Bio Intelligence Service

European Commission DG ENV

A project under the Framework contract G.4/FRA/2007/0067

STUDY ON ANNEX IIIA OF THE EU WASTE SHIPMENT REGULATION

Final Report

August 17th, 2009

Bio Intelligence Service - Scaling sustainable development
Industrial Ecology - Nutritional Health
Bio Intelligence Service S.A.S - bio@biois.com
1 rue Berthelot - 94200 Ivry-sur-Seine - France
Tél. +33 (0)1 56 20 23 98 - Fax. +33 (0)1 58 46 09 95

Contact BIO Intelligence Service
Shailendra Mudgal – Patricia Benito
Arianna De Toni
☏ + 33 (0) 1 56 20 28 98
shailendra.mudgal@biois.com
patricia.benito@biois.com
arianna.detoni@biois.com

Project Team

- **BIO Intelligence Service**
  Mr. Shailendra Mudgal
  Ms. Patricia Benito
  Ms. Arianna De Toni
  Ms. Lea Turunen

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1. EXECUTIVE SUMMARY

1.1. BACKGROUND

The Waste Shipment Regulation (WSR)[1] sets limits on the Trans-frontier Shipment of waste (TFS) within and outside the European Union (EU) from an environmental perspective. A 'green' listed waste is defined in Annex III of the WSR. Furthermore, mixtures of two or more wastes listed in Annex III, but not classified under one single entry in this Annex, can be considered 'green' (to be listed in Annex IIIA of WSR). Shipment of wastes listed 'green' destined for recovery operations are subject to the "general information requirements", as opposed to a more elaborate procedure of prior written notification and consent. Some guidance for the selection of entries that may be relevant for Annex IIIA is provided in recital 39 of the WSR.

1.2. OBJECTIVES AND METHODOLOGY

The objective of this study is to assist the Commission in analysing and assessing eighteen waste mixtures proposed by Member States (MS) for inclusion in the Annex IIIA[2].

The main focus of this study is to assess data and information relating to the proposed waste mixtures, and on the basis of this analysis, to recommend which of these mixtures could be included in Annex IIIA. In particular, the proposed waste has been assessed with regard to the requirements specified in recital 39, and the items of the "List of issues relevant for adding mixtures of waste to Annex IIIA" of the WSR.

For each waste mixture, a factsheet has been prepared, which includes the gathered information which has been used to assess the proposal, as well as the results of the assessment, i.e. conclusions and recommendations. The analysis was focused on 6 main points:

- Identification and description of the waste mixture
- Hazardous characteristics of the waste mixture
- Potential for contamination of the waste mixture[3]
- The capacity to recover the waste mixture in EU and in OECD countries
- The environmental benefits/ impacts of recovery
- The enforceability

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1 Regulation (EC) No 1013/2006 of the European Parliament and of the Council, of 14 June 2006 on shipments of waste.

2 Three waste mixtures have been amended and presented for inclusion in Annex IIIB rather than IIIA. The waste included in Annex IIIB is not supposed to be transported in non-OECD countries. The criteria used for the analysis were the same used for the rest of proposals.

3 Risk for contamination is here intended as the risk to be contaminated with unwanted waste

1.3. ASSESSMENT OF THE PROPOSALS

The assessment of the proposals has been performed on the basis of the six main points mentioned above. For each proposal, following key issues have been identified:

Proposal No.	Definition	Key identified issues
1	Mixture of ferrous and non-ferrous metals in non-dispersible form	Measure the concentration of potentially hazardous components traces
2	Ferrous and non-ferrous metals in non-dispersible form mixed with dispersible forms of Cu	Storage and shipment of Cu in dispersible form
3	Cu and precious metal bearing scrap in dispersible form – waste of Cu with metal slags and comer smelting wastes	Storage and shipment of Cu in dispersible form, availability of the best recovery technology
4	Non-ferrous metal-bearing waste arising from melting, smelting and refining including slags from precious metals and Cu processing	Storage and shipment of Cu in dispersible form, availability of best recovery technology
5	Mixture of ferrous and non-ferrous metals in non-dispersible form	Containing shredded waste from end-of life vehicles (ELV), quality of pre-treatment
6	Mixture of ferrous and non-ferrous metals with plastics	Containing shredded ELV, halogenated flame retardants (HFR), quality of pre-treatment
7	Mixture of solid plastic waste with 3-8% ferrous and non-ferrous metals	Containing shredded ELV, waste originated from electric and electronic equipments (WEEE), HFR, quality of pre-treatment
8	Mixture of solid plastic and rubber with 10% ferrous and non-ferrous metals	Containing shredded ELV, HFR, quality of pre-treatment
9	Mixture of solid rubber with 10% ferrous and non-ferrous metals	Origin of the rubber fraction (ELV?), possible presence of hazardous components
10	Mixture of waste metal cables and wires (75-90%) with non ferrous metals (<10%), including stones	Origin of the stone fraction, heavy metals based PVC stabilisers, other hazardous contaminants in cables
11	Mixture of non-ferrous metals with 10% plastic and/or rubber	Containing WEEE, HFR and other hazardous components (e.g. lead and cadmium-based stabilisers in PVC), quality of pre-treatment
12	Label laminate waste- pressure sensitive adhesive (PSA) laminate waste including minor quantities of raw materials used in label material production.	Definition of the entry, presence of raw material
13	Plastic-Al –cardboard-fibre composite from the pre-treatment of liquid packages (fibres 10%, Al 10%, plastic 60%, moisture 20%)	Contamination with other waste streams, eventual presence of heavy metals based PVC stabilisers, choice of recovery option
14	Mixture of plastic and cardboard from industry, retail, business properties and offices	Contamination with other waste streams, eventual presence of heavy metals based PVC stabilisers, choice of recovery option
15	Plastic-cardboard-fibre composite from the pre-treatment of liquid packages (fibres 10%, plastic 70%, moisture 20%)	Contamination with other waste streams, eventual presence of heavy metals based PVC stabilisers, choice of recovery option
16	Metal and metal alloys in a solid metallic non-dispersible form with solid plastic waste	Definition ,containing shredded ELV, WEEE, HFR, presence of heavy metals based PVC stabilisers, quality of pre-treatment
17	Non-metallic waste of plastic and rubber from waste management facilities	Containing shredded ELV, WEEE, HFR, presence of heavy metals based PVC stabilisers, risk of

Proposal No.	Definition	Key identified issues
		landfilling
18	Combination packaging consisting of a paper outer package with an attached and easily removable separate plastic inner bag	Eventual traces of the packaging content

1.4. CONCLUSIONS

Based on the assessment, some general conclusions and recommendations have been drawn.

- **Identification and description of the proposed waste mixtures**

According to Article 58 of the WSR, the mixtures to be included in Annex IIIA should be exclusively composed of the green listed wastes already included in Annex III, which are defined only by Basel codes. Therefore, the waste mixtures in the Annex IIIA will be defined using only the Basel codes, as this is the level of detail provided in Annex III itself. Nevertheless, the Basel codes are considered too general to identify the exact nature of the shipping waste. In this regard, a more detailed description of the waste mixtures, providing information on the nature and origin of the waste could be consider for defining green wastes in Annex III in order to avoid any misunderstanding and ensure the environmental sound management during the recovery operations.

- **Hazardous characteristics of the proposed waste mixtures**

Some of the waste mixtures may present hazardous characteristics. For example, waste mixture originated from WEEE and/or waste from ELV. These categories of waste are considered to have hazardous characteristics and are the object of specific EU Directives (Directives 2002/95/EC; 2002/96/EC; Directive 2000/53/EC[4]). In general, they could require taking special precautions during recovery. Thus, it is recommended to perform the recovery of WEEE and ELV containing waste in appropriately equipped facilities, and, following the precautionary principle, to export these mixtures only in EU and OECD countries.

Several waste mixtures are also susceptible to include plastic containing presence of heavy metals based PVC stabilisers[5] and/or HFR (e.g. brominated flame retardants, BFR). The environmental sound management and recovery of both of these components is currently under debate and a number of scientific publications have highlighted their potential deleterious impacts on both human health and environment especially when they are not appropriately managed. As a consequence, based on the precautionary principle, the transport of HFR containing waste should be limited to EU

4 In 2007, the Commission adopted a Report on the implementation of Directive 2000/53/EC on End-Of-Life Vehicles for the period 2002-2005.

5 Different additives can be added to PVC in order to modify its properties including plasticisers (e.g. phthalates) and stabilisers (e.g. Pb and Cd containing stabilisers). Some of these additives could be at the origin of both environmental and health impacts.

countries (where an appropriate incineration is in principle ensured) and the absence of hazardous components (e.g. some species of stabilizers) ensured by a specific document provided by the original facility where the waste mixture is produced.

- **Potential for contamination of the proposed waste mixture entries**

In general, if the waste mixtures are precisely described and if they correspond exactly to the description, the risk for contamination with an unwanted waste stream is minimised (e.g. organic waste).

- **The capacity to recover the waste mixture in EU and in OECD countries**

The technological capacity of recovery vary if we consider the interim recovery operations (e.g. manual sorting, sink-float sorting) or the non-interim recovery operations on a base by case basis. As a matter of fact, the interim recovery operations are possible in almost all EU and OECD countries. However, depending on the considered fraction, the technological capacity varies. Metal recovery, for example, is easily performed in many non-OECD countries while plastics, ELV, and WEEE recovery are more problematic. As a consequence, the shipment of problematic mixtures included in Annex IIIA, should be restricted to the Community and OECD-area. Exports of these specific waste mixtures to non-OECD countries would thus remain subject to a notification procedure.

- **The environmental benefits/impacts of recovery of the waste mixture proposals**

The recovery of the different waste mixtures fractions presents a number of environmental benefits including material, energy, and water conservation and reduction of greenhouse gases (GHG) emissions. In addition, after the recovery, the quantity of landfilled material is reduced. However, some deleterious impacts of recovery operations on both environment and human health have been highlighted for different waste mixture proposals. In EU countries, recovery facilities are equipped with the Best Available Technologies (BAT), as required by existing legislation (e.g. the best available filters to control air emissions during smelting or to avoid dioxins emissions during incineration) in order to minimise the environmental impacts of recovery operations. It should be consider that this could not be the case of third countries, especially non-OECD countries, and transporting waste which requires special precautions to these countries should be avoided.

- **Enforceability of the proposed entries**

A precise verification of the composition of a waste mixture is very difficult to perform during shipment inspection, mainly because of the difficulty to obtain a homogenous sample which is representative of the mixture. As a consequence, the compliance of the waste mixtures to the description (e.g. percentages of each fraction, absence of hazardous components, origin, etc.) should be verified at the original facility and ensured by appropriate documents.

- **Suitability for inclusion in Annex IIIA and IIIB (proposals #12, 13, 15)**

As a result of our analysis we recommend the exclusion of only one mixture of the eighteen assessed. Three of the mixtures are immediately suitable for inclusion, while fourteen can be suitable only if determined conditions are satisfied:

Proposal No.	Definition	Suitability for inclusion in Annex IIIA and IIIB (proposals #12, 13, 15)
1	Mixture of ferrous and non-ferrous metals in non-dispersible form	Suitable for inclusion
2	Ferrous and non-ferrous metals in non-dispersible form mixed with dispersible forms of Cu	Suitable for inclusion
3	Cu and precious metal bearing scrap in dispersible form – waste of Cu with metal slags and comer smelting wastes	Suitable for inclusion (only in BAT equipped facilities; EU and OECD)
4	Non-ferrous metal-bearing waste arising from melting, smelting and refining including slags from precious metals and Cu processing	Suitable for inclusion (only in BAT equipped facilities; EU and OECD)
5	Mixture of ferrous and non-ferrous metals in non-dispersible form	Suitable for inclusion
6	Mixture of ferrous and non-ferrous metals with plastics	Suitable for inclusion – limited to EU and OECD countries
7	Mixture of solid plastic waste with 3-8% ferrous and non-ferrous metals	Suitable for inclusion (only if absence of lead and cadmium stabilisers from the PVC fraction is ensured by the original facility)- limited to EU and OECD
8	Mixture of solid plastic and rubber with 10% ferrous and non-ferrous metals	Suitable for inclusion (only if absence of lead and cadmium stabilisers from the PVC fraction and other ELV problematic components is ensured by the original facility) - limited to EU and OECD
9	Mixture of solid rubber with 10% ferrous and non-ferrous metals	Suitable for inclusion (only if absence of tyres and other problematic components is ensured by the original facility)
10	Mixture of waste metal cables and wires (75-90%) with non ferrous metals (<10%), including stones	Non suitable for inclusion
11	Mixture of non-ferrous metals with 10% plastic and/or rubber	Suitable for inclusion (only if absence of lead and cadmium-based stabilisers from the PVC fraction is ensured by the original facility and HFR containing fraction is appropriately managed) - limited to EU and OECD
12	Label laminate waste- pressure sensitive adhesive (PSA) laminate waste including minor quantities of raw materials used in label material production.	Suitable for inclusion (only if limited to waste from PSA laminate production excluding raw material and if the narrow definition is explicit in the final text of Annex III)
13	Plastic-Al –cardboard-fibre composite from the pre-treatment of liquid packages (fibres 10%, Al 10%, plastic 60%, moisture 20%)	Suitable for inclusion (only if absence of lead and cadmium stabilisers from the PVC fraction is ensured by the original facility and if recycling/pyrolysis-gasification are favoured vs incineration)
14	Mixture of plastic and cardboard from industry, retail,	Suitable for inclusion (only if

Proposal No.	Definition	Suitability for inclusion in Annex IIIA and IIIB (proposals #12, 13, 15)
	business properties and offices	absence of PVC lead and cadmium-based stabilisers is ensured by the original facility and if the waste stream origin is strictly limited to office, retails and business properties)
15	Plastic-cardboard-fibre composite from the pre-treatment of liquid packages (fibres 10%, plastic 70%, moisture 20%)	Suitable for inclusion (only if absence of PVC lead and cadmium-based stabilisers is ensured by the original facility and if recycling/pyrolysis-gasification are favoured vs incineration)
16	Metal and metal alloys in a solid metallic non-dispersible form with solid plastic waste	Suitable for inclusion (only if a better definition is provided and if the absence of PVC lead and cadmium stabilisers is ensured by the original facility)-limited to EU and OECD
17	Non-metallic waste of plastic and rubber from waste management facilities	Suitable for inclusion (only if absence of lead and cadmium based stabilisers and other problematic components is ensured by the original facility) - limited to EU and OECD
18	Combination packaging consisting of a paper outer package with an attached and easily removable separate plastic inner bag	Suitable for inclusion (if the packaging did not contain hazardous components that could be present in traces in the waste)

2. INTRODUCTION

2.1. BACKGROUND

2.1.1. WASTE SHIPMENT REGULATION (2006)

The Waste Shipment Regulation (WSR) sets limits on the Trans-frontier Shipment of waste (TFS) within and outside the European Union (EU) from an environmental perspective. It also implements the Basel Convention and OECD-Council decisions within EU. The original WSR[6] was fundamentally amended in 2006[7] and the new stipulations took effect from 1st August 2007 and will be referred to in this report.[8]

The controls on TFS aim to ensure a high level of protection for the environment and for human health. They also aim to prevent unauthorised disposal of international waste shipments and unregulated recovery of hazardous wastes, without hindering legitimate trade of waste.

The WSR[9] provides two waste shipment control procedures for shipments between Member States (MS):

- the procedure for prior written notification and consent, which is applicable to all shipments of waste intended for disposal and hazardous and semi-hazardous waste intended for recovery (for the latter see “Amber List” in Annex IV and IV A of the WSR and Art. 3 (1)(b) of the WSR); and
- the procedure in which shipments are accompanied by certain information, applicable to non-hazardous waste intended for recovery (see “Green List” Annex III, IIIA and IIIB of the WSR).

The Trans-frontier shipment of **waste listed in the green list and destined for recovery** does not need to be notified to the authorities nor requires an authorisation.

2.1.2. ‘GREEN’ LISTED WASTE

According to the Art. 18 of the WSR, shipment of wastes listed ‘green’ or certain mixtures of such waste are subject to the “general information requirements”, as opposed to a more elaborate procedure of prior written notification and consent which applies to other types of waste shipments.

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6 Council Regulation (EEC) No. 259/93 of 1 February 1993 on the supervision and control of shipments of waste within, into and out of the European Community.

7 Regulation (EC) No 1013/2006 of the European Parliament and of the Council, of 14 June 2006 on shipments of waste.

8 The original Waste Shipment Regulation had to be applied by the MS 15 months after its publication.

9 The Regulation 2006 has reduced the number of lists of waste authorised for shipment from three to two, corresponding to the two control procedures described above: waste subject to notification and consent features in the "orange list" (Annex IV), while waste referred to for information purposes only features in the "green list" (Annex III). On the other hand, waste that is prohibited for shipment features in separate lists (Annex V).

A 'green' listed waste, defined in Annex III of WSR, is based on the OECD Decision and comprises of wastes listed in:

- Annex V, Part 1, List B of WSR, with exceptions and clarifications provided in Part I of Annex III.
- Part II of Annex III.

Furthermore, mixtures of two or more wastes listed in Annex III, but not classified under one single entry in this Annex, can be considered 'green' provided that the composition of these mixtures does not impair their environmentally sound recovery. Such mixtures are to be listed in Annex IIIA of WSR. At the time of the publication of the WSR, no mixture was listed in Annex IIIA and Art. 58 states that a mixture may be considered for inclusion following the submission of a request by a MS. Further, it states that "the initial entries to be included in Annex IIIA shall be inserted, if practicable, by the date of application of this Regulation and at the latest six months after that date." Some guidance for the selection of entries that may be relevant for Annex IIIA is provided in recital 39 of the WSR.

Recital 39 criteria and items in "List of issues"

Recital 39 states that while considering the mixtures of wastes to be added in Annex IIIA, the following information should be considered (inter alia):

Properties of the waste mixture, such as

- possible hazardous characteristics
- potential for contamination
- physical state

Management aspects, such as

- technological capacity to recover waste
- environmental benefits arising from the recovery operation, including whether the environmental sound management may be impaired

On the basis of the criteria provided in the recital 39, MS agreed upon "a List of issues relevant for adding mixtures of waste to Annex IIIA of Regulation (EC) No 1013/2006[10]." The "list of issues" is presented as a form, which has been used by MS to request inclusion of a waste mix to Annex IIIA. Some of the information items are "recommended to be provided" while others may be provided as additional information (see

Table 2-1, the item numbers correspond to the numbering used in the form):

[10] List of issues relevant for adding mixtures of waste to Annex IIIA of Regulation (EC) No 1013/2006 on shipments of waste available at: http://ec.europa.eu/environment/waste/shipments/pdf/annex3.pdf

Table 2-1: List of issues

Recommended to be provided	Additional information
General	
Proposed wording for the entry in Annex IIIA	
A. Properties of the waste mixture	
Usual description Waste identification (European Community (EC) list of wastes; Basel Convention list) Physical characteristics 5. Potential for contamination Information on the process(es) by which the mixture of waste is produced	Chemical characteristics
B. Management aspects	
Recovery operation(s) for the mixture of waste Description of recovery operation(s) 8. Recovery quota (rough indication)	Technological capacity (for recovery in the EU) Packaging types Storage Trade aspects 7. Use of recovered materials
C. Environmental benefits	
Overall environmental benefits of the recovery of the mixture of waste	
D. Enforceability	
Possible methods for the control of compliance of the mixture of waste by enforcement officers (e.g. simple tests)	

2.2. IDENTIFICATION AND DESCRIPTION OF WASTE MIXTURES

Based on the list of issues (

Table 2-1), some MS have identified the proposed waste mixtures using Basel Convention code (also referred as "Basel code"), European Community list of wastes code, and when appropriate, commercial specifications code e.g. Institute of Scrap Recycling Industries, Inc. (ISRI) code. The level of accuracy in defining waste is substantially different between these three codes. The Basel codes are very general and describe the nature of waste, while the EC codes give more precise information on both the nature and the origin of waste. The ISRI codes are commercial codes intended to be used in trade of different kinds of scrap material and normally give a complete description of the scrap. In the case of metal scrap, for example, the ISRI code specifies the degree of purity of metal and the absence of contaminants, e.g. ashes from incineration.

In addition, some MS have provided a "usual description" of the mixture including the names of the major components. In some proposals, this usual description gives additional information about the nature and the origin of the waste mixture.

Altogether, these different identification codes and the "usual description" give a quite complete description of the waste mixture in the proposal.

However, in Annex III of the WSR, the green listed wastes are defined only by Basel codes and according to Article 58 of the WSR the mixtures to be included in Annex IIIA should be exclusively composed of the green listed wastes already included in Annex III. This would mean that any additional information on the waste mixture provided in the MS proposals such as EU code, ISRI code, and "usual description" will be difficult to capture in Annex IIIA.

In a previously published report[11] of the European Environment Agency (EEA), the Basel codes are considered too general to identify the exact nature of the shipping waste. This report also suggests using the codes from the European Waste List in order to give a much better overview of the shipments. Such a consideration seems also valid for mixture included in Annex IIIA, yet this would require an amendment of Annex III (and thus WSR), which is beyond the scope of this study.

Consequently, the detailed descriptions of the waste mixture provided by the MS and the possible controversies when using the more detailed descriptions are considered and discussed as part of the analysis in this study.

2.3. SCOPE OF THE WORK

The objective of this study is to assist the Commission in analysing and assessing the proposals for «green» waste mixtures considering the proposals made by MS and also the comments of other MS on the proposals. The proposals need to be assessed in particular with regard to the requirements of recital 39, and the conformity with the items of the "List of issues relevant for adding mixtures of waste to Annex IIIA of Regulation (EC) 1013/2006."

Thus, the main focus of this study is to assess data and information relating to proposed waste mixtures, and on the basis of this analysis, to recommend which of these mixtures could be included in Annex IIIA. The overall objective is to assist the Commission in preparing its proposal for the entries to be included in Annex IIIA.

The starting point of the study was the eighteen waste mixtures proposals made by MS. These proposals have been assessed in two stages, namely Task 1 and Task 2, dealing with eight and ten waste mixtures respectively.

The submitted proposals were circulated by the Commission to MS representatives for comments. These proposals received comments from six MS which have also been taken into account during the assessment.

- **Task 1**

Task 1 focused on the following eight waste mixtures:

[11] ETC/RWM Technical Report 2008, p.104.

Mixture no.	Applicable waste categories	Proposed entry	Submitting MS
1	B1010, B1050	Mixture of ferrous and non-ferrous metals in non-dispersible form	AT
2	B1010, B1070	Ferrous and non-ferrous metals in non-dispersible form mixed with dispersible forms of Cu	AT
3	B1070, GB040, B1100	Cu and precious metal bearing scrap in dispersible form – waste of Cu with metal slags and comer smelting wastes	AT
4	GB040, B1100	Non-ferrous metal-bearing waste arising from melting, smelting and refining including slags from precious metals and Cu processing	AT
5	B1010, B1050	Mixture of ferrous and non-ferrous metals in non-dispersible form	FI
6	B1010, B1050, B3010	Mixture of ferrous and non-ferrous metals with plastics	FI
7	B3010, B1010	Mixture of solid plastic waste with 3-8% ferrous and non-ferrous metals	FI
8	B1010, B1050, B3010, B3040, B3080	Mixture of solid plastic and rubber with 10% ferrous and non-ferrous metals	FI

- **Task 2**

In Task 2, the assessment covered following ten waste mixtures[12]:

Mixture no.	Applicable waste categories	Proposed entry	Submitting MS
9	B1010, B3040, B3080	Mixture of solid rubber with 10% ferrous and non-ferrous metals	FI
10	B1050, B1115	Mixture of waste metal cables and wires (75-90%) with non ferrous metals (<10%), including stones	FI
11	B1050, B3010, B3040, B3080	Mixture of non-ferrous metals with 10% plastic and/or rubber	FI
12	B3020	Label laminate waste- pressure sensitive adhesive laminate waste including minor quantities of raw materials used in label production.	FI
13	030307	Plastic-Al –cardboard-fibre mixture from the pre-treatment of liquid packages (fibres 10%, Al 10%, plastic 60%, moisture 20%)	FI
14	B3010, B3020	Mixture of plastic and cardboard from industry, retail, business properties and offices	FI
15	030307	Plastic-cardboard-fibre mixture from the pre-treatment of liquid packages (fibres 10%, plastic 70%, moisture 20%)	FI
16	B3010, B1010,B1050	Metal and metal alloys in a solid metallic non-dispersible form with solid plastic waste	UK
17	B3040, B3010	Non-metallic waste of plastic and rubber from waste management facilities	UK
18	B3010, B3020	Combination packaging consisting of a paper outer package with an attached and easily removable separate plastic inner bag	NL

2.4. METHODOLOGY

[12] The waste mixtures with brown background were amended by Finland in February 2009 for inclusion in Annex IIIB instead of IIIA. Consequently, these were not regarded as a 'mixture' of individual waste entries but as a 'composite' which becomes waste. See sections 13, 14 and 16 for more details.

A common methodology has been applied to assess each waste mixture. The proposed waste mixtures have been analysed to see whether and how each waste mixture corresponds to the criteria mentioned in recital 39 of the Regulation and the items listed in the "List of issues" agreed with the MS.

The proposal forms submitted by the MS were the starting point of the analysis. The first step was to go through each proposal carefully to **verify the coherence and clarity of the data and identify any missing/incomplete information**. When necessary, additional information has been collected in order to fill the data gaps. Different approaches were adopted to obtain the additional information, including:

- Contacting the national authorities who submitted the proposal and/or commented on it
- Desk study on material and waste handbooks and other relevant publications
- Contacting recycling industries

For each waste mixture, a factsheet has been prepared whose structure builds upon the "List of issues". Each factsheet includes the gathered information which has been used to assess the proposal, as well as the results of the assessment, i.e. conclusions and recommendations. Special attention is paid to judge to what extent the proposal meets the recital 39 criteria and a mixture is recommended to be included in Annex IIIA only if:

- it does not have hazardous characteristics
- has no risk for contamination[13]
- its physical state does not represent health or environmental hazards during shipment or recovery
- there is sufficient capacity to recover the waste mixture
- the recovery of the waste mixture brings environmental benefits, i.e. the mixture does not impair the environmentally sound management of each of its fractions

The comments from the MS were verified, and when pertinent, included in factsheet. Finally, all the above-mentioned elements were considered together to assess whether the proposal meets the criteria for inclusion in Annex IIIA. In addition, the MS proposals for minor adaptations or further conditions have been carefully evaluated to judge if a proposal should be added to Annex IIIA in an amended form.

A full list of references and contacts is provided at the end of each factsheet.

Following sections present a detailed analysis of each of the eighteen waste mixtures analysed in the study.

[13] Risk for contamination is here intended as the risk to be contaminated with unwanted waste

3. WASTE MIXTURE PROPOSAL #1

Proposed entry in Annex IIIA: Mixture of ferrous and non-ferrous metals in non-dispersible form (B1010 + B1050)

Proposal submitted by: Austria

Amendments: the proposal has been amended by Finland, B1020 has been substituted with B1050

3.1. PROPERTIES OF THE WASTE MIXTURE

Description: Mixture of ferrous and non-ferrous metals in non-dispersible form.

Basel codes:

Basel Code	Code description
B1010	Metal and metal alloy wastes in metallic, non dispersible form; precious metal (gold, silver, the platinum group, but not Hg). Scrap of Fe, Steel, Cu, Ni, Al, Zn, Sn, W, Mo, Ta, Mg, Co, Bi, Ti, Zr, Mn
B1050	Mixed non ferrous metal, heavy fraction scrap, not containing Annex I materials in concentrations sufficient to exhibit Annex III characteristics (see annex 1 and 2 of this report)

Based on the MS proposal, the mixture would cover the following waste of the **European waste list**:

EU Code	Code description	Origin
02 01 10	Waste metal	From agriculture, horticulture, aquaculture, forestry, hunting and fishing [category 02 01]
12 01 01	Ferrous metal filings and turnings	From shaping and physical and mechanical surface treatment of metals (and plastics) [cat. 12 01]
12 01 03	Non ferrous metal filings and turnings	
15 01 04	Metallic packaging	Waste packaging (incl. separately collected municipal packaging waste)
16 01 17	Ferrous metals	From dismantling ELV (End-of-Life Vehicle) and vehicle maintenance [cat. 16 01]
16 01 18	Non-ferrous metal	
17 04 01	Cu, bronze, brass	From construction and demolition wastes
17 04 02	Al	
17 04 03	Pb	
17 04 04	Zn	
17 04 05	Fe and steel	
17 04 06	Tin	
17 04 07	Mixed metals	
19 01 02	Ferrous materials removed from bottom ash	From incineration or pyrolysis of waste [cat. 19 01]
19 02 03	Premixed wastes composed only of non hazardous wastes	From physic/chemical treatments of waste [cat. 19 02]

EU Code	Code description	Origin
19 10 01	Fe and steel	From shredding of metal-containing wastes [cat. 19 10]
19 10 02	Non- ferrous metals	
19 12 02	No otherwise specified material	From mechanical treatment of waste (e.g. sorting, crushing, compacting, pelletising) not otherwise specified [cat. 19 12]
19 12 03	Non-ferrous metals	
19 12 12	Wastes (including mixtures of materials) from mechanical treatment of wastes non containing dangerous wastes	
20 01 40	Metals	Separately collected fraction of municipal wastes (household waste and similar commercial industrial and institutional wastes) [cat. 20 01]

Depending on the content of the pre-dominating metal, different **commercial classifications** are possible. In the case of predominant copper content (light Cu), the ISRI codes are:

- **Dream** (minimum 88% Cu as determined by electrolytic assay): the Cu fraction should be free of the following: burnt hair wire, Cu clad, plating racks, grindings, Cu wire from burning[14], containing insulation, radiators and fire extinguishers, refrigerator units, electrotype shells, screening, excessively leaded, tinned, soldered scrap, brasses and bronzes, excessive oil, Fe and non-metallic material, and should be reasonably free of ash.
- **Drink Refinery Brass** (minimum of 61.3% Cu and maximum 5% Fe) shall consist of brass and bronze solids and turnings, and alloyed and contaminated Cu scrap. Shall be free of insulated wire, grindings, electrotype shells, and non-metallic material. Hydraulically briquetted material subject to agreement.

Process(es) by which mixture is produced

As the EC list of wastes shows, a mixture of ferrous and non-ferrous metals can originate from a variety of sources, both from **production** and **post-consumption**, in principle any place where scrap metals can arise. Post-consumption metals comprise separately collected metal fractions of municipal wastes (household waste and similar commercial, industrial, and institutional wastes), ELV, and construction and demolition waste.

However, considering that the wastes listed in Annex III of the WSR should not be contaminated by other materials to an extent which increases the risks associated with the wastes to render then hazardous and/or prevents the recovery of the wastes in an environmentally sound manner, especially post-consumer scrap needs to be pre-treated to yield sufficiently clean metal waste.

Pre-treatment operation(s): scrap mixture resulting from scrap collection activities (originally from worn-out, discarded or obsolete metal products), pre-treatment activity of metal wastes (shredding, magnetic separation, float and sink processes), and

[14] Incineration of electrical and electronic scrap, as well as cable incineration, produce hazardous fumes and needs environmental controls. Electrical wire must be stripped and not incinerated. Once stripped, electrical wire is not hazardous for melting because it is very high-quality Cu.

waste management facilities (shredding, other mechanical treatment). Incoming scrap should be screened for eventual radioactivity. Pre-treatment may also include burning-off oil and volatiles in rotary kilns or floatation processes in order to eliminate non-metallic material.

- **Percentage of each of the components in the mixture**

The composition of the mixture varies depending on the content of the pre-dominant metals and the share of ferrous and non-ferrous metals is not constant.

- **Physical characteristics**

Solid: scrap (Cu sheets, gutters, downspouts, kettles, boilers), metal alloy, finished form, and eventually hydraulically briquetted form

- **Chemical characteristics**

The mixture does not present hazardous properties, except if Pb and Cd are present in quantities that render the solution hazardous.

- **Potential for contamination**

In general, metal scrap may contain Cu wire from burning, burnt hair wire, insulation, fire extinguisher, excessive oil, ashes, as well as non-metallic contaminants, which may hamper effective recovery of this waste. However, there should be little potential contamination if an appropriate pre-treatment of the scrap mixture is performed prior to metal recycling process R4. Different steps of pre-treatment could be appropriate in different cases: burning off of oil and organic fraction in a rotary kiln, sorting, and float sink processes. As described above, pre-treatment is in most cases necessary to yield waste fractions that conform to Annex III and Annex IIIA.

3.2. MANAGEMENT ASPECTS

3.2.1. GENERATION

- **Quantity produced in the EU**

A major share of recovered ferrous and non-ferrous metals in EU could potentially be included in this waste mixture, e.g. 14 million tonnes of ferrous metals and 1.7 million tonnes of non-ferrous metals recovered in France in 2006, 400 million tonnes of metals are recovered worldwide every year (Federec, British Metal Recycling Association).

3.2.2. Recovery

- **Recovery operations**

  - **Interim recovery operations[15]:** Possibly, R 12[16], i.e. exchange of wastes for submission to the non-interim recovery operations, in this case R 4 (see Annex 3 of this report)

  - **Non-interim recovery operations:** R 4 - Recycling/reclamation of metals and metal compounds. The chosen treatment depends on the Cu content of the scrap mixture. In the case of lower-grade scrap quality, the process is performed using a blast furnace (Reddy et al., 2004) and in the case of higher-grade scrap quality (containing metals with higher redox potential than Cu) the process is performed in a converter[17] or in an anode furnace. Alternatively, the use of flash smelter technology is possible (especially lower-grade concentrates, e.g. Cu bearing electronic scrap). The advantage of flash smelter technology is that it can achieve up to 99% capture of sulphur-rich acids to produce sulphuric acids[18]. In addition, metallic impurities (e.g. Pb, Cd, Zn) or oxides with high vapour pressure volatilise and can be collected in the Zn-rich dust. During operations, Fe reacts with silica flux to form a silicate slug (fayalite slug). Depending on the process, metals like Zn, Pb, Fe and other impurities of Cu are separated from the Cu and further recovered/refined in special installations.

