigerants'.

Consequently, this definition of refrigerating systems also includes heat pumps and airconditioning devices. In real terms, this definition means that smaller refrigerating systems, such as household refrigerators and freezers, as well as small commercial refrigerated cabinets of which the total power of the compressor(s) does not exceed 500 watt, do not have to comply with the requirements specified in the decree for refrigerating systems.

These refrigerating systems are classified as products containing substances causing ozone depletion. The importation, production and marketing of such products shall as a consequence of the decree also be prohibited as of 1 July 1997.

Refrigerating systems which will be installed subsequently to the implementation of the decree (expected in the middle of 1992) shall not use or contain CFC's classified as group 1A refrigerants.

In addition, pursuant to the decree, all refrigerating systems (of which the total power of the compressors exceeds 500 watt) charged with group 1A or group 1B refrigerants shall meet the technical requirements for refrigerating systems as specified below. A refrigerating system shall be considered leaktight if it complies with the technical requirements stipulated in this decree.

For this purpose a distinction is made between:
- new installations (installed after the implementation of the decree;
- existing installations;
- modifications of existing installations.

Refer to chapter 2 for more information on these terms.
Refer to the table of contents for the regulations which are applicable to the described installations.

Owners or users of such installations shall ensure that the requirements for (preventive) maintenance, registration and leakage detection are complied with. The fitters/installers carrying out maintenance or installation should be competent and have the necessary knowledge. Companies employing fitters/installers for performing these activities will have to possess a certificate stating the competence of their employees, issued by the foundation for the registration of qualified installers of refrigerating systems (STEK) appointed to this task by the Ministry of Housing, Physical Planning and Environment.

Following the implementation of the Netherlands decree for substances causing ozone depletion only qualified companies shall carry out the described tasks.

Concurrent with the formulation of the decree for substances causing ozone depletion a decree for partially halogenated hydrocarbons will be drafted. This decree will extend the requirements for refrigerating systems stipulated in the decree for substances causing ozone depletion to HFC's. In this way, tasks involving refrigerants entirely or partially composed of CFC's, HCFC's or HFC's shall be carried out with the necessary caution. Furthermore, this Netherlands decree ensures that these refrigerants shall only be used in refrigerating systems which are sufficiently tight.

2 Definitions

Bursting disc	Thin metal disc (in a holder which bursts when a certain pressure is exceeded.
CFC fitter	Person who meets the requirements stipulated in the Qualification Standard (= Erkenningsregeling).
Change-over valve	Shut-off device mounted on a set of pressure relief devices and constructed in such a way as to prevent simultaneous closing of both relief devices.
Cold-transferring fluid	Any fluid circulating in a circuit which is cooled in order to be able to absorb heat in another part of the circuit.
Direct communication	Rooms are considered to be in direct communication if the partition wall contains an opening which can or cannot be closed with a door, window or hatch.
Displacement type	(compressor or pump of the) Device in which a higher pressure is obtained by reducing the volume of the compression chamber.
European Standards	The requirements for pressurised devices or components stipulated by the European Committee (see appendix 1).
Existing installation	Installation installed or supplied prior to the implementation of the Netherlands decree on substances that cause ozone depletion.
Eye-glass (liquid indicator)	Glass in a holder fitted parallel to a vessel in order to be able to determine the liquid level in the vessel (visual).
Flange joint	Pipe ends with a radially projecting collar or rim which are connected with bolts.
Factory-made unit system	Unit systems manufactured on a large scale.
Fitter	Specialist registered as a refrigeration fitter or qualified to practise as such under the regulations stipulated in the STEK.
Group 1A refrigerants	CFC's 11, 12, 113, 114, 115, 13 and compounds of these CFC's.

Group 1B refrigerants	HCFC's 21, 22, 123, 124, ... and the HCF's 125 and 134A, ...(non-toxic or toxic to a small degree and non-flammable, see § 3.2).
Heat pump	Installation with a refrigerant system of which the purpose, however, is to apply the heat discharged from the condenser for heating purposes.
Heat-transferring fluid	Any fluid circulating in a circuit which is heated in order to be able to exude heat in another part of the circuit.
Hermetic cooler	Evaporator in which a passing liquid is cooled by evaporating refrigerant.
High pressure side	Part of a refrigerant circuit in which condenser pressure or intermediate pressure can occur or in which vapour can be discharged.
Impact strength	Property of materials which complies with the requirements for impact strength as stipulated in the Euronorm 25-72.
Inspection	Testing of performance and characteristics of devices or components according to prescribed or generally accepted testing methods by trained inspectors.
Liquid level indicator	Device for indicating the liquid level in a vessel with no control functions.
Low pressure side	Each part of a refrigerant system not pertaining to the high pressure side.
Machinery room	Room specially designed for the installation of compressors and other components of refrigerating systems with a refrigerant charge exceeding 300 kg or 450 kg (§ 7.4).
Modifications of existing installations	Changes to existing installations, carried out after the implementation of the Netherlands decree on substances that cause ozone depletion, which can reasonably be carried out in such a way that the components of the installation comply with the 'Requirements'. Modification does **not** include the replacement of faulty or worn-out components by components which reasonably should be identical to the original (for example the replacement of a faulty compressor).

Modification also does not include the rearrangement of an existing installation in which refrigerants are not repositioned.

Modification includes for example:
- changing the type of refrigerant used
- rearranging piping
- replacing pressure vessels
- adding main components.

An installation is considered 'new' if the installation is modified to such an extent that the majority of the main components has been replaced.

New installation	Installation installed or delivered after the implementation of the Netherlands decree on substances causing ozone depletion; including subsequent modifications or repairs of such installations.
Non-positive displacement compressor	Compressor (or pump) in which a higher pressure is obtained without changing the volume of the compression chamber.
Occupancy	Room where one or more persons are usually present, excluding a machinery room or a 'Special room' as described in § 7.4.
Open air	Space which may or may not be roofed, which is in direct communication with the air outside.
Pressure gauge	Device which is activated when the pressure drops below or exceeds the set value and which inactivates the part causing the pressure drop or pressure increase.
Pressure limiting device	Device which inactivates the pressure increasing or pressure reducing component when the set value is reached.
Pressure relief device	Generic name for pressure relief valves and safety valves, bursting discs etc.
Pressure relief valve	Component (usually) having a set value at which the spring-loaded valve opens in order to protect the relevant part against excessive pressures so that the discharged medium cannot leave the system.

Pressure vessel	Each component of the refrigerating system, except: — compressors — pumps — evaporators of which the functional composite parts (dividers and headers, pipe serpentines) each have a volume of no more than 15 liters — serpentines and shell and tube condensers — pipelines and relevant valves, fittings and couplings — measurement and control equipment — headers and other components with an inside diameter of less than 152 mm and a net volume of < 100 liters. Note: this definition of a pressure vessel does not imply any technical requirements for pressure vessels. Refer to the appropriate sections for this information (for example § 5.4).
Qualification Standard	The Qualification Standard for companies installing refrigerating systems and all requirements and stipulations resulting from this standard.
Quick-closing valve	Valve of which the handle is located on the outside and which is closed with a spring. By means of a special connecting swivel with a central push button the valve can be opened, as a result of which the system is easily accessible.
Receiver	Vessel which is part of the refrigerating system and which is connected to it with piping and which contains liquid refrigerant.
Refrigerant	Substance which is evaporated in order to create or maintain a low temperature; in this decree substances or components consisting of completely or partially halogenated carbon compounds with chlorine, bromine or fluorine.
Refrigerant devices	Components of a refrigerating system.
Refrigerating system/ Refrigerating installation Including heat pumps	Combination of connected parts containing refrigerant which together form a closed circuit in which refrigerant circulates for the purpose of extracting or producing heat.
Safety valve	Component with usually a variable setting at which the spring-loaded valve is opened in order to protect the relevant part against excessive pressures so that the medium is discharged to the atmosphere.

Sight glass	Glass in a holder fitted in a line or on a vessel in order to be able to determine whether liquid is present.
Small unit system	Unit system with a system charge of less than 3 kg.
Standpipe	Tube fitted parallel to a vessel for estimating the liquid level in the vessel on the basis of the forming of frost or condensation on the outside of the tube.
System with limited charge ('intrinsic' safety)	Refrigerant system having a net internal volume and a refrigerant charge which are chosen so that when the installation is not in operation, the maximum working pressure cannot be exceeded when complete evaporation of the refrigerant occurs.
Tight joint	Loose pipe joint which is sealed by distortion of a cutting ring that is pushed over the pipe.
Type-tested pressure gauge	Pressure gauge which has been designed to function fail-safe (and which is therefore type-tested) and which cuts off the electricity supply in the case of malfunctions.
Unit system	Serial manufactured refrigeration system.

Contents chapter 3

3 Classification

3.1 Refrigerating systems

Refrigerating systems are classified according to the method of transporting the heat from the substance to be cooled to the evaporator of the refrigerating system and are divided into direct and indirect systems, depending on the location of the evaporator.

Direct system: the evaporator of the refrigerating system is in direct communication (including possible air ducts) with the air or the substances to be cooled (see figure 3.1).

Indirect system: the evaporator of the refrigerating system, located externally to the space where the air or substances are cooled, absorbs the heat from the air or substance by means of one or more cold-transferring fluids. Indirect systems are classified as shown in figure 3.1.

3.2 Refrigerants

The current requirements can be applied to refrigerants of which: 'the presence of vapour in dry air (20°C, atmospheric pressure) is never flammable or dangerous to the health of persons'.

Refer to CEN378 Part 3 for the definition and classification of these so-called 'Group L1' refrigerants.
All refrigerants mentioned in appendix 5 are 'L1' refrigerants.

The current requirements are statutory in the Netherlands by means of the 'Decree on substances that deplete the ozone layer'.
The group 'L1' refrigerants can be further classified as follows:

Group 1A: refrigerants included in the appendix to the 'Decree'.

Group 1B: other refrigerants which consist of a:
- hydrocarbon compound with no more than two carbon atoms which partially halogenated with chlorine and fluorine and without bromine;
- hydrocarbon compound with no more than two carbon atoms which partially halogenated with only fluorine.

Refer to appendix 5 for a classification of various substances.

Compounds containing group 1A refrigerants are classified as group 1A refrigerants.
Example:
The compound R500 contains the component R12. Accordingly, R500 is regarded as a group 1A refrigerant.

R502 contains the component R115. Accordingly, R502 is classified as a group 1A refrigerant.A.

Refrigeration systems

Direct system 3.1.2

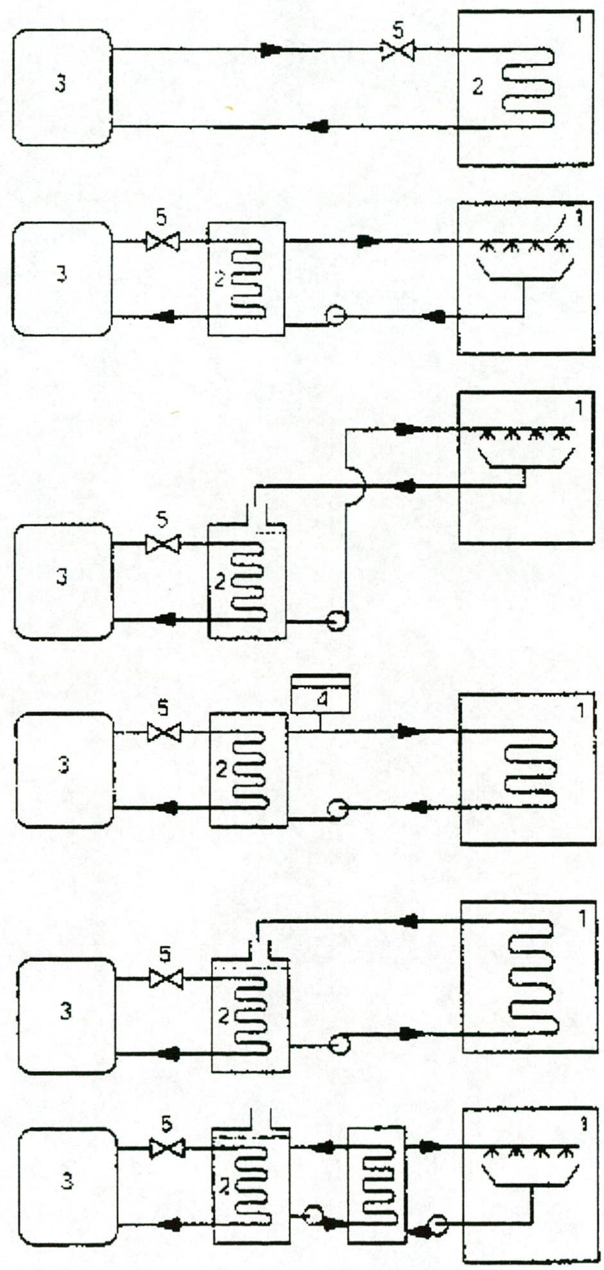
Indirect system

Indirect vented open system 3.1.3B

Indirect closed system 3.1.3C

Indirect vented closed system 3.1.3D

Double indirect system 3.1.3E



1. Cooled room
2. Evaporator of the refrigerating system
3. Compressor and condensor
4. Receiver
5. Expansion valve

Figuur 3.1

3.3 Occupancies

3.3.1 General

Occupancies containing or in the proximity of refrigerating equipment, are classified into categories, depending on the number of people occupying the site and the degree to which these people are restricted in their movement and are acquainted with the necessary safety precautions.
These categories are described as follows.

3.3.2 Occupancies

Category A Rooms where persons are restricted in their movement (for example hospitals, prisons). Rooms where people can sleep (for example hotels, boarding schools).
Rooms where a relatively large number of people may be assembled, not aware of possible dangers and not acquainted with the necessary safety precautions in case of danger (for example theatres, department stores, schools, churches, train stations).

Category B Rooms where a relatively small number of people may be assembled, and where at least some persons are aware of possible dangers and are acquainted with the safety precautions in case of danger (for example shops, offices).
This category also includes the interiors of cars and buses which are equipped with airconditioning.

Category C Rooms where manufacturing or storage of products or materials takes place, where only authorized persons have access, who should be acquainted with the possible dangers and the necessary safety precautions (for example factories, cold rooms and slaughterhouses).

3.3.3 Machinery rooms

Machinery rooms are not classified in the above mentioned categories.

3.3.4 Connected rooms

If different occupancies as described in 3.3.1 are directly connected, the category of the room which comes first in the above mentioned categories applies for all rooms.

Explanatory notes

When determining the category of the room involved, the designer shall also take into account rooms without refrigerating equipment. If there is, for example, a hall in a hospital where no refrigerating equipment is located but where patients can temporarily be present (for example on a stretcher), and the hall is directly connected to a working space (for example a laboratory or a kitchen) in which refrigerating equipment has to be installed, then this space has to comply with the requirements for rooms of category A, because the hall is classified into this category according to the above mentioned requirements.

Contents chapter 4

4 Materials

This chapter specifies the regulations for choosing the materials used in refrigerating systems.

The materials shall be chosen in accordance with the requirements stipulated in the European Standards (see appendix 1).

Chapter 4 applies to 'new installations' and to the components which during 'modifications of existing installations' are added.

