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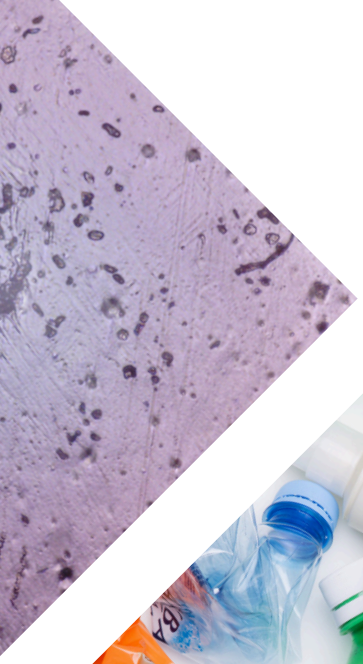
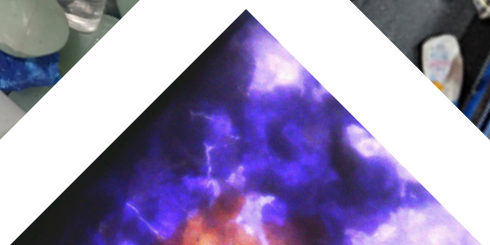


RECYCLABILTY BY DESIGN

The essential guide for all those involved in the development and design of plastic packaging.

2024



Recyclability By Design
Version 11 : Updated 2024

This work has been published by RECOUP in consultation with experts in the plastic packaging industry and the recycling industry.

The information contained within this document is for guidance only. Any details given are intended as a general recommendation based on the best of our knowledge at the time of publication.

The guidance in this document does not imply any endorsement of the recyclability of any given polymer or pckaging format. Guidance does not necessarily guarantee compliance with the different recycling schemes. Users are advised to contact RECOUP to check for specific up-to-date information.

While every effort has been made to ensure the accuracy of the contents of this publication, RECOUP cannot accept any responsibility or liability for any errors or omissions. Opinions expressed by external contributors may not reflect RECOUP positions. Recommendations provided herein are offered for the purpose of guidance only and should not be considered legal advice.

The 2024 RBD has been written, researched and compiled by
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RECOUP, founded in 1990, is the UK's leading independent authority and trusted voice on plastics resource efficiency and recycling.

RECOUP works to maximise plastic packaging recycling through stimulating the development of sustainable plastics waste management, including the improvement of plastics collection and sorting activities across the UK, undertaking research and analysis to identify good practices and remove barriers to the adoption of efficient recycling systems.

Contents

Introduction

Climate change and sustainable development are recognised as two of the biggest issues facing society today. It is therefore increasingly important for companies to reduce the environmental impacts of products and services through their whole life cycle. Companies failing to address environmental performance in product design and development will find it increasingly difficult to compete in the global market.

As part of these considerations, packaging should be designed to satisfy technical, consumer and customer needs in a way that minimises environmental impact. This means, that amongst other things, packaging should be designed to use the minimum amount of resources for purpose and once it has completed its job, the scope for recovery maximised.

These guidelines focus on the design of plastic packaging to facilitate recycling and represent a small but important aid for the journey to sustainable production and consumption.

Background to Document

This publication is intended as a definitive general guidance document that has wide international agreement. It will provide plastic packaging designers, in particular, with a better understanding of the environmental implications of their design decisions, thus promoting good environmental practices but without unnecessarily restricting choice. Designers can be reassured that through following these recommendations, their plastic packaging should not cause recycling issues in any European country and be acceptable internationally.

This document is intended to address the issues in a way that will encourage packaging designers and specifiers to follow agreed good practice.

The advice contained in the document has been provided both to help users maintain the value of the post-used material resulting from the mechanical recycling of their packaging and to avoid significant interference with established recycling processes and material streams. The chapter “Recycling of Plastic Packaging” summarises the key aspects concerning the recycling of plastics.

Document Scope

This practical document seeks to answer in a pragmatic way many of the immediate questions for designers and specifiers of plastic packaging. The guidelines provided here are broadly applicable and internationally consistent at the time of publication.

This document does not attempt to provide a full strategic overview of all issues in plastic packaging recycling. The authors acknowledge that guidance on designing for recyclability is only one component of a larger sustainability challenge. There are wider issues of relevance, both in considering the overall environmental impact of differentiated packaging systems, and in developing efficient operational solutions to recycling and recovery of used plastic packaging.

It is noted that continuing work will be required by many parties including designers, manufacturers, waste and resource management professionals and governments to address these developing issues.

It is important to note that since the packaging market is characterised by innovation, there are specific circumstances where the relationship of packaging production and recycling continues to develop.

There will also continue to be developments in the use of labels, glues and other packaging components. In addition good practices will develop and, changes in regulations will continue.

European Legislation

In 2008, the EFSA (European Food Safety Authority) published the regulation 'Recycled plastic materials and articles intended to come into contact with foods'. The extended regulation covers any recyclable material, rather than specifically PET bottles. This ruling was updated in September 2022 with regulation 2022/1616. This regulation requires traceability of supply chains for food grade recycling and potential future requirements have led to increase demands in this area even more. As a consequence this may lead to additional recommendations for designers as well as for those involved in the logistics of recycling to ensure that compliance with the current and future regulatory standards is achieved.

Following these guidelines will also help European companies demonstrate compliance with the European recycling standard linked to the Essential Requirements legislation and more generally, will aid demonstration of 'due diligence'.

New EU regulations outline support for a circular economy. The circular economy package encourages new measures which will promote the inclusion of repairability, durability and recyclability in initial design.

Aims

The aim of this document is to encourage designers to consider recycling possibilities, provide guidelines for those wishing to make their packaging (more) recyclable and provide everyone with information to prevent their packaging inadvertently interfering with existing plastic recycling streams.

Pursuit of these aims must be proportionate; the guiding principle for any packaging design should be "fitness for purpose". Thus the goal of improving the recyclability of the packaging cannot compromise product safety, functionality or general consumer acceptance and should positively contribute to an overall reduction in the environmental impact of the total product offering.

As the recycling industry grows, collection rates and recycling rates improve, recyclability will more frequently be the most environmentally sound option. Energy recovery or composting are other options to be considered, depending on the nature of packaging and the local solid waste management infrastructure. These recovery routes are complementary and their relative use needs to be optimised to meet local conditions, thereby providing an integrated and sustainable approach to packaging waste management.

Is this document relevant to me?

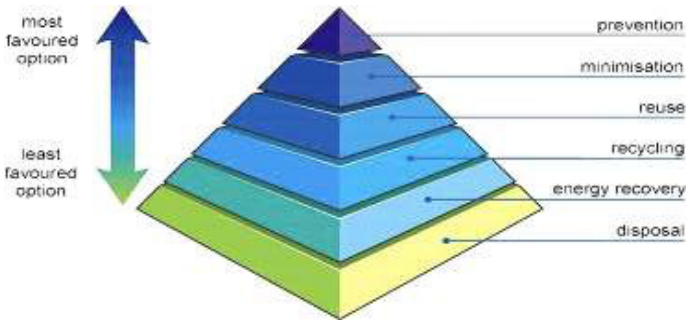
This document is of relevance to anyone specifying, designing or using plastic packaging. The focus is on plastic packaging that ends up in the domestic waste stream but it is also of relevance to commercial & industrial waste streams.

The document gives practical advice and information on environmental considerations to the whole supply chain i.e. designers, packaging technologists, buyers, marketing and retailers but is primarily focused on those responsible for specifying the packaging being used. Any specifier following the guidelines can be reassured that their packaging should not cause recycling issues.