- **Technological capacity of recovery**

In the proposal, the number of facilities for recovery of such waste mixture is estimated to be 10-100. In the EU, many metal smelters have capacities above 100 000 tonnes per year.

The number of facilities for recovery in third countries (OECD countries) is also estimated to be 10-100. Metal smelters are also common in non-OECD countries[19].

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15 The interim recovery operations are the recovery operations performed to prepare the waste mixture to be recovered and are normally performed before shipment. The non-interim recovery operations are the “effective” recovery operations and are performed after shipment.

16 Operations as described by the codes of Directive 75/442/EEC, Annex IIB (recovery operations). R12 and R13 are defined as interim recovery operation in the Article 2 of the Regulation (EC) N° 1013/2006 on shipment of waste.

17 A converter is a piece of equipment for the treatment of metals (usually refining of alloys) in the molten state, by blowing air or oxygen either through the bottom, or sidewise through the melt, or at the surface and provided with a tilting system for charging and emptying it.

18 The flash smelting (e.g. Outokumpu process) offers also other advantages: low investment and operating costs, the capability to treat different qualities of raw materials with variable feed rates, high recovery of valuable metals. It present some environmental benefits including high sulphur recovery (no SO_2 emissions to the environment) and the efficient energy utilisation (20 to 30% of that required by a conventional furnace).

19 For an overview of metal recyclers in the world: http://www.bir.org/organisation/onlinedatabase/a-zindex.asp

- **Recovery quota**

Almost 100% of the predominating metal (e.g. Cu) in the mixture is recycled. All other metals present in the mixture can be recycled after a multi-step process (e.g. metal recovery from flue dust and slag).

- **Methods of storage at the recovery facility**

The waste mixture is stored in open storage or covered storage.

- **Use of recovered material**

Depending on the input scrap, new pure Cu, Zn, Pb, etc. can be reused by the industry. Fe-silicate slug can be used for sandblasting.

- **Environmental benefits from recovery**

In general, recovery and recycling of waste mixtures conserve primary raw materials and energy (Table 3-1). Further benefits include reduction of the amount of waste destined to disposal, reduction of landfill waste, water conservation, and reduction of green-house gases emissions.

Table 3-1: Energy savings - metal recycling compared to virgin metal production (British Metal Recycling Association)

Metal	New metals made using recycled metals	Energy saving
Al	39%	95%
Cu	32%	85%
Pb	74%	60%
Steel	42%	62-74%
Zn	20%	60%

- **Environmental/health impacts of recovery operations**

  - **General impacts of metal recovery operations:** Metal recovery works in general can generate air pollutants emissions (e.g. dioxin and furan emissions). As a general guideline, emission of air pollutants in the recovery facilities should be minimised and controlled to prevent harm to the environment or adverse effects to the human health.

  - **Specific impacts of the mixture recovery**: In the particular case of this waste mixture, a special attention should be paid to the potential Pb and Cd emissions during recovery, in case the waste mixture contains these metals (as a part of B1050 fraction). During the recovery of Pb containing scrap there is a potential of soil pollution nearby smelters (Vidic T. et al., 2008). However, by definition, Pb and Cd in B1050 should not be at dangerous concentration.

3.2.3. SHIPMENT AND TRADE

- **Packaging types during shipment**

The waste mixture is transported in bulks and open loads on trucks and/or containers

- **Amount shipped**

The data on total shipping amount of the proposed waste mixture #1 within the EU is not readily available. For illustration, it has been indicated that 36% of collected Cu scrap in Austria is exported to EU-15 and 12% to other parts of Europe, remainder being recovered in the country. In France, an export of 5 million tonnes of ferrous metals to other MS (mostly Spain and Italy) is reported every year.

No data was available on the quantities imported from third countries into EU.

- **Enforceability**

ISRI scrap specifications are given in documents accompanying scrap mixture shipment. Visual control is also possible in order to verify if any non-metal fractions are present, but a control of the exact quantity of Pb and Cd cannot be verified during shipment.

3.3. ASSESSMENT OF THE WASTE MIXTURE

The waste mixture may contain Pb and/or Cd in the fraction covered by the Basel code B1050. Pb and Cd containing mixtures, in particular, may pose an environmental risk due to potential soil and water contamination. The recovery of Pb containing waste needs special precautions in order to avoid deleterious effects on both environment and health. In fact, high levels of Pb in air are usually found near Pb smelters or near waste incinerators. Pb is persistent in the environment and accumulates in soils and sediments through deposition from air sources, direct discharge of waste streams to water bodies, and erosion. Thus, in addition to air exposure, other major exposure pathways include ingestion of Pb in drinking water and Pb-contaminated food as well as incidental ingestion of Pb-contaminated soil and dust. Depending on the level of exposure, Pb can adversely affect the nervous system, kidney function, immune system, reproductive and developmental systems and the cardiovascular system. Ecosystems near point sources of Pb demonstrate a wide range of adverse effects including losses in biodiversity, changes in community composition, decreased growth and reproductive rates in plants and animals, and neurological effects in vertebrates (US Environmental Protection Agency Lead website).

Other concern is that waste Zn scrap from primary Zn processing may include leaching residues such as jarosite which is hazardous in nature and its worldwide disposal has become a major environmental concern. Jarosite contains a number of toxic elements (Pb, Zn, Cd, Cu, S, and Cr) that could cause water, soil, vegetation and aquatic life contamination (Pappu et al., 2006).

However, in this specific mixture, the presence of dangerous substances (Pb, Cd, etc.) should not be a cause of concern due to the very low concentrations, according to the definition of B1050. Indeed, it is worth stressing that during shipment inspections, the verification of the exact concentration of hazardous components in the mixture is difficult to verify.

Few MS have considered that the potential for contamination with organic materials is considerable in the case of metal from municipal waste including household waste (EU code 20 01 40). However, this issue should be resolved with an appropriate pre-treatment and is more a question of Annex III interpretation.

The technological capacity to recover this mixture is quite good in both EU and OECD countries. Some non-OECD countries are also equipped to recover metal scrap.

3.4. CONCLUSIONS AND RECOMMENDATIONS

Based on the assessment presented above, the proposed waste mixture #1 has:

- no hazardous characteristics that can pose a risk to the environment and human health if the concentrations of Pb and Cd are not in concentrations sufficient to exhibit Annex III characteristics (see annex 1 and 2 of this report)
- no potential for contamination with hazardous components if the concentrations of Pb and Cd are not in concentrations sufficient to exhibit Annex III characteristics (see annex 1 and 2 of this report)
- acceptable environmental benefits from recovery if Pb and Cd are not in concentrations sufficient to exhibit Annex III characteristics (see annex 1 and 2 of this report)
- difficulty in verifying the concentration of hazardous metals during shipment inspection

Therefore, this mixture can be considered suitable for inclusion in Annex IIIA in view of the Recital 39 if the concentrations of Pb and Cd are not in concentrations sufficient to exhibit Annex III characteristics (see annex 1 and 2 of this report). Thus, a document including data on Pb and Cd concentrations within the waste mixture and ensuring that the concentrations are not sufficient to exhibit Annex III characteristics (see 1 and 2 of this report) could be additionally provided by the original facility.

3.5. REFERENCES

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Wambach PF, Laul JC. Be health effects, exposure limits and regulatory requirements. Journal of Chemical Health and Safety, Volume 15, Issue 4, 2008, pages 5-12.

3.6. CONTACTS

- Kaija Rainio, Senior adviser, Finnish Environment Institute (SYKE)
- Mari Parviainen, Project Manager, Kuusakoski Oy

4. WASTE MIXTURE PROPOSAL #2

Proposed entry in Annex IIIA: Mixture of ferrous and non-ferrous metals in non-dispersible form mixed with dispersible form of Cu (B1010 + B1070)

Proposal submitted by: Austria

4.1. PROPERTIES OF THE WASTE MIXTURE

Description: Ferrous and non-ferrous metals in non dispersible form mixed with dispersible form of Cu.

Basel code:

Basel Code	Code description
B1010	Metal and metal alloy wastes in metallic, non dispersible form: precious metal (gold, silver, the platinum group, but not Hg); Fe and steel scrap; scrap of Cu, Ni, Al, Zn, Sn, W, Mo, Mg, Co, Bi, Ti, Zr, Mn
B1070	Waste of Cu and Cu alloys in dispersible form, unless they contain Annex I constituents (see annex 1 of this report) to an extent that they exhibit Annex III characteristics (see annex 2 of this report)

Based on the MS proposal, the mixture would cover the following waste of the European Community list of wastes:

EU Code	Code description	Origin
02 01 10	Waste metal	From agriculture, horticulture, aquaculture, forestry, hunting and fishing [cat. 02 01]
12 01 01	Ferrous metal filings and turnings	Filings and turnings from shaping and physical and mechanical surface treatment of metals [cat.1201]
12 01 03	Non ferrous metal filings and turnings	
15 01 04	Metallic packaging	Waste packaging (incl. separately collected municipal packaging waste) [cat. 1501]
16 01 17	Ferrous metals	From dismantling ELV and vehicle maintenance [cat. 16 01]
16 01 18	Non-ferrous metal	
17 04 01	Cu,, bronze, brass	From construction and demolition wastes
17 04 02	Al	
17 04 03	Pb	
17 04 04	Zn	
17 04 05	Fe and steel	
17 04 06	Tin	
17 04 07	Mixed metals	
19 01 02	Ferrous materials removed from bottom ash	From incineration or pyrolysis of waste [cat. 19 01]
19 10 01	Fe and steel	From shredding of metal-containing wastes [cat. 19 10]
19 10 02	Non- ferrous metals	
19 12 02	Ferrous metals	From mechanical treatment of waste (e.g. sorting, crushing, compacting, pelletising) not otherwise specified [cat. 19 12]
19 12 03	Non-ferrous metals	
20 01 40	Metals	Separately collected fraction of municipal wastes (household waste and similar commercial industrial and institutional wastes) [cat. 20 01]

Depending on the content of the pre-dominating metal, different **commercial classifications** may be appropriate. In the case of predominant Cu contents (light Cu), the ISRI (Institute of Scrap Recycling Industries, Inc.) codes are:

- **Dream** (minimum 88% as determined by electrolytic assay) and should be free of the following: burnt hair wire, Cu clad, plating racks, grindings, Cu wire from burning[20], containing insulation, radiators and fire extinguishers, refrigerator units, electrotype shells, screening, excessively leaded, tinned, soldered scrap, brasses and bronzes, excessive oil, Fe and non-metallics, and should be reasonably free of ash.
- **Drink REFINERY BRASS** (minimum of 61.3% Cu and maximum 5% Fe) shall consist of brass and bronze solids and turnings, and alloyed and contaminated Cu scrap. It shall be free of insulated wire, grindings, electrotype shells and non-metallics. Hydraulically briquetted material subject to agreement.
- **Drove CU-BEARING SCRAP** shall consist of miscellaneous Cu-containing skimmings, grindings, ashes, Fe brass and Cu, residues and slags. Shall be free of insulated wires, Cu chlorides, unprepared tangled material, large motors, pyrophoric material, asbestos brake linings, furnace bottoms, high Pb materials, graphite crucibles, and noxious and explosive materials. Fine powdered material by agreement. Hydraulically briquetted material subject to agreement.

Process(es) by which mixture is produced

As the EC list of wastes list shows, a mixture of ferrous and non-ferrous metals in non-dispersible form mixed with dispersible form of Cu can originate from a variety of sources, both from **production** and **post-consumption** – in principle wherever scrap metal arises. Post-consumption metals comprise separately collected metal fractions of municipal wastes (household waste and similar commercial industrial and institutional wastes), ELV, construction and demolition waste.

However, considering that the wastes listed in Annex III of the WSR should not be contaminated by other materials to an extent which increases the risks associated with the wastes to render then hazardous and/or prevents the recovery of the wastes in an environmentally sound manner, especially post-consumer scrap needs to be pre-treated to yield sufficiently clean metal waste.

Pre-treatment operation(s): scrap mixture resulting from scrap collection activities (originally from worn-out, discarded or obsolete metal products), pre-treatment activity of metal wastes in waste management facilities (shredding, magnetic separation, float and sink processes). During pre-treatment, incoming scrap should be screened for eventual radioactivity. Pre-treatment may also include burning-off oil and volatiles in rotary kilns or floatation processes in order to eliminate non-metallic material.

[20] Incineration of electrical and electronic scrap, as well as cable incineration, produce hazardous fumes and needs environmental controls. Electrical wire must be stripped and not incinerated. Once stripped, electrical wire is not hazardous for melting because it is very high-quality Cu.

- **Percentage of each of the components in the mixture**

The composition of the mixture varies depending on the content of the pre-dominant metals and the share of ferrous and non-ferrous metals is not constant.

- **Physical characteristics**

The waste mixture is in powdery and solid physical state.

- **Chemical characteristics**

The mixture does not have any hazardous properties

- **Potential for contamination**

No potential contamination if an appropriate pre-treatment of the scrap mixture is performed prior to metal recycling process R4. Different steps of pre-treatment could be appropriate in different cases: burning off of oil and organic fraction in a rotary kiln, sorting, and float sink processes. In general, the scrap may contain Cu wire from burning, burnt hair wire, insulated wire, excessive oil, pyrophoric material, and explosives which may hamper effective recovery of this waste.

4.2. MANAGEMENT ASPECTS

4.2.1. GENERATION

- **Quantity produced in the EU**

As with proposal #1, a major share of recovered ferrous and non-ferrous metals could potentially be included in this waste mixture. For example, 14 million tonnes of ferrous metals and 1.7 million tonnes of non-ferrous metals recovered in France in 2006. About 400 million tonnes of metals are recovered worldwide every year (Federec, British Metal Recycling Association).

4.2.2. RECOVERY

- **Recovery operations**

Based on the proposal for this waste mixture, no interim recovery operations are foreseen and the mixture would thus be shipped directly to the final (non-interim) recovery.

Non-interim recovery operations: R4: Recycling / reclamation of metals and metal compounds

As for the proposal #1, the chosen treatment depends on the Cu content of the scrap mixture and the available technology. In the case of lower-grade scrap quality, the process is performed using a blast furnace (Reddy et al., 2004). Alternatively, the use of flash smelter technology or converter[21] is possible (especially lower-grade concentrates, e.g. Cu bearing electronic scrap)[22].

- **Technological capacity of recovery**

In the original proposal, the number of facilities for recovery of such waste mixture in the EU is estimated to be in the range of 10-100. Many metal smelters have capacities above 100 000 tonnes per year. The number of facilities for recovery in third countries (OECD countries) is also estimated to 10-100. Metal smelters are also common in non-OECD countries[19], the capacity vary a lot from country to country.

- **Recovery quota**

Almost 100% of the predominating metal (e.g. Cu) in this mixture can be and is recycled. All the other metals present in the mixture can be recycled after a multi-step process (e.g. metal recovery from flue dust and slag); resulting wastes like slags and dust are mostly recovered.

- **Methods of storage at the recovery facility**

The waste is stored in a covered storage.

- **Use of recovered material**

Depending on the input scrap, new pure Cu, Zn, Pb, etc. can be reused by the industry. Fe-silicate slug can be used for sandblasting.

- **Environmental benefits from recovery**

As in factsheet #1, the recovery of this mixture presents a number of general environmental benefits such as material conservation, energy conservation, reduction of the amount of waste destined to disposal, reduction of landfill waste, reduction of dangerous gas emissions[23], reduction of dust production, water conservation, and reduction of green-house gases emissions (Table 3-1). It is worth noticing that 41% of the EU Copper demand is met by recycling. There are also economic benefits of recycling, e.g. recycled Cu is worth up to 90% of the cost of the original Cu.

- **Environmental/health impacts of recovery**

  - General impacts of metal recovery operations: Metal recovery works in general can generate air pollutants emissions (e.g. dioxin and furan emissions). As a general guideline, emission of air pollutants should be minimised and controlled to prevent harm to the environment, adverse effects to human health, or creation of any nuisance situation.

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[21] A converter is a piece of equipment for the treatment of metals (usually refining of alloys) in the molten state, by blowing air or oxygen either through the bottom, or sidewise through the melt, or at the surface and provided with a tilting system for charging and emptying it.

[22] For more details on these operations, see Section 2.2.2. in the previous factsheet

[23] During mining and refining (purification) of Cu, for example, dust and waste gases such as sulphur dioxide are produced which may have a harmful effect on the environment. Although these harmful effects are minimised by Cu producers (sulphur dioxide is captured and used to make sulphuric acid), with recycling there are little, if any, harmful gases emitted.

- Specific impacts of the mixture recovery: Cu smelting especially requires modern pollution control equipment. Cu, particularly if originating from electronic scrap, may contain Be (Be), which, because of its hazardousness, must be captured in the air pollution control equipment. Grinding of Cu can release Be-containing dusts that can be dangerous for health (Wambach and Laul, 2008). However, in this mixture the concentration of Be and of other potentially dangerous residues should not be hazardous as defined by the code B1070.

4.2.3. Shipment and trade

- **Packaging types during shipment**

Bulk and drum. Scrap mixtures with dispersible form of Cu are normally be transported in covered trucks and/or containers.

- **Amount shipped**

The data on total shipping amount of the proposed waste mixture #2 within the EU is not readily available. For illustration, it has been indicated that 36% of collected Cu scrap in Austria is exported to EU-15 and 12% to other parts of Europe, remainder being recovered in the country. In France, an export of 5 million tonnes of ferrous metals to other MS (mostly Spain and Italy) is reported every year.

No data was available on the imported quantities from third countries into EU.

- **Enforceability**

ISRI scrap specifications are given in documents accompanying scrap mixture shipment. Visual control is also possible in order to verify if any non-metal fractions are present, but it would be difficult to control visually whether the mixture contains contaminants Annex I constituents (see annex 1 of this report) to an extent that they exhibit Annex III characteristics (see annex 2 of this report) due to the difficulty in obtaining a representative sample of the mixture.

4.3. ASSESSMENT OF THE WASTE MIXTURE

If we consider the detailed description given by the ISRI codes this waste mixture may contain ashes from the incineration of Cu wire, dust and residues from gas cleaning systems of Cu smelters, waste sludges, excluding anode slimes, from electrolyte purification systems in Cu electro-refining, and electro-winning operations. These materials are considered to be hazardous wastes if they contain traces of Sb, As, Be, Cd, Pb, Hg, Se, Te, and Ti. However, based on the Basel code definition of this mixture, these components included in Annex III should not be present to an extent to present Annex I characteristics (see annex 2 of this report).

As commented in factsheet #1, the concern about the potential for contamination with organic materials in the case of metal from municipal waste including household waste (EU code 20 01 40) raised by the MS should be solved after an appropriate pre-treatment.

As a general guideline, precautions against dispersion (e.g. by wind), and leakage of the dispersible metal fraction should be provided during storage and shipment of waste mixture containing fraction in dispersible form. In the case of metals, problems may arise in situations where the metal or metal residue (compounds) is in a readily dispersible form such as a powder and is stockpiled without adequate protection from wind, which could result in the material being transported off site and onto the ground. If there is inadequate protection against rain and stockpiles of such material become wet, the material may be subject to leaching and the leachate may run off into surface waters or seep into groundwater. For this reason, the storage area should have an impervious surface and may even be paved. In particular, for this specific mixture, Cu containing wastes in dispersible form may present an environmental risk due to potential soil pollution and water contamination.

Similarly to proposal #1, particular attention should be paid to Zn scrap (jarosite) which may contain a number of toxic elements (Pb, Zn, Cd, Cu, S, Cr) that could cause water, soil, vegetation and aquatic life contamination (Pappu et al., 2006).

Some MS have proposed that the mixture may be more appropriately named in «usual description» section of the proposal. However, it is important to highlight that once included in Annex IIIA, the mixture will be only be identified by Basel codes and all additional information given in the proposal will be lost.

As shown in the previous sections of the factsheet, the existing technical capacity to recover the mixture is good, including in non OECD countries. Importantly, the recovery of the mixture, like all metal recovery operations, generates significant environmental benefits. In addition, the eventual presence of hazardous components in Cu containing waste (e.g. Be) should not be of concern, since, as defined in B1070 code, the absence of Annex I constituents (see annex 1 of this report) to an extent that they exhibit Annex III characteristics (see annex 2 of this report) is ensured.

4.4. CONCLUSIONS AND RECOMMENDATIONS

Based on the assessment above, the proposed waste mixture #2 presents:

- no hazardous characteristics that can be a risk for the environment
- no potential for contamination if we considered the definition of the mixture based on Basel code
- sufficient technical recovery capacity in EU, other OECD countries, and a number of non-OECD countries

- an overall beneficial effect from recovery if the mixture is properly managed during operations
- a possible enforceability

As a conclusion, this mixture seems to be suitable for the addition to Annex IIIA in view of the Recital 39.

4.5. REFERENCES

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Vidic T, Lah B, Berden-Zrimec M, Marinsek-Logar R. Bioassays for evaluating the water-extractable genotoxic and toxic potential of soils polluted by metal smelters. Environmental Toxicology, 2008.

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4.6. CONTACTS

- Mme Fock-Hiou, Service Commun de laboratoires, Ile de France

5. WASTE MIXTURE PROPOSAL # 3

Proposed entry in Annex IIIA: Cu and precious metal bearing scrap in dispersible form (B1100 + GB040 + B1070).

Proposal submitted by: Austria

5.1. PROPERTIES OF THE WASTE MIXTURE

Description: Cu and precious metal bearing scrap in dispersible form

Basel code:

Basel Code	Code description
B1070	Waste of Cu and Cu alloys in dispersible form, unless they contain Annex I (see annex 1 of this report) constituents to an extent they exhibit Annex III (see annex 2 of this report) characteristics.
GB040	Slags from precious metals and Cu processing for further refining
B1100	Limited to: wastes of refractory linings, including crucibles, originating from Cu smelting

Based on the MS proposal, the mixture would cover the following waste of the **EC list of wastes**:

EU Code	Code description	Origin
10 06 01	Slags from primary and secondary production (Cu metallurgy)	From thermal processes of Cu metallurgy [cat.1006]
10 06 02	Dross and skimmings from primary and secondary production	
10 06 04	Other particulates and dust	
10 07 01	Slags from primary and secondary production)	From thermal processes of Ag, Au and Pt metallurgy [cat.1007]
10 08 09	Slags	From non-ferrous metal metallurgy [cat.1008]
10 10 03	Furnace slags	From casting of non-ferrous pieces [cat. 1010]
12 01 03	Non ferrous metal filings and turnings	From shaping and physical and mechanical surface treatment of metals [cat. 1201]
12 01 04	Non ferrous metal dust and particles	
12 01 15	Machining sludges other that those mentioned in 12 01 14 [24]	
16 11 04	Waste linings and refractories	From metallurgical processes other than those mentioned in 16 11 03 [25]
19 02 03	Premixed wastes composed only of non hazardous wastes	From physico-chemical treatment of waste [cat.1902]
19 12 12	Wastes (including mixtures of materials)	From mechanical treatment of wastes other than those mentioned in 19 12 11 [26][cat.1912]

[24] Machining sludges containing dangerous substances
[25] Other linings and refractories from metallurgical processes containing dangerous substances

Depending on the content of the pre-dominating metal, different **commercial classifications** are possible. In the case of predominant Cu contents (light Cu), the ISRI codes are:

- **Drove CU-BEARING SCRAP** shall consist of miscellaneous Cu-containing skimmings, grindings, ashes, Fe brass and Cu, residues and slags. It shall be free of insulated wires, Cu chlorides, unprepared tangled material, large motors, pyrophoric material, asbestos brake linings, furnace bottoms, high Pb materials, graphite crucibles, and noxious and explosive materials. Fine powdered material by agreement. Hydraulically briquetted material subject to agreement.

Process(es) by which mixture is produced

As the EC list of wastes shows, a mixture of Cu and precious metal bearing scrap in dispersible form can originate from a variety of **production** process of Cu metallurgical industry, including processing for further refining, thermal processes, Cu smelting, shaping and physical and mechanical surface treatment, and maintenance operation of furnaces.

Pre-treatment: the mixture could be generated as well by sorting of metal containing waste (e.g. physically separation of Cu powder from other metallic fraction).

Percentage of each of the components in the mixture

The composition of the mixture varies depending on the content of the pre-dominant metals. Cu it is likely to be the predominant metal.

Physical characteristics

The physical state of the waste mixture is powdery and solid.

Chemical characteristics

The mixture does not present any chemical hazardous characteristics if properly managed and recovered.

Potential for contamination

There should be no potential for contamination if an appropriate pre-treatment is performed.

5.2. MANAGEMENT ASPECTS

5.2.1. RECOVERY

Recovery operations

[26] Other wastes (including mixtures of materials) from mechanical treatment of wastes containing dangerous material

- **Interim recovery operations:** Possibly, R 12[27] i.e. exchange of wastes for submission to the non-interim recovery operations (see annex 3 of this report).
- **Non-interim recovery operations:** R 4 - Recycling/reclamation of metals and metal compounds

The recovery operations depend on the yield of Cu in the mixture. In the case of lower-grade scrap quality, the process is performed using a blast furnace (Reddy et al., 2004). Alternatively, in the presence of high amounts of Cu brass, the use of a converter[28] is possible. The use of a flash smelter technology is also possible but only for lower grade concentrates[29].

Technological capacity of recovery

The number of facilities for recovery of such waste mixture in Europe is estimated to be 10-100 in the proposal. In EU, 740 000 tonnes of Cu are recycled every year (Bertram et al., 2002). Similar range of Cu recovery is also performed in OECD countries.

Recovery quota

Almost 100% of the predominating metal (e.g. Cu) in the mixture is recycled. All the other metals present in the mixture can be recycled after a multi-step process (e.g. metal recovery from flue dust and slag).

Methods of storage at the recovery facility

The waste is stored in a covered storage.

Use of recovered material

Depending on the input scrap, new pure Cu can be reused by the industry.

Environmental benefits of recovery

In general, metal recovery present important environmental benefits (see section 4.2.2.). In the specific case of this mixture, which is predominantly Cu it is important to notice that Cu recycling permit to save 85% of energy comparing to primary production. It is worth noticing, that 41% of the EU Copper demand is met by recycling.

In addition, Cu ores are relatively scarce. Thus, it is economically advantageous to recover Cu because of the intrinsic value of the material. Secondary Cu recovery can therefore repeat many of the processing steps of primary recovery and still remain an economically viable proposition (recycled Cu is worth up to 90% of the cost of the original Cu).

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27 Operations as described by the codes of Directive 75/442/EEC, Annex IIB (recovery operations). R12 and R13 are defined as interim recovery operation in the Article 2 of the Regulation (EC) N° 1013/2006 on shipment of waste.

28 Cu-alloy scrap is melted in small converters with coke and Fe scrap (but no silica) during air blowing. Crude Cu in the converter contains some impurities and must be refined. The Cu-rich slag must be processed by reducing blast furnace smelting to yield black Cu.

29 For more details on these operations, see Section 2.2.2. in the factsheet #2

- **Environmental/health impacts of recovery**

  - **General impacts of metal recovery operations:** metal recovery works in general can generate air pollutants emissions (e.g. dioxin and furan emissions). As a general guideline, in the facilities emission of air pollutants should be minimised and controlled to prevent harm to the environment or adverse effects to human health.

  - **Specific impacts of the mixture recovery:** Cu smelting requires modern pollution control equipment. Cu, especially if it originates from waste electronics, may contain Be (Be), which because of its health hazard must be captured in the air pollution control equipment. Grinding of Cu can release Be-containing dusts that can be dangerous for health (Wambach and Laul, 2008; Infante and Newman, 2004). The concentration of Be and of other potentially dangerous residues in the component B1070, should not be hazardous. However B1100 and GB040 could also contain Be and other potentially hazardous residues. In these two fractions the concentration limits of potentially hazardous waste are not specified. However, re-melters in the EU are equipped with the Best Available Technology (e.g. appropriate filters) that should provide sufficient pollution control equipments (European Commission, 2001) to avoid hazardous contamination due to this kind of residues.

5.2.2. SHIPMENT AND TRADE

- **Packaging types during shipment**

The waste mixture is transported in bulk and containers. Scrap mixtures with dispersible form of Cu/noble metals are normally transported in covered trucks and/or containers.

- **Amount shipped**

In the proposal, it has been estimated that, 36% of collected Cu scrap is exported to EU15 and 12% to other parts of Europe.

- **Enforceability**

ISRI scrap specifications can be given in documents accompanying scrap mixture shipment. However, it is advisable to perform analysis, proof of non hazardous characteristics of the mixture and any of the fractions (particularly B1100 and GB040). This could complete the information provided by the visual inspection.

5.3. ASSESSMENT OF THE WASTE MIXTURE

As shown in the previous sections of the factsheet, this waste mixture may contain unwanted residues (ashes from the incineration of Cu wire, dust and residues from gas cleaning systems of Cu smelters, etc.) which may have hazardous characteristics (e.g. if they contain traces of Be). However, for the fraction B1070, this should not be a cause of concern if the mixture respect the conditions defined in the Basel code (absence of Annex I constituents to an extent that they present Annex III characteristics). In addition, in the EU, since secondary smelters are equipped with the Best Available Technology (e.g. appropriate filters) that should provide sufficient pollution control equipments (European Commission, 2001). This is likely the case also for OECD countries, but non-OECD countries may not be equipped with such facilities.

As commented in factsheet #2, Cu containing wastes in dispersible form may present an environmental risk due to potential soil pollution and water contamination. Thus, the storage facility should provide precautions against dispersion (e.g. by wind), and leakage.

MS have proposed that this mixture may be more appropriately named in «usual description» section of the proposal. However, it is important to remind that once included in Annex IIIA, the mixture will be only be identified by Basel code and that all additional information given in the proposal may not be included in Annex IIIA.

Regarding enforceability, the visual inspection alone may not be sufficient to verify the compliance of the mixture and additional chemical analysis could be needed.

5.4. CONCLUSIONS AND RECOMMENDATIONS

To summarise, the waste mixture #3 presents:

- no hazardous characteristics that can be a risk for the environment if the recovery is performed in BAT equipped facilities;
- no potential for contamination
- good technical recovery capacity in EU and OECD countries
- a substantial beneficial effect from recovery
- a good level of enforceability

As a conclusion, based on Recital 39 criteria, the mixture could be included in Annex IIIA. However, as discussed in the previous section, the shipment should be limited to EU and OECD countries.

5.5. REFERENCES

Bertram M, Graedel TE, Rechberger H, Spatari S. The contemporary European Cu cycle: waste management subsystem. Ecological Economics, Volume 42, Issues 1-2, 2002.

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European Commission. Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques in the Non Ferrous Metals Industries, 2001.

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Reddy RG, Prabhu VL, Mantha D. Recovery of Cu from Cu blast furnace slag. SME Annual Meeting and Exhibit February 23– 25, Denver, CO, 2004.

Wambach PF, Laul JC. Be health effects, exposure limits and regulatory requirements. Journal of Chemical Health and Safety, Volume 15, Issue 4, 2008, pages 5-12.

6. WASTE MIXTURE PROPOSAL # 4

Proposed entry in Annex IIIA: non ferrous metal-bearing wastes arising from melting, smelting and refining of including slags from precious metals and Cu processing for further refining (GB040 + B1100).

Proposal submitted by: Austria

6.1. PROPERTIES OF THE WASTE MIXTURE

Description: non-ferrous metal-bearing wastes arising from melting, smelting and refining of including slags from precious metals and Cu processing for further refining.

Basel code:

Basel Code	Code description
B1100	Metal bearing wastes arising from melting, smelting and refining of metals limited to the following entries: -Hard Zn spelter -Zn-containing drosses Galvanizing slab Zn top dross (>90% Zn) Galvanizing slab Zn bottom dross (>92% Zn) Zn die casting dross (>85% Zn) Zn skimmings Al skimmings (or skims) excluding salt slag Wastes of refractory linings, including crucibles, originating from Cu smelting
GB040	Slags from precious metals and Cu processing for further refining

Based on the MS proposal, the mixture would cover the following waste of the **EC list of wastes**:

EU Code	Code description	Origin
10 03 16	Skimmings others than those mentioned in 10 03 15[30]	From Al-metallurgy [cat.1003]
10 05 01	Slags from primary and secondary production	From Zn- metallurgy [cat.1005]
10 05 04	Other particulates and dust	
10 06 01	Slags from primary and secondary production	From Cu metallurgy [cat.1006]
10 06 02	Dross and skimmings from primary and secondary production	

30 Skimmings are flammable or emit, upon contact with water flammable gases in dangerous quantities.

EU Code	Code description	Origin
10 06 04	Other particulates and dust	
10 07 01	Slags from primary and secondary production	From Ag, Au and Pt metallurgy [cat. 1007]
10 08 09	Slags	From others non-ferrous metals metallurgy [cat. 1008]
10 10 03	Furnace slag	From casting of non-ferrous pieces [cat. 1010]
16 11 04	Linings and refractories	From metallurgical processes other than those mentioned in 16 11 03[31]
19 02 03	Premixed wastes composed only of non hazardous wastes	From physico-chemical treatment of waste [cat.1902]
19 12 12	Wastes (including mixtures of materials) other than those mentioned in 19 12 11[32]	From the mechanical treatment of waste [cat.1912]

Depending on the content of the predominating metal, different **commercial classifications** are possible. In the case of predominant Cu content, the ISRI code is:

- **Drove CU-BEARING SCRAP** shall consist of miscellaneous Cu-containing skimmings, grindings, ashes, Fe brass and Cu, residues and slags. It shall be free of insulated wires, Cu chlorides, unprepared tangled material, large motors, pyrophoric material, asbestos brake linings, furnace bottoms, high Pb materials, graphite crucibles, and noxious and explosive materials. Fine powdered material by agreement. Hydraulically briquetted material subject to agreement.

