



Comments submitted by the RAL Quality Assurance Association
concerning the document

**U.S. Ozone-Depleting Substances
Project Protocol**
Destruction of Domestic
Ozone-Depleting Substances
Public Draft, Version 1.0, November 20, 2009

Dear Sirs,

For more than 10 years the RAL Quality Assurance Association for the Demanufacture of Refrigeration Equipment has been concerned with all aspects of the recovery of ozone-depleting substances (ODS) from end-of-life refrigeration equipment and other ODS-containing products. The author of these comments, Christoph Becker, has more than 20 years of professional experience in the fridge recycling sector and has a thorough understanding of the key issues in the industry. As the CAR public draft paper is primarily concerned with issues that correspond directly to RAL's core competence, we are submitting the following comments on a number of the topics addressed in the paper.

RAL welcomes the fact that the CAR Draft Protocol addresses the fundamental questions of the subject in great detail. This is extremely important as considerable care and attention to detail is necessary when developing ODS projects. We congratulate CAR on its excellent work.

Our comments, which are set out in appendix 1, are split into the following three sections.

- A. Summary
- B. Justification
- C. Suggested amendments to the document

We would be pleased to visit you at your offices in order to discuss our comments in more detail and to provide further factual support for our position.

Yours faithfully

Dipl.-Ing. Christoph Becker

**RAL Quality Assurance Association
for the Demanufactue of Refrigeration Equipment**

**B.P. 1228, 29, avenue de la Gare
L-1012 Luxembourg**

Tel.: +352-(0)488361-41

Fax: +352-(0)488361-42

www.ral-online.org info@ral-online.org

Annex 1

A Summary of the RAL statement

A.1 General remarks

The RAL Quality Assurance Association has more than ten years' experience in the development, codification and application of standards. One of our fundamental objectives was and remains to ensure that standards are phrased in such a way that they offer the least possible room for interpretation of their requirements. This minimizes the risk of misinterpretation or malpractice. In the light of this, some of the amendments to the CAR Draft Protocol that we suggest in section C of our comments are primarily designed to clarify the wording of certain passages in the original text. All the other proposed amendments are content-based.

A.2 The main reservations held by the RAL Quality Assurance Association

A.2.1 Project boundaries

At present, the recovery of ODS from appliances and equipment (SSR 2 Refrigerant Recovery and Collection) is located outside of project boundaries. However, this part of the overall treatment chain harbours a large ODS loss potential and, as such, we consider it extremely important that these operations are included within the GHG Assessment Boundary.

A.2.2 90% recovery and destruction efficiency (RDE)

We welcome the fact that the Draft Protocol stipulates a recovery and destruction efficiency of greater than 90% for the recovery of ODS from foams. Nevertheless, RAL considers it necessary that

- a. an RDE of at least 90% is introduced for the recovery of ODS refrigerants from appliances and equipment (SSR 2), which in accordance with our proposal above should be placed within the GHG Assessment Boundary;
- b. the Draft Protocol specifies the internationally recognized RAL GZ-728¹ standard as the benchmark method to be used in determining the RDE;
- c. the manual stripping of ODS-containing foams is only permitted when it can be continuously verified that the ODS loss rate is lower than 10%. However, a very recent study by the German environmental research organization Öko-Institut has shown that there is considerable doubt as to whether this can be achieved.

¹ See appendix 2

A.2.3 No direct incineration of ODS-containing foams from appliances and equipment

The requirements contained in section 6.5.3 of the Draft Protocol concerning the sampling and analysis of foams are nowhere near adequate if the aim is to obtain reliable quantitative data on the actual amounts of ODS destroyed from foams that have been stripped manually from the waste appliances and then being subject of direct incineration..

In section B of our comments, we will provide evidence to demonstrate that:

- a. continuous and systematic monitoring of the ODs streams in foams (even with improved sampling and analysis) can never yield an exact result;
- b. any figures purporting to represent the actual quantities of ODS destroyed from foam sources (even with improved sampling and analysis) will necessarily have large uncertainties associated with them, because different appliances may well contain different types of ODS and these may be present in widely varying amounts. Even sampling “pure-ODS” appliances (e.g. those containing only the CFC R11 as blowing agent), the amount of blowing agent in an appliance can vary very significantly from appliance to appliance;
- c. during foam sampling and preparation of the foams for analysis, ODS will escape and thus falsify the result;
- d. as a result, it is not possible to generate any serious and sustainable figures for the Climate Reserve Tonnes (CRT).

Given the variety and difficulties in predicting the type and amount of insulating foam in waste refrigeration appliances and the blowing agents these foams contain (different ODS, HFCs, HCs and other non-ODS), it is not possible to generate any meaningful and generally applicable formula for the amount of ODS destroyed. In view of this huge uncertainty, the only reasonable response is to prohibit any direct incineration of ODS-containing foams from appliances and equipment.

We therefore continue to urge that the ODS in appliance foams must be recovered, liquefied and then destroyed.

A.2.4 Direct incineration of ODS-containing building foams only with optimized foam sampling and analysis procedures

The sampling and analysis of ODS-containing building foams must be significantly improved with respect to the representativeness of the samples taken. Only then can somewhat more reliable statements be made regarding the actual quantities of ODS destroyed by a project and the CRT figure that it generates.

In section C we propose a number of amendments to the text of the Draft Protocol.

B Justification

Re. A.1 – General remarks

We have appended our arguments to the proposed changes to the text listed in section C.

Re. A.2.1 – Project boundaries

If we have correctly understood the arguments presented by CAR in the Draft Protocol and at the Public Workshop on 7 December 2009, projects should be designed in such a way as to prevent needless ODS emissions. As these projects are climate protection projects, it is, in our opinion, absolutely necessary to prevent a situation in which a project recovers and destroys a fraction of the ODS (and is therefore eligible for CRT credits as a result), while elsewhere in that same project ODS are needlessly lost through emissions to the environment, thereby having a negative effect on the carbon balance. Such a situation would be wholly incompatible with climate protection goals of these projects.