This document consolidates and develops information from RECOUP members in both waste management and the packaging supply chain, together with various sources in Europe to provide a comprehensive guide on plastic packaging design best practice. It is, therefore, particularly relevant to companies selling into markets across Europe but has more general international relevance.

The Waste Hierarchy

The Waste Hierarchy was part of the revised EU framework directive in 2008. This sets out the methods of dealing with waste, ranked in order of potential environmental impact. This is based on life cycle assessment.



The Waste Hierarchy has now been incorporated in UK law, via the Waste (England and Wales) Regulations 2011.

Why is Plastics Recycling Important for the Environment?

- Recycling plastics can, in many cases, significantly reduce the consumption of resources and emissions to the environment.
- Plastics recycling can conserve energy and non-renewable resources as recycling replaces the need for primary extraction and manufacture of new plastics.
- Plastics recycling also reduces the reliance on traditional, and less environmental beneficial, landfill waste disposal.
- The environmental impacts and benefits of recycling plastic products vary significantly depending on the type of product and its condition at end of life.
- Relatively large, clear supplies of plastic products can normally be recycled with a positive environmental gain.
- Creating a circular economy would have a number of benefits for plastics which can be a valuable and circular resource.

The economic benefits of recycling are clear; compliance with regulation is mandatory; public image preservation is vital. By ensuring consumer and political demands are met, organisations involved in the plastics waste stream are less likely to come under attack for poor environmental performance, or as polluters. Political backlash to consumer and pressure group complaints will be minimised, with a greater level of dialogue and discussion taking place between sector and political representatives.

Although changes in legislation and policy may appear bewildering, there is an underlying certainty:

- Businesses that understand and act on the fundamental principle of sustainable development will gain competitive advantage.
- Businesses and sectors that fail to recognise the implications of these issues will lose out.

Protecting Your Freedom of Material Choice

Plastic packaging manufacturers understand the demonstrable benefits of plastics as a packaging material. Its lightweight nature is of particular benefit due to transport cost minimisation. In addition, plastic is often the most appropriate material to meet consumer demands of ensured freshness, safety and product visibility.

Companies involved in the packaging supply chain can safeguard their freedom of material choice by engaging with the recycling industry to provide support for the development of effective plastics recycling within the UK. Developing packaging that can easily be recycled by incorporating recyclability into the product development stage, combined with involvement in the development of the recycling industry, will help to protect both the public and political profile of plastic packaging and reduce the risk of material choice restriction via political intervention.

Genuine efforts to minimise environmental impact and maximise environmental benefit through the introduction of efficient plastics recycling programmes both protects and enhances the public image so vital to maintaining competitive advantage.

Following these guidelines will at a minimum, provide an important contribution to help you ensure that your packaging is compliant with relevant legislation /agreements, that recycling costs are minimised and that societal expectations and your company practices are matched in the area of plastic packaging recycling.

The document however is designed to go beyond being a simple aid to legal compliance; it provides up-to-date guidelines that can be used to support a process of continuous environmental improvement, a key element of both Sustainable Development and Corporate Social Responsibility.

Are there Benefits to me if I Follow the Guidelines?

The guidelines allow you to maximise the opportunity for your packs to be mechanically recycled whilst avoiding significant interference with established recycling processes and material streams (requirement of European recycling standard linked to legislation) without unnecessarily restricting choice.

Adopting these guidelines at the start of the design phase will ensure unnecessary difficulties are avoided and hence unwanted project delays and associated on-costs prevented.

A number of countries across Europe seek to reward packaging that conforms to specific design rules and / or penalise those that don't. Compliance with these guidelines will help ensure that you obtain any benefits and avoid potential penalties in this area.

Following these guidelines will help minimise the costs to your company in satisfying its recycling obligations under European legislation and national / state agreements by maximising recycling efficiencies and thus minimising reprocessing costs.

What are you Asking me to Do?

For existing plastic packaging, you are asked to review your current portfolio against these recycling guidelines, highlight any aspects where the design could be improved and then implement changes, as the opportunity arises.

For new packaging, you are asked to integrate these guidelines into the design process at the start, to minimise cost and maximise the opportunity for compliance.

More generally, these guidelines should be integrated into any Environmental Management Systems (e.g. ISO 14001) and new product innovation protocols that you have, and become part of your automatic environmental assessment process for new products.

Will it Cost me Money?

Adoption of good eco-design practice should not result in an on-cost provided that these aspects are considered along with the many other business factors at the start of the design process. Conversely, if environmental considerations are only factored in at the end of the design process, then any changes necessary are likely to be costly in terms of both money and project delays.

Following the guidelines should help you reduce costs by:

- Helping to ensure that your company is compliant with relevant legislation (e.g. the recycling requirements of the essential requirements legislation of the European Packaging and Packaging Waste Directive) / voluntary agreements
- Minimising company recycling costs
- Matching societal expectations and company practices in the area of plastic packaging recycling.

Conversely, the potential consequences to a business of getting these aspects wrong in terms of legal, market share and corporate image issues can be significant.

Where Can I Get More Information?

Where Can I Get More Information?

The current guidelines provide a good point of entry. This document consolidates and develops information from RECOUP members in both waste management and the packaging supply chain, together with various sources in Europe to provide a simple but comprehensive guide on plastics packaging design best practice. Any specifier following the guidelines can be reassured that their packaging should not cause recycling issues. This document will be periodically updated and the most up to date version will be available for download from the RECOUP website;
www.recoup.org

The document also provides reference to key industry organisations and websites dealing with the recyclability and recycling of plastics packaging in Europe. You are encouraged to visit the websites and if necessary, contact the relevant organisation(s) to discuss any specific issues not covered within the current guidelines or obtain further information on a specific area. These organisations can also help put you in touch with your local organisation should this be desired.

If you are unsure who to contact, or require any further guidance in relation to this document or any issues relating to recyclability of plastic packaging, please contact RECOUP (enquiry@recoup.org).

Conclusion

Following these design for recyclability guidelines will be an important contributor towards helping to ensure that companies are compliant with relevant legislation / agreements, company recycling costs are minimised and that societal expectations and company practices in the area of plastic packaging recycling are matched.

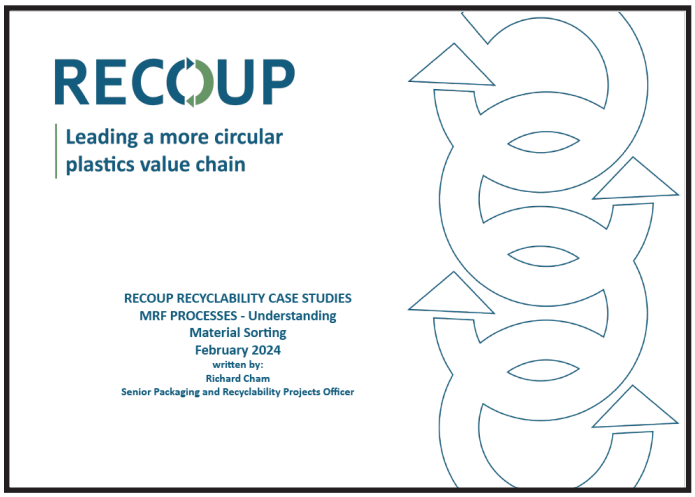
In addition, the production of consistently high quality, post-use plastic material will overcome the quality and consistency supply issues experienced in the past. This will make it commercially a more attractive raw material and thus help to further stimulate sustainable secondary markets. Thus the use of post consumer plastic in packaging whenever possible should be encouraged.

