

Description of the European standard EN 378: Refrigerating systems and heat pumps – Safety and environmental requirements

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INTRODUCTION

The global warming potential (GWP) of common fluorocarbon refrigerants have generated concerns in recent years.

⇒ Several low-GWP refrigerants have caused increasing attention.

The most promised options are:

- carbon dioxide (CO₂), ammonia and hydrocarbons (under development: hydrofluoroolefins (HFOs)).

However, the flammability, toxicity, and safety of some of these alternative refrigerants limit their application.

CO₂: very high pressure.

Ammonia refrigerant is toxic and with a lower flammability .

Hydrocarbon refrigerants are highly flammable.

INTRODUCTION (continued)

There are differences in regulation among regions and application and the diversity of relevant regulatory instruments.

These create uncertainty and complexity for HVAC&R manufacturers who wish to implement these refrigerants.

Manufacturers need guidance regarding the regulations, code requirements, and to overcome barriers related to low-GWP refrigerants.

Service technicians need education and training for technologies with natural refrigerants.

End users need information, regulations and training for technologies with natural refrigerants.

INTRODUCTION (continued)

Appropriate standards applied in practice mean safe, sustainable, energy efficient and cost-effective operation of refrigeration systems, including an accelerated use of systems with natural refrigerants.

We must recognise that the existing standards are not perfect and in some cases need to be improved,

It is in the business interest of the global refrigeration community to harmonise standards globally, i.e. National => European (EN)/American (ANSI)/Asian => Global (ISO).

We have to pay attention to avoid domination of groups with specific interests in the global or regional communities.

**European standard EN 378:
Refrigerating systems and heat pumps –
Safety and environmental requirements**

This standard consists of four parts:

Part 1: Basic requirements, definitions, classification and selection criteria

Part 2: Design, construction, testing, marking and documentation

Part 3: Installation site and personal protection

Part 4: Operation, maintenance, repair and recovery

Part 1: Basic requirements, definitions, classification and selection criteria

1. Scope

2. Normative references

3. Terms and definitions

3.1 Refrigerating systems

3.2 Occupancies, localities

3.3 Pressures

3.4 Components of refrigerating systems

3.5 Piping and joints

3.6 Safety accessories

3.7 Fluids

3.8 Miscellaneous

continue

Part 1: Basic requirements, definitions, classification and selection criteria (continued)

4. Classification

4.1 Refrigerating systems

4.2 Occupancies

4.3 Designation and Classification of refrigerants

4.4 Examples of systems

4.5 Special requirements for skating rinks

Annexes

Annex A (informative) Equivalent terms in English, French and German

Annex B (informative) Total equivalent warming impact (TEWI)

Annex C (normative) Refrigerant charge limitations

Annex D (informative) Protection for people who are inside cold rooms

Annex E (normat.) Safety classification and information about refrigerants

Annex F (informative) Safety group classifications

Annex G (normative) Special requirements for ice rinks

Part 2: Design, construction, testing, marking and documentation

1. Scope

2. Normative references

3. Terms, definitions, designations, classification and abbreviations

3.1 Terms and definitions

3.2. Designations and classification

3.3 Abbreviations

4. Significant hazards

5. Safety requirements and/or measures

5.1 General safety and/or environmental requirements

5.2 Safety requirements for components and piping

5.3 Miscellaneous components

6 Requirements for assemblies

6.1 General

6.2 Design and construction

6.3 Testing

6.4 Marking and documentation

Part 2: Design, construction, testing, marking and documentation (continued)

Annex A (normative) Additional requirements for refrigerating systems and heat pumps with R717

Annex B (normative) Determination of category for assemblies

Annex C (normative) Requirements for intrinsic safety test

Annex D (normative) List of significant hazards

Annex E (informative) Assessment of assemblies for compliance with directive 97/23/EC

Annex F (informative) Examples for arrangement of pressure relief devices in refrigerating systems

Annex G (informative) Checklist for external visual inspection of the installation