While it is obviously in the financial interests of the project developers to recover the greatest possible amount of ODS and to send these for destruction, if requirements regarding the technology used, the personnel deployed and the ODS recovery levels to be achieved are not clearly stipulated, then it will be extremely difficult to avoid a situation in which the quantities of ODS recovered are simply too low. This applies equally to the recovery of ODS blowing agents from the appliance insulating foams as to the recovery of ODS refrigerants from the appliance cooling circuits.

For logistical reasons, the recovery of ODS from the cooling circuits and the insulating foams of waste refrigeration appliances are usually carried out at the same site and at the same time. This is particularly the case when treating household refrigeration appliances. It therefore seems expedient, at least as far as these projects are concerned, to place both stage I processing (vacuum extraction of ODS from the appliance cooling circuit) and stage II processing (removal of ODS-containing foams and recovery of the ODS in the foam) within the same GHG Assessment Boundary.

As explained in A.2.2, this is important if a minimum RDE of 90 % is to be set for the stage I recovery process (SSR 2 Refrigerant Recovery and Collection).

Re. A.2.2 – 90 % recovery and destruction efficiency (RDE)

- a. There has for some time been clear international agreement that a recovery and destruction efficiency of 90 % applies to the recovery of ODS from the insulating foams found in appliances and equipment. It is not just since the publication of the TEAP² report that there has been a consensus that any overall assessment of efficiency must start before appliance and equipment carcasses are treated. This approach has been implemented since 1998 in the internationally recognized RAL

² United Nations Environment Programme, Technology and Economic Assessment Panel. (2005). *Report of the Task Force on Foam End-of-Life Issues*.

GZ-728 standard (last update: 2007). Not only the RAL GZ-728 standard itself, but also the subsequent legislation and regulations based on it (e.g. the Austrian Waste Treatment Obligation Ordinance (*Abfallbehandlungspflichten-Verordnung*) – **appendix 3**, the WEEE Forum’s requirements for fridge recycling operations – **appendix 4** etc.), **all** explicitly include stage I processing (SSR 2 Refrigerant Recovery and Collection) in the 90 % minimum recovery requirement. Experience gathered over the last twenty years in Europe has shown that the technology deployed for the vacuum extraction of ODS from the appliance cooling circuits has all too often been inadequate with substantial leakages resulting in the recovery of only a fraction of the ODS refrigerants, while the remainder is allowed to escape to the environment. We believe that this can only be prevented if environmentally meaningful minimum recovery efficiency levels are stipulated **in addition** to the financial incentives offered by CRT credits. A recovery and destruction efficiency of at least 90 % is the right approach to adopt in this case.

- b. Currently, the most comprehensive and thorough description of a methodology for detecting compliance with a 90 % RDE for the recovery of ODS from appliances and equipment is that in the RAL GZ-728 standard. RAL stipulates definite quantities of ODS that have to be recovered in grams per appliance for specified appliance categories. In view of the stated objectives of the CAR Protocol, we recommend incorporating this standard into the Draft Protocol. If the method to be used to determine the RDE is not specified in the Protocol, project developers and the verification bodies will face considerable difficulties in demonstrating that the project does in fact comply with the minimum requirement of 90 % recovery efficiency.
- c. By stipulating a recovery and destruction efficiency of at least 90 %, it is clear that the starting point for determining recovery efficiency is the appliance carcass before it has undergone any processing – and this also applies even if the foam insulation is later to be stripped manually from the appliance.

As already reported, the research organization Öko-Institut is currently compiling a report on the manual disassembly of household refrigeration appliances. The interim report (**appendix 5**) on the Öko-Institut research states that even in small appliances up to 30 % of the ODS they contain are lost. In the course of their study, the researchers have also learned that in a number of countries manual disassembly does not include the removal of the foam from the appliance door as this is a particularly time-consuming procedure that would it seems make these projects unprofitable. If the doors are left untreated, even greater quantities, in fact up to half, of the ODS are lost.

The specifications in section 6.4(2) present requirements for the manual removal of foams and are designed to ensure that the RDE achieved is at least 90 %. However, in our opinion, the list contains only theoretical pointers that are hard to implement in practice and difficult to verify. In particular, the requirement that “90% of separated foam must be in pieces greater than 100 cubic inches” (sec. 6.4(2c)) is in our opinion not only infeasible in practice, but compliance with this requirement cannot be

verified without the introduction of systematic and continuous documentation (e.g. photographic evidence).

The requirement in sec. 6.4(2d), that “*Separated foam shall be categorized and stored according to ODS species and year of manufacture*” is purely theoretical as neither piece of information is readily visible on the appliances, and comprehensive databases containing this information are not available from manufacturers. In view of this one is forced to conclude that a hermetically sealed container (e.g. a plastic bag of sufficient size) has to be provided for each appliance undergoing treatment. This would at least enable the type and quantity of ODS to be determined by analysis of representative samples. To minimize errors, this would have to be carried out before the foams are filled into the bag (see our comments on analysis).

As a hermetically sealed container (bag) only makes sense if the bag remains closed and is incinerated together with its contents, this may make it harder to meet the requirements in 6.5.1 “*Prior to destruction, the precise mass and composition of ODS to be destroyed must be determined.*” If the bag was opened for sampling, the ODS that had volatilized from the foam would escape, which would obviously call into serious question the sense in requiring a hermetically sealed container (sec. 6.4(2e/f)).

We can summarize the above by stating that the manual disassembly of appliances to remove foams and the subsequent incineration of these foams necessitates very complex monitoring and verification procedures. However, the effort involved is likely to be so great that the associated costs are unacceptably high for the benefits achieved.

