BRITISH STANDARD

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13437:2003

Packaging and material recycling —

Criteria for recycling methods — Description of recycling processes and flow chart

The European Standard EN 13437:2003 has the status of a British Standard

ICS 13.030.50; 55.040

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 13437:2003.

The UK participation in its preparation was entrusted to Technical Committee PKW/4, Packaging and the environment, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

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English version

Packaging and material recycling - Criteria for recycling methods - Description of recycling processes and flow chart

Emballages et recyclage matière - Critères pour les méthodes de recyclage - Description des procédés de recyclage et schéma de flux

Verpackungen und stoffliche Verwertung - Kriterien für stoffliche Verwertungsverfahren - Beschreibung von stofflichen Verwertungsprozessen und Flußdiagrammen

This European Standard was approved by CEN on 11 March 2003.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Contents

Foreword

This document (EN 13437:2003) has been prepared by Technical Committee CEN/TC 261 "Packaging", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2003, and conflicting national standards shall be withdrawn at the latest by November 2003.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document contains Annexes A, B, C, D, E, F, G and H which are normative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

The Directive on Packaging and Packaging Waste (94/62/EC) defines requirements for the manufacturing and composition of packaging. EN 13427 provides a framework within which this and other standards may be used together to support a claim that a packaging is in compliance with the essential requirements for packaging to be placed on the market as required by the Directive.

This European Standard outlines the stages through which packaging passes from raw material to the recovery of the used packaging after it has served its purpose. It amplifies these requirements by describing the process of material recycling for the various materials used for packaging and its principal aim is to provide practical guidance.

The recycling processes used for the recovery of used packaging, (which are often comprised of more than one material) and other used applications, are influenced by three main aspects:

1) the material from which the product is manufactured;

2) the source of the used packaging; and

3) the application for which the recycled material is intended to be used.

Consideration of all these aspects is necessary in order to optimise the technical, economic and environmental effectiveness of the recovery operations. This European Standard describes the recycling operations for the main material types and their position within the overall material production, use and recovery cycle.

Material recycling of used packaging should be seen within the overall life cycle of products and packaging. The purpose of packaging is the containment, protection, distribution and presentation of products including instructions as to their use. A major role is one of prevention of damage/wastage of the products contained in the packaging.

1 Scope

This European Standard defines the criteria for a recycling process and describes the principal existing processes for material recycling and their inter-relationship.

Both packaging and recovery technologies are subject to continuing and rapid development. This European Standard describes the present stage of knowledge but may be subject to modifications in the light of new developments.

The essential relationship between this and the five mandated European Packaging Standards and one (mandated) CEN Report is specified in EN 13427.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 643, *Paper and board – European list of standard grades of recovered paper and board.*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply:

3.1
packaging
all products made of any materials of any nature to be used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer

"Non returnable" items used for the same purpose shall also be considered to constitute packaging.

[Directive 94/62/EC]

3.2
recycling
reprocessing in a production process of the waste materials for the original purpose or for other purposes including organic recycling but excluding energy recovery

[Directive 94/62/EC]

3.3
feedstock recycling
recycling whereby typically organic materials are converted into low-molecular weight products which are reused for the production of other materials or in other chemical/production processes

3.4
packaging waste
any packaging or packaging material covered by the definition of waste in Directive 75/442/EEC, excluding production residues

[Directive 94/62/EC]

3.5
scrap
material which has passed through one or more of the operations of production, conversion and filling but is not part of the packaging or the packaging material sold for its intended purpose

3.6
reconditioning
necessary operations to bring a reusable packaging back into a functional state and having the same basic specification as the original packaging

NOTE An operation carried out on a used packaging, whether originally supplied as a single trip or reusable packaging, to bring it into a functional item of packaging but which changes its basic specification is defined as recycling, and not reconditioning.

3.7
primary raw material
material which has never been processed into any form of end use product

[EN 13430]

3.8
secondary raw material
material recovered for use as a raw material from used products and from scrap with the exception of the scrap arising within a primary production process

NOTE The precise nature of the primary production process may vary between material sectors. Reference to the relevant flow diagram will clearly identify this process.

3.9
recycling process
process which converts collected and sorted used packaging and scrap, together in some instances with other material, into secondary raw material or products

4 Description of Material Recycling Processes

4.1 Criteria for recycling processes

The basic criterion for a recycling process is that it has a specified input of used (packaging) material from which it recovers value in usable material. Recycling of used packaging will have an input of used packaging, which may or may not be processed with other materials, and the output will be feedstock or material used in the production of new products, which may, or may not, be for packaging applications. The recycling process will vary substantially according to the material to be processed, the source from which it comes, and the applications for which the recovered/recycled material is to be used.

Additionally the recycling process will use scrap from the various production, filling and packaging operations. Subsequent to the primary production process, the recycling process is a useful means of diverting this material from landfill. It should be noted that used packaging reprocessed through material recycling will be included in the recycling rate described by Directive 94/62/EC, while scrap will not be included in this rate.

Where the ‘second life’ application has a high demand for cleanliness and consistency, the recycling process will be required to ensure a high level of removal of extraneous/different material with stages in the recycling process for cleaning the recovered material by washing, de-inking etc. In other operations where the new application has a lower demand on the specification, separation of small amounts of extraneous material may not be necessary, nor complex cleaning operations. It will be environmentally and economically wrong to base recycling on the higher end of the quality specification, and the recycling operation is often designed to meet the specific needs of the source recovered products and the application for which the recycled material is to be used.

To cover this wide diversity of processes, the following clauses introduce the methodology and detailed descriptions of the recycling processes.

Detailed information on the specific material recycling processes is given in the explanatory notes for the individual material flow charts.

4.2 General Flow Chart

The General Flow Chart is in annex A and defines the Packaging and Packaging Material Flows for packaging in general. Explanatory notes to annex A give the definition of the flows designated by letters in the diagram. The nature of some flows is also indicated by text in the diagram and the main processes are identified by text on the diagram with additional information provided as appropriate in annex A.

4.3 Multi Component Packaging

For packaging to effectively meet its functional requirements, the unit of packaging will often comprise more than one component. Examples of these are:

— a liquid container with a label and closure with a sealing pad inside the closure;

— a corrugated case with adhesive tape or metal staples to effect closure;

— a drum with loose liner with lid and labels.

For material recycling it is necessary that the various components of the unit of packaging be compatible with the overall system and the expected final application in which the recycled material will be used.

To achieve this, the components need to satisfy at least one of the following requirements:

— compatible with each other in meeting the specification requirements of the application in which they are to be used;

— separable in the recycling process such that the targeted material/component can be cleaned and processed to the necessary specification;

— separable by hand, or in the sorting process prior to recycling, to leave the targeted material/component ready for recycling to the necessary specification.

Different recycling processes have been developed for the various materials used in packaging and are described in the annexes B, C, D, E, F, G and H. In addition, the recycling processes for any one material can vary dependant on the source of material and application into which the recycled material is to be used.

The compatibility of materials and requirements are further detailed in EN 13430 and CR 13688.

4.4 Technological Development

Research continues in the technology for the recovery and recycling of all materials so that they can be reused within and outside of the field of packaging, as indicated by the flows y and z. The descriptions given in each of the elaborations for the specific flow chart are therefore examples and are not limiting to the current and future processes.

4.5 Import and Export

Import and export occur for raw materials, packaging, (both unfilled and filled) and also used packaging for recovery and recycling. These are influenced by commercial pressures on supply and demand, as well as the availability of process capacity, in particular for recycling.

4.6 Specific Flow Charts

In addition to the General Flow Chart, a number of material-specific flow charts have been elaborated and these are as follows:

— annex B, Aluminium;

— annex C, Glass;

- annex D, Paper and Board;
- annex E, Plastic;
- annex F, Steel;
- annex G, Wood;
- annex H, Other Materials

In a number of situations, two or more of these material will be used together in the production of packaging in order to achieve specific properties. Where this is the case, the flow sheet associated with the dominant material by weight should be used.

These material-specific flow charts have the same overall layout as the general flow chart and retain the same identification for the flows. In particular, the lower half of the material-specific flow diagrams are identical to the general flow chart. The upper half however allows a definition of the variations in flows and processes which are specific to each material type.

Flows which are not possible with particular materials are hatched on the relevant diagrams.

