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Packaging material recycling — Report on substances and materials which may impede recycling

Recyclage des matériaux d'emballage — Rapport sur les substances et les matériaux pouvant empêcher le recyclage

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Foreword

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The committee responsible for this document is ISO/TC 122, *Packaging*, Subcommittee SC 4, *Packaging and environment*.

Introduction

Saving resources and increasing resource efficiency, together with minimizing the negative environmental impacts, are acknowledged as important objectives in the search for sustainability. The recycling of used packaging is one of the principal strategies that contribute significantly to the fulfilment of these objectives.

To ensure the efficacy of this strategy, recycled materials need to meet the requirements of the identified applications. The supply of used packaging has to be sufficiently continuous and stable in order to sustain an industrial recycling operation. Furthermore, the collection and sorting schemes have to be designed and managed for delivering the required fractions of used packaging fit for recycling.

It is essential that consistent information and communication about recycling be provided to users. This includes raising awareness of the value of recycling, as well as providing specific instructions as to how users can actively participate in the collection and sorting of used packaging for subsequent material recycling.

The composition of the used packaging streams, the sorting and recycling practices and technologies, as well as the market demand for recycled materials will continue to change due to innovation, regulations, and other developments. In such a context, it is important to always keep in mind the importance of the yield and efficiency of the whole recycling system, in addition to the quality and the intrinsic properties of materials to be recycled. Sometimes, innovations can themselves act as impediments to recycling, at least at the moment of their introduction. Precautions must be taken so that innovations do not jeopardize the functionality of existing schemes.

The recovery of used packaging by material recycling is largely influenced by the materials and substances used for packaging and the condition in which they arrive at the recycling operations, notably the presence of impurities such as product residues and extraneously introduced materials. Collection of several packaging materials together (co-mingling) can often result in lower quality materials with high content of impurities. In turn, this may lead to lower yields and increased costs. The proper design of collection and sorting schemes is of critical importance. This Technical Report provides examples covering the main packaging materials and can be used as a guide for taking into account substances and materials that may be incorporated in packaging and which may inhibit subsequent operations related to recycling.

This Technical Report covers the following aspects:

— materials, combinations of materials, or designs of packaging that may create problems in collecting and sorting before material recycling;

— substances or materials that have the potential to create problems in the recycling process;

— the presence of substances or materials that may negatively influence the quality of the recycled material.

ISO 18604 sets out the basis for classifying packaging as recoverable by material recycling. This is one of the routes for the recovery of used packaging, with the inter-relationship between the various routes being covered in ISO 18601.

ISO 18604 requires that the design, choice of materials, and the manufacturing operations of packaging take into account the activities to which the used packaging will be exposed when processed through the expected recovery operations. In particular, that International Standard deals with the need to take into account the collection, sorting, and recycling of the materials.

This Technical Report, therefore, provides a non-exhaustive overview of substances, materials, and components that need to be considered in the design and control of packaging as defined in ISO 18604.

Packaging material recycling — Report on substances and materials which may impede recycling

1 Scope

This Technical Report provides a non-exhaustive overview of substances and materials that may cause a sustained impediment to recycling activities and is intended to assist in the assessment requirements set out in ISO 18604.

It describes substances or materials which cause problems or inhibit the recycling process, or which have a negative influence on the quality of recycled material, where technical solutions are not expected to be developed in the near future.

These examples are, however, qualified by the fact that the recycling operations can vary regionally, that technology is constantly changing, and that the use to which the recycled material is put will also determine whether the presence of such substances and materials is a problem.

2 Normative references

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

ISO 18601, *Packaging and the environment — General requirements for the use of ISO standards in the field of packaging and the environment*

ISO 18604, *Packaging and the environment — Material recycling*

ISO 21067, *Packaging — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21067 apply.

4 Recycling

A viable recycling system requires, in the first place, a well-functioning market for the recycled materials. The recycled materials need to meet the requirements of the identified applications, and the supply of used packaging has to be sufficiently continuous and stable in order to sustain an industrial recycling operation. Furthermore, the collection and sorting schemes have to be designed and managed for delivering the required fractions of used packaging fit for recycling.