Annex ZA (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 97/23/EC

Annex ZB (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC

Annex ZC (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC

Part 3: Installation site and personal protection

1. Scope
 2. Normative references
 3. Terms and definitions
 4. Location of refrigerating equipment
 5. Machinery rooms
 6. Electrical installations
 7. Safety alarms
 8. Detectors
 9. Instructions, manual and notices
 10. Heat sources and temporary high temperatures
- Annex A (informative) Personal protective equipment

Part 4: Operation, maintenance, repair and recovery

1. Scope
2. Normative references
3. Terms and definitions
4. General requirements
 - 4.1 Operational instructions
 - 4.2 Instruction of operating personnel
 - 4.3 Documentation
5. Maintenance and repair
 - 5.1 General
 - 5.2 Maintenance
 - 5.3 Repair
 - 5.4 Change of refrigerant type

Part 4: Operation, maintenance, repair and recovery (continued)

6. Requirements for recovery, reuse and disposal

6.1 General requirements

6.2 Requirements for recovery and reuse of refrigerant

6.3 Requirements for refrigerant transfer, transport and storage

6.4 Requirements for recovery equipment

6.5 Requirements for disposal

6.6 Requirements for documentation

Annex A (normative) Draining the oil from a refrigerating system

Annex B (informat.) Guide specification (parameters) for recycled refrigerant

Annex C (informative) Handling and storage of refrigerants

Annex D (informative) In-service inspection

Annex E (informat.) Guidelines for repairs of equipment using flammable refrigerants

Part 1: Basic requirements, definitions, classification and selection criteria

Table C.1 — Refrigerant safety groups

Refrigerant safety group — A3		
Location of the refrigerating system	Occupancy General occupancy — Class A	
	Direct systems	Indirect systems
Human occupied space which is not a machinery room	1 A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: Only sealed systems with Max. charge = practical limit x room volume and not exceeding 1,5 kg	2 Considered as direct system see box nr. 1
Compressor and liquid receiver in an unoccupied machinery room or in the open air	3 A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: Only sealed systems with Max. charge = practical limit x room volume and not exceeding 1,5 kg;	4 A/C Systems and heat pumps for human comfort: see C.3 Max. charge = practical limit x room volume and not exceeding 1,5 kg
All refrigerant containing parts in an unoccupied machinery room or in the open air	5 A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: Only sealed systems with max charge = practical limit x room volume and not exceeding 1 kg below or 5 kg above ground floor level	6 A/C Systems and heat pumps for human comfort: see C.3 Max. charge = practical limit x room volume and not exceeding 1 kg Below ground floor level or 5 kg above ground floor level
	Supervised occupancy — Class B	
Human occupied space which is not a machinery room	7 A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: Max charge = practical limit x room volume and not exceeding 1 kg Below ground floor level and 2,5 kg above ground floor level	8 Considered as direct system; see box nr. 7
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Part 1, Annex C – Refrigerant charge limitation

Category	Examples	Requirements
A (domestic/ public)	Hospitals, prisons, theatres, schools, supermarkets, hotels, dwellings.	<ul style="list-style-type: none"> • <1.5kg per sealed system • <5kg in special machinery rooms or in the open air for indirect systems
B (commercial/ private)	Offices, small shops, restaurants, places for general manufacturing and where people work.	<ul style="list-style-type: none"> • <2.5kg per sealed system • <10kg in special machinery rooms or open air for indirect systems.
C (industrial/ restricted)	Cold stores, dairies, abattoirs, non-public areas of supermarkets, plant rooms.	<ul style="list-style-type: none"> • <10kg in human occupied spaces • <25kg if high pressure side (except air cooled condenser) is located in a special machinery room or in the open air • No limit if all refrigerant is contained in a special machinery room or in the open air.

Systems with charge sizes of 0.15kg or less can be installed in any size of room. Systems with charge size of more than 0.15kg room size should be such that a sudden loss of refrigerant shall not raise the mean concentration in the room above the practical limit (approximately 0.008kg/m^3).

C.3 Charge limitations due to flammability for A/C systems or heat pumps for human comfort

C.3.1 General

A factory sealed refrigerating systems with less than 150 g of A2 or A3 refrigerant can be located in an occupied space which is not a machinery or special machinery room without restriction.