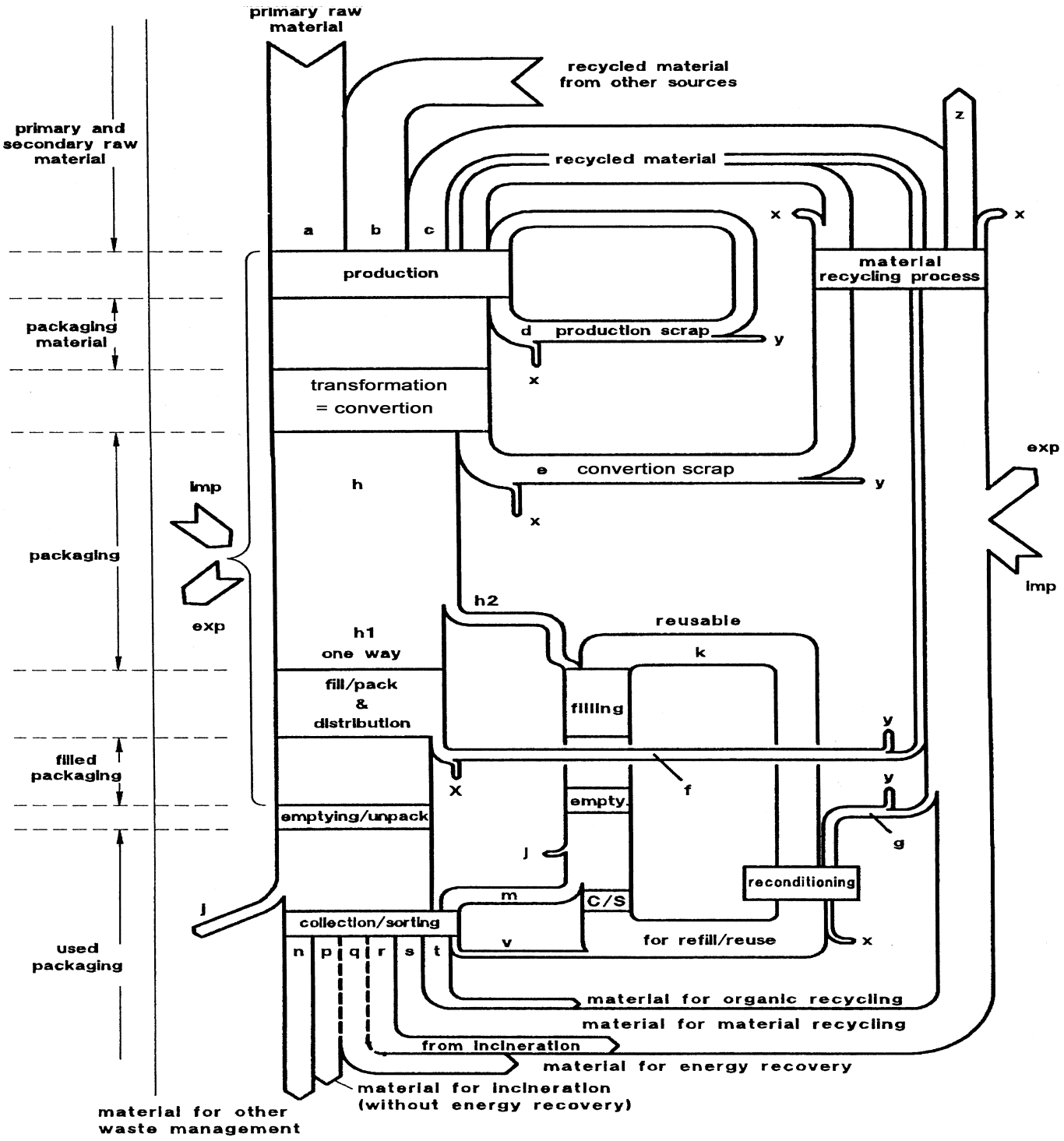
Explanatory notes to annex A also apply to annexes B to G.

The following sections of this standard contain a commentary on each of the material-specific flow charts to enable a full appreciation of the processes and flows described.

Annex A
(normative)

Packaging and packaging material flows

(relating to packaging as defined in the packaging and packaging waste directive)



The size of flows do not correspond to the volume of the flows.

Figure A.1 – Packaging and packaging material flows

Explanatory notes to annex A.

A.1 Flows

a) primary raw material;

b) recycled material from sources other than packaging;

c) recycled material from packaging or scrap;

d) production scrap;

e) conversion scrap;

f) scrap from the processes fill/pack and distribution;

g) waste from reconditioning (e.g. broken glass bottles);

h) all packaging supplied for the first filling/packing;

h_1) packaging supplied for single use;

h_2) packaging designed for refill/reuse and supplied for the first filling/packaging;

j) used packaging lost and not collected due to litter and/or other factors;

k) used and reconditioned packaging for filling/packing again ;

m) used packaging designed for refill/reuse leaving the refill/reuse loop through the waste management flows n to *v*;

n) material for other waste management than in flows p to t (e. g. disposal);

p) material for incineration in plants without energy recovery;

q) material for incineration in plants with energy recovery;

r) inorganic material from incineration plants can be used for recycling;

s) material for recycling (without organic recycling);

t) material for organic recycling (composting or biomethanisation);

v) packaging returned after collection/sorting of used one way packaging in the refill/reuse loop and used again (e. g. wooden crates);

x) material loss;

y) material for applications other than packaging;

z) recycled material for other applications (e. g. for automotive or building industry).

A.2 Flows - Import/Export

Raw materials, unfilled and filled packaging, and used packaging traded across national boundaries.

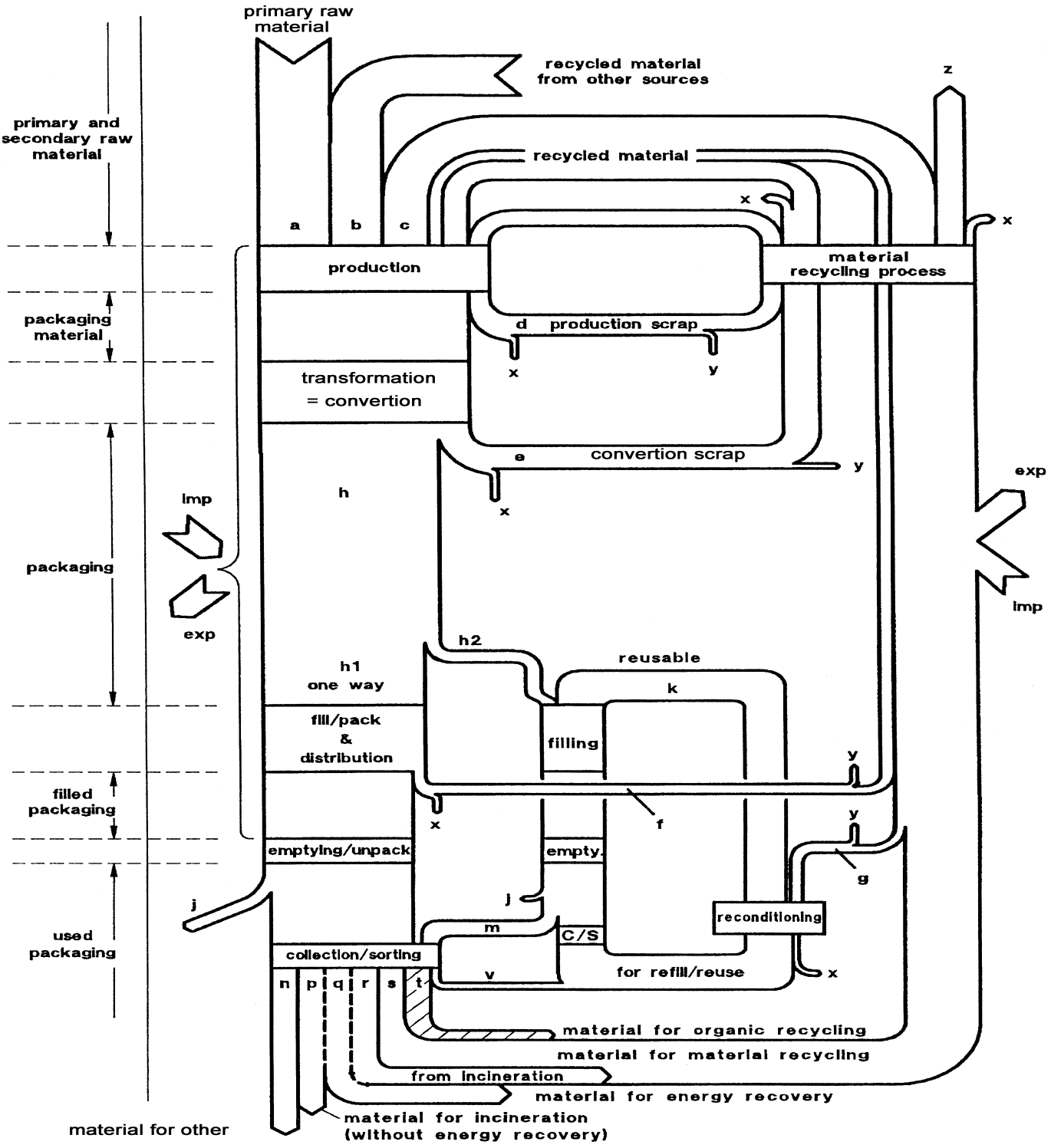
A.3 Process

C/S	collection and sorting of used empty packaging
Fill/Pack (and filling)	process of containing the product in the packaging
Empty	emptying/unpacking of the packaging by the user/consumer

Annex B
(normative)

Aluminium packaging and aluminium packaging material flows

(relating to packaging as defined in the packaging and packaging waste directive)



The size of flows do not correspond to the volume of the flows.
Flows which are not possible with this material are shown hatched

Figure B.1 – Aluminium packaging and aluminium packaging material flows

Explanatory notes (to be read in conjunction with annex A).