Re. A.2.3 – No direct incineration of ODS-containing foams from appliances and equipment

The requirements in sec. 6.5.3 concerning the analysis of foams fall far short of what is needed in order to have quantitative dependable data regarding the actual amounts of ODS destroyed. As currently worded, even optimized sampling (i.e. more representative sampling) would only yield an unreliable estimate of the quantity of ODS in the foams and the CRT value that can be derived from it.

We therefore continue to urge that the ODS in appliance foams must be recovered, liquefied and then destroyed.

The arguments in support of our demand are set out in the following:

a. Different insulation materials

Appliances and equipment can contain a broad range of insulation materials and the mixture of these materials present in end-of-life appliances sent for destruction cannot be defined with any degree of accuracy. Insulating materials may include:

- Polyurethane
- Expanded polystyrene (Styrofoam)
- Glass wool / Rockwool

b. Different blowing agents in polyurethane

The polyurethane in waste appliances may contain the following foam blowing agents:

- ODS (R11, R12, R141b, R22 etc.)
- ODS substitutes: HFCs (R123, R134a, R152a, R245fa etc.)

see also: <http://www.epa.gov/ozone/snap/foams/lists/applianc.html>

- ODS substitutes: HCs (cyclopentane)

The amount of blowing agent used will depend on its particular chemical and physical properties, so that the quantities of blowing agents contained in the insulating foam of waste appliances will depend on the particular blowing agent used.

c. Different quantities of ODS in different waste appliances

As can be seen in **appendixes 6 and 7**, the amount of CFC blowing agent in the foam varies widely from appliance to appliance even if only pure R11 appliances are considered.

The overview in **appendix 6** is taken from a study carried out in 2000 on waste refrigeration appliances that contained only the CFC R11 as the foam blowing agent. The amount of ODS per kilogram of PU foam ranges from 18 g R11 per kg foam to 128 g R11 per kg foam (table 3.1 in the study authored by Dr. Hug).

Appendix 7 contains the results of analyses carried out in 2009. In this case, the range spans from 4.6 g of the CFC R11 per kilogram of PU foam to 110 g of R11 per kg of PU foam.

This shows that even within waste refrigeration appliances that contain only CFC R11 as the blowing agent, the range of values of blowing agent per unit weight of foam is so great that each appliance would need to be sampled and analysed individually if reliable figures on the ODS content are to be generated.

d. Different quantities of ODS in one and the same appliance

As **appendix 6** demonstrates, the results of the ODS analysis even vary within the foam taken from a single waste refrigeration appliance. This means that a single foam sample will not be sufficiently representative. In our opinion, three foam samples would need to be taken from a single appliance in order to generate a reliable average value. This would then be multiplied by the relevant weight of foam contained in the appliance to yield the amount of ODS contained in that appliance.

e. Foam analyses are subject to error

The analytical method attributed in section 6.5.3 to Scheutz et al. had in fact been developed as early as 2001 at the laboratories of a RAL member company in Luxembourg (*Oeco Service Luxembourg, Colmar-Berg, Luxembourg*) and the method was published by RAL in the 2003 edition of the RAL GZ-728 standard. The method yields excellent, precise and reliable results when examining the amount of residual ODS in the almost ODS-free powdery PU foam generated by a stage II fridge processing plant. Typically PU powder from this source contains only about 0.2 % w/w of residual ODS.

But like all the other analytical methods (including that in the German industrial standard DIN 51727), this method also has come up against its limits when analysing original foam samples that have not been subjected to prior treatment to remove the ODS.

Appendix 8, which is unfortunately only available in German, shows that simply sampling foam samples from appliances is associated with an error of up to 49 %. The analytical procedure described in the Draft Protocol requires foam samples with a thickness of less than 1 cm. It is a fact that when these samples are prepared, ODS can escape from the cut surfaces and are not then detected in the analysis. Results generated by this method are therefore best treated as approximate values.

The arguments presented in the subsections a. to e. above are, in our opinion, reason enough to reconsider the representativeness of the number of samples taken and the adequacy of the analytical method currently being propagated. In our opinion, however, the time, cost and effort involved in achieving the requisite level of statistical reliability and the requisite accuracy when analysing foam samples from manually stripped appliances are not economically justifiable.

Given the variety and the difficulty in predicting the type and amount of insulating foam in waste refrigeration appliances and the blowing agents these foams contain (different ODS, HFCs, HCs and other non-ODS), it is simply not possible to generate any meaningful and generally applicable formula for the amount of ODS destroyed.

In our opinion, the only reasonable response is to prohibit the direct incineration of ODS-containing foams from appliances and equipment.

Should the manual removal of foams (hand stripping) continue to be allowed, we believe that the only environmentally meaningful approach is to stipulate that the ODS contained in these foams be extracted and liquefied prior to destruction.

Re. A.2.4 – Direct incineration of ODS-containing building foams only with optimized foam sampling and analysis procedures

Although determining the ODS content in building foams is simpler than in the foams in appliances, our remarks above concerning section A.2.3 (points d. and e.) are also applicable to ODS-containing building foams.

In most cases, ODS-containing foams from the building sector will be in the form of large panels. Even the ODS-blown foam on a single roof may exhibit a heterogeneous distribution

of ODS throughout the foam depending on how different parts of the foam panel are situated relative to incident sunlight, sources of heat, cold or warm rooms, humidity levels, etc. A single sample from such a panel would clearly be unrepresentative of the panel as a whole.

Our reservations above (A.2.3) concerning the analytical method specified in the Draft Protocol also apply in the case of building foams.

For these reasons, we believe that the specifications governing the sampling and analysis of building foams must also be optimized.

C Suggested amendments to the Draft Protocol

On the following pages, we have made a number of constructive suggestions for amendments to the wording of the Protocol:

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2.3 Eligible ODS

- Refrigerants

[...]