C.3.2 Refrigerant containing parts in a occupied space

The maximum charge in a room shall be in accordance with the following:

If the charge size is greater than $4 \text{ m}^3 \times \text{LFL}$ the maximum charge in a room shall be in accordance with the following:

$$m_{\max} = 2,5 \times \text{LFL}^{5/4} \times h_0 \times A^{1/2}$$

or the required minimum floor area A_{\min} to install a system with refrigerant charge m (kg) shall be in accordance with following;

$$A_{\min} = (m / (2,5 \times \text{LFL}^{5/4} \times h_0))^2$$

where

m_{\max} is the allowable maximum charge in a room in kg;

Part1, Annex F

SAFETY GROUP CLASSIFICATIONS

Toxicity classification:

Class A: toxicity has not been identified at concentrations ≤ 400 ppm, based on TLV.

Class B: there is evidence of toxicity at concentrations below 400 ppm, based on TLV.

Flammability classification:

Class 1: No flame propagation in air at 21°C and 1,01 bar;

Class 2: Lower flammability limit (LFL) $> \text{Vol}3.5\%$ at 21°C and 1,01 bar and heat of combustion $< 19\ 000$ kJ/kg;

Class 3: Highly flammable LFL ≤ 3.5 Vol% at 21°C and 1,01 bar or heat of combustion $\geq 19\ 000$ kJ/kg.

Part 1, Annex F
SAFETY GROUP CLASSIFICATIONS

FLAMMABILITY	TOXICITY	
	Lower	Higher
No Flame propagation	A1	B1
Lower flammability	A2	B2
Higher flammability	A3	B3

Part 2, Annex A

Additional requirements for refrigerating systems and heat pumps with R717

A.1 Systems with a refrigerant charge above 50 kg

Refrigerating systems with a refrigerant charge above 50 kg shall have shut-off facilities in order to isolate components of the system like receivers, accumulators and flooded type heat exchangers.

If safety valves which blow off into the atmosphere are used as protection devices against excessive pressure, two safety valves each of them having the total required relief capacity and connected by a change-over valve shall be used.

Part 2, Annex A

Additional requirements for refrigerating systems and heat pumps with R717 (continued)

A.2 Systems with a refrigerant charge above 3 000 kg

Groups of components shall be equipped with a functionally remote-controlled shut-off device in the liquid line.

This device shall close in the case of control power failure, detection of a leak or emergency stop.

Pumps shall be mounted between valves, of which the valve on the suction side of the pump shall be a remote controlled valve.

A.3 Pumps

Pumps for R717 shall either be a centrifugal pump with hermetic motor, or be equipped with a double seal system.

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Part 2, Annex A

Additional requirements for refrigerating systems and heat pumps with R717 (continued)

A.4 Emergency stop system for refrigerating systems with a refrigerant charge above 3 000 kg

An emergency stop system that acts on the relevant drives and actuators shall be installed for the refrigerating system.

The refrigerating system shall be put in a safe mode after activation of the emergency control.

Where the risk of trapping of liquid exists, subject piping shall be provided with a relief device.

When the emergency stop system is triggered, it shall be possible to shut off the pipes

Part 2, Annex G

Checklist for external visual inspection of the installation

This checklist covers the following items:

- a) check for transit or storage damage to the equipment;
- b) compare the complete installation with the refrigerating and electrical system drawings;
- c) check that all components are as specified;
- d) check that all safety documents and equipment required by this European Standard are present;
- e) check that all devices and arrangements for safety and environmental protection are present and in compliance with this European Standard;
- f) check that pressure vessel documents, certificates, identification plates, instruction manual and documentation required in this European Standard are present;
- g) check that volume of receivers is sufficient;

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Part 3: Installation site and personal protection