4.1 Parts charged with refrigerant

4.1.1 General

This section provides guidelines for the choice of the construction materials which are used in refrigerating systems. The materials shall be chosen taking into account the refrigerant used and shall be resistant to this refrigerant and be sufficiently corrosion resistant. Corrosive substances in the immediate vicinity of the system shall be taken into account when choosing the materials.

4.1.1.1
Steel and steel castings may be used in all parts charged with refrigerant. Steel of sufficient impact strength may be used in low-temperature installations, taking into account the thickness of the steel, the minimum working pressure, etc.

4.1.1.2
Copper that comes in direct contact with the refrigerant shall not be oxygenous or deoxidised.

4.1.1.3
Copper alloys (such as brass and bronze) may be used after assessment that they can be applied in combination with the refrigerant.

4.1.1.4
If aluminium is used as the material for gaskets, pure (unalloyed) aluminium shall be used.
If aluminium alloys are used, the magnesium content shall not exceed 2% of the alloy.

4.1.1.5
Magnesium shall not be used, except in special cases where it is possible to determine that alloys with a low magnesium content are sufficiently resistant to the refrigerants with which the metal comes into contact.

Zinc shall not be used.

Lead shall not be used, except in materials for gaskets.
Tin and lead alloys shall only be applied if they can be used in combination with the materials and refrigerants.

4.1.1.6
Alloys for soldering and brazing.
Soldered alloys on the basis of tin shall not be used because of tin pest.

In the case of brazing, the constituents of the alloy shall be checked with respect to their resistance to the refrigerants.

Soldering materials containing zinc or other materials that usually cannot be used with certain refrigerants, shall only be used if it has been certified that such soldering materials can be used in combination with the refrigerants.

4.1.1.7
Glass that is used in equipment and piping for liquid level indicators and sight glasses shall be heat treated, colourless, free from bubbles and resistant to occurring pressures, temperatures and chemical corrosion.

4.1.1.8
Plastics may be used provided that the density complies with the requirement specified in appendix 2 and when it has been ascertained that they are durably resistant to the occurring mechanical, thermal, electrical and chemical influences and long-term creep stresses and/or contraction phenomenons. Furthermore, the application of plastics shall not constitute any fire hazards.

4.1.1.9
Packing materials for sealing joints and for gaskets etc., shall be resistant to the refrigerants and lubricants, as well as to the occurring stresses and temperatures. See also section 4.1.1.5 on the use of lead.

4.1.2 Materials for pressure vessels

Materials used for pressure vessels shall comply with the requirements stipulated in the European Standards.

4.1.3 Materials for piping

Materials for piping and fittings shall comply with the requirements in the European Standards. Refer to the table in appendix 4 for more information on the use of copper piping and to section 5.5.1.4 for details on the application of steel piping.

Cast iron may be used in fittings if the following requirements are complied with:
- The design pressure must not exceed 25 bar (o).
- The cast iron must be of sufficient quality.
- The cast iron must be annealed.
- Welding or welded repairs are not allowed.
- The fittings shall not be subjected to external/internal loads.
- The fittings shall be adequately protected from possible damage.

4.2 Materials for other parts

4.2.1
Materials connected with a flanged joint to pressurised devices shall be chosen in compliance with the regulations stipulated in the European Standards.

4.2.2
If a refrigerant is used as the heat or cold-transferring medium, the instructions in section 4.1 shall be applicable in regard to the choice of materials for parts on the heat or cold-transferring medium side.

4.3 Testing of materials

Marking, identification and testing of materials shall be carried out in accordance with the requirements stipulated in the European Standards.

A visual check for flaws in cast iron and density shall be carried out.

Contents chapter 5

5 Design and construction

This chapter specifies instructions for the design and construction of equipment used in refrigerating systems.

Chapter 5 fully applies to 'new installations' as classified in the 'Netherlands decree' (that is > 500W) and is partly applicable to those components which are added during 'modifications of existing installations' unless noted.

The equipment shall comply with specific safety regulations in order to prevent accidental discharge of refrigerant due to leakage, pipe fractures or other faults. Refrigerating systems shall be designed as to be completely tight so that leakage of refrigerant is not possible. Furthermore, the system shall be designed so as to withstand corrosion and the pressures and vibrations which may occur.
Refrigerating systems shall be designed as to facilitate the repair, maintenance and inspection of the system in such a way that loss of refrigerant is avoided. Refrigerating systems shall be designed with respect to the volume of refrigerant in such a way that the refrigerant charge can be kept as small as reasonably practicable.

5.1 Choice of refrigerant

New refrigerating systems shall use refrigerants which have the least possible effect on the environment. As a result of the agreements in the CFC Action Program, group 1A refrigerants shall not be used as of the dates mentioned in appendix 3.
The quality of the refrigerant has to comply with the specifications in appendix 8.

5.2 Strength calculation and design pressure

5.2.1
Strength calculations shall be carried out in compliance with the regulations stipulated in the European Standards (see appendix 1) and when necessary a different method of strength calculation shall be used. If there is no reliable method of calculation for a particular part, its mechanical strength shall be assessed by experiment.

5.2.2
All parts of the refrigerating system shall be designed and manufactured to withstand the pressures which may occur during operation, standstill and transportation, taking into account the temperatures to be expected, mechanical stress and stress as a result of chemical reactions.

The maximum working pressure (MWP) shall be determined by taking into account such factors as:
- the ambient temperature
- the presence of non-condensable gases
- the margins between the normal operating pressure of the system and the switching pressure of the pressure limiting device
- the method of defrosting
- the application (for example cooling or heat pump systems)
- the influence of solar radiation
- fouling/damaging.

Note 1:
The system may be divided into several parts (e.g. low and high pressure sides) for each of which there exists a different maximum working pressure. The pressure at which the system (or part of the system) normally operates will be lower than the maximum working pressure.

Note 2:
The manufacturer of standard components designs these components based on a given design pressure.
The designer of an installation which consists of such standard components shall take into account these factors when selecting installation components.

5.2.3
The design pressure of a component shall not be less than the maximum working pressure of the system or part of the system.

5.2.4
The relation between the pressure and maximum working pressure of new installations shall comply with the pressure ratios as shown in table 1.

For small unit systems containing not more than 1.5 kg of refrigerant and where the low pressure side cannot be isolated from the high pressure side, the test pressure of the whole system may be equal to the maximum working pressure of the low pressure side, provided that the components of the high pressure side have been pre-tested in accordance with table 1 or type-tested.

Table 1 Relation between the various pressures and the maximum working pressure (MWP)

Design pressure	not less than	1,0x	MWP
Strength test pressure for components made of casting	not less than	1,5x	MWP
Strength test pressure for components made of rolled or drawn materials	not less than	1,3x	MWP
Test pressure for systems or system parts	not less than	1,0x	MWP
	not more than	1,3x	MWP
Leakage test pressure	not more than	1,0x	MWP
Pressure limiting device setting	less than	1,0x	MWP
Pressure relief device setting		1,0x	MWP
Pressure relief device rated discharge	not more than	1,1x	MWP

5.2.5
For the modification of existing installations, the relation between the pressures mentioned in table 1 and the maximum working pressure shall be chosen on the basis of the original calculations for the existing installation.

Refer to §5.2.4 if these calculations are not available.

5.3 Welding and brazing

Welding shall be carried out by qualified welders at the responsibility (supervision) of a registered CFC fitter having the necessary qualifications and competence. This also applies to brazing and braze welding.

Welding does not have to be carried out under the supervision of a CFC fitter if the welded components are standard factory-made components.
The welder is responsible for an adequate quality of welded and brazed components.

5.4 Pressure vessels

The regulations governing the design, production, inspection and testing of pressure vessels are stipulated in the European Standards (see appendix 1).

5.5 Piping

The regulations governing the design, production, inspection and testing of piping are stipulated in the European Standards (see appendix 1). For piping in refrigerating systems the following instructions apply:

5.5.1 Dimensions and materials

5.5.1.1
Steel piping shall be used that maintains the requisite impact strength at the lowest possible operating temperature; see §5.5.1.4.

5.5.1.2
Copper piping shall be in compliance with the requirements specified in the table in appendix 4.

5.5.1.3
For copper piping in finned components with pressed-on aluminium fins the wall thickness may be less as a result of the mechanical protection by fins or a metal casing. When used in a caustic (corrosive) environment, it is necessary to protect the piping against corrosion, for example with a coating or thicker walls.
For pipe sizes with a cross-section between 9.5 and 15.9 mm a wall thickness of 0.4 mm is permitted. For smaller finned components (with a volume smaller than 3 dm3) with 9.5 mm piping, a wall thickness of 0.3 mm is allowed. For finned components with piping exceeding 15.9 mm, the wall thickness has to be assessed by the manufacturer on the basis of tests and calculations. Headers for such finned components (condensers and evaporators) shall be fitted with reinforced joints having the dimensions shown in the table in appendix 4.
This also applies to pipe bends which are not protected with an adequate casing.

Heat exchangers fitted with inner piping shall be protected in such a way that they cannot damage pipe bends.

Taking into account the occurring temperature fluctuations, such as when defrosting or evaporating, the dimensions of the joints to the headers shall be checked by means of strength calculations.

5.5.1.4
The materials used for piping, bends and fittings shall be suitable for the required application. If steel piping is used for low temperatures, the following regulations are applicable:

The following impact strength values apply to piping as well as welded joints:
working temperature: >-30 °C maximum wall thickness 12 mm 28 joule at 0 °C

working temperature: >-40 °C maximum wall thickness 7 mm 28 joule at 0 °C

working temperature: <-40 °C maximum wall thickness 7 mm 27 joule at -20 °C

It is recommended that refrigerant piping is marked with colours to indicate the type and state (gaseous or liquid) of the substance passing through the pipe. The colour code specified in NEN 3050 can be used for this purpose.

5.5.1.5
The use of synthetic hoses or piping shall be avoided if possible.
The hoses or pipes, including tubes, shall be constructed in such a way that the leakage (permeation) of refrigerant shall meet the requirements stated in appendix 2.

Note:
Damage (holes) to synthetic rubber can be caused by static electricity in combination with the use of CFC refrigerants.
Alternatively, synthetic rubber can be replaced by stainless steel reinforced bellows or PTFE hoses having properties which do not create a difference in electric potential.

5.5.2 Joints

5.5.2.1
Joints shall consist of hard soldered or welded joints.
The following joints can also be used:
- flanged joints;
- tight joints (steel or solid copper piping);
- joints with a swivel and a flat gasket (provided that the gasket is replaced after the joint is disconnected).

5.5.2.2
Soft soldering of joints shall only be carried out when soldering screwed couplings.

5.5.2.3
Welded/Soldered joints in straight lengths of piping with the same diameter may be carried out by extending the diameter or by applying factory-made sleeves.

Pipes with varying diameters shall be connected using factory-made reducing couplings.

5.5.2.4
Modifications of existing installations shall preferably not be carried out using flared joints.
It is essential to be extremely cautious when repairing flared joints.

5.5.2.5
Flanged joints shall be in compliance with the regulations stipulated in the European Standards (see appendix 1).

Flanged joints and packing material shall be chosen so that the packing cannot be pressed out.

The packing material shall be compatible with the refrigerant and oil being used and shall guarantee a 'minimal permeation'.

5.5.2.6
Screwed couplings shall only be used in steel piping with an inside diameter of ≤ 32 mm for liquid lines and ≤ 40 mm for vapour lines. The couplings shall be sealed by welding or soft soldering. Screwed couplings shall preferably not be used.

5.6 Liquid level indicators

Liquid level indicators consisting of glass gauges fitted in a refrigerating system shall be made of glass resistant to the occurring stresses and temperatures. The glass gauge shall be protected from possible damage (see also 6.3.1).

Construction of liquid level indicators

The testing pressure of liquid level indicators shall be at least equal to the testing pressure of the system parts on which they are mounted. If glass gauges are used, these shall on both sides be equipped with shut-off devices which will close in case of glass breakage and they shall also be protected from external mechanical breakage. In any case, persons reading the gauges shall not suffer any injuries if glass breakage should occur. Liquid level indicators shall preferably be fitted with a drain plug.

5.7 Shut-off devices

5.7.1
Shut-off devices which are used in refrigerating systems shall be state of the art devices.

5.7.2
Refrigerating systems shall be equipped with sufficient shut-off devices to minimize danger and minimize the loss of refrigerant both during maintenance and repair works. See also §7.11.

5.7.3
Hand-operated valves required for use during operation shall be fitted with a hand wheel or operating handle.

5.7.4
Shut-off valves which do not have to be operated when the system is in use shall be designed to be safeguarded against operation by unauthorized persons, for example by using caps, sleeves or locks which can only be removed by authorized persons with the necessary tools. In the case of emergency valves, the necessary tools shall be located nearby and shall be protected against misuse.

5.7.5
The spindle of the shut-off device shall be equipped with a so-called 'two-way valve' with which it is possible to close off both sides. In this way the spindle cannot be removed from the upper part and it makes it possible to replace the stuffing box rings while the shut-off device is exposed to system pressure.

5.7.6
Valves which are used for isolating shall prevent flow in either direction when closed.

5.7.7
Caps fitted over valve spindles shall be so constructed that any pressure which may be present under the cap shall be rapidly vented as soon as removal of the cap is started.

Caution!
Exercise care when removing the cap on a valve with a threaded gland in order to ensure that the cap and not the gland is unscrewed.

5.7.8
System components which are susceptible to breakdowns or damage (liquid level indicators, sight glasses) shall be equipped with shut-off devices that close automatically, for example by means of a spring, a quick-closing ball or a very small closing angle.

5.7.9
The spindles of valves shall be made of rustproof steel and shall be equipped with packing material so that leakage of refrigerant to the atmosphere is prevented. If possible, it is preferable to use a bellow valve or diaphragm valve.

5.8 Pressure gauges

5.8.1
The requirements in this article only apply to permanently mounted gauges. The high pressure side manometer shall be calibrated to a pressure that is not below the maximum working pressure.

5.8.2
If the dials or the display of the manometers are calibrated in pressures and the corresponding saturation temperature, the manometers shall be marked to indicate the refrigerants for which they are suitable.

5.8.3
Where practicable, the dials or the display of the manometer shall be marked with the maximum working pressure of the part of the system where the gauge is located.

5.8.4
Pressure gauges shall be resistant to the testing pressure of the relevant part of the system.

Contents chapter 6

6 Requirements for equipment

Chapter 6 applies to 'new installations' and to those components which during 'modifications of existing installations' are added.

6.1 Compressors

6.1.1 General

Compressors shall be fitted with a pressure gauge for both the high pressure side and the low pressure side when the charge volume of the installation exceeds 100 kg of refrigerant.

The pressure gauge shall be mounted in such a way that the pressure can be easily read.

In the case of smaller charge volumes, connections for pressure gauges shall be installed. However, such devices are not required if the charge volume in installations is less than 10 kg of refrigerant.

In compressors which are directly connected with an oil separator, the connection can be located immediately after the oil separator.

6.1.2 Positive displacement compressors

Compressors of the positive displacement type shall be equipped with the following parts.

Compressors with a shut-off device and compressors with a displacement of >90 m^3/h shall be provided with a type-tested pressure gauge.

The pressure gauge measurement position shall be located between the compressor and the shut-off device.

The shut-off device which might be present between the compressor and this pressure gauge shall be sealed in the open position.