- **Foams:** a project may either extract eligible ODS blowing agent from **intact foams or foams contained in equipment and appliances** and destroy the extracted blowing agent at a qualifying destruction facility; or, a project may destroy intact foam sourced from building insulation at a qualified destruction facility.

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2.3.1 Refrigerant Sources

[...]

Only destruction of the following ODS refrigerants is eligible for crediting under this protocol:

- ~~CFC-11~~
- ~~CFC-12~~
- ~~CFC-114~~
- ~~CFC-115~~

ODS controlled by the Montreal Protocol for which the IPCC publishes a Global Warming Potential (100-year time horizon):³

- 1) Annex A, Group I
- 2) Annex B, Group I
- 3) Annex C, Group I

2.3.2 Foam Sources

This source category consists of ODS entrained *in foams from waste refrigeration appliances and equipment, construction materials and other ODS-containing products* that would have been released at end of life. The ODS must originate from domestic U.S. foam sources; imported foams are excluded from this protocol. Project developers seeking to

³ Justification: CAR should be in line with VCS Standard

register projects from the domestic destruction of imported foams must use the Reserve's Imported Ozone Depleting Substances Project Protocol

Only the following ODS foam blowing agents are eligible to generate reductions under this protocol:

- ~~□ CFC 11~~
- ~~□ CFC 12~~
- ~~□ HCFC 141b~~

ODS controlled by the Montreal Protocol for which the IPCC publishes a Global Warming Potential (100-year time horizon):⁴

- 1) Annex A, Group I
- 2) Annex B, Group I
- 3) Annex C, Group I

To be eligible for crediting, the foam blowing agent must be destroyed in one of two ways:

1. **ODS blowing agent extracted from intact foams or foams contained in equipment and appliances and blowing agent destroyed.**

The ODS blowing agent must be extracted from the foam or foam contained in equipment and appliances to a liquid form prior to destruction. This must be done under negative pressure in a vacuum to ensure that fugitive release of ODS cannot occur. The recovered ODS must be collected, stored, and transported in cylinders or other hermetically sealed containers.⁵

2. **Intact foam containing ODS blowing agent separated from panels or from foams contained in equipment and appliances and destroyed when intact or not intact.**

When the intact foam⁶ is separated from building panels, appliances or equipment, it must be stored, transported, and destroyed in hermetically sealed containers. ~~Foam extracted from equipment and appliances must be categorized and stored in containers according to the type of ODS and the year the equipment or appliance was manufactured.~~⁷

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SSR 2 and SSR 3 should be included within the GHG Assessment Boundary⁸.

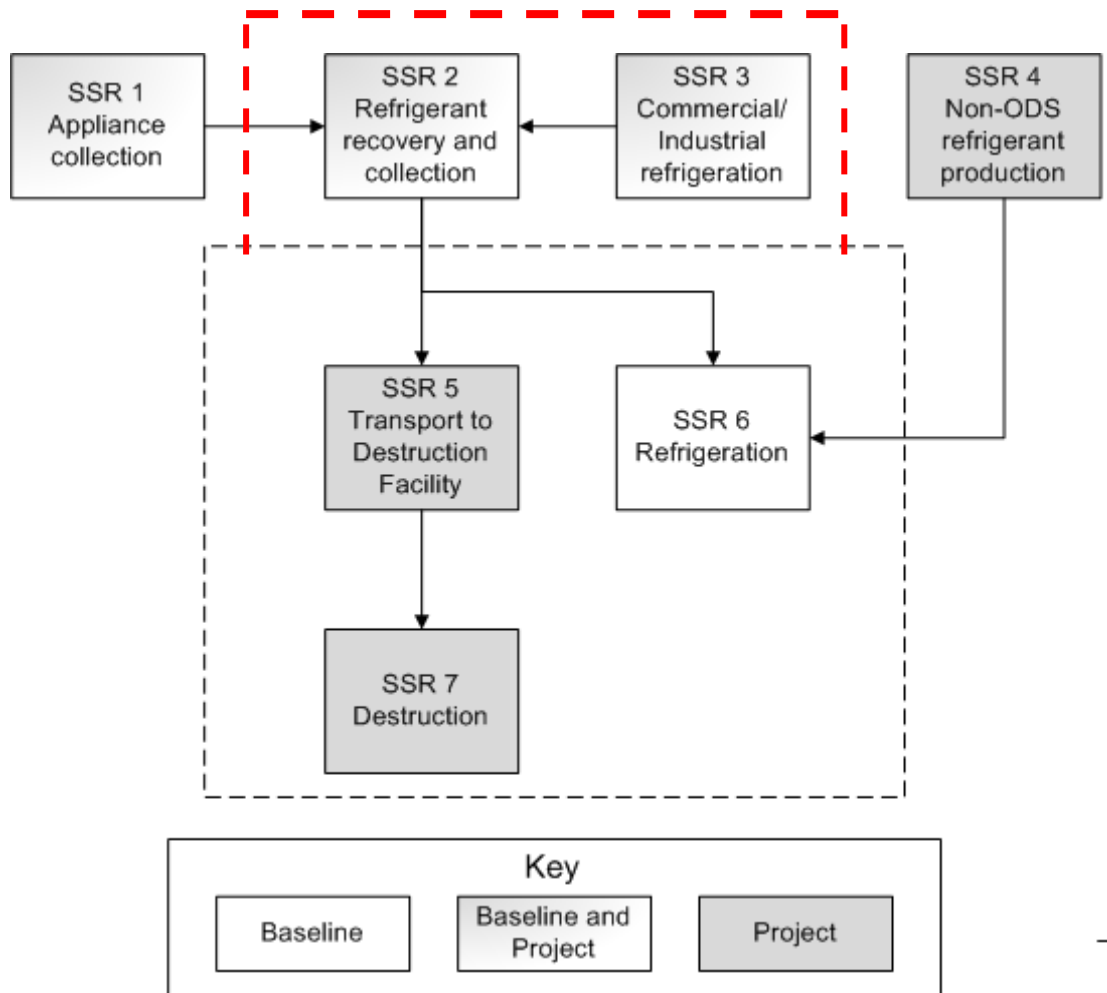
⁴ Justification: CAR should be in line with VCS Standard

⁵ We would like to be given a more precise definition of the term "container". It is also necessary to establish whether the containers are to be incinerated together with their contents.

