INTERNATIONAL STANDARD

ISO 5149-4

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Refrigerating systems and heat pumps — Safety and environmental requirements —

Part 4: Operation, maintenance, repair and recovery

Systèmes frigorifiques et pompes à chaleur — Exigences de sécurité et d'environnement —

Partie 4: Fonctionnement, maintenance, réparation et récupération

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 5149-4 was prepared by Technical Committee ISO/TC 86, *Refrigeration and air-conditioning*, Subcommittee SC 1, *Safety and environmental requirements for refrigerating systems*.

This first edition of ISO 5149-4, together with ISO 5149-1, ISO 5149-2 and ISO 5149-3, cancels and replaces ISO 5149:1993, which has been technically revised.

ISO 5149 consists of the following parts, under the general title *Refrigerating systems and heat pumps — Safety and environmental requirements*:

Part 1: Definitions, classification and selection criteria

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

Part 3: Installation site

Part 4: Operation, maintenance, repair and recovery

Refrigerating systems and heat pumps — Safety and environmental requirements —

Part 4: Operation, maintenance, repair and recovery

1 Scope

This part of ISO 5149 specifies requirements for safety and environmental aspects in relation to operation, maintenance and repair of refrigerating systems and the recovery, reuse and disposal of all types of refrigerant, refrigerant oil, heat transfer fluid, refrigerating system and part thereof.

These requirements are intended to minimize risks of injury to persons and damage to property and the environment resulting from improper handling of the refrigerants or from contaminants leading to system breakdown and resultant emission of the refrigerant.

Subclauses 4.1.1, 4.1.2, 4.3, 5.1.1 to 5.1.4, 5.2, 5.3.1, 5.3.3 and 6.6 of this part of ISO 5149 are not applicable to unitary systems having a power cord, being factory sealed, and in conformance with IEC 60335 series.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5149-1:2014, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 1: Definitions, classification and selection criteria*

ISO 5149-2:2014,*Refrigerating systems and heat pumps — Safety and environmental requirements — Part 2: Design, construction, testing, marking and documentation*

ISO 11650, *Performance of refrigerant recovery and/or recycling equipment*

IEC 60335-2-104, *Household and similar electrical appliances — Safety — Part 2-104: Particular requirements for appliances to recover and/or recycle refrigerant from air conditioning and refrigeration equipment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5149-1 apply.

4 General requirements

4.1 Operation instructions

4.1.1 Care shall be taken to ensure that the personnel charged with the operation, supervision and maintenance of the refrigerating system are adequately instructed and competent with respect to their tasks. The installer of the refrigerating system shall draw attention to the necessity for adequate instruction of operating and supervising personnel. Typical in-service inspection requirements are shown in Annex D.

4.1.2 Personnel in charge of the refrigerating system shall have knowledge and experience of the mode of functioning, operation and day-by-day monitoring of this system.

4.1.3 The mixing of different refrigerants within a system shall not be permitted under any circumstances. Change of the refrigerant type shall be in accordance with 5.4.

4.2 Instruction of operating personnel

Before a new refrigerating system is put into service, the person responsible for placing the system in operation shall ensure that the operating personnel are instructed on the basis of the instruction manual about the construction, supervision, operation and maintenance of the refrigerating system, as well as the safety measures to be observed, and the properties and handling of the refrigerant used.

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.

4.3 Documentation

4.3.1 The party concerned shall keep an updated logbook of the refrigerating system.

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, and the quantities of refrigerant which have been transferred from the system on each occasion (see also 6.6);

c) analysis of any reused refrigerant, if available, the results of which shall also be kept in the logbook;

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.

4.3.3 The logbook shall either be kept in the machinery room, or the data shall be stored in a computer of the party concerned with a printout in the machinery room, in which case the information shall be accessible to the competent person when servicing or testing.

5 Maintenance and repair

5.1 General

5.1.1 Each refrigerating system shall be subjected to preventive maintenance in accordance with the instruction manual (see ISO 5149-2).

NOTE The frequency of such maintenance depends on the type, size, age, use, etc. of the system. In many cases more than one maintenance service is required in the course of one year in accordance with legal requirements.

5.1.2 The person responsible for the refrigerating system shall ensure that the system is inspected, regularly supervised and maintained.

5.1.3 The person responsible for the refrigerating system shall also be responsible when another person uses the refrigerating system, unless another division of responsibility has been agreed upon.

5.1.4 Regular maintenance which does not include interference with, nor adjustment of, the refrigerating system and which requires no specialized knowledge of refrigeration engineering shall be carried out by a person of appropriate competence employed by the person responsible.

5.2 Maintenance

5.2.1 Maintenance shall be undertaken in such a way that:

a) accidents to personnel are prevented;

b) damage to goods is prevented;

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 is identified and remedied;

f) waste of energy is minimized.

5.2.2 The extent and time schedule for maintenance shall be fully described in the instruction manual (see ISO 5149-2).

5.2.3 If the discharge line of a pressure relief device is connected into a common discharge line and the valve is temporarily dismounted for reasons of testing and maintenance, the connecting ends of the remaining ends entering the common discharge header are to be blocked.

5.2.4 When a secondary cooling or heating system is used, the heat-transfer medium shall be periodically inspected in accordance with manufacturer instructions for its composition, and the secondary system shall be tested and inspected for the presence of refrigerant from the primary circuit.