Positive displacement compressors with a displacement (rate of flow) of more than 90 m^3/h shall be provided with a discharge valve or a bursting disc (discharge to the suction side or a special receiver) between the compressor and the shut-off device in order to prevent damage to the compressor as a result of a rise in pressure.

If the maximum working pressure with regard to the compressor cannot be exceeded, no discharge valve or bursting disc will be required. This is for example the case in a compressor which is directly connected to an oil separator fitted with the requisite safety valve.

6.1.3 Non-positive displacement compressors

Non-positive displacement compressors are not required to have a pressure gauge for the high pressure side as described above, provided that the maximum working pressure cannot be exceeded.

Note:
1. Discharge to the low pressure side of the compressor may result in overheating;
2. The adjustment of the discharge device on the compressor is usually > maximum working pressure.

6.1.4 Shaft seals

Shaft seals on compressors shall be durably resistant to the maximum working pressure and temperature in order to prevent damage which may result in leakage.

6.1.5 Marking

Compressors shall be provided with a sign containing the following information:
- name of the manufacturer;
- type of compressor;
- serial number;
- test pressure;
- maximum working pressure, both for the high pressure side and the low pressure side;
- maximum number of revolutions (for open compressors); For fully hermetic and semi-hermetic compressors:
- nominal voltage;
- maximum input power.

6.2 Pressure vessels

Pressure vessels which may contain liquid refrigerant and which may be shut off from other parts of the refrigerating system shall be protected by pressure relief devices as follows:

a. Pressure vessels with an internal gross volume of 100 L or more shall be equipped with safety valves as described in § 7.9.3. Compliant with the conditions in § 7.9.6.2 a single pressure relief valve may be used discharging to the low pressure side of the system. Measures should be taken in order to avoid leakage of significant quantities of refrigerant when installing components for bypassing and removing the valve.
b. Pressure vessels having an internal gross volume of less than 100 L shall be equipped with at least one relief valve discharging to the low pressure side (7.9.6.2)
c. Pressure vessels having a nominal inside diameter of less than 152 mm do not require a pressure relief device.

The pressure relief device has to comply with the instructions stipulated in chapter 7.9.

6.2.2
Refer to the regulations in the 'European Standards' for information about the marking of pressure vessels.

6.3 Receivers

6.3.1
Separators are also classified as receivers. In addition to the components mentioned in section 6.2, receivers shall be provided with a liquid level indicator if the gross volume exceeds 0.3 m^3.

For refrigerating plants which are continuously in operation, a corrosion-resistant standpipe may be used on condition that the receiver is also provided with a sight glass mounted at the maximum working pressure level.

The maximum volume of liquid corresponds to 80% of the volume of the receiver for both the maximum and the minimum expected temperature of the refrigerant. This level shall be clearly marked on the liquid level indicator.

Receivers having a volume of less than 0.3 m3 may be provided with a sight glass that is of such design that it is durably resistant against the used refrigerant and that is located in such a place that the maximum level can be easily read.

6.3.2
Refrigerating systems without a receiver or with a receiver without a level indicator shall be fitted with a sight glass in the main refrigerant line.

6.4 Miscellaneous

6.4.1
Pressure vessels fitted with a heating jacket (heating chamber) shall be equipped with a manometer and a thermometer.

6.4.2
Positive displacement pumps in each part of the refrigerating system shall be provided with a relief device on the discharge side that discharges to the low pressure side of the system.

Contents chapter 7

7 The installation of refrigerating systems

This chapter specifies instructions for the installation of a refrigerating system and the arrangement of the components of the system, as well as instructions for the installation of necessary components such as shut-off devices, safety equipment, etc.

Chapter 7 applies to new installations.

The addition of new components during 'modifications of existing installations' has to comply with the following sections only.

7.1
7.6
7.7 partly; see text
7.9 partly; see marking in text
7.10
7.12
7.13
7.14 applies to the entire modified installation; section §7.14.4 also applies to existing installations.

Note:
The permissible combinations of refrigerating system, refrigerant and occupancy are described in this chapter. Refer to chapter 3, Classification, for information on the classification of occupancies.

7.1 General

7.1.1
Regarding the arrangement and installation of refrigerating systems, the type of occupancy and refrigerant as well as the conditions under which the system will be used, shall be taken into account. Equipment, vessels and components of the system shall be so arranged and installed as to be easily accessible for maintenance and inspection without any danger of bodily injuries. Furthermore, the various components shall be so arranged as to be protected from damage and in such a way that unauthorised persons cannot have access to them.

7.1.2
Shut-off devices, controls and pressure limiting devices in the refrigerating system shall be marked in order to make sure that the required control and maintenance tasks can be carried out correctly.

7.1.3
The charge of refrigerant in refrigerating systems shall be kept as small as possible. If possible, indirect systems shall be used, provided that they do not cause a substantial increase in energy consumption.

In order to minimise the charge of refrigerant in refrigerating systems it is necessary to take into account the following considerations:
- the volume of the selected components shall be as small as possible
- the refrigerant lines shall be as short as possible
- the inside diameter of the lines shall be as small as possible.

7.2 Use of refrigerating systems and refrigerants in relation to occupancies

7.2.1 Maximum refrigerant charge

7.2.1.1 Introduction

Refrigerating equipment can be installed in the following three locations:
a. all components charged with refrigerant are located in a machinery room or in the open air;
b. only the high-pressure side of the refrigerating system (excluding air-cooled condensers) is located in a machinery room or in the open air;
c. the refrigerating system is not located in a machinery room or in the open air.

No restrictions apply to the amount of refrigerant charge used in the installations described under a).

The refrigerant charge of installations defined under b) and c) is determined by the type of occupancy (see § 3.3) and the type of refrigerating system.

The following requirement applies to the cases described in sections § 7.2.1.2 through § 7.2.1.4.

requirement: the refrigerant charge in kg shall not exceed the multiplication of:
- the concentration allowed for the refrigerant, in kg/m^3 according to table 5;
- the volume in m^3 of the smallest occupancy in which a component charged with refrigerant is located.

In the case of cooling/heating with air using a single refrigerating system, the total volume of all the occupancies may be used in the calculation provided that the air supply to each occupancy cannot drop below 25% of the full air supply to the occupancies.

7.2.1.2 Occupancy category A

Refrigerating system on location b
- direct and indirect open systems: see 'requirement' in § 7.2.1.1
- other refrigerating systems: no restrictions

Refrigerating system on location c
– in all cases: see 'requirement' in § 7.2.1.1

7.2.1.3 Occupancy category B

Refrigerating system on location b
– in all cases: no restrictions

Refrigerating system on location c
For occupancies located below ground or occupancies not having adequate emergency exits, refer to 'requirement' in § 7.2.1.1.
– in all other cases: no restrictions.

7.2.1.4 Occupancy category C

Refrigerating system on location b
For direct or indirect open systems located underground or not having adequate emergency exits, refer to 'requirement' in § 7.2.1.1.
– in all other cases: no restrictions.

Refrigerating system on location c
– in all cases: no restrictions

7.2.2 Ventilation of occupancies

Occupancies where people may be restricted in their movements and in which open flames or comparable hot surfaces are present shall be sufficiently vented in order to avoid danger as the result of decomposition of products.
If occupancies are not adequately vented, direct and indirect open systems shall not be used.

7.2.3 Arrangement of refrigerating systems

No refrigerating system or parts of it shall be installed in or on public stairways, entrances or exits, or on landings if it may hinder free passage.

7.3 Heat pump systems with direct evaporation

The 'direct' refrigerant charge of heat pump systems with direct evaporation and pipelines in the ground, rock, lakes or watercourse shall not exceed 10 kg.

7.4 The installation of refrigerating systems in special rooms

7.4.1
Special rooms shall be equipped for the installation of compressors, headers, heat exchangers and other appropriate components based on the following subdivision:

For refrigerating systems with a total refrigerant charge of more than 300 kg, the appropriate components shall be located in a machinery room.

If several refrigerating systems or systems with several refrigerants are located in one room, the room will have to comply with the requirements for machinery rooms if the total refrigerant charge exceeds 450 kg.

This also applies if two or more refrigerating systems have an open connection.

Refer to chapter 8, Refrigerating machinery rooms, for details on the installation of machinery rooms.

7.4.2
For refrigerating systems with a total refrigerant charge of 50 to 300 kg, the appropriate components shall be located in a room which is not open to unauthorized persons.

The air in these rooms shall be refreshed at least once every hour.

7.4.3
Refrigerating systems with a refrigerant charge of less than 50 kg shall be arranged in such a way that they are adequately protected against external damage.

7.5 Refrigerating systems in the open air

Machinery and equipment installed in the open air shall be weatherproof. All requirements and restrictions stipulated shall be complied with, if applicable. Pressurised liquid containers shall be adequately protected from excessive solar radiation. The machinery and equipment shall not be accessible to unauthorised persons (this does not apply to vehicles). In the case of refrigerating systems or parts of it located on the roof of a building, arrangements shall be made in such a way that liquid refrigerant from the systems cannot enter the building.

7.6 Installation of piping

7.6.1 Support

7.6.1.1
Refrigerant piping shall be suitably supported. The distance between supports depends on the dimensions and the weight (including the charge) of the piping.

7.6.1.2
Piping shall be constructed in such a way that provision is included for expansion in order to avoid dangerous stresses.

Note:
In these cases flexible pipes or bellows can be used.

7.6.2 Insulation and completion

7.6.2.1
Flanged joints and screwed joints, except insulated pipelines, shall be accessible for inspection. Joints which cannot be easily located on insulated pipelines, for example on a straight length of piping, shall be marked on the outside of the insulation. The clearance around the piping shall be sufficient to allow inspection and sealing of the flanges and pipe connections.

Insulated piping shall be so constructed that the insulation material can be easily removed on flanged joints and pipe connections so that leak detection can be carried out.

7.6.2.2
Piping that may come into contact with vapour and insulated cold piping shall be resistant to corrosion. Uninsulated piping shall be installed in such a way that accumulation cannot occur and that the condensation is drained.

7.6.3 Installation of piping

7.6.3.1
The free passage of persons must not be obstructed by pipelines.

7.6.3.2
Refrigerant pipelines exposed to damage shall be adequately protected by means of casings. This is particularly the case for piping in public rooms that is located lower than 2.20 m above the floor.

An exception can be made for steel piping larger than DN 100 in cases where the strength of the piping is considered to be sufficient to resist possible damage.

In machinery rooms or special rooms (see §7.4) refrigerant piping may be installed without protection.

7.6.4 Passing through of piping

7.6.4.1
Piping passing through fire-resistant walls and ceilings (NEN 1076) shall be installed in such a way that fire cannot spread to adjoining rooms.

Ducts containing piping shall be sealed as not to allow spreading of fire to adjacent rooms.

Piping shall not pass through lift shafts.

7.6.4.2
Piping passing through walls, floors, etc. and piping in ducts shall not be equipped with flanged joints, screwed joints or equivalent connections.

Piping running through floors and walls shall be fitted with sleeves.

7.6.5 Measuring piping

Pipelines to pressure gauges, pressure limiting devices and the like shall preferably be made of steel tubing if there is danger of vibrations or possible damage. Refer to appendix 2 for the application of synthetic piping.

7.7 Shut-off devices

7.7.1
Shut-off devices shall be installed correctly and shall be easily accessible.

7.7.2
Shut-off devices shall not be installed in crawl spaces.

7.7.3
Service valves shall be fitted with a blank seal when not in use.

7.7.4
Shut-off devices in new refrigerating systems with a refrigerant charge > 300 kg shall be clearly labelled (with numbers, letters or a combination of these). This marking shall be included in the appropriate flow diagram and/or operating instructions.

7.7.5
Shut-off devices which can constitute operational hazards shall be marked accordingly.

7.8 Receivers

Every refrigerating system with the exception of small unit systems (see chapter 9) shall be fitted with a condenser and/or receiver which can contain the refrigerant charge of the system.

The receiver installed may be 'active' or 'passive'.

An 'active' receiver forms part of the refrigerant circuit.

A 'passive' receiver cannot be easily removed and cannot be used as a transport container. A 'passive' receiver can serve several refrigerating systems by means of fixed or removable piping. The refrigerant charge may be distributed among smaller receivers in the system.

Refer to section 6.3 for information about the equipment for receivers.

7.9 Protection of refrigerating systems

Section 7.9 applies to new installations.
The protection of existing installations must be safeguarded when modifications are carried out.
If pressure relief devices are modified, these devices will have to comply with the requirements marked with an asterisk (*) in section §7.9.

7.9.1 General

The pressure in a refrigerating system during operation, standstill or transportation shall never exceed the maximum working pressure by more than 10%, regardless of the cause of the pressure rise.
High internal pressures have to be avoided or restricted by means of pressure relief devices.

The building up of pressure by pressure-increasing components (compressor, pump) has, where practicable, to be restricted by means of a pressure limiting device.
The excessive pressure has, where practicable, to be removed using a pressure relief valve that discharges to the low-pressure side of the system.

A refrigerating system shall be protected by at least one pressure relief device unless the installation is protected in accordance with sections § 7.9.1.1 a or b or § 7.9.1.2 a or b.

Pressure vessels and receivers having a specified volume shall always be protected with a pressure relief device (see § 6.2 and 6.3).
This also applies to compressors having a specified swept volume (§ 6.1).

7.9.1.1

Refrigerating systems which do not contain a pressure relief device shall be protected as follows:

a. a type-tested pressure limiting device can be the only protection if: the refrigerant charge < 100 kg and the swept volume of each compressor is < 90 m^3/h.
b. a type-tested pressure limiting device with manual reset and a second parallel device with mechanical reset, in combination with a pressure relief device located on the compressor discharging to the low pressure side or to a special receiver.

If a system is protected in accordance with either 7.9.1.1a or 7.9.1.1b, all components shall be able to withstand a pressure that corresponds to the saturated vapour pressure of the following ambient temperatures of the components.

Room/Ambient temperature up to 32 °C

— high pressure side with air-cooled condenser :	55 °C
— high pressure side with water-cooled condenser:	43 °C
— low pressure side:	32 °C

Room/Ambient temperature up to 43 °C

— high pressure side with air-cooled condenser:	63°C
— high pressure side with water-cooled condenser:	43 °C
— low pressure side:	43 °C

7.9.1.2

Note:

For the high pressure side, the operating temperature is considered as the maximum temperature. This temperature is higher than the temperature during compressor shut-down.

For the low pressure side it is sufficient to base the calculation of pressure on the expected temperature during the compressor standstill period. These temperatures are minimum temperatures and thus determine the minimum pressures which refrigerant piping, instruments and pressure vessels have to withstand.

At least one pressure limiting device shall be provided on all systems that are so constructed that the pressure-imposing element is capable of producing a pressure in excess of the maximum working pressure, except in the following cases:

a. Systems with a refrigerant charge < 1.5 kg for which one of the following conditions applies before reaching the maximum working pressure and without releasing refrigerant.
   1. the motor runs continuously until steady state pressure is reached;
   2. the motor stalls due to overload;
   3. the energy supply to the pressure imposing element is switched off by a (type-tested) thermal safety device;
   4. a part within the refrigerant system breaks, for example the valve plate or gasket of a hermetically sealed compressor.
   5. an internal pressure relief valve connects the high pressure side to the low pressure side.

b. Systems with a refrigerant charge < 1.5 kg in which:
   1. the pressure imposing element is not capable of creating a stress pressure exceeding one-fifth of the ultimate strength of the system.
   2. a (type-tested) thermal safety device stops the pressure imposing element before the pressure developed produces a pressure exceeding one-fifth of the ultimate strength of the system.
   3. a part of the system safely discharges with a minimum practicable risk.