⁶ It should be obvious that manual disassembly of appliances (i.e. manual stripping of foams) will not result in intact foam.

⁷ Not realizable; see our arguments with respect to A.2.2 c.

⁸ Justification: Stimulation of a high recovery rate. Otherwise high ODS emissions from the recovery and collection of ODS-containing waste is very likely, see our arguments with respect to A.2.1



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Table 5.2. Emissions from Shredding and Landfilling ODS Foam Blowing Agents⁹

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5.2.1 Project Emissions from the Use of Refrigerant Substitutes

Projects that destroy refrigerant ODS must account for the emissions associated with the non- ODS substitute chemicals that will be used in their place using Equation 5.6. Like the destroyed ODS calculations used in the baseline, substitute emissions shall also be accounted for based on the projected emissions over a ten year crediting period. ODS substitute emissions are based on the weighted average of new refrigerant supplies into the refrigeration market. These substitute refrigerants were modeled using the EPA Vintaging Model and data provided by industry sources. Calculation of ODS substitute emission rates from the data provided by the EPA Vintaging Model is provided in Appendix D. The analysis identified the emission factors in Table 5.3 for each ODS refrigerant covered under this protocol.

⁹ The table is continuously updated to ensure that it reflects current knowledge.

5.2.2 Project Emissions from the Recovery and Collection of ODS

Projects that recover ODS from equipment or appliances must account for the emissions of ODS that occur during recovery. Recovery must be conducted in a manner that achieves at least a 90% recovery and destruction efficiency (RDE).¹⁰

5.2.3 Project Emissions from Foam Separation

Projects that separate foam from building or appliance panels and destroy foam intact must account for the emissions of ODS that occur during separation using Equation 5.7. Separation must be conducted in a manner that achieves at least a 90% recovery and destruction efficiency (RDE)¹¹, per the recommendations of the TEAP Report of the Task Force on Foam End-of-Life Issues. The losses calculated in Equation 5.7 include the original foam blowing agent that is released during the entire process of deconstruction (for buildings), de-manufacture (for appliances), and transport to destruction facility.

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6.4 Foam Collection and Management Requirements

Appliances and equipment containing foam or foam that has been extracted from appliances and equipment included in the project shall be collected and the following information recorded:¹²

- Number, **weight and type**¹³ of appliances processed, differentiated **by type of insulation and blowing agent**¹⁴
- Facility at which appliance de-manufacture occurs
- Facility at which ODS blowing agent is extracted (if applicable)
- Year of appliance manufacture (if the foam is destroyed intact)
- **Quantity of extracted ODS, amount of PU, ferrous metal, non-ferrous metal, etc. recovered**

Foam from building insulation included in the project shall be collected and the following information recorded:

- Building address
- Date of construction
- **Foam weight**
- Blowing agent used
- Building dimensions

The foam blowing agent shall be collected and destroyed to ensure a 90% recovery and destruction efficiency (RDE) **of ODS**. This requirement is consistent with the TEAP Report of the Task Force on Foam End-of-Life Issues. RDE describes the proportion of blowing

¹⁰ Justification: see our arguments with respect to A.2.1 and A.2.2

¹¹ e.g. as determined by the methodologies in the RAL GZ-728 standard.

¹² We reiterate here our fundamental doubts about the soundness and environmental sense of allowing foams to be manually extracted from appliances.

¹³ International classification system used by WEEE Forum and RAL (Type 1, Type 2, Type 3)

¹⁴ ODS in polyurethane, polyurethane without ODS, polystyrene without ODS, fibreglass

agent (ODS) remaining in the product¹⁵ before decommissioning that is recovered in the overall end-of-life management step, including ultimate destruction.

90% recovery and destruction efficiency shall be demonstrated through a standard of performance¹⁶ that must be followed by all project developers. All foam must be recovered in a manner that meets the following criteria:

1. ODS blowing agent extracted from intact foams or foams contained in equipment and appliances, and only ODS blowing agent destroyed.

- a. The ODS blowing agent must be extracted from the foam **or foam contained in equipment and appliances** to a liquid form prior to destruction.
- b. ODS blowing agent shall be extracted under negative pressure in a vacuum to ensure that fugitive release of ODS cannot occur.
- c. The recovered ODS shall be collected, stored, and transported in cylinders or other hermetically sealed containers.

2. Intact foam containing ODS blowing agent separated from panels or from foams contained in equipment and appliances and destroyed intact or not intact.

- a. Appliance carcass shall be cut **no more than 6 times**¹⁷ (for appliances only)
- b. Separation of foam from panels must be done by trained personnel¹⁸, and in a manner demonstrated to minimize foam tearing.
- c. 90% of separated foam must be in pieces greater than **100 cubic inches**¹⁹
- d. ~~Separated foam shall be categorized and stored according to ODS species and year of manufacture of the equipment or appliance~~
- d.e. Separated foam **from each individual appliance or from each individual source of building foam** shall be transferred to **its own** hermetically sealed container²⁰ within 15 minutes of separation.²¹
- e.f. Foam shall be stored, transported, and destroyed while sealed inside hermetically sealed containers to ensure no release of blowing agent
- f.g. No foam shall be shredded prior to destruction.