5.2.5 Regular leak tests, inspections and checking of the safety equipment shall be carried out. See Annex D.

5.2.6 When oil is drained from a refrigerating system it shall be carried out safely in accordance with the instruction manual. A procedure is provided in Annex A.

5.3 Repair

5.3.1 Repairs on refrigerant containing components shall be carried out in the following order, if appropriate:

a) instructing of the maintenance staff;

b) emptying, recovery and evacuation;

c) disconnecting and safeguarding of the components to be repaired (e.g. powerdrive, pressure vessel, piping);

d) cleaning and purging (e.g. with nitrogen);

e) releasing for repair;

f) carrying out the repair;

g) testing and checking of the repaired component (pressure test, leakage test, functional test), see ISO 5149-2;

h) replacing, evacuating and recharging with refrigerant.

NOTE For welding or using arc- and flame-producing apparatus, specific personnel and welding or brazing procedure approvals are used.

5.3.2 Refrigerant leaks shall be identified and repaired as soon as practicable by a competent person and the system shall only be put into service again when all the leaks have been repaired.

5.3.3 During each periodic maintenance and following each repair, as necessary, at least the following tasks shall be performed:

a) all safety, control and measurement devices as well as alarm systems shall be checked to verify operation and that they are within the calibration period;

b) leakage tests shall be carried out at the relevant repaired part of the refrigerating system or the entire system;

c) charge isolation and evacuation of the repaired part of the refrigerating system.

5.3.4 Maintenance and repair requiring the assistance of other skilled personnel (such as welders, electricians, measuring and control specialists) shall be carried out under the supervision of a competent person.

5.3.5 Welding and brazing shall only be carried out by competent personnel and only after the section has been purged according to an approved procedure.

5.3.6 Replacements of components or changes to the refrigerating system shall be ordered and carried out by a competent person or by authorized repair service centre for systems that do not require periodic maintenance.

5.3.7 After a pressure relief valve, which discharges to atmosphere, has been actuated, it shall be replaced if it is not tight.

5.4 Change of refrigerant type

5.4.1 General

In the event of a change of the refrigerant type used in the refrigerating system, the following planning and execution steps shall be taken.

5.4.2 Planning the change of refrigerant type

Before changing the refrigerant type a plan shall be prepared. It shall include at least the following actions:

a) verify that the refrigerating system and components are suitable for the refrigerant type change;

b) examine all materials used in the refrigerating system to ensure they are compatible with the new refrigerant type;

c) determine whether the existing lubricant type is suitable for use with the new refrigerant type;

d) verify that the system allowable pressure (PS) shall not be exceeded;

e) verify that the relief valve required discharge capacity is adequate for the new refrigerant type;

f) verify that the motor and switchgear current ratings are adequate for the new refrigerant type;

g) verify that the liquid receiver is sufficiently large for the new refrigerant charge;

h) if the new refrigerant has a different classification, ensure that the consequences of the change of refrigerant classification are addressed.

NOTE Guidance on equipment suitability for refrigerant type change should be sought from the original equipment manufacturer, new refrigerant manufacturer and lubricant manufacturer, as appropriate.

5.4.3 Execution of the change of refrigerant type

Follow the recommendations of the equipment manufacturer, the compressor manufacturer, the refrigerant supplier or apply the following procedure in accordance with the plan developed according to 5.4.2:

a) record a full set of system operating parameters to establish baseline performance;

b) repair any issues identified by a);

c) conduct a thorough leak check and identify any joints and seals to be replaced;

d) recover the original refrigerant in accordance with 6.2;

e) drain the lubricant;

f) check whether the lubricant is in good condition. If not, then remove the residual lubricant from the system;

g) change the joints, seals, indicating and control devices, filters, oil filters, driers and relief valves as required;

h) evacuate the system to less than 132 Pa absolute pressure;

i) charge with lubricant;

j) charge with refrigerant;

k) adjust indicating and control devices, including software modifications if required;

l) amend all indications as to the refrigerant type used, including the log book and documentation at operating site;

m) conduct a thorough leak check and repair any joints and seals as required;

n) record a full set of system operating parameters to compare with the previous baseline performance.

6 Requirements for recovery, reuse and disposal

6.1 General requirements

6.1.1 Disposal

Disposal of refrigerating systems and parts shall be undertaken in accordance with national regulations.

6.1.2 Personnel

Recovery, reuse, recycle, reclaim and disposal shall only be undertaken by competent persons. See Figure 1 for the relationship between the processes.