7.9.1.3
There shall be no shut-off device between the pressure limiting device and the pressure imposing element unless either:
a. a second pressure limiting device is fitted and the shut-off device is a change-over valve or:
b. a pressure relief device or bursting disc is installed in the system between the high pressure side and the low pressure side.

7.9.1.4
Pressure limiting devices shall be so arranged that adjustment (after setting) can only be carried out with a tool.

7.9.1.5
Pressure limiting devices may be wired directly into the control circuit or into a computer/microprocessor. In the case of a power failure in the control circuit or a breakdown of the computer/processor the compressor shall stop. If the signal from the pressure limiting device to the compressor is analogue, the computer/processor shall stop the compressor when the signal reaches either end of its possible scale/ range.

7.9.1.6
Parts of the system that can be completely filled with liquid refrigerant and that can be shut off from the rest of the system, shall be protected against the danger of rupture due to liquid expansion.

7.9.2 Pressure relief devices general (*)

7.9.2.1
Pressure relief devices shall discharge at a pressure corresponding to or below the maximum working pressure. During operation, the pressure shall not exceed the maximum pressure with more than 10%.

Discharge shall take place in such a way that persons are not hindered or injured. The refrigerant may be discharged to:
1. where practicable, the low pressure side (= pressure relief valve).
2. the open air (=safety valve).

Pressure relief devices shall preferably be fitted with pressure relief valves (high pressure side to low pressure side) which cannot be sealed and which can be easily removed for inspection.

The pressure relief device shall continue to function in case of external mechanical damage.

7.9.2.2
The flow area of the pressure relief device shall not be reduced as a result of the deposition of welding material on connections.

7.9.2.3
The sleeve on which the pressure relief device is mounted, shall be as short as possible.

Sleeves and change-over valves that are located before safety valves shall have the same nominal DN size as the pressure relief devices.

7.9.3 Safety valves (*)

7.9.3.1
Pressure relief devices discharging to the atmosphere (i.e. safety valves) shall always be used in pairs with a change-over valve so that it is possible to repair or check one device while the other device remains functioning.

7.9.3.2
Each safety valve shall be protected against leakage by means of a bursting disc. The disc must be located upstream (i.e. on the side of the refrigerant). In the space between the bursting disc and the safety valve a provision has to be made for inspecting the pressure.

The bursting disc may be located downstream if a balanced safety valve is used which cannot be influenced by the pressure between the valve and the bursting disc. In this case it is not necessary to check the pressure.

Other types of safety valves can also be provided if it is guaranteed that no leakage can occur.

The bursting disc for the discharge device shall not be larger but certainly not smaller than the inlet side of the discharge device. The bursting disc shall be so constructed that no piece of the broken disc may obstruct the discharge device or reduce the discharge capacity.

7.9.3.3
If a change-over valve is used, one of the valve outlets shall be fully opened when the other valve is closed. In each position of the valves, the total flow area of the change-over valve shall be sufficient for a correct operation as stipulated in section 7.9.7.

7.9.3.4
Pressure relief devices located on a change-over valve or equivalent, shall be of sufficient capacity for the protection of the relevant parts.

Change-over valves or equivalent are not classified as shut-off valves in this case.

7.9.3.5
Safety valves shall be marked with a label or sticker stating the following information:
- the opening pressure;
- the discharge capacity or:
- the flow area and flow-through coefficient.

7.9.3.6
The safety valve and the discharge line shall be installed in such a way that condensation, frost and breakage as a result of atmospheric influences cannot occur.

7.9.4 Bursting discs (*)

7.9.4.1
A bursting disc shall only be used as a safety device for low pressures or internal excessive pressures. Otherwise, a bursting disc shall only be installed in series with a safety valve.

7.9.4.2
The bursting disc shall be clamped safely in its holder. The inside diameter of the holder serves as the flow area of the disc. This diameter shall be maintained throughout the holder.

7.9.4.3
Each bursting disc shall be marked with the name of the manufacturer and the nominal bursting pressure.
The markings on the disc must be clearly visible without having to remove the holder.

Manufacturers of bursting discs must be able to show that the indicated bursting pressure corresponds to the actual bursting pressure of the disc.

7.9.5 Fusible plugs (*)

Systems having a refrigerant charge of more than 1.5 kg. An exception can be made when the fusible plug is used as a relief device from the high pressure side to the low pressure side of the system. In this case, it is recommended however to use a pressure relief valve.

7.9.6 Arrangement of pressure relief devices (*)

7.9.6.1
Pressure relief devices shall be mounted on, or in the proximity of, the part of the refrigerating system they protect. They shall be easily accessible and shall be mounted above the level of the liquid refrigerant. Pressure relief devices installed in refrigerant lines and refrigerant containers do not have to comply with these requirements.

- There shall be no shut-off device between the pressure relief device and the part of the system it protects.
- A change-over device and a second pressure relief device may be used in order to facilitate testing and repair of the pressure relief device.

7.9.6.2
Where the pressure relief device discharges into the low pressure side of the system, the following shall apply:
a. the pressure relief valve shall be of a type that is not affected by back pressure to a large extent;
b. the low pressure side of the system shall be equipped with a pressure relief device.
c. the capacity of the pressure relief device on the low pressure side of the system shall protect all connected vessels, compressors and pumps subjected to high pressure simultaneously.

7.9.7 Discharge capacity of pressure relief devices (*)

7.9.7.1 General

The discharge capacity or the coefficient of discharge of a pressure relief device shall be established based on a test in accordance wit ISO 4126, giving preference to the coefficient of discharge method. In the refrigeration industry the use of tables with thermodynamic data is common and considering that the group 1 refrigerants are highly compressible, preference is given to the following method for the calculation of valve sizes:

$$A_o = \frac{Q}{\psi \times K_d \sqrt{2P/v}} = \frac{Q}{\psi \times K_d \sqrt{2P/\rho}}$$

where:

A_o = minimum cross-section of flow before the valve seat in m^2
Q = flow-through capacity in kg/s
ψ = outflow function (figure 7.1)

$$\psi = \left(\frac{2}{k+1}\right)^{\frac{1}{k-1}} \times \sqrt{\frac{k}{k+1}} = \frac{1}{\sqrt{2}} \times \sqrt{K \times \left(\frac{2}{k+1}\right)^{\frac{K+1}{K-1}}}$$

K_d = coefficient of discharge of the valve
P = absolute pressure in the pressure chamber in Pa (corresponding to the maximum working pressure)
v = specific volume of the medium in the pressure chamber in m^3/kg
ρ = density of the medium in the pressure chamber in kg/m^3
K = isentropic exponent of the medium in the pressure chamber, for example for the valve.

For the usual refrigerants, the values of K and v are given in figure 7.1.

Notes:
1. According to table 1 (see 5.2), the nominal capacity must be rated at a pressure not higher than 1.1 times the maximum working pressure.
2. According to ISO 4126, the certified coefficient of discharge corresponds to a capacity of 90% of the capacity determined by testing.

7.9.7.2 Discharge capacity of bursting discs or fusible plugs

The discharge capacity of a bursting disc or fusible plug is calculated according to the equations in 7.9.7.1, using one of the following values for Kd, depending on how the pipe between the vessel and the plug is mounted on the vessel:
through-wall mounting : Kd = 0.55
inside-flush mounting : Kd = 0.70
If the Kd value of the device itself is lower than the above values, this lower value shall be used in the calculation.

7.9.7.3 Dimensions of pressure relief devices

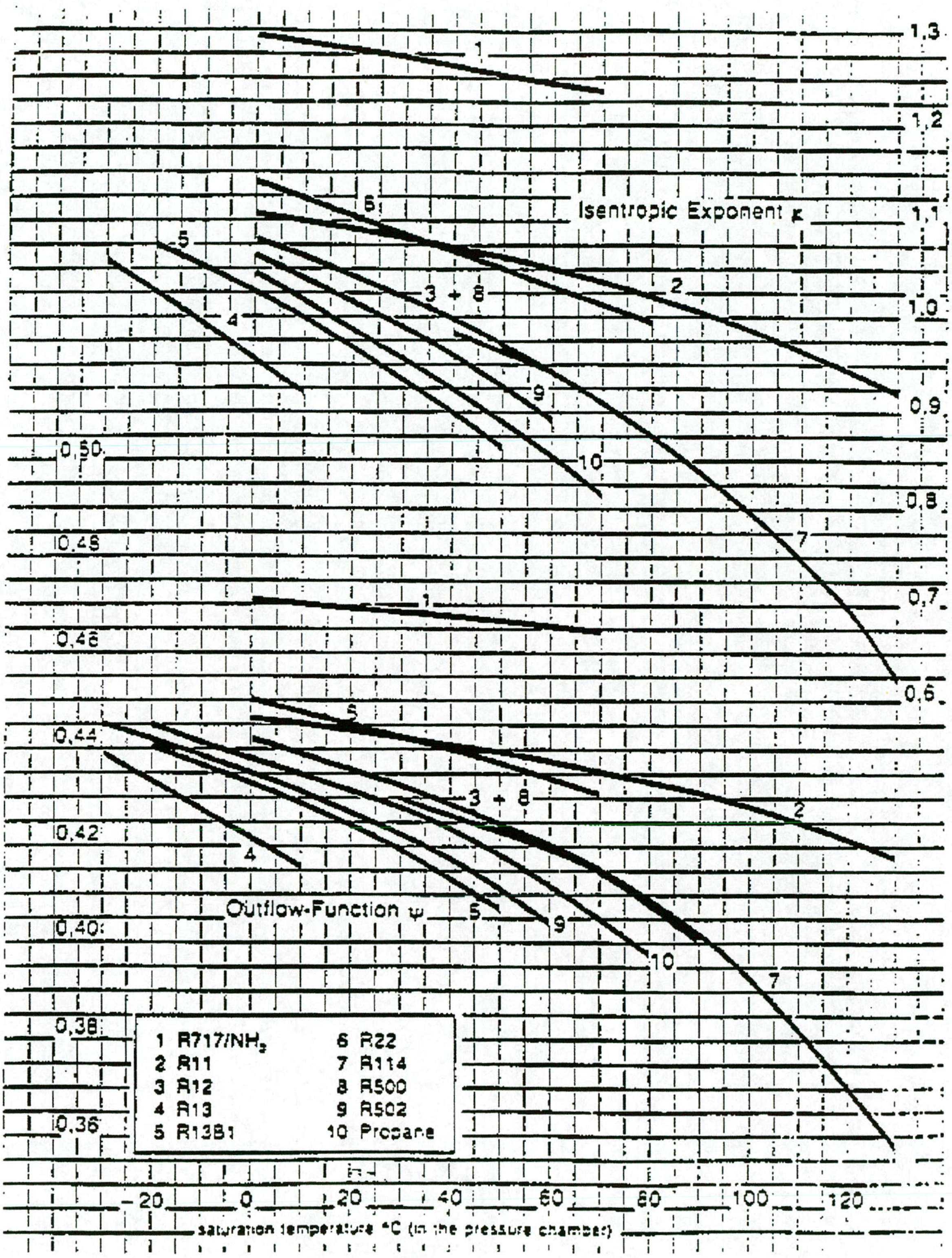
Two or more devices in parallel may be considered as a single device.
If two pressure relief devices are used, controlled by a change-over device, each relief device shall have a capacity required for the protection of the system.
In the case of pressure vessels with an internal heat exchanger/shell and tube exchanger, pipe or tube fractures or unintentional extra heat due to the interchange of heat shall be taken into consideration.

Pressure relief devices for pressure vessels shall have a capacity based on the highest possible heat flow in case of fire. The minimum required discharge capacity of a relief device for each vessel shall be determined by the following:

$$Q_R = \frac{\rho \times A}{r}$$

Q_R = minimum required discharge capacity in kg/s of refrigerant
ρ = density of heat flow = 10 kW/m^2
A = external surface of the vessel in m^2
r = latent heat of vaporization in KJ/kg

Requirements for refrigerating systems pertaining to the Netherlands decree on substances that deplete the ozone layer



Figuur 7.1 Isentropic exponent K and outflow-function ψ for the most common refrigerants

7.9.8 Discharge lines and pressure relief devices (*)

The discharge of pressure relief devices shall take place in such a way that persons are not endangered by the escaping refrigerant. The refrigerant may be discharged into the open air, provided that the discharge outlet is not located near air inlets.
Pressure relief devices shall be protected against adverse climatic effects.
In the case of a common discharge line for several relief devices, the pressure drop in the line shall be calculated on the basis of the lowest opening pressure occurring and simultaneous discharge from all connected relief devices.
If a common line is used, the pressure relief devices shall be counted as a single device and consideration shall be given to the effect of back pressure.
The connection of discharge lines to relief devices shall be such that individual tightness testing of the relief devices is possible.

7.10 Other safety devices

In addition to the described safety devices, refrigerating systems shall be equipped with the following devices:

7.10.1
Systems in which it is possible that components break due to freezing as a result of too low temperatures (water-cooled components and the like) shall be fitted with a low temperature or low pressure safety device.

7.10.2
High pressure and low pressure limiting devices as well as temperature limiting devices protecting refrigerating systems with a refrigerant charge > 30 kg, shall be resetted manually (i.e. by the operator).

7.11 Provisions for collecting, charging and draining refrigerants

7.11.1
Each refrigerating system except 'small unit systems' (§9) has to be provided with sufficient shut-off devices in order to be able to divide the refrigerant charge over various sections (§7.8). Shut-off valves shall be installed on:
- the inlets of compressors;
- the outlet of compressors (possibly behind the oil separator)
- the discharge side of the condenser or receiver.

7.11.2
Installations containing > 1000 kg of refrigerant shall be fitted with sectioning valves in order to avoid possible extensive leakage of refrigerant. These valves shall be remote-controlled (motor-driven) or easily accessible when manually controlled.

7.11.3
Refrigerating systems shall be equipped with shut-off devices or connection valves which can be used to drain refrigerant by means of an external unit.

7.12 Refrigerant transfer, transportation and storage

7.12.1
Refrigerant containers shall comply with the regulations stipulated by the 'Dienst van het Stoomwezen' (Steam Engineering Office).

7.12.2
a. Refrigerant shall not be discharged to the open air.
b. If the compressor of the refrigerating system cannot be used to remove the refrigerant, a unit shall be installed to transfer the refrigerant to another part of the system or to a special container or vessel.
c. Prior to maintenance or repair works in the system (or part of it), the system pressure of high-pressure systems shall be reduced to 1.05 bar(a)/20°C.
d. Prior to the destruction of the system (or part of it), the pressure shall be reduced to:
   - 0.6 bar(a)/20 °C for systems with a volume of not more than 0.2 m^3;
   - 0.3 bar(a)/20 °C for systems with a volume > 0.2 m^3.