In the case of predominant Zn content the ISRI codes are: Scrub, Seal, Seam and Shelf.

- **Shelf PRIME ZN DIE CAST DROSS** shall consist of metal skimmed from the top of pot of molten Zn die cast metal. Must be unsweated, unfluxed, shiny, smooth, metallic and free from corrosion or oxidation. Should be poured in molds or in small mounds weighing not over 75 pounds each. Zn content shall be minimum of 85%.

Process(es) by which mixture is produced

As shown in EC list of wastes, the waste mixture could be originated by a number of metallurgical production processes, including thermal processes of Al, Zn, Cu, Ag, Au and Pt metallurgy. In addition, the mixture could be produced by the collection of metal bearing wastes from different foundries or the mechanical treatment of metal containing wastes.

[31] Other linings and refractories from metallurgical processes containing dangerous substances.
[32] Other wastes (including mixtures of materials) from mechanical treatment of wastes including dangerous substances.

Pre-treatment: sorting of metal-containing parts mechanically separated from the more easily removed non-metallic constituents of the products that have been recovered from the post-industrial sources.

- **Percentage of each of the components in the mixture**

The composition of the mixture varies depending on the content of the pre-dominant metals.

- **Physical characteristics**

The waste mixture is in a solid, viscous and pasty physical state.

- **Chemical characteristics**

This mixture does not present any hazardous chemical characteristics if properly managed and recovered.

- **Potential for contamination**

There is no potential contamination with non metallic fractions since the mixture is originated by metallurgical industrial processes. If an adequate pre-treatment is performed, there should not been any ferrous metals either.

6.2. MANAGEMENT ASPECTS

6.2.1. GENERATION

- **Quantity produced in Europe**

Several million tonnes of non-ferrous metals are recovered every year, e.g. 1.7 million tonnes recovered in France in 2006 (Federtec).

6.2.2. RECOVERY

- **Recovery operations**

R4: Recycling/reclamation of metals and metal compounds

The basic sequence of operations carried out by secondary smelters of each of the non-ferrous metals is quite similar. After pre-treatment, the metals are separated from more tightly bound contaminants, generally by a sequence of processes of increasing temperature. The first step may volatilise or burn off organics, leaving the desired metals along with the more refractory constituents. Then the desired metals melt away from the remaining materials, leaving behind the higher melting metals, such as Cu, to be dealt with by other means. Finally, the metals recovered in the sweating process are refined until they can re-enter commerce with the appropriate materials specifications as raw materials for subsequent manufacturing into finished products.

- **Technological capacity of recovery**

The estimated number of facilities for recovery in the EU is between 10 and 100. Many metal smelters have capacities above 100 000 tonnes per year. OECD countries also have a similar number of facilities[19].

- **Recovery quota**

Almost 100% of the predominating metal (e.g. Cu or Zn) in the mixture is recycled. All the other metals present in the mixture can be recycled after a multi-step process (e.g. metal recovery from flue dust and slag).

- **Methods of storage at the recovery facility**

The waste is stored in a covered storage.

- **Use of recovered material**

Depending on the input scrap, new pure Cu, Zn, etc. can be provided for industry.

- **Environmental benefits of recovery**

As previously discussed, recycling of metals has number of environmental benefits such as material conservation, energy conservation, reduction of the amount of waste destined to disposal, reduction of landfill waste, reduction of dangerous gas emissions[33], reduction of dust production, water conservation , and reduction of green-house gases emissions (Table 3-1).

- **Environmental/health impacts of recovery**

  - **General impacts of metal recovery operations:** metal recovery works in general can generate air pollutants emissions (e.g. dioxin and furan emissions). As a general guideline, emission of air pollutants in the recovery facilities should be minimised and controlled to prevent harm to the environment or adverse effects to human health.
  - **Specific impacts of the mixture recovery:** Cu smelting requires modern pollution control equipment. Cu may contain Be (Be), which because of its health hazard must be captured in the air pollution control equipment. If Cu-containing electronic scrap is grind for recovery, the dust must be controlled and captured. Grinding can release Be-containing dusts that can be dangerous for health (Wambach and Laul, 2008; Infante and Newman, 2004). B1100 and GB040 could also contain Be and other potentially hazardous residues. In these two fractions the concentration limits of potentially hazardous waste are not specified. However, in EU re-smelters are equipped with the Best Available Technology (e.g. appropriate filters) that should provide sufficient pollution

[33] During mining and refining (purification) of Cu, for example, dust and waste gases such as sulphur dioxide are produced which may have a harmful effect on the environment. Although these harmful effects are minimised by Cu producers (sulphur dioxide is captured and used to make sulphuric acid), with recycling there are little, if any, harmful gases emitted.

control equipments (European Commission, 2001) to avoid hazardous contamination due to this kind of residues.

6.2.3. Shipment and trade

- **Packaging types during shipment**

The waste mixture is transported in bulk, drum and containers.

- **Enforceability**

ISRI scrap specifications can be given in documents accompanying scrap mixture shipment. However, it is advisable to carry along analysis, proof of non hazardous characteristics of the mixture and any of the fractions (particularly B1100 and GB040). This could complete the information provided by the visual inspection.

6.3. ASSESSMENT OF THE WASTE MIXTURE

Scraps of Cu and their alloys are considered to be hazardous wastes if they contain residues of Sb, As, Be, Cd, Pb, Hg, Se, Ti, and Te. As previously commented, In EU, secondary smelters are equipped with the Best Available Technology (e.g. appropriate filters) that should provide sufficient pollution control equipments (European Commission, 2001) to avoid contamination. This is likely the case also for OECD countries, but not for non-OECD countries that may not have such equipped facilities.

As for the mixture #2, the storage facility should provide precautions against the dispersion (e.g. by wind) of Cu containing wastes in dispersible form. In addition, precautions should be taken in the case of Zn scrap containing jarosite (see section 5.3.).

As in the case of proposals #2 and #3, MS have proposed that the mixture may be more appropriately named in «usual description» section of the proposal. However, it is important to remind that all additional information given in the proposal will not figure in Annex IIIA, since the mixture will be identified exclusively by Basel code.

To conclude, the technological capacity to recover this specific mixture is good in EU and OECD countries. The shipment of the mixture to non-OECD countries should be avoided, since the appropriate technologies to ensure an Environmental Sound Management may not be available in these countries.

Regarding the enforceability, the visual inspection alone may not be sufficient to verify the compliance of the mixture and additional chemical analysis could be needed.

6.4. CONCLUSIONS AND RECOMMENDATIONS

The waste mixture presents:

- no hazardous characteristics that can be a risk for the environment if the mixture is properly managed and recovered
- no potential for contamination
- good technical recovery capacity in EU and OECD countries
- a beneficial effect from recovery
- an acceptable level of enforceability

On the basis of Recital 39 criteria, the waste mixture could be included in Annex IIIA. However, as discussed in the previous section, the shipment should be limited to EU and OECD countries.

6.5. REFERENCES

European Commission. Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques in the Non Ferrous Metals Industries, 2001.

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7. WASTE MIXTURE PROPOSAL # 5

Proposed entry in Annex IIIA: Mixture of ferrous and non-ferrous metals in non-dispersible form (B1010 + B1050).

Proposal submitted by: Finland

Amendments: The proposal has been amended by Finland - B1020 was omitted.

7.1. PROPERTIES OF THE WASTE MIXTURE

Description: Mixture of ferrous and non-ferrous metals in non-dispersible form (predominately Fe, Cu, Zn, Al, brass, stainless steel in different sizes).

Basel code:

Basel Code	Code description
B1010	Metal and metal alloy wastes in metallic, non-dispersible form
B1050	Mixed non ferrous metal, heavy fraction scrap, not containing Annex I materials in concentrations sufficient to exhibit Annex III characteristics (see annex 1 and 2 of this report)

Based on the MS proposal, the mixture would cover the following waste of the European Community list of wastes:

EU Code	Code description	Origin
19 10 01	Fe and steel	From shredding of metal containing waste [cat. 1910]
19 10 02	Non- ferrous metals	

- **Process(es) by which mixture is produced**

Pre-treatment: Preliminary sorting and separation of metallic materials from waste management facilities; potentially including sorting of shredded ELV. The mixture could be also originated by pre-treated white goods (such as washing machines, etc.), or, more generally, by post-consumer metals containing waste. Most of the ferrous metals are already separated by magnetic separation, but due to form factor some ferrous metal particles are missed by this magnetic separation. The resulting mixture contains mostly non-ferrous metals with some remaining ferrous metals.

- **Percentage of each of the components in the mixture**

The proposal for this waste mixture specifies that the mixture is meant to consist of mostly non-ferrous metals (90-100%), with 0-10% ferrous metals. It is also mentioned that the mixture could contain 0-2% shredder waste (plastics, textile, rubber), but these are considered impurities rather than constituents of the waste mixture.

- **Physical characteristics**

The waste mixture is in a solid physical state

- **Chemical characteristics**

The chemical characteristics reflect the dominating non-ferrous metal content. Exact chemical characteristics are determined by the content of the different metals in the mixture. But the mixture does not present any hazardous chemical characteristics.

- **Potential for contamination**

No potential for contamination if the original pre-treatment is appropriately done. Risk of contamination is low since the metals are present in solid metallic form.

7.2. MANAGEMENT ASPECTS

7.2.1. GENERATION

- **Quantity produced in Europe**

This mixture is partially generated from shredding of ELV and it is known that annually 8-9 million tonnes of ELV waste are produced in EU (ETC/RWM, 2008). Since the 70% of ELV is metallic (Environment Australia, 2002), at least 5-6 millions of this mixture is potentially produced every year in EU.

7.2.2. RECOVERY

- **Recovery operations**

R4: Recycling/reclamation of metals and metal compounds[34]

- **Interim recovery operations:** In order to further separate the different material fractions, a number of treatments could be used, notably gravity separation (e.g. sink-float in water, salt solutions or organic liquids), eddy current separation and/or electromagnetic separation, shredding, manually or automatically performed separation. Bigger plastic pieces (> 10 cm) are separated and sorted by different plastic types and separated by a shaking table. After this step, separated ferrous and non-ferrous metals can be sold as raw materials to metal industry.
- **Non-interim recovery operations:** The metallic fraction is recycled by the metal industry. The plastic is fraction is crushed, extruded and granulated. Plastic granules are a raw material for plastic industry and rest of the shredder waste is landfilled.

[34] The R3 (recycling/reclamation of organic substances which are not used as solvents) was included in the original Finnish proposal. However, the Finnish correspondent, Ms Rainio defined it as an error (personal communication).

- **Technological capacity of recovery**

The recovery of this waste mixture is performed in two steps: the separation of metallic from non-metallic fractions and a further recycling step that differs for each fraction. The capacity of recovery in EU and OECD countries varies depending on the considered step: 1) separation of fractions; 2) metal /plastic recovery; 3) incineration or landfilling of discarded shredder waste fraction.

1. Hand sorting is possible in almost all countries. The other interim operations are likely to be possible in all EU and OECD countries, e.g. in North America there are approximately 6 000 scrap collection and dismantling yards, 200 scrap shredders, ten sink-float plants.
2. In EU27+NO/CH, 50% of all plastics (12 million tonnes) are actually recovered (recycling and energy recovery)(Plastics Europe, 2008). The number of facilities for metal recovery is estimated to be 10-100. In EU, many metal smelters have capacities above 100 000 tonnes per year.
3. Dedicated municipal solid waste incineration capacity is estimated to be at least of 45 million tonnes/year in EU and 100 million tonnes/year in OECD countries (OECD Compendium, 2006-2007).

- **Recovery quota**

Almost 100% of the predominating metal in the mixture is recycled. All other metals present in the mixture can be recycled after a multi-step process (e.g. metal recovery from flue dust and slag).The non recoverable shredder waste (plastics, textile, rubber, etc.) is usually landfilled or incinerated.

- **Methods of storage at the recovery facility**

The waste mixture is stored in piles

- **Use of recovered material**

Recovered plastic and metals are sold as raw material to industry that can use them in place of raw material.

- **Environmental benefits of recovery**

The main environmental benefits of recovery are material conservation and reduced landfill.

- **Environmental/health impacts of recovery**

  - **General impacts of metal recovery operations:** metal recovery works in general can generate air pollutants emissions (see section 5.2.1.).
  - **Specific impacts of the mixture:** there are no specific impacts due to the recovery of the waste mixture.

7.2.3. SHIPMENT AND TRADE

- **Packaging types during shipment**

The waste is transported in bulk.

- **Amount shipped**

In the proposal the amount of mixture shipped within the EU was estimated to be 30 000 tonnes/year. The amount imported/exported from/to third countries was estimated to be 1 000 tonnes/year.

- **Enforceability**

The verification of the percentage of each fraction in the mixture is made at the beginning of the process by sampling and hand sorting. After a practice it can be made by visual inspection. Exact percentage of each component of the waste mixture is of course not easily controllable by simple visual check, but it should enable to see that the mixture is practically free from shredder waste, except minor (indicatively 0-2%) impurities.

7.3. ASSESSMENT OF THE WASTE MIXTURE

Some MS have raised a concern about the definition of this waste mixture using percentages of each component (ferrous metals, non-ferrous metals, and organic materials). In fact, the percentages of each type of material (including the exact percentage of shredder waste to be landfilled) are checked at the original facilities by sampling and sorting. During shipment it can be verified by visual inspection if inspectors are appropriately trained. In addition, it could be useful to have percentages defined in the definition of a waste mixture in order to have information about the predominant fraction (e.g. in this case the metal fraction).

Since the waste mixture is at least partially shredder material from ELV, it should be clearly specified in the proposal at the level of EU codes, (e.g. using the appropriate category 1601). However, it is important to remind that in the Annex IIIA, the mixture will be described exclusively by Basel codes which in this case are B1010 and B1050. Thus, the information about the ELV origin of the mixture will not figure in Annex IIIA.

The analysed mixture does not present any particular hazardous characteristic. The potential for contamination is also low if the pre-treatment is appropriately done and shredded fraction is lower than 2%. Thus, the environmental benefits of recovery are acceptable since the landfilling of the unwanted fraction should be limited to 2%.

7.4. CONCLUSIONS AND RECOMMENDATIONS

To summarise, the waste mixture presents:

- no hazardous characteristics
- no potential for contamination
- good existing recovery capacity
- an acceptable level of environmental benefits due to recovery
- an acceptable suitability for environmentally sound management
- an acceptable enforceability

As a conclusion, in view of Recital 39, this mixture could be included in Annex IIIA

7.5. REFERENCES

Environment Australia. Environmental impact of End-of-life vehicles, an information paper, 2002.

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Plastics Europe. Compelling facts about plastics, 2008.

OECD. Environmental Data, Compendium 2006-2007.

7.6. CONTACTS

- Kaija Rainio, Senior adviser, Finnish Environment Institute (SYKE)
- Mari Parviainen, Project Manager, Kuusakoski Oy

8. WASTE MIXTURE PROPOSAL # 6

Proposed entry to Annex IIIA: pre-sorted and pre-treated post consumer waste consisting of ferrous and non-ferrous metals (predominantly Fe, Cu, Zn, Al, Pb, brass, stainless steel) for metal recovery with <10% of plastic (B1010 + B1050 + B3010).

Proposal submitted by: Finland

Amendments: the proposal has been amended by Finland: B1020 has been erased.

8.1. PROPERTIES OF THE WASTE MIXTURE

Description: pre-sorted and pre-treated post consumer waste consisting of ferrous and non-ferrous metals (predominantly Fe, Cu, Zn, Al, Pb, brass, stainless steel) for metal recovery with <10% of plastic.

Basel codes:

Basel Code	Code description
B1010	Metal and metal alloy wastes in metallic, non dispersible form
B1050	Mixed non ferrous metal, heavy fraction scrap, not containing Annex I material (see annex 1 of this report)
B3010	Solid plastic waste not mixed with other wastes and prepared to a specification

Based on the MS proposal, the mixture would cover the following waste of the European Community list of wastes:

EU Code	Code description	Origin
20 01 40	Metals	Separately collected fractions of municipal waste [cat.2001]

- **Process(es) by which mixture is produced**

Pre-treatment: this mixture is produced by preliminary sorting and separation of metallic materials from waste management facilities. The mixture, even if not explicitly indicated in the proposal it is likely originated from sorting of shredded ELV and household Electrical and Electronic Equipment (EEE).

- **Percentage of each of the components in the mixture**

The proposal for this waste mixture specifies that the mixture is meant to consist of mostly ferrous metals (50-80%), with 2-15% non-ferrous metals. It is also mentioned that the mixture contains a maximum of 10% of plastics and a less than 5% of shredded material. The mixture is likely to contain pieces, so called ‘compound’ pieces, which are mainly metals, but may contain plastic pieces as well.

- **Physical characteristics**

The waste mixture is solid.

- **Chemical characteristics**

The eventual presence of some species of flame retardants over certain concentrations in the plastic fraction could give the waste mixture hazardous characteristics[35]. However, the post consumer waste is normally pre-sorted to avoid plastic pieces containing halogenated flame retardants (HFR) in the waste mixture (personal communication Ms. Parviainen, Kuusakoski Oy). In addition, plastic containing flame retardants should not be included in B3010 plastic fraction (personal communication Mr. Shafii, UNEP).

- **Potential for contamination**

No potential for contamination if an appropriate sorting is performed at the original recovery facilities.

8.2. MANAGEMENT ASPECTS

8.2.1. RECOVERY

- **Recovery operations**

R4: Recycling/reclamation of metals and metal compounds

R3: Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes).

Description of Recovery operations:

- **Interim recovery operations:** In order to recover the metallic fraction these kinds of waste mixtures need to be further pre-treated. The specific pre-treatments that could be used are small crusher, water-table separator, dismantling machine or methods of gravity separation (e.g. sink-float in water, salt solutions or organic liquids), Eddy current separation and/or electromagnetic separation. Manually or automatically separation can also be performed. For non-ferrous metals and plastic separation, a new method combining Eddy Current separator and a Worm Screw is also available. The main advantage of the system lies in separation purity (up to 95% of non-ferrous metals extraction), mobility and compactness of the system (e.g.

[35] As most flame retardants, including brominated flame retardants, are not classified as hazardous according to European legislation, waste and products containing these substances should also not be classified as hazardous. Exceptions are waste containing PBB's, which were phased out a long time ago, Penta-BDE, which was used in small quantities in electrical and electronic applications, and ABS containing Octa-BDE, which can still constitute a major fraction of the ABS waste stream (EBFRIP Statement: Classification of plastic waste containing BFRs, February 2009).

Cogelme separation technology)(Cogelme website). Plastics are separated as following: bigger plastic pieces (> 10 cm) are separated and sorted by different plastic types and separated by a shaking table. Separated ferrous and non-ferrous metals reused as raw materials for the metal industry.

- **Non-interim recovery operations:** After separation, the plastic is then crushed, extruded and granulated. Plastic granules are a raw material to plastic industry. Small plastic pieces (<10 cm) are first separated in a sink-float process and then separated and sorted like bigger plastic pieces. Separated rubber and textile is energy raw material for incinerator (energy waste). The non-recoverable fraction (dust etc) <2% is most probably landfilled. In general, in the plastic fraction there are quite distinct groups of materials of different molecular construction and recycling depends on the use of effective and efficient identification and separation technologies.

- **Technological capacity of recovery**

The recovery of this waste mixture is to be performed in two steps: a pre-treatment to separate metallic from non-metallic fractions and a recycling step that differs for each fraction. The capacity of recovery in EU and OECD countries varies depending on the considered step: 1) pre-treatment (separation of fractions); 2) metal recovery (ferrous and no-ferrous); 3) plastic recovery (recycling and energy recovery); and 4) incineration of shredded waste.

1. Hand sorting is possible in almost any country. The other non-interim operations are possible in a number of countries, e.g. in North America there are approximately 6000 scrap collection and dismantling yards, 200 scrap shredders, and ten sink-float plants (Gesing A and Wolanski R, 2001).
2. The number of facilities for metal recovery is estimated to be between 10 and 100. In the EU, many metal smelters have capacities above 100 000 tonnes per year.
3. In EU27+NO/CH, 50% of all plastics (12 million of tonnes) are actually recovered (recycling and energy recovery)(Plastics Europe, 2008).
4. Dedicated municipal solid waste incineration capacity is estimated to be at least of 45 million tonnes/year in EU and 100 million tonnes/year in OECD countries (OECD Compendium, 2006-2007).

- **Recovery quota**

In the proposal the recovery quota was estimated to be more than 98%. This quota can be reached only of the plastic fraction is almost entirely recovered and not landfilled.

- **Methods of storage at the recovery facility**

The waste mixture is stored in piles.

- **Use of recovered material**

The recovered material is used as raw material.

- **Environmental benefits of recovery**

Material conservation, energy conservation (e.g. for plastics up to 80% of energy saving)(ACRR et al., 2004), water conservation.

- **Environmental/health impacts of recovery**

For general impacts of metal recovery operations, relevant also for this waste mixture, see section 3.2.2.

Specific impacts of the mixture recovery: The presence of HFR in the plastic fraction could lead to the liberation of toxic molecules to the environment during recovery operations, if the operations are not performed in a modern and appropriately equipped incinerator. However, in principle HRF containing plastics should not be present in the mixture, since their inclusion in B3010 is unlikely (personal communication Mr. Shafii, UNEP).

8.2.2. SHIPMENT AND TRADE

- **Packaging types during shipment**

The waste mixture is transported in bulk

- **Amount shipped**

In the proposal the amount of the mixture shipped within the EU was estimated to be 2 million tonnes/year and the amount imported/exported from/to third countries was estimated to be 200 000 tonnes/year.

- **Enforceability**

The verification of the percentage of each fraction in the mixture is made at the beginning of the process by sampling and hand sorting. During shipment, it can be made by visual inspection only by trained inspectors. The absence of potentially hazardous components (e.g. HFR) is difficult to verify during shipment inspection.

8.3. ASSESSMENT OF THE WASTE MIXTURE

As for proposal # 5, some MS have raised a concern about the definition of this waste mixture using percentages of each component (ferrous metals, non-ferrous metals, and plastic). Also in this case, the percentages of each type of material are normally checked at the original facilities and during shipment they can be verified by visual inspection if inspectors are appropriately trained. As a general comment, it could be useful to indicate percentages to define the mixture composition in order to know which is the predominant fraction (in this case the metallic fraction).

As in the case of proposal #5, if this mixture contains significant ELV material it should be clearly specified in the proposal at the level of EU codes, (e.g. using the appropriate category 1601). However, again in the Annex IIIA, the mixture will be described exclusively by Basel codes which in this case are B1010, B1050 and B3010. None of these codes are specifies for ELV waste. Thus, using Basel codes the information about the ELV origin of the mixture will be lost.

Another concern related to this mixture could be if plastic fraction contains some species of HFR that may give hazardous characteristics to the mixture in recycling processes. Flame retardants are applied to plastic compounds and technical products in order to reduce the risk of fire accidents. Brominated flame retardants (BFR) are most commonly used for these purposes. During thermal stress like recycling, plastics protected by BFR can produce polybrominated dibenzo-p-dioxins and dibenzofurans (PBDD/F), dangerous molecules for both environment and human health (Bahadir, 2007; Schlummer et al., 2007). However, the concentration of the potentially dangerous HFR (i.e. Octa-BDE and Penta-BDE) should be under the legal requirements defined in the Electric and Electronic Equipments (WEEE) Directive and, in general, incineration in a modern and appropriately equipped incinerator is sufficient to avoid the formation and emission of such hazardous molecules[36].Moreover, during sorting of post-consumer waste, flame retardants containing waste are avoided in the waste mixture (personal communication Mari Parviainen, Kuusakoski Oy). In addition, it is worth noticing that the plastic fraction of this mixture will be described as B3010 in Annex IIIA. B3010 fraction is already defined as a green waste in Annex III. B3010, in principle does not contain HFR (personal communication Mr. Shafii, UNEP).

8.4. CONCLUSIONS AND RECOMMENDATIONS

To summarise, the waste mixture presents:

- no hazardous characteristics that can be a risk for the environment (if the concentration of specific potentially dangerous flame retardants is under the legal requirements and if, in the case of ELV origin of the mixture, the pre-treatment is appropriately performed)
- no potential for contamination (if, in the case of ELV origin of the mixture, the pre-treatment is appropriately performed)
- a good technical recovery capacity in EU and OECD countries
- environmental benefits from recovery (if the absence of hazardous components is ensured)
- an acceptable enforceability

Based on this analysis, the inclusion of this waste mixture in Annex IIIA could be considered if:

[36] Personal communication Mr. Tange

- the concentration of the potentially dangerous HFR (i.e. Octa-BDE and Penta-BDE) is under the legal requirements defined in the WEEE Directive and, in general, incineration in a modern and appropriately equipped incinerator is ensured.
- in the case of ELV origin, the absence of hazardous components is ensured by an appropriately performed pre-treatment

  As a consequence, the waste mixture is suitable for inclusion in Annex IIIA if its transport is limited to EU and OECD countries.

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8.6. CONTACTS

- Kaija Rainio, Senior adviser, Finnish Environment Institute (SYKE)
- Mari Parviainen, Project Manager, Kuusakoski Oy
- Ibrahim Shafii, Programme Officer (Technical & Scientific), Secretariat of Basel Convention United Nations Environment Programme (UNEP)
- Lein Tange, Product Stewardship Manager ICL-IP Europe

9. WASTE MIXTURE PROPOSAL # 7

Proposed entry for the Annex IIIA: Mixture of solid plastic waste with 3-8 % ferrous and non-ferrous metals (B1010 + B3010)

Proposal submitted by: Finland

Amendments: the proposal has been amended by Finland: B1020 has been erased.

9.1. PROPERTIES OF THE WASTE MIXTURE

Description: Different plastics (ABS, PS, PP, PE, etc.)[37]which are removed from electrical equipment and other equipment (B3010). Plastics contain small amounts (3-8%) of holder metals (Fe, Cu, Al, stainless steel etc. B1010).

Basel code:

Basel Code	Code description
B1010	Meta land metal alloy wastes in metallic, non dispersible form (metals not specified
B3010	Solid plastic waste not mixed with other wastes and prepared to a specification

Based on the MS proposal, the mixture would cover the following waste of the European Community list of wastes:

EU Code	Code description	Origin
19 12 04	Plastic and rubber	From the mechanical treatment of waste [cat.1912]

- **Process(es) by which mixture is produced**
  - **Consumption:** municipal wastes from household waste and similar commercial industrial and institutional wastes.
  - **Pre-treatment:** the mixture is originated by dismantling of wasted electric and electronic equipment (WEEE) and by sorting and separation of the plastic and metallic fractions.
- **Percentage of each of the components in the mixture**

The proposal for this waste mixture specifies that the mixture is meant to consist of plastic (>95%), with less than 8% of metals, including ferrous and non-ferrous metals.

- **Physical characteristics**

The waste mixture is solid.

37 ABS: Acrylonitrile butadiene styrene; PS: Polystyrene; PP: Polypropylene; PE: Polyethylene

■ **Chemical characteristics**

The presence of some types of flame retardants over certain concentrations, normally present in a part of WEEE plastic fraction, can give to the waste mixture hazardous characteristics. However, it is worth stressing, that in Annex IIIA, the information regarding the WEEE origin of the mixture given in the proposal will be lost, and based on Basel code, this mixture does not present any hazardous characteristics. In addition, as previously discussed, the classification of plastic containing HFR under the B3010 code is unlikely (personal communication Mr. Shafii, UNEP).

■ **Potential for contamination**

No potential for contamination if the pre-treatment is appropriately done.

9.2. MANAGEMENT ASPECTS

9.2.1. GENERATION

■ **Quantity produced in Europe**

The amount of WEEE generated in the EU was estimated at 6.5-7.5 million tonnes per year in the late 1990 increasing by 16-28 % every five years. The plastic fraction represents the 21% of the WEEE (ETC/RWM, 2008).

9.2.2. RECOVERY

■ **Recovery operations**[38]

R4: Recycling/reclamation of metals and metal compounds

R3: Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes).

Description of Recovery operations:

- **Interim operations:** in general these kinds of waste mixtures are pre-treated in order to separate plastic and metallic fraction. Sorting is mostly done by manual sorting. Alternatively, this can be performed using methods of gravity separation (e.g. sink-float in water, salt solutions or organic liquids) or Eddy current separation in order to separate metals and plastic fractions. Bigger plastic pieces (> 10 cm) are separated and sorted by different plastic types and separated by a shaking table. Small plastic pieces (<10 cm) are first separated in a sink/float process and then separated and sorted like bigger plastic pieces. For non-ferrous metals and plastic separation, a new method combining Eddy Current separator and a Worm Screw is also available (e.g. Cogelme separation

[38] Operations as described by the codes of Directive 75/442/EEC, Annex IIB (recovery operations).

technology)(Cogelme website). Separated ferrous and non-ferrous metals are raw materials to the metal industry.

- **Non interim operations:** after the pre-treatment the different fractions are recycled. The recyclable plastic is crushed, extruded and granulated. Plastic granules are a raw material to plastic industry. However, in the plastic fraction there are quite distinct groups of materials of different molecular construction, and so recycling depends on the use of effective and efficient identification and separation technologies. The non-recyclable plastics, rubber and dust are incinerated for energy recovery. The non recoverable fraction is landfilled.

Technological capacity of recovery

The recovery of this waste mixture has to be performed in two steps: a pre-treatment to separate metallic from non-metallic fractions and a recycling step that differs for each fraction. The capacity of recovery in EU and OECD countries varies depending on the considered step: 1) pre-treatment (separation of fractions); 2) metal recovery (ferrous and no-ferrous); 3) plastic recovery (recycling and energy recovery); 4) incineration for energy recovery.

1. Hand sorting is possible in almost any country. The other non-interim operations are possible in a number of countries, e.g. in North America there are approximately 6000 scrap collection and dismantling yards, 200 scrap shredders, and ten sink-float plants (Bell et al., 2003).
2. The number of facilities for metal recovery is estimated to be 10-100. In EU, many metal smelters have capacities above 100 000 tonnes per year.
3. The number of facilities for plastic recovery is also estimated to be 10-100. In EU27+NO/CH, 50% of all plastics (12 million of tonnes) are actually recovered (recycling and energy recovery)(Plastics Europe, 2008).
4. Dedicated municipal solid waste incineration capacity is estimated to be at least of 45 million tonnes/year in EU and 100 million tonnes/year in OECD countries (OECD Compendium, 2006-2007).

Recovery quota

The recovery quota (recycling and energy recovery) has been estimated as more than 98% in the proposal.

Methods of storage at the recovery facility

The waste is stored in piles.

Use of recovered material

The recovered material is used as raw material.

Environmental benefits of recovery

The main environmental benefits associated to the recovery of this waste mixture are material conservation, energy conservation (e.g. 80% of energy saving for plastic), water conservation.

Environmental/health impacts of recovery

- **General impacts of plastic recovery (recycling and energy recovery):** It is worth noticing that the majority of recovered plastic in Europe is incinerated for energy recovery. For example, in the case of recovered plastic from WEEE, the share of plastic being recycled into new plastics is generally low (Table 9-1), the rest is incinerated for energy recover. After plastic incineration, about 20 to 30 % of material is still present as ash that must be handled for final disposal. In addition, the incineration could produce emission to air of substances escaping flue gas cleaning and the large amount of residues from gas cleaning and combustion.

  For general impacts of metal recovery operations, which are also valid for this proposal, see section 3.2.2.

Table 9-1: Recycling quota of plastic from WEEE

	Refrigerators	TV	PC	Small appliances
Plastic recycled quota [% by weight]	18%	1.4%	3.3%	1.7%

- **Specific impacts of mixture recovery:** the potential presence of certain types of flame retardants in the plastic fraction could lead to the liberation of toxic molecules to the environment during recovery operations. However, this will not be the case if the incineration is performed in a modern incinerator appropriately equipped (personal communication Mr. L. Tange).

9.2.3. Shipment and trade

Packaging types during shipment

The waste mixture is transported in bulks.

Amount shipped

In the proposal the amount shipped within the EU has been estimated as 800 000 tonnes/year (plastics from WEEE and plastic from other equipments). Regarding the WEEE, in the trade statistics the registered shipments of WEEE from EU show a maximum of 250 000 tonnes (including used products). 90% of the shipments take place within the EU. At least 20 000 tonnes are exported to Africa and the Middle Eastern countries (ETC/RWM, 2008). Since the plastic fraction represents the 20% of WEEE weight this means approximately 50 000 tonnes shipped within the EU and 4 000 shipped to third countries.

- **Enforceability**

The percentages of each fraction in the mixture are normally verified at the original facility by sampling and manual sorting. Visual control is possible to see that the mixture is mostly plastics, but the exact percentage of each component of the waste mixture (ferrous metal, non-ferrous metals, plastic, organic material) in not easily verifiable. Furthermore, to identify the presence of some species of flame retardants, chemical analysis of the plastics would be necessary, but this already the case if B3010 is shipped alone under Annex III.

9.3. ASSESSMENT OF THE WASTE MIXTURE

The use of percentages to describe mixtures composition is discussed in section 7.3.

As for mixture #6, if ELV waste is present in a significant yield it should be clearly specified in the proposal at the level of EU codes (e.g. using the appropriate category 1601). However, in the Annex IIIA, the mixture will be described exclusively by Basel codes which in this case are B1010 and B3010. Thus, in Annex IIIA the eventual ELV origin of the waste will not appear.

In the plastic fraction from WEEE the 5.3% is flame retardants containing plastic. Flame retardants are applied to plastic compounds and technical products in order to reduce the risk of fire accidents. As mentioned previously, during thermal stress like recycling, plastics protected by HFR can produce dangerous molecules for both environment and human health (Bahadir, 2007; Schlummer et al., 2007). However, as in mixture #6, if the incineration is performed in a modern incinerator appropriately equipped the risk of liberation of hazardous molecules in the environment is highly reduced (personal communication Mr. Tange). Moreover, the plastic fraction of this mixture will be described as B3010 in Annex IIIA which is already defined as a green waste in Annex III and which should be free of this class of molecules (personal communication Mr. Shafii, UNEP).

