

Requirements for the Collection, Transportation, Storage and Treatment of Cooling and Freezing Appliances containing Hydrocarbons (HC)

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1. Introduction

The use of Chlorofluorocarbons (CFCs) in the production of insulation foams and refrigerant circuits for cooling and freezing appliances was banned in the mid-1990s [1].

As a consequence the producers of cooling appliances developed a new technology based on the use of pure Hydrocarbons (HC) such as butane, propane and pentane instead of CFCs as usable refrigerants.

Cyclopentane continues to be used almost exclusively as the blowing agent of choice for the polyurethane (PUR) foam insulation.

One of the main characteristics, in comparison with CFC, H-CFC and HFC [2] is that HC has no ozone depleting potential (ODP) and only a low global warming potential (GWP) (see Figure 1).

	example	Formula	global climate change (GWP)	ozone depletion (ODP)
CFC	R11	$C Cl_3 F$	2400	1
H-CFC	R22	$CH Cl F_2$	1700	0,04 - 0,05
HFC	R134a	$C_2 H_2 F_4$	1300	0
HC	cyclopentane	$C_5 H_{10}$	11	0

Figure 1: environmental impacts of blowing agents in PUR-foam

In total the environmental impact of HC is marginal in comparison to CFC.

The new cooling and freezing appliances - so-called HC-appliances - increasingly emerge at collection facilities for WEEE and in following treatment processes. For 2006 the estimated share lies at around 10-30 % of the total amount of treated waste cooling and freezing appliances collected and treated in Europe [3].

[1] Regulation No 2037/2000 of the European Parliament and of the Council of 29 June 2000 on substances that deplete the ozone layer.

[2] Chlorofluorocarbon (CFC), Hydrochlorofluorocarbon (HCFC) and Hydrofluorocarbon (HFC)

[3] It is expected that the estimated share of waste HC appliances in the WEEE stream will increase in the future. The requirements presented in this paper are based on practices and best available

The potential HC emissions from treatment of cooling and freezing appliances represent only a small part of the total annual VOC emissions.

2. Objective

The objective of the following specifications is to set up requirements for the collection, transport, storage and treatment of HC containing cooling and freezing appliances in order to ensure low environmental impact and to secure the respect of the necessary safety measures.

This can be assured by treatment in specialised treatment plants for waste cooling and freezing appliances that comply with all European Community legislation on health, safety and environment.

3. General requirements

The requirements apply to the separation of HC as liquids and/or gases from cooling and freezing appliances for recovery or disposal by means of dismantling and treatment [4].

Overall this document consists of a set of requirements concerning:

- Collection, storage, transport and handling
- Recovery or disposal of HC
- HC emissions to the surrounding
- Use of output fractions (recovery and recycling targets of 80% and 75% respectively, these targets as according to Directive 2002/96/EC or future amended versions)
- Safety measures
- Quality assurance
- Inspection and control

With these requirements also other legal aspects shall be covered:

1. Safety features at the construction of treatment plant [5].
2. Precautionary safety measures during the whole process [6].
3. Environmental sound treatment, recovery, recycling and disposal of hazardous substances [7].

technologies of today. It may be that new and better practices and technologies will emerge in the next 5 to 10 years. The signatories commit to reviewing the requirements document after a period of 5 years or when new developments make a revision necessary.

[4] Step 1 for the separation of HC and oil from the cooling circuits and step 2 for the separation of HC from the foam for recovery or disposal and the separation of recyclable and recoverable materials (metals, glass, plastics, cables etc.).

[5] Directive 94/9/EC on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres

[6] Directive 1999/92/EC on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres (15th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)

4. National legal requirements concerning HC emissions.

4. Collection, Storage, Transport and Handling

1. Sorting of types of cooling and freezing appliances [8] shall take place at the treatment plant.
2. Sorting of types of cooling and freezing appliances for end of life treatment in advance of the treatment process shall be performed by and supervised by trained personnel and in accordance with the treatment requirements of cooling and freezing appliances.
3. The signatories of this document commit to not allowing in their contracts with collection points, or with any party collecting appliances, to pre-sort types of cooling and freezing appliances for end of life treatment purposes.
4. Collection, storage, transport and handling of cooling and freezing appliances shall be done carefully to avoid damage of the appliances and leakage of controlled substances. If oil leakage is recognized, appropriate measures shall be taken to minimize environmental impacts.
5. All sites for storage and treatment shall at least be in line with the technical requirements of Annex III of Directive 2002/96/EC.
6. As for storage, transport and handling also the treatment of HC appliances demand corresponding protective precautionary measures due to the flammability of hydrocarbons. Places where hazardous explosive atmospheres may occur shall be specially designated. Furthermore, the ban on ignition sources and the ban on entering by unauthorized persons shall be labelled and enforced (Annex III of Directive 2002/96/EC).
7. Transports optimisation is allowed as long as the initial size of the cooling and freezing appliances incl. cabinets is not reduced and good condition of the appliances is ensured.
8. All sites shall demonstrate that they are secured against unauthorised access.