7.12.3
The refrigerant shall only be transferred to a container which is suitable for the refrigerant in question. The container shall be clearly marked and labelled with a colour code (or otherwise) to indicate the type of refrigerant that can be contained in it. Containers holding regenerated refrigerant shall be labelled with a special designation, for example R12- regenerated - check before using -.
Containers for single use shall not be used in order to avoid discharge of residual gas into the atmosphere.

7.12.4
The refrigerant container shall not overflow.

This requires special attention since mixtures of oil and refrigerant have a lower density than pure refrigerant. The storage capacity of the container shall therefore be reduced for mixtures of oil and refrigerant (to approximately 75% of the capacity) and this shall be checked by weighing.
Refrigerant containers can be fitted with special shut-off devices so that they cannot overflow.
The maximum working pressure of the container shall not be exceeded, not even for a short period.

7.12.5
Different types of refrigerant shall be stored in different containers. Refrigerants shall not be stored in containers which also contain another or unknown refrigerant.
Different types of refrigerant shall not be mixed.
Mixed refrigerants cannot be regenerated and therefore they have to be destroyed.
An unknown refrigerant stored in a container shall not be discharged to the atmosphere.

7.12.6
Refrigerants shall be transported in a safe way.

Note:
All legal requirements, including registration, permits, etc. shall be complied with.

7.12.7
Refrigerants shall be safely stored (see appendix 7). The storeroom shall be dry and protected against weather influences in order to minimize corrosion of the refrigerant containers.

7.13 Electrical installations

7.13.1

The electrical equipment and the connected electrical installations shall be in accordance with the requirements stipulated in NEN 1010, as well as with the regulations issued by the local electricity company.

Note:
Electrical installations in machinery rooms for refrigerating systems may be arranged in dry rooms, except when the humidity can increase as a result of, for example, the use of revolving sprinklers, open tanks for cold-transferring fluid, etc.

7.13.2 Main power supply

The electrical power supply to the part of the system containing refrigerant, shall be arranged in such a way that it can be switched off independently of the electricity supply to other parts of the system, such as ventilation equipment, lighting systems and alarm and other safety equipment.

7.13.3 Auxiliary electrical supply

a. Mechanical ventilation.
   If mechanical ventilation is required (machinery room, pecial rooms), the ventilation devices shall be so arranged that they can be controlled by switching devices both inside and outside these rooms.
b. Lighting.
   The lighting of rooms shall be sufficient in order to work safely in all locations within the rooms. Machinery rooms shall be provided with adequate emergency lighting, if necessary in the form of portable lamps, so that in case of an emergency persons can be evacuated safely or that important duties can be carried out (NEN 3006).

c. Alarm systems and leak detection systems.
   Alarm systems and leak detection systems shall be powered by an independent system.

7.14 Miscellaneous

7.14.1
Each refrigerating system shall be so designed that liquid slugging is prevented.

7.14.2
Condensers in heat pumps shall be protected against excessive pressure caused by unexpected temperature fluctuations in the heat transferring system.

7.14.3
Positive displacement compressors shall be fitted with equipment for collecting the refrigerant that is separated from the oil of the compressor.

7.14.4
Air vent devices, such as used for example in low-pressure refrigerating systems, shall be constructed in such a way that unnecessary venting is avoided and that the vented gas does not contain more than 20% of refrigerant.

Automatic air vent devices shall be fitted with provisions for the registration of the operating time.

Contents Chapter 8

8 Refrigerating machinery rooms

This chapter contains instructions for the installation of refrigerating machinery rooms on land. Refrigerating systems installed on ships shall comply with requirements stipulated by classification agencies (such as Lloyd's).

Chapter 8 applies to new installations and to modifications of existing installations in which the machinery room is renovated or in which a machinery room is added.

8.1 General

8.1.1
Refrigerating machinery rooms shall have well-fitting doors opening outwards. The doors shall be self-closing if they provide access to other rooms of the building.

8.1.2
The walls of the machinery rooms shall not have any openings as a result of which the room is in direct communication with another room.

8.1.3
Machinery rooms shall have sufficient exits in order to ensure that in case of danger all persons present can escape from the room.

8.1.4
Refrigerating machinery rooms may also be used for the installation of other machinery, such as circulation pumps or (electric) hot-water boilers, provided that there are no 'open' flames in the room; see § 8.1.9.

Ventilators for other rooms shall not be installed in refrigerating machinery rooms. Ventilation ducts connecting machinery rooms shall not be in communication with other rooms.

8.1.5
The machinery room shall be of such dimensions that all parts of the installation are easily accessible and that sufficient space is provided for operation, maintenance, repairs and inspection of the installed equipment.

8.1.6
Machinery rooms shall be kept clean and shall not be used for storage of equipment or parts that are not required for the maintenance or operation of the installation.

8.1.7
Emergency switches to stop the compressor(s) and refrigerating pump(s) shall be provided both inside and outside the machinery room.

Emergency switches do not have to be installed on the outside of the machinery room if the exits of the machinery room lead to public rooms.

8.1.8
The construction of refrigerating machinery rooms shall be fire-resistant.

Note:
Refer to the Netherlands Building Regulations for a definition of fire-resistant rooms.

8.1.9
Open flames or hot surfaces shall not be present in machinery rooms.

8.2 Ventilation of machinery rooms

Machinery rooms shall be provided with devices for basic ventilation and emergency ventilation.

The emergency ventilation designed to evacuate gaseous refrigerant in the event of leakage, shall have a capacity based on the amount of refrigerant charge of the largest refrigerating system installed in the machinery room. The capacity shall be determined according to the following formula;

$$Qv = 50\sqrt[3]{G^2}$$

Qv = air flow rate in m^3/h
G = mass of refrigerant charge in kg

Air suction shall be positioned close to the floor.

Ventilation ducts shall be made of non-flammable material and discharge the air to the open air at an adequate distance from doors, windows and air inlets, so that no danger can arise as a result of gaseous refrigerant leakage.

Switches for the activation of the emergency ventilation system shall be provided both inside and outside the machinery room.

8.3 Gas detection equipment

A machinery room with refrigerating systems having a total refrigerant charge of more than 1000 kg per system shall be equipped with a permanently installed gas detection system for the refrigerant in question.

The alarm shall have two levels. A low level corresponding with approximately 100 ppm and a high level corresponding with approximately the MAC value (see appendix 6).
If the MAC value is lower than 100 ppm, both levels correspond to the MAC value.

As a minimum, 5 gas detection devices shall be installed at places where leakage may occur and at places close to the floor, of which one shall be located in the air outlet.

Note:
It is recommended to install additional gas detectors near the air outlet and in the discharge lines of pressure relief devices and ventilation devices.

An alarm indicator and/or an alarm signal shall be installed at a clearly visible place outside the machinery room.

See also chapter 11, Supervision, operation and maintenance.

8.4 Control and monitoring panel

Large refrigerating systems (> 300 kg/system) shall be provided with a central control and monitoring panel outside the machinery room, with which the following actions can be carried out (by qualified and authorized employees):
- the operation of emergency switches for stopping compressors, etc.
- the activation of the emergency ventilation system.
- an inspection in the case of alarm signals from gas detectors.

8.5 Underground machinery rooms

Machinery rooms entirely or partly located underground for refrigerating systems with refrigerants heavier than air, shall be provided with mechanical ventilation which must function when persons are present. When no persons are present, the emergency ventilation system shall be automatically controlled by a detector which activates the system at levels approximating the MAC value.

Contents chapter 9

9 Small unit systems

9.1 General

'Small unit systems' are systems:
- that are included in the Netherlands decree on substances that deplete the ozone layer (i.e. electric capacity > 500W) and:
- with a refrigerant charge of less than 3 kg.

Examples are cold shelves in stores, room air conditioners, small heat pumps, etc.

9.2 Requirements

Many requirements concern the refrigerant charge. These requirements are not applicable to small unit systems if the refrigerant charge is less than 3 kg.

All prevailing requirements are applicable to small unit systems, except for the following sections.
A number of sections only concern small unit systems, and these are also mentioned below.

7.2 Nullified

7.3 Nullified

7.4 Nullified

7.8 Nullified

7.11 Minimum of 3 shut-off devices not required

10.4.4 Test pressure

11.1.4 + 11.3 Nullified, replaced by:

Small unit systems shall be maintained and inspected according to the instructions of the manufacturer.

11.1.7 Nullified

Contents Chapter 10

10 Checking and inspection of refrigerating systems in the case of completion and/or extensive modifications

10.1 General

The European Standards for pressurised devices (appendix 1) contains guidelines for the compulsory inspection of pressurised devices.

Apart from these and other inspections with regard to 'safety', the tightness of the installation shall also be checked.
Together these checks constitute the 'installation checking' which shall be carried out in new installations.
The regulations also apply to modifications of existing installations provided that
- the modified part complies with the necessary requirements;
- section 10.5 is also applied to the complete installation.

The owner/user shall ensure that the above mentioned installation checking is performed, for example by the manufacturer.

10.2 Description of 'installation checking'

The 'installation checking' shall consist of the following:
- checking of the documents of pressurised devices;
- checking of required safety equipment;
- checking of refrigerant lines;
- checking of the tightness of the refrigerating system;
- preparation of an installation certificate stating that installation checking has been performed.

10.2.1 Checking of pressure vessel documents, etc.

It shall be evident from the documents that pressurised devices in refrigerating systems comply with the requirements specified in the European Standards (appendix 1), which also describes documents relating to design checking and production control with the relevant pressure testing certificates. The device in question shall also be provided with an inspection plate as described in §6.2.2.

10.2.2 Checking of required safety equipment

A check shall be carried out in order to ascertain that the safety equipment for the refrigerating system is installed and in good working order (relief devices, pressure limiting devices, emergency devices) and that the pressure at which these devices operate has been chosen so that the safety of the system is guaranteed.

- Safety valves and pressure relief valves shall be inspected to ensure that the correct opening pressure is stamped on the valve and is specified on a sign affixed to the valve by means of a seal. If this information is missing, the valve shall be checked or replaced.
- Bursting discs shall be checked with respect to the correct nominal bursting pressure.
- The flow area or equivalent of the relief device shall be checked in accordance with section 7.9.7. and a check shall also be carried out to ensure that the pressure drop in the discharge lines shall not exceed the permitted values.

Note:
The pressure drop can be checked by examining the performed calculations.

10.2.3 Checking of the tightness of the refrigerating system

A check of the tightness of the refrigerating system shall first be carried out in combination with a test of the maximum working pressure. Tightness checking shall again be carried out when the refrigerating system is put into operation (see §10.4 en §10.5).

10.2.4 Documents for the 'installation checking' certificate and other documents

A certificate shall be issued containing the following information:
- supplier/fitter;
- inspection date;
- name of the person performing the check and of his company;
- type of refrigerating system;
- identification number;
- type and volume of refrigerant (the actual charge);
- highest and lowest temperature and pressure;
- opening pressure of the pressure relief device.

In addition to the installation checking certificate the following documents shall be presented to the user of the installation:
- the documents for pressurised devices, in accordance with § 10.2.1;
- pressure testing documents (§ 10.4);
- leak testing documents (§ 10.5).

10.2.5 Inspection plate

On completion of the 'installation checking', a number of 'installation checking' data shall be provided on the refrigerating system in question; see section 11.6.1.

10.3 Pressure and leak testing of components

10.3.1
Testing shall be carried out in accordance with the requirements in the 'European Standards' (see appendix 1).

The pressure testing has to be carried out with the values specified in table 1 (§ 5.2). Especially:

10.3.2
Pressure testing of pressure vessels for refrigerating systems shall be carried out at a pressure corresponding to 1.3 times the maximum working pressure.

Pressure testing of the refrigerating system compressors shall be carried out at a pressure corresponding to at least 1.1 times the maximum working pressure.

For compressors and vessels, the inspection plate may serve as a pressure testing certificate.

10.3.3
If loss of tightness or permanent harmful deformation has occurred during pressure testing, repairs shall be carried out or other measures taken and the pressure testing shall be carried out once more.

10.3.4
Fittings and other parts shall be mounted on site during pressure testing. Fittings which are not mounted on site during pressure testing shall be tested separately or have a pressure testing certificate on delivery. In the case of doubt as to the quality of welding, x-rays can be used.

10.4 Pressure testing, leak testing and applying a vacuum to complete installations

10.4.1
Testing of connections that are fitted on pipelines of the installation may be carried out with air or another suitable gas, such as nitrogen, provided that the components, such as compressors, pressure vessels and prefabricated pipe components in the installation, are already pressure tested. Such testing may be carried out in stages during construction of the installation.
Oxygen, flammable gases, carbon dioxide, refrigerants or water shall not be used as testing materials.

10.4.2
Mounted joints shall be accessible for inspection during testing.

10.4.3
Pressure testing shall be carried out at a pressure of at least 1.0 times and at the most 1.3 times the maximum working pressure (see also table 1, § 5.2).

10.4.4
Pressure testing of small unit systems.
The opening pressure of small unit systems with a refrigerant charge of not more than 1.5 kg in which the low-pressure side cannot be separated from the high-pressure side may be equal to the maximum working pressure of the low-pressure side, provided that the components of the high-pressure side have been tested with the pressures mentioned in table 1 (§ 5.2) or type-tested.

10.4.1 Applying a vacuum

After leak testing, the installation shall be subjected to a vacuum in order to remove moisture and non-condensable gases.
The following method is recommended: The vacuum must comply with 270 Pa (2 mm Hg) and must be maintained, for example with a pump, during 1 hour and then be removed using dry nitrogen.

In installations containing > 200 kg, a vacuum shall be created again up to 270 Pa (2 mm Hg) during 30 minutes and shall be removed using dry nitrogen. Subsequently, another vacuum shall be formed during 6 hours and this vacuum shall be dissolved by using the refrigerant that is used in the installation.

10.4.6
A pressure testing certificate must be issued.

10.5 Tightness

In addition to pressure testing and inspection of the complete installation, the whole installation shall also be checked for tightness after the system has been put into operation. This inspection shall be performed with leak detection equipment (having a detection limit which approximates 5 ppm) or by alternative methods with a similar accuracy.

A 'tightness checking certificate' shall be issued.

Contents chapter 11

11 Supervision, operation and maintenance

This chapter contains guidelines for the supervision, operation and maintenance of refrigerating systems.

Chapter 11 applies, except for parts of section § 11.6, to new and existing installations.

11.1 General

11.1.1
The system shall be managed in such a way that it is safely operated and that loss of refrigerant is avoided.

Owners or users of refrigerating systems shall therefore ensure that the system is inspected and supervised regularly and that the system is maintained in a satisfactory manner.

11.1.2
Inspection, supervision and maintenance shall be carried out by a qualified person who is well acquainted with the maintenance and operating instructions, and also has the competence to perform these tasks.

Note:
This is understood to be knowledge of the functioning and operation of the refrigerating system and knowledge of the safety regulations. Refer to the ARBO Law, § 12,28 etc.

11.1.3
Except in the case of small unit systems, inspection shall be carried out on a regularly basis to such an extent considered (in all fairness) adequate by the manufacturer of the system, the fitter or the relevant authority.

11.1.4
Owners of refrigerating systems shall ensure that at least once a calendar year preventive maintenance is carried out and that inspection is performed with regard to the refrigerating system and the applicable refrigeration components.

For this purpose, a check shall be performed with regard to the safety equipment and to check whether no serious damage has occurred due to corrosion.