Sector Specific Guidelines and Case Studies

RECOUP work with Members and Stakeholders to develop initiatives and share best practice across the whole value chain. Using case studies; RECOUP illustrates how Recyclability by Design principles can be applied in practice.

Examples include the following documents:

MRF Processes – Understanding Material Sorting - Case Studies - Document explaining the plastic sorting process at a MRF, including looking into the issues of design for recyclability for sleeves on bottles, new MRF sorting technology which may solve those issues, and new products available from the packaging manufacturers.



Packaging Design Principles - This publication outlines some of the basics of design for recyclability for plastic packaging, and new products available from packaging manufacturers.

General Guidelines

Introduction

The guidelines have been compiled to help maximise the opportunity for plastic packaging to be mechanically recycled, without unnecessarily restricting material choice, and to help maximise the value of the post-used material resulting from the mechanical recycling of the packaging.

Up-to-date guidelines can be used to support a process of continuous environmental improvement, a key element of both Sustainable Development and Corporate Social Responsibility.

Careful selection of materials at the design stage will help overcome potential legislative issues, reduce cost and help conserve resources by avoiding obstacles to recovery, improving yields, producing less waste and ensuring a higher value of the recovered material.

The information contained within the guidelines implies no criticism of any material and merely seeks to point out that certain combinations should be avoided to maximise the recyclability of the plastic packaging in question. Plastic materials that cannot be processed with the main material at best reduce reprocessing yields and can, unless care is taken in the design, significantly reduce process efficiency and introduce unacceptable costs. Matrices summarising material compatibilities are provided within each material specific guideline.

Following the recommendations provided in these guidelines should avoid the necessity to evaluate component compatibility. However, if use of non-recommended material combinations is desired, then the user may arrange for more definitive compatibility evaluation tests to be carried out. In addition, specific applications (e.g. food contact) may stipulate more demanding requirements than provided in these general guidelines.

General Principles for Container / Components

In an ideal world, use of mono-materials or mixed materials of the same type are the preferred choice from a recycler's point of view. In this context, type means materials that for all intents and purposes act as if they were a homogeneous material i.e. they are fully compatible, do not downgrade the properties of the recycled plastic and can be sorted and subsequently processed as if it were a single material.

It is recognised that to provide both the technical properties required and to satisfy user needs, sometimes a combination of different types of material is required. Under these circumstances, materials of different densities should be used to facilitate the separation of incompatible materials during mechanical shredding or crushing, or during the subsequent water based washing process. Combinations of different types of plastic with the same density ranges should be avoided.

Unpigmented polymer has the highest recycling value and the widest variety of end uses. Therefore, use of unpigmented plastic containers is preferred to pigmented.

For food contact applications, the additional specific requirements of traceability, guarantee of the use of qualified processes and producer responsibility for recyclates would ensure that specifiers use only food approved additives, to maintain the potential for the recyclate to be subsequently used in food applications.

General Guidelines

Residues

To help ensure packs are emptied to their maximum, packaging designers should carefully consider what good design features can be incorporated to aid the emptying of packs.

For example:
- Design the pack with a wide neck.
- Consider using a pack that can be stood inverted to ease emptying.

Non-stick additives can be used to reduce the cling of contents to the container to ease emptying. Such additives should not, however, affect the ultimate recyclability of the pack.

No firm target figures can be provided as to what constitutes acceptable residue levels as these will be very dependent upon pack size and product viscosity. As a rough guide however, for non-viscous products (i.e. where thickness is similar to water) aim for 50ml-99ml bottle residues <10%, 100ml-499ml bottles < 5% and 500ml+ bottles <2% bottle resides of declared contents when considered empty. For viscous contents it is not practical to set target residue guidelines as the amount of residue depends in part on the properties of the contents.

Composite Materials / Barrier Layers

Where a composite material is necessary to provide the requisite properties (e.g. provide a barrier function) and cannot be designed in such a way that the different types of materials can be separated mechanically or are compatible with the recycling stream, consideration should be given to the use of thin layers.

Colour of Plastic

Colour interferes with the mechanical recycling process in two main ways: Firstly, strongly coloured plastic material has a much lower economic value than nonpigmented plastic. Secondly, heavily coloured (and hence strongly light absorbing) plastic may interfere with automated sorting machinery that uses Near-Infrared (NIR) spectroscopy to identify the nature of the plastic. Such equipment relies on the reflection of NIR radiation and thus there is an issue in identifying plastic items containing carbon black pigment.

The amount of colour to be used should be minimised as much as possible within the constraints set by technical considerations, branding and consumer acceptance.

Avoid direct printing onto natural (not coloured or opacified) plastics.

Readily separable attachments allow reprocessors to remove associated contaminants such as pigments, inks and residual adhesives, hereby raising the quality of the recyclate. This is particularly significant when the primary packaging polymer is colourless or ‘natural’. When the primary packaging polymer is pigmented, e.g. coloured HDPE, the reprocessor specification is less sensitive to low levels of ink contamination and in this case the polymer type of the label, cap and other attachments should be matched to that of the container.

General Guidelines

Closures / Closure Liners / Cap Sleeves / Seals

Closures, liners and cap seals should not interfere with the recyclability of the material to be recycled and ideally be recyclable themselves, preferably in conjunction with the plastic of the main container. Unfortunately, this does not mean PET closures on PET bottles. Ideally, HDPE closures are used on PET bottles for carbonated applications.

Closure systems that contain no liners and leave no residual rings or attachments when removed are optimum. Designers should assume seals may be pushed back into empty containers and choose materials accordingly.

Avoid use of metal caps. They are more difficult and more costly to remove in conventional reclamation systems compared to preferred plastic closure systems. Metal residues cause unacceptably high plastic rejection rates with the metal detectors installed in sortation lines and residues can catalyse polymer oxidation and block injection nozzles. Automatic sortation equipment such as eddy current units or electrostatic separation equipment can remove aluminium closures from recovered polymer. However, not all reprocessors have such equipment. In addition, most reprocessors use a caustic wash and any aluminium residues will be converted to aluminium hydroxide, which will then become a contaminant in the recycled material, that could prevent its suitability as a food grade material (e.g. in the case of PET). Use of threaded / snap-on metal closures should be avoided, as these can be difficult and relatively expensive to remove. Prised off (crown) caps are acceptable provided they are completely detached from the bottle on opening and cannot be pushed back on / into the container.

In certain circumstances, seal residues and minor components of a different type of plastic if present in very minor amounts, may not significantly interfere with the recycling process or the quality of the recycled material. However, this should not be assumed and further guidance should be sought in these instances.

In applications where tamper-resistance is required, integration into the design feature is preferable. Provided functionality can be maintained, sleeves and safety seals should be designed to completely detach from the container or be easily removed in conventional separation systems. Otherwise they will act as contaminants.

Where a removable sleeve is used on a bottle, instruction to remove the sleeve should be included on the labelling text.

If a full sleeve was to be left on, there is a risk that the bottle may not be correctly recognised by automated Near Infrared (NIR) sorting equipment, in which case the bottle could be either mis-read, or at worst possibly rejected and sent to landfill.