4 Location of refrigerating equipment

4.1 General

4.2 Refrigerating equipment located outside in the open air

4.3 Refrigerating equipment located inside in a machinery room

4.4 Refrigerating equipment located in an occupied space

4.5 Refrigerating equipment located in an unoccupied space not designated a machinery room

4.6 Refrigerating equipment located within a ventilated enclosure

Part 3: Installation site and personal protection

5 Machinery rooms

5.1 General

5.2 Occupation of machinery rooms

5.3 Venting

5.4 Emergency

5.5 Combustion equipment

5.6 Open flame

5.7 Storage

5.8 Remote emergency switch

5.9 Exterior openings of the machinery rooms

5.10 Piping and ducting

Part 3: Installation site and personal protection

5 Machinery rooms (continued)

5.11 Normal lighting

5.12 Emergency lighting

5.13 Warning notice and access

5.14 Dimensions and accessibility

5.15 Doors, walls and ducts

5.16 Ventilation

5.17 Machinery rooms for groups A2, A3, B2 and B3 refrigerants

5.17.1.2 Emergency exhaust ventilation

5.17.2 Additional requirements for R717: Drainage; Specific equipment for emergency washing; Fire sprinkler systems.

Part 3: Installation site and personal protection

7 Safety alarms

7.1 General; 7.2 Alarm system power; 7.3 Alarm system warning;
7.4 Additional alarm system requirements for R717 systems with charges above 3 000 kg.

8 Detectors

8.1 General; 8.2 Location of detectors; 8.3 Number of detectors;
8.4 Function of the detector; 8.5 Type and performance of a detector;
8.6 Construction and installation;
8.7 R717 detectors; 8.8 Refrigerant detectors for A2/A3 refrigerants

Part 3: Annex A

Personal protective equipment

A.1 General requirements

A.1.1 Type of protective equipment

A.1.2 Accessibility

A.1.3 Location

A.1.4 Check and maintenance

A.1.5 Temperature

A.1.6 Respirators

A.2 Normal use

A.3 Emergency use

A.3.1 General

A.3.2 Respiratory protective devices

A.3.3 First aid equipment

A.3.4 Emergency showers

Part 4: Operation, maintenance, repair and recover

4 General requirements

4.1 Operational instructions

4.1.1 ...the personnel charged with the operation, supervision and maintenance ... are adequately instructed ...

4.1.2 Personnel in charge of the refrigerating system that contain more than 3 kg of refrigerant shall have knowledge and experience of the mode of functioning, operation and monitoring of this system.

4.1.3 The mixing of different refrigerants within a system is not permitted under any circumstances. ...

4.2 Instruction of operating personnel

Before a new refrigerating system is put into service, it shall be ensured that the operating personnel are instructed ...

NOTE: It is advisable that the operating personnel are present during evacuation, charging with refrigerant and adjustment of the refrigerating system as well as, if possible, during assembly on site.

Part 4: Operation, maintenance, repair and recover

4.3 Documentation

4.3.1 The owner / operator shall keep an updated logbook of the refrigerating system if the refrigerant charge exceeds 3 kg.

4.3.2 In the logbook the following information shall be recorded:

- a) details of all maintenance and repair work;
- b) quantities and kind of (new, reused or recycled) refrigerant which have been charged on each occasion, ...
- c) analysis of a reused refrigerant, ...
- d) source of the reused refrigerant;
- e) changes and replacements of components of the system;
- f) results of all periodic routine tests;
- g) record of significant periods of non-use.

Part 4: Operation, maintenance, repair and recover

5 Maintenance and repair

5.1.1 Each refrigerating system shall be subjected to preventive maintenance in accordance with the instruction manual, see EN 378-2.

5.1.2 The user / owner concerned for the refrigerating system shall ensure that the system is inspected, regularly supervised and maintained in a satisfactory manner.

5.1.3 Systems with a charge larger than 3 kg should be subject to tightness inspection at least on an annual basis. ...

5.2 Maintenance

5.2.1 Maintenance shall be undertaken in such a way that:

- a) accidents to personnel are minimised;
- b) damage to goods is minimised;
- c) components of the system remain in good working order;
- d) the purpose and availability of the system are maintained;
- e) leakage of refrigerant or oil are identified and remedied;
- f) waste of energy is minimised.

Part 4: Annex A

Draining the oil from a refrigerating system

A.1 General

A.2 Ammonia systems

A.2.1 General

Usually both the high and the low pressure sides of a refrigerating system containing R717 (ammonia) are equipped with oil collectors with draining valves in order to be able to remove ...

A.2.2 Draining procedure

The pressure of the section from which the oil is drained shall be above atmospheric pressure.

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Thank you.