9.4. CONCLUSIONS AND RECOMMENDATIONS

To summarise, the mixture presents:

- possible hazardous characteristics if the recovery operations are not appropriately performed or if it contains PVC lead (Pb) and cadmium (Cd) based stabilisers
- no potential for contamination
- a good technical recovery capacity in EU and OECD countries
- a potentially negative environmental impact of recovery if the recovery operations are not appropriately performed

- a problematic enforceability

The Environmental Sound Management is dependent on the degree of certainty with which is possible to affirm that this mixture will be appropriately managed during the recovery operations. Thus, since there is a good technological capacity for recovery in EU and OECD countries, the inclusion of this waste mixture in the Annex IIIA could be considered only if the transport is limited to EU and OECD countries, where the incineration in modern equipped incinerators is ensured.

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- Kaija Rainio, Senior adviser, Finnish Environment Institute (SYKE)
- Mari Parviainen, Project Manager, Kuusakoski Oy
- Ibrahim Shafii, Programme Officer (Technical & Scientific), Secretariat of Basel Convention United Nations Environment Programme (UNEP)
- Lein Tange, Product Stewardship Manager ICL-IP Europe

10. WASTE MIXTURE PROPOSAL # 8

Proposed entry to Annex IIIA: Mixture of plastic and rubber which contains 10% of ferrous and non-ferrous metals, predominantly Fe, Cu, Al, Zn, stainless steel in different size (B1010 + B1050 + B3010 + B3040 + B3080).

Proposal submitted by: Finland

10.1. PROPERTIES OF THE WASTE MIXTURE

Description: Mixture of plastic and rubber which contains 10 % of ferrous and non-ferrous metals, predominantly Fe, Cu, Al, Zn, stainless steel in different size.

Basel code:

Basel code	Code description
B1010	Metal and metal alloy wastes in metallic, non dispersible form
B1050	Mixed non ferrous metal, heavy fraction scrap, not containing Annex I material (see annex 1 of this report)
B3010	Solid plastic waste not mixed with other wastes and prepared to a specification
B3040	Rubber wastes, provided they are not mixed with other wastes
B3080	waste parings and scrap of rubber

Based on the MS proposal, the mixture would cover the following waste of the European Community list of wastes:

EU Code	Code description	Origin
16 01 19	Plastic	From the dismantling of ELV [cat.1601]

- **Process(es) by which mixture is produced**

According to the proposal, this waste mixture is originated from dismantling and shredding of ELV. The 25% of the shredder's output is a non-metallic shredder residue that corresponds to the proposed mixture. In order to yield the waste mixture, it is assumed that the ELV are adequately decontaminated (e.g. removal of oils and refrigerants). Also, after shredding, **pre-treatment** steps (e.g. sorting and sink-float separation) of the shredded ELV are assumed to yield the described mixture.

- **Percentage of each of the components in the mixture**

In the proposal, this mixture has been described as composed by a majority of plastic (5-85%) or rubber (5-85%) fractions. Ferrous and non-ferrous metals are also included in the mixture but in minor quantities (ferrous metals: 0-10%; non ferrous metals: 0-10%).

- **Physical characteristics**

The waste mixture is in a solid physical state.

- **Chemical characteristics**

The plastic and rubber fractions represent at least the 80% of the waste mixture. The eventual presence of some types of flame retardants (HFR) and of heavy metals based PVC stabilisers could give to the waste mixture hazardous characteristics if not appropriately managed. However, the plastic fraction of the mixture is defined as B3010 (solid plastic waste) which is already included in Annex III as, in principle, non containing HFR plastic waste (personal communication Mr. Shafii UNEP).

- **Potential for contamination**

There is no particular risk for contamination if the pre-treatment is appropriately done.

10.2. MANAGEMENT ASPECTS

10.2.1. Generation

- **Quantity produced in Europe**

In EU-25, the yearly generation of ELV is between 8 and 9 million tonnes. It can be roughly estimated that 2 million tonnes of the mixture are produced yearly in the EU, since plastic and rubber fraction of the shredded ELV waste represents roughly the 25% of the total (ETC/RWM, 2008; Environment Australia, 2002).

10.2.2. Recovery

- **Recovery operations**

R4: Recycling/reclamation of metals and metal compounds

R3: Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes).

Description of Recovery operations:

- **Interim recovery operations:** in general these kinds of waste mixtures are sorted using manual separation. Alternatively, this mixture could be pre-treated using methods of gravity separation (e.g. sink-float in water, salt solutions or organic liquids) or Eddy current separation in order to separate metals and plastic fractions. Big plastic pieces (> 10 cm) are separated and sorted by different plastic types and separated by a shaking table. Small plastic pieces (<10 cm) are first separated in a sink-float process and then separated and sorted like bigger plastic pieces. For non-ferrous metals and plastic separation, a new method combining Eddy Current separator and a Worm Screw is also available. Main advantage of the system lies in separation purity (up to 95% of non-ferrous metals extraction), mobility and compactness of the system (e.g. Cogelme separation technology)(Cogelme website). Manual sorting is also possible.

- **Non-interim recovery operations:** after the pre-treatment the different fractions are ready to be recycled: the plastic is crushed, extruded and granulated, metals are sold as raw material to metal industry for recovery. However, in the plastic fraction there are quite distinct groups of materials of different molecular construction, and so recycling depends on the use of effective and efficient identification and separation technologies[39]. In Europe it is estimated that only 8% of ELV plastics are recycled (Roumpf, 2000). At the end of the process, the non-recyclable plastics are incinerated for energy recovery or landfilled. Alternatively the plastic fraction can be recovered by feedstock recycling. Feedstock recycling describes a range of plastic recovery techniques to make plastics, which break down polymer into their constituent monomers, which in turn can be used again in refineries, or petrochemical and chemical production. Feedstock recycling technologies include: pyrolysis, hydrogenation, gasification and thermal-cracking. Feedstock recycling has a greater flexibility over composition and is more tolerant to impurities than mechanical recycling, although it is capital-intensive and requires very large quantities of used plastic for reprocessing to be economically viable.

  Metallic fraction can also be recovered as described in 3.2.2.

  Rubber and non-recoverable waste is landfilled or burned in incinerator plant to energy.

- **Technological capacity of recovery**

The recovery of this waste mixture has to be performed in two steps: a pre-treatment to separate metallic from non-metallic fractions and a recycling step that differs for each fraction. The capacity of recovery in EU and OECD countries varies depending on the considered step: 1) pre-treatment (separation of fractions); 2) metal recovery (ferrous and no-ferrous); 3) plastic and rubber recycling; 4) incineration for energy recovery.

1. Hand sorting is possible in almost any country. The other non-interim operations are possible in a number of countries, e.g. in North America there are approximately 6000 scrap collection and dismantling yards, 200 scrap shredders, ten sink-float plants (Bell et al.,2003).
2. The number of facilities for metal recovery is estimated to be 10-100. In the EU, many metal smelters have capacities above 100 000 tonnes per year.
3. The number of facilities for plastic recovery is estimated to be 10-100. In EU27+NO/CH, 50% of all plastics (12 million tonnes) are actually recovered (recycling and energy recovery). More than half of recovered plastic is used for energy recovery, the rest is recycled (Plastics Europe, 2008).

[39] An example of innovative method used to recover plastics from mixed plastic waste is the froth-flotation process developed by Argonne National Laboratory (Argonne website).

4. The rubber fraction is incinerated for energy recovery. Dedicated municipal solid waste incineration capacity is estimated to be at least of 45 million tonnes/year in EU and 100 million tonnes/year in OECD countries (OECD Compendium, 2006-2007).

- **Recovery quota**

The recovery quota is more than 95% (2-5% of dust is landfilled), as indicated in the proposal.

- **Methods of storage at the recovery facility**

The waste mixture is stored in piles.

- **Use of recovered material**

The recovered material is used as raw material.

- **Environmental benefits of recovery**

The main benefits from the recovery of this waste mixture are Material conservation and energy conservation (e.g. 80% for plastic).

- **Environmental/health impacts of recovery**

  - **General impacts of plastic incineration:** after plastic incineration, from 20 to 30 % of material is still present as ash that must be handled and taken to final disposal. In addition, the incineration could produce emission to air of substances escaping flue gas cleaning and the large amount of residues from gas cleaning and combustion.
  - **Specific impacts of the mixture:** negative environmental impacts may be occurring through the landfilling of heavy metals, hazardous fluids and other materials contained in traces in the non recoverable shredder fraction.

10.2.3. SHIPMENT AND TRADE

- **Packaging types during shipment**

The waste mixture is transported in bulks.

- **Enforceability**

Visual control is possible but percentage of each component of the waste mixture (ferrous metal, non-ferrous metals, plastic, and rubber) and the eventual presence of traces of hazardous material seems difficult to verify easily and efficiently during shipment inspection.

10.3. ASSESSMENT OF THE WASTE MIXTURE

Some MS have raised a concern about the definition of this waste mixture using percentages. This issue has been discussed in section 7.3.

This mixture contains ELV waste. Shredder waste from ELV may contain traces of a variety of materials including heavy metals used in vehicle manufacture: Pb (in resins, batteries, solder, wheel weight, fluids etc), Zn, Cd, and hexavalent Cr, (primarily as protective metal coatings) and Hg (in HID headlights, Hg switches in early model vehicles). These heavy metals may cause environmental degradation as toxic leachate seeping through landfill, and may be bio-accumulative, persistent toxins. In addition, there could be a risk of contamination with other materials from ELV (e.g. motor oil) if the shredder operations and the preliminary separation of material is not appropriately performed. The presence of flame retardants could also be a cause for concern if these components are not appropriately managed during recovery, as discussed in the previous factsheet. However, shredder in-feed containing hazardous waste is normally pre-treated before shredding, and the hazardous residues are removed (personal communication, Ms Parviainen).Thus, if the ELV fluff is appropriately pre-treated, this mixture could be suitable for an Environmental Sound Management of the recovery.

It is important to remind that in the Annex IIIA, the mixture will be described exclusively by Basel codes which in this case are B1010, B1050, B3010 and B3040. As a consequence, any additional information given by EU code or «usual description» (e.g. the ELV origin of the mixture) will not figure in the Annex IIIA.

10.4. CONCLUSIONS AND RECOMMENDATIONS

If the waste mixture is considered based on proposed Basel codes, and if these constituent waste fractions respect the general conditions of Annex III (avoid of hazardous contaminants), the mixture would not seem to pose hazardous risks.

In practice, this mixture could present a potential for contamination depending on the accuracy of sorting. Indeed, the described mixture would typically originate from shredding of ELV, which could contain PVC. In such case, only if the pre-treatment has been appropriately performed and the shredded material does not contain any trace of hazardous substance, like Pb and Cd stabilisers possibly present in PVC, the mixture will present no hazardous characteristics.

If the pre-treatment has been appropriately carried out and no hazardous characteristics are present, the mixture would present the following charaxteristics:

- a good technical recovery capacity in EU and OECD countries
- environmental benefits from recovery
- a possible enforceability

The Environmental Sound Management of this waste mixture is dependent on the degree of certainty with which is possible to affirm that this mixture is free of hazardous components. Thus, even if there is a good technological capacity for recovery in EU and OECD countries, the related environmental benefits are difficult to estimate. As a conclusion, the inclusion of this waste mixture in the Annex IIIA could be considered only if the absence of hazardous components (i.e. Pb and Cd stabilisers in PVC) can be ensured by the original facilities and the transport should be limited to EU and OECD countries.

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- Kaija Rainio, Senior adviser, Finnish Environment Institute (SYKE)
- Mari Parviainen, Project Manager, Kuusakoski Oy

11. WASTE MIXTURE PROPOSAL # 9

Proposed entry to Annex IIIA: Mixture of solid rubber with 10% ferrous and non-ferrous metals (B1010+B3040+B3080)

Proposal submitted by: Finland

Amendments: The proposal has been amended by Finland; the mention of B1020 in the description has been erased.

11.1. PROPERTIES OF THE WASTE MIXTURE

Description: Rubber material with small amounts of ferrous and non-ferrous metals from B1010, predominantly Fe, Cu, Zn, Al, Pb, brass, and stainless steel

Basel code:

Basel Code	Code description
B1010	Metal and metal-alloy wastes in metallic, non-dispersible form
B3040	Rubber wastes, provided they are not mixed with other wastes
B3080	Waste parings and scrap of rubber

Based on the MS proposal, the mixture would cover the following waste of the European Community list of wastes:

EU Code	Code description	Origin
19 12 04	Plastic and rubber	From the mechanical treatment of waste [cat.1912]

- **Process(es) by which mixture is produced**

This waste mixture is originated from the sorting and separation of metal and rubber containing equipment including conveyor belts, roller carpets, vehicles sealings, etc. After sorting and separation, further processing is not completed in the original facility due to several economic and logistical factors.

The used conveyor belts can be classified into three categories:

- Scrap – badly damaged belt, shredded or worn out
- Recyclable – belt that can be reused by on selling for mud flaps, lining truck trays, covering concrete on stable floors, lining water troughs, etc.
- Reconditionable – belt that is reconditioned and reused

The waste mixture could be partially originated by the shredding of used conveyor belts.

- **Percentage of each of the components in the mixture**

The proposal for this waste mixture specifies that the mixture is meant to consist of mostly rubber (> 90%), with 0-10% ferrous metals and/or 0-10% of non-ferrous metals.

- **Physical characteristics**

The physical state of the waste mixture is solid.

- **Chemical characteristics**

The chemical characteristics reflect the dominating rubber content. Exact chemical characteristics are also determined by the content and the type of the different metals in the mixture. Rubber used in conveyor belts is usually vulcanised rubber.

- **Potential for contamination**

Rubber fraction from conveyor belts may contain traces of hazardous components, depending on the original usage of the belt. However, if the pre-treatment is appropriately performed, the potential for contamination is minimised.

11.2. MANAGEMENT ASPECTS

11.2.1. Generation

- **Quantity produced in Europe**

Data are not available.

11.2.2. Recovery

- **Recovery operations**

R4: Recycling/reclamation of metals and metal compounds

R3: Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes).

Description of Recovery operations:

- **Interim recovery operations:** manual or machine sorting to obtain separated fraction of materials to be recycled.
- **Non-interim recovery operations:** The R4 recovery operations have been already described in section 3.2.2. The R3 recovery operations include rubber recovery. Used rubber can be reclaimed or broken down (e.g. by cryogenic grinding) into granulated or crumbed rubber particles. This process produces a range of crumb sizes through the progressive size reduction process. Recovered rubber can be used in a number of applications (see "use of recovered material").The non-recoverable rubber fraction is incinerated for energy recovery. The four main options for energy recovery are: cement kilns, other co-firing applications (paper mills, power plants), direct combustion (for electricity or steam) and pyrolysis.

- **Technological capacity of recovery**

Regarding the interim recovery operations, in the proposal it is indicated that manual sorting is possible in almost any country and the number of facilities for recovery of such waste mixture is estimated to be 10-100. In the EU, many metal smelters have capacities above 100 000 tonnes per year. Metal smelters are also common in non-OECD countries[19]. The rubber fraction can be recycled or incinerated for energy recovery. Dedicated municipal solid waste incineration capacity is estimated to be at least of 45 million tonnes/year in EU and 100 million tonnes/year in OECD countries (OECD Compendium, 2006-2007).

- **Recovery quota**

If incineration for energy recovery is considered as recovery, the recovery quota could be estimated to be more than 98% (0-2% of dust is landfilled), as indicated in the proposal.

- **Methods of storage at the recovery facility**

This waste mixture is stored in piles.

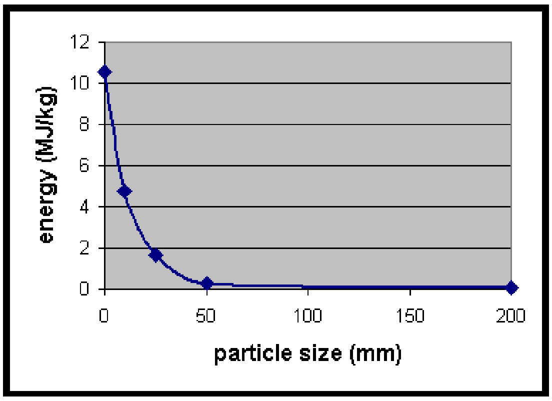
- **Use of recovered material**

Recovered rubber can be used in a number of applications (e.g. carpet underlay, hosepipe, and rubber boots) or mixed with plastic waste for different kinds of items. Crumb is used in sports and play surfaces, brake linings, landscaping mulch, carpet underlay, absorbents for wastes and shoe soles. Crumb can also be recycled in road asphalt. Rubber could also be used as earthwork material and/or raw material for incinerators (Bontoux, 1999).

- **Environmental benefits of recovery**

The environmental benefits include material conservation, energy conservation, avoided green house gases (GHG) emissions. However, it has been reported that the energy saving and greenhouse effects of recycling rubber are largely determined by the final size of the rubber particles. Some studies show that, as the particle size decreases, the energy needed for grinding increases substantially, rising to 100 MJ/kg (Commonwealth Department of Environment, 2001) (Figure 11-1).

Figure 11-1: Energy used to obtain rubber particles of different size (Commonwealth Department of Environment, 2001)



- **Environmental/health impacts of recovery**
  - **General impacts of metal and rubber recovery operations:** for general impacts of metal recovery operations, which are also valid for this proposal, see section 3.2.2. The rubber incineration could produce emission to air of dangerous substances (e.g. dioxins, furans, NO_X, SO_X) and GHG (e.g. CO_2). Eventual traces of heavy metals are not destroyed and end up in combustion residues.
  - **Specific impacts of the mixture:** depending on the specific origin, rubber may contain a range of potentially toxic materials that can be released into the atmosphere during combustion.

11.2.3. SHIPMENT AND TRADE

- **Packaging types during shipment**

The waste is transported in bulks.

- **Enforceability**

The percentages of each fraction in the mixture are normally verified at the original facility by sampling and manual sorting. Visual control is possible to verify that the mixture is mostly rubber, but the exact percentage of each component of the waste mixture (ferrous metal, non-ferrous metals, rubber, etc.) is not easily verifiable during shipment inspection. The eventual presence of hazardous metals (e.g. Pb or Cd) can be detected, but a precise quantification is more difficult to determine and is mainly dependent on the possibility to perform a representative sampling of the waste mixture.

11.3. ASSESSMENT OF THE WASTE MIXTURE

The main issue related to the recovery of this waste mixture is the exact origin of the rubber fraction. This waste mixture can be originated by shredding of conveyor belts, roller carpets, vehicles sealings, etc. It is worth stressing that the Bureau of International Recycling (BIR) and the European Tyres Recycling Association (ETRA) have raised the concern that this mixture could be at least partially originated by ELV shredding. If considering their assumption, it could be estimated that approximately 140 000 tonnes of this waste could be produced every year, since the rubber fraction represents the 7% of the total ELV automobile shredder residue (ASR) which is approximately 2 million tonnes in the EU. However, it should be considered that this percentage includes tyres which, being a priority waste managed as a separate waste stream, should not be included in this mixture (Kanari et al., 2003).

As discussed for proposal #8, ASR may contain traces of a variety of materials including heavy metals used in vehicle manufacture: Pb (in resins, batteries, solder, wheel weight, fluids etc), Zn, Cd, and hexavalent Cr, (primarily as protective metal coatings) and Hg (in HID headlights, Hg containing switches in early model vehicles). These heavy metals may cause environmental damage as toxic leachate may leak in landfills, and they may be bio-accumulative. In addition, there could be a risk of contamination with other materials from ELV (e.g. motor oil) if the shredder operations and the preliminary separation of material is not carried out appropriately. However, shredder in-feed containing hazardous waste is normally pre-treated before shredding, and the hazardous residues are removed (Environment Australia, 2002). Thus, if the ELV fluff is appropriately pre-treated, this mixture could be suitable for an environmental sound management during recovery.

It is important to remind that in the Annex IIIA, the mixture will be described exclusively using Basel codes, which in this case are B1010, B3080, and B3040. As a consequence, any additional information given by the EU code or «usual description» (e.g. the ELV origin of the mixture) will not figure in the Annex IIIA.

In contrast, according to other relevant stakeholders (Kuusakoski Oy) this waste mixture does not contain ELV material and is exclusively formed by shredded conveyor belts, roller carpets, rubber sealings, etc. In this case, the potential for contamination with hazardous residues is reduced.

11.4. CONCLUSIONS AND RECOMMENDATIONS

Assuming that this waste mixture does not originate from ELV shredding, thus that it does not contain tyres and traces of heavy metals from other vehicle components, the proposed entry presents:

- no hazardous characteristics if appropriately pre-treated
- no potential for contamination (if the pre-treatment is appropriately performed and if conveyor belts containing traces of hazardous components are excluded from the mixture)
- good technological capacity for recycling and energy recovery
- important environmental benefits especially if the rubber fraction is recycled
- an acceptable level of enforceability

Thus, the environmental sound management of this waste mixture is dependent on the degree of certainty with which is possible to affirm that this mixture does not contain any hazardous material from ELV. Thus, the inclusion of this waste mixture in the Annex IIIA could be considered only if the absence of hazardous components is ensured by the facilities of waste origin.

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Bontoux L. The incineration of waste in Europe: issues and perspectives. Report for the European Commission, 1999.

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11.6. CONTACTS

- Kaija Rainio, Senior adviser, Finnish Environment Institute (SYKE)
- Mari Parviainen, Project Manager, Kuusakoski Oy
- Ross Bartley, Environmental & Technical Director, Bureau of International Recycling (BIR)
- Valerie L. Shulman, Ph.D., European Tyres Recycling Association (ETRA)

12. WASTE MIXTURE PROPOSAL # 10

Proposed entry to Annex IIIA: Mixture of waste metal cables and wires with non-ferrous metals (B1050 + B1115).

Proposal submitted by: Finland

12.1. PROPERTIES OF THE WASTE MIXTURE

Description: Mixture of waste metal cables coated with plastics with non-ferrous metals and plastics in non dispersible form with following concentrations: 75-80% waste metal cables, <10% non-ferrous metals, and 10-15% of stones.

Basel code:

Basel Code	Code description
B1050	Mixed non-ferrous metal, heavy fraction scrap, not containing Annex I material in concentrations sufficient to exhibit Annex III characteristics
B1115	Waste metal cables coated or insulated with plastics not included in list A1190[40], excluded those destined for Annex IVA operations or any other disposal operation involving, at any stage, uncontrolled thermal processes, such as open burning

Based on the MS proposal, the mixture would cover the following waste of the European Community list of wastes:

EU Code	Code description	Origin
19 10 06	Other fractions than those mentioned in 19 10 05[41]	From shredding of metal-containing wastes [cat.1910]

- **Process(es) by which mixture is produced**

This mixture is produced by pre-sorting of metal cable containing waste from demolition waste. The separation of metals and inert material (e.g. plastic, stone) is not completed for technical reasons (e.g. particle size, low process recovery)(Figure 12-1 and Table 12-1).

[40] A1190: Waste metal cables coated or insulated with plastics containing or contaminated with coal tar, PCB (at a concentration level of 50 mg/kg or more), Pb, Cd, other organohalogen compounds or other Annex I constituents, to the extent that they exhibit Annex III characteristics.

[41] Fractions containing dangerous substances

Figure 12-1: Sequences of steps for cable waste recovery

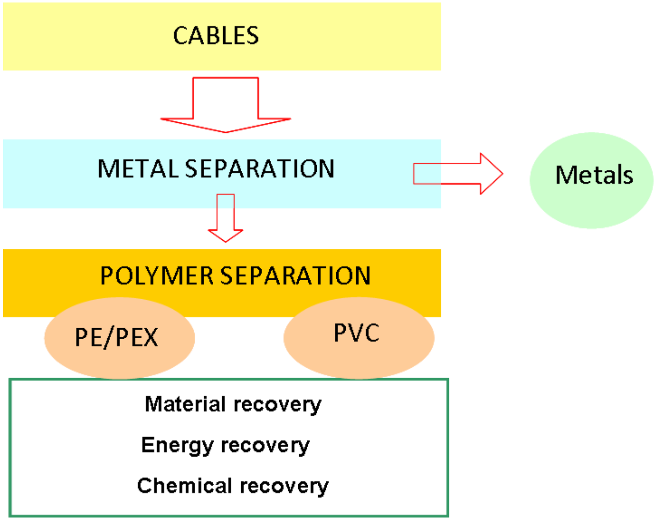

Table 12-1: Consumption of different materials for cables (communication and energy) in Western Europe (Hagstrom et al., 2006)

Material	%
Cu	41.2
PVC	16.0
PE	9.1
Al	7.1
Fillers	8.3
Fe	6.3
Elastomer + other	6.9
Pb	3.8
Optical fibres	1.2

- **Percentage of each of the components in the mixture**

The proposal for this waste mixture specifies that the mixture is meant to consist of mostly metal cables (> 75-80%), with <10% of non-ferrous metals and 10-15% of stones.

- **Physical characteristics**

The physical state of the waste mixture is solid.

- **Chemical characteristics**

The chemical characteristics depend on the content and on the type of the different metals present in the mixture. The mixture is, in principle, free of any hazardous compounds or other Annex I constituents, to the extent that they exhibit Annex III characteristics (annex 1 and 2 of this report).

- **Potential for contamination**

Stone fraction is a contaminant in this waste mixture probably originated during demolition. Cables may contain heavy metals based PVC stabilisers[42], Pb-compounds, phthalates, and halogen chemicals. In addition, traces of PCB (polychlorinated biphenyl), oil and other greases could be easily present in the mixture.

12.2. MANAGEMENT ASPECTS

12.2.1. GENERATION

- **Quantity produced in Europe**

When buildings and old installations need to be demolished, renewed and/or upgraded, cable scrap is generated. According to BIR (Bureau of International Recycling), in 1997 over 1.8 million tonnes of insulated wire and cable scrap was generated worldwide. Stones represent the 5% of the total demolition waste in EU 15 (Symonds, 1999).

12.2.2. RECOVERY

- **Recovery operations**

R4: Recycling/reclamation of metals and metal compounds

R3: Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes).

R5: Recycling/reclamation of other inorganic materials

Description of Recovery operations:

- **Interim recovery operations:** after the pre-sorting, additional manual sorting is needed to separate the cables, the non-ferrous metal fraction, and the stones.
- **Non-interim recovery operations:** the predominant way of recovering the metal from cable scrap in the developed countries is automated cable chopping. The cable scrap chopping process has different steps. First a pre-sorting is performed in order to separate cable scrap and to prepare it for feeding into the shredder. Pre-sorting also includes sorting Cu from Al containing cable and removing unsuitable cables before entering the automatic chopping system. Then, during the cable chopping, the size of the cable is reduced (to 30-50 mm pieces). The steel is removed by magnets and the rest of the stream continues to granulators. Two steps of granulation are performed in order to ensure that most of the insulation is liberated from the cable: in the first step the size is reduced to 10-17 mm, in the second to 4-6

[42] PVC is defined as an organohalogen compound, thus belong to A1190.

mm to reveal the metal. The mixed metal/polymer fraction is passed through a fluidized bed at which density differences are used to separate the different types of metal. Similar-size chop fractions are separated into clean metal products and essentially metal-free tailings (polymer). Alternatively, cable stripping can be performed to obtain a higher purity of the recovered jacketing and insulation materials that will ideally consist of one type of polymer at the end of the process, but in most cases the polymer is extracted as a single mixed fraction. Based on their different density, the polymers can be separated by swim-sink method (water, alcohol or salt solutions can be used as medium). Polymers can also be separated through triboelectric or electrostatic separation[43]. Additives like pigments, flame retardants, or plasticizer will influence the charging and therefore the effectiveness of separation. After a successful separation the material, energy or chemical recovery of the plastic fraction can be performed. The material recycling of polyolefins is more complex since they are normally constituted by mixed material. The PE containing plastics are heated to break down the long polymer chains. This process leaves ethylene monomers in an oil-like state. Alternatively, polyolefins can be used for energy recovery. As inert material from construction and demolition waste, stones are crushed to recover sand and granular materials.

- **Technological capacity of recovery**

In EU, many cable processors have a capacity to recover from 0.5 to 3 tonnes/hr of scrap cables. Machines de Triages et de Broyages (MTB), a major cable and wire processor in Europe, processes some 15 000 to 18 000 tonnes of cable a year of which about a third is Al and two-thirds is Cu. The chemical recovery of PE fraction from cable can be performed, for example, in the pilot plant of BASF in Germany. The plant has a capacity of 15 000 tonnes/year (Hagstrom et al., 2006).

- **Recovery quota**

In the proposal, the recovery quota is estimated to be more than 98%. However, this percentage refers exclusively to the metallic fraction (mainly Cu) and does not refer to the fraction of recovered plastic polymers. According to Stena Recycling (Sweden), polymer recycling from waste cables is close to zero.

- **Methods of storage at the recovery facility**

The waste is stored in piles.

- **Use of recovered material**

In general, the recovered material is used as raw material for industry. The recycled PE can be reused to make new PE and PE teraphthalate (PET) products.

[43] For a recent overview of electrostatic separation applied to waste cables: Amar Tilmatine et al., Electrostatic separators of particles: Application to plastic/metal, metal/metal and plastic/plastic mixtures, 2009.

■ **Environmental benefits of recovery**

The major benefits of recovery this waste mixture are material and energy conservation. Regarding the recovery of metals (mainly Al and Cu), the energy saving of recycling is of 95% and 85% respectively (British metal Recycling Association). Regarding the recovery of the plastic fraction from cable scrap, which mainly includes PVC and PE, one environmental benefit is avoided landfilling. In addition, comparing to production, the release of chlorine, Hg, Pb, Cd and other potentially hazardous chemicals into the environment are reduced when PVC containing material is recycled. An important quantity of GHG emissions is also avoided by PVC recycling.

■ **Environmental/health impacts of recovery**

- **General impacts of recovery operations:** general impacts of metal recovery operations and of incineration, which are also valid for this proposal.
- **Specific impacts of the mixture:** the presence of specific polymers containing additives (e.g. PVC, PE) and metals (mainly Cu and Al) could be at the origin of the environmental impacts of this mixture recovery. A range of Pb and Cd-based stabilizers are used in PVC. These molecules are normally immobilized in the PVC matrix. However, during the recovery (e.g. granulation) the increased surface area may facilitate extraction under certain conditions. Regarding the metal fraction, as previously commented, Cu smelting requires modern pollution control equipment. Cu, especially if it originates from waste electronics, may contain Be, which because of its health hazard must be captured in the air pollution control equipment. Grinding of Cu can release Be-containing dusts that can be dangerous for health.

12.2.3. SHIPMENT AND TRADE

■ **Packaging types during shipment**

The waste is transported in bulks.

■ **Amount shipped**

According to BIR, Europe ship cable scrap to the developing countries, in particular, China, Vietnam, S. Korea, Mexico, Indonesia, Malaysia, Thailand, Taiwan, India, Pakistan, Argentina, Brazil, and Chile. Export of metal-containing cable scrap from Europe to developing countries amounts to 20 000 tonnes per year.

■ **Enforceability**

As previously commented, the percentages of each fraction in the mixture are normally verified at the original facility by sampling and manual sorting. Visual control allows verifying that the mixture is mostly waste metal cable, and chemical analysis can determine the eventual presence of PVC additives (e.g. Pb and Cd stabilisers). However, neither the exact percentage of each component of the waste mixture, nor the quantity of potentially hazardous components (e.g. Be) is easily verifiable during shipment inspection. The precise quantification is mainly dependent on the possibility to perform an appropriate and representative sampling of the waste mixture.

12.3. ASSESSMENT OF THE WASTE MIXTURE

The polymer fraction from waste cables is often considered as the waste product of metal recovery that should be disposed at lower cost. However, it is worth noticing that plastic polymers are valuable sources of energy and material. The polyolefin stream from waste cables have mixed materials, all having different characteristics. In particular this waste stream is constituted by a mix of thermoplastic and cross-linked materials. In general, the melting points of the components are very different and it would be impossible to produce an industrially viable material. Thus, the theoretical remeltability of thermoplastic is often not applicable. However, in practice, it is possible to mix the meltable PE with the non-meltable fraction (e.g. cross-linked polyolefins) in a composite material with good impact strength. This composite material can be used in a number of applications: injection moulding, bedding material in cables, co-extrusion, etc. (Hagstrom et al., 2006).

Alternatively, plastic polymers from cables can be used for energy recovery since they have, in general, high energy content.

PVC is an organ-halogen compound that should be classified under the Basel code A1190, rather than B3010, thus not be included in this mixture for inclusion in the green list. However, it is worth noticing that, in practice, PVC is by far the most used plastic in cables. Waste cables are very seldom separated on the basis of plastic type. As a consequence, the probability to find in this mixture PVC coated cables is very high.

When PVC burns hydrochloric acid is formed chlorine, which may be a cause of environmental concern. In addition, burning of PVC containing waste in incineration plants can release dioxins and furans. This could be a cause of concern especially for countries without a strict legislation on the subject or not equipped with modern incinerators. In addition, different additives can be added to PVC in order to modify its properties including plasticisers (e.g. phthalates) and stabilisers (e.g. Pb and Cd containing stabilisers). Some of these additives could be at the origin of both environmental and health impacts (European Commission, 2000; Pan et al., 2006). It is worth noticing that, Vinyl 2010 the organism representing the European PVC industry is doing remarkable efforts to phase out potentially dangerous additives from PVC. However, PVC containing Pb and Cd stabilisers are probably still present in the waste stream.

Thus, in the case of energy recovery option, the polyolefins and PVC fractions should be separated in order to avoid the presence of PVC and related additives in the mixture. If the PE is not perfectly clean, it can be used in incineration plant since these facilities have more advance flue gas cleaning system than units using plastic as fuel. If considering this option, plastic has to be mixed with other waste in order to avoid an excess of energy produced.