The performance of a recycling system typically depends on a number of elements. These are the design, production, distribution, and use of packaging placed on the market, as well as the collection and sorting of used packaging and subsequent recycling operations for the identified applications of the recycled materials. Not all recycling technologies are widely available or used in all regions and countries.

The recovery of used packaging by material recycling is largely influenced by the materials used for packaging and the condition in which they arrive at the recycling operations, notably the presence of impurities such as product residues and extraneously introduced materials. This Technical Report provides examples covering the main packaging materials and can be used as a guide for taking into account substances and materials that may be incorporated in packaging and which may or do inhibit subsequent operations related to recycling.

In providing examples of substances and materials that may impede recycling, a number of key issues need to be considered. These include:

— the specific composition of the packaging (or packaging components), including base materials used;

— the physical characteristics of the packaging, such as shape, colour, volume, weight, dimensions, and (non) detachable pieces;

— the mix of packaging materials in the collection stream;

— the collection/sorting and recycling operations available in the location where the packaging completes its functional life;

— the residues of the packaging contents and extraneous contamination resulting from the use of the packaging, or from the collection and sorting processes. The contamination may be very small in quantity but can result in a disproportionate problem;

— the ease with which constituents or contaminants which may impede recycling can be separated from the materials to be recycled;

— the specifications for a new product made from the used packaging, including quality and functionality.

The examples in Clause 5 include data from current and typical specifications associated with used packaging supplied for recycling on a commercial and practical basis. It should be noted that these specifications may vary from location to location.

5 Material examples

Packaging is produced from a wide range of materials and combinations of materials, selected according to the functional requirements of the packaging application.

The following tables provide a non-exhaustive list of examples, guidelines, and common industrial practices for materials and substances which cause problems in the recycling operations of each of the main packaging materials:

— Table 1 Aluminium;

— Table 2 Glass;

— Table 3 Paper and paperboard;

— Table 4 Plastic;

— Table 5 Steel;

— Table 6 Wood.

Depending on the guidelines and conditions for the individual systems in place, non-packaging products, with the same or very similar material composition as the packaging items concerned, may be accepted within these packaging collection and sorting systems.

Table 1 — Aluminium

Packaging recoverable by material recycling		
Reference to ISO 18604		
B.2 Design criteria NOTE c)	**Materials and substances integral with the packaging**	**Comments**
i) Separability of components	— Beverage and food cans require no separation as the lids, tabs, and body are in similar alloying elements. — Composite containers should easily be separated to allow source separation by the user or separation during the collection and sorting stage. — Semi-rigid and flexible aluminium foil packaging can be separated at source by the user. — Foil laminates require specifically adapted separation and recovery processes which allow for material recycling and/or incineration with energy recovery.	The majority of aluminium rigid and semi-rigid packaging is single material of similar alloying elements, which ensures that closed-loop (can-to-can recycling) or open-loop recycling (into other aluminium products) is feasible. Non-aluminium components or substances are effectively removed during the collection and sorting processes, at the input side to the recycling process, or during processing. Separation normally involves the recovery of the aluminium fraction using a thermal process which results in the destruction of the laminating ply, with an associated energy or by-product recovery. Small aluminium packaging items are increasingly collected and recycled from the bottom ashes in incinerators. New sorting techniques including optimized eddy current separation allow for the collection of even the smallest fraction.
ii) Compatibility of material compositions or material combinations with the recycling process	— Material compositions are uniform in respect of the major aluminium components of the packaging/packaging system, i.e. similar alloying elements. — Non-aluminium components, printing inks, lacquers, and any sealants are accepted as easily removable during the recycling process.	
iii) Acceptable tolerances for non-compatible elements or substances in the recycling process	— Acceptable tolerances are determined by the individual recycling process plant and its design.	