Insulated system components shall be visually inspected once a year in order to verify that the vapour-resistant coating is intact. If it is suspected that the coating may not be tight, a further inspection shall be carried out.

Depending on the type of refrigerating system and its condition, it can however be necessary to perform the described tasks on a more regular basis.

The tightness of the system shall be inspected by means of leak detection at the intervals specified in section 11.3.1.

Requirements for the continuous inspection of refrigerant containers are stipulated in the standard of the 'Dienst voor het Stoomwezen'.

11.1.5
Refrigerating systems with a refrigerant charge exceeding 1000 kg shall be continuously supervised by qualified personnel (§ 11.1.2) when the installation is in operation.
Continuous supervision can be replaced by periodic supervision if the refrigerating system is fitted with automatic control and alarm equipment which in the event of failure activates an alarm in a manned control room.

11.1.6
Refrigerant leakage and other faults shall be remedied immediately.

Charging with new refrigerant shall only take place after the fault has been repaired.

Repair works in which it is possible that refrigerant leakage may occur shall only be performed under the supervision of CFC fitters.

Welding repairs to pressure vessels shall be carried out by welders having the welding qualifications as defined in the 'European Standards'.

11.1.7
Owners of refrigerating systems shall ensure that the important system parameters are periodically registered. Furthermore, all events in which an alarm was sent shall be registered (preferably stating location, sequence and time). This requirement does not apply to small unit systems (see chapter 9).

Charging and draining of the refrigerant, as well as any other measures which may have been taken in regard to the refrigerant circuit and the connected equipment, shall be noted in a log.

The name of the person and the firm that performs the actions shall also be noted.

11.2 Inspection of detection equipment

Equipment for detecting refrigerant leakage in machinery rooms for refrigerating systems (gas alarm, etc.) shall be regularly inspected, at least every six months, focusing on the measurement accuracy, calibration and alarm levels.
This inspection shall be carried out by a manufacturer or supplier of such equipment or by a specialised agency for the inspection of weights and measures.
The result of these inspections shall be noted in the log.

Portable equipment shall also be inspected on a regular basis.

11.3 Leak detection and refrigerant leakage
(not applicable to small unit systems, chapter 9)

11.3.1
Leak detection for refrigerating systems shall be carried out periodically (also for systems which are not in operation) by means of leak detection equipment which is suitable for the relevant refrigerant and which has a sufficiently low detection value 5 ppm).

11.3.2
Leak detection shall be carried out at least once a month for refrigerating systems having a total charge of more than 300 kg.

For refrigerating systems with a refrigerant charge exceeding 30 kg, leak detection shall be carried out at least 4 times a year.

For commercial refrigerated cabinets, leak detection shall be carried out at least once a year.
If refrigerant leakage is detected, however, the next leak detection shall be carried out within 6 months.

11.3.3
The results of leak detection shall be noted in the log.

11.3.4
In the event of a major uncontrolled refrigerant leakage, the fitter, maintenance personnel and/or factory inspection (ARBO Law, Article 9: duty to report) shall be notified.

11.3.5
If a major refrigerant leakage is suspected, the emergency ventilation system shall be activated prior to entering the machinery room.

11.3.6
For refrigerating systems provided with fixed ventilation devices (purge units), the devices shall be tested periodically (at least once a month). The operating time of the purge unit indicates the magnitude of the leakage.

11.4 Maintenance

11.4.1
If a fault has been detected in the refrigerating system which may constitute a danger (to persons and the environment), the system shall be stopped without delay. The system shall only be put into service again after the fault has been remedied (by a specialist) in a satisfactory manner and after necessary inspection has been carried out (§ 10.1).

11.4.2
If work has to be carried out in connection with repairs or modifications requiring welding or soldering, this work shall only be commenced after the occupancy has been sufficiently ventilated and subsequently checked to ensure that the air does not contain refrigerant.

The ventilation system shall not be switched off while the work is carried out. If the air contains a large amount of refrigerant, no welding or soldering shall be carried out unless the necessary safety measures have been taken, for example, the installation of local extraction devices.

With regard to these repair works in a refrigerating system, safety measures might require that a second person is present in order to be able to offer help in emergency situations.

In connection with repair works, etc. carried out in a refrigerating system, it should be noted that the system may contain explosive mixtures of refrigerant and oil. The required safety equipment, including fire extinguishers, shall be available.

If the refrigerating system has to be opened in order to carry out extensive repair works and if this entails that piping is unprotected for a longer period of time, disconnected piping shall be fitted with blank flanges in order to avoid refrigerant leakage and penetration of moisture and dirt.

11.4.3
In order to prevent uncontrolled leakage of refrigerant, the shut-off devices mounted on the liquid level indicator shall always be closed, unless the indicator has to be read.

When the shut-off devices are closed, the liquid level indicator shall be filled to a maximum of 80% in order to avoid possible breakage of the indicator (glass or gaskets) as a result of excessive pressure.

11.4.4
After repair works and the like in the refrigerating system, all affected connections shall be thoroughly checked for tightness and, if applicable, these connections shall be inspected again after a certain period of operation.

11.4.5
Prior to the charging of refrigerant, a careful inspection shall be carried out in order to ensure that the content of the refrigerant container corresponds to the type of refrigerant that is used in the system.

The system shall be charged with refrigerant in such a way that overflowing cannot occur.

11.4.6
Emptying of the system shall be carried out using refrigerant containers or transport containers. The container shall be carefully weighed before the system is emptied and they shall not be filled with a larger quantity of refrigerant than the net maximum weight indicated on the container.

The system shall not be emptied into the atmosphere.

Note:
The possible presence of oil in the refrigerant should be taken into consideration.

Emptying a refrigerant container or transferring the refrigerant from one container to another, shall preferably be carried out by means of a pump.

11.4.7
Great care must be exercised when transferring refrigerant. Protective glasses and gloves shall be worn, depending on the situation.

11.4.8
Refrigerant which is drained from a system and which will not be used again in the same system shall be transferred to special refrigerant containers (see section 7.12).

Refrigerants may be used again in the same system if the quality of the refrigerants has been ascertained. The relevant information should be noted in the log.

These containers shall be returned to the supplier/fitter for regeneration or destruction of the refrigerant.
Regenerated refrigerant must have the same quality (obviously) as new refrigerant (§ 5.1).

The refrigerant which is drained from a system must be identical to the refrigerant which is indicated on the refrigerant container.
In this case it is not allowed to mix different types of refrigerant.

11.4.9
If oil is drained from a compressor or other part of the system, the refrigerant that is dissolved in the oil must first be evaporated by means of a pressure drop (or heating) of the relevant part of the system and subsequently the refrigerant can be transferred to another part of the system, such as a receiver or equivalent.

11.4.10
The CFC 11 shall not be used for cleaning purposes.

11.4.11
It is recommended to use measuring equipment only for a particular refrigerant if the equipment comes into direct contact with the refrigerant. The equipment has to be marked accordingly (one calibration for one type of refrigerant).

If possible, pressure measurements have to be carried out during the gaseous phase of refrigerants.

11.4.12
In refrigerating systems with open compressors it is possible that a prolonged standstill causes the shaft components to 'dry out' and cause leaking.

In refrigerating systems with open compressors which are stopped for a longer period of time the refrigerant shall be collected (for example in a receiver/condenser) in order to avoid refrigerant leakage through the shaft coupling.

11.5 Pressure relief devices

If a bursting disc has burst or if a safety valve has opened, the reason for this shall be established and the necessary measures shall be taken in order to avoid a recurrence before the system can be used again.

11.6 Nameplates, instructions and documents

§ 11.6 applies to new installations.
For existing installations and modifications of existing installations, only those requirements apply which on the basis of the available information can reasonably be complied with.

11.6.1 Nameplate

Subsequent to the installation inspection described in § 10.2, a plate shall be attached to the relevant refrigerating system stating the following information:
- supplier/fitter
- type of refrigerating system;
- identification number;
- type of refrigerant and nominal charge;
- the year in which the installation inspection was carried out.

11.6.2 Inspection plate

The door(s) of machinery rooms for refrigerating systems shall be marked with one or more inspection plates clearly stating the type of refrigerant and the refrigerant charge of the system.
If a machinery room houses several systems, the name of the refrigerant and the refrigerant charge for each individual system shall be stated.
A detailed plan of the machinery room marking the location of the main components shall also be affixed.

11.6.3 Instruction card

11.6.3.1
Each refrigerating system shall be provided with concise instructions in the form of an adequately protected card or plate located in a clearly visible space in the proximity of the operating area. These instructions shall at least provide the following information:

a. Name, address and telephone number of the fitter and maintenance department*.
b. Type of refrigerant (chemical name or symbol).
c. Refrigerant charge required for normal operation of the system, stating also that this is only a part of the total internal volume charge and not the total refrigerant charge (to avoid overflowing!).
d. Brief instructions for activating or inactivating the system or aggregate.
e. Instructions for stopping the system or aggregate in emergency situations (if applicable)*.
f. Reference to operating instructions (if applicable).

Several refrigerating systems charged with the same type of refrigerant can have a common instruction card. The refrigerant charge in kg for each individual system should be stated separately.

11.6.3.2
A flow chart, protected by plastic or otherwise, shall be provided for refrigerating systems having a refrigerant charge of more than 30 kg or having 2 or more evaporators. The flow chart shall be affixed in the proximity of the refrigerating system.

The shut-off devices needed for the operation and maintenance of the system shall be indicated on the chart. The flow chart shall be updated when the refrigerating system is renovated or modified.

* Does not apply to mobile installations (transportation cooling equipment, air conditioning in cars, etc.).

11.6.4 Operating instructions

Refrigerating systems with a refrigerant charge exceeding 300 kg require operating instructions provided by the manufacturer. These instructions shall always be available in the refrigerating system and shall contain the following information:

- the purpose of the refrigerating system;
- a description of the equipment and parts of the system, including a flow chart of the refrigerant and a chart of the electrical circuit;
- the name, address and telephone number of the manufacturer and/or the fitter;
- the names, addresses and telephone numbers of the maintenance and emergency fitters;
- the type of refrigerant and the refrigerant charge;
- the highest permissible pressure;
- instructions for starting and stopping the installation;

- instructions for stopping and, when necessary, sectioning the system in case of an emergency (such as a major refrigerant leakage);
- shut-off devices shall be clearly indicated on the flow chart, as described in §7.7;
- a description of possible faults, their causes and the necessary actions;
- a notice stating that work on refrigerating systems shall only be carried out by CFC fitters;
- details of maintenance procedures, leak detection and safety regulations;
- a notice stating that refrigerants shall only be discharged in accordance with the prevailing requirements;
- other instructions for handling refrigerants, their danger to the health and environment, hygienic values and explosion values;
- a warning against charging the system with the wrong type of refrigerant;
- instructions for the use of safety equipment;
- instructions for attending to injured persons (first aid).

Refrigerating systems having a refrigerant charge of more than 1000 kg also require the following information in addition to the above mentioned required information:
- instructions for operating leak detection equipment;
- instructions for sectioning the refrigerant in the event of routine work in the system;
- instructions for operating the refrigerant pump/suction compressor in order to transfer refrigerant to receivers;
- instructions for handling oil which is released as the esult of work carried out in the system;
- the necessary actions in the event of a major leakage of refrigerant;
- instructions for operating the emergency ventilation system;
- the necessary actions in the case of fire;
- the address and telephone number of the service which has to be warned in the case of an emergency (fire);
- instructions for measuring refrigerant levels in condensers, evaporators, receivers, etc.

Note:
In accordance with the ARBO Law (Law on working conditions), the manufacturer shall provide the necessary instructions for the supervision and operation of the system.

11.6.5 Documents

The owner/user shall ensure that the instructions described in sections 11.6.3 and 11.6.4 are present near the refrigerating system.

The owner/user shall also ensure that the log and the documents and certificates pertaining to the refrigerating system mentioned in §10.2.4 are stored in a suitable place and are readily available.

If the system is sold, the instructions, documents and certificates as well as the log shall be handed to the new owner.

11.7 Auxiliary equipment for treatment of refrigerants

In regard to equipment designed for:
- drainage of refrigerant;
- transport of refrigerant;
- regeneration of refrigerant;

the appropriate parts of this decree are applicable.

12 Authentication

Name and address of the principal
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Names and functions of the cooperators

Ir. P.E.J. Vermeulen	- research coordinator
H. Koffijberg	- research assistent

Names of establishments to which part of the research was put out to contract
–

Date upon which, or period in which, the research took place
1990 - 1991

Signature	Approved by
Ir. P.E.J. Vermeulen research coordinator	Ir. R.J.M. van Gerwen section leader

Appendices 1-7

Appendix 1 European Standards

The member countries of the European Community are working on the harmonisation and mutual recognition of the requirements for pressure vessels.
In order to achieve this goal a Directive ('Pressure Vessel Directive') is being drafted. The outline of this Directive was .... published in the EC Journal.
Until this Directive has been finalized, the 'European Standards' is meant to include any of the Standards below:

- Dienst voor het Stoomwezen
- TÜV
- Lloyd's
- Service des Mines
- AFS 1986:9, Pressure Vessels (Sweden)
- ISPESL (Italy)

As well as:
- ASME

Appendix 2 SAE. J51 May 1985 (synthetic hoses)

As a result of the publication of the document CEN/TC 182 for the purpose of the 'European Standard for Refrigerating Systems and Heat Pumps' , the CEN is now preparing a standard for 'Flexible Pipe Elements in Refrigerating Systems'.
This standard may among other things stipulate requirements for the maximum allowable permeation rate of refrigerant through synthetic hoses and the corresponding tubes.
Until this CEN standard has been finalized, the 'requirements for the effusion of refrigerant 12 through synthetic automotive air conditioning systems' published in SAE J51 (May 1985) are applicable. The allowable permeation levels for the refrigerant 12 (in kg/m^2 per year) also apply to other refrigerants.

Eisen voor Koelinstallaties behorende bij het besluit ozonlaagaantastende stoffen

AUTOMOTIVE AIR CONDITIONING HOSE—SAE J51 MAY85

SAE Standard

Report of the Nonmetallic Materials Committee, approved September 1960, completely revised May 1985

1. Scope—This specification covers reinforced rubber and reinforced thermoplastic hose, or hose assemblies, intended for conducting liquid and gaseous dichlorodifluoromethane (refrigerant 12) in automotive air conditioning systems. The hose shall be designed to minimize permeation of refrigerant 12 and contamination of the system and to be serviceable over a temperature range of −30 to 120°C (−22 to 248°F). Specific construction details are to be agreed upon between user and supplier.

2. Manufacture

2.1 Size—Standard dimensions are given in Table 1.

2.2 Type A1 and A2—Rubber, Textile Reinforced—The hose shall be built having a seamless oil resistant synthetic rubber tube. The reinforcement shall consist of textile yarn, cord, or fabric adhered to the tube and cover. The outer cover shall be heat and ozone-resistant synthetic rubber. It is recommended that the cover be pin-pricked.

NOTE: Commercial product normally offered for Type A1 hose has been a one braid reinforcement of rayon textile yarn with a smaller OD than Type A2 hoses. Type A2 hoses has been a two braid hose. Hose fittings for Type A1 and A2 hoses are not normally interchangeable.