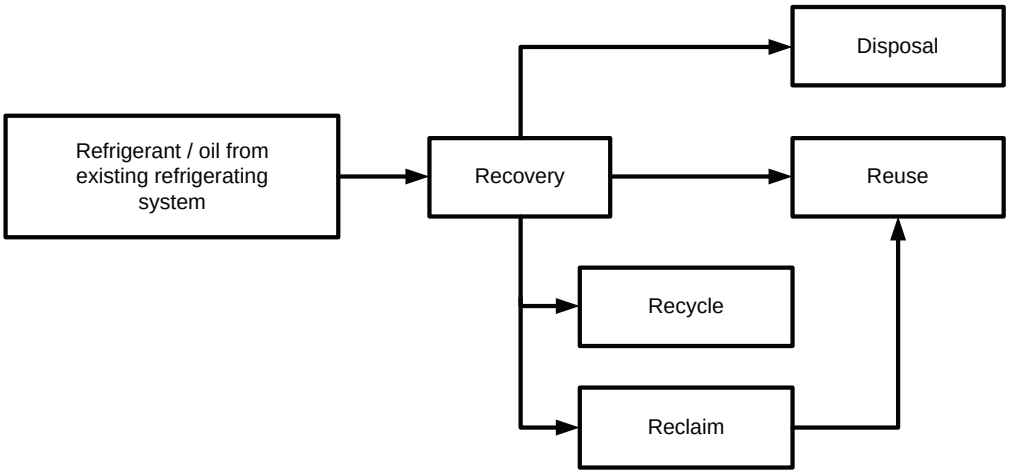

Figure 1 — Simplified representation of the relationship between the processes

6.1.3 Parts of refrigerating systems

All parts of refrigerating systems, e.g. refrigerant, oil, heat-transfer medium, filter, drier, insulation material, shall be recovered, reused and/or disposed of properly in accordance with national regulations (see 6.5).

6.1.4 Refrigerants

All refrigerants shall be recovered for reuse, recycled or reclaimed for reuse, or shall be properly disposed in accordance with national regulations (see 6.5).

Destruction of refrigerants shall require an authorized facility for destruction.

6.1.5 Handling

The method of handling of the refrigerant shall be decided before it is removed from the refrigerating system or the equipment (see also Annex C).

Such decision shall be based upon considerations including:

— history of the refrigerating system;

— type and disposition of the refrigerant in the refrigerating system;

— reason for removal of the refrigerant from the refrigerating system;

— condition of the refrigerating system or the equipment and whether or not it shall be returned to service.

6.2 Requirements for recovery and reuse of refrigerant

6.2.1 General

The directions given regarding the treatment of recovered refrigerant before reuse shall apply to all types of refrigerant.

Dependent on the situation, recovered refrigerant shall follow one of the paths indicated in Figure 2.