B.1 Introduction

This flow chart applies to all aluminium packaging materials and aluminium packaging such as beverage and food cans, trays, foil packaging, aerosols, beer kegs, and closures.

B.2 Input Materials

Flow a: First use ingot from primary smelters.

Flow b: Secondary material from sources other than packaging and of comparable chemical composition.

Flow c: Recycled aluminium from packaging.

B.3 Production

Initial production takes place using raw material which typically comprises both first-use ingot and ingot from secondary (recycled) material. The quantities of each depends on availability and purity requirements of the packaging material application. The ingot, or billet, produced is subsequently hot worked and cold worked to the required form and size for the packaging material. Production scrap is returned through the remelt facilities at the production site or through recycling process stages.

Flow d: Production scrap consisting of ingot ends, hot and cold mill croppings, edge trimmings, coil ends, etc.

B.4 Conversion

The conversion stage is the point at which packaging material becomes packaging by further processing or fabrication, i.e., deep drawn into cans or closures, fabricated into beer kegs or pressed into foil containers. The conversion scrap is returned through the recycling process.

Flow e: Conversion scrap consisting of webbings, edge trims and reject containers.

B.5 Fill/Pack & Distribution

At the filler/packer stage the packaging is filled with the product, packed and distributed for sale to the end user, the filler scrap is returned to the recycling process.

The majority of aluminium packaging is single trip (recyclable) packaging but for example aluminium beer kegs are reused.

Flow f: Filler scrap consisting of can/container bodies and ends and damaged packaging from packing and distribution.

B.6 Emptying/Unpacking

The majority of aluminium packaging is used by the domestic consumer and hence enters the domestic waste stream where it is collected and sorted by various methods depending upon individual material requirements and national recovery schemes.

Flow j: Details as given in the Annex to the General Material Recycling Flow.

B.7 Collection & Sorting

Collection of used aluminium packaging is by "Collect" or "Bring" systems. The "Collect" systems are reliant on the local authority/municipalities waste organisation or private contractor to collect by kerbside or home waste collection for central sorting for recycling, incineration or landfill. "Bring" systems incorporate the use of collection banks, charity collection, buyback, cash for cans and deposit systems. In these cases, initial sorting is completed by the householder who separates the used aluminium packaging from other household waste.

Sorting is made within sorting centres by mechanical, eddy current and magnetic means or manual methods. High standards are required of the sorted aluminium packaging to avoid contamination during the recycling process, with limits set for steel, food, plastics, moisture and other contaminants.

Flow n: Component of waste in managed landfill.

Flow p: This is normally as a disposal option for unsorted waste (see CR 1460).

Flow q: Thin aluminium foil packaging (typically up to 0.05 mm) contributes to the net output of available energy from incineration by its oxidation.

Flow r: Sorting aluminium for recycling through eddy current operation on the residue after incineration.

Flow s: Aluminium recovered for recycling through collection and sorting as detailed above.

B.8 Recycling Process

This comprises one or more operations which will convert used materials into a secondary raw material.

Aluminium packaging which is collected and sorted is returned to the recycling process in baled, shredded or loose form and is further processed to eliminate any remaining contamination such as iron, lacquers, food/product residues and moisture.

The remelting operation is carried out in appropriate furnaces and alloying elements added to the recycled metal and primary material to reach the required specification for the product. In the case of specialised facilities for the remelting of aluminium drinks cans the process is a closed loop system where the used drinks cans are recycled and remelted into ingot for rolling into further can-stock sheet.

Flow x, y and z: Details as given in the Annex to the General material Recycling Flow.

B.9 Reusable Packaging

Only small quantities of aluminium packaging are intended for reuse, mainly consisting of beer barrels and other containers. Reconditioning can involve cleaning, recoating and structural repair. All flows refer to inputs and outputs to the reuse loop.

Flows h, k, g, m and v are as detailed in annex A to general material recycling flow.

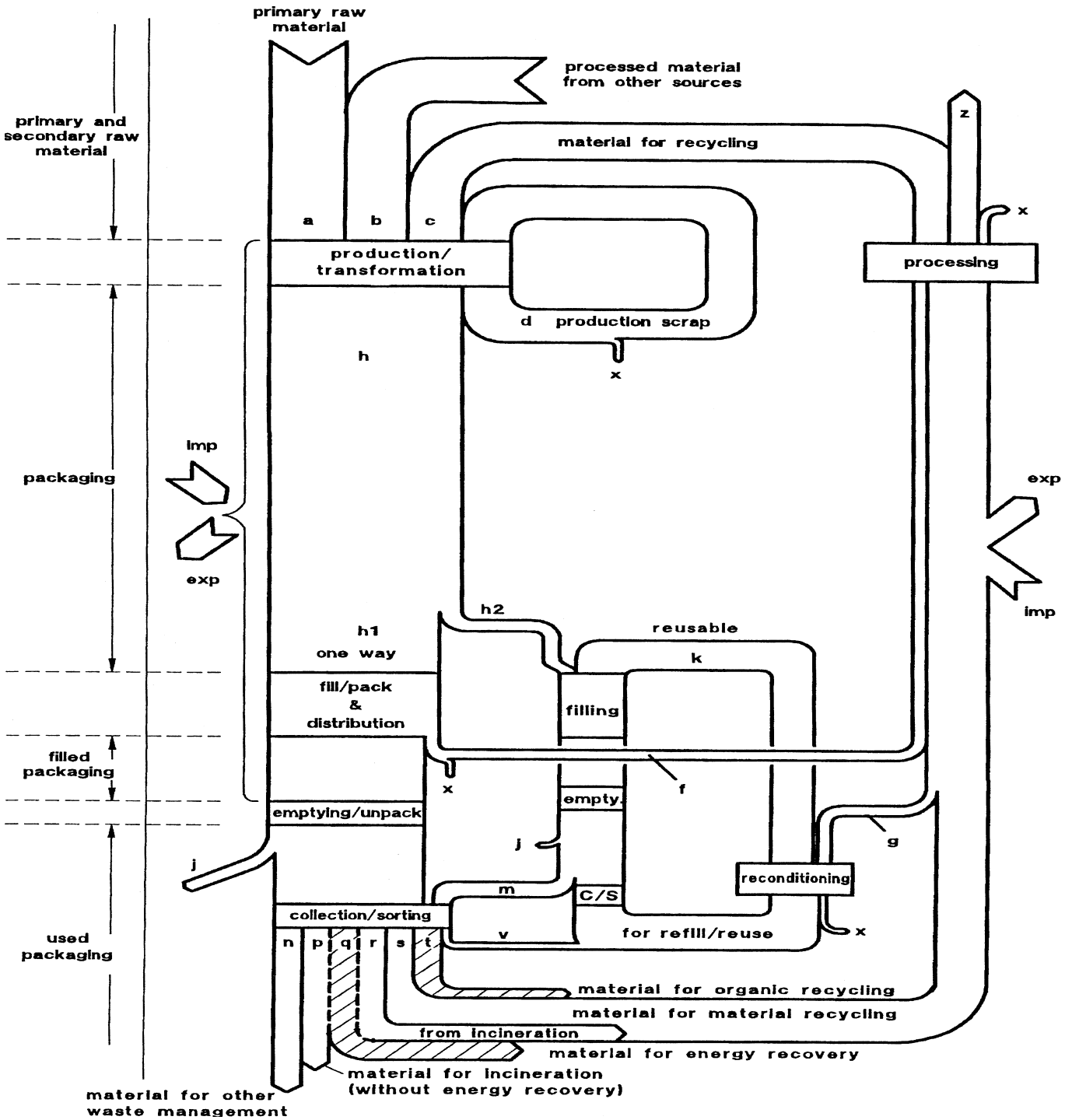
B.10 Import/Export

Aluminium materials and packaging at each stage of the flow can be imported or exported across national boundaries, reference 4.5.

Annex C
(normative)

Glass packaging and glass packaging material flows

(relating to packaging as defined in the packaging and packaging waste directive)



The size of flows do not correspond to the volume of the flows.
Flows which are not possible with this material are shown hatched

Figure C.1 – Glass packaging and glass packaging material flows

Explanatory notes (to be read in conjunction with annex A).

C.1 Introduction

This flow chart applies to all glass packaging such as bottles and jars of all sizes, shapes and colours.

C.2 Input Materials

Flow a: Primary raw material: a batch consisting of a mix of sand, soda ash, limestone/dolomite and feldspar together with additional refining and colouring agents.