Each of the recovery options presents different outputs and costs. Table 12-2 shows the relative costs and outputs for the polymer recovery options.

Table 12-2: Relative cost of different plastic recovery options from waste cables, comparing to landfill (= 100%) (Hagstrom, 2006).

Type	Transport (%)	Separation (%)	Recovery or disposal (%)	Total cost (%)[44]	Useful outputs
PVC incineration	29	11	500	539	none
PE material use	29	18	357	396	PE material
Unsorted polymer fraction incinerated	29	0	214	243	none
PVC material recovery (e.g. Watech process)	29	18	143	182	Salt, oil, sand
PE incineration	29	11	71	111	Heat
Unsorted polymer fraction to landfill	29	0	71	100	none
PVC material recovery	29	18	36	75	PVC material
PE low grade fuel	29	11	21	61	Energy 20-30 MJ/Kg
PE high grade fuel	29	18	7	46	Energy 30-40 MJ/Kg

As stated by Hagstrom et al.(2006), the efficiency of the separation is the critical step in waste cable recovery. Material recovery of PVC is interesting compared to the incineration of the unsorted polymer fraction. Both energy and material recovery are attractive for polyolefins. However, the quality of recovered PE is lower than the quality of virgin material and it cannot be used in a number of application (e.g. cable jacketing). Thus, the combustion of polyolefin containing fraction as high-grade fuel is a technically, environmentally and economically acceptable way of recovery (Hagstrom, 2006).

However, it is worth noticing that although it could be technically possible to mechanically recycle part of the plastics after separating them in PVC, PE, etc., very little of the cable waste plastics are today recycled. According to Stena Recycling (Sweden)(personal communication), this is due to high costs and little market demand for the recovered material. In addition, as PVC is the single largest plastic in cables and often used in combination with PE or cross-linked foam sheet (XLPE) in the same cable, the plastic waste arising after a typical cable recycling process is very difficult to incinerate in many kind of incinerators including waste incinerators and cement ovens.

Cable-scrap recycling is often performed in non-OECD countries by hand sorting. In general, the overall cost of the recycling operations would be lower. In addition, there may be internal markets for secondary plastics (e.g. PVC and PE). However, it is important to note that in most cases, incinerators in non-OECD countries are not

44 When the cost is over 100% it means that the cost of recovery option is more expensive that landfilling which is the 100% reference cost.

equipped with BATs. As a consequence, incineration of the plastic fraction of this mixture will probably lead to a significant environmental impact.

Regarding the stone fraction in the proposed waste mixture, the demolition waste origin seems to be the more probable. However, it could be difficult to control the fraction that could contain contaminated material and its precise origin.

Another environmental issue related to the recovery of this waste mixture may be linked to the presence of Be in Cu cables. As previously reported, Be in Cu scrap, if not appropriately treated, may be at the origin of environmental and health impacts.

12.4. CONCLUSIONS AND RECOMMENDATIONS

Based on the assessment presented above, the proposed waste mixture # 10 presents:

- a good technological capacity of recovery
- possible hazardous characteristics
- a high potential for contamination with stones of unidentified origin, PVC containing potentially hazardous stabilisers, PCB, oil, etc.
- a number of negative impacts on the environment mainly due to its potential contamination with PVC heavy metal stabilisers
- a difficult enforceability

As a conclusion, based on our analysis, the inclusion of this mixture in Annex IIIA seems not appropriate.

12.5. REFERENCES

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12.6. CONTACTS

- Annika Boss, Swerea, Sweden
- Rolf Neuendorff, Technical Support TSD, Stena Recycling, Sweden
- Kaija Rainio, Senior adviser, Finnish Environment Institute (SYKE)
- Mari Parviainen, Project Manager, Kuusakoski Oy, Finland

13. WASTE MIXTURE PROPOSAL # 11

Proposed entry to Annex IIIA: Mixture of non-ferrous metals with 10% plastic and/or rubber (B1050 + B3010 + B3040 + B3080)

Proposal submitted by: Finland

13.1. PROPERTIES OF THE WASTE MIXTURE

Description: non-ferrous metals predominantly Cu, Zn, Al, Pb, brass, stainless steel in different size with small amounts of plastic/rubber (max 10%), depending on the specific method of separation

Basel code:

Basel Code	Code description
B1050	Mixed non-ferrous metal, heavy fraction scrap, not containing Annex I (see annex 1 of this report) material to an extent they exhibit Annex III (see annex 2 of this report) characteristics
B3010	Solid plastic waste, not mixed with other wastes and are prepared to a specification
B3040	Rubber wastes, provided they are not mixed with other wastes
B3080	Waste parings and scrap of rubber

Based on the MS proposal, the mixture would cover the following waste of the European Community list of wastes:

EU Code	Code description	Origin
19 10 02	Non-ferrous waste	From shredding of metal-containing waste [cat.1910]

- **Process(es) by which mixture is produced**

This mixture **is likely to originate** from a preliminary sorting of shredded electric and electronic equipments (EEE) waste. Before shredding, EEE are manually dismantled. Manual sorting involves the removal of hazardous components such as batteries and other items proscribed by the WEEE Directive[45], or the sorting into classifications such as high and low grade material. Disassembly is a systematic approach that allows the removal of a component, part, group of parts or a sub-assembly from a product (partial disassembly) or the separation of a product into all of its component parts (complete disassembly) for a defined purpose. After dismantling, mechanical processes such as physical impaction, shredding/fragmentation and granulation, which break down products to enable the salvaging of reusable and recyclable parts, components and materials, are performed. A number of methods for sorting are available: screeners, air

45 Directive 2002/96/EC on waste electrical and electronic equipment.

classifiers, density separators, electrostatic separators, floatation systems, magnetic separators, trammels, etc (Dalrymple et al., 2007).

The proposed waste mixture could also originate from ELV shredding. ELV are collected and dismantled to remove valuable spare parts and other components such as engines, batteries, oils and fuels, and airbags. The dismantling is done to recover ELV parts that are suitable for reuse, recycling, or sale. After dismantling, the remainders of the ELV, so-called 'hulks', are processed by shredding companies.

After the hulks are shredded, the obtained materials undergo a series of mechanical and physical separations in order to recover the ferrous and non-ferrous metals. The residual of the shredding process, ASR, represents about 20–25% of the ELV weight. The ASR can be further recovered/ recycled after appropriate sorting. This waste mixture could also originate from a preliminary sorting of ASR.

- **Percentage of each of the components in the mixture**

In the proposal, this waste mixture is described as composed of metals with less than 10% of plastic and/or rubber. Typical plastic content from WEEE originated by different sectors are showed in Table 13-1.

Table 13-1: Plastic % in WEEE (adapted from Mark and Lehner, 2000)

WEEE sector	Rough % of plastic
Cables	10
Brown goods	8
Data processing equipments	3
Telecommunications	4

In the case of ELV origin, ferrous and non-ferrous metals (Zn, Cu, Mg, and Pb) constitute about 67.5% of the vehicle. The plastics content in average cars is roughly 9% and the major type of plastic use are polyvinyl chloride, polypropylene, polyurethane, etc. (Table 13-2).

Table 13-2: Typical vehicle composition
(the fractions included in the waste mixture are in red).

Material	Proportion by weight (%)
Steel	66
Zn, Cu, Pb	2
Al	6
Plastics	9
Rubber (tyres)	4
Adhesive, paints	3
Glass	3
Textiles	1
Fluids	1
Other	3

- **Physical characteristics**

The physical state of the waste mixture is solid.

- **Chemical characteristics**

The chemical characteristics of the mixture depend on the predominant metal (Cu, Zn, Al, Pb, brass, stainless steel) and on the predominant plastic polymer. The plastics that are commonly encountered in EEE are Acrylonitrile Butadiene Styrene (ABS), Polycarbonate (PC), PC/ABS blends, High Impact Poly-Styrene and Poly-Phenylene Oxide blends (PHA, 2006)(Table 13-3). The eventual presence of some types of flame retardants in the plastic fraction and Pb in the metallic fraction could give the waste mixture hazardous characteristics, if it is not appropriately managed. However, in principle, the Pb containing fraction B1050, do not contain enough Pb to present hazardous characteristics.

Table 13-3: Plastics Composition of TVs, Computers and Cell Phones (rough approximation) (PHA, 2006).

Plastics	Televisions	Computers	Cell phones
HIPS	75%	5%	0
ABS	8%	57%	0
PPO	12%	36%	0
PP	3%	0	0
PC/ABS	0	2%	81%
Other	2%	1%	19%

In the case of an ELV origin of the waste mixture, the predominant metal is steel. The presence of Pb, Cd, hexavalent chromium (Cr), Hg and some types of PVC stabilisers (e.g. Pb and Cd) could give to the mixture hazardous characteristics.

- **Potential for contamination**

The potential for contamination is determined during the initial disassembly of WEEE or ELV. This step allows removing potentially toxic materials, such as batteries. It also simplifies the further processing by providing better defined streams for the subsequent separation and recovery stages. Following sorting steps are also important to determine potential contamination.

13.2. MANAGEMENT ASPECTS

13.2.1. GENERATION

- **Quantity produced in Europe**

Approximately 6 million tonnes of WEEE is generated in Western Europe annually. This quantity includes 675 000 tonnes of plastics waste that is available for collection, and an equal quantity of non-ferrous metals (Mark and Lehner, 2000).

This mixture could also be partially generated from shredding of ELV and it is known that annually 8-9 million tonnes (including reuse) of ELV waste are produced in EU 25 (ETC/RWM, 2008). As showed in Table 13-2, this waste mixture could represent roughly the 90% of ELV waste.

13.2.2. RECOVERY

- **Recovery operations**

R 4: Recycling/reclamation of metals and metal compounds

R 3: Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes).

Description of Recovery operations:

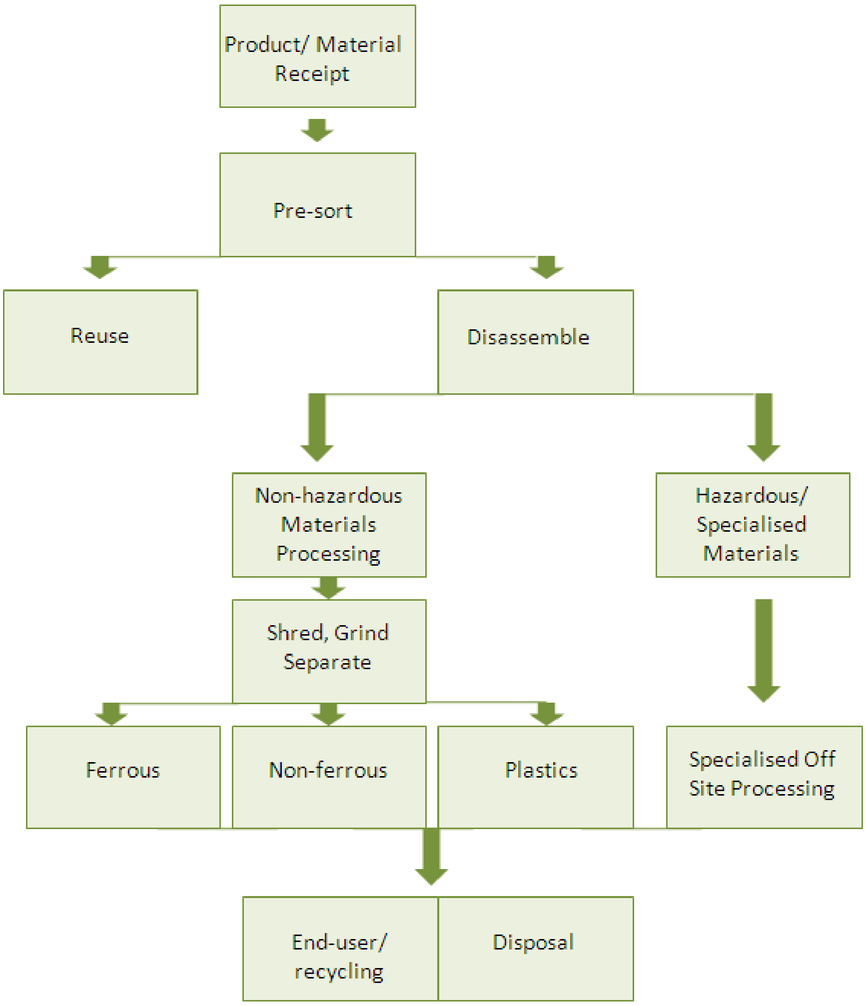
- **Interim recovery operations:** ELVs and WEEE are processed through automated shredders, along with other end-of-life metal products. A powerful shredding action processes vehicles into fist-sized pieces of metal scrap of a high physical and chemical quality. However, the shredded fraction may also contain non metallic components. As a consequence, in order to recover the metallic fraction these types of waste mixtures need to be further manually or automatically sorted.
- **Non-interim recovery operations:** since the metals recycling is the main scope of the recovery of this waste mixture, there are clear advantages in adopting routes involving thermal treatments. Thermal incineration combined with pyrometallurgical treatments is used for metal recovery from WEEE. Printed circuit boards, for example, contain significant quantities of valuable including Cu and noble metals. However, only partial separation of metals can be performed using pyrometallurgy, resulting in a limited upgrading of the metal value. Further processing at specialised refineries is subsequently necessary. Regarding non-metallic fraction, after separation, the plastic is crushed, extruded and granulated. Plastic granules are a raw material to plastic industry. Small plastic pieces (<10 cm) are first separated in a sink-float process and then separated and sorted like bigger plastic pieces. Separated rubber is energy raw material for incinerator (energy waste). The non-recoverable fraction (dust etc) <2% is most probably landfilled. The basic technologies that are used in commercial installations for plastics coming from the packaging waste can be applied to separate the plastic fraction from the rest. However, in general plastic from packaging waste does not contain high amounts of heavy metals or halogens. Therefore, these existing technologies need to be upgraded for the WEEE. For plastic originated by WEEE, energy recovery in cement kilns or in the steel industry can be a possible option. An alternative is pelletizing the mix in order to gasify it. A clean alternative consists in producing solid, liquid and gaseous fuels by pyrolysis. Pyrolysis is a pre-treatment of waste at moderate temperature (450-750 °C) in the absence of oxygen. The decomposition of the contained organic matter leads to the formation of gaseous and solid phases. These phases have a homogeneous composition which enables their thermal

energy recovery to be performed easily and in better environmental conditions than in the case of direct incineration (Hornung et al., 2004)[46].

- **Technological capacity of recovery**

The WEEE treatment system entails different processes and phases, including acquisition and collection, transportation, sorting and disassembly of products, as well as storage and selling of material fractions. In order to evaluate the recovery capacity for this waste mixture, we will consider two steps: the separation of metallic from non-metallic fractions and a further recycling step that differs for each fraction (Figure 13-1).

Figure 13-1: Main steps of a general WEEE recycling process



After shredding, magnetic separation may be applied to separate ferrous from non-ferrous metals, eddy-current technologies may be applied to separate non-ferrous metals from each other and air classifiers may be used to separate light and heavy

46 In the context of a European project the ''Haloclean'' pyrolysis procedure has been developed. The purpose of the Haloclean pyrolysis process is to separate brominated additives from inert and valuable materials in electronic scrap.

fractions (e.g. metals from plastics). In some cases, only some of these processes may be carried out at one facility. The capacity of recovery in EU and OECD countries varies depending on the considered step: 1) separation of fractions (interim operations); 2) metal /plastic/rubber recycling or recovery; 3) pyrolysis/incineration for energy recovery or landfilling of non recyclable fraction.

1. Hand sorting is possible in almost all countries. Automatic sorting is likely to be possible in all EU and OECD countries, e.g. in North America there are approximately 6 000 scrap collection and dismantling yards, 200 scrap shredders, ten sink-float plants (Bell et al., 2003).
2. In EU27+NO/CH, roughly 20% of recovered plastic is actually recycled, 50% of total is recovered (including incineration for energy recovery). Recycling processes of waste plastics are classified in two categories: mechanical (3.13 million tonnes/y) and feedstock recycling (350 000 tonnes/y)(Aguado et al., 2006). In EU, small plants for PE and PP recycling are quite common. In EU, many metal smelters have capacities above 100 000 tonnes per year.
3. Pyrolysis furnaces can be sized for variable tonnage. Current trend seems to fit a scale from 2 to 6 metric tonnes/h per unit, corresponding to a capacity between 15 000 and 50 000 metric tons/year. On the other hand, small pyrolysis furnaces from 1 to 2t/h (8000 to 15 000 metric ton/year) can be decentralised to reach local waste elimination. In Europe, there is sufficient household waste incinerating capacity which could absorb current and future levels of plastic waste. In EU27+NO/CH, 80% of recovered plastic (7 million tonnes) is incinerated for energy recovery. Dedicated municipal solid waste incineration capacity is estimated to be at least of 45 million tonnes/year in EU and 100 million tonnes/year in OECD countries (OECD Compendium, 2006-2007).

- **Recovery quota**

If incineration for energy recovery is considered as recovery, the recovery quota is estimated to be 95- 98% (less than 5% is landfilled).

- **Methods of storage at the recovery facility**

The waste is stored in piles.

- **Use of recovered material**

The recovered material is sold as raw material for metal and plastic industry or is used as fuel for energy recovery.

- **Environmental benefits from recovery**

The major environmental benefits of the mixture recovery (including incineration for energy recovery) are material conservation, reduced landfilling and energy conservation. Most waste plastics have a high calorific value (about 40 MJ/kg) which is similar to fuel oil (ACRR, 2004). With an efficient incineration of plastics it is possible to save 41.5% of energy[47]. Emission of GHG by plastic recycling is lower comparing to plastic production. Regarding the metallic fraction, the recycling can save high amounts of energy (Table 3-1). It has been estimated that, compared to manufacture from virgin materials, recycled steel uses 74% less energy, 40% less water, reduces air pollution by 86% and water pollution by 76% (BIR, 2000).

- **Environmental/health impacts of recovery**
  - **General impacts of recovery operations:** for general impacts of metal recovery operations, which are also valid for this proposal, see section 3.2.2. . The incineration could produce emission of dangerous substances (e.g. dioxins, furans, NO_X, SO_X) and GHG (e.g. CO_2) into the atmosphere. Eventual traces of heavy metals present in the waste are not destroyed and end up in combustion residues.
  - **Specific impacts of the mixture:** the quantity and the quality of specific plastic polymers and metals in the mixture may vary. This could be at the origin of different environmental impacts during the mixture recovery depending on the mixture components. For example, during the recovery (e.g. granulation) of PVC containing plastic fraction, the increased surface area may facilitate the extraction of Pb containing stabilisers. In addition, mechanical recycling of older WEEE which contains plastics can cause a specific problem. Without strict temperature control during extrusion there is a potential of generating dioxins and furans from some halogenated flame-retardants. However, it is important to highlight that an experimental work has demonstrated that amounts up to 3% of plastic waste from EEE can be safely added to incinerators. The formation of PBDD/F or so called dioxins and furans, is not altered by the presence of the bromine containing waste and remains well within emission standards in these processes (Tange et al., 2005). Thus these impacts are in general eliminated if the energy recovery is performed in modern equipped incinerators (personal communication Mr. Tange). Regarding the metal fraction, as previously commented, Cu smelting requires modern pollution control equipment since this process can release dusts that can be dangerous for health.

13.2.3. Shipment and Trade

- **Packaging types during shipment**

The waste mixture is transported in bulks.

[47] There are only few municipal incineration plants of this efficiency in Europe.

- **Amount shipped**

In the proposal, Finland indicated that the amount shipped in the EU is roughly 100 000 tonnes per year. The imported/ exported amount has been estimated to be 50 000 tonnes per year in the proposal.

- **Enforceability**

As commented in previous factsheets, the percentages of each fraction in the mixture are normally verified at the original facility by sampling and manual sorting. It is possible to verify that the mixture is mostly non-ferrous metals by visual control. The presence of specific metals and PVC heavy metals stabilisers can be detected by chemical analysis. On the other hand, it might be difficult to perform chemical analysis during shipment inspections. However, the quantity of specific components in the mixture is not easily verifiable during shipment inspection due to the difficulty to perform an appropriate and representative sampling of the waste mixture.

13.3. ASSESSMENT OF THE WASTE MIXTURE

The production of electrical and electronic equipment (EEE) is growing very fast (Cui and Forssberg, 2003). Despite the growing recycling rate, the annual volume generated increases between at least 3 and 5% per year in Europe (Hischier et al., 2005). A recent annual estimation for WEEE was almost 6.5 million tonnes, and it has been estimated that by 2015 the figure could be as high as 12 million tonnes. This is the equivalent of approximately 14 kg per person per year (Goosey, 2004). These figures suggest that an important quantity of this waste mixture could be produced in EU in the next years.

Before recycling, WEEEs are subjected to disassembly to remove potentially hazardous components (e.g. Hg switches, PCBs, etc.). Hazardous materials must typically be processed at off-site specialised facilities. As a consequence, after this step, the waste mixture should not contain any hazardous contaminants.

Disassembly also includes the removal and separation of some components from others on the basis of their recyclable materials value. The separation of the metallic and non-metallic fractions from plastic is, in general, a basic step. However, such a separation is often difficult to perform: a simple ferrous and non- ferrous separation through application of a magnet fails when non-ferrous and ferrous metals are attached. Another challenge is the separation of different types of plastics. About 10 types of thermoplastics can be found in WEEEs, which could be recycled if appropriately separated, but recycling opportunities continue to be highly limited if any of them are mixed with any others. Many experts have highlighted that techniques that can facilitate the recovery of pure polymers from heterogeneous streams of recyclable plastics will be a key factor in the widespread implementation of WEEE recycling. There is concerted effort to develop such methods, either by innovative separation processes based on physical attributes, or on sophisticated sensing methods that can be integrated into intelligent sorting systems. Many of these issues can be resolved in materials separation for recycling is undertaken through manual disassembly and without mechanised processing. However, not all plastics can be separated from each other unless they are marked (Dalrymple et al., 2007).

In addition, from a technical point of view, the recycling of WEEE plastics has hardly been possible due to their contamination by hazardous waste and other strongly regulated compounds, for example heavy metals and brominated flame retardants (BFR)(Table 13-4).

Table 13-4: Percentages of WEEE plastics containing flame retardants in Europe (Tange, 2006)

70% of WEEE plastics do not contain flame retardants = 1 030 000 tonnes	
30% of WEEE plastics contain flame retardants = 450 000 tonnes	59% of plastics is treated with non HFR = 264 000 tonnes
	41% of plastic is treated with HFR = 186 000 tonnes

Thus, the separation of HFR from the waste stream is a major issue, and in a recycling context, flame retardants may limit the applications in which recycled plastics may be used. In a recent article, Schlummer et al. (2007) highlight that one of the consequences of the contamination of polymer fraction of WEEE is that material recycling is limited by the absence of technologies capable to remove HFR. Even if the thermal treatment is an important end-of life management route for the plastic fraction, especially regarding the high heating value of these materials, the high level of HFR in some polymer fractions might lead to these materials being classified as hazardous. However, it is important to notice that other authors have shown that flame retardants in plastic wastes are compatible with valorisation in metal smelters and recovery of the precious metal and Cu contents of mixed wastes. In fact the plastic fraction partly substitutes coke as a reducing agent, and partly provides smelter feed energy. A full scale test was carried at Umicore using mixed WEEE materials (flame retarded plastics/metals). The results demonstrate the feasibility of this route for WEEE plastic fraction containing flame retardants (Tange et al., 2006).

Importantly, to date, recycling of WEEE plastic fraction has been limited by a number of obstacles including:

- the cost of hand separation followed by materials preparation and transportation to an end-use market in comparison with the cost and performance predictability of virgin plastics;
- the lack of adequate means of identifying/separating individual plastics; and
- the availability of other options, specifically recovery of energy and landfilling disposal.

As a consequence, when evaluating the feasibility of the environmental sound management of this waste mixture recycling, we should be aware that incineration and landfilling will be the most probable performed operations. Interestingly, Swiss researchers calculated the environmental impacts of the full recycling chain of WEEE compared to a scenario assuming no recycling with incineration and energy recovery of all WEEE and primary production of raw materials. This study concluded that recycling is more ecologically advantageous over incineration (Hischier et al., 2005).

Another recent paper demonstrates that, depending on the distance travelled to collect the EEE, recycling is not as environmentally friendly as expected. Thus, this factor should also be considered when evaluating the shipment of waste from an environmental perspective.

As previously discussed, in the case of an ELV origin of the waste mixture, the shredder flock (ASR) may contain a variety of hazardous materials including:

- Pb
- Hg
- Cd
- Hexavalent Cr
- PVC[48]

The hazardous components of ASR are normally removed by an appropriate pre-treatment. In addition, it is important to stress that, in principle, both HFR and PVC are not covered by B3010 category (personal communication Mr. Shafii, UNEP), thus, these components should not be included in the mixture. However, in practice the absence of such material in the waste mixture is not easily verifiable during shipment inspection and, if necessary, should be certified by documents provided by the original facility.

13.4. CONCLUSIONS AND RECOMMENDATIONS

If the absence of PVC hazardous additives (Pb and Cd-based stabilisers) and other hazardous components is ensured by official documents from the original facility and if the HFR containing fraction is appropriately managed, the waste mixture # 11 presents:

- no hazardous characteristics
- no potential for contamination (if the disassembling and pre-treatment are appropriately performed)
- good environmental benefits from recovery
- an acceptable enforceability

As a conclusion, in absence of hazardous components, the waste mixture could be included in Annex IIIA, but its transport should be limited to EU and OECD countries.

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13.6. CONTACTS

- Ibrahim Shafii, Programme Officer (Technical & Scientific), Secretariat of Basel Convention United Nations Environment Programme (UNEP)

14. WASTE PROPOSAL # 12

Proposed entry to Annex IIIA: Label laminate waste (B3020)

Proposal submitted by: Finland

Amendments: The proposal, originally submitted to be included in Annex IIIA has been amended by Finland and it is now evaluated for inclusion under Annex IIIB: "Green listed waste awaiting inclusion in the relevant annexes to the Basel convention or the OECD decision as referred to in article 58 (1) (B)".

14.1. PROPERTIES OF THE WASTE

Description: Pressure sensitive adhesive laminate waste including minor quantities of raw materials used in label material production.

Note: It is important to highlight that this waste can be considered as a composite material which became waste rather than a waste mixture and it is evaluated here for a possible inclusion under Annex IIIB.

The Basel codes and the European Waste List codes are used hereafter to describe the proposed entry under consideration (as indicated in the proposal).

Basel code:

Basel Code	Code description
B3020	Paper, paperboard and paper product waste

Based on the MS proposal, the waste would cover the following waste of the European Community list of wastes:

EU Code	Code description	Origin
16 03 06	Organic wastes other than those mentioned in 16 03 05[49]	Off specification batches and unused products[16 03]

Note: There is a general agreement that the wording of the entries of Annex IIIB should not include a Basel code. Indeed, Annex IIIB includes unclassified green waste that is added on a provisional basis pending a decision on their inclusion in the relevant Annexes to the Basel Convention or to the OECD Decision. Therefore Annex IIIB defines the wastes that would be regarded as green-listed for shipments within the European Union only. This means that the export of any Annex IIIB entry, even to OECD countries, shall be subject to the procedure of prior written notification and consent. In this context, the use of European Waste List codes to describe proposed entries for Annex IIIB is therefore preferred by the Commission; however, this description may not be restricted to these codes only.

[49] Organic waste containing dangerous substances.

- **Process(es) by which waste is produced**

As indicated in the usual description, this waste is originated during the production of pressure sensitive adhesive (PSA) laminate (paper or plastic) containing silicone and label material.

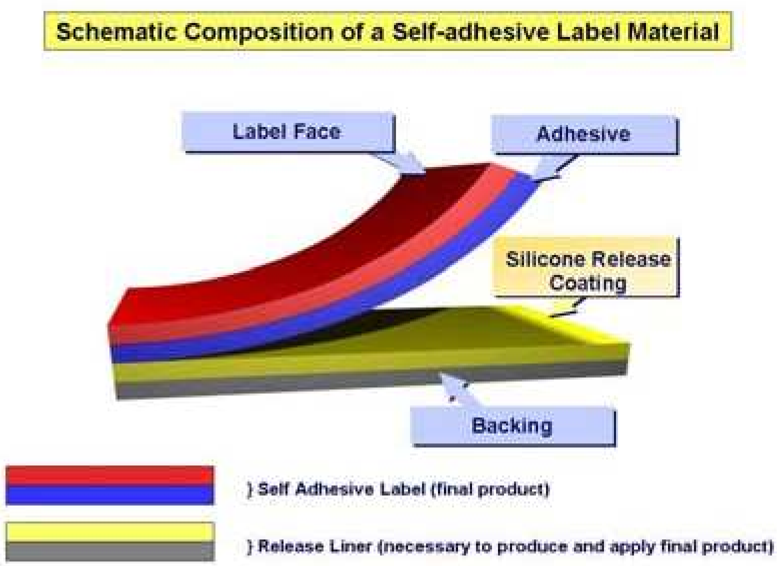
In particular, the source of the waste is the process during which the face material, which is plastic or paper label material, is laminated on siliconised plastic or paper backing material (lamination process)(Figure 14-1). In fact, the application of silicon and adhesive (acrylic) on paper or plastic is performed in the same process. First, solid silicone is applied on backing material and cured by heat or UV. Then, solid rubber or acrylic based adhesive is applied and cured by heat (rubber based) or by UV (acrylic based adhesive). This process produces laminated material. An equivalent volume of labelled material is coated with emulsion of acrylic adhesive and dried before lamination. Mother-rolls are slitted to the required width for label producers.

In a second process, the label material is printed and applied on the PSA laminate. Then, the label producers cut the PSA label material until the liner and strip the material around the labels (matrix) from the laminate.

Waste is generated during preliminary off-cut of untreated material (paper and plastic). Laminated material and siliconised liner waste are produced in the initial phase of the process. The biggest volume of waste is the matrix material generated at the end of the process (personal communication, FINAT).

According to the proposal, at the end of the process, four types of waste including paper, plastics, adhesive, silicone, and cardboard are generated (see following section).

Figure 14-1: The layout of a self adhesive laminate



Percentage of each of the components in the waste

As indicated in the proposal, this waste is formed by paper, plastic, adhesive, cardboard, and silicone in different percentages. Four types of wastes have been described in the proposal:

- Raw materials: 80% paper, 15% plastic and 5% cardboard
- Paper based laminate: 88% paper, 11% adhesive, 0.6% silicone and 0.4% cardboard.
- Paper and plastic laminate: 50% paper, 39% plastic, 10% adhesive and 0.5% cardboard
- Plastic based laminate: 89% plastic, 10% adhesive, 0.5% silicon and 0.5% cardboard

Physical characteristics

The waste is in solid physical state.

Chemical characteristics

The chemical characteristics essentially depend on the predominant fraction which could be paper and plastic raw material or laminated material. Plastic fraction is formed by PE, PP, and PET polymers that do not have, in principle, any hazardous characteristics. The adhesive fraction is constituted by water dispersion of acrylate polymers. The polymers composition may vary, giving rise to a number of different adhesive products. In general, water-based adhesive acrylic dispersions do not present hazardous characteristics. Adhesives based on polymers like polyvinyl alcohol, polyvinylpyrrolidone and its copolymers, polyethyloxazoline, copolyesters containing sulphonated material, hydrophilic polyurethane and polyethyleneoxide, but also adhesives based on starch, dextrin and cellulose show a good water solubility or re-dispersibility (Onusseit, 2003). Even if some polymers can cause skin irritation, these products are in general classified as non-hazardous.

Potential for contamination

If considering that this possible waste entry is originated exclusively by the industry and segregated from household municipal waste stream, there is no potential for contamination. Thus, if would be important to define this waste entry in a very narrow way to avoid any risk of contamination.

14.2. MANAGEMENT ASPECTS

14.2.1. GENERATION

- **Quantity produced in Europe**

According to FINAT, the total volume of laminated material waste is approximately 250 000 tonnes per year in EU. According to UPM Raflatc, the volume is between 150 000 and 200 000 tonnes per year. The majority of this waste is matrix waste originated by label producers.

14.2.2. RECOVERY

- **Recovery operations**

R3: Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes).

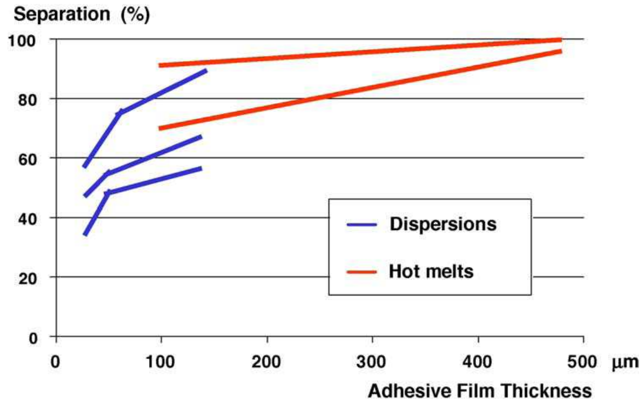
Description of Recovery operations:

Paper recycling is performed to utilise the fibres contained in recovered paper. Untreated papers and foils are collected as separate fractions (uncoated-coated paper, polyolefins, polyesters, etc.). Non-fibrous components, derived from paper or added during the processing or the use of paper, should be removed as much as possible to avoid quality defects in the produced papers and production process faults. In general, the paper mills that produce paper or cardboard out of recovered paper have lavish cleaning systems, sorting machines and deinking systems. After fibres removal, the suspension passes through several successive cleaning systems in which impurities are separated by their density, size, or shape. In the case of paper containing adhesive material the recycling rate depends on the kind of adhesive that is used. In the proposal it has been specified that this waste contains water-based dispersible adhesive. The sorting rate of this kind of adhesion for paper depends on the adhesive film thickness (

Figure 14-2). In fact, all the components of a PSA label, laminate, face-stock, primers, and adhesive, play a role in determining the behaviour of adhesives during pulping and screening (Houtman, 2004).