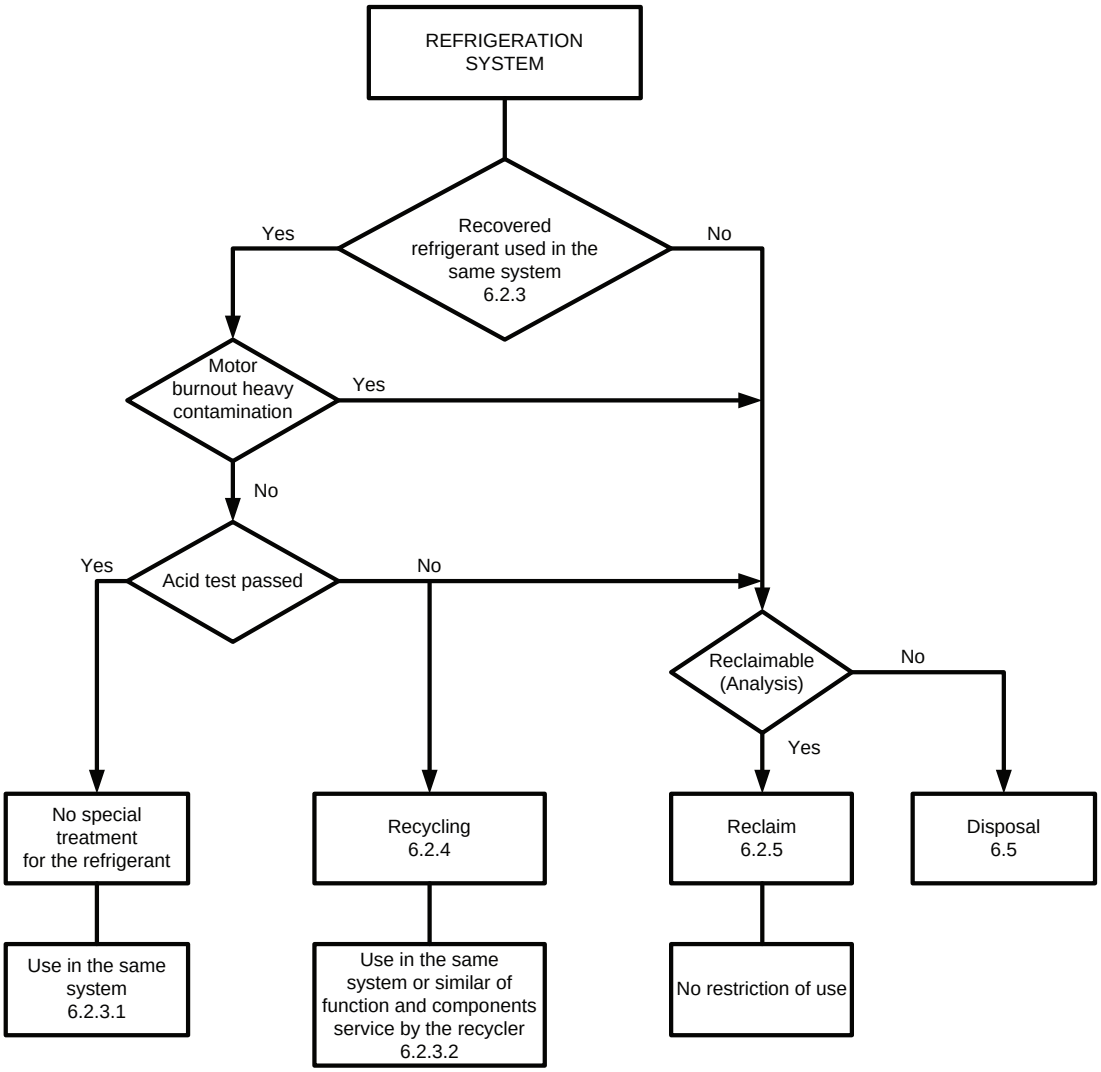

Figure 2 — Flow chart for recovered refrigerant

6.2.2 Recovery for general reuse

Recovered refrigerants intended for reuse in refrigerating systems shall be reclaimed and shall comply with the appropriate specification for new refrigerants.

NOTE Pass and fail criteria are outlined in AHRI 700:2011.

The acceptability shall be determined before reuse of the refrigerant.

6.2.3 Recovery for reuse in the same or similar system

6.2.3.1 For reuse in the same system

For halocarbon refrigerant, the following tests shall be carried out.

a) Acid test

The acid test uses the titration principle to detect any compound that ionizes as an acid. The test requires a sample of between 100 g and 120 g and has a lower detection limit of $0{,}1 \times 10^{-6}$ by mass (as HCl).

If the acid test fails, the total refrigerant charge shall undergo a recycling or reclaiming process, and the filter drier(s) in the refrigerating system shall be replaced.

NOTE 1 Pass and fail criteria are outlined in AHRI 700:2011.

Such a test is normally not required if recovery is from a refrigerating system during its manufacture.

NOTE 2 Refrigerant recovered from a refrigerating system (e.g. removed overcharge, refrigerant taken out for system service, local non-contaminating repair, major overhaul or replacement of a component) can normally be returned to the same system.

When a refrigerating system has been taken out of service because of heavy contamination of the refrigerant or motor burnout, the refrigerant shall be reclaimed or disposed of properly.

The evacuation and charging procedures specified in this part of ISO 5149 should be followed when returning the refrigerant to the refrigerating system.

b) Moisture test

The Coulometric Karl Fischer Titration shall be used for determining the water content of refrigerants. This method can be used for refrigerants that are either a liquid or a gas at room temperature. For all refrigerants, the sample for water analysis shall be taken from the liquid phase of the container to be tested.

If the moisture test fails, the total refrigerant charge shall undergo a recycling or reclaiming process, and the filter drier(s) in the refrigerating system shall be replaced.

6.2.3.2 For use in a similar system

The use of recycled refrigerant in a refrigerating system which is similar in function and components shall comply with the following requirements:

— the system is serviced by the competent person or company who recycled the refrigerant;

— the recycling equipment complies with the requirements of 6.2.4;

— the history of the refrigerant and the refrigerating system is known from the date of commissioning;

— the competent person or company informs the party concerned when recycled refrigerant is used and the source from which it comes and the result of the tests or, if necessary, of the analysis.

For halocarbon refrigerant, the tests are carried out in accordance with 6.2.3.1 a).

If any of the above conditions is not met or the history of the refrigerant indicates a heavy contamination of the refrigerant, e.g. motor burnout, then the refrigerant shall be either reclaimed or disposed of properly.

A recycled refrigerant shall comply with the specifications in Annex B.

6.2.4 Requirements for refrigerant recovery and recycling equipment and procedures

Recovery and recycling equipment shall comply with IEC 60335-2-104 and for halocarbon refrigerants with ISO 11650.

Equipment shall be regularly inspected to verify that equipment and instruments are well maintained and in good order. Equipment and instruments shall be function tested and calibrated regularly.

6.2.5 Reclaim

6.2.5.1 Analysis

A refrigerant sent for reclaim shall be analysed and either reclaimed or disposed of properly.

6.2.5.2 Specification

After the refrigerant has been reclaimed it shall meet the specification for new refrigerant.

NOTE Reclaimed refrigerant can be used as new refrigerant.

6.3 Requirements for refrigerant transfer, transport and storage

6.3.1 General

Appropriate safety practices shall be followed during transfer of refrigerant from a refrigerating system to a refrigerant container for transport or storage.

6.3.2 Refrigerant transfer

6.3.2.1 Procedure

Refrigerant recovery shall be carried out according to legal requirement. If such a requirement is not established or at least as severe as this part of ISO 5149, transfer/evacuation of the refrigerant shall be carried out as follows.

a) If the compressor of the refrigerating system cannot be used for the transfer, refrigerant recovery equipment shall be connected to the refrigerating system in order to transfer the refrigerant, either into another part of the refrigerating system, or into a separate container.

b) Before service, repair, etc., which involves opening the system, the pressure of the refrigerating system or of the relevant parts shall be reduced, by transferring refrigerant, to:

   — 0,6 bar[1)] absolute for a refrigerating system, or part system, with internal volume up to and including 0,2 m^3;

   — 0,3 bar absolute for a refrigerating system, or part system, with internal volume greater than 0,2 m^3.