General Guidelines

Labels / Safety Seals / Adhesives

The type of labels and adhesives used has important implications for ease of container recycling. Amount of adhesive used and surface coverage should be minimised to maximise yield and ease reprocessing. Water releasable at 60 to 80°C (140 to 180°F) and hot melt alkali soluble adhesives are the adhesives of choice as they are the most readily removed during reprocessing. Label adhesives that can't be removed can coat the plastic regrind and embed unwanted contaminants.

APR in the USA have developed testing protocols for adhesive manufacturers to use to evaluate the impact of any adhesive product on conventional PET and HDPE bottle reclamation systems. The European PET Bottle Platform also has developed similar protocols to test acceptability of adhesives in conventional European bottle recycling systems.

For bottles; sleeves and wraparound or collar labels that are only glued to the container at only a few points are optimum.

Foil safety seals that leave remnants of the foil and / or adhesive should be avoided.

Labels should not delaminate in the washing process. Use of paper labels on bottles is not ideal, as some fibres can be carried over into the recycled plastic, causing problems such as surface defects and pinholes during the blow moulding of the recyclate. Paper labels also may pulp in the wash tank. They are acceptable, however, provided they are attached using water soluble adhesives and are not coated in such a way that prevents separation and removal from occurring during reprocessing. For this reason use of decorative / protective finishes (e.g. foil, lacquers, coatings, etc.) should be minimised.

Metallised / foil labels increase contamination and separation costs and should be avoided whenever possible.

Deposition techniques that provide a very thin layer of metal (only atoms deep) are acceptable however and are the method of choice to provide a metallised effect on labels.

Where in-mould labelling is desirable (e.g. to protect containers frequently coming into contact with oils or water) the same plastic as the container should be used wherever possible.

Reference should be made to the specific material sheets to obtain more detailed information about acceptable options for label materials.

The choice of label or sleeve polymer should not have the potential to lead to an error in the identification of the material used for the container itself. This is why various published guidelines for bottles often stipulate that the sleeve labels should cover no more than 40% of the bottle surface.

For pots, tubs and trays and other plastic items, a label should not cover more than 60% as presented for sorting.

General Guidelines

Pigments / Inks

Inks and pigments selected to colour and print the container and label already have to comply with existing restrictions on the use of heavy metal components and, although beyond the scope of these guidelines, also with relevant health and safety regulations.

In any case, hazardous substances should be avoided in the interests of good manufacturing practice and heavy metal inks not used for printing as they may contaminate the recovered plastic. For these reasons, it is recommended that the regularly updated exclusion list for printing inks and related products, provided by the European Printing Ink Association (EuPIA) is followed.

Inks that would dye the wash solution should be avoided as this may discolour the recovered plastic diminishing or eliminating its value.

Heavily pigmented containers should be avoided. They can result in a significant increase in the density of the polymer thereby causing separation problems and can also cause problems for automated sorting equipment using NIR sensors.

Other Components

The use of other components of a different material (e.g. handles, pour spouts) is discouraged as they may reduce base resin yield and increase separation costs. When required, compatible materials (preferably unpigmented) should be used.

Material Identification

In Europe, material identification is voluntary, but if it is to be used then Commission Decision 97/129/EC should be followed, although the widely adopted and substantially similar SPI system, developed in the US for plastic, seems also to be acceptable.

When used, the symbol should be shown clearly and ideally moulded into the container / component.

On containers, the marking should be clearly distinct from any other letter or cavity reference number to avoid confusion. For consistency, material identifiers should generally be embossed on the base of a container. Exceptionally, the identifier can be located on an alternative position close to the base (e.g. to avoid the risk of cracking due to bottle design).

Printing the material identifier on a label should be avoided, as this is likely to lead to confusion as it could refer to the label material, the container plastic or the full container.

With the use of automated sorting for household waste, the recycler’s need for material identification has become less important.

General Guidelines

Markets for Recycled Plastics

Recycling benefits and economics are maximised when the quality of the recyclate is appropriate and there are strong and diverse market outlets for the secondary material recovered. Today, there are opportunities to manufacture a range of plastic packaging products, including food grade applications such as containers and trays, with a proportion of recycled plastic. In this latter case, traceability is a critical parameter. Designers should consider the possibility of including recycled plastics in their packaging for both environmental and commercial reasons.

Integration of Environmental and Legal Aspects into the Packaging Design Process

The design of packaging is a complex process and is often a key element of product change / new product introduction. If environmental and regulatory assessments are included with the wide range of inputs that have to be taken into account at the start of a project they can become part of the process of maximising the product opportunity. Where environmental considerations are an afterthought issues are invariably more difficult to resolve and can lead to significant on-costs and serious time delays.

It is recommended that companies adopt a new product innovation process that automatically includes an environmental assessment. Ideally, this environmental assessment becomes part of a recognised environmental management system (e.g. ISO 14001). The European CEN standards provide an excellent management approach for carrying out this environmental assessment. Following these standards should ensure that companies automatically cover the key environmental aspects that need to be addressed for packaging. Use of this document by packaging designers / specifiers should help ensure that the key criteria covered in these standards concerning plastic packaging has been satisfied.

Material Specific Guidelines

General guidelines apply to all plastic materials used for packaging. Specific guidelines have also been produced for plastic packaging. These material specific guidelines complement the general guidelines and should be used in conjunction with them where appropriate. In the unlikely event that the general and specific guidelines appear contradictory, the material specific guidelines should take precedence.

The compatibility matrices contained in the material specific guidelines are divided into three columns, namely:

- **COMPATIBLE** for recycling in most applications
- **MAY BE SUITABLE** for recycling for some applications
- **NOT SUITABLE** for recycling

The meaning of these three columns is as follows:

COMPATIBLE for recycling in most applications	MAY BE SUITABLE for recycling for some applications	NOT SUITABLE for recycling
Generally the material is compatible with or separable from the main material and is acceptable in industrialised recycling processes in large volumes.	Use of material could cause severe recycling issues if used in large volumes. Under certain specific conditions the material may be recyclable, but this would need to be confirmed with the appropriate recycling organisations and/or recyclers.	Material is generally not compatible with or separable from the main material in current industrialised recycling processes and will therefore cause severe recycling issues/ cause rejection of recyclate if present even at low volumes.

It should be noted that under certain circumstances suppliers may require, for a specific application, recycled material that conforms to the most demanding requirements outlined in the material compatibility matrices supplied in this document, as evidenced by the following example:

Example - Polyethylene

For the manufacture of polythene bottles from recycled HDPE, one UK manufacturer highlights the importance from a recyclability perspective of the HDPE material stream including only containers made from HDPE, linerless HDPE caps, labels made from only HDPE and that any inserts or other minor components are also manufactured from only HDPE.

Material Specific Guidelines - PET

Material Specific Guidelines - PET

General

The recommendations given in this section were originally written to cover PET bottles. The same recommendations cover PET trays. These guidelines are driven by the requirements of the mechanical recycling process. For efficient separation and removal in conventional density separation processes, parts of the packaging system that are not compatible with PET should have a density < 1 g / cm3.

Material / Material Combinations

Contaminants which generate acidic compounds during extrusion cause problems when recycling PET, as these catalyse ester depolymerisation reactions, decreasing intrinsic viscosity.

A range of contaminants including PVC, rosin acids from label adhesives and EVA cap liners can act as sources of acids. PVC contamination is a potentially major problem as the similar appearance and overlapping range of densities make the two polymers difficult to separate. PET melts between 250°C and 260°C, and at this temperature PVC begins to decompose producing HCl. The presence of very low levels of PVC (ca50- 200ppm) in recycled PET results in measurable deterioration in chemical and physical properties and can render large amounts of PET useless for most recycling applications. For this reason, the use of PVC components of any kind with PET containers should be scrupulously avoided. These components generally include, but are not limited to closures, closure liners, labels, sleeves and safety seals.