Flow b: Recycled material from other sources: small quantities of flat glass.

Flow c: Recycled material from glass packaging: used glass packaging collected from consumers and from fillers, which are either colour separated or left mixed, and then sorted and processed into furnace ready “cullet”.

NOTE “Cullet” is processed used glass from different sources, crushed to specifications and separated from contaminated material.

C.3 Production/Conversion

Glass packaging production consists of the following steps:

1) batch mixing;
2) melting;
3) forming;
4) cooling;
5) quality control;
6) packaging.

C.3.1 Batch mixing

Depending on the colour of the final packaging, the mix of the cullet into a batch varies. Up to 95% used glass could be used in the manufacture of green glass. White glass normally is made with a significant proportion of primary raw (virgin) material.

C.3.2 Melting

Is carried out in a continuous process, in which the use of cullet reduces energy consumption.

C.3.3 Forming

Starts with the cutting of the melted glass into gobs. The gob is then formed in an automated moulding machine in two steps to its final shape.

C.3.4 Cooling

The raw product is rebaked and cooled in a controlled manner in an “annealing lehr” to remove residual mechanical stresses.

C.3.5 Packaging

Palletisation for warehousing and transport to packers/fillers.

Flow d: Production scrap: in-house cullet from production of glass containers (mainly containers not fulfilling quality specifications).

C.4 Fill/Pack and Distribution

No material specific comment.

Flow f: Scrap from process fill/pack and distribution: mainly packaging damaged in filling, internal distribution and warehousing, etc.

C.5 Emptying/Unpack

Flow j: Details as given in the Annex to the General Material Recycling Flow.

C.6 Collection/Sorting of Used Glass Packaging

The predominant way of collecting used glass packaging is in glass container banks placed in public places, conveniently available to the consumer. Glass exists in different colours: mainly white, green and brown. In order to be of maximum use again in the glass production process, used glass packaging is increasingly sorted into two or three colour fractions by the consumer. Glass packaging is also collected by kerbside collection systems. The responsible collector (the local municipalities' waste organisation or a private company) collects glass from the banks for later distribution to a cullet processing plant.

Flow n: Component of waste in managed landfill.

Flow p: This is normally as a disposal option for unsorted waste (see CR 1460). Details as given in the Annex to the General Material Recycling Flow.

Flow r: Research is under way to identify applications for glass residues from incinerators.

Flow s: The predominant used glass stream destined for recycling.

C.7 Recycling Process

At the cullet processing plant, used glass packaging is sorted and processed. Organic material, metals, ceramics, plastics and paper are separated by means of automated methods as well as by hand. The glass is then crushed and delivered to the glassworks.

This comprises one or more operations which will convert used material into a secondary raw material.

Flow x: Material losses.

Flow z: Processed cullet for other applications. Processed cullet can be used also as a replacement for primary raw material in insulation production, as a constitute in concrete for the building industry and in asphalt for road making.

C.8 Reusable Packaging

Glass packaging designed for, and used in, refill/reuse systems may also be joined in the reuse loop by packaging returning after collection/sorting of used one-way packaging.

One-way glass bottles are designed for a single trip and should be used only once. However, flow v allows for the possibility that some may be used again. This should only be done after the bottles have been checked for fitness for use.

Flows h, k, g, m and v are as detailed in annex A to general material recycling flow.

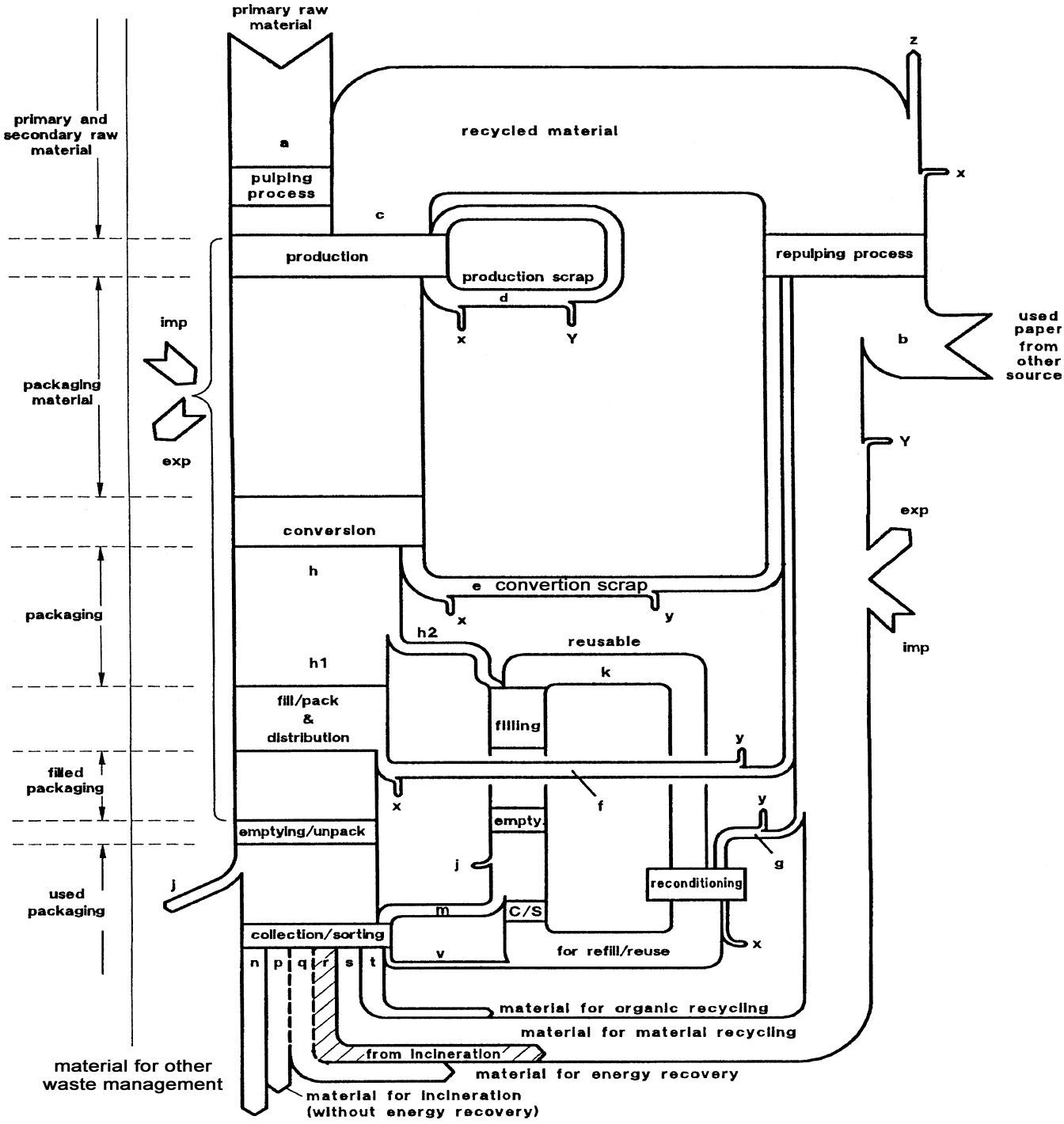
C.9 Import/Export

Glass packaging and cullet at each stage of the flow can be imported or exported across national boundaries, reference 4.5.

Annex D
(normative)

Paper/board packaging and paper/board packaging material flows

(relating to packaging as defined in the packaging and packaging waste directive)



The size of flows do not correspond to the volume of the flows.
Flows which are not possible with this material are shown hatched

Figure D.1 – Paper/board packaging and paper/board packaging material flows

Explanatory notes (to be read in conjunction with the annex A).

D.1 Introduction

This flow chart applies to all paper and board packaging and paper and board packaging materials such as corrugated and solid fibreboard, cartons, drums, sacks and bags.

D.2 Input Materials

NOTE The combination of starting materials for paper and board making is quite diverse but the two principal operations for packaging grades are; (a) the paper or board mill using primary (or virgin) fibre made from wood pulp with the possibility of introducing recycled fibre, (b) the paper or board mill based on secondary (or recycled) fibre. Paper making operations can also be sub-divided into integrated operations where pulp and paper making is all on one site and non-integrated operations where they are in separate locations. The diagram gives a generalised flow encompassing all operations which can used within any defined boundaries.

Flow a: The principal source of pulped fibre for packaging grades of paper and board is wood. Other sources of fibre include straw but these are not widely used within Western Europe.

Flow b: Used paper and board from sources other than used packaging. EN 643 gives a classification covering all grades of used paper (including board).

Flow c: Used paper and board packaging for recycling. The classification of these is included in EN 643.

D.3 Production

NOTE The recycling loop described is based on paper and board making as the major process through which used paper and board is recovered. A number of other processes exist, for example the direct moulding of pulp into either packaging or non-packaging products. These processes make a small but still significant contribution to the overall material flow. Some of the products so manufactured will again be recycled as part of the packaging loop while others may be further recycled into other products.