These practices shall be documented in operating and training materials, and must be **continuously recorded**²² **in an operations logbook**²³ **as well as being** demonstrated on-site during verification activities (see Section 8.5).

¹⁵ i.e. appliances and equipment

¹⁶ i.e. RAL GZ-728

¹⁷ What is the origin of these specific requirements? Were they taken from a study?

¹⁸ We reiterate here our fundamental doubts about the soundness and environmental sense of allowing foams to be manually extracted from appliances.

¹⁹ What is the origin of these specific requirements? Were they taken from a study?

²⁰ We would like to be given a more precise definition of the term “container”.

²¹ Justification: see our arguments with respect to A.2.2. c

1. A single **scale**²⁴ must be used for generating both the full and empty weight tickets
2. The scale used must be properly calibrated per the facility's RCRA permit, or calibrated at least quarterly for non-RCRA facilities

Composition and concentration of ODS shall be established for each individual container by taking a **representative sample** from each container of ODS and having it analyzed for composition and concentration at an Air-Conditioning, Heating and Refrigeration Institute (AHRI) certified laboratory using the AHRI 700-200629 standard²⁵, or its successor.

1. A **representative sample** must be taken while ODS is in the possession of the final destruction facility

[...]

6. Each sample must be individually labeled and tracked according to the container from which it was taken, and record:

- i. Time and date of sample
- ii. Name of project developer
- iii. Name of person pulling sample
- iv. Employer of person pulling sample
- v. Volume **and weight of liquid ODS**²⁶~~-container~~ from which sample was extracted
- vi. Ambient air temperature at time of sampling

- All project samples shall be analyzed using ARI 700-2006 or its successor **or a similarly validated analysis method**²⁷ to confirm the mass % and identity of each component of the sample. The analysis shall provide:

1. Identification of the ~~refrigerant~~ ODS
2. ...
3. ...

²² daily logging of every appliance and every foam building panel processed.

²³ e.g. by continuous and meaningful photographic documentation

²⁴ Measurement precision? Measurement range?

²⁵ or an equivalent method of analysis

²⁶ The weight of the container is not of interest. What is important is the weight of the ODS.

²⁷ The suggested amendment is made here despite strong reservations.; see our arguments with respect to A.2.3.

The composition and mass ratio of the ODS blowing agent(s) present will be determined as follows²⁸:

- ~~2=~~Statistically representative²⁹ samples shall be taken from the foam of each single appliance or building foam source in each air and water-tight container
- Each foam sample shall be 2 inches in length and 2 inches in width, no thicker than 0.4 inches (1 cm)
- All samples from a single site shall be placed and sealed in separate waterproof, air-tight containers, at minimum 2 millimeters of thickness for storage and transport
- ~~The duplicate~~ An additional sample shall be held in inventory for verification if necessary
- The analysis of ODS blowing agent content and mass ratio shall be done at an independent laboratory
- The analysis shall be done using the heating method to extract blowing agent from the foam samples, as described in RAL- GZ 728 (2003/2007) or Scheutz et al. (2007)³⁰ or similarly validated analysis method:
 - Each sample, no thicker than 1 cm, must be placed in a 1123 mL glass bottle, sealed with Teflon-coated septa and aluminum caps to be measured for blowing agent content
 - To release the blowing agent from the foam, the samples must be incubated in an oven for 48 hours at 140 degrees C
 - When cooled to room temperatures, gas samples must be redrawn from the headspace by gas chromatography
 - The lids must be removed after analysis, and the headspace must be flushed with atmospheric air for approximately 5 minutes using a normal compressor.
 - Afterwards, septa and caps must be replaced and the bottles subjected to a second 48-hr heating step to drive out the remaining blowing agent from the sampled foam.
 - When cooled down to room temperature after the second heating step, gas samples must be redrawn from the headspace and analyzed by gas chromatography
- The mass of ODS blowing agent(s) recovered shall then be compared to the total mass of the initial foam samples prior to extraction to determine the mass ratio of each ODS foam blowing agent present

²⁸ The suggested amendments are made here despite strong reservations.; see our arguments with respect to A.2.3.

²⁹ Justification: see our arguments with respect to A.2.3.

³⁰ Not the original developer of this kind of analysis; see the RAL GZ-728 standard (2003 / 2007)

**All appendixes (2-8) will be sent in a direct
email to CAR**

Appendix 2



Rückproduktion von Kühlgeräten

Quality Assurance and Test Specifications for the Demanufacture of Refrigeration Equipment

Gütesicherung RAL-GZ 728

Ausgabe September 2007



DEUTSCHES INSTITUT FÜR GÜTESICHERUNG UND KENNZEICHNUNG E. V.

Appendix 3:

Last updated: 2 February 2004

Ordinance of the Federal Ministry of Agriculture, Forestry, Environment and Water Management on Obligations to Treat Waste – ('Waste Treatment Obligations Ordinance')

On the basis of paragraphs 8 and 23 section 1 and paragraph 65 section 1 of the Waste Management Act (AWG 2002), Federal Law Gazette (BGBl.) No.110/1993, and with regard to paragraph 23 section 1 and paragraph 65 section 1 of AWG 2002 and in consultation with the Federal Minister for Economic Affairs and Labour, it is hereby decreed:

Article I General Provisions

Objectives

1. The objectives of this ordinance are: the setting down of minimum requirements for the collection, storage and treatment of waste in order to meet waste management targets and implement waste management principles; the promotion of waste avoidance, recycling and the efficient use of materials; the establishment of the environmentally compatible collection, storage, transport and treatment of waste.

Scope / Responsibilities

2. (1) This ordinance applies to hazardous and non-hazardous waste within the meaning of AWG 2002.
- (2) If waste electrical and electronic equipment is re-used, the provisions of this ordinance shall not apply to such equipment for the duration of its re-use.
- (3) Compliance with this ordinance is the responsibility of the waste owner (original waste producer, waste collector or waste processor).