Table 1 — Aluminium *(continued)*

Packaging recoverable by material recycling		
Reference to ISO 18604		
B.5 Criteria for collection/sorting	**Materials and substances external to the packaging**	**Comments**
Compatibility with the collection and sorting systems	Materials which require separation in the collection and sorting system and are not acceptable in the recycling process. — steel — lead — iron — plastics — paper — sand — glass — dirt — food residues — grease — any other foreign substances — excessive moisture	No aluminium packaging is made of alloying elements, including lead. However, occasionally, lumps of lead can be found inside beverage cans to make these heavier and therefore more attractive for cash-for-cans weight-based collection schemes. Sorting centres either do not accept unspecified bales of used beverage cans or carry out extra controls to detect the lead with x-ray machines and subsequently remove it.
	These guideline tolerances are indicative and subject to on-going review. Contractual specifications are negotiated directly between aluminium packaging scrap suppliers and users in the various countries. These specifications may show variances from the guideline tolerances due to the differences in local conditions and technologies.	

Table 2 — Glass

Packaging recoverable by material recycling		
Reference to ISO 18604		
B.2 Design criteria NOTE c)	**Materials and substances integral with the packaging**	**Comments**
i) Separability of components	Closures and capsules should be easily separable from the glass packaging to allow source separation by the user. Labels and sleeves of paper, plastics, or aluminium foil are generally accepted in the recycling process. Care should be taken to ensure that any inorganic electronic parts or devices used with glass packaging are readily separable from the glass container prior to its recycling.	The glass container industry lays great stress on a maximum separation at source as a key to cullet quality management. A ban on lead-containing overcaps was introduced in the EU in 1993.
ii) Compatibility of material compositions or material combinations with the recycling process	The printing and glueing medium associated with labels, etc. or polymer coatings are generally accepted in the recycling process.	Non-glass packaging components or substances are effectively removed in the processing of cullet (with the exception of ceramics, porcelain, and certain plastic adhesive labels).

Table 2 *(continued)*

Packaging recoverable by material recycling		
iii) Acceptable tolerances for non-compatible elements or substances in the recycling process for processed and unprocessed cullet.	**Processed cullet** Impurity: Indicative level Stones, ceramics porcelain, pottery: < 50 g/t Magnetic metals: < 5 g/t Non-magnetic metals: < 5 g/t Organic matter: <500 g/t with Minimum variability Plastics: <100 g/t Grain size: > 5 cm 0 % < 0,5 cm max 5 % Moisture: < 3 % Cullet content Colour Green Amber Flint Green > 85 % < 5 % < 15 % Amber < 10 % > 82 % < 8 % Flint < 1 % < 1 % > 98 % Mixed national specification **Unprocessed cullet** Recommended bulk density: < 700 kg/m3 Container glass — minimum content: 98 % Ceramics, porcelain, stones — maximum content: — < 10 mm < 100 g/t — in all < 2 500 g/t Unacceptable materials, not to be added: as per the list below in B.5: — glasses — other (B.5 Guidelines)	These materials and substances may have originated from sources integral with or external to the packaging.
	These guideline tolerances are indicative and subject to on-going review. Contractual specifications are negotiated directly between cullet suppliers and users in the various countries. These specifications may show variances from the guideline tolerances due to the differences in local conditions and technologies.	

Table 2 *(continued)*

Packaging recoverable by material recycling		
B.5 criteria for collection/sorting	**Materials and substances integral with the packaging**	**Comments**

Compatibility with the collection and sorting systems	List of materials which are not to be added intentionally to container glass cullet
	1. Types of glass:
	— screen glass (TV, computers, etc.);
	— lead crystal tableware;
	— sheet glass;
	— wired glass;
	— coated glass;
	— all forms of glass ceramics (for example: cookware and cooktops);
	— car windshields and rear windows;
	— mirrors;
	— lamp glass (light bulbs, fluorescent; tubes, etc.);
	— borosilicate glass (hard glass, "Pyrex", ovenware);
	— laboratory glass;
	— pharmaceutical ampoule glass;
	— quartz glass (some lamps, laboratory glass);
	— opal glass (white glass used for services and lamps);
	— optical glass.
	2. Other materials and products:
	— refractories (aluminouse, zirconium, bearing, chromites, etc.);
	— residues from furnace tapping (which might be contaminated with refractories in particular);
	— earthenware, ceramics, porcelain, stones, concrete;
	— metals, including closures and lead capsules;
	— organic materials which are not food residues;
	— hazardous and small-scale chemical waste, for example:
	  — glass with nail polish remover residues;
	  — glass with (photo) chemical residues;
	— material classified as clinical waste;
	— non-glass packaging materials.
		This list is indicative and subject to on-going review.