Paper and board production has the following steps:

1) Primary fibre production (where relevant):

Timber (usually that of unsuitable dimensions for sawmills, thinnings from forestry operations and additionally wood chips from sawmills) is chipped and pulped by an appropriate chemical or chemi-mechanical process. Mechanical pulping is used for some packaging grades. In an integrated operation the resulting pulp is cleaned and refined and delivered in a dilute suspension to the paper or board making machine. Pulp may alternatively be dried and supplied to a separate paper making operation.

2) Secondary fibre production (where relevant):

Used paper and board is repulped in water under high shear which effectively allows its reversion to a fibrous state. A range of cleaning, screening and refining operations follow which give pulp of the required characteristics and cleanliness for paper and board making.

3) Paper and Board Making:

The fibre from the pulping operations is mixed as required in a dilute suspension in water and deposited on to a moving mesh (known as a wire). The resultant fibrous web is dewatered, dried and reeled. Multilayer paper or board can be manufactured by simultaneous deposition on the wire or by the combination of two or more such webs at various points in the process.

4) Finishing:

The reels from the paper or board making operation are slit, rewound and/or sheeted to the appropriate dimensions required by the converting operation. Some of the heaviest grades of board may be sheeted directly on the board machine.

Flow d: Production scrap (usually known as “broke” in the industry) is material re-pulped within the paper or board mill’s operation and consists mainly of side-trim and material produced during grade changes.

D.4 Conversion

Paper and board is used in a wide variety of packaging products and the range of converting operations employed is diverse, often using a number of different stages.

Various grades of paper may be combined to give corrugated board or solid board which as a packaging material can be used directly or can be subject to further conversion operations principally cutting, creasing, slotting, die-cutting and printing to give bespoke products.

Carton board is generally supplied as board from the mill and can similarly be converted by the processes described above. Both corrugated and solid fibreboard and carton board may be coated, laminated or otherwise combined with other materials for specific applications. Other paper-based packaging products include sacks, bags, and tubes which are converted from paper supplied as reels or sheet and can be the subject of a range of printing and finishing operations. The scrap produced in the converting processes, consisting mainly of trim, die-cuts and other offcuts will generally be sent for recycling by the processes described above.

Flow e: Conversion scrap is material which goes into the converting process but is not incorporated into the final packaging product. Much of this is packaging material which is removed by die-cutting or slotting to give the final product. It is a preferred source of fibre for recycling because it is generally clean and to a well-defined specification.

D.5 Fill/Pack & Distribution

Some packing/filling operations may result in die-cuts or offcuts from the packaging or packaging material which if available in sufficient quantities may be collected for recycling by the processes described above. Packaging damaged or rejected during the filling/packing operation may also be collected although quantities are generally small.

Flow f: Packaging which is damaged during the packing/filling operation or in some instances trim and cutting of packaging material from on-site packing operations.

D.6 Emptying/Unpacking

Flow j: Details as given in the Annex to the General Material Recycling Flow.

D.7 Collecting/Sorting

Paper and board packaging is collected though a range of systems covering both industrial/ commercial and domestic users. Because used paper is a tradable commodity, a widespread network of “waste paper” merchants exists in the EU who collect, sort and grade used paper and supply it principally for paper making. For industrial and commercial users, packaging is generally collected as part of a contracted arrangement. Collection from domestic users can be by “bring” systems, usually to Local Authority depots, by kerbside collection or by other private schemes.

Flow n: Component of waste in managed landfill.

Flow p: This is normally as a disposal option for unsorted waste (see CR 1460). Details as given in the Annex to the General Material Recycling Flow.

Flow q: Details as given in the Annex to the General Material Recycling Flow.

Flow s: This is the principle route for the recovery of used paper and board packaging.

Flow t: Paper and board is readily compostable.

D.8 Recycling Process

This comprises one or more operations which will convert used material into a secondary raw material. The predominant recycling process for used paper and board is the re-pulping operation described under “secondary fibre production”. This process in commonly integrated with a paper making operation but the pulp may also be used in other applications.

Flow y: This flow is the proportion of used paper and board packaging not repulped but recycled into other products.

Flow z: This flow is the proportion of repulped paper and board used for non-packaging purposes. As shown in the diagram, used paper and board from other sources can also be a significant component of paper and board for packaging purposes.

Flow x: These flows are the material losses at various points around the loop. Probably the most significant are short fibres, “fines” and fillers contained in used paper and board packaging materials and not incorporated into the finished sheet in the paper or board making process.

D.9 Reusable Packaging

Only relatively small quantities of paper and board packaging are intended for reuse and these are usually in “closed loop” systems. The processes of Filling, Emptying and Collecting/Sorting are similar to those described for the main loop. Reconditioning which involves some form of cleaning or "laundering" is applicable to fibreboard drums usually in "open loop" systems.

Flow k, h, m and v are as detailed in annex A to general material recycling flow.

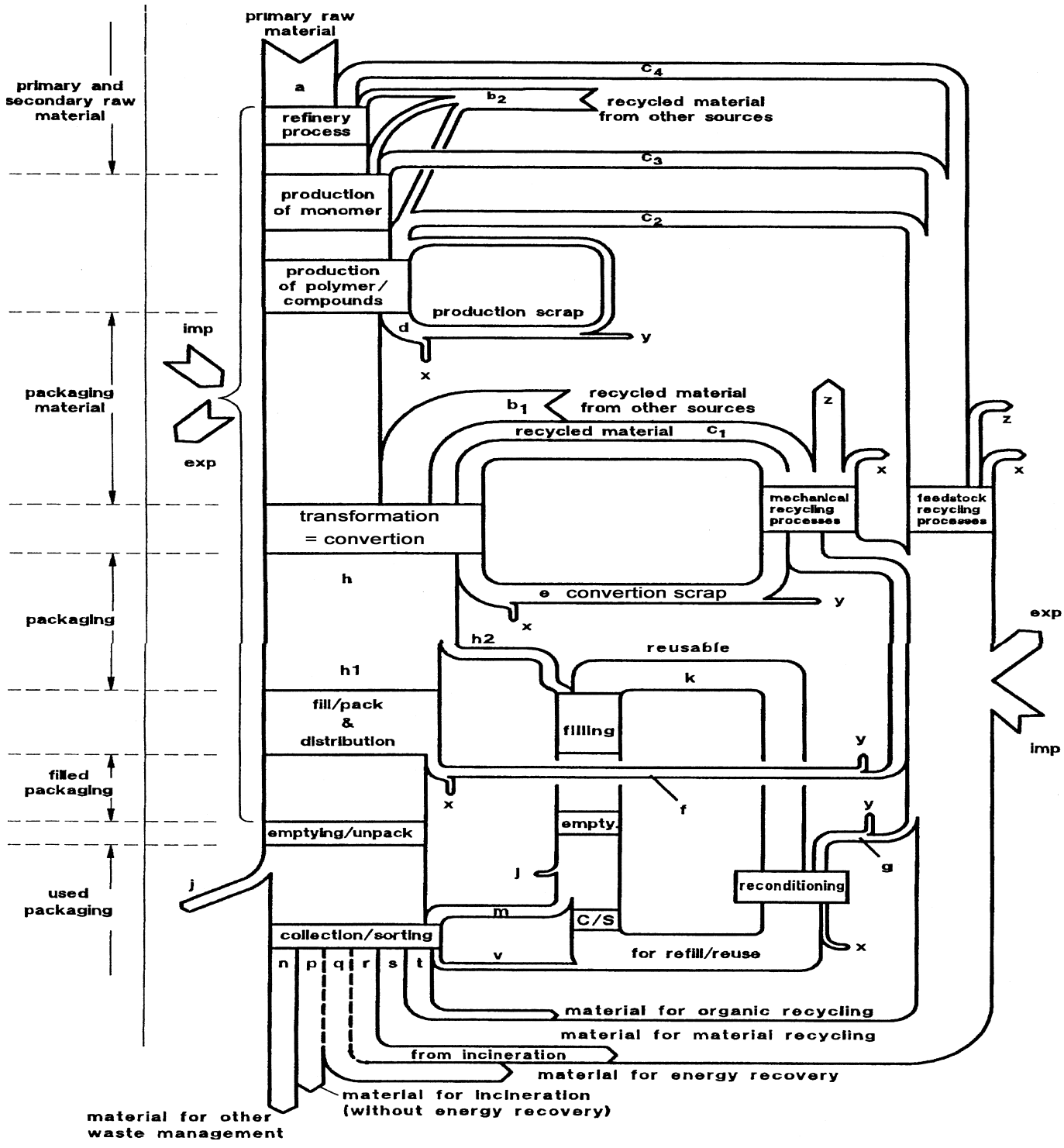
D.10 Import/Export

Paper and paper board materials and packaging at each stage of the flow can be imported or exported across national boundaries reference 4.5.