   Thereafter the pressure can be further reduced using a vacuum pump before breaking the vacuum with dry oxygen free nitrogen.

c) Before scrapping, the refrigerating system or its parts shall be evacuated down to a pressure of:

   — 0,6 bar absolute for a refrigerating system with an internal volume up to and including 0,2 m^3;

   — 0,3 bar absolute for a refrigerating system with an internal volume greater than 0,2 m^3.

The above pressures apply in an ambient temperature of 20 °C. For other temperatures the pressure will need to be changed accordingly.

The time required for transfer or emptying is dependent on the pressure. It should only be stopped when the pressure no longer rises and remains constant and the total system is at ambient temperature.

6.3.2.2 Refrigerant container

The refrigerant shall only be transferred to a container suitable for the specific refrigerant involved.

The container shall be labelled (refrigerant number, chemical name(s), hazards and warnings) and colour coded in compliance with national regulation.

NOTE AHRI Guideline N provides information on colour coding.

1) 1 bar = 100 kPa.

The container with recovered refrigerant shall be specifically marked to note any special conditions, e.g. "CFC R-12 – Recovered – Do not use before investigation" or "NH_3 (Ammonia) – Recovered", in accordance with national regulation.

6.3.2.3 Disposable container

Except for hydrocarbons, a disposable "one way" container shall not be used because of the possibility of the remaining gas content being discharged into the atmosphere when disposed.

6.3.2.4 Container filling

The refrigerant container shall not be overfilled.

When a container is filled with refrigerant, the maximum charge shall always be observed, taking into account that possible refrigerant–oil mixtures have a lower density than pure refrigerant. The usable container capacity shall therefore be reduced for a refrigerant–oil mixture (80 % of maximum refrigerant charge or 70 % bottle volume, whichever is lower) controlled by mass.

This shall be defined at a temperature that is the highest expected and then reduced for the temperature where the tank is filled.

The allowable pressure of the container shall not be exceeded, even temporarily, during any operation.

NOTE 1 Special valves may be fitted to the refrigerant container to avoid the possibility of overfilling.

NOTE 2 Container filling may be carried out according to a national or regional regulation.

6.3.2.5 Different refrigerants

Different refrigerants shall not be mixed and shall be stored in different containers.

A refrigerant shall not be placed in a container that contains a different or an unknown refrigerant.

An unknown refrigerant already in a container is not to be vented to the atmosphere but shall be identified and reclaimed or shall be disposed of properly.

NOTE A refrigerant contaminated with another refrigerant may make it impossible to reclaim.

6.3.3 Transport

Refrigerants shall be transported in a safe manner.

6.3.4 Storage

Refrigerants shall be stored in a safe manner according to national or regional regulation. If these regulations are not established, Annex C should be followed.

NOTE The storage site should be dry and protected from weather to minimize corrosion of refrigerant containers.

6.4 Requirements for recovery equipment

6.4.1 General

The recovery equipment draws refrigerant/oil out of the refrigerating system and transfers it into a container in a safe manner, and shall be leak-tight.

NOTE The equipment may employ replaceable core filter driers to remove moisture, acid, particles and other contaminants.

6.4.2 Operation in respect to the environment

The recovery equipment shall be operated in such a way as to minimize the risk of emission of refrigerants or oil to the environment.

6.4.3 Performance

Refrigerant recovery equipment shall have performance according to national or regional requirement. If such requirements are not available, refrigerant recovery units shall meet the following requirements.

The recovery equipment shall at a corresponding temperature of 20 °C be able to operate down to a final pressure of:

a) 0,6 bar absolute if used for a refrigerating system with an internal volume up to and including 0,2 m^3;

b) 0,3 bar absolute if used for a refrigerating system with an internal volume greater than 0,2 m^3.

NOTE A method for measuring the performance of this equipment is contained in ISO 11650.

6.4.4 Operation and maintenance

The recovery equipment and filters shall be operated and maintained in accordance with ISO 11650 and the specifications of the manufacturer of the recovery equipment.

When changing replaceable core filter driers in the recovery equipment, the section containing the filters should be isolated and the refrigerant should be transferred into a suitable storage container prior to opening the filter shell. Any air introduced into the recovery equipment during the core change should be removed by evacuation and not by flushing out or purging out with the refrigerant.

6.5 Requirements for disposal

6.5.1 Refrigerant not intended for reuse

Used refrigerant which is not intended for reuse shall be dealt with as waste for safe disposal. Emission to the environment shall be avoided.

The release of CO_2 shall be permitted.

6.5.2 Absorbed ammonia

After absorbing ammonia (NH_3) in water, the “mixture” shall be dealt with as waste for safe disposal.

6.5.3 Refrigerating machine oil

Used oil, recovered from a refrigerating system, which cannot be reprocessed, shall be stored in a separate appropriate container and shall be dealt with as waste for safe disposal.

6.5.4 Other components

It shall be ensured that other components of the refrigerating system containing refrigerant and oil are also disposed of properly.

NOTE When necessary, a person competent in dealing with the disposal of refrigerants and oils should be consulted.

6.6 Requirements for documentation

All operations of recovery and reuse of refrigerant, and its source, shall be recorded in the logbook of the refrigerating system (see 4.3). If requested by the customer, a certificate shall be supplied by the refrigerant supplier or by the service company.

Annex A
(normative)

Draining the oil from a refrigerating system

A.1 General

The oil shall be drained carefully by competent personnel.