Table 3 — Paper and paperboard

Packaging recoverable by material recycling		
Reference to ISO 18604		
B.2 Design criteria NOTE c)	**Materials and substances integral with the packaging**	**Comments**
i) Separability of components	Non-paper components not usually removed prior to delivery to the recycling operation include adhesive tapes, RFID tags, metal stitches, and other fasteners, non-paper labels, and various other packaging adjuncts.	Separation of these components can be effectively achieved either in the initial re-pulping process itself for the larger components or in the initial screening of the pulp. It is unusual for the components described to disintegrate into particles small enough to interfere with the papermaking process.
ii) Compatibility	Screening equipment may limit the ability of some combinations of paper or paperboard with other materials to be properly screened. Additional processing may be required to separate these materials from the fibres.	Large volumes of plastic-coated paper and paperboard are recycled efficiently in increasingly numerous installations as technology to separate the plastic lamination from the pulp becomes widely available. Dispersion technology can be used as part of the pulp preparation process, for example to remove waxy substances. Dispersion technology is available and is widely used in some regions. However, recycling waxed paper can be a problem in some regions.
iii) Acceptable tolerances for non-compatible elements or substances in the recycling process	Guidelines and listings of non-compatible elements and substances can be found in international, national, and commercial standards (examples of such guidelines are included in the bibliography). However, because of the widely differing nature of equipment used and the wide range of specifications for secondary fibre products, the individual recycling operations will normally set their own acceptance tolerance.	The diversity of operations and requirements means that even within organized collection schemes, only general guidelines will apply.

Table 3 — Paper and paperboard *(continued)*

Packaging recoverable by material recycling		
Reference to ISO 18604		
B.5 Criteria for collection/sorting	**Materials and substances external to the packaging**	**Comments**
Compatibility with the collection and sorting systems	Paper and paperboard may contain materials and substances not part of the packaging but which may be unintentionally introduced. Paper and paperboard packaging which has been in direct contact with the product may contain residues of that product. This may, in certain circumstances, limit recycling. The following list of materials which are not part of the packaging may be unintentionally introduced into the recovered material stream through the collection systems and are considered contaminants in the recycling process. Therefore, the proper design of collection and sorting schemes for paper and paperboard is of critical importance. — glass, glass fragments (including fibreglass, paper) — stone, sand — wood — metal (other than pins or staples) — textile, Non-woven fabric — plastic — oil, grease, wax — excessive food waste	Standards and guidelines have been developed for use by industry and organizations to assist in the buying and selling of paper and paperboard (examples of such guidelines are included in the bibliography). Many of the materials and substances named may be effectively removed by the screening and cleaning treatments in the recycling operation. Co-mingling of paper and glass can cause damage to paper and paperboard machinery.
	Contractual specifications for recovered paper and paperboard are negotiated directly between suppliers and users in the various countries. These specifications may show variances due to the differences in local conditions and technologies.	

Table 4 — Plastics [a]

Packaging recoverable by material recycling		
Reference to ISO 18604		
B.2 Design criteria NOTE c)	**Materials and substances integral with the packaging**	**Comments**
i) Separability of components	If possible or necessary, separation of rigid and flexible plastic packaging should be encouraged at the source by the user for the purpose of mechanical recycling. Components, such as closures, labels, sleeves, etc. of different types of plastic, in particular those with similar densities, as well as other materials should be readily removable by the user or in the recycling process. For example, for facilities unable to sort them out automatically without regard to their density, design, and use, it is better to use labels or sleeves material with a significantly different density of water related to PET and polyolefine bottles. Care should be taken to ensure that ancillary components (e.g. caps and labels) are readily separable from the plastic bottle during recycling. Closures of polyethylene or polypropylene can be retained on the bottle for separation and recovery by the reclaiming industry.	Normally, if paper labels are used, the use of solvent/contact adhesives should be avoided to enable separation in the pre-recycling preparation. However, when the labels are associated with packaging for substances hazardous to the environment, the permanence of the labels is essential. Separation of different types of plastics and other materials by 'sink/swim' floatation technology is widely used and the choice of materials for the packaging components should facilitate this principle.