Other types of PET that share the same material identifier may cause problems in separation and conventional recycling. Use of PLA (a biodegradable material) with PET should be avoided as the polymers are incompatible and not readily separable (both have a density > 1g/cm3). The presence of very low levels of PLA in PET causes haze and a deterioration of physical properties with the recycled PET. MXD6 also will reduce clarity.

In addition, PLA causes processability problems in the drier as it melts at the drier temperature. Blends of PET with other resins are undesirable unless they are compatible with PET recycling. Inclusion of nucleating agents, hazing agents, fluorescers, scavengers and other additives for visual and technical effects should be examined on a case by case basis for their impact on the overall plastic recycling stream. Such additives which cause the PET to discolour and/or haze should be avoided unless means are readily and economically available to minimise their effect.

Barriers / Coatings

New PET bottles incorporating additives or barrier materials to further improve barrier performance are continuously being developed and will at some time challenge existing recovery schemes. Non-PET multilayers or coatings are not always fully compatible with current recovery technologies and may reduce recoverability of PET bottles. Indeed, constituents can be difficult to separate. It is accepted that newer containers and containers for oxygen sensitive contents may be multi-layer and will, therefore, require additional attention during recovery operations. The European PET Bottle Platform has published guidelines to help the PET production, filling and recovery chain evaluate the impact of such bottles. EVOH barriers in particular have a history of causing significant issues during recycling if residual levels are >= 500ppm. This could include haze and colour issues at low levels and deterioration of mechanical properties at high residual levels. Hence EVOH as a potential barrier material with PET is not recommended at this time.

Material Specific Guidelines - PET

Product manufacturers, and their suppliers, would need to ensure that levels employed are minimised and that data to show that the proposed packaging provides a recyclate that satisfies all technical requirements (especially discolouration and haze) and that recyclers in general can achieve the separation efficiencies required. Alternatively, where performance enhancing barrier layers are used which could interfere with current recycling, for example in PET beer bottles, it is important to ensure that the container is easily distinguished and sorted from conventional PET bottles.

Clear plasma coatings in general cause no recycling issues, although use of high levels of carbon should be avoided. Other external coatings (e.g. O_2 or CO_2 barriers) can cause issues. To be acceptable the barrier needs to flake off the PET and be efficiently removed during reprocessing. European PET Bottle Platform protocols have been developed to test suitability.

Colour

Non-coloured, unpigmented PET not only has the highest value and the highest recovery rates but also the widest variety of end markets. At present, tinted (other than light green and blue tints) or opaque PET bottles are not desirable to many PET recyclers because the quality of their end products are colour sensitive. As a result, strongly coloured PET is rejected by many recyclers and can interfere with the recycling process and therefore clear PET should be used as much as possible. The use of opacifiers should be avoided as they significantly reduce the value of the PET recyclate. The presence of TiO_2 in particular causes breakage during fibre production and thus use of this opacifier in particular should be avoided.

Closures / Closure Lines

EVA liners are only acceptable in combination with plastics. When combined with aluminium they cause contamination and thus should not be used.

Conventional silicone seals (density >= 1 g/cm³) are neither compatible with PET or easily separable and therefore should not be used in combination with PET. Seal manufacturers have recognised this problem and are now designing silicone seals with a density < 1 g/cm³. These seals should be separable from the PET and avoid potential issue. Potential users are recommended to check that the supplier can provide proof of the compatibility of the seal with conventional PET recycling. It is also worth noting that whilst this development was designed to overcome potential issues within the PET recycling stream, these lower density silicone seals have the potential to end up in the polyolefin stream and adversely affect the quality of this stream.

Closures made from PS or thermoset plastics are undesirable and should be avoided. In general the use of aluminium closures should be avoided, as they are more difficult to separate from bottles compared to the preferred closure systems (PP and HDPE) and add both capital and operating costs to conventional reclamation systems. Foil safety seals that leave foil or remnants or attaching adhesive on the PET bottle should be avoided.

Material Specific Guidelines - PET

Labelling

Polypropylene and polyethylene are the preferred label materials. Foil, lacquered and coated labels become contaminants and are undesirable. Presently all direct printing and decoration contaminates recovered PET in conventional reclamation systems and discolours the conventional base material. Colour and printing therefore (other than date coding) should be confined to labels.

Other Components

It is preferred that base cups, handles, transportation aids and other attachments are avoided but if used, they should not be welded to the container. If attachments are glued on, they should separate in hot aqueous detergent or caustic solution (60 to 80°C).

	Material Guidelines - PET Bottles			
		COMPATIBLE for recycling most applications	MAY BE SUITABLE for recycling for some applications	NOT SUITABLE for recycling
BODY	Colour	Clear/Light blue/light tints	dark blue / dark green / brown / strong tints	Opaque / solid colours Carbon Black
	Barriers/ Coatings	Clear plasma coating	External coating / PA - 3 layers	EVOH / PA monolayer blends
	Additives		UV stabilisers / AA blockers	Nanocomposites
CLOSURE	Caps	PP HDPE, LDPE - Europe only		Steel / Aluminium / PS / PVC / Thermosets
	Seals	PE/PP	Silicone (density <1 g/cm³)	PVC / Aluminium / Silicone (density >=1 g/cm³)
DECORATION	Direct Printing	None / Embossed / laser printing (minimal)	Minimal direct printing, e.g. production or expiry date	
	Labels	HDPE / LDPE / PP / OPP less than 60% coverage on face	Paper Over 60% coverage on face	PET PVC Metalised
	Sleeves (incl. tamper resistance)	PE / PP / OPP / EPS (density <1 g/cm³) Foamed PET / Foamed PET-G less than 60% coverage on face	over 60% coverage on face	PET PVC PS PS (density > 1 g/cm³) / PET-G
	Adhesive for labels	Removeable water releasable in 60 - 80°C		Not removable in water
	Ink	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye wash-solution
OTHER	Trigger sprays	PP / HDPE / LDPE		Glass components Metal springs / ball bearings

Material Specific Guidelines - PET

Material Guidelines - PET Trays				
		COMPATIBLE for recycling most applications	**MAY BE SUITABLE for recycling for some applications**	**NOT SUITABLE for recycling**
BODY	Colour	Clear / uncoloured	NIR detectable colours*	Non-NIR detectable colours e.g containing carbon black*
	Barriers/ Coatings	None		PE seal Layer EVOH PA (Nylon)
	Additives	Minimal silicone surface coating (de-nest)*	O_2 scavengers / UV stabilisers / AA blockers / Anti-block	
CLOSURE	Lidding film	Easily removed by end user or easily removed early in the recycling process; or; as main polymer (PET)	Removed later in the recycling process (washing process)	
DECORATION	Direct Printing	None / Embossed / laser printing (minimal)	Minimal direct printing, e.g. production or expiry date Printing inks that do not lead to NIAS after the washing process	Extensive colour printing with printing inks that result in NIAS
	Labels	HDPE / LDPE / PP / OPP Less than 60% coverage on face Labels that are removed in or before the wash step*	Paper Over 60% coverage on face In Mould label	PET PVC Metalised Labels that cannot be removed Labels that result in detection error
	Adhesive for labels	Removeable Water releasable in 60 - 80°C		Not removable in water
	Ink	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye wash-solution
OTHER	Inserts	Must be fully removable without leaving a trace*	HDPE / LDPE / PP / PET / paper	PVC / PS / EPS / PU / PA (Nylon) PC (Polycarbonate) / PMMA (Acrylic) Thermoset plastics / Metallic

*No additives or processes should result in not intentionally added substances (NIAS) as this would contaminate food grade recycled content

Material Specific Guidelines - HDPE

Material Specific Guidelines - HDPE

General

For efficient separation and removal in conventional density separation processes, parts of the packaging system that are not compatible with HDPE should have a density > 1 g / cm³.