During the draining operation the room shall be effectively vented. Smoking and presence of any other open fire shall be prohibited.

When draining oil from compressors (or collectors) by means of a drain plug, it is required to reduce the pressure in the compressor (or collector) to atmospheric pressure before removing the plug.

Oil shall not be discharged into sewers, canals, rivers, ground or seawater.

A.2 Ammonia systems with immiscible oil

A.2.1 General

Usually both the high and the low pressure sides of a refrigerating system containing ammonia are equipped with oil collectors with draining valves in order to be able to remove the entrained and accumulated oil from the system. The oil draining apertures shall be equipped with a stop valve and a quick closing valve downstream, or a catch pot oil collecting system, which enables isolation from the part of the refrigerating system containing liquid refrigerant, safe venting of oil containing refrigerant, and isolation of the vapour line before the oil is drained off.

A.2.2 Draining procedure

The pressure of the section from which the oil is drained shall be above atmospheric pressure, therefore draining shall only take place during defrosting or when the refrigerating system is at standstill.

If the draining aperture is blocked, additional care is necessary.

Two valves are provided on the oil drain, one manually operated valve and one quick closing valve. If the quick closing valve is partly opened and no oil or refrigerant is emitted it shall be disassembled, cleaned and reinstalled. Ensure that the manually operated valve remains closed during this operation.

It is recommended that oil is drained regularly at the points intended for this purpose to avoid, amongst other things, the disturbance of the refrigerant level control and the danger of liquid hammer which this entails.

Annex B
(informative)

Guide specification (parameters) for recycled refrigerant

B.1 This part of ISO 5149 specifies the performance requirements for equipment to recycle halocarbon (and some other) refrigerants, but recognizes that for certification purposes such equipment can only be tested against "standard contaminated refrigerant samples", see ISO 11650.

B.2 In practice, refrigerants being recovered cannot be expected at all times to reproduce only these standard contaminants and currently it is not certain with what levels of contamination systems are coping.

B.3 This part of ISO 5149 makes no direct reference to a specification for recycled refrigerants, the parameters for which have, in any case, still to be determined.

B.4 The recoverer may wish to compare the results of analysis for the recycled refrigerant to the specification for virgin product, understanding that the recycled refrigerant may not meet the virgin refrigerant specification.

B.5 Attention is drawn to the possibility of significant property changes if mixed refrigerants are recycled in proportions different from the original mixture or if other refrigerants not in the original blend have contaminated the mixture.

Annex C
(informative)

Handling and storage of refrigerants

C.1 General

Information about handling and storage given in this Annex may be used where no similar criteria exist in national regulations.

Losses of refrigerants to the atmosphere should be minimized during handling and storage of refrigerant.

C.2 Handling

C.2.1 Refrigerant should only be charged into refrigerating systems after a pressure test and a leak detection.

C.2.2 Refrigerant containers should not be connected to a system at a higher pressure or to piping with hydraulic pressure of liquid refrigerant where the pressure is sufficient to cause a backflow into the container.

Backflow of refrigerant can result in charging errors up to an overfill of the containers. After that the pressure may be become such that the container bursts or the pressure relief device, if fitted, opens.

C.2.3 Charging lines should be as short as possible and equipped with valves or self-closing connections to minimize the losses of refrigerant.

C.2.4 Refrigerant transferred to a system should be measured by either mass or volume using scales or a volumetric charging device. When charging zeotropic mixtures, the refrigerant is charged as liquid in accordance with the refrigerant manufacturer's instructions.

When charging a system, care should be taken that its maximum permissible charge is never exceeded (see C.2.7), in view of, among other things, the danger of liquid hammer.

Charging with refrigerant should preferably be done in the low pressure part of the system. Each point downstream from a closed shut-off valve in the main liquid line is regarded as a low pressure side point.

C.2.5 Before charging refrigerant into a system the contents of the refrigerant containers should be confirmed. The adding of an unsuitable substance may cause explosions or other accidents.

C.2.6 Refrigerant containers should be slowly and carefully opened.

Refrigerant containers should be disconnected from the system immediately upon completion of the addition or removal of the refrigerant.

Refrigerant containers should not be knocked, dropped, thrown on the ground or exposed to thermal radiation during the addition or removal.

Refrigerant containers should be checked for corrosion.

C.2.7 When adding a refrigerant to a system, e.g. after repair, care should be exercised to add refrigerant in small amounts to avoid overcharging, while observing high and low side pressures.

If the maximum permissible refrigerant charge of a system has been exceeded and the necessity arises to transfer part of the refrigerant charge to refrigerant containers, the containers should be carefully weighed during transfer, taking care that the maximum charge for the container is never exceeded. The container should not be charged to a point where expansion of liquid refrigerant, as a consequence of a temperature rise, can cause a rupture. The maximum permitted mass should be marked on the containers.

C.2.8 Refrigerant containers should be constructed to meet different requirements for refillable applications according to national regulations. This may include a properly set pressure relief device and a valve guard.

C.2.9 Refrigerant containers should not be manifolded together. This could result in uncontrolled refrigerant transfer up to an overfill of the coldest container.

C.2.10 When filling refrigerant containers, the maximum carrying capacity should not be exceeded (approximately 80 % liquid by volume at approximately 20 °C).