Adhesive can thus affect the recycling process depending on cohesion and geometry of used adhesive. For paper recycling, there are a lot of adhesives today that fulfil the requirements of recyclers. But, in practice, the paper recycling from this kind of waste is not technically easy.

Figure 14-2: Influence of adhesive film thickness on separation of paper and adhesive fraction (Onusseit, 2006).



In fact, the recycling of laminated material is restricted to obtain low quality paper products (e.g. wall paper) and this kind of waste is often landfilled or burnt for energy recovery. This waste is shredded and mixed with other combustible materials, eventually palletised and used as alternative fuel in boilers or cement kilns. However, accordingly to UPM Raflatac, only the 25% (rough estimation) of the total is burnt, the rest is landfilled. New developments in the industry make reuse of this material possible. It can be used as a mix in new raw materials to be used for components in the building industry. However, the percentage of material that is recycled as composite material is still very low.

- **Technological capacity of recovery**

In the proposal the European capacity of recovery has been estimated to be 65 000 tonnes per year

- **Recovery quota**

In the proposal the recovered quota is estimated at 100%. However, according to UPM Raflatac the great majority of this waste (75%) is actually landfilled.

- **Methods of storage at the recovery facility**

The waste is stored in covered dry storage.

- **Use of recovered material**

Extruded fibre plastic composite (similar to wood-plastic composite, WPC) used as planks, cover lists, frames, etc. Siliconised paper liners are reused to produce paper based products like tissues, towels, cardboard, and multi-layer products like wall paper or cores. In general, this kind of material can be used for any kind of paper based product which does not require high quality printing processes. Siliconised plastic can be recycled in the plastic industry.

- **Environmental benefits of recovery**

The recovery of this waste is beneficial because it leads to a material conservation, avoided landfilling, resource conservation, and avoided transport.

- **Environmental/health impacts of recovery**

General impacts of recovery operations: CO_2 emission, water emission, air emissions varying depending on the considered process (incineration vs. recycling). A number of life cycle analyses (LCAs) have been published comparing the environmental impact of waste paper recycling and incineration. Of these, some conclude that under certain conditions paper recycling has less environmental impact than incineration (British Newspaper Manufacturers Association, 1995). Others conclude the opposite (Karner et al., 1993; Pajula et al., 1995). In any case, paper recovery has less environmental impacts that producing virgin paper (Friends of the Earth, UK).

14.2.3. SHIPMENT AND TRADE

- **Packaging types during shipment**

The waste is transported in boxes, pressure receptacles and bulks.

- **Amount shipped**

In the proposal, the amount of shipped waste within the EU was estimated to be 65 000 tonnes.

- **Enforceability**

It is possible to check the quality of the waste by visual control (e.g. the fact that the waste is formed by clean cuts from laminate material production). However, the exact percentage of each component (plastic, paper, cardboard, silicone and, adhesive) is difficult to estimate during shipment inspection.

14.3. ASSESSMENT OF THE WASTE PROPOSAL

This waste is originated during the production of a multi-material composite, like, for example, laminated cardboard. This waste is partly covered by the entry B3020. However, it is not mandatory to use Basel codes for Annex IIIB included waste and the code B3020 does not cover the pure plastic waste included in the raw material (e.g. first waste type in the proposal).

In fact, according to FINAT (self-adhesive label industry federation) this waste should be better defined as following: “Pressure sensitive adhesive label material, laminate waste and matrix waste – minor quantities of raw materials and siliconised liners”. In addition, FINAT identified three types of waste that could be originated by the described industrial processes:

- Untreated paper and plastic (which may include the raw material in the first type of waste described in the proposal)

- Siliconised liners (which may include the second and forth mixture types)
- Laminate and matrix waste: a mixture of all PSA waste from laminating and label production (which may include the second, the third and the forth types of waste as defined in the proposal).

Considering these alternative categories of waste, the code B3020 alone would not be sufficient to cover all of them.

However, it is worth noticing that if the laminated cardboard waste stream is maintained segregated from the raw material waste stream at the original facility, the code B3020 would be sufficient to define this waste. In addition if the raw material waste stream is excluded and if the definitions are extremely precise and written in a narrow way it would under no circumstances open up the possibility of mixing this specific waste stream with other waste streams. The latter would always be detrimental for environment as it unavoidably leads to contamination, losses in resource efficiency (decreasing rate of paper recycling) and increased transportation of materials unusable for recycling.

Importantly, even if a narrow definition is given in the proposal, the final definition in the Annex IIIB should be precise enough to exclude contaminant waste streams from the mixture, thus not limited to codes but including a precise wording.

14.4. CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis, proposal # 12 presents:

- no hazardous characteristics
- a potential for contamination with unwanted waste stream, if the waste is not appropriately defined and if the appropriate description does not appear in the Annex IIIB.
- A good technological capacity for energy recovery, but a scarce capacity for recycling the waste as WPC
- good environmental benefits from recovery compared to virgin material production
- a difficult enforceability

The environmental sound management of this waste stream could be possible only if the laminated cardboard is kept segregated from the raw material waste stream.

As a conclusion, this waste could be included in the Annex IIIB, only if:

- it is defined more precisely, excluding raw material waste streams (e.g. pure plastic)
- the precise definition, not limited to codes but including a precise wording, is maintained in the final form of Annex IIIB

- the fact that the waste stream is limited to waste stream from the production of PSA laminate (paper or plastic) containing silicone and label material is ensured.

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14.6. CONTACTS

- Constantijn Horák, FINAT Issues Manager
- Jori Ringman, Secretary of the European Recovered Paper Council, Recycling and Product Director, Confederation of European Paper Industries (CEPI)
- Jan-Erik Forsström, Senior Vice President Technology & Development at UPM / Raflatac

15. WASTE PROPOSAL # 13

Proposed entry to Annex IIIA: Non-separable plastic Al fraction from the pre-treatment of liquid packages

Proposal submitted by: Finland

Amendments: The proposal, originally submitted to be included in Annex IIIA has been amended by Finland and it is now evaluated for inclusion in Annex IIIB: "Green listed waste awaiting inclusion in the relevant annexes to the Basel convention or the OECD decision as referred to in article 58 (1) (B)".

15.1. PROPERTIES OF THE WASTE

Description: The non separable waste of plastic coating, Al coating and cardboard fibres from the carton fibre recovery process of used laminated liquid packages.

Note: It is important to highlight that this waste can be considered as a composite material which became waste rather than a waste mixture and it is evaluated here for a possible inclusion under Annex IIIB.

Based on the MS proposal, the waste would cover the following codes of the European Community list of wastes[50]:

EU Code	Code description	Origin
03 03 07	Mechanically separated rejects from pulping of waste paper and cardboard	From pulp paper, paper and cardboard production and processing [cat.0303]

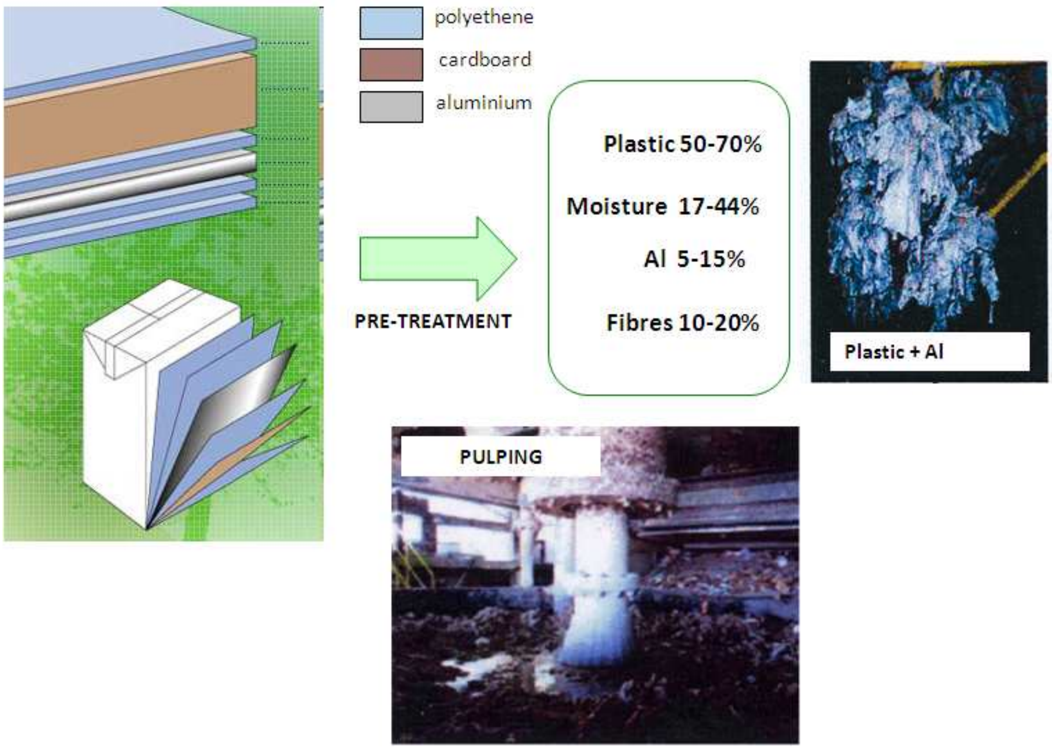
Note: Basel codes were not indicated in the received proposed entry and are not specified here neither. As indicated for proposal #12, there is a general agreement that the wording of the entries of Annex IIIB should not include a Basel code. Indeed, Annex IIIB includes unclassified green waste that is added on a provisional basis pending a decision on their inclusion in the relevant Annexes to the Basel Convention or to the OECD Decision. Therefore Annex IIIB defines the wastes that would be regarded as green-listed for shipments within the European Union only. This means that the export of any Annex IIIB entry, even to OECD countries, shall be subject to the procedure of prior written notification and consent. In this context, the use of European Waste List codes to describe proposed entries for Annex IIIB is therefore preferred by the Commission; however, this description may not be restricted to these codes only.

50 There is no Basel code specified for this waste mixture in the proposal

- **Process(es) by which waste is produced**

The waste is generated by the pulping of multi-material packages (e.g. tetrapak). During pulping, the fibre, and the plastic-Al fraction are separated from each other. The cellulosic layer can be separated from the PE/Al layers by a mechanical process based on hydration of paper fibres. The hydrated paper forms a pulp of high consistency that allows removing fibres by pumping. However, even if the fibre content is kept as low as possible, it is still present after separation in the plastic-Al fraction (Rinaldelli et al., 2006)(Figure 15-1).

Figure 15-1: process by which the waste is produced (Malgoalvise)



- **Percentage of each of the components in the waste**

In the proposal, the plastic-Al fraction resulting from pre-treatment is defined as approximately containing 50-70% of plastic, 17-44% moisture, 5-15% Al, and 10-20% fibre.

- **Physical characteristics**

The physical state of the waste is solid, in form of shredded material.

- **Chemical characteristics**

The plastic fraction, which is the predominant fraction, is made of polyethene, a chemical inert polymer that does not present any hazardous characteristics in principle.

■ **Potential for contamination**

The average quantity of undesired materials contained in the liquid packaging bales is estimated around 2% (personal communication, Ms. Herrenschmidt-Munoz, Pro Europe). There is a potential for contamination with other plastics (e.g. PVC) or inks, since the waste is originated by wet pulping industrial process after the treatment of heterogeneous paper waste stream, not limited to liquid packaging (personal communication, Mr. Nannariello, Tetrapak Italia).

15.2. MANAGEMENT ASPECTS

15.2.1. GENERATION

■ **Quantity produced in Europe**

In Europe, about 1 million of tonnes of this kind of packages are produced every year (ACE, Ecoemballage). About 100 billions of Tetrapack[51] packages are produced yearly in the word.

15.2.2. RECOVERY

■ **Recovery operations**

R 1: Use as a fuel (other than direct incineration) or other means to generate energy/use principally as a fuel or other means to generate energy.

R 4: Recycling/reclamation of metals and metal compound

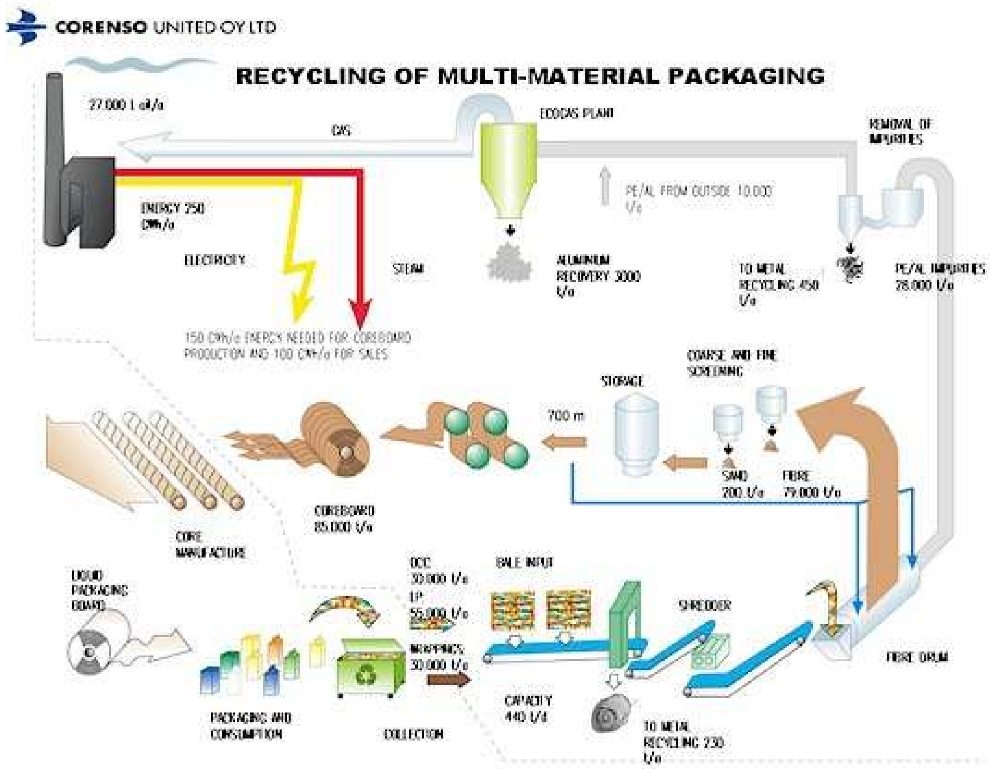
Description of Recovery operations:

- **Non-interim recovery operations:** the plastic-Al fraction containing residual fibre can be recovered by four different processes: energy recovery in paper mill or cement kilns, mechanical recycling, gasification/pyrolysis for energy production, and plasma technology. The gasification/pyrolysis process is currently done only in Corenso recycling plant - Varkaus (Finland). Plastic is gasified in bubbling fluidised bed gasifier and Al is recovered (2 500 tonnes/year) for recycling. The product gas is burned in a boiler replacing heavy flue oil (HFO) in the power plant of Stora-Enso (165 GWh/year)(Figure 15-2). The combustion of the waste as secondary fuel for energy recovery in cement kilns is also possible: the produced AlO_3 becomes a part of the cement. In the cement kilns the high temperatures and long residence times ensure the complete combustion of all organic portions of the waste. This total combustion of the waste is ensured by maintaining an oxidising atmosphere in the kiln. However, in some cases, AlO_3 can deposit in the boilers creating a

[51] Tetrapak is one of the major producers in the world of this kind of liquid packages

problem. The plasma technology employs electrical energy to produce a jet of plasma at 15 thousand degrees Celsius to heat the plastic and Al mixture. With this process, plastic is transformed into paraffin (almost 50% in weight of the original feedstock) and the Al (approximately 8% of the original feedstock) is recovered in a high purity form. The mechanical recycling involves the separation of paper from PE and Al foil. Following this preliminary separation, the fibres are discarded and the plastic-Al fraction is washed, pressed, dried, agglutinated and extruded to generate pellets of a composite material (Lopes and Filiberti, 2006)[52].

Figure 15-2: Pyrolysis gasification process in Varkaus (Letsrecycle)



■ Technological capacity of recovery

In 2006, 313 000 tonnes of beverage carton were recycled within a total capacity for recycling of 12 billion tonnes, which represents a recycling rate of 30% in Europe (EU 27, Norway and Switzerland)(ACE). According to ProEurope[53], the recycling rate of this kind of liquid packages increased in 2007. Indeed, even if European figures are not available, only in France 474 000 tonnes have been recycled. This represents the 55% of the total for France (personal communication, Ms. Herrenschmidt-Munoz, Pro Europe).

There is one plant in Europe to perform plasma technology. Its capacity is of 1 800 kg/h, thus approximately 1.5 million of tonnes per year (Recycle for Wiltshire). The

52 See also: http://www.ecoallene.com/
53 Packaging recovery organisation Europe

plant based in Varkaus has a capacity of approximately 60 000 tonnes per year for gasification. Dedicated municipal solid waste incineration capacity is estimated to be at least of 45 million tonnes/year in the EU27 and 100 million tonnes/year in OECD countries (OECD Compendium, 2006-2007).

- **Recovery quota**

The recovery quota for incineration in cement kiln, plasma technology and gasification /pyrolysis is almost 100% (Hands, 2004).

- **Methods of storage at the recovery facility**

In the case of energy recovery in paper mills, the waste is stored in a warehouse.

- **Use of recovered material**

Aluminium from pyrolysis/gasification process is recovered as ingots that can be processed to obtain foils. Pyrolysis/ gasification process also generates bale wires, sand and other metal objects. Plastic-Al composite materials and panel boards are originated by mechanical recycling of the waste. Plastic recovered in the form of paraffin by the plasma process can be used to prepare wax and lubrificants.

- **Environmental benefits of recovery**

In the case of pyrolysis/gasification process and the plasma process there is no waste left after the recovery: 100% of material is recycled. Thus, the main environmental benefits are virgin material conservation and reduction of waste to disposal. In the case of cement kiln combustion the main advantage is the reduced need for incineration. Compared to incinerators, cement kilns have far superior capabilities, with longer residence times and higher temperatures which ensure the total combustion of any waste in the system. The self-cleaning nature of the cement kilns ensures an efficient emissions barrier for hazardous emissions, with 5 stages of inherent emissions control built into the cement process. The emissions from the co-processing of waste are essentially the same as when using conventional fuels. There is no ash from the co-processing of waste in cement kilns. All the ash from the waste materials is incorporated into the clinker.

A LCA of aseptic packaging for long-life milk has been performed to compare the GHG emissions of various rate of recycling (0-70%). The results are showed in

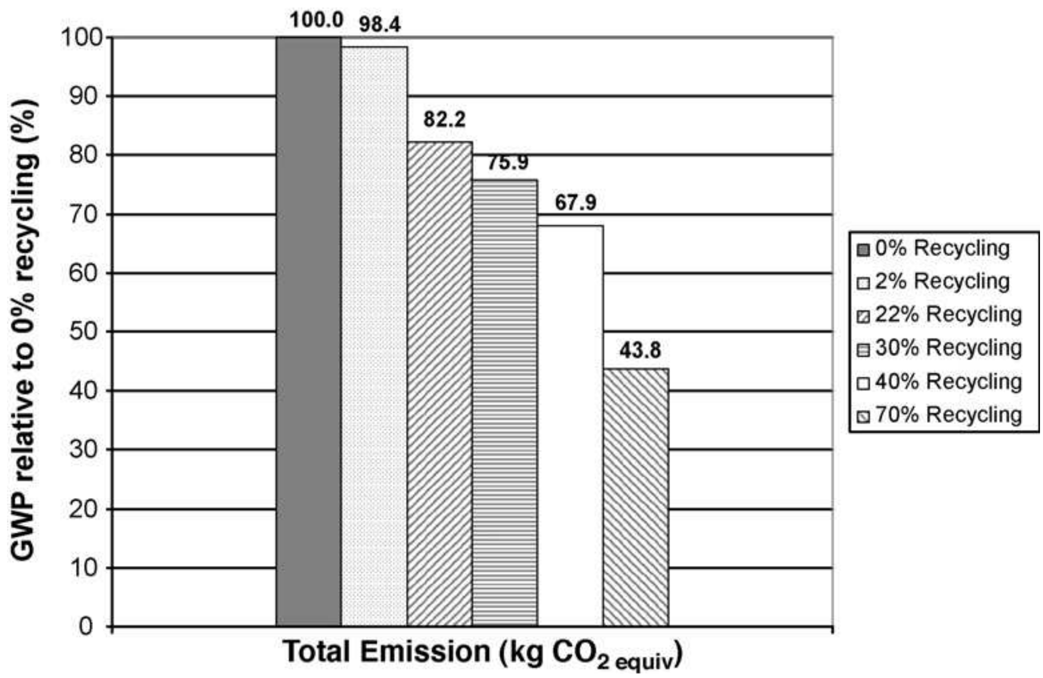
Table 15-1 and in Figure 15-3. The study concluded that the increase of recycling rates brings about several benefits in terms of reduction of energy consumption, use of virgin materials and air pollutant emissions. Furthermore, increasing the recycling rate also probably reduces the total amount of solid waste for final disposal and the consumption of natural resources (Mourada et al., 2008). In

Table 15-1, a comparison of the GHG emissions and energy consumption in a scenario taking into account the recycling of all the components of the liquid package (cardboard, Al and PE) is shown.

Table 15-1: Reduction in emissions with increased recycling (functional unit: 1000 litres of milk)(Mourada et al., 2008)

GHG emissions	0% of recycling (g)	Reduction relative to 0% of recycling (g)				
		Recycling rate				
		2%	22%	30%	40%	70%
CH_4 (g)	5539.8	109.6	1217.5	1644.3	2192.4	3836.8
CF_4(g)	0.3	0.0	0.1	0.1	0.1	0.2
CO_2(non-renewable)(g)	54105.4	411.2	4520.9	6164.4	8219.1	14383.2
CO (g)	1205.9	14.1	155.1	211.5	282.0	493.5
N_2O	11.6	0.1	1.5	2.1	2.8	5.0
Other parameters						
CO_2 (renewable)(g)	150812.4	2101.4	23144.1	31521.0	42028.0	73549.0
Energy consumption (MJ)	2166	1.1	11.7	16.0	21.3	37.3

Figure 15-3: Relative reduction of the global warming potential, measured in equivalent CO_2 units at different recycling rates (Mourada et al., 2008)



- **Environmental/health impacts of recovery operations**

  - **General impacts of recovery operations:** emission of GHG and eventually hazardous emissions into the atmosphere from incineration. Carbon dioxide is released when plastics are burned. Pollution concerns include the emission of particulate matter, acidic gases (particularly sulphur dioxide and nitrogen oxides), heavy metals, halogens, dioxins, and products of incomplete combustion. Dioxins and halogens are released from incineration of chlorinated polymers, such as PVC. Pb and Cd based additives for plastics and colorants contribute to the heavy metal content of incineration plant ash. However, the majority of incineration plants are equipped with particulates and acid gas controls and this waste will be most likely incinerated in cement kiln without ash residues.

15.2.3. SHIPMENT AND TRADE

- **Packaging types during shipment**

The waste is transported in bales strapped with steel wires.

- **Amount shipped**

In the proposal it has been estimated that 15 000 tonnes per year are shipped to Varkaus.

- **Enforceability**

The composition of the waste is ensured by the producing facility. During shipment inspection, the plastic/Al/fibre waste can be manually identified. However, the verification of the exact composition (determination of the % for each fraction) of the waste would require a chemical analysis.

15.3. ASSESSMENT OF THE WASTE

According to ProEurope, between 30% and 40% of laminated liquid packages is currently recycled in Europe (personal communication). Thus, the great majority is incinerated for energy recovery or landfilled. Major environmental benefits are associated to the recovery of this waste , in particular if pyrolysis gasification and plasma process are used. However, to date, only two facilities in Europe are able to perform such kind of recycling. The mechanical recycling of this waste to obtain a composite material is also possible. A study conducted by a group of Brazilian scientists shows that polymeric blends can be prepared by mechanical recycling of this type of waste . Plastic-Al residues were blended with recycled HDPE/LDPE and virgin PE resins. In addition, it is worth noticing that it is possible to obtain cardboard directly from entire laminated beverage cartons containing paper, plastic and Al using different types of adhesive. The cardboard formed using polyurethane adhesive had the best mechanical properties and water resistance. This kind of cardboard can be used as an alternative raw material for furniture construction (Da Santa Paula et al., 2005).

The main issue related to the inclusion of this waste in Annex IIIB is to determine if the inclusion will permit a development of such recycling processes or if it will only favour incineration. In the latter case, it is important to highlight that there is a potential for contamination of this waste with other plastics (e.g. PVC), since the waste is originated by wet pulping industrial process after the treatment of heterogeneous laminated paper waste stream, not limited to liquid packaging (personal communication, Mr. Nannariello, Tetrapak Italia).

15.4. CONCLUSIONS AND RECOMMENDATIONS

Based on our analysis, the potential entry # 13 presents:

- no hazardous characteristics
- a potential for contamination with other laminated paper waste stream containing PVC Pb and cadmium (Cd) based stabilisers
- important environmental benefits if pyrolysis-gasification, plasma process and mechanical recycling are performed.
- an acceptable enforceability

As a conclusion, the potential entry #13 can be included in Annex IIIB if:

- the absence of PVC potentially hazardous additives is ensured by the original facility
- pyrolysis-gasification, plasma process and mechanical recycling are preferred to incineration

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- Lorenzo Nannariello, Tetrapak Italia.
- Valérie Herrenschmidt-Munoz, in charge of Material Department, Ecoemballage – ProEurope.
- Arturo Sciullo, ARPAT Toscana

16. WASTE MIXTURE PROPOSAL # 14

Proposed entry to Annex IIIA: Mixture of plastic and cardboard from industry, retail, business properties and offices (B3010 + B3020)

Proposal submitted by: Finland

16.1. PROPERTIES OF THE WASTE MIXTURE

Description:

Cardboard mainly including corrugated cardboard and plastic mainly including PE and PP, without PVC.

Basel code:

Basel Code	Code description
B3010	Solid plastic waste
B3020	Paper, paperboard and paper product waste

Based on the MS proposal, the mixture would cover the following waste of the European Community list of wastes:

EU Code	Code description	Origin
15 01 06	Mixed packaging	From waste packaging [cat.1501]

In the received proposal, the Harmonised System (HS) codes have also been indicated. This code of tariff nomenclature is an internationally standardized system of names and numbers for classifying traded products developed and maintained by the World Customs Organization (WCO), an independent intergovernmental organisation. In the case of this waste mixture the codes are:

HS Code	Code description
3923 1000	Boxes, cases, crates and similar articles, of plastics
4707 1000	Waste and scrap of unbleached kraft paper or of corrugated paper or paperboard

- **Process(es) by which mixture is produced**

The waste mixture is originated from the collection of waste material from industry, retail, and offices and is compacted by a waste compactor before shipment.

- **Percentage of each of the components in the mixture**

In the proposal the percentages of each component of the mixture are indicated as following: 50-80% of plastic (80-90% PE, 5-15% PP, <5% other plastic excluding PVC), 20-50% of cardboard (85-95% corrugated cardboard, 5-15% other cardboard).

- **Physical characteristics**

The waste is in form of solid bales.

- **Chemical characteristics**

The paper fraction is not hazardous. The plastic fraction is predominantly made of PE and PP, two chemical inert polymers that do not present any hazardous characteristics (PSLC).

- **Potential for contamination**

The potential for contamination depends on the separation efficiency at the source as some wood, metal, glass and bio-waste may be present. However, the quality of the mixture is, in principle, verified at a recycling facility before shipment.

16.2. MANAGEMENT ASPECTS

16.2.1. GENERATION

- **Quantity produced in Europe**

The distribution and industry sectors generate some 2.6 million tonnes out of the 9.8 million tonnes of post-user packaging waste produced in Western Europe (European Directive of packaging waste). A study shows that 8.7 kg/inhabitant of plastic containing packaging (including all type of plastic) are originated in EU 15 + NO/CH (Taylor, 2000). The PE containing packaging represents the 11.6% and the PP containing packaging the 2.3% of the total waste from packaging (Anderson et al., 2002). However, this mixture represents only a fraction of the total plastic packaging waste.

16.2.2. RECOVERY

- **Recovery operations**

R 12: Exchange of wastes for submission to any of the operations numbered to R 1 to R 12[54]

Description of Recovery operations:

- **Interim recovery operations:** manual and mechanical pre-sorting on a solid waste sorting line (SWSL). SWSL are typically designed to process between 200-700 tonnes per day of solid waste. Recyclable material is extracted in SWSL. Sorting systems can be fully automated, partially automated or consist solely of

[54] This is the definition of recovery operations given in the proposal made by Finland and it is referred to interim operations. The non-interim operations to recover each of the fractions (plastic and cardboard) are not included in the proposal. However, in order to evaluate the Environmental Sound Management of this waste mixture, the downstream operations to recover each of the fractions after sorting (non-interim operations) have been considered.

manual sorting systems. A combined system of automated and manual sorting usually begins with automated sizing and sorting and ends with manual sorting. The waste travels down a flat conveyor belt and workers remove the recyclables as they pass by. The conveyor belt for sorting may be long enough to accommodate between five and 20 sorters. Once the recyclables are separated, they must be processed into materials for sale. Processing typically includes baling for paper-plastic packaging waste. Once processed, the materials (in this case cardboard and plastic) are sold directly to specialty recyclers for reuse (Opportunity Handbook, 2003).

- **Non-interim recovery operations:** after sorting, cardboard is mixed with water and blended to a slurry pulp, or pulp of individual fibres. Then, if the paper is printed paper, a de-inking process may be performed. The clean pulp is passed through a screen of wire mesh which draws out all the water, leaving behind the strong paper fibres. The pulp that is left on the mesh is then passed through a pressing machine to flat and dry it. Homogeneous films manufactured from PE or PP can be recycled optimally.

Technological capacity of recovery

In the proposal, the technological capacity of recovery is estimated to be 500 000 - 5 million tonnes per year. This estimation is referred exclusively to the interim operations (R 12). The capacity of a SWSL can vary from 2 400 to 12 000 tonnes per year. Regarding the capacity to perform the non-interim operations, it has been estimated that in 2006, 48.9 million tonnes of paper were recycled in Europe (ERPC) while in 2004, 9 million tonnes of plastic has been recovered (recycling and energy recovery) in EU15+NO/CH (Plastics Europe, 2008).

Recovery quota

The recovery quota of this waste mixture has been estimated to be 99% in the proposal.

Methods of storage at the recovery facility

Baling is a suitable option for storage since it provides a reduction in volume. Plastic containing mixture is also normally protected from UV during storage.

Use of recovered material

Recovered materials are sold to be recycled by plastic and cardboard industry.

Environmental benefits of recovery

The major environmental benefits of the mixture recovery are virgin material conservation, reduced land-fill and energy conservation. According to BIR, energy consumption is reduced of 64% by recycling paper. In 2000, the German Federal Environmental Protection Agency Germany has conducted a life cycle assessment for graphical paper. This assessment concluded that it is considerably more environmentally compatible to recycle waste paper for new paper production than it is to burn waste paper for energy production while others made just the opposite conclusions (Karner et al., 1993; Pajula et al., 1995). Nevertheless, either of the options remain preferable to landfilling (German federal EPA).

Regarding plastic recovery, it's worth noticing that most waste plastics have a high calorific value (about 40 MJ/kg) which is similar to fuel oil. With an efficient incineration of plastics it is possible to save 41.5% of energy (Johansonn, 2005). Emission of GHG is also limited by plastic recycling comparing to plastic production.

- **Environmental/health impacts of recovery**

  - **General impacts of recovery operations:** it is worth noticing that the majority of recovered plastic (63%) in EU 15 + NO/CH is burnt for energy recovery. After plastic incineration, about 20 to 30% of material is still present as ash that must be handled for final disposal. In addition, the incineration could produce emission to air of substances escaping flue gas cleaning and the large amount of residues from gas cleaning and combustion. Regarding paper recycling, life cycle assessments carried out to assess paper recycling have arrived at different conclusions, partly due to methodological differences in the inventory analysis. One study showed that the effluent from de-inked paper had slightly higher levels than effluent produced from virgin pulp (Virtanen and Nilson, 1993), but technology is available to reduce these pollutants from the effluent stream.

16.2.3. Shipment and Trade

- **Packaging types during shipment**

The waste is transported in bales.

- **Amount shipped**

In the proposal the quantity of the waste mixture shipped within the EU has been estimated to be 50 000 - 200 000 per year. The quantity exported from the EU or imported to EU from third countries has been estimated as 50 000 - 100 000 tonnes per year.

- **Enforceability**

The quality and the composition of the waste mixture are normally verified at the source facility, this in principle, should guarantee the absence of contaminants such wood, glass, bio-waste, PVC, and metals. However, it is not possible to verify by simple visual control the complete absence of contaminants during shipment. The main issue related to an eventual chemical analysis would be the difficulty to obtain a sample which is representative of the waste mixture load as a whole[55].

[55] Kaivac has produced a rapid detection kit for bio-waste. However, it is probably too sensitive for the scope of inspection and it could give rise to false positive results. In addition these highly precise laboratory methods are difficult to perform during shipment.

16.3. ASSESSMENT OF THE WASTE MIXTURE

Large amounts of synthetic polymers are produced every day and polymeric wastes are disposed in municipal solid waste stream. In general two plastic types, PE and PP, are mixed with paper in the waste materials. As presented in the previous section, this waste mixture is, in principle, easily recyclable. If the paper and the plastic fraction can easily be separated, they can be submitted to standard recycling processes or incinerated. In the case of commingled plastics waste that contains paper, hydrolytic treatment is needed prior to conventional processing. It has been shown that the hydrolytic treatment of paper improves the mechanical properties of the PP/PE/paper composites and that up to 30% paper can be added to commingled PP and HDPE blends. The plastics waste containing paper can be used in applications such as artificial wood (Mehrabzadeh and Farahmand, 2001).