5. Treatment

HC appliances can be treated in many different ways. The right choice of a technology is not only a question of minimising the risk of explosion, but also of getting the best separation results for the secondary raw-material market.

Even though the environmental impact of HC is low (its global warming potential is below 15) the national air limiting values have to be respected.

[7] Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE) or corresponding national regulations

[8] "Types of appliances" are distinguished as CFC, H-CFC, HC or NH₃ containing appliances.

If there is any doubt about the type of refrigerant or foaming agent, the cooling and freezing appliances must be treated as CFC-containing ones. Therefore also treatment facilities for CFC appliances shall comply with explosion protection measures as stated in Directive 1999/92/EC.

Cooling and freezing appliances and components, materials and substances thereof have to be processed at a rate of recovery of at least 80% and a reuse and recycling rate of at least 75% by weight per appliance [see footnote 7].

The treatment process of end of life cooling and freezing appliances is usually performed in two steps:

Step 1 (removal of all liquids - Article 6.1 [see footnote 7]):

1. All liquids that may contribute to a contamination of separated fractions during or after the treatment process shall be removed.
2. All HC refrigerants [9] shall be separated from oil.
3. HC emissions shall comply with national legislation.
4. All installations shall be equipped and operated with protective measures against possible fires and explosions.

If step 1 and 2 are being carried out at 2 different physical locations, the treatment company has to ensure that HC cabinets are not been mixed up with CFC cabinets at the time of collection and storage or during transport.

Step 2 (Further processing of HC cabinets):

It is essential for the treatment of HC cabinets that the necessary safety measures and the welfare of employees are observed.

1. The treatment of appliances in step 2 shall be carried out with step 1 treated appliances only (called "cabinets") from which refrigerants and oil have been removed.
2. HC emissions shall comply with national legislation.
3. In case HCs from the insulation foam are not captured, they shall be released in a controlled manner respecting the health and safety regulations. Special care to precautionary safety has to be assured as stated in Directive 1999/92/EC [see footnote 6].

Explosion protection measures in accordance with Directive 1999/92/EC

Plants shall comply with Directive 1999/92/EC on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres.

In practice, explosions inside the shredder can be avoided by controlling conditions. Examples of measures to control those conditions:

- Rarefaction of the HC atmosphere by blowing air into the process or

[9] HC refrigerants used in "Commercial refrigeration equipment" mainly contain HC-290, HC-600a, HC-1270 or blends of HC-290/HC-600a, "Household refrigerators" mainly isobutane (HC-600a)

- Reduction of the oxygen content by substituting air with inert gases [10].
- Use of alternative explosion proof processing-technologies.

6. Quality Assurance

1. Treatment companies for HC containing cooling and freezing appliances shall have a certified ISO 9001:2000 and ISO 14001, or equivalent audited quality management systems in place, also covering treatment processes and in-house monitoring.
2. In addition to the usual documentation and controlling exercised by the quality system, treatment companies are requested to keep operation journals which register all incoming cooling and freezing appliances according to types and categories and all the outgoing materials.

7. Inspection and Control

The quantity of separated liquids and fractions and their destination of forwarding shall be documented in a retrievable way to be compliant with monitoring requirements of the national implementations of Directive 2002/96/EC on waste electrical and electronic equipment (WEEE).

1. Compliance with the quality requirements will be decided by the relevant environmental authorities, responsible take-back system (individual or collective) or other bodies being responsible in the respective countries.
2. It is recommended that an independent organisation with adequate knowledge of the treatment processes of cooling and freezing appliances will make annual inspections on behalf of the respective body to control the following points:
 - Publication of annual report of treated HC appliances and removed liquids and/or HC cabinets
 - The capability of the treatment company to comply with requirements put forward in this document
 - Compliance with environmental legal and other requirements (permits, storage area etc.)

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CECED represents the household appliance industry in Europe. Its member companies employ over 200,000 people, are mainly based in Europe, and have a turnover of about €40 billion. If upstream and downstream business is taken together, the sector employs over 500,000 people. Direct Members are Arçelik, BSH Bosch und Siemens Hausgeräte, Candy Group, De'Longhi, Electrolux Holdings, Fagor, Gorenje, Liebherr, Indesit Company, Miele, Philips, SEB and Whirlpool Europe. CECED's member associations cover the following countries: Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Sweden, Switzerland, Turkey and the United Kingdom.

The **WEEE Forum** is an open non-profit association of voluntary industry-driven collective WEEE take-back systems, taking care of individual producers' responsibility in Europe.

[10] There is a choice between different types of inert gases. Normally nitrogen is used (this is the usual way for treatment of HC appliances in treatment plants for CFC appliances).

EERA, the European Electronics Recyclers Association, is a non-profit organisation that promotes the interest of recycling companies who are treating waste electrical and electronic equipment WEEE in Europe. EERA aims for the harmonisation of national and international regulations for WEEE recycling in order to obtain a free market for demand and supply of services. EERA calls for environmentally sound operating practices for WEEE recycling activities and members are signatories to the rules of conduct to safeguard protection of human health and the environment.