Table 4 *(continued)*

Packaging recoverable by material recycling		
ii) Compatibility of material compositions or material combinations with the recycling process	Laminates using different types of plastic, or thin layers of other materials, will require additional resources for most options of traditional mechanical material recycling (shredding, separation, pelletization). In specific cases, new recycling technologies, based on dissolution/precipitation of one or more components, can perform such separation with lower energy requirements. Some mixed colours of the same form of packaging (e.g. black-coloured bottles and PET bottles) may be unacceptable for the applications of the secondary materials produced in the recycling process.	These limitations relate to the current and foreseeable developments of mechanical recycling processes for such packaging. Development of the feedstock recycling technology (i.e. production of monomers or other chemicals by depolymerization or thermal cracking) and also the use of used packaging as a reducing agent is expected to increasingly be able to accommodate such combinations. Full bottle labels that are opaque to the near infrared radiation (NIR) will cause an error in bottle material identification.
iii) Acceptable tolerances for non-compatible elements or substances in the recycling process.	An example of typical acceptance tolerances for the collected container input to the mechanical recycling processes: Intended plastic material 94 % min. Other plastics 3-5 % max. Impurities 3-5 % max. The impurities usually are coming from sources other than the intended packaging, such as non-plastic materials, food, or miscellaneous household. NOTE The minimum percentage of intended plastic material may depend on both the recycling technology and the economic viability. In some cases, this threshold may be significantly lower. Another example is the typical acceptance tolerances for the input to an olefine feedstock recycling process. Prepared agglomerates: Free flowing grain size 10 mm max. Fine grain less than 250 µ 1 % max. Moisture 1 % max. Bulk density 300 kg/m^3 min Plastic content 90 % min. of which polyolefines 70 % min. and non-olefinicplastics 4 % max. Moisture 1 % max. Residue on ignition 4,5 % max. of which metal 1 % max.	The actual acceptance will depend on a number of factors: — type of packaging and the main material, i.e. film, bottles, mouldings, thermoformings, i.e. LDPE,HDPE, PET, PP, PS, EPS, PVC, etc.; — the specific recycling operation, whether equipped with additional sorting and washing facilities; — the application in which the recycled material is to be used, e.g. food-grade packaging, fence posts, waste bags, carrier bags, textile fibres, etc. Techniques to check the plastic content of agglomerates are being developed but are currently limited to spot checks and statistical analysis. Technologies are likely to continue to be developed which may widen the acceptance tolerances, but conversely, increasing the use of recycled materials will involve a demand for even higher standards of recycling specification and tighten the indicated tolerances. Example: Other plastics packaging that cannot be removed by the process from the main stream.

Table 4 — Plastics [a] *(continued)*

Packaging recoverable by material recycling		
Reference to ISO 18604		
B.5 Criteria for collection/sorting	**Materials and substances external to the packaging**	**Comments**
Compatibility with the collection and sorting systems	The following list of materials which are not part of the packaging may be unintentionally introduced into the recovered material stream through the collection systems and are deemed to be difficult to remove or immiscible with mainstream plastic in the recycling processes: — metal; — glass; — paper; — other materials such as rubber, stones, soil, oils and grease, wood, textiles, and paint; — composite carton materials, disposable nappies, circuit boards, battery packs, medical waste, syringes/hypodermic needles, packages for which special chemicals are included to cause otherwise non-degrading plastics to degrade; — compostable waste such as food and garden waste; — packaging with remnants of hazardous contents. Materials and substances originating from sources integral with or external to the packaging, such as oxo/bio degradable plastics, may create problems with readily recyclable plastics in some recycling systems.	This is not an exhaustive list but provides a guide to the type of materials and substances that can find their way into the used plastic packaging sent for recycling.
a Applicable to the most common recycling technologies, i.e. mechanical recycling. Feedstock recycling (i.e. going back to chemicals) may, depending on the application targeted, be more flexible. See also: — in the scope of this Technical Report, the comments on the evolution of recycling technologies; — CEN/TR 15353 and EN 15342 to 15348 on characterization of plastics waste and of plastic recyclates.		
These guideline tolerances are indicative and subject to on-going review. These specifications may show variances from the guideline tolerances due to the differences in local conditions and technologies.		