In principle, the recycling of this waste mixture is feasible and present important environmental benefits, especially when the two fractions, plastic and paper, are recycled rather than incinerated. It is worth noticing that, following the inclusion of this waste mixture to Annex IIIA a significant risk could be that, in order to avoid interim operation (separation of paper and plastic waste stream), the waste mixture would be mainly incinerated. Another eventual risk could be related to the potential contamination with other waste stream (other than office, retail, business properties and industry). This could be a non negligible risk since the origin of the waste is not specified by the Basel codes. Thus, since, in principle, the waste mixtures will only be defined by the Basel codes in Annex IIIA, the limitation to office, retail, business properties and industry will not be ensured. In addition, experimental protocols to ensure the absence of undesirable contaminating components (e.g. PVC containing potentially hazardous additives) are not easily enforceable during shipment inspection. In this case, providing details on the source of the waste mixture in the Annex IIIA is important to avoid potential contamination with plastic or paper material of unknown origin.

16.4. CONCLUSIONS AND RECOMMENDATIONS

On the basis of our analysis, the waste mixture presents:

- no hazardous characteristics if the origin from office and retails and the absence of PVC Pb and Cd-based stabilisers are ensured by the original facility
- no potential for contamination if the origin from office and retails and the absence of PVC potentially hazardous additives are ensured by the original facility
- good environmental benefits especially if the mixture is recycled rather than incinerated for energy recovery
- a good level of enforceability if the origin from office and retails and the absence of PVC potentially hazardous additives are ensured by the original facility

As a conclusion, the waste mixture can be included in Annex IIIA if the origin from office and retails and the absence of PVC potentially hazardous additives are ensured by the original facility. In addition, legislative measures to facilitate recovery of each fraction rather than direct incineration of the mixture would ensure an environmental sound management.

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17. WASTE PROPOSAL # 15

Proposed entry to Annex IIIA: Non separable plastic fraction from the pre-treatment of liquid packages

Proposal submitted by: Finland

Amendments: The proposal, originally submitted to be included in Annex IIIA has been amended by Finland and it is now evaluated for inclusion in Annex IIIB: "Green listed waste awaiting inclusion in the relevant annexes to the Basel convention or the OECD decision as referred to in article 58 (1) (B)".

17.1. PROPERTIES OF THE WASTE

Description:

Non separable plastic fraction from the recovery process of used laminated liquid packages.

Note: It is important to highlight that this waste can be considered as a composite material which became waste rather than a waste mixture and it is evaluated here for a possible inclusion under Annex IIIB.

Based on the MS proposal, the proposed entry would cover the following waste of the European Community list of wastes[56]:

EU Code	Code description	Origin
03 03 07	Mechanically separated rejects from pulping of waste paper and cardboard	From pulp paper, paper and cardboard production and processing [cat.0303]

Note: Basel codes were not indicated in the received proposed entry and are not specified here neither. As indicated for proposal #12 and #13, there is a general agreement that the wording of the entries of Annex IIIB should not include a Basel code. Indeed, Annex IIIB includes unclassified green waste that is added on a provisional basis pending a decision on their inclusion in the relevant Annexes to the Basel Convention or to the OECD Decision. Therefore Annex IIIB defines the wastes that would be regarded as green-listed for shipments within the European Union only. This means that the export of any Annex IIIB entry, even to OECD countries, shall be subject to the procedure of prior written notification and consent. In this context, the use of European Waste List codes to describe proposed entries for Annex IIIB is therefore preferred by the Commission; however, this description may not be restricted to these codes only.

56 The Basel codes have not been provided in the proposal

- **Process(es) by which waste is produced**

Pulping of multi-material packages (e.g. laminated board): this kind of packaging is made from several thin layers of paper that can be laminated with PE in liquid packaging. During pulping (adding water and applying mechanical action), the fibre, and the plastic fraction are separated from each other. However, even if the fibre content is kept as low as possible, it is still present after separation in the plastic fraction.

- **Percentage of each of the components in the waste**

In the proposal the plastic-cardboard fibre fraction resulting from pre-treatment of liquid packaging is defined as approximately containing 50-70% of plastic, 17-20% moisture, and 10-30% fibres.

- **Physical characteristics**

The waste is in form of solid shredded material.

- **Chemical characteristics**

The plastic fraction, which is the predominant fraction in this waste, is most likely to be made of PE, a chemical inert polymer that does not present any hazardous characteristics. Paper containing fraction does not present any hazardous characteristics.

- **Potential for contamination**

There is no potential for contamination if the waste originated by wet pulping industrial process of liquid packaging is not mixed with other waste streams.

17.2. MANAGEMENT ASPECTS

17.2.1. GENERATION

- **Quantity produced in Europe**

In Europe (EU-27 + Norway + Switzerland), about 1 million of tonnes of this kind of packages are produced every year (Ecoemballage, ACE).

17.2.2. RECOVERY

- **Recovery operations**

R 1: Use as a fuel (other than direct incineration) or other means to generate energy/use principally as a fuel or other means to generate energy.

R 4: Recycling/reclamation of metals and metal compound

Description of Recovery operations:

- **Non-interim recovery operations:** similarly to proposed waste #13, the plastic-cardboard fibre fraction can be recovered by two different processes: energy recovery in paper mill or cement kilns (most frequent), and gasification/pyrolysis for energy production. The gasification/pyrolysis process is currently done only in Corenso recycling plant- Varkaus (Finland). Plastic is gasified in bubbling fluidised bed gasifier. The product gas is burned in a boiler replacing heavy flue oil (HFO) in the power plant of Stora-Enso (165 GWh/year). The combustion of the waste as secondary fuel for energy recovery in cement kilns is also possible. In the cement kilns the high temperatures and long residence times ensure the complete combustion of all organic portions of the waste. This total combustion of the waste is ensured by maintaining an oxidising atmosphere in the kiln.

- **Technological capacity of recovery**

The plant based in Varkaus has a capacity for gasification of approximately 60 000 tonnes per year. Dedicated municipal solid waste incineration capacity is estimated to be approximately of 45 million tonnes/year in EU and 100 million tonnes/year in OECD countries (OECD Compendium, 2006).

- **Recovery quota**

The recovery quota for cement-kiln incineration and gasification /pyrolysis is 100%.

- **Methods of storage at the recovery facility**

In the case of energy recovery in paper mills, the waste is stored in a warehouse.

- **Use of recovered material**

The recovery of this waste by pyrolysis/gasification or cement kiln incineration originates energy for Combined Heat and Power (CHP) production.

- **Environmental benefits of recovery**

As in proposal #13, there is no waste left after the recovery through pyrolysis/gasification process: 100% of material is gasified. Thus, the main environmental benefits are virgin material conservation and reduction of waste to disposal. In the case of cement kiln combustion the main advantage is the reduced need for incineration in standard incinerators. Compared to incinerators, cement kilns have far superior capabilities, with longer residence times and higher temperatures which ensure the total combustion of any waste in the system. The self-cleaning nature of the cement kilns ensures an efficient emissions barrier for hazardous emissions, with 5 stages of inherent emissions control built into the cement process. The emissions from the co-processing of waste are essentially the same as when using conventional fuels. There is no ash from the co-processing of waste in cement kilns. All the ash from the waste materials is incorporated into the clinker.

- **Environmental/health impacts of recovery operations**
  - **General impacts of recovery operations:** emission of GHG and eventually hazardous air emissions from incineration. Carbon dioxide is released when plastics are burned. Pollution concerns include the emission of particulate matter, acidic gases (particularly sulphur dioxide and nitrogen oxides), heavy metals, halogens, dioxins, and products of incomplete combustion. Dioxins and halogens are released from incineration of chlorinated polymers, the most abundant of which is PVC. Pb and Cd-based additives for plastics and colorants contribute to the heavy metal content of incineration plant ash. However, the majority of incineration plants are equipped with particulates and acid gas controls.

17.2.3. SHIPMENT AND TRADE

- **Packaging types during shipment**

This waste is transported in form of bales strapped with steel wires.

- **Amount shipped**

In the proposal it has been estimated that 15 000 tonnes per year are shipped to Varkaus.

- **Enforceability**

The composition of the waste is ensured by the producing facility (by the fact that the waste is originated during a defined pulping industrial process). During shipment inspection, the plastic/ fibre containing waste can be visually and manually identified. However, the verification of the exact % of each component would require a chemical analysis. In this particular case, if the waste stream is maintained segregated from other waste stream (e.g. municipal waste), it would be possible to obtain a homogenous and representative sample of the waste to be analysed.

17.3. ASSESSMENT OF THE WASTE

Plastics containing waste are already a big percentage (~20%) of municipal and toxic waste and their incineration has become a major environmental problem. Many researches are being carried out to develop technologies for the recycling of plastic waste due to declining landfill capacity as well as increasing cost of petroleum product. PE is quite easily recyclable, at least in its semi-rigid form, but identification and separation are more difficult for films or commingled materials, like in this case.

As a consequence, the incineration is the most frequently chosen option for this kind of waste. Incineration is also the simplest and most effective method for recovering energy from plastic waste, but it is worth noticing that heat recovery is not efficient at 100%. In addition, a number of carcinogenic substances (PAHs, nitro-PAHs, dioxins, etc.) have been identified in airborne particles from incineration of plastic polymers. Some of these substances and particulates have been found to be highly mutagenic. However, based on the proposal, the only plastic polymer contained in this waste should be PE, and as shown in Table 17-1, particulate emissions and residual ashes from PE containing waste incineration is low compared to other polymers.

Table 17-1: Controlled combustion of polymeric material at 600–750 ◦C (three samples with the same amount were used for each burning-combustion test) (Valavanidis A et al., 2008). HDPE= high-density PE; LDPE=low-density PE.

Type of plastic	Production of black smoke	Difficulty in burning	Particulate soot emission (%, w/w) (n=3)	Residue solid ash (%, w/w) (n=3)
PE (HDPE) poly(ethylene)	No	No	0.10-0.25	0.25-0.33
PE (LDPE) poly(ethylene)	No	No	0.10-0.15	0.1-0.2
PP poly(propylene)	No	No	0.2-0.3	0.1
PS poly(styrene)	Yes	No	0.52-0.65	2.63-2.85
PVC poly(vinyl chloride)	No	Yes	0.21-0.33	9.14-9.62
PET poly(ethylene terephthalate)	No	Yes	0.21-0.25	4.75-5.26

In addition, many techniques effective to reduce persistent organic pollutants in incineration emissions are available in European incinerators (e.g. the use of adsorbents and catalysts)(UNEP,2007). Alternatively pyrolysis/gasification, which have been studied extensively and applied by CORENSO in Varkaus, or incineration in cement kiln can be performed. However, the pyrolysis/gasification technique, can be efficiently performed if this plastic fraction from the pre-treatment of liquid packages, is not contaminated with other plastic containing waste streams.

17.4. CONCLUSIONS AND RECOMMENDATIONS

Based on our analysis, this proposed waste entry presents:

- no hazardous characteristic if it is ensured that the waste is not contaminated with other plastic-containing waste streams (e.g. PVC containing Pb and Cd-based stabilisers). This is to be achieved by keeping this waste separated from other plastic-containing waste streams.
- important environmental benefits if the pyrolysis/gasification process is performed
- a good enforceability, if the waste stream is maintained separated from other plastic-containing waste stream

As a conclusion, this waste composite is suitable for inclusion in Annex IIIB, if the waste stream is maintained separated from other plastic-containing waste stream, notably containing PVC with Pb and Cd-based stabilisers, and if the pyrolysis/gasification process and recycling are preferred to incineration.

17.5. REFERENCES

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17.6. CONTACTS

- Lorenzo Nannariello, Tetrapak Italia.
- Valérie Herrenschmidt-Munoz, in charge of Material Department, Ecoemballage – ProEurope.
- Arturo Sciullo, ARPAT Toscana

18. WASTE MIXTURE PROPOSAL # 16

Proposed entry to Annex IIIA: B1010 metal and metal-alloy wastes in metallic, non-dispersible form and/or B1050 mixed non-ferrous metal, heavy fraction scrap, not containing Annex I materials in concentrations sufficient to exhibit Annex III characteristics and B1030 solid plastic waste.

Proposal submitted by: United Kingdom

18.1. PROPERTIES OF THE WASTE MIXTURE

Description: Metals and metal alloys in a solid metallic non-dispersible form with solid plastic waste from waste management facilities[57]

Basel code:

Basel Code	Code description
B1010	Metal and metal-alloy wastes in metallic non-dispersible form
B1050	Mixed non-ferrous metal, heavy fraction scrap, not containing Annex I material in concentrations sufficient to exhibit Annex III characteristics
B3010	Solid plastic waste

Based on the MS proposal, the mixture would cover the following waste of the European Community list of wastes:

EU Code	Code description	Origin
19 10 01	Fe and steel waste	From shredding of metal containing waste [cat.1910]
19 10 02	Non-ferrous waste	
19 10 06	Other fractions other than those mentioned in 19 10 05[58]	

- **Process(es) by which mixture is produced**

As indicated in the proposal, this mixture is originated from shredding or other mechanical treatment of post-consumer waste including ELV and WEEE. After shredding, the metallic fractions, ferrous and non-ferrous, are separated by magnetic separation and cyclone/eddy-current separation respectively. The remaining plastic-metal fraction is further separated by mechanical media separation. The mechanical separation includes several different size reduction aggregates like hammer mills, impact crushers, chippers, and different cutting mills like rotor scissors, rasp mills and rotary drum cutters.

[57] In the proposal it is specified that « the mixture does not include cables because these would be classified as B1115 if suitable for classification as Annex III waste ».

[58] Other fractions containing dangerous substances

Physical characteristics

The waste mixture is in a solid physical state.

Chemical characteristics

In ELV waste, ferrous and non-ferrous metals (Zn, Cu, Mg, and Pb) constitute about 67.5% of the vehicle. The plastics content in average cars is roughly 9% (Table 18-1) and the major type of plastic use are polyvinyl chloride, polypropylene, polyurethane, etc. The plastics that are commonly encountered in EEE are Acrylonitrile Butadiene Styrene (ABS), Polycarbonate (PC), PC/ABS blends, High Impact Poly-Styrene and Poly-Phenylene Oxide blends (Table 13-3). The eventual presence of some types of flame retardants in the plastic fraction (e.g. Octa-BDE > 0.5%) and Pb in the metallic fraction could give the waste mixture hazardous characteristics and/or create a problem during recovery. However, in principle, the Pb containing fraction B1050, do not contain enough Pb to present hazardous characteristics.

Table 18-1: Typical vehicle composition (the fractions included in the waste mixture are in red) (UK Department of Environment, 2000)

Material	Proportion by weight (%)
Steel	66
Zn, Cu, Pb	2
Al	6
Plastics	9
Rubber (tyres)	4
Adhesive, paints	3
Glass	3
Textiles	1
Fluids	1
Other	3

The chemical characteristics of the mixture depend on the type of metal and/or plastic contained in the predominant fraction.

Potential for contamination

An appropriate sorting is normally performed at the original recovery facilities. In the case of ELV, the contamination with hazardous components (e.g. motor oil) is normally avoided thanks to pre-treatment of shredded fraction. In the case of WEEE, the waste stream containing hazardous material is separated from non-hazardous waste stream after dismantling. However, the plastic fraction may contain PVC potentially hazardous additives and some types of HFR at concentrations that could give to the mixture hazardous characteristics and/or create problems during recovery operations. In principle, plastic containing flame retardants and PVC should not be included in the B3010 (personal communication Mr. Shafii, UNEP).

18.2. MANAGEMENT ASPECTS

18.2.1. Generation

- **Quantity produced in Europe**

This mixture is partially generated from shredding of ELV and it is known that annually 8-9 million tonnes of ELV waste are produced in EU (ETC/RWM, 2008). Metallic fraction represents almost 75% and plastic 9% of ELV weight. International statistics indicate that the shredder residue (flock) comprises approximately 8% ferrous metal (680 000 tonnes) and 4% (340 000 tonnes) non-ferrous metals (Environment Australia, 2002). These figures equate to approximately 98% efficiency in recovering ferrous metals, and 99% recovery of non-ferrous metals, from ELVs. This waste mixture also contains shredded WEEE. The amount of WEEE generated in the EU was estimated at 6.5-7.5 million tonnes per year in the late 1990 increasing by 16-28% every five years. Of the EEE equipment covered by the Directive, it is estimated that 715 000 tonnes of plastics waste was generated (Western Europe, 2003) and this can be expected to increase over time with the dynamic growth of this market sector (Mark, 2006).

18.2.2. Recovery

- **Recovery operations**

R 4: Recycling/reclamation of metals and metal compounds

R 3: recycling/reclamation of organic substances which are not used as solvents[59]

Description of Recovery operations:

- **Non-interim recovery operations:** After separation, the metal rich fraction is smelted at high temperature (for metal recycling see section 3.2.2. The plastic containing fraction is then crushed, extruded and granulated. Plastic granules are a raw material to plastic industry. In general, in the plastic fraction there are quite distinct groups of materials of different molecular construction and recycling depends on the use of effective and efficient identification and separation technologies. As a consequence, the majority of the plastic fraction is likely incinerated for energy recovery and/or landfilled. Alternatively, the plastic fraction can be used as chemical feedstock for chemical recycling.

- **Technological capacity of recovery**

The capacity of recovery in EU and OECD countries varies depending on the considered recovery step: 1) metal or plastic recovery; 2) incineration or landfilling of discarded shredder waste fraction.

[59] In the proposal, only R 4 recovery operation is indicated. However, since this waste mixture contains plastic (B3010) the recycling operation "R 3: recycling/reclamation of organic substances which are not used as solvents", should be indicated. Thus, we consider plastic recovery as a recovery operation in the factsheet.

1. In EU27+NO/CH, 50% of all plastics (12 million tonnes) are actually recovered (including recycling and energy recovery)(Plastics Europe, 2008). In EU, many metal smelters have capacities above 100 000 tonnes per year.
2. Dedicated municipal solid waste incineration capacity is estimated to be at least of 45 million tonnes/year in EU and 100 million tonnes/year in OECD countries (OECD Compendium, 2007).

- **Recovery quota**

Almost 100% of the predominating metal in the mixture is recycled. All other metals present in the mixture can be recycled after a multi-step process (e.g. metal recovery from flue dust and slag). However, the recovery quota depends on the percentage of plastic in the mixture. As said in the previous section (technological capacity of recovery) only 50% of plastic is recovered in EU (including incineration). The rest is usually landfilled.

- **Methods of storage at the recovery facility**

Hard standing with groundwater protection.

- **Use of recovered material**

Recovered plastic and metals are sold as raw material to industry that can use them in place of raw material.

- **Environmental benefits of recovery**

Metal recycling produces substantial environmental benefits from reduced environmental releases and resource reuse and avoided landfilling. Recycled metals consume significantly less energy and water, and produce less air pollution, than smelting processes. It has been estimated that, compared to manufacture from virgin materials, recycled steel uses 74% less energy, 40% less water and reduces air pollution by 86% and water pollution by 76%. For other metals, the energy savings are: 95% (Al), 85% (Cu), 65% (Pb), 60% (Zn) (British Metal Recycling Association). Recycling of plastics represents 80% of energy saving. In addition substantial reduction of CO_2 emissions can be reached by recycling (Table 18-2).

Table 18-2: Average tonnes of equivalent CO_2 emission reductions resulting from materials recycled

Recycled material	CO_2 emission reductions factors (tonnes)
Al	10.10
Steel	1.11
Cu	3.66
Plastics	1.77

- **Environmental/health impacts of recovery**

  - **General impacts of recovery operations:** Metal recovery works in general can generate air pollutants emissions (e.g. dioxin and furan emissions). As a general guideline, emission of air pollutants in the recovery facilities should be minimised and controlled to prevent harm to the environment or adverse effects to the human health. After plastic incineration, about 20 to 30% of material is still present as ash that must be handled for final disposal. In addition, the incineration could produce emission to air of substances escaping flue gas cleaning and the large amount of residues from gas cleaning and combustion.

- **Specific impacts of the mixture:** the presence of some types of flame retardants (HFR) in the plastic fraction could lead to the liberation of toxic molecules to the environment during recovery operations, if the recovery is not performed in appropriately equipped facilities (personal communication Mr. Tange). There is also a high probability for this waste mixture to be contaminated with PVC. Incineration of PVC could have non negligible impacts on both environment and human health if it is not performed in an appropriately equipped incinerator. However, if incineration is performed in a modern incinerator appropriately equipped the presence of HFR is not of concern (personal communication Mr. L. Tange). Moreover, in principle HRF containing plastics and PVC should not be present in the mixture, since their inclusion in the fraction B3010 is unlikely (personal communication, Mr. Shafii, UNEP).

18.2.3. Shipment and trade

- **Packaging types during shipment**

The waste is transported in form of drum, wooden barrel, box and bag.

- **Amount shipped**

This waste mixture is originated by shredding of ELV and WEEE. Regarding the WEEE, in the trade statistics the registered shipments from EU show a maximum of 250 000 tonnes (including used products). 90% of the shipments take place within the EU. At least 20 000 tonnes are exported to Africa and the Middle Eastern countries. Since the plastic fraction represents the 20% of WEEE weight this means approximately 50 000 tonnes shipped within the EU and 4 000 shipped to third countries. This mixture also originated by treated ELV (metal and plastic fraction). The available data on shipment of ELV describe only the stream of vehicles in terms of used products not in terms of treated ELV (ETC/RWM, 2008).

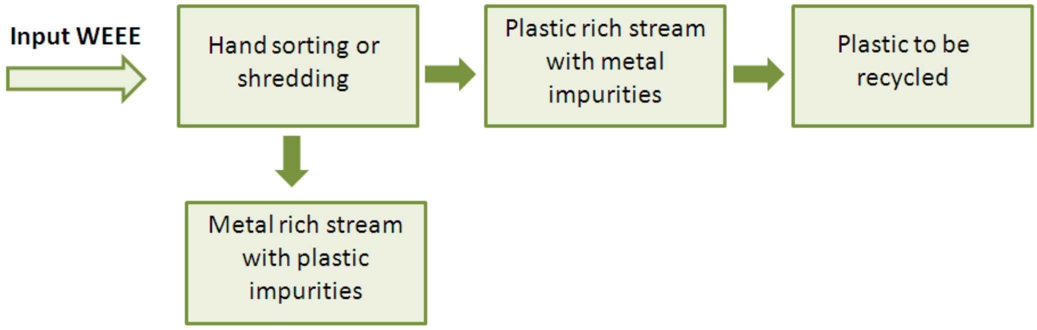
- **Enforceability**

The absence of Annex I materials to an extent they present Annex III characteristics (e.g. Pb in B1050) is normally verified at the original facility. However it is worth stressing that verifying the absence or the exact concentration of potentially hazardous components during shipment inspection would be hardly achievable due to the difficulty of obtaining a representative sample of the waste mixture.

18.3. ASSESSMENT OF THE WASTE MIXTURE

The percentage of each component of this mixture (metals and plastic fraction) has not been clearly defined in the proposal. The major information gap is the nature of the predominant fraction. In fact, it is not clear if the mixture contains mainly metals or mainly plastics. Therefore, when considering a simplified scheme of WEEE recycling it is very difficult to determine what is the step generating the described waste mixture and if the mixture corresponds to the metal rich stream or to the plastic rich stream (Figure 18-1).

Figure 18-1: schematic diagram for WEEE recycling

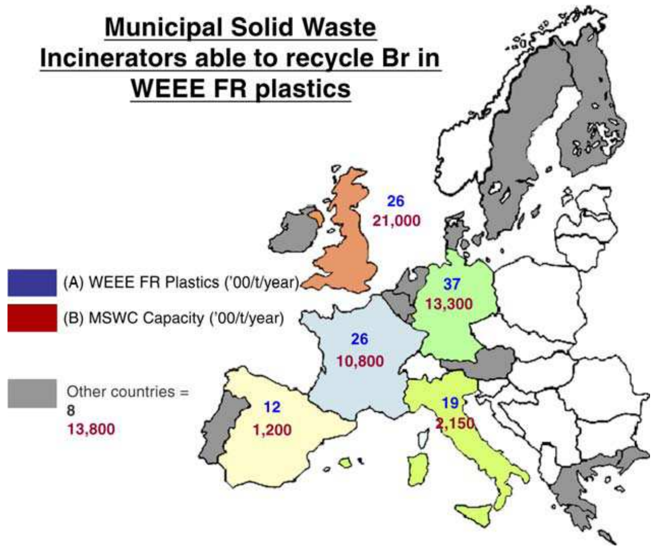


The most popular existing treatment for WEEE components containing significant quantities of precious metals (e.g. printed circuit boards) is feeding metal smelter furnaces. The hydrocarbon component of these items acts as a reducing agent in the smelter and the ceramics and glass contribute as fluxes. Precious metal smelters include sophisticated gas cleaning systems which capture any halogenated compounds that are liberated in the smelter flue gas.

In the case of a plastic major fraction, an aspect to be kept in mind is that the primary driving forces for any WEEE treatment operation are the removal of any hazardous materials and again the recycling of metals. Thus, any operation to recover plastics from WEEE would be secondary in respect to metal recycling. Plastics-rich streams with a plastic content of more than 90% can be achieved by manual dismantling and sorting but this is usually very expensive. Alternatively, a multi-step mechanical separation can be performed but the quality and the characteristics of this plastics-rich stream derived from shreddering depend very much on the market sector supplying the input material and the various categories collected. Importantly, economic pressures can lead the shredder operators to perform a further recovery of metals from the shredder residue. This further step may result in a plastics-rich residue which may not have the characteristics to perform mechanical recycling, incineration or chemical recycling. Another factor to consider is the possibility to have HFR and PVC heavy metals based stabilisers in the plastic fraction. Even if incineration is an efficient option for the plastic fraction recycling, especially regarding the high heating value of these materials, the high level of HFR in some polymer fractions might lead to these materials being classified as hazardous (Schlummer, 2007).

It is important to notice that, some authors stated that from an energy recovery point of view, sufficient capacity exists to handle all flame retardants containing plastics from WEEE in Europe (Figure 18-2). For example, in Germany, more than 60 modern incinerators exist, with a capacity of more than 13 million tonnes/year. In general, there is enough capacity today for adding up to 3% plastics containing 2-3% bromine from Brominated Flame Retardants and being in safe conditions (Tange, 2005).

Figure 18-2: Municipal solid waste incinerators able to recycle Brominated flame retardants containing plastic from WEEE (from Tange and Drohmann, 2005).



PVC could be present in the plastic fraction from ELV. PVC incineration may impact both health and environment if not appropriately performed, as explained before. Most of the concerns regarding the health impacts of the disposal of PVC-containing products are focused on the emission of toxic compounds during incineration. This could be a cause of concern especially for countries without a strict legislation on the subject or not possessinf modern and appropriately equipped incinerators. Burning of PVC containing waste in incineration plants can release dioxins and furans. Several adverse health effects have been associated with dioxins, including soft tissue, sarcomas, lymphomas, skin lesions (chloracne), stomach cancer, biochemical liver-test abnormalities, elevated blood lipids, fatal injury, immune system and neurological effects (Mitrou, 2001). In addition, a recent review concluded that dioxin exposure is associated with mortality from both ischemic heart disease and all cardio-vascular diseases (Humblet, 2008).However, it is worth noticing that dioxins and furans formation and emission is under control in modern incinerators.

Regarding the environment, PVC production and end-of-life could lead to potential environment contamination. As for health, some kind of additives and toxic emissions are of particular environmental concern (European Commission, 2000; Moore, 2008; Ohelmann et al., 2008), in particular:

- **Pb and Cd containing stabilisers:** most Pb compounds and Cd compounds including those used in PVC are classified as dangerous for the environment and can accumulate in certain organisms.
- **Phthalates plasticizers:** phthalates are not chemically bonded to PVC, and as a result, they volatilise from PVC plastic. Importantly, some classes of phthalates can be at the origin of endocrine disruption in aquatic organisms.
- **Dioxin emissions during PVC production and incineration:** dioxins are global pollutants. They can be found in the tissues of whales in the deep oceans, polar bears in the high Arctic, and virtually every human being on earth.

However it is worth noticing that the production and the emission of hazardous components during incineration are highly dependent on the type of incinerator and can be strongly reduced if the incineration is performed in modern and appropriately equipped facilities (personal communication L. Tange).

18.4. CONCLUSIONS AND RECOMMENDATIONS

Based on our analysis, the waste mixture presents:

- no hazardous characteristics if the absence of hazardous components is ensured by the original facility
- a potential for contamination with PVC potentially hazardous additives as well as with other hazardous components (e.g. motor oil) if the pre-treatment is not appropriately performed
- good environmental benefits
- a difficult enforceability

As a conclusion, the waste mixture could be included in Annex IIIA only if the mixture is better define (e.g. percentages of plastic and metal fraction) and the absence of PVC potentially hazardous additives, and other hazardous components is ensured by documents provided at the original facility. In general, the recovery of this mixture requires modern and appropriately equipped facilities. As a consequence the transport of this mixture should be limited to EU and OECD countries.

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19. WASTE MIXTURE PROPOSAL # 17

Proposed entry to Annex IIIA: B3010 solid plastic waste with B3040 rubber wastes

Proposal submitted by: United Kingdom

19.1. PROPERTIES OF THE WASTE MIXTURE

Description: Non-metallic waste of plastic and rubber from waste management facilities.

Basel code:

Basel Code	Code description
B3010	Solid plastic waste
B3040	Rubber wastes

Based on the MS proposal, the mixture would cover the following waste of the European Community list of wastes:

EU Code	Code description	Origin
19 10 06	Other fractions other than those mentioned in 19 10 05[60]	From shredding of metal-containing wastes [cat. 1910]
19 12 04	Plastic and rubber	From the mechanical treatment of waste [cat. 1912]

- **Process(es) by which mixture is produced**

The waste mixture originates from shredding of post-consumer ELV and WEEE. During shredding, several different size reduction aggregates like hammer mills, impact crushers, chippers, and different cutting mills like rotor scissors, rasp mills and rotary drum cutters are used. Existing separating units are sieves, air classifiers, cyclones, magnetic separators, eddy current separators, vibration sorters, air table separators, and more complex facilities like heavy media separators, up to even more sophisticated technologies, like linear motor plants, corona separators or micro sorters. The mechanical separation permits to obtain the rubber and plastic mixture described in the proposal.

- **Physical characteristics**

This waste mixture is in a solid form.

- **Chemical characteristics**

The waste mixture contains exclusively plastic and rubber. The eventual presence of PVC potentially hazardous additives and some types of flame retardants (HFR) if not appropriately managed could give to the waste mixture hazardous characteristics.

[60] Other fractions containing dangerous substances

However, the plastic fraction of the mixture is defined as B3010 (solid plastic waste) which is already included in Annex III as, in principle, non containing PVC or HFR plastic waste (personal communication of Mr. Shafii, UNEP).

- **Potential for contamination**

If an appropriate sorting is carried out at the original recovery facilities, there is no potential for contamination. The post consumer waste is normally pre-sorted to avoid plastic pieces containing HFR in the waste mixture[61]. In the case of ELV, the contamination with hazardous components (e.g. motor oil) is normally avoided thanks to pre-treatment of shredded fraction. However, PVC containing potentially hazardous additives may be present in the plastic fraction from ELV.

19.2. MANAGEMENT ASPECTS

19.2.1. GENERATION

- **Quantity produced in Europe**

The mixture is partially generated by shredding of ELV. In EU-25, the yearly generation of ELV is between 8 and 9 million tonnes. As for factsheet #8, it can be roughly estimated that 2 million tonnes of the mixture are produced yearly in the EU, since plastic and rubber fraction of the shredded ELV waste represents roughly the 25% of the total (Environment Australia, 2002). The mixture could also be partially generated by shredded WEEE. The WEEE generated in the EU was estimated at 6.5-7.5 million tonnes per year in the late 1990 increasing by 16-28% every five years. It is estimated that 715 000 tonnes of plastics waste was generated in 2003 and this can be expected to increase over time with the dynamic growth of this market sector (ETC/RWM, 2008).

19.2.2. RECOVERY

- **Recovery operations**

R 3: Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes).

R 5: Recycling/reclamation of other inorganic materials

Description of Recovery operations:

- **Non-interim recovery operations:** After separation, the plastic containing fraction is crushed, extruded and granulated. Plastic granules are a raw material to plastic industry. In general, in the plastic fraction there are quite

[61] The WEEE Directive requires the separation of plastics containing brominated flame retardents prior to recycling, energy recovery or disposal. A study has been financed by WRAP to find ways to treat polymers containing brominated flame retardants in line with the requirements of the WEEE Directive (WRAP, Develop a process to separate brominated flame retardants from WEEE polymers, Final Report, 2006).

distinct groups of materials of different molecular construction and recycling depends on the use of effective and efficient identification and separation technologies. As a consequence, the majority of the plastic fraction is likely incinerated for energy recovery and/or landfilled. Alternatively, the plastic fraction can be used as chemical feedstock for chemical recycling. The rubber fraction is more likely incinerated for energy recovery or sold as raw material.

- **Technological capacity of recovery**

In EU27+NO/CH, 50% of all plastics (12 million tonnes) are actually recovered (including recycling and energy recovery). The capacity for incineration is of several millions of tonnes per year (Plastics Europe, 2008).

- **Recovery quota**

The recovery quota is potentially 100% if we consider energy recovery option.

- **Methods of storage at the recovery facility**

Concrete hard standing with drainage and groundwater protection.

- **Use of recovered material**

Raw material to be sold on international markets or to be burnt in incinerators.

- **Environmental benefits of recovery**

The main environmental benefits from recovery of this waste mixture include avoided landfilling, avoided emissions (Table 18-2), and material and energy conservation.