Article II

Part 1

Waste Electrical and Electronic Equipment

Definition of terms

3. (1) The term 'Electrical and electronic equipment' is understood to mean devices that require electric current or electromagnetic fields in order to function correctly, or that generate, transmit and measure such currents and fields, and that are included in one of the following categories and that are designed for a.c. operation up to a maximum of 1000 volts or for d.c. operation up to a maximum of 1500 volts:
 1. Large domestic appliances, including but not limited to: refrigerators and freezers (devices with a cooling assembly), washing machines, cookers and ovens, electrical heaters, microwave ovens, electric hobs
 2. Small domestic appliances, including but not limited to: vacuum cleaners, toasters, deep fat fryers, alarm clocks, wristwatches, balances.
 3. IT and telecommunications equipment, including but not limited to: mainframe computers, PCs, printers, pocket and desktop calculators, telephones, mobile phones
 4. Consumer electronics, including but not limited to: radios, televisions, video cameras, video recorders, hi-fi systems, DVD players
 5. Luminaires and light fittings, including but not limited to: fluorescent lamps, lamps but excluding incandescent (filament) lamps, other lighting fittings
 6. Electric and electronic tools (excluding static industrial-scale tools), including but not limited to: sewing machines, power drills, lawn mowers
 7. Toys and sports and leisure equipment, including but not limited to: video games consoles, electric train and racing car sets, minicomputers for cycling, diving, running, rowing etc.



Requirements for the Collection, Transportation, Storage, Handling and Treatment of Household Cooling and Freezing Appliances containing CFC, HCFC or HFC

21 December 2007

1. Objective

The objective of these requirements is to ensure:

- the non-polluting separation of household cooling and freezing appliances in fractions, for material recycling or energy recovery;
- the environmentally sound disposal of CFC, HCFC and HFC ("controlled substances") [1]. This means the destruction of ozone depleting substances in accordance with Regulation (EC) No 2037/2000 on substances that deplete the ozone layer, such as CFC and HCFC, and the destruction of climate endangering compounds such as HFC and also CFC and HCFC.
- safe treatment of HC [3]. Precise requirements for treatment of HC is described in the document "Requirements for the Collection, Transportation, Storage and Treatment of Cooling and Freezing Appliances containing Hydrocarbons (HC)" [11].

This document follows the legal requirements concerning monitoring, recycling and recovery targets according to the Directive 2002/96/EC or corresponding national regulations, monitoring of "controlled substances" as recovered for destruction and implement a regular performance verification test procedure carried out by an independent auditor (see chapter 6, Annex 1).

[1] In this paper CFC, HFC, HCFC are summarized as "controlled substances":
CFC - Chlorofluorocarbon (e.g. R12, R11), HCFC Hydrochlorofluorocarbon (e.g. R22, R141b) and HFC - Hydrofluorocarbon (e.g. R134a)). CFC and HCFC are ozone depleting substances and have a high global warming potential (GWP) while HFC do not deplete the ozone layer but have a significant global warming potential.

Öko-Institut e.V. • Rheinstr. 95 • 64295 Darmstadt • D

Dipl. Ing. Christoph Becker
RAL-Gütegemeinschaft Rückproduktion von
Kühlgeräten e.V.
29, Avenue de la gare
L-1012 Luxembourg

29 October 2009

**Interim results from tests of the manual disassembly of waste
refrigeration appliances**

Dear Mr Becker,

Öko-Institut e.V. is currently undertaking a study of the various disposal and treatment channels for waste refrigeration appliances. The complete study should be available by the end of November.

We can, however, already provide the following data that relate to one aspect of the study:

In September 2009, a series of tests were conducted that aimed to determine the levels of CFC emissions when waste refrigeration appliances are disassembled by hand. In order to establish a CFC-emissions dataset that could be used for comparative purposes, the manual disassembly techniques used were copied from the methods employed at waste fridge processing facilities in North and South America.

The tests demonstrated that manual disassembly leads to emissions of CFCs from the following three channels:

- a) Cutting up the appliances with a saw
- b) Manual removal/extraction of the foams from the appliance carcass (due to rupturing and opening of the cells in the foam polymer and outgassing of CFCs)
- c) Residual quantities of insulating foam still adhering to metal and plastic.

The losses from channels a) and b) were estimated by weighing the intact appliances prior to disassembly and then weighing the material fractions after manual disassembly. It was assumed that the difference in weight is due to CFC losses to the environment. For the purposes of calculation, it was also assumed that in all the appliances tested, the average percentage weight of CFCs originally present in the polyurethane (PU) insulating foam was 8.5%.



Bereich Infrastruktur und
Unternehmen

Büro Darmstadt
Rheinstr. 95
64295 Darmstadt

Tel. +49 (0) 6151 - 81 91-0
Durchwahl -27
Fax +49 (0) 6151 - 8191-33
E-Mail d.schueler@oeko.de

Geschäftsstelle Freiburg

Postfach 50 02 40
79028 Freiburg

Hausadresse

Mozthausstr. 173
79100 Freiburg

Tel. +49 (0) 761 - 4 52 95-0
Fax +49 (0) 761 - 4 52 95-88

Büro Berlin

Novallsstr. 10
10115 Berlin

Tel. +49 (0) 30 - 40 50 85-0
Fax +49 (0) 30 - 40 50 85-888

Geschäftsführung:

Michael Sailer (kommissarische Leitung)
Dr. Rainer Großhammer
Christian Hochfeld

Vorstand:

Helmfried Mairal
Dorothea Michaelson-Friedlieb
Dr. Wolfgang Brühl
Nicola Moczak
Dr. Barbara Probstorius
Nadja vom Scheidt
Franz Untertaler
der Geschäftsführer
drei Mitarbeiterinnen