2.3 Type B1 and B2—Rubber, Wire Reinforced—The hose shall be built having a seamless oil resistant synthetic rubber tube. The reinforcement shall consist of steel wire adhered to the rubber tube. The cover shall consist of a heat resistant textile yarn impregnated with a synthetic rubber cement.

NOTE: Type B1 hose is currently not being manufactured. Commercial product normally offered for Type B1 hose has been a one braid reinforcement of wire with unique ID and OD dimensions. Type B2 hose has been a one braid reinforcement of wire with ID and OD dimensions conforming to those specified in SAE 100R5 hose and compatible with SAE 100R5 hose fittings. Hose fittings for Types B1 and Type B2 are not normally interchangeable.

2.4 Type C—Thermoplastic, Textile Reinforced—The hose shall have a thermoplastic tube. The reinforcement shall consist of suitable textile yarn. The outer cover shall be heat and ozone resistant. It is recommended that the cover be pin-pricked.

2.5 Type D—Thermoplastic, Textile Reinforced, Rubber Covered—The hose shall have a thermoplastic tube. The reinforcement shall consist of textile yarn, cord, or fabric adhered to the tube and cover. It is recommended that the cover be pin-pricked.

3. Hose Identification—The hose shall be identified with the SAE number, type, and size of inside diameter in fraction of inches and/or metric mm equivalents and hose manufacturer's code marking. This marking shall appear on the outer cover of the hose at intervals not greater than 380 mm (15 in).

4. Testing—The test procedures described in the current issue of ASTM D380, Standard Methods of Testing Rubber Hose, shall be followed whenever applicable.

4.1 Test Conditions—The temperature of the testing room shall be maintained at 23 ± 2°C (73 ± 3.6°F). The temperature of the test hose or hose assemblies shall be stabilized for 24 h at the testing room temperature prior to testing.

4.2 Permeation Tests—Hose and hose assemblies shall not permit effusion of refrigerant 12 at a rate greater than that listed in Table 2 when tested at the specified temperature. Hose and hose assemblies intended for high pressure side service (discharge and liquid line applications) shall be tested at 100 ± 2°C (212 ± 3.6°F). Hose and hose assemblies intended for low pressure side service (suction line applications) shall be tested at 80 ± 2°C (176 ± 3.6°F).

The permeation test is designed to measure, by loss of mass, the rate of effusion of refrigerant 12 through the hose wall. The apparatus required consists of canisters with internal volumes of 475 to 525 cm³ (29 to 32 in³) and a 21 MPa (3000 psi) minimum burst pressure with appropriate fittings to connect to the hose assemblies, halogen detector, circulating air oven capable of maintaining uniform test temperature throughout the test periods, and a weighing scale capable of mass measurements to 0.1 g accuracy.

4.2.1 PROCEDURE—Four hose assemblies, having a free hose length of 1 m are required. Three of the hose assemblies shall be used for determining the loss of refrigerant and the fourth assembly shall be run as an empty plugged blank to be used as a means of determining the mass loss of the hose body alone.

Measure the free length of hose in each assembly at zero gage pressure to the nearest 1 mm (0.04 in). Connect each of the four hose assemblies to a canister and obtain the total mass of each test unit including end plugs to the nearest 0.1 g.

TABLE 2—ALLOWABLE PERMEATION RATE

Test Temperature		Reference Pressure		Maximum Allowable Loss of Refrigerant 12			
				kg/m²/year*		lbs/ft²/year*	
°C	°F	MPa	PSIG	Types B2 A1, A2, B1	Types C, D	Types B2 A1, A2, B1	Types C, D
100	212	3.24	470	93	22	20	[illegible]
80	176	2.21	320	58	14	12	[illegible]

* Based on internal surface area of the hose.

Load three of the test units with 0.6 mg of liquid refrigerant 12 per mm³ of each test unit's volume to a total variance of ±5 g. Check the loaded test units with a halogen detector at a sensitivity of 11 g/year (1 lb/40 years) to be sure that they do not leak. Any suitable method for safely loading may be used.

Two suggested methods are as follows:

Method I—Hose assemblies may be conveniently loaded by conditioning the hose assemblies, connected canisters, and refrigerant 12 cylinder in a cold box for 4 h minimum at a temperature below the boiling point of the refrigerant 12. Using the density of the refrigerant 12 at the conditioning temperature, the proper load weight may be calculated in terms of volume at that temperature. While keeping the refrigerant 12, hose assemblies, and connected canisters at the conditioning temperature, they may be loaded by measuring the calculated volume of liquid refrigerant 12 with a graduate. The filled hose assemblies and connected canisters should be capped while still at the conditioning temperature, but may be removed from the cold box to complete the tightening to ensure proper seal.

Method II—The hose assemblies and connected canisters may be loaded at room temperature by transferring the refrigerant 12 under pressure through suitable valves and connections. A suitable apparatus consists of a refrigerant 12 cylinder, liquid accumulator, piston pump, and controls for metering the required charge.

Place the three loaded and one blank test units in the air oven at the specified test temperature for a period of 30 ± 5 min to drive off surface moisture. Do not bend the hose in a curve with a diameter smaller than 20 times the outside diameter of the hose while in the oven. Check the loaded test units for leakage and weight all test units not less than 15 min or more than 30 min after removal from the oven. Record the mass obtained as the original mass.

Place the test units back in the air oven at the specified temperature for 24 h. At the end of the 24 h period, remove the test units, weigh in the same manner as previously specified, and return to the oven. If a loss of 20 g or more occurs, discontinue the test, check for leaks, and repeat test procedure.

Consider the first 24 h period as the preconditioning period. Disregard the mass loss during this period in final calculations. 72 h after the preconditioning weighing, weigh in the same manner as previously described. Calculate the 72 h mass loss. Determine the effusion rate by subtracting the corresponding mass loss of the blank from that of the loaded test unit. Express the effusion rate in kg/m²/year or lb/ft²/year. Calculate the rate of loss of refrigerant 12 mass for the loaded test units as follows:

$$R = \left[\frac{(A - B)}{L_1} - \frac{(C - E)}{L_2}\right] \cdot \frac{K}{D}$$

Where: A = Initial mass after preconditioning period of loaded test unit, g.
B = Final mass after 72 h period of loaded test unit, g.
C = Initial mass after preconditioning period of blank test unit, g.
D = Nominal hose inside diameter, mm.
E = Final mass after 72 h period of blank test unit, g
K = 38.7
R = Rate of refrigerant 12 mass loss, kilograms per square meter per year.
L_1 = Free hose length of loaded test unit, m.
L_2 = Free hose length of blank test unit, m.

Or Where: D = Nominal hose inside diameter, in.
K = 12.3
R = Rate of refrigerant 12 mass loss, pounds per square foot per year.
L_1 = Free hose length of loaded test unit, in.
L_2 = Free hose length of blank test unit, in.

4.3 Integrity Test—The hose shall show no signs of tube splitting causing rupture when tested at 107 ± 2°C (225 ± 3.6°F) for 24 h when loaded with refrigerant 12 as described in the Permeation Test. Three test units are required.[1] This test may be conducted as a separate test or as part of the Permeation Test by running the 24 h preconditioning period at 107 ± 2°C (225 ± 3.6°F).

4.4 Aging Test—The hose shall show no cracks or other disintegration when tested as specified after aging at 120 ± 2°C (218 ± 3.6°F) for 168 h. The mandrel used shall have a diameter eight times the nominal OD for Types A1, A2, B1, B2, and D, and shall have a diameter twice the minimum bend radius shown in Table 3 for Type C. The test unit shall have a free hose length not less than 300 mm (12 in) or more than 1000 mm (39 in).

[1] Failure of this test is indicated by a weight loss exceeding 20% of the original refrigerant 12 mass.

TABLE 3—MINIMUM BEND RADIUS FOR TYPE C HOSE

Size		Minimum Bend Radius	
mm	in	mm	in
4.8	3/16	51	2.0
6.4	1/4	76	3.0
8	5/16	89	3.5
9.5	3/8	102	4.0
10	13/32	114	4.5
13	1/2	127	5.0
16	5/8	165	6.5

4.4.1 PROCEDURE—Coil the uncapped hose assembly around the mandrel of the designated size. Place in a circulating air oven for the time and at the temperature specified. After removal from the oven, allow the hose assembly to cool to room temperature, then open the hose assembly to a straight length and examine the hose externally for cracks or r disintegration. Place the hose assembly under an internal hydrostatic pressure of 2.4 MPa (350 psi) for a period of 5 min. Report any leakage through the hose as evidence of cracking.

4.5 Cold Test—The hose shall show no evidence of cracking or breaking when tested as specified. The mandrel used for Types A1, A2, B1, B2, and D shall have a diameter eight times the nominal OD of the hose and for Type C shall have a diameter twice the minimum bend radius shown in Table 3. The test hose assembly shall have a free hose length not less than 450 mm (18 in) or more than 1000 mm (39 in).

4.5.1 PROCEDURE—Load the test hose assembly to 70% of capacity with refrigerant 12 at room temperature. For convenience, the hose assembly and refrigerant 12 may be chilled below the boiling point of the refrigerant 12 in order that the refrigerant 12 may be handled in the liquid state. Place the loaded hose assembly in an air oven at 70 ± 2°C (158 ± 3.6°F) for 48 h. Remove hose assembly from the air oven and allow it to cool to room temperature. Allow the liquid to remain in the hose assembly. Place the hose assembly in a straight position along with designated size mandrel in a cold chamber at −30°C (−22°F) for 24 h. The cold chamber shall be capable of maintaining a uniform atmosphere of cold dry air or a mixture of air and carbon dioxide at the specified temperature with a tolerance of ± 2°C (±3.6°F). Without removing the hose assembly from the cold chamber, bend it through 180 deg over the mandrel of the designated size at a uniform rate within a time period of 4 to 8 s. Allow the hose assembly to warm to room temperature and exhaust the refrigerant 12. Place the hose assembly under an internal hy tatic pressure of 2.4 MPa (350 psi) for a period of 5 min. Report any leakage through the hose as evidence of cracking.

4.6 Vacuum Test—The collapse of the outside diameter of the hose shall not exceed 20% of the original outside diameter when subjected to a reduced pressure (vacuum) of 81 kPa (24 in of mercury) for 2 min.

4.6.1 PROCEDURE—The test hose assembly shall have a free hose length not less than 610 mm (24 in) nor more than 1000 mm (39 in). This hose assembly shall be subjected to the vacuum test followed by length change test and then burst test. Bend the hose assembly to a "U" shape with the inside radius of the base of the "U" being five times the nominal outside diameter of the hose. Apply a reduced pressure (vacuum) of 81 kPa (24 in of mercury) to the bent hose assembly for 2 min. At the end of the 2 min period, while the hose is still under reduced pressure, measure the outside diameter of the hose at the base of the "U," to determine the minimum diameter in any plane.

4.7 Length Change—All hose types shall not contract in length more than 4% or elongate more than 2% when subjected to a pressure of 2.4 MPa (350 psi). Test in accordance with ASTM D380.

4.8 Bursting Strength—The minimum bursting strength for all hose and hose assemblies except the 5/8 ID Types A1 and A2 shall be 12 MPa (1750 psi). 5/8 ID Types A1 and A2 are intended for low pressure side service and shall have minimum bursting strengths of 8.5 MPa (1250 psi). Test in accordance with ASTM D380.

4.9 Proof Test—All hose shall satisfactorily withstand a hydrostatic proof test with a minimum hydrostatic pressure equal to 50% of the minimum required burst strength for a period not less than 30 s or more than 5 min.

4.10 Extraction Test—The extractables of the inside surface of the hose tube shall not exceed 118 g/m² (76 mg/in²) and any extractables shall be oily or soft/greasy in nature. The test hose assembly shall have a free hose length not less than 450 mm (18 in) or more than 1000 mm (39 in).

4.10.1 Procedure—Fill the hose assembly to capacity with trichlorotrifluoroethane (refrigerant 11F) and then empty it immediately to remove any surface material. Load the hose assembly to approximately 70% capacity with refrigerant 12 at room temperature. For convenience, the hose assembly and refrigerant 12 may be chilled below the boiling point of refrigerant 12 in order that the refrigerant 12 may be handled in the liquid state. Place the loaded hose assembly in the air oven at 70 ± 2°C (158 ± 3.6°F) for 24 h. At the end of the aging period, chill the hose assembly to −34°C (−30°F) or colder and pour the liquid refrigerant 12 into a weighed beaker and allow it to evaporate at room temperature. After the refrigerant 12 has evaporated, condition the beaker at approximately 70°C (158°F) for 1 h to remove condensed moisture, then weigh the beaker again. Report the extract in terms of grams per square meter (milligrams per square inch) of the hose inner surface based on the nominal inside diameter of the hose.

4.11 Change in Volume

4.11.1 RUBBER MATERIALS—A specimen prepared from a rubber material inner tube of the hose shall show a volume change between −5 to +35% within 5 min after removal from ASTM Oil No. 3 in which it has been immersed for 70 h at a temperature of 100 ± 2°C (212 ± 3.6°F). Test in accordance with ASTM D380.

4.11.2 THERMOPLASTIC MATERIALS—A specimen prepared from a thermoplastic material tube shall show a volume change between −35 to +5% when measured within 5 min after removal from ASTM Oil No. 3 in which it has been immersed for 70 h at a temperature of 100 ± 2°C (212 ± 3.6°F). Test in accordance with ASTM D380.

4.12 Tensile Test of Hose Assembly—The minimum force required to separate the hose from the coupling shall not be less than specified in Table 4. The test hose assembly shall have a minimum free hose length of 300 mm (12 in). Test in accordance with ASTM D380.

4.13 Ozone Test—This test is not applicable to hoses of types B1 and B2. When the hose is bent around a mandrel with a diameter 8 times the nominal diameter of the hose and exposed for 70 h to ozone air atmosphere in which the ozone partial pressure is 50 ± 5 MPa at 40 ± 2°C (104 ± 3.6°F), the outer cover of the hose shall show no cracks when examined under 7X magnification. The test hose shall be about 250 mm (10 in) longer than the mandrel circumference. Test in accordance with ASTM D380.

4.14 Cleanliness Test—The bore of all hose and hose assemblies shall be clean and dry. When subjected to this test, there shall not be more than 270 mg/m² (25 mg/ft²) of foreign material. The test hose shall not be less than 300 mm (12 in).

4.14.1 PROCEDURE—Bend the hose or hose assembly to a "U" shape, the legs of the "U" being of equal length. Position the hose in a vertical plane and fill the hose to capacity with trichlorotrifluoroethane (refrigerant 11F). Then filter the trichlorotrifluoroethane through a prepared Gooch crucible, sintered glass crucible, or 0.8 m filter of known weight. After drying at approximately 70°C (158°F) for 20 min, determine by weight difference the insoluble contamination.

4.15 Impulse test—A minimum of two hose assemblies shall be installed in a test fixture and then subjected to a pulsating pressure from 170 ± 170 kPa (25 ± 25 psi) to 2.6 MPa ± 170 kPa (375 ± 25 psi) at 30 to 40 cycles per min using a petroleum base hydraulic oil such as refrigerant oil, power steering oil or automotic transmission oil having viscosity at 107 ± 2°C (225 ± 3.6°F) of 5.0 to 10.0 cSt, at 107 ± 2°C (225 ± 3.6°F) for a minimum of 150 000 cycles with no leakage or failure. For types A1, A2, B1, B2, and D, the minimum bend radius should be five times the nominal OD of the hose. For type C hoses, see Table 3.