- **Environmental/health impacts of recovery**

  - **Specific impacts of the mixture:** specific impacts of the mixture recovery may be linked to the presence of PVC potentially hazardous additives and HFR in ELV shredded residues. As for mixture # 10, the presence of PVC could be at the origin of the environmental impacts of the mixture recovery due to the presence of Pb and Cd-based stabilizers. These molecules are normally immobilized in the PVC matrix. However, during the recovery (e.g. granulation) the increased surface area may facilitate extraction under certain conditions.

19.2.3. Shipment and trade

- **Packaging types during shipment**

The waste is transported in drum, wooden barrel, box, bag or bulk.

- **Amount shipped**

According to the proposal, this waste mixture is not normally shipped due to required notification.

- **Enforceability**

The composition of this waste mixture can be easily verified by visual inspection (e.g. the fact that the waste is constituted only by plastic and rubber fraction). However, the eventual presence of contaminants, which could require precaution during recovery (e.g. some types of PVC stabilisers), could only be determined by chemical analysis. Even if a qualitative analysis of the waste is quite easy to be performed during shipment inspection, the possibility to perform a quantitative analysis would depend on the feasibility of sampling.

19.3. ASSESSMENT OF THE WASTE MIXTURE

In the most cases, this waste mixture is landfilled or incinerated due to the high cost of the sorting process needed to separate the plastic and the rubber fraction prior to sell them as raw materials. In the case of plastics from WEEE, the quality varies to a very large extent as a result of the different requirements for the various market sectors. The critical criteria determining the suitability of post-consumer recycled plastics for new applications are the content of metals, heavy metals, and halogenated compounds. The reduction of metals, heavy metals and brominated flame retardant compound concentrations from post consumer WEEE plastics can be achieved by using the best available identification and separation technologies. The degree of separation required to guarantee a high quality plastics product for sale is significant and subsequently the cost of such a separation system is also important and only economically justified in the case of high value plastics products. As a consequence, this waste mixture would be more probably incinerated for energy recovery rather than separated in fractions and recycled. Interestingly, Dodbiba et al. (2008) compared the two treatment options, energy recovery and mechanical recycling of plastic wastes from discarded TV sets, in the context of life cycle assessment (LCA) methodology. They concluded that mechanical recycling of plastics is more attractive in environmental terms than incineration for energy recovery, which generates a larger environmental burden (Dodbiba, 2008). In addition, it is also possible that this plastics-rich residue may not have the characteristics to be incinerated due to the previous treatments performed to obtain a metal rich fraction from the shredded residue. As a consequence, this mixture would be more likely landfilled. Another factor to consider is the possibility to have some types of HFR and PVC potentially hazardous additives in the plastic fraction. Even if incineration is an efficient option for the plastic fraction recycling, especially regarding the high heating value of these materials, the high level of HFR or PVC potentially hazardous additives in the plastic fraction might lead to these materials being classified as hazardous (see section 18.3.).

19.4. CONCLUSIONS AND RECOMMENDATIONS

Based on our analysis the waste mixture presents:

- no hazardous characteristics if the absence of hazardous components (e.g. Pb and Cd-based stabilisers) is ensured by the original facility
- a potential for contamination with hazardous components (e.g. motor oil) if the pre-treatment is not appropriately performed
- good environmental benefits if landfilling is surely avoided
- a difficult enforceability

As a conclusion, the waste mixture could be included in Annex IIIA only if the absence of other hazardous components is ensured by documents provided at the original facility. Due to the high probability to find HFR in this mixture, transport should be limited to EU and OECD countries in order to ensure an incineration in appropriately equipped facilities.

19.5. REFERENCES

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20. WASTE MIXTURE PROPOSAL # 18

Proposed entry to Annex IIIA: Combination packaging consisting of a paper outer package with an attached and easily removable separate plastic inner bag (B3010 + B3020)

Proposal submitted by: Netherlands

20.1. PROPERTIES OF THE WASTE MIXTURE

Description: Combination packaging consisting of a paper outer package with an attached and easily removable separate plastic inner bag

Basel code[62]:

Basel Code	Code description
3010	Solid plastic waste
3020	Paper, paperboard and paper product wastes

- **Process(es) by which mixture is produced**

Disposal of combination packages from post-consumer waste stream and production failures from the packaging industry (Figure 20-1).

- **Percentage of each of the components in the mixture**

In the proposal, the percentages of each component of the mixture are indicated as following: paper 70-95% and plastic 5-30%.

- **Physical characteristics**

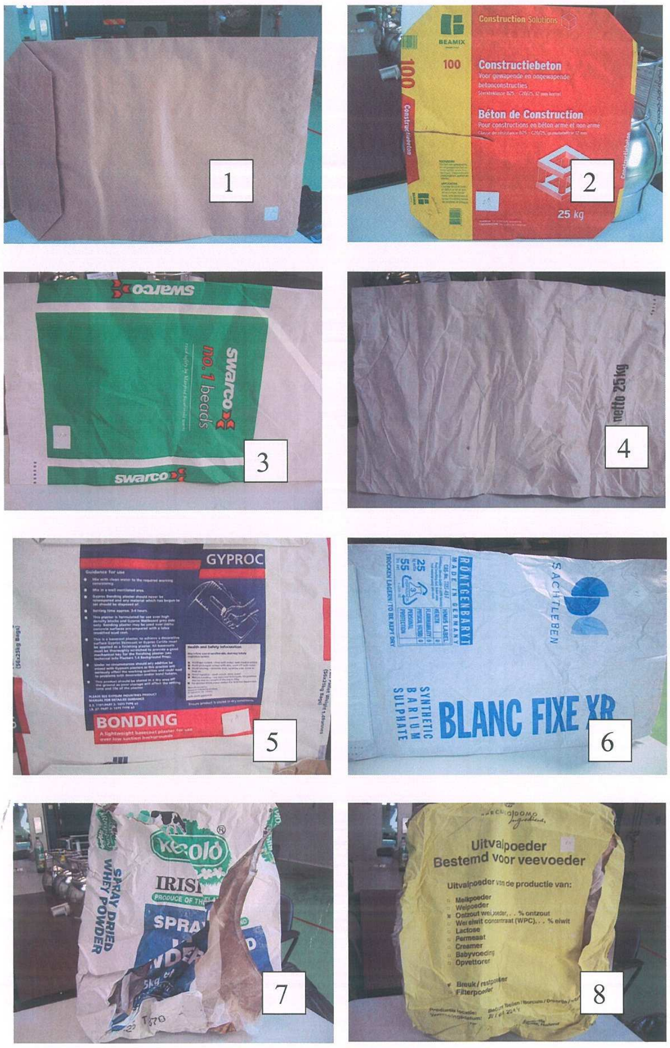
The proposed entry is in solid state.

- **Chemical characteristics**

The chemical characteristics depend on the predominant fraction which is paper and/or the plastic polymer used in the packaging. The polymer that is normally used in this kind of composite packaging is Polypropylene (PP), which is a linear hydrocarbon polymer. It is referred to as a polyolefin or saturated polymer, which is known for its chemical inertness. Polypropylene is one of those most versatile polymers available with applications in virtually all of the plastics end-use markets. Polypropylene possess a successful combination of properties, including flexibility, strength, lightness, stability, moisture and chemical resistance, and easy processability, and are well suited for recycling and reuse. Polypropylene is a combustible material and will burn if involved in a fire. It is however not considered to be a significant fire risk.

[62] In the proposal, the European Community codes are not specified. However, the category 15 01 05, which is a specific code for composite packaging, could be appropriate.

Figure 20-1: examples of paper and plastic combination packages



Decomposition and combustion products include carbon monoxide, carbon dioxide, carbon (soot), formaldehyde, and acrolein. The chemical characteristics could also depend on the residues potentially present inside the packaging generated from consumption.

- **Potential for contamination**

In the case of composite packaging waste generated by consumption, there is a potential for contamination with residues of previous content of the packaging, for example food or chemical residues (e.g. cement). In the case of packaging disposed by packaging industry there is no risk of contamination with other material.

20.2. MANAGEMENT ASPECTS

20.2.1. Generation

- **Quantity produced in Europe**

No data are available on this specific composite packaging.

20.2.2. Recovery

- **Recovery operations**

R 1: Use as a fuel (other than direct incineration) or other means to generate energy/use principally as a fuel or other means to generate energy

R 3: Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes)

R 12: Exchange of wastes for submission to any of the operations numbered R 1 to R 11

Description of Recovery operations:

- **Interim recovery operations:** the recycling process of this kind of waste mixture consists of five interim stages: waste collection, separation, grinding (only if plastic is used for recycling or as a fuel), cleaning and washing, and drying. These stages are dependent on the economic conditions and technical availabilities of different countries. The separation of plastic and paper is necessary to improve the subsequent recycling process: generally, reprocessing of plastics waste that is contaminated with more than 5% paper by conventional plastics processing machinery is difficult and becomes almost impossible at paper levels exceeding 15%. However, to note, that on the basis of other studies, it has been concluded that the process of commingling plastics waste containing 30–40% paper is also feasible through hydrolytic treatment of the plastics waste containing paper prior to conventional processing (Mehrabzadeh, 2001). Sorting technology is being introduced to sort plastics automatically, using various techniques such as X-ray fluorescence, infrared and near infrared spectroscopy, electrostatics and flotation.
- **Non-interim recovery operations:** After sorting, the plastic fraction can be materially recycled, usually to products of lesser value, particularly if plastic mixtures are used, or thermally recycled in municipal waste incineration plants or steel works. Plastics are derived from petroleum feed-stocks and possess a high heat content that is advantageous for waste-to-energy incineration (heating value almost equivalent to that of the coal). There are 3 types of incinerators, also known as municipal waste combustors (MWCs): mass-burn incinerators, refuse-derived fuel incinerators, and modular combustors. Alternatively, plastic can be mechanically recycled through melting, shredding or granulation of waste plastics. The plastic is either melted down directly and

moulded into a new shape, or melted down after being shredded into flakes and then processed into granules called re-granulate.

- **Technological capacity of recovery**

According to CEPI, in EU there are 1219 paper mills including 214 pulp plants and 1005 paper facilities for paper production from both wood-pulp and recovered paper. In 2005, 47.3 million tonnes of paper was recycled (recycling rate 54.6%)(BIR, 2006). In EU27+NO/CH, 50% of all plastics (12 million tonnes) are actually recovered (including recycling and energy recovery). The capacity for incineration is of several millions of tonnes per year.

- **Use of recovered material**

Recovered plastics can be reprocessed or used as raw material or fuel in a number of processes, including generating concrete (Siddique, 2008). One study also shows the possibility of reuse paper and plastic combination packages (e.g. cement bags) to improve the drying sensitivity of clay bricks (Mortel, 2001). Recycled PP can be used as raw material for production of compost bins, kerbside recycling crates, etc.

Recycled paper is mostly used in the newsprint plants and in the packaging sector.

- **Environmental benefits of recovery**

The general environmental benefits of plastic recycling are: conservation of non-renewable fossil fuels (plastic production uses 8% of the world's oil production, 4% as feedstock and 4% during manufacture), reduced consumption of energy, reduced amounts of solid waste going to landfill, reduced emissions of carbon-dioxide (CO_2), nitrogen oxide (NO) and sulphur-dioxide (SO_2). Plastic incineration greatly reduces the volume of garbage by about 90–95%. Paper recycling ensures natural resources conservation.

- **Environmental/health impacts of recovery**

  - **General impacts of recovery operations:** paper recycling leads to fuel consumption and emissions of greenhouse and acidifying gases. If plastic incineration is performed, at the end, about 20 to 30% of material is still present as ash that must be handled for final disposal. In addition, the incineration could produce emission to air of substances escaping flue gas cleaning and the large amount of residues from gas cleaning and combustion.

20.2.3. SHIPMENT AND TRADE

- **Packaging types during shipment**

The waste is transported in bales.

- **Enforceability**

The verification that the waste mixture consists exclusively of paper-plastic composite packages and that it is not contaminated with undesired material could be quite easily done during shipment inspection.

20.3. ASSESSMENT OF THE WASTE MIXTURE

According to ProEurope, this waste mixture cannot be considered as a composite waste, because the plastic part can be separated easily from the cardboard part and the plastic fraction is not recycled, but rather incinerated or landfilled afterwards. Thus, the relative proportion of landfilled and incinerated plastic fraction will determine the real value of the Environmental Benefits associated to the inclusion of this mixture in Annex IIIA.

It is important to mention that the environmental benefits of recycling paper have been questioned in light of studies that have shown increased fossil fuel consumption and greater emissions of greenhouse and acidifying gases (Pearce, 1997). Regarding plastic incineration, there is always public resistance emerging because of the emission of some toxic fumes. However, current technology permit to operate incineration plants in a way that emissions would not be a problem. Two types of ash are produced by an incineration process:

- fly ash (the very fine particles entrained in incinerator exhaust gases)
- bottom ash (the large and heavy particles removed from the bed of the incinerator),which require disposal.

Landfilling these ash residues may not always be acceptable because of the potential for groundwater and soil pollution due to leachate carrying heavy metals such as Pb and Cd. Methods of protecting groundwater and soil from leachate, such as lining the landfill, can be expensive and are not always effective from an environmental standpoint. Accordingly, some research is being undertaken to effectively stabilise and recycle incineration residues in construction applications (Goumans, 1991).

20.4. CONCLUSIONS AND RECOMMENDATIONS

On the basis of our analysis, the mixture presents:

- no hazardous characteristics, given that the packaging do not contain hazardous components that could be present in traces in the waste (e.g. contamination with residues of previous content of the packaging)
- a potential for contamination with the content of packaging which varies depending on the waste source
- acceptable environmental benefits
- an acceptable enforceability

As a conclusion, this waste mixture could be included in Annex IIIA if the absence of contaminants capable of preventing an environmental sound recovery is ensured.

20.5. REFERENCES

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Siddique R, Jamal Khatib B, Inderpreet Kaur A. Use of recycled plastic in concrete: A review, Waste Management, Volume 28, Issue 10, 2008.

20.6. CONTACTS

- Valérie Herrenschmidt-Munoz, in charge of Material Department, Ecoemballage – ProEurope.

21. CONCLUSIONS AND RECOMMENDATIONS

During this study, eighteen proposals of waste mixture presented by MS to the Commission were evaluated (Table 21-1), in order to assess whether and how each of them meets the criteria mentioned in recital 39 of the WSR and a factsheet was elaborated for each proposal. The analysis focused on 6 key points:

- Identification and description of the waste mixture
- Hazardous characteristics of the waste mixture
- Potential for contamination of the waste mixture
- The capacity to recover the waste mixture in EU and in OECD countries
- The environmental benefits/ impacts of recovery
- The enforceability

For these key points, following general conclusions and recommendations can be drawn.

Identification and description of the waste mixture

MS have been asked to identify the proposed waste mixture using Basel code, European Community list of waste code and, when appropriate, commercial specifications code (e.g. ISRI codes). The level of accuracy in definition of the waste is substantially different between these three codes. The Basel codes in particular do not provide information on the origin of the waste mixture[63]. In addition, MS have given a «usual description» of the mixture including the names of the major components. The usual description may then give additional information about the nature and the origin of the waste mixture.

As reported in our analysis, in some cases the proposed mixture should be more precisely identified and described. In particular, a precise and narrow description of the waste mixture specifying its origin, its components and when necessary, the absence of hazardous materials (e.g. components of particular concern or that need special precautions during recovery like WEEE, ELV, Pb, etc.) is crucial. However, it is worth noticing that, based on the current WSR and its annexes, the mixtures will be described in Annex III only at the level of Basel codes, as this is the level of detail provided in Annex III itself. **Thus, including the description of the waste mixture in addition to Basel codes in the final version of Annex IIIA (or IIIB) is crucial to avoid any misunderstanding and ensure the environmental sound management of the waste mixtures.**

[63] In a previously published report for the European Environment Agency (EEA), the Basel codes are considered too general to identify the exact nature of the shipping waste. This report also suggests using the codes from the European Waste List in order to give a much better overview of the shipments (ETC/RWM, Trans-boundary shipments of waste in the EU, Developments 1995-2005 and possible drivers, 2008, p.104).

Hazardous characteristics of the proposed waste mixtures

A number of potential hazardous characteristics have been identified in the proposed mixtures:

- The origin of the waste mixture is not always clearly described in the proposals. In some cases, the presence of WEEE and ELV is declared but in other cases we can only guess it. These categories of waste are the object of specific EU Directives (Directives 2002/95/EC; 2002/96/EC; Directive 2000/53/EC[64]) and could require taking special precautions during recovery. **Thus, the recovery of WEEE and ELV containing waste should be done in appropriately equipped facilities, and, following the precautionary principle, export of these mixtures may be limited to EU and OECD countries.**
- Several waste mixtures could include plastic containing PVC potentially hazardous additives and/or some types of HFR, (e.g. brominated flame retardants, BFR) which could be problematic for recovery over certain concentration. A range of Pb and Cd-based stabilisers are used in PVC and are normally immobilised in the PVC matrix. However, during the recovery (e.g. granulation) the increased surface area may facilitate extraction under certain conditions and lead to contamination with heavy metals (European Commission, 2000; Pan et al., 2006). When PVC burns hydrochloric acid is formed chlorine, which may be a cause of environmental concern. In addition, burning of PVC containing waste in incineration plants can release dioxins and furans. This could be a cause of concern especially for countries without a strict legislation on the subject or if incineration is not performed in appropriately equipped incinerators.
- Some of the HFR are forbidden in Europe (Directive 2002/95/CE). Depending on their concentration some HFR containing plastics are more or les suitable for incineration (e.g. Octa BDE). However, HRF containing products are still imported and commercialised in EU. As a consequence, the possibility to find some HFR at not authorised concentration in plastic containing fraction of municipal waste is not negligible. During thermal stress like recycling, plastics protected by BFR often produce polybrominated dibenzo-p-dioxins and dibenzofurans (PBDD/F), dangerous molecules for both environment and human health. However, it is important to remind that during preliminary sorting, the HFR containing plastics are normally discarded and not include in recoverable mixture. Moreover, incineration in a modern appropriately equipped incinerator will limit the production and the emission of potentially hazardous components.
- Plastic containing waste in general is covered by the B3010 Basel code. This code should not cover, in principle, neither HFR nor PVC containing plastics

[64] In 2007 the Commission adopted a Report on the implementation of Directive 2000/53/EC on End-Of-Life Vehicles for the period 2002-2005.

since is already listed as a “green waste”, however the exclusion of HFR and PVC is not explicit in the text of the Basel code. In addition, the verification of the absence of such potentially hazardous components (e.g. PVC heavy metal based stabilisers) is not easily verifiable during shipment inspection. **As a consequence, in the cases in which it will be necessary to ensure the absence of such problematic components, a specific document should be provided by the original facility where the waste mixture is produced.**

- **Potential for contamination of the waste mixtures**
  - Some MS have raised a concern about the risk to have organic contaminants in mixture arising from municipal waste. However, this risk is normally avoided by an appropriate pre-treatment.
  - Some MS have raised concern about the fact that percentages of the different waste fractions cannot be verified during shipment. However, the percentages of each fraction are normally verified at the origin by sampling and manual sorting. During shipment inspection, visual control could be carried out by a trained inspector. In addition, in many cases, indicating the percentages of each fraction in the waste mixture is advantageous because the description of the waste mixture is more precise and the contamination with similar waste streams of unknown origin is limited.
- **Hazardous characteristics linked to the physical state of waste**

The majority of the proposed mixtures have a solid physical state. The only hazardous characteristic linked to the physical state of the analysed waste mixtures could be linked to a potential dispersion during storage, shipment, and recovery. **Thus, particular attention should be paid to waste mixtures containing components in dispersible forms (e.g. powdery) and preventing measures including covered and paved storage areas should be applied.**

- **Technological capacity to recover waste in EU and OECD**

The technological capacity of recovery vary if the interim recovery operations are considered (e.g. manual sorting, sink-float sorting) or the non-interim recovery operations. In general, the interim recovery operations are possible in almost all EU and OECD countries. However, the capacity to recover a waste mixture varies depending on the mixture and on the considered fraction. Ferrous and non-ferrous metal recovery facilities, for example, are available in the majority of EU and OECD countries, while the technical capacity for the recycling of laminated liquid packages (e.g. Tetrapak) or plastic polymers mixtures is rarer. The plastic recovery sector is under constant evolution due to the ever increasing richness of commercialised polymers and complexity of recovery operations. In fact, one of the major challenges regarding the recycling of plastic containing fraction is the collection of small quantities of material from a multitude of sources (municipal waste is highly heterogeneous): the important cost of such operations is the major obstacle to recycling of plastic polymers.

As a consequence, in EU, the majority of recovered plastics is not recycled but burnt to perform energy recovery. This is likely to be the case of OECD countries as well.

In non-OECD countries the environmentally sound management of all waste mixtures, including the recovery or disposal of any residual waste and residues generated during the operations, is not necessarily ensured. **Thus, the shipment of problematic mixtures included in Annex IIIA, in accordance with Art. 58(1)c, should be restricted to the Community and OECD-area. Exports of these specific waste mixtures to non-OECD countries would thus remain subject to a notification procedure.**

- **Benefits and impacts of recovery**

In general, the recovery of the different waste mixtures fractions presents a number of environmental benefits including material, energy, and water conservation and reduction of GHG emissions. In addition, after the recovery, the quantity of landfilled material is reduced. However, some deleterious impacts on both environment and human health should also be considered. For example, a number of possible negative environmental effects of metal recovery activities are related to the presence of a thermal process. In this case, environmental effects are mainly related to the emitted gases. Emissions to air are the key environmental concern. The smelting process can generate mineral dusts, acidifying compounds, products of incomplete combustion and volatile organic carbons. Dust is a major issue, since it is generated in all process steps, in varying types and compositions. Any dust generated may contain metal and metal oxides.

Some plastic waste containing PVC potentially hazardous additives or HFR could also be a cause for concern during recovery operations (see "Hazardous characteristics of the proposed waste mixtures" section) causing impacts on both environment and human health.

We assume that in EU countries recovery facilities are equipped with the Best Available Technologies (BAT), as required by existing legislation (e.g. the best available filters to control air emissions during smelting or to avoid dioxins emissions during incineration) in order to minimize the environmental impacts of recovery operations. It should be consider that this could not be the case of third countries, especially non-OECD countries.

In addition, for the majority of wastes, recycling is preferable to energy recovery by incineration in terms of environmental and health impacts. **As a consequence, when feasible and appropriate, measures to favour recycling rather than incineration should be taken.**

- **Enforceability**

The level of enforceability varies between the different proposals. Regarding metal containing mixtures, the ISRI scrap specifications codes, when possible, may be provided by the country that has produced the waste mixture. It is worth noticing that, even if the percentages of each component are determined at the original facility by manual sorting and sampling, during shipment inspection, the declared percentages can be only roughly verified. As a consequence, the acceptance of percentages containing proposals should consider this aspect. Similarly, **the absence of hazardous components in compliance with the waste mixture definition should be ensured by official documents provided by the original facility (e.g. chemical analysis results)**. The verification of the chemical composition of a waste mixture is very difficult to perform during shipment inspection, mainly because of the difficulty to obtain a homogenous sample which is representative of the mixture.

Table 21-1: Table summarising the conclusions and recommendations for the analysed proposals (green= suitable for inclusion in Annex IIIA; yellow= conditionally acceptable for inclusion; orange=non suitable for inclusion in Annex IIIA). (*)= Regarding the use of EC waste codes instead of Basel codes for the waste to be included in Annex IIIB, please see explanation in the relevant factsheet

Proposal serial No.	Country	Basel codes	Definition	Suitability for inclusion in Annex IIIA and IIIB (proposals # 12, 13, 15)
1	Austria	B1010 + B1050	Mixture of ferrous and non-ferrous metals in non-dispersible form	Suitable for inclusion
2	Austria	B1010 + B1070	Ferrous and non-ferrous metals in non-dispersible form mixed with dispersible forms of Cu	Suitable for inclusion
3	Austria	B1070 + GB040 + B1100	Cu and precious metal bearing scrap in dispersible form – waste of Cu with metal slags and comer smelting wastes	Suitable for inclusion (only in BAT equipped facilities; EU and OECD)
4	Austria	GB040 + B1100	Non-ferrous metal-bearing waste arising from melting, smelting and refining including slags from precious metals and Cu processing	Suitable for inclusion (only in BAT equipped facilities; EU and OECD)
5	Finland	B1010 + B1050	Mixture of ferrous and non-ferrous metals in non-dispersible form	Suitable for inclusion
6	Finland	B1010 + B1020 + B1050 + B3010	Mixture of ferrous and non-ferrous metals with plastics	Suitable for inclusion–limited to EU and OECD
7	Finland	B1010 + B3010	Mixture of solid plastic waste with 3-8% ferrous and non-ferrous metals	Suitable for inclusion –(only if absence of lead and cadmium stabilisers from the PVC fraction is ensured by the original facility)- limited to EU and OECD
8	Finland	B1010 + B1050 + B3010 + B3040 + B3080	Mixture of solid plastic and rubber with 10% ferrous and non-ferrous metals	Suitable for inclusion –(only if absence of lead and cadmium stabilisers from the PVC fraction and other ELV problematic components is ensured by the original facility) –limited to EU and OECD
9	Finland	B1010 + B3040 + B3080	Mixture of solid rubber with 10% ferrous and non-ferrous metals	Suitable for inclusion (only if absence of tyres and other problematic components is ensured by the original facility)
10	Finland	B1050 + B1115	Mixture of waste metal cables and wires (75-90%) with non ferrous metals (<10%), including stones	Non suitable for inclusion
11	Finland	B1050 + B3010 + B3040 + B3080	Mixture of non-ferrous metals with 10% plastic and/or rubber	Suitable for inclusion (only if absence of lead and cadmium stabilisers from the PVC fraction is ensured by the original facility)-limited to EU and OECD

Proposal serial No.	Country	Basel codes	Definition	Suitability for inclusion in Annex IIIA and IIIB (proposals # 12, 13, 15)
12	Finland	B3020	Label laminate waste- pressure sensitive adhesive (PSA) laminate waste including minor quantities of raw materials used in label material production.	Suitable for inclusion (only if limited to waste from PSA laminate production excluding raw material and if the narrow definition is explicit in the final text of Annex III)
13	Finland	030307 (*)	Plastic-Al –cardboard-fibre composite from the pre-treatment of liquid packages (fibres 10%, Al 10%, plastic 60%, moisture 20%)	Suitable for inclusion (only if absence of lead and cadmium stabilisers from the PVC fraction is ensured by the original facility and if recycling/pyrolysis-gasification are favoured vs incineration)
14	Finland	B3010 + B3020	Mixture of plastic and cardboard from industry, retail, business properties and offices	Suitable for inclusion (only if absence of PVC lead and cadmium based stabilisers is ensured by the original facility and if the waste stream origin is strictly limited to office, retails and business properties)
15	Finland	030307 (*)	Plastic-cardboard-fibre composite from the pre-treatment of liquid packages (fibres 10%, plastic 70%, moisture 20%)	Suitable for inclusion (only if absence of PVC lead and cadmium based stabilisers is ensured by the original facility and if recycling/pyrolysis-gasification are favoured vs incineration)
16	United Kingdom	B3010 + B1010 + B1050	Metal and metal alloys in a solid metallic non-dispersible form with solid plastic waste	Suitable for inclusion (only if a better definition is provided and if the absence of PVC lead and cadmium based stabilisers is ensured by the original facility)-limited to EU and OECD
17	United Kingdom	B3040 + B3010	Non-metallic waste of plastic and rubber from waste management facilities	Suitable for inclusion (only if absence of PVC lead and cadmium based stabilisers and other problematic components is ensured by the original facility)-limited to EU and OECD
18	Netherlands	B3010 + B3020	Combination packaging consisting of a paper outer package with an attached and easily removable separate plastic inner bag	Suitable for inclusion (if the packaging did not contain hazardous components that could be present in traces in the waste)

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ANNEX 1 - CATEGORIES OF WASTES TO BE CONTROLLED

Waste Streams

Y1	Clinical wastes from medical care in hospitals, medical centers and clinics
Y2	Wastes from the production and preparation of pharmaceutical products
Y3	Waste pharmaceuticals, drugs and medicines
Y4	Wastes from the production, formulation and use of biocides and phytopharmaceuticals
Y5	Wastes from the manufacture, formulation and use of wood preserving chemicals
Y6	Wastes from the production, formulation and use of organic solvents
Y7	Wastes from heat treatment and tempering operations containing cyanides
Y8	Waste mineral oils unfit for their originally intended use
Y9	Waste oils/water, hydrocarbons/water mixtures, emulsions
Y10	Waste substances and articles containing or contaminated with polychlorinated biphenyls (PCBs) and/or polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs)
Y11	Waste tarry residues arising from refining, distillation and any pyrolytic treatment
Y12	Wastes from production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish
Y13	Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives
Y14	Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on man and/or the environment are not known
Y15	Wastes of an explosive nature not subject to other legislation
Y16	Wastes from production, formulation and use of photographic chemicals and processing materials
Y17	Wastes resulting from surface treatment of metals and plastics
Y18	Residues arising from industrial waste disposal operations

Wastes having as constituents:

Y19	Metal carbonyls
Y20	Be; Be compounds
Y21	Hexavalent chromium compounds
Y22	Cu compounds
Y23	Zn compounds
Y24	Arsenic; arsenic compounds

Y25	Selenium; selenium compounds
Y26	Cd; Cd compounds
Y27	Antimony; antimony compounds
Y28	Tellurium; tellurium compounds
Y29	Hg; Hg compounds
Y30	Thallium; thallium compounds
Y31	Pb; Pb compounds
Y32	Inorganic fluorine compounds excluding calcium fluoride
Y33	Inorganic cyanides
Y34	Acidic solutions or acids in solid form
Y35	Basic solutions or bases in solid form
Y36	Asbestos (dust and fibres)
Y37	Organic phosphorus compounds
Y38	Organic cyanides
Y39	Phenols; phenol compounds including chlorophenols
Y40	Ethers
Y41	Halogenated organic solvents
Y42	Organic solvents excluding halogenated solvents
Y43	Any congenor of polychlorinated dibenzo-furan
Y44	Any congenor of polychlorinated dibenzo-p-dioxin
Y45	Organohalogen compounds other than substances referred to in this Annex (e.g. Y39, Y41, Y42, Y43, Y44)

ANNEX 2 - LIST OF HAZARDOUS CHARACTERISTICS IN THE BASEL CONVENTION ANNEX III

UN Class[65]	Code	Characteristics
1	H1	Explosive
		An explosive substance or waste is a solid or liquid substance or waste (or mixture of substances or wastes) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings.
3	H3	Flammable liquids
		The word "flammable" has the same meaning as "inflammable". Flammable liquids are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers, etc., but not including substances or wastes otherwise classified on account of their dangerous characteristics) which give off a flammable vapour at temperatures of not more than 60.5ºC, closed-cup test, or not more than 65.6ºC, open-cup test. (Since the results of open-cup tests and of closed-cup tests are not strictly comparable and even individual results by the same test are often variable, regulations varying from the above figures to make allowance for such differences would be within the spirit of this definition.)
4.1	H4.1	Flammable solids
		Solids, or waste solids, other than those classed as explosives, which under conditions encountered in transport are readily combustible, or may cause or contribute to fire through friction.
4.2	H4.2	Substances or wastes liable to spontaneous combustion
		Substances or wastes which are liable to spontaneous heating under normal conditions encountered in transport, or to heating up on contact with air, and being then liable to catch fire.
4.3	H4.3	Substances or wastes which, in contact with water emit flammable gases
		Substances or wastes which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.

[65] Corresponds to the hazard classification system included in the United Nations Recommendations on the Transport of Dangerous Goods (ST/SG/AC.10/1Rev.5, United Nations, New York, 1988).

5.1	H5.1	Oxidizing Substances or wastes which, while in themselves not necessarily combustible, may, generally by yielding oxygen cause, or contribute to, the combustion of other materials.
5.2	H5.2	Organic Peroxides Organic substances or wastes which contain the bivalent-o-o-structure are thermally unstable substances which may undergo exothermic self-accelerating decomposition.
6.1	H6.1	Poisonous (Acute) Substances or wastes liable either to cause death or serious injury or to harm human health if swallowed or inhaled or by skin contact.
6.2	H6.2	Infectious substances Substances or wastes containing viable micro organisms or their toxins which are known or suspected to cause disease in animals or humans.
8	H8	Corrosives Substances or wastes which, by chemical action, will cause severe damage when in contact with living tissue, or, in the case of leakage, will materially damage, or even destroy, other goods or the means of transport; they may also cause other hazards.
9	H10	Liberation of toxic gases in contact with air or water Substances or wastes which, by interaction with air or water, are liable to give off toxic gases in dangerous quantities.
9	H11	Toxic (Delayed or chronic) Substances or wastes which, if they are inhaled or ingested or if they penetrate the skin, may involve delayed or chronic effects, including carcinogenicity.
9	H12	Ecotoxic Substances or wastes which if released present or may present immediate or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon biotic systems.
9	H13	Capable, by any means, after disposal, of yielding another material, e.g., leachate, which possesses any of the characteristics listed above.

ANNEX 3 - OPERATIONS AS DESCRIBED BY THE CODES OF DIRECTIVE 75/442/EEC

Non-interim recovery operations

R1: Use principally as a fuel or other means to generate energy

R2: Solvent reclamation/regeneration

R3: Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes)

R4: Recycling/reclamation of metals and metal compounds

R5: Recycling/reclamation of other inorganic materials

R6: Regeneration of acids or bases

R7: Recovery of components used for pollution abatement

R8: Recovery of components from catalysts

R9: Oil re-refining or other reuses of oil

R10: Land treatment resulting in benefit to agriculture or ecological improvement

R11: Use of wastes obtained from any of the operations numbered R 1 to R 11.

Interim recovery operations

R12: Exchange of wastes for submission to any of the operations numbered to R1 to R11

R13: Accumulation of material intended for any operation in the list