Colour

Applications using clear, natural, colourless polyethylene have the highest recycling value, therefore use of unpigmented containers is preferred. Coloured containers, tubes and films are acceptable.

Barriers / Additives

Some applications require the use of additional barrier layers for specific applications. The use of non-PE layers should be minimised (to maximise PE yield and reduce potential contamination and separation costs), but when required they should be compatible with or easily separable from PE in conventional recycling systems. Current HDPE recycling systems can tolerate the use of low levels of EVOH layers. Similarly MXD6 and other nylon-based barrier layers are tolerated, particularly if the layers are readily separated from the HDPE in conventional reclamation systems. In all such cases their content should be minimised to the greatest extent possible to maximise HDPE yield and reduce potential contamination and separation costs. PVdC barriers should be avoided.

The use of additives / fillers such as calcium carbonate, talc, etc. in concentrations that alter the density such that they cause the HDPE plastic to sink in water or alter the properties of the regrind are undesirable and should be avoided. For this reason, the HDPE density should be kept at <= 0.995 g/cm³.

Other Components

Use of PVC components should be avoided as they can cause discolouration and malodour.

HDPE Bottles - Material / Material Combinations

Unpigmented, homopolymer HDPE bottles generally do not use a multi-layer construction at present. It is possible that future bottle designs, however, might require the use of layers for specific product applications and then the barrier advice given should be followed. The principal polymer contaminant of recovered HDPE is PP from bottle caps and bottles. HDPE and PP are opaque and less dense than water and consequently difficult for reprocessors to separate. Even in the small number of reprocessing plants able to separate PE from PP, this is not common as it is costly to carry out. PP has a higher melting point (160-170°C) than HDPE (ca130°C), and so does not disperse readily in the HDPE recyclate mix. PP contamination can limit the recovered HDPE specification to lower value applications. In general, a level of PP contamination up to 5% can be tolerated in the total mix and levels of PP cross contamination in finished product are frequently at around 5%. Higher levels e.g. 10% in the total mix can be tolerated for certain lower specification applications. When designing packaging, it is recommended that PP levels are restricted to a maximum of 5% to avoid potential end use issues. This is in line with US recommendations. Higher levels may be possible but this would require the difficult task of investigating the likely effects on the total mix during recycling.

HDPE is very susceptible to contamination from the contents (e.g. pesticides, motor oil, etc.) which can result in colour and odour problems. Whilst recyclate derived from milk bottles can result in malodour issues, this should be avoidable using a hot washing stage during reprocessing. HDPE containers used for mineral oil based products (e.g. motor oil) are not generally mechanically recyclable as they can cause residual malodour issues but more importantly, the oil migrates into the plastic and is not removed during normal reprocessing operations.

Material Specific Guidelines - HDPE

Colour

In general homopolymer bottles are unpigmented whilst copolymer HDPE bottles (detergent bottles) are pigmented. Indeed, some plastic recyclers use pigmentation as the basis for distinguishing and separating copolymer from homopolymer containers. For this reason a communication program to alert recyclers to the potential confusion should accompany any use of unpigmented copolymer bottles. In multilayer HDPE bottle designs, the use of inner layers of the same colour as the outer layer is preferred to maximise recyclability but inner and outer layers of different colour can be tolerated.

Closures

The use of closures that are the same colour as the bottle is desirable (although not essential). Foil safety seals that leave foil or remnants or attaching adhesive on the HDPE bottle should be avoided.

Labelling

In applications using unpigmented, homopolymer HDPE, all direct printing other than date coding, used either for product labelling or decoration, presently contaminates the recycled unpigmented HDPE in conventional reclamation systems. Use of PVC labels should be avoided as during the density separation the foil is so thin that it is carried over with the PE and does not sink as would be expected from its intrinsic density.

Other attachments

The use of any other attachments is discouraged, as they reduce base resin yield and increase separation costs. If attachments are added to a bottle, they should be made from either materials that are easily separable from HDPE in conventional separation systems or are compatible e.g. PP, LDPE or preferably, unpigmented, homopolymer HDPE. Use of PP or LDPE attachments, if necessary, should be limited to less than 5 percent of the total bottle weight wherever possible as higher percentages can contaminate the HDPE for many recycling applications. If pour spouts are added to a bottle they should allow for complete removal of product contents and be designed to leave virtually no product residue when the bottle is empty. If adhesives are used to affix attachments, they should be water releasable or dispersible at temperatures between 60°C and 80°C in order to be removed in conventional washing and separation systems. The use of attachments that contain metallic and other non-plastic components is discouraged and should be avoided.

Material Specific Guidelines - HDPE

		COMPATIBLE for recycling most applications	MAY BE SUITABLE for recycling for some applications	NOT SUITABLE for recycling
BODY	Colour	Natural	Light blue / green / light tints Opaque / Heavy colours	Carbon Black
	Barriers/ Coatings	EVOH	PA (incl. MXD6)	PVDC
	Additives			Talc / $CaCO_3$ / other fillers that increase the density of HDPE abover 0.995 g/cm_2
CLOSURE	Caps	HDPE / LDPE / PP		Steel / Aluminium / PS / PVC / Thermosets
	Liner	HDPE / LDPE / PE + EVA / PP		PS / PVC / EVA with aluminium
	Seals	PE / PP / OPP	Aluminium	PVC / Silicone
DECORATION	Direct Printing	Minimal or moderate direct printing, e.g. production or expiry date laser printing (minimal)	Excessive direct printing	
	Labels	HDPE / MDPE / LDPE / LLDPE PP / OPP less than 60% coverage on face	Paper Over 60% coverage on face In Mould label	PVC / Aluminium / Metalised PET
	Sleeves (incl. tamper resistance)	PE / PP		PVC / PS
	Adhesive for labels	Water releasable in ambient conditions	Water soluble up to 80°C	Not removable in water
	Ink	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye wash-solution
OTHER	Trigger sprays	PP / HDPE / LDPE		Glass components Metal springs / ball bearings

Material Specific Guidelines - PP

Material Specific Guidelines - PP

General

For efficient separation and removal in conventional density separation processes, parts of the packaging system that are not compatible with PP should have a density > 1 g/cm³.

Colour

The use of unpigmented PP is preferred to pigmented as the recyclate from unpigmented bottles will have a greater value due to the larger number of potential applications. Clarified PP is acceptable when bottles are shown to be compatible with end uses for recyclate.

Material Combinations

The principal polymer contaminant of recovered PP is HDPE from bottles, closures and attachments.

PP and HDPE are opaque and less dense than water and consequently difficult for reprocessors to separate. Since HDPE has a lower melting point (ca 130°C) than PP (160-170°C) the overall PP mix will be more tolerant to HDPE contamination than the converse.

Nonetheless, when designing packaging, it is recommended that PE levels are restricted to a maximum of 5% to avoid potential end use issues. This is in line with US recommendations. Higher levels may be possible but this would require the difficult task of investigating the likely effects on the total mix during recycling.