Wissenschaftl. Kuratorium:

Prof. Dr. Armin Bachmann
Dr. Erhard Eppler
Prof. Piero Formisano
Prof. Dr. Ludvig von Frideburg
Prof. Dr. Martin Führ
Hermann Graf Habzoldt
Prof. Dr. Doris Jarshen
Prof. Dr. Regina Kollak
Prof. Dr. Heinrich Fritze von Larnsar
Prof. Dr. Peter C. Mayer-Tasch
Prof. Dr. Eckard Rehbindar
Dr. Hans Erich Schött
Dr. Christian Schütze
Prof. Dr. Udo Ernst Simonis

Bankverbindungen:

Sparkasse Freiburg – Nord. Breisgau
BLZ 660 501 01
Konto-Nr. 2 063 447
IBAN: DE36 6805 0101 0002 0634 47
BIC: FRSFDE33

Postgironkonto
Postbank Karlsruhe
BLZ 660 100 75
Konto-Nr. 136 018 759

Steuernr.: 06 470 / 45 009
USt-ID-Nr.: DE 142 117 254

Appendix 6:

ROOS-PAARTNER AG
Quadratstr. 25
10557 Berlin
030 240 40 40
Telefon 030 240 40 40
Telefax 030 240 40 40
roos-partners@tiscali.de
www.roos-partner.com

ROOS I-PARTNER FÜR UMWELT UND TECHNIK

Qualitätsgemeinschaft
zur Verwertung von Kühlgeräten
und Elektro-/Elektronikgeräten e.V.

Haushaltskühlgeräteentsorgung in
Deutschland

Untersuchung zur FCKW Input-
Bestimmung

Beurteilender Bericht

Linzen, 10. Mai 2000

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KONZEPT VIER

Umweltliche Analysen und Konzeption für
Umwelt • Sicherheit • Energie • Arbeit

Appendix 7:

Analysen
1483357.10

Prüfbericht Nr. 752957
Auftrag Nr. 1483651

Seite 2 von 4
02.10.2009

Proben durch Kunden entnommen

Matrix: Feststoff

Probennummer	9500611	9500612	9500613		
Bezeichnung	09/0143-1	09/0143-2	09/0143-4		
Eingangsdatum:	18.09.2009	18.09.2009	18.09.2009		
Parameter	Einheit			Bestimmungsgrenze	Methode
LNKW Headspace :					
Dichlordifluormethan	mg/kg	< 5,0	< 20	80	0,005
1,1,2-Trichlorfluorethan	mg/kg	n.a. ⁽¹⁾	n.a. ⁽¹⁾	n.a. ⁽¹⁾	0,001
Trichlorfluormethan	mg/kg	4600	31000	110000	0,001
(1) nicht auswertbar					
FKKW Headspace :					
Summe nachgewiesener FKKW	mg/kg	4600	51000	110000	

R11-Gehalte in PUR-Schäumen

Das Bestreben der Schaumhersteller war es, möglichst gute Isolierwirkung zu erzielen, d. h. möglichst das gesamte Porenvolumen mit R11 zu füllen (R11 hat eine sehr geringe Wärmeleitfähigkeit von 0,0079 W/m K; zum Vergleich zur Luft 0,0243 W/m K und CO₂ 0,0148 W/m K).

Theoretisch läßt sich der R11-Gehalt in PUR-Hartschäumen wie folgt abschätzen:

Gemäß der Rezeptur zur Herstellung von PUR-Hartschäumen wurden auf 100 Teile Polyol + Isocyanat ca. 15 Teile R11 zugegeben.
Bei einem Raumgewicht von 35 kg/m³ entspricht dies einer Menge von 5,25 kg pro m³ Schaum.

Unter der Voraussetzung, daß ein Großteil der geschlossenen Poren im PUR-Schaum (Anteil 90% bis 95%) zu 90% mit R11 gefüllt sind, ergibt sich für einen Schaum mit einem Raumgewicht von 35 kg/m³ eine R11-Menge von ca. 13,7% entsprechend 4,8 kg/m³ Schaum.

Ansatz der rechnerischen Abschätzung

- Rezeptur PUR Hartschäume

Polyol + Isocyanat = 100 Teile, dazu ca. 15 Teile R11

Dichte der Schäumungsmasse Polyol / Isocyanat 1 kg/l

- Molmasse R11: 137 kg/mol. = 22,4 l Gasvolumen

Bei einem Raumgewicht von 35 kg/m³ ist das Verhältnis von Zellgerüst zu Porenvolumen 35 l zu 965 l.

Unter der Annahme, daß 90 % der Poren geschlossen sind, und daß diese geschlossenen Poren zu 90 % mit R11 gefüllt sind, ergibt sich ein R11-Gasvolumen von ca. 781 l/m³ Schaum.

Dieses Gasvolumen entspricht einer R11-Menge von 4,8 kg/m³ Schaum bzw. 13,7 Gew %.

Ein so gefertigter Schaum weist unmittelbar nach der Herstellung eine Wärmeleitfähigkeit von 0,020 W/m K auf. Innerhalb von 6 Wochen steigt die Wärmeleitfähigkeit in Folge R11 Ausgasung auf ca. 0,025 W/m K an.

Infolge von Diffusionsvorgängen innerhalb des Schaumes kommt es über einen langen Zeitraum (Monate, Jahre) zu einem weiteren geringen Verlust von R11, was sich in einem weiteren Anstieg der Wärmeleitfähigkeit auf ca. 0,027 W/m K bemerkbar macht.

Alterungsprozesse von Hartschäumen verlaufen sehr langsam (30 bis 40 Jahre), d. h. das Zellgerüst ist über einen langen Zeitraum stabil und verhindert so größere R11-Ausgasungen.