Annex E
(normative)

Plastic packaging and plastic packaging material flows

(relating to packaging as defined in the packaging and packaging waste directive)



The size of flows do not correspond to the volume of the flows

Figure E.1 – Plastic packaging and plastic packaging material flows

Explanatory notes (to be read in conjunction with the annex A).

E.1 Introduction

This flow chart applies to all plastic packaging materials and plastic packaging such as film, moulded containers, bottles, closures, crates and drums.

E.2 Input Materials

Flow a: Basic hydrocarbon in the form of crude oil or natural gas.

Flow c_4: Heavy hydrocarbon oil/wax from feedstock recycling processes. This feedstock will be absorbed into the petro-chemical process and service the resultant wide range of applications and not just plastics and packaging.

Flow c_3: Feedstock recovered to a higher level of refinement such as glycols from depolymerisation of polyesters or naphtha from polyethylene.

Flow c_2: Feedstock recovered from the depolymerisation process yielding products (monomers) such as ethylene glycol and di-methyl terephthalate from polyester, and methyl acrylate from PMMA.

Flow b_2: Feedstock as described for $C_{(2\text{-}4)}$ from non packaging applications.

E.3 Production

The material flows are described according to the chart specific to plastic materials, starting with the primary raw material. Plastics use hydrocarbon compounds predominantly as a starting material, and for simplicity the following descriptions reflects this position. However, this simplification shall not overlook the use of other starting materials and detailed differences that may occur through the flow diagram from raw materials to recovery and reuse.

The production of polymers involves a series of steps in which the raw materials are progressively processed to produce formulated polymeric materials to meet the specific requirements of the wide range of end applications. As an example the primary raw material, oil, gas, etc., is initially 'cracked' in a petrochemical process producing a range of products from which naphtha is passed to the next stage of monomer production. The monomer is then converted to the desired grade of polymer as determined by the application needs of the converted product. Formulations are achieved as part of the polymerisation and granulation process, and/or through separate compounding operations where blending of polymers and/or additives (such as colours, plasticizers, impact modifiers etc.) are produced to meet the specific application requirements.

Throughout the various stages of production, quality control procedures including on-line automated systems are used to maintain material and packaging properties to national and European Standards.

Flow d: With many polymerisation processes the conversion rate is not 100 % and the unconverted monomer, such as ethylene, is collected and returned for reprocessing.

Off specification polymers can be (re)compounded to achieve the necessary properties.

Flow y: Off specification polymers and compounds supplied to non packaging applications

E.4 Conversion

Plastic packaging is produced from the polymer by a range of different processes. For example, rigid packaging such as bottles and drums use a moulding process where an extruded length of tube is inflated whilst still above its softening point into a mould which forms the shape/size of the container. For flexible packaging, the film is produced by extrusion techniques, such as casting, blowing or callendering depending on the material and the thickness. The films are then usually printed with product (content) data and may also be laminated to other plastic films or non plastic materials.

The opportunity to use recycled materials is very much influenced, and limited, by the application. An example of this is the largest packaging application for plastics where the packaging is in direct contact with foodstuffs. In these applications the use of recycled materials is limited for safety and health reasons.

Flow b_1: Polymer recovered by mechanical recycling processes from non packaging applications.

Flow c_1: Polymer recovered by mechanical recycling processes from packaging applications and from conversion scrap/residues.

Flow e: Conversion scrap resulting from off specification production and off cuts inherent in the manufacturing process. This would include the 'sprues' or 'runners' from the injection moulding processes, or side trims from film extrusion. These are the preferred secondary materials as they are of known quality and source.

E.5 Fill/Pack and Distribution

Flow f: Some filling operations result in off cuts of packaging. This is exampled by the forming of tubs/containers from a sheet material, the product poured into the formed shape and a lid sealed into position. The individual containers are then cut from the web and the remaining 'skeleton' is removed for recovery.

There is also the possibility of rejected product from the packaging line, but this is considered to be small enough to be discounted.

E.6 Emptying/Unpack

No material specific comment.

Flow j: Details as given in the Annex to the General Material Recycling Flow.

E.7 Collection/Sorting

Plastic packaging is collected through a range of systems covering industrial/commercial use and domestic users. Industrial/commercial packaging is usually collected as part of a contracted arrangement, for example polyethylene film used for collation, and are sorted by type before collection.

Domestic waste is collected by various methods depending on national and local conditions. Kerbside collection of separated waste and drop off facilities for rigid containers are widely used. Separation of the main types of plastic used for bottles is achieved by consumer sorting and increasingly supplemented by automatic identification and separation through material recovery facilities. Plastic packaging remaining in waste sent for incineration with or without energy recovery provides a contribution to the overall calorific value.

Flow n: Component of waste in managed landfill.

Flow p: This is normally a disposal option for unsorted waste (see CR 1460). Details as given in the Annex to the General Material Recycling Flow.

Flow q: Details as given in the Annex to the General Material Recycling Flow.

Flow s: See general description of collection/sorting operation.

Flow t: This relates to specific types of plastics only.

E.8 Recycling Process

This comprises one or more operations which will convert used material into a secondary raw material.

E.8.1 Mechanical Recycling Process

In this operation the waste plastics are reprocessed to secondary material with unchanged chemical structure such as grinding stock (powder), flake or granules, or directly into new products.

The mechanical recycling processes vary in complexity and scale. The specification for the process will be dictated by the source of the used packaging and the use for which the recovered material is intended. The recycling process may be an integral part of a conversion operation, or it may be a free standing plant. Such plants will take their feedstock from used packaging and non-packaging applications as well as production residues. Equally, the output from such plants will supply non packaging applications as well as contributing to the closed loop operation.

Flow c_1: Polymer recycled and returned to the packaging chain, see material flow to Conversion above.

Flow z: Polymer recycled and supplied for use in the non-packaging market.

E.8.2 Feedstock Recycling

The process is defined in 3.3

There are a range of different approaches for this technology, these being influenced by the polymer involved and the level of polymeric breakdown to be achieved. Generally these operating units are larger than those for mechanical recycling. The outputs are as described for flows $c_{(2\text{-}4)}$.

The flow diagrams show the feedstock recycled materials being re-used in the same basic raw material manufacturing process. The products of the polymer breakdown can however also be used in the manufacture of other materials. Examples of this are:

- recycling of plastic in the blast furnace for the production of ‘pig iron’. In the blast furnace, iron ore is reduced to pig iron by the reaction with carbon monoxide and hydrogen. At the temperature of the blast furnace the plastics are instantaneously gassified, contributing mainly to the reduction process and, to only a minor extent, to heat the reaction partners. The output of this recycling will be in flow “z”.
- recycling of plastic for the production of polyols obtained by the glycolisis of PET bottles followed by polyesterification. The polyols produced are typically used in the production of polyurethane foams for thermal insulation or elastomers. Methanol generated as a by-product of the chemical reaction can be used as an energy source in the process so that the process generates no waste.

E.9 Reusable Packaging

Plastic packaging is used in both flexible and rigid forms.

Examples of reusable plastic packaging are predominantly in the rigid applications such as crate, pallets, trays and refillable bottles for milk and soft drinks.

Flows h, k, g, m and v are as detailed in annex A to general material recycling flows.