The carrying capacity is a function of the internal volume of the container and the liquid density of the refrigerant at a reference temperature (normally 20 °C).

C.2.11 Refrigerants should only be transferred into properly labelled containers having appropriate pressure rating as different refrigerants have different saturation pressures.

C.2.12 To avoid the danger of mixing different refrigerant types and grades, e.g. recycled, the receiving container should only have been used previously for that grade of refrigerant. The grade should be clearly marked.

C.2.13 Transferring refrigerant from one container to another should be carried out using safe and approved methods.

A pressure differential should be established between the containers by either cooling the receiving container or heating the discharge container. Heating should be achieved using blanket heater equipment with a thermostat set at 55 °C or less and a thermal fuse or a non self-resetting thermal cut out set at a temperature at which the refrigerant saturation pressure does not exceed 85 % of the container pressure relief device setting.

Under no circumstances should refrigerants be vented to the atmosphere from the receiving container in order to lower the pressure.

There should be no heating of refrigerant containers by open flames, radiant heaters, or direct contact heaters.

C.2.14 Charging cylinders with graduated volumetric scales should be equipped with a pressure relief valve.

These cylinders should be filled in accordance with C.2.

Immersion heaters for this type of cylinder are permissible without a temperature limiting device if the power input is limited by a current limiter, so that continuous operation of the heater results in a cylinder pressure for the subject refrigerant of less than 85 % of the safety valve setting, regardless of the liquid level inside the cylinder.

C.3 Storage

C.3.1 Refrigerant containers should be stored in an especially provided cool space, away from fire risk, out of direct sunlight and away from sources of direct heating.

Containers stored outside should be weather resistant and protected from solar radiation.

C.3.2 Mechanical damage to the container and its valve should be avoided by careful handling. Even if fitted with a valve guard, containers should not be dropped. In the storage area, containers should be effectively secured to prevent them from falling.

C.3.3 The container valve should be closed and capped when the container is not in use. Gaskets should be replaced as required.

C.3.4 Refrigerant may be stored in the special machinery room in containers provided that the quantity of refrigerant does not exceed 200 kg excluding refrigerants in components forming part of the system.

C.4 Special provisions for handling ammonia vapour during maintenance or de-commissioning

C.4.1 General

Where subsections of an ammonia system are to be opened for maintenance, repair or dismantling the ammonia must be removed from the system safely. Small quantities of vapour (up to 10 kg) can be vented to atmosphere, subject to local or national regulations. This must be done safely and in a manner which does not damage the local environment. It is also possible to absorb the residual ammonia vapour in water to reduce the loss of ammonia to atmosphere. However this creates a solution of aqua-ammonia, which must be handled with care and removed from site safely.

C.4.2 Limitations of ammonia vapour absorption

The maximum quantity of aqua-ammonia that should be produced during this procedure is 200 l. The solution concentration should be no more than 30 %, so it follows that the maximum amount of ammonia vapour which can be extracted by this method is 60 kg. Preferably the solution strength created by the procedure should not be more than 10 %.

NOTE A 30 % solution of aqua-ammonia has a vapour pressure of 1 bar absolute pressure at 25 °C. Higher concentrations are likely to emit ammonia vapour at standard temperature and pressure.

The solution strength can be determined by measuring the pH of the solution. Table C.1 gives solution strengths.

Table C.1 — Aqua-ammonia solution strength at standard temperature and pressure

Solution mass fraction	1 %	5 %	10 %	30 %
pH	11,7	12,2	12,4	13,5

The specific gravity of the liquid can also be used. The specific gravity of a 28,5 % mass fraction solution is 0,9.

C.4.3 Procedure for ammonia vapour absorption

Before starting work, prepare a written risk assessment and method statement. Ensure that all necessary notifications have been made (site managers, workers in the vicinity and neighbours as appropriate). Estimate the quantity of ammonia to be removed. To minimize the quantity, transfer as much liquid as

possible to other parts of the system and then lower the pressure of the part of the system to be opened by connecting a vapour line from the vent point to a low pressure part of the system. The pressure should be reduced to less than 5 bar gauge in this way, and preferably as low as possible.

EXAMPLE 1 60 kg of ammonia vapour has a volume of 12,6 m^3 at 5 bar and a temperature of 10 °C.

EXAMPLE 2 60 kg of ammonia liquid has a volume of 96 l at 5 bar and a temperature of 10 °C.

Ensure that the following precautions are observed.

a) Use suitable personal protective equipment in accordance with the risk assessment.

b) Position a suitable water container outdoors in a well-ventilated, safe location. The container should have a wide neck, but should have a lid to prevent liquid spills when it is being moved. Securely fix the water container so that it cannot move during the operation.

c) Use a hose fitted with non-return valve to ensure that water cannot enter the refrigeration system. Fit the hose to the system vent valve.

d) Fill the water container to no more than 75 % full (maximum quantity 200 l).

e) Securely fix the hose outlet well below the water level.

f) Gradually open the vent valve.

g) Monitor the water container to ensure that splashes do not spill and the hose or container do not become loose. The absorption reaction is quite vigorous and generates heat so the water will get warm. There will be a strong smell of ammonia in the vicinity.

h) Do not leave the water container or the vent valve unattended at any time. If the vent valve is indoors then this will require at least two operatives in attendance at all times.

i) As soon as bubbles are no longer visible at the hose outlet, close the vent valve and disconnect the hose. This is to prevent water siphoning into the refrigeration system.

j) When the system pressure has dropped to 1 bar, close the vent valve and disconnect the hose.

k) Vent the remaining vapour to atmosphere in a safe and controlled manner.