Test in accordance with SAE J343—Impulse Test.

TABLE 4—TENSILE STRENGTH OF HOSE ASSEMBLY

Size		Types A1, A2, C, D		Types B1, B2	
mm	in	kg	lb	kg	lb
4.8	3/16	91	200	91	200
6.4	1/4	113	250	181	400
8	5/16	159	350	272	600
9.5	3/8	204	450		
10	13/32	227	500	329	725
13	1/2	249	550	329	725
16	5/8	249	550	329	725
22	7/8	249	550	329	725
29	1 1/8	249	550	329	725

TABLE 1—AUTOMOTIVE AIR CONDITIONING HOSE DIMENSIONS[b,c]

Inside Diameter

Size		Type A1, A2, B1				Type C				Type B2, D[a]			
		Max		Min		Max		Min		Max		Min	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
4.8	3/16					5.1	0.202	4.6	0.182	5.4	0.214	4.8	0.188
6.4	1/4	7.0	0.275	6.2	0.245	6.7	0.265	6.1	0.240				
8	5/16	8.6	0.337	7.8	0.307	8.3	0.327	7.6	0.300	8.7	0.343	8.0	0.313
9.5	3/8					9.9	0.390	9.1	0.360				
10	13/32	11.1	0.436	10.2	0.401	10.7	0.423	9.9	0.389	11.1	0.437	10.3	0.406
13	1/2	13.6	0.535	12.4	0.490	13.2	0.520	12.2	0.480	13.7	0.539	12.7	0.500
16	5/8	16.8	0.660	15.6	0.615	16.5	0.650	15.2	0.680	16.9	0.667	15.9	0.625
22	7/8									23.3	0.917	22.2	0.825
29	1 1/8									29.8	1.172	28.6	1.125

Outside Diameter

Size		Type A1				Type A2				Type B1				Type C[b]		Type B2, D[a]			
		Max		Min		Max		Min		Max		Min		Max		Max		Min	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
4.8	3/16															13.7	0.530	12.7	0.500
6.4	1/4	15.1	0.594	13.5	0.532					16.5	0.648	15.3	0.602	8.3	0.328				
														11.4	0.450	17.6	0.695	16.7	0.656
8	5/16	19.1	0.750	17.5	0.688	19.8	0.781	18.3	0.719	18.8	0.742	17.7	0.696	13.5	0.530				
9.5	3/8													15.2	0.600	20.0	0.789	18.9	0.743
10	13/32	23.0	0.906	21.4	0.844	23.8	0.937	22.2	0.875	21.2	0.835	20.0	0.789	16.1	0.635	24.0	0.945	22.8	0.899
13	1/2	25.4	1.000	23.8	0.937	26.2	1.031	24.6	0.969	23.8	0.937	22.2	0.875	18.8	0.740	28.0	1.101	26.8	1.055
16	5/8	28.5	1.124	27.8	1.062	29.4	1.156	27.8	1.094	27.0	1.862	25.4	1.080	23.4	0.920	32.2	1.266	30.6	1.203
22	7/8															38.9	1.531	37.3	1.469
29	1 1/8																		

[a] Dimensions for 3/16 in size apply only to Type B2 hose.
[b] Fitting compatibility-fittings for thermoplastic hose may not necessarily be interchangeable. Therefore, it is recommended that fittings for hose be properly matched. Fittings and/or hose manufacturers' recommendations should be followed.
[c] Concentricity based on total indicator reading between inside bore of hose and outer surface of hose shall not exceed the following values:

Types A1, A2, B1, B2, and D		Type C
Sizes 6.4 mm (1/4 in) and under	0.8 mm (0.030 in)	Sizes 6.4 mm (1/4 in) and under 0.5 mm (0.020 in)
Sizes over 6.4 mm to 22 mm (1/4 in to 7/8 in)	1.0 mm (0.040 in)	Sizes over 6.4 mm to 13 mm 0.6 mm (0.025 in) (1/4 in to 1/2 in)
Sizes over 22 mm (7/8 in)	1.3 mm (0.050 in)	Sizes over 13 mm (1/2 in) 0.8 mm (0.030 in)

Appendix 3 Choice of refrigerant

In new refrigerating systems refrigerants shall be used which are as harmless as possible to the environment. The agreements in the CFC Action Programme stipulate that group 1A refrigerants may not be used in new installations as from the dates mentioned below.

Compressor power	Date
< 500 W	01-07-1997
> 500 W	mid-1992 [1]

[1] to be set

Appendix 4 Wall thickness of copper piping

Straight lengths of refrigerant piping, semihard

Outside diameter	Wall thickness	Inside diameter	P_{max}
	mm	mm	bar
3/8"	0.81	7.905	91
1/2"	0.82	11.080	81
5/8"	0.89	14.095	75
3/4"	0.90	17.250	65
< 10 mm	1.0	-	60
10 mm	1.0	8	60
12 mm	1.0	10	60
15 mm	1.0	13	46
22 mm	1.1	19.8	33
28 mm	1.2	25.6	28
35 mm	1.3	32.4	24
42 mm	1.4	39.2	21
54 mm	1.5	51.0	17
67 mm	1.9	63.2	17
80 mm	2.1	75.8	16

Soft copper piping

Outside diameter	Wall thickness	P_{max}
	mm	bar
capilair	0.66	-
1/8"	0.76	217
3/16"	0.76	137
1/4"	0.76	100
5/16"	0.81	84
3/8"	0.81	70
1/2"	0.81	55
5/8"	0.89	51
3/4"	0.89	44
7/8"	0.89	40

Note: at higher pressures it is necessary to use thicker walls.
Contact your supplier.

Appendix 5 Classification of refregerants

The values in this appendix comply with Draft CEN prEN 378 Part 3.

Group 1A refrigerants

Symbol	Chemical name	Chemical formula	Allowable concentration with respect to the toxicity in kg/m^3	Ozone depletion value based on R11 = 1
R11	Trichlorofluoromethane	CCl_3F	0.3	1
R12	Dichlorodifluoromethane	CCl_2F_2	0.5	1
R13	Chlorotrifluoromethane	$CClF_3$	0.5	0.45
R13B1	Bromotrifluoromethane	$CBrF_3$	0.6	1
R113	Trichlorotrifluoroethane	$CClF_3F_3$	0.2	0.8
R114	Dichlorotetrafluoroethane	$C_2CL_2F_4$	0.7	1
R115	Chloropentafluoroethane	C_2ClF_5	0.6	0.6
RC318	Octafluorocyclobutane	C_4F_8	0.8	-
R500	R12 (73.8%) + R152a (26.2%)	$CCl_2F_2/C_2H_4F_2$	0.4	0.8
R502	R22 (48.8%) + R115 (51.2%)	$CHClF_2/C_2ClF_5$	0.4	0.3

(1) Value not yet decided; in the magnitude of R12 or R22.
To be added as soon as it has been decided.

Group 1B refregerants

Symbol	Chemical name	Chemical formula	Allowable concentration with respect to the toxicity in kg/m^3	Ozone depletion value based on R11 = 1
R21	Dichlorotrifluormethane	$ChCl_2F$	0.1	0.04
R22	Chlorodifluoromethane	$CHClF_2$	0.4	0.05
R123	Dichlorotrifluoroethane	$C_2HCl_2F_3$	-	0.02
R124	Chlorotetrafluoroethane	$CHClFCF_3$	-	0.02
R125	Pentafluoroethane	CF_3CHF_2	-	0
R134a	Tetrafluoroethane	F_3CH_2F	-	0

Appendix 6 MAC values of refrigerants (based on volume)

R11	-	1000 ppm
R12	-	1000 ppm
R13	-	-
R13B1	-	1000 ppm
R14	-	-
R21	-	10 ppm
R22	-	1000 ppm
R23	-	-
R113	-	1000 ppm
R114	-	1000 ppm

Appendix 7 Handbook Environmental Permits, part 4

Appendix 8 Quality specification for halocarbon - refrigerants

A1. Characteristics of Refrigerants and Contaminants

A1.1 Characteristics of refrigerants and contaminants addressed are listed in the following general classifications:

A1.2 *Characteristics*
a. Boiling point
b. Boiling point range

A1.3 *Contaminants*
a. Water
b. Chloride ion
c. Acidity
d. High boiling residue
e. Particulates/solids
f. Non-condensables
g. Other refrigerants

A2. Sampling, Test Methods and Maximum Permissible Contaminant Levels

A2.1 The recommended reference test methods for the various contaminants are given in the following paragraphs. If alternate test methods are employed, the user must be able to demonstrate that they produce results equivalent to the specified reference method.

A2.2 *Refrigerant Sampling*

A2.2.1 Special precautions should be taken to ensure that representative samples are obtained for analysis. Sampling shall be done by trained laboratory personnel following accepted sampling and safety procedures.

A2.2.2 *Gas Phase Sample.* A gas phase sample shall be obtained for determining the non-condensables by connecting the sample cylinder to an evacuated gas sampling bulb by means of a manifold. The manifold should have a valve arrangement that facilitates evacuation of all connecting tubing leading to the sampling bulb. Since non-condensable gases, if present, will concentrate in the vapor phase of the refrigerant, care must be exercised to eliminate introduction of air during the sample transfer. Purging is not an acceptable procedure for a gas phase sample since it may introduce a foreign product. Since R11 and R113 have normal boiling points at or above room temperature, non-condensable determinations is not required for these refrigerants.

A2.2.3 *Liquid Phase Sample.* A liquid phase sample, which may be obtained as follows, is required for all tests listed in this standard, except the test for non-condensables. Place an empty sample cylinder with the valve opened in an oven at 110°C for one hour. Remove it from the oven whilst hot, immediately connect to an evacuation system and evacuate to less than 1 mm mercury (1000 microns). Close the valve and allow it to cool.

A2.2.3.1 The valve and lines from the unit to be sampled shall be clean and dry. Take the sample as a liquid by chilling the sample cylinder slightly. Do not load the cylinder over 80 percent full at room temperature. This can be accomplished by weighing the empty cylinder and then the cylinder with refrigerant. The cylinder must not become completely full of liquid below 55°C. When the desired amount of refrigerants has been collected, close the valve(s) and disconnect the sample cylinder immediately.

A2.2.3.2 Check the sample cylinder for leaks and record the gross weight.

A2.3 *Refrigerant Boiling Point and Boiling Range*

A2.3.1 The required values for boiling point and boiling point range are given in table "Quality specification for refrigerants".

A2.3.2 Gas chromatography (GC) is an acceptable test method which can be used to characterize refrigerants. This is done by comparison to be known standards.

A2.4 *Water Content*

A2.4.1 The Karl Fischer Test Method shall be used for determining the water content of refrigerant. This method can be used for refrigerants that are either a liquid or a gas at room temperature, including refrigerants R11 and R113. For all refrigerants, the sample for water analysis shall be taken from the liquid phase of the container to be tested. Proper operation of the analytical method requires special equipment and an experienced operator. The precision of the results is excellent if proper sampling and handling procedures are followed. Refrigerants containing a colored dye can be successfully analyzed for water using this method.

A2.4.2 Water is a harmful contaminant in refrigerants because it causes freeze up, corrosion and promotes unfavorable chemical breakdown.

A2.5 *Chloride Ions.* The refrigerant shall be tested for chlorides as an indication of the presence of hydrochloric or similar acids.

A2.5.1 This test will detect HCl and other halogens and requires only a sample of 5 ml. The test will show noticeable turbidity at equivalent HCl levels of about 25 ppm by weight or higher.

A2.5.2 The results of the test shall not exhibit any sign of turbidity.
Results should be reported as "pass" or "fail".

A2.6 *Acidity*

A2.6.1 The acidity test uses the titration principle to detect any compound that ionizes as an acid. The test requires about a 100 to120 gram sample and has a lower detection limit of 0.1 ppm by weight.

A2.7 *High Boiling Residue*

A2.7.1 High boiling residue will be determined by measuring the residue after evaporation of a standard volume of refrigerant at a temperature 10.0°C, above the boiling point of the sample using a Goetz tube. Oils and organic acids will be captured by this method.

A2.7.2 The value for high boiling residue shall be expressed as a percentage by volume and shall not exceed the maximum percent specified in table "Quality specifications of refrigerants".

A2.8 *Particulates/Solids*

A2.8.1 During the Boiling Range test, a measured amount of sample is evaporated from a Goetz tube under controlled temperature conditions. The particulates/solids shall be determined by visual examination of the empty Goetz tube after the sample has evaporated completely. Presence of dirt, rust or other particulate contamination is reported as "fail".

A2.9 *Non-Condensables*

A2.9.1 Non-condensable gases consist primarily of air accumulated in the vapor phase of refrigerant-containing tanks. The solubility of air in the refrigerants liquid phase is extremely low and air is not significant as a liquid phase contaminant. The presence of non-condensable gases may reflect poor quality control in transferring refrigerants to storage tanks and cylinders.

A2.9.2 Chromatography is an acceptable test method.

A2.9.3 The maximum level of non-condensables in the vapor phase of a refrigerant in a container shall not exceed the maximum percent specified in table "Quality specification for refrigerants".

A2.10 *Other refrigerants*

A2.10.1 The amount of other refrigerants in the subject refrigerant shall be determined by the gas chromatograph for the appropriate refrigerant.

A3 Reporting Procedure

A3.1 The source (manufacturer, reclaimer or repackager) of the packaged refrigerant should be identified. The fluorcarbon refrigerant shall be identified by its accepted refrigerant number and/or its chemical name. Maximum permissible levels of contaminants are shown in table "Quality specification for refrigerants". Test results shall be tabulated in a like manner.

QUALITY SPECIFICATION FOR REFRIGERANTS

Physical Properties of Refrigerants and Maximum Contaminant Levels

	REFRIGERANTS													
	R11	R12	R13	R22	R113	R114	R123	134a	R141b	R142b	R500	R502	R503	R717(NH_3)
PHYSICAL PROPERTIES Boiling point °C at 760 mm Hg	23.8	-29.8	-81.4	-40.8	47.6	3.8	27.6	-26.5	32	-9.6	-33.5	-45.4	-88.7	-33.3
Boiling range °C for 5% to 85% by volume distilled	0.3	0.3	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.5	0.5	0.5	0.5 [1]
VAPOR PHASE CONTAMINANTS Air and other non-condensables (in filled container) Max. % by volume	-	1.5	1.5	1.5	-	1.5	-	1.5	1.5	1.5	1.5	1.5	1.5	5.0 [2]
LIQUID PHASE CONTAMINANTS Water - ppm by weight	10	10	10	10	10	10	10	10	10	10	10	10	10	400
Chloride ion - no turbidity to pass by test	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	-
Acidity - Max. ppm by weight	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-
High boiling residues - Max. % by volume	0.01	0.01	0.05	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.05	0.01	0.01	-
Particulates/Solids - visualy clean to pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	-
Other refrigerants - Max. %by weight	0.5	0.5	0.5	0.5	0.5	0.5	0.5 [3]	0.5	0.5	0.5	0.5	0.5	0.5	

1) Boiling range for 5% to 97 % by volume distilled.

2) cm^3 gas in 100 cm^3 liquid.

3) A maximum of 4% of R123a is allowed