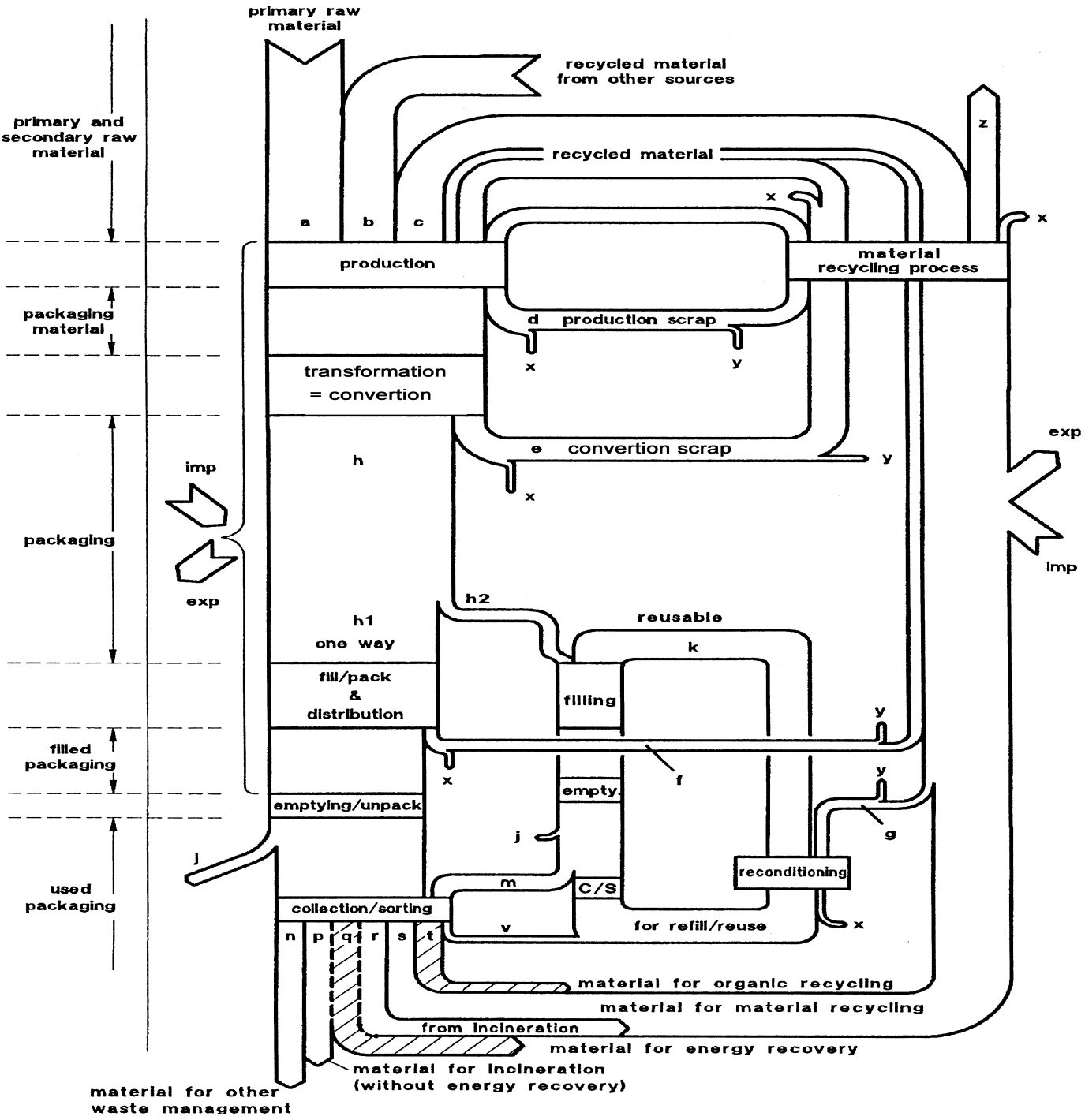
E.10 Import/Export

Plastic materials and packaging at each stage of the flow can be imported or exported across national boundaries, reference 4.5.

Annex F
(normative)

Steel packaging and steel packaging material flows

(relating to packaging as defined in the packaging and packaging waste directive)



The size of flows do not correspond to the volume of the flows.
Flows which are not possible with this material are shown hatched

Figure F.1 – Steel packaging and steel packaging material flows

Explanatory notes (to be read in conjunction with the annex A).

F.1Introduction

This flow chart applies to all steel packaging materials and steel packaging such as food and beverage cans, aerosol cans, general line cans, steel drums, closures, all as used in the domestic and industrial/commercial markets.

F.2Input Materials

Flow a: Iron ore and pellets (agglomerated fine ore, in most cases directly produced at the ore mine).

Flow b: Used materials from sources other than packaging steel, according to national and European scrap listings.

NOTE In the steel industry the term ‘scrap’ has not traditionally been restricted to production residue.

Flow c: Recycled steel packaging.

F.3Production

The production of packaging steel consists of four basic steps:

— Primary material production (coke oven, sinterplant, blast furnace).

— The product is liquid pig iron, which is replaced by using recycled scrap.

— Steel plant: Basic oxygen furnace (BOF) is directly connected with continuous casting.

NOTE For metallurgical reasons (BOF) uses an input of ~ 20 % scrap and 80 % pig iron. Electric arc furnaces (EAF) use 100 % scrap but are not connected to packaging steel finishing facilities.

— Hot rolling: Hot strip mill.

— Packaging steel production: Pickling, cold-rolling, cleaning, annealing, temper-rolling, electrolytically tin and chromium coating.

Flow d: Production scrap: Basically crop scrap and edge trimming from strip production.

F.4Conversion

Steel packaging are produced by a combination of different production steps such as lacquering, printing, stamping, forming, application of sealant. The sequence of operation depends on the type of end product as shown by example in the introduction.

Flow e: Conversion scrap, predominantly skeleton scrap from stamping operations at can maker, and also rejects.

F.5Fill/pack & distribution

No material specific comment.

Flow f: Packaging damaged in filling operation and distribution.

F.6 Emptying/unpack

No material specific comment.

Flow j: Details as given in the Annex to the General Material Recycling Flow.

F.7 Collection/sorting

The majority of steel packaging is used by the domestic consumer and hence enters the domestic waste stream. This steel packaging is collected by kerbside collection systems, consumer aided reclamation, municipal waste management via incineration or by special collection systems for consumer or industrial packaging. Thanks to magnetic properties of steel, sorting in any waste flow can be done automatically by magnetic separation.

Flow n: Component of waste in managed landfill.

Flow p: Only relevant if no magnetic separation is used. This is normally as a disposal option for unsorted waste (see CR 1460).

Flow r: steel packaging extracted by magnetic separation following incineration of the other waste and passed for recycling.

Flow s: steel packaging for recycling other than from incineration.

F.8 Recycling Process

There is no unique recycling process for the different types of scrap. For heavy production scrap (steel plant, hot strip mill) no additional processing is applied. Production scrap from the tinplate mill and converting scrap from can making is processed by baling. In some cases detinning is applied.

Used steel packaging from recycling flows r + s are either directly baled or processed by shredding. In special cases material from flow s is treated by special processes such as detinning (steel packaging collected and sorted from municipal waste) or other special cleaning operations (steel packaging from general line applications). The quality of used steel packaging is described in national or European “scrap” trading lists.

Flow z: As used steel packaging can be used widely for other than steel packaging products (cold rolled sheets for automotive industry, coil coated strip for civil engineering, plates, shapes, etc.) and other steel making processes (electric arc furnace with 100% used material/scrap input), this flow is important.

Flow x, y: Material losses: Because of the physical properties of steel and well organised recycling/scrap handling businesses, material losses are not important.

F.9 Reusable Packaging

The main example of reusable/refillable steel packaging is in the form of drums, which may be reconditioned by refurbishing and/or cleaning before returning for reuse.

Flows h, k, g, m and v an as detailed in annex A to general material recycling flows.