Barriers

Current PP recycling systems can tolerate the use of EVOH layers. Similarly MXD6 and other nylon-based barrier layers are tolerated, particularly if the layers are readily separated from the PP in conventional reclamation systems. In all such cases their content should be minimised to the greatest extent possible to maximise PP yield and reduce potential contamination and separation costs. PVDC barriers should be avoided.

Closures / Closure Liners

The use of closures that are unpigmented or the same colour as the bottle are desirable (although not essential). Foil safety seals that leave foil or remnants of the attaching adhesive on the PP bottle should be avoided.

Labelling

In applications using unpigmented PP, all direct printing other than date coding, either for product labelling or decoration, presently contaminates the recycled unpigmented PP in conventional reclamation systems.

Other Components

Use of PVC components should be avoided as they can cause discolouration and malodour.

Material Specific Guidelines - PP

		COMPATIBLE for recycling most applications	MAY BE SUITABLE for recycling for some applications	NOT SUITABLE for recycling
BODY	Colour	Clear / Natural, or lightly tinted	Opaque / Heavy colours	Carbon Black
	Barriers/ Coatings	EVOH	PA (incl. MXD6)	PVDC
	Additives		Clarifier	
CLOSURE	Caps	HDPE / LDPE / PP		PS / Thermoset plastics / Aluminium / Steel / PVC
	Lidding film	No residue after removal by consumer; or; as main polymer (PP)		
DECORATION	Direct Printing	Minimal or moderate direct printing, e.g. production or expiry date laser printing (minimal)	Excessive direct printing	
	Labels	HDPE / MDPE / LDPE / LLDPE PP / OPP less than 60% coverage on face	Paper over 60% coverage on face In Mould label	PVC / Metalised PET
	Sleeves (incl. tamper resistance)	PE / PP		PET / PVC
	Adhesive for labels	Water releasable in ambient conditions	Water soluble up to 80°C	Not removable in water
	Ink	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye wash-solution
OTHER	Inserts	PP	HDPE / LDPE paper PET (light)	PVC / PS/ EPS / PU / PA (Nylon) PET (Heavy) PC (Polycarbonate) / PMMA (Acrylic) Thermoset plastics / Metallic
	Trigger sprays	PP / HDPE / LDPE		Glass components Metal springs / ball bearings

Guidelines - Other Plastic Packaging

The term ‘mixed plastics’ has been used to cover all non-bottle plastic packaging sourced from the domestic waste stream. This includes rigid and flexible plastic items of various polymer types and colours that are typically found in the household waste bin. It excluded plastic bottles and non-packaging items. It is now widely believed that the term is too general, and even misleading.

With an increasing range of materials being recovered in domestic waste recycling systems, non-bottle plastic packaging items form some of the most visible remaining components of the domestic waste bin.

In addition, for those countries in Europe that collect all packaging waste within their respective recovery schemes (e.g. Germany, Italy and Spain), the same fee scale is used for all plastics. Hence the manufacturers who have to pay the fees for plastic packaging expect a progressively higher percentage of the material to be recycled. There is, therefore, a growing need to develop sustainable waste management options for non-bottle plastic packaging in Europe.

Where a range of plastic packaging is collected for recycling, the flexible packaging is first separated from the rigid plastic packaging and then the bottles are extracted from the rigid mixed plastic components.

The rigid mixed plastic component (pots, tubs and trays - PTTs - form the bulk of this packaging type) is generally then separated into a polyolefin stream (PE+PP or PE & PP separately) and a PET stream using near NIR detectors.

General

The basic design principles for PTTs are no different to those given in the general guidelines section and in the specific polymer sections. However, the processes used for the recycling of other plastic packaging containers are not identical to those used for plastics bottle and hence exactly the same rules may not apply.

Rigid Mixed Packaging
Material / Material Combinations

As with rigid bottles, use of mono-materials or mixed materials of the same type are the materials of choice from a recycler’s point of view.

In the absence of any other specific guidance, designers should follow the recommendations provided in the corresponding polymer table when designing a plastic rigid container.

Guidelines - Other Plastic Packaging

Contamination

Plastic containers are generally lightweight. Product contamination can therefore represent a significant proportion by weight of the collected material (e.g. the weight of product residues in yoghurt pots can be as much or more than the weight of the container itself).

Contamination lowers the efficiency of the recycling process as polymer weights are much less than weights of material collected and the residues themselves (often oily food) can interfere with the washing process. It is therefore important that containers are designed in such a way as to ensure levels of contamination are minimised as much as possible. This not only provides a benefit to recyclers, but also to the consumer. To further facilitate recycling, consumers / end-users should remove any plastic film, paper, cardboard and foil present and as much food residue as possible before putting the container out for collection.

PET/PE Trays

Rigid PET packaging represents a significant fraction by weight of the domestic plastic waste stream. One particular difficulty is the widespread use of PET/PE multi-layers (e.g. in the processed meat sector). As already indicated, use of mono-materials or mixed materials of the same type are the materials of choice from a recycler's point of view. Hence the current efforts by some producers, encouraged by RECOUP, to switch from PET/PE blends to monolayer PET for trays should further facilitate recycling. However, it should be restated here that it is appreciated that use of multi layers in this way may have a greater environmental benefit, in extending shelf life, than consideration of recyclability.

As with other PET packaging formats, it is vitally important that contamination by PVC is avoided. PVC trays and blisters represent an important potential contaminant of the PET tray and blister stream and every effort needs to be made to try and ensure that such contamination is avoided either through design and / or at the recycling stage.

PE - Tubs / Dishes

Tubs and dishes are often made of injection grade HDPE, exhibiting higher melt flow rates than blow moulding grade HDPE. Mixing the two types of HDPE together decreases the value of the mixture. Do not mix HDPE bottles with HDPE tubs or dishes.

In principle aluminium lids are acceptable on PE, especially peel-off ones. Adhesive should stay with the aluminium lid.

Tubs that have a clear or colourless body and where the information is presented on the lid are particularly suitable for recycling.

Direct printing is acceptable provided attention is paid to ink types to avoid interference with the quality of regranulate.

Excessive paper content can cause issues during recycling and thus use of paper labels is less desirable. If used, they should be lightweight and cover only a minor area of the container. Paper labels are liable to pulp in a hot caustic washing step.

Guidelines - Other Plastic Packaging

PE - Tubes

Cap and tube should be manufactured from the same type of plastic and ideally from the same polymer (in this case HDPE). An elevated percentage of PP lowers the quality of the recycled plastic.

Direct printing is acceptable for marking tubes provided the printing is in compliance with the EuPIA Exclusion list. Paper labels also can be used, provided they are easily removed in water and leave no adhesive residue that is difficult to remove.

PP - Tubs / Dishes / Trays

In principle aluminium lids are acceptable, especially peel-off ones. Adhesive should stay with the aluminium lid.

Tubs that have a clear or colourless body and where the information is presented on the lid are particularly suitable for recycling.

Direct printing is acceptable provided attention is paid to ink types to avoid interference with quality of regranulate.

Excessive paper content can cause issues during recycling and thus use of paper labels is less desirable. If used, they should be lightweight and cover only a minor area of the container. Paper labels are liable to pulp in a hot caustic washing step.

PP - Tubes

Cap and tube should be manufactured from the same type of material and ideally from the same polymer (in this case both from PP). Direct printing is acceptable for marking tubes provided the printing is in compliance with the EuPIA Exclusion list. Paper labels also can be used, provided they are easily removed in water and leave no adhesive residue that is difficult to remove.