Table 5 — Steel

Packaging recoverable by material recycling		
Reference to ISO 18604		
B.2 Design criteria NOTE c)	**Materials and substances integral with the packaging**	**Comments**
i) Separability of components	— Metallic components of steel packaging (steel/aluminium) do not need to be separable. For example with cans, when aluminium is used in combination with steel in packaging design, it may enhance the remelting process by acting as deoxidizer. — Non-metallic components (caps, sleeves) should preferably be easily separable by the user.	No limitation for packaging design. Whilst magnetic separation and scrap upgrading help to guarantee specified cleanliness of collected and sorted steel scrap, this helps to ensure maximum efficiency in meeting specified grade parameters.
ii) Compatibility of material compositions or material combinations with the recycling process	No limitations for packaging design (e.g. use of plastic or aluminium closures and dispensing features, paper labels, or polymer coatings) as long as steel remains the dominant material.	
iii) Acceptable tolerances for non-compatible elements or substances in the recycling process	National, regional, or company-specific steel scrap specifications prevail.	For example, European packaging steel scrap specification (draft version) (tin coated): — Shredded: 92 % Fe — Compressed/baled: ≥93 % metallic
B.5 Criteria for collection/sorting	**Materials and substances external to the packaging**	
Compatibility with the collection and sorting systems	— Due to its magnetic properties, steel packaging is compatible with all collection schemes as it is easily separated from co-mingled, selective, and incinerator waste streams. — Packaging should be emptied by the end user/consumer before it enters the packaging waste stream	
	All guidelines are indicative and subject to on-going review. Contractual specifications are negotiated directly between scrap suppliers and users in the various countries. These specifications may show variances due to the differences in local conditions and technologies.	

Table 6 — Wood

Packaging recoverable by material recycling		
Reference to ISO 18604		
B.2 Design criteria NOTE c)	**Materials and substances integral with the packaging**	**Comments**
i) Separability of components	Nails (boxes and pallets) and staples (crates) are sorted by magnetic separators. Therefore, nails and staples should be magnetic.	The first stage of the recycling process is to crush the wood/packaging. During this process, the crushed wood passes through a magnetic separator.
ii) Compatibility of material compositions or material combinations with the recycling process	No paint or lacquered woods — no impregnated wood (e.g. CCA: chromated copper arsenate) or wood that exceeds the maximum level of allowed chemicals. Wooden packaging is mainly made of untreated wood. NOTE The European Panel Federation has set a maximum level of allowed chemicals for recycled wood going into panels. In case of printing, the inks should be free of any heavy metals. It is better to avoid the use of glued papers on packaging sides; an allowance is given for a stick-on label.	Some pallet pools use colour to identify their pallets, most often glazing paints. Today, nearly all the painting systems, used for this purpose, are water-based. They do not contain heavy metals. The proportion of inks used for the crates is less than 1/1 000 of the total packaging weight. They are considered negligible for pallets and boxes.
iii) Acceptable tolerances for non-compatible elements or substances in the recycling process	No materials other than wood, and magnetic nails and staples. Papers, plastic films, complexes, soil, concrete, or textile remaining after use should be sorted or removed. No organic wastes. No trace of any added components, including heavy metals or hazardous substances, including contamination by the users.	

Table 6 *(continued)*

Packaging recoverable by material recycling		
B.5 Criteria for collection/sorting	**Materials and substances external to the packaging**	**Comment**
Compatibility with the collection and sorting systems	Wood is normally readily recognizable and for recycling, it is essential that the wood is free from contamination, both from components and constituents in the packaging and from other materials in the waste stream. No materials other than wood, and magnetic components and constituents which can be separated by magnetic separators. No plastic, organic wastes, or other chemical contamination.	This is not an exhaustive list but provides an indication of the materials and substances which will inhibit the acceptability of wood for recycling.

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