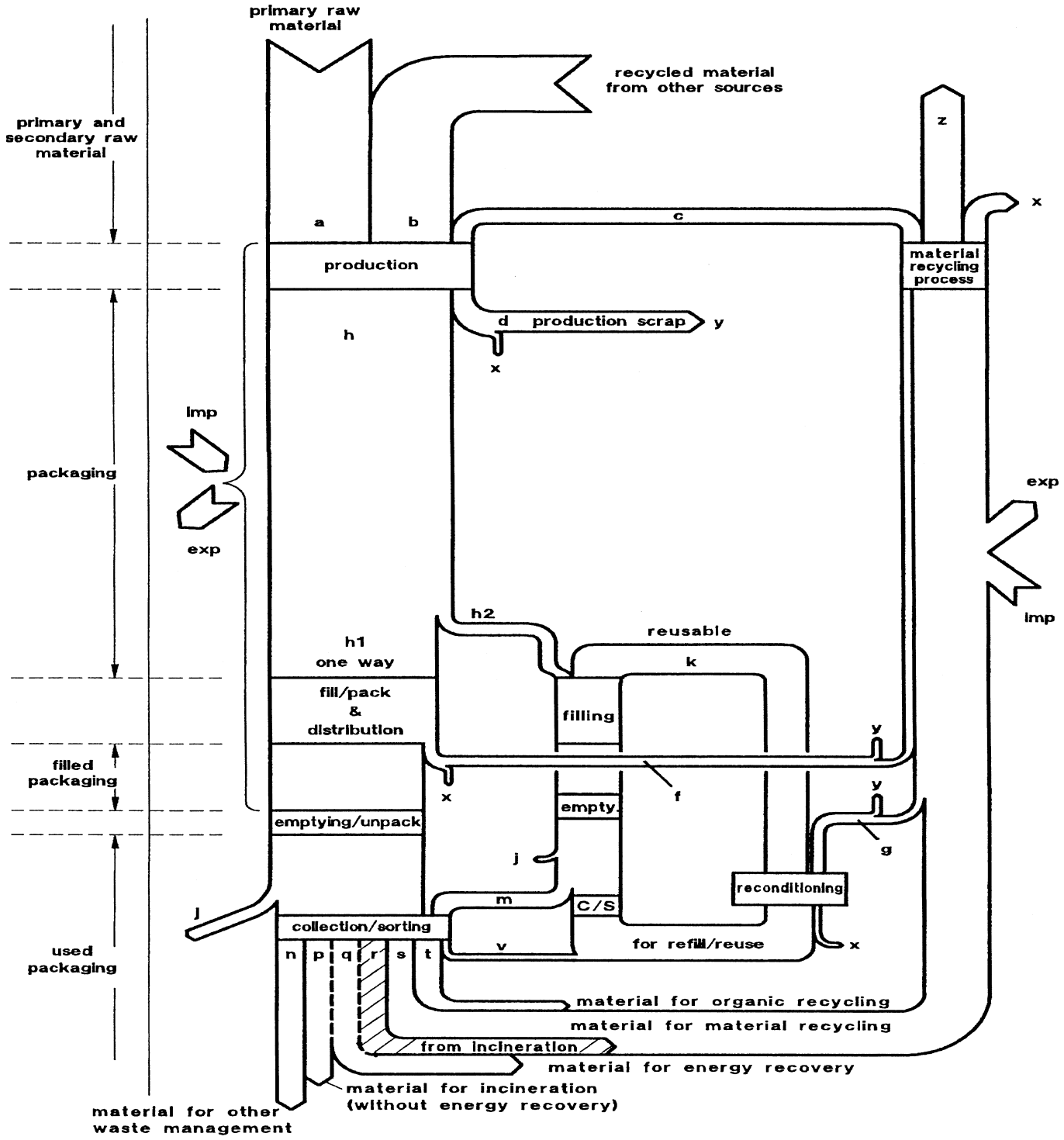
F.10 Import/Export

Steel materials and packaging at each stage of the flow can be imported or exported across national boundaries as influenced by supply and demand, reference 4.5.

Annex G
(normative)

Wood packaging and wood packaging material flows

(relating to packaging as defined in the packaging and packaging waste directive)



The size of flows do not correspond to the volume of the flows.
Flows which are not possible with this material are shown hatched

Figure G.1 – Wood packaging and wood packaging material flows

Explanatory notes (to be read in conjunction with the annex A).

G.1 Introduction

This flow chart applies to all wood packaging materials and wood packaging such as light crates and trays, pallets, industrial boxes and heavy industrial wooden packaging, and various small wooden boxes such as wine bottle boxes and cigar boxes.

G.2 Input Materials

Flow a: This is the main stream of flow material use. It starts from raw timbers, and logs, which are barked, then cut and further are sawn or peeled.

Flow b: Secondary flow using reconditioned woods as chipped and fibreboard woods.

Flow c: Secondary flow, for example the use of planks provided by the dismantling of pallets or heavy industrial packaging and used for the building of new packaging.

G.3 Production and Conversion

The timbers and logs used for packaging come from all temperate species of tree except the oak. Some fibreboard or chipboard and plywood also can be components of wooden packaging.

Flow d: Scrap resulting from the sawing and peeling operations can be, and are mostly recycled in paper mills or in the fibreboard and/or chipboard industries, alternatively are used in application such as, but not limited by, compost, cattle litter, or used as a fuel for energy recovery.

Scrap coming from debarking (typically from poplars or coniferous trees) is used as garden wild grass protector, or applications such as, but not limited by, compost or as a fuel for energy recovery.

NOTE Wooden scraps cannot be reintroduced in the packaging production line (except in the form of fibreboard and/or chipboard). They represent about 50 % of the wood consumption and are increasingly recycled.

Conversion is part of the production operation for the manufacture of wooden packaging. All the packaging is fabricated in the production factories and then sent to the filling stations. The exception to this is heavy industrial wooden packaging which is fabricated directly at the filling station (e.g. for export of nuclear power station components).

G.4 Fill/Pack and Distribution

No additional material specific comments.

Flow f: Packaging damaged in filling/loading operations and in distribution to an extent that renders them unsuitable for repairing/reconditioning.

NOTE Packaging capable of being repaired will follow flow (v). Pallets are sent back to a repairing system and return to the reuse cycle, otherwise the packaging follows the same disposal or recovery routes following collecting and sorting.

G.5 Emptying and Unpacking

Packaging designed under the name of box, such as “punnets” (in French: “barquette”, in German: “Körbchen”) are sales packaging and hence enter the domestic waste stream. These are managed through the different national organisations, however it is apparent that many of them never reach a waste stream due to other uses or used as domestic fuel.

Other packaging such as crates, trays, pallets and industrial packaging are transport packaging. They are collected and sorted by various methods depending upon different national or private organisation systems.

Flow j: The characteristics of wood packaging, when compared with other materials, provide a wide range of secondary uses other than packaging. Even in countries having efficient collecting systems, the rate of recovery is low. See also the details as given in the Annex to the General Material Recycling Flow.

G.6 Collection and Sorting

Generally sales packaging collected through the domestic waste streams is not sorted. As a result very small quantities are collected. Operators prefer to burn this wooden packaging with the domestic waste where it adds calorific value, or include it in compost.

There are various ways of collecting transport packaging. A major method of collection is through private/commercial organisations. They are collected either for re-use by specialised organisations or by private networks such as GROW for light wooden packaging in France, Germany, Italy and Spain, or HPE for pallets in Germany.

Flow m: Packaging intended for reuse but diverted to the waste stream.

Flow n: Component of waste in managed landfill.

Flow p: Wood contributes to the combustion of incinerated wastes (as flow q).

Flow q: This is normally as a disposal option for unsorted waste (see CR 1460). Crushed woods can be used as a fuel in boilers either alone or in mixed form with other waste materials or fuels.

Flow s: Used wood packaging can be used as fibreboard and chipboard raw material, in paper mills, as cattle or cat litters.

Flow t: Material for organic recycling

G.7 Reusable Packaging

The main application for wooden packaging is as transport packaging where the pallets have been designed for repeated use (multi trip). This packaging may be joined in the reuse loop by used one-way packaging returning after collecting/sorting. Normally, such one-way packaging is not re-used but sometimes crates and pallets in this category are sorted and used again (flow v).

Flows h, k, g, m and v are as detailed in annex A to general material recycling flow.

G.8 Import/Export

Wood materials and wooden packaging at each stage of the flow can be imported or exported across national boundaries Reference 4.5.

Annex H
(normative)

Other packaging materials

H.1 Other packaging materials

The materials used for packaging are dominated by those described in annexes B, C, D, E, F and G. However some other materials are used and their recycling is summarised in this annex. Detailed flow charts are not provided but where recycling is undertaken the flow is similar to that in the general flow chart in annex A.

H.2 Textiles

Textiles represent a significant part of these other materials and can be further subdivided into two groups, synthetic materials and natural fibres.

H.2.1 Synthetic Textiles

The main material is polypropylene, and is used because of its lightness and strength. Typical applications are the distribution of fertiliser, chemicals and grain in 500 to 1000 kg units. Smaller sized packaging units are used for vegetables where the woven structure provides good ventilation for protection of the foodstuff.

Such packaging, often classified as ‘plastic packaging’ can be collected, sorted and recovered within the same system as described in annex E.

H.2.2 Natural Textiles

The two main materials are jute and cotton, supplied in a wide variety of sizes of bags and sacks. These materials provide ‘breathable’ packaging where the contents may be of a powder format and the degree of weave provides a means of retaining the contents and allowing the entrapped air to escape. Again, as with the synthetic textiles, ventilation for the contents can be a major reason for the selection of a natural textile container.

These forms of packaging are often used many times for packaging and non packaging applications before being discarded. Recycling of used textiles is undertaken on a limited scale. Typically the textiles are processed through a ‘carding’ machine which tears the fabric releasing the fibres into a ‘tow’. This is a loose structure of fibres which can than be further processed in a textile plant. The ‘tow’ can be divided and spun into yarn/threads ready for weaving into ‘new’ cloth. Alternatively the ‘tow’ can be stretched sideways in a stenter to form a non-woven fabric for industrial and agricultural applications. The ‘cared’ jute is also used in soil conditioning materials where it can replace peat.

The necessary level of segregation of different natural materials will depend upon the application for which the recovered fibre is to be used, and also the consistency in which the different material arrive in the recovery stream.

The basic technology for recycling is known and the use is dependent on the quality and cleanliness of the used packaging. The applications for which textile packaging are often used involve chemicals and dirty environments such that the contaminated fibre may have very restricted reuse applications. Recycling therefore has to be considered within the overall waste management policy.

H.3 Cork

The use of cork in packaging is as a component of the packaging rather than a whole functional packaging unit. The principal application is as a closure in bottles.

Cork is a natural material and can be recycled by material recycling and also by organic recycling. Following collection and sorting, mechanical recycling can be achieved by shredding and then pressure compacting/moulding the cork materials together with a resinous binder to form new products. These products will include thermal resistant mats, flooring and other cushioning products.

Natural cork, following collection and sorting can biodegrade and be compatible with organic recycling processes.

H.4 Ceramics

The use of ceramic materials for packaging is limited to specialist applications. To date there is no recycling process for this material although if available in sufficient quantities could be crushed and used as a filler material in other substrates. This standard therefore does not provide any information on material recycling and material flows for this material.

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