The system can be opened up, but beware that there may still be liquid ammonia in low areas, and the vapour in the system is at atmospheric pressure.

NOTE Ammonia has a very strong affinity for water and draws water into the system against a pressure of several bar if care is not taken. This is why it is essential to monitor the hose outlet and close the vent valve quickly.

C.4.4 Disposal of the aqua-ammonia solution

Aqua-ammonia solution has many industrial uses, including window-cleaning fluid, NOx reduction agent in furnaces and fertilizer. However the ammonia recovered from a refrigeration system may be contaminated with lubricant, so it may not be sufficiently pure to be used for these purposes. If the aqua-ammonia is oil-free and sufficiently pure to be used as fertilizer, it should be diluted to strength of less than 10 % mass fraction (pH 12,4, specific gravity 0,96 at 15 °C) and applied at a concentration of not more than 20 l/m^2.

The aqua-ammonia solution should not be put into storm drains, watercourses or on land which drains to a water course, as it is highly toxic to aquatic life. It may be released in a controlled manner to a foul drain by prior arrangement with the waste water company. The waste water company may require the solution to be further diluted and they may require a period of notice to prepare their plant for the ammonia solution. If it is removed from site then local and national hazardous waste transfer regulations apply.

The pH of the aqua-ammonia solution can be reduced by dosing with a weak acid solution or by leaving the open container to stand in an outdoor, well ventilated location. This location shall not be accessible to the general public.

Annex D
(informative)

In-service inspection

D.1 During the operational life of the system, inspection and testing are carried out according to national regulations.

Information about in-service inspection given in this annex can be used where no similar criteria exist in national regulations.

Table D.1 — In-service inspection

	Inspection		Test		
Clause	**External visual**	**Corrosion**	**Pressure test for system**	**Refrigerant [a] leakage detection**	**Safety device**
	ISO 5149-2:2014, Annex A	Annex E			Check
D.2	X	X	X	X	
D.3	X		X	X	
D.4	X	X [b]		X	
D.5		X		X	
D.6					X
D.7	X			X	

[a] The low pressure side of an operating system is brought to overpressure.

[b] Not for new equipment.

D.2 In-service inspection is carried out after work likely to affect strength, or when a change in use has occurred, or when changing to another refrigerant at a higher pressure, or after standstill for longer than two years. Components which do not conform are changed. Test pressures higher than appropriate for the design pressures of the components are not applied.

D.3 In-service inspection is carried out after repair or significant alterations or extensions to the systems or components.

NOTE Testing should be restricted to the parts affected.

D.4 In-service inspection is carried out after reinstalling on another site.

D.5 Leak testing of the system is to be performed if serious suspicion of leaks is raised. For the purposes of this paragraph, “inspected for leakage” means that the equipment or system is examined primarily for leakage using direct or indirect measuring methods, focusing on those parts of the equipment or system most likely to leak.

Frequency of inspection for leakage varies from:

— once every 12 months for systems with 3 kg or more of refrigerant except for hermetically sealed systems containing less than 6 kg;

— once every six months for applications containing 30 kg or more of refrigerant;

— once every three months for applications containing 300 kg or more of refrigerant.

The applications should be inspected for leakage within one month after a leak has been repaired to ensure that the repair has been effective.

Operators of the applications referred to above, containing 3 kg or more of refrigerant, should maintain records on the quantity and type of refrigerant installed, any quantities added and the quantity recovered during maintenance, servicing and final disposal.

Operators of the applications referred to above, containing 300 kg or more of refrigerant, should install leakage indication systems. These leakage indication systems should be inspected at least once every 12 months to ensure their proper functioning. Where a properly functioning appropriate leakage indication system is in place, the frequency of the inspections required should be halved.

High leakage rates are unacceptable. Action should be taken to eliminate every detected leak.

NOTE Fixed refrigerant detectors are not leak detectors because they do not locate the leak.

D.6 Safety devices are checked on site: annually for safety switching devices (see 5.3.3), emergency signals and alarm systems; every five years for external pressure relief devices.

D.7 Safety valves, bursting discs and fusible plugs are visually checked in accordance with 5.2.5, 5.2.7.2 and 5.2.7.3 of ISO 5149-2:2014 and leak tested according to D.5.

D.8 For unit systems and self-contained systems as defined in ISO 5149-1:2014, in-service inspection is carried out after repairs have been made. If loss of refrigerant is evident, the whole system is leak tested.

Annex E
(informative)

Corrosion inspection

The following corrosion inspection may be carried out:

a) where piping, piping supports, components and component supports are not insulated, they should be visually inspected;

b) insulated piping and components should be visually inspected if the vapour barrier is damaged or if it does not function as intended;

c) when the system has been out of use for some time.

Bibliography

[1] ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

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[3] AHRI 700: 2011, *Specifications for Fluorocarbon Refrigerants*

[4] AHRI Guideline N, *Assignment of Refrigerant Container Colors*

[5] ISO 5149-3, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 3: Installation site*

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