Film - Material / Material Combinations

As with rigid bottles and mixed plastics, homogeneous films can be recycled optimally. Use of mono-materials or mixed materials of the same type are the materials of choice from a recycler's point of view and combinations with a different type of plastic of similar density should be avoided wherever possible.

Packaging film very often requires the use of a variety of plastic materials, to provide both the technical properties required and to satisfy user needs. Designers should follow the film guidelines now available: for example the RecyClass guidelines from Plastics Recyclers Europe. In the case of films, as some film recyclate is used in applications that have a more tolerant specification e.g. furniture, bin liners, etc, plastic film users can feel less restricted to use material combinations in the MAY BE categories than with rigid containers. Combinations in the NOT SUITABLE category should still be avoided.

Film Recycling

In the UK, the significant quantity of plastic films and flexible packaging on the market continues to draw focus. The intention is to be collected kerbside for recycling, as part of the 'Simpler Recycling' legislation from 2027.

There is a steady increase in front of store collection schemes at major retailers for flexible materials. This material is sent for industrial recycling with other post-industrial films. These schemes are not always a success and issues such as the decline in carrier bag use and high levels of contamination have contributed to the collected material not reaching the film recyclers.

Looking ahead to the kerbside collection, it is important that designers of this packaging follow Design-for-Recycling guidelines to ensure the materials can be handled effortlessly during the recycling process.

European Guidelines for Film

For Europe, where film is collected, both RecyClass and CEFLEX have produced recyclability guidelines for flexible packaging.

The tables are not based on the UK market, however design guidance is compatible with UK recommendations for film and flexible packaging.

The RecyClass tables are available to download and are continuously updated based on new laboratory findings, including technology approvals.

https://recyclass.eu/recyclability/design-for-recycling-guidelines/

RecyClass

Compostables Summary

The demand from consumers for more ‘green’ and ‘eco-friendly’ options has seen biodegradable or compostable alternatives to everyday conventional plastic items become more popular in the market today. However, confusion over terminology and how to dispose of these items correctly can create a range of problems, including to mechanical recycling facilities.

Common terms used in this space are ‘bio-based’, ‘biodegradable’, and ‘compostable’.

A ‘bio-based’ plastic gains its name through the feedstock that is used in its manufacture, for example it is made from plants or biological materials rather than fossil fuels.

‘Biodegradable’ refers to the ability for a material to be broken down by bacteria or organisms under precise conditions in a natural environment. The use of the term ‘biodegradable’ in isolation should be avoided as it does not specify the conditions, environment or time frame needed in order for an item to biodegrade, and therefore can cause confusion among consumers.

A biodegradable plastic could also be a ‘compostable’ plastic. To be classed as such it must either meet home or industrial composting requirements. There is currently no widely recognised standard for home composting, however the product must be certified through an independent scheme or self-assessment and compliance with ISO 14021. For industrial composting, the product must be compliant with European Standard BS EN13432. Where necessary, a product must also be able to be collected and sent to an appropriate site that accommodates the specific conditions needed for treatment and processing. All compostable plastics are biodegradable, but not all biodegradable plastics are compostable. It is also important to bear in mind that not all bio-based plastics are compostable and not all compostable plastics are bio-based .

‘Oxo-degradable’ plastics include additives that hasten the process of fragmentation. In 2019, the UK voted in support of the EU Single-Use Plastics Directive (Directive (EU) 2019/904) which includes a ban on single-use plastic products made from oxo-degradable plastic.

When used in relation to food waste, compostable plastics can be collected and sent to specific industrial composting sites, and as a result do not reach a mechanical recycling facility. However, with the increase in usage of compostable plastics in other packaging situations (for example carrier bags, food pots and trays, etc.), there is a higher risk that these items will be placed for recycling with other conventional plastics. Here they can contaminate otherwise recyclable materials as well as potentially congest machinery. It has also been noted that the presence of any biodegradable material in recycling streams could compromise the quality of the recyclate, and in turn the end market product. Due to this it is highly important compostable plastics are disposed of in a way in which they are able to reach their intended end of life destination, and to ensure this happens all compostable packaging should have clear disposal instructions to consumers. Contamination of recycling streams is of high concern and needs to be addressed if further compostable items and packaging is introduced.

What is the problem with Oxo-degradables?

Why are the European Plastic Recycling Trade Associations opposed to Oxo material?

The debate surrounding the use of Oxo-degradable additive materials in plastic packaging products such as carrier bags has been ongoing for many years. More recently one of the original proposals in the draft Government legislation introducing a charge for single use polythene bags – known as 'the carrier bag tax' – included the option for an exemption from the charge for bags manufactured with an Oxo degradable additive included in the raw material blend. This proposal resulted in a fierce debate between the supporters of Oxo-degradable material, primarily the Oxo-Degradable Manufacturers Association, and those opposed to the use of Oxo materials in plastic packaging including the British Plastics Federation, INCPEN, Foodservice Packaging Association, RECOUP together with European Plastic Packaging Trade Associations including Plastic Recyclers Europe and EuPR.

When the charge for single use plastic bags was introduced in July 2015 no exemption was included in the Regulations. However, the debate surrounding the use of Oxo-degradable additives in plastic packaging continues. One sector of the plastic manufacturing industry which is the most vociferous in its opposition to the use of Oxo-degradable materials is UK plastic films recycling businesses. Why is this, after all there do not appear to be any immediate business conflicts between the suppliers of a plastic additive which can be included in the raw material blend for polythene extruders, and the recyclers of waste polythene film? The answer to this question is simple – the risk of Oxo-degradable contaminated plastic entering and thus contaminating the waste stream. If this were to happen plastic recyclers fear for the integrity of their products, especially with their end use customers some of whom have already expressed concern stating that merely 'the risk' that a finished product could contain an oxo degradable additive would be too great, thus the raw material specifications for the manufacture of these products, including building and construction polythene films and membranes, would revert to using 100% virgin/prime polythene raw materials.

In order to successfully compete with the demand for waste polythene film for the export market, UK plastic film recyclers have to be both efficient and provide guaranteed high quality recyclate to their customers for manufacture into a new product, both of these key business requirements could be compromised if the plastic waste stream becomes contaminated with Oxo-degradable materials.

The plastics recycling sector provides many thousands of jobs in UK manufacturing and is ideally placed to support any initiatives to expand the Circular Economy. To do this investment will be needed to increase recycling capacity with high output machines. The final requirement to encourage growth will be markets for the additional tonnages of plastic recyclate produced, with existing customers of UK plastic recyclers already expressing concern at the potential risk of product contamination with Oxo degradable residues, it is difficult to see any benefits an increased use of these materials in plastic packaging could have? However, the negative consequences in the form of a potential reduction in demand for recycled plastic and a consequent contraction of the UK plastic film recycling sector are obvious.

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RECOUP Member

Recycling of Plastic Packaging

Plastic Packaging Recycling Overview

The development of collection, sorting and reprocessing technology and its techniques is constantly changing. The following information will provide an informative picture of current practices and technologies for the recycling of plastic packaging.

Following the success and interest in recycling plastic bottles, other forms of plastic packaging recycling have been developed and introduced into collection streams. These are primarily, other 'rigid' plastic packaging, such as pots, tubs and trays (PTTs) used for both food and non-food applications, both from households and from commercial and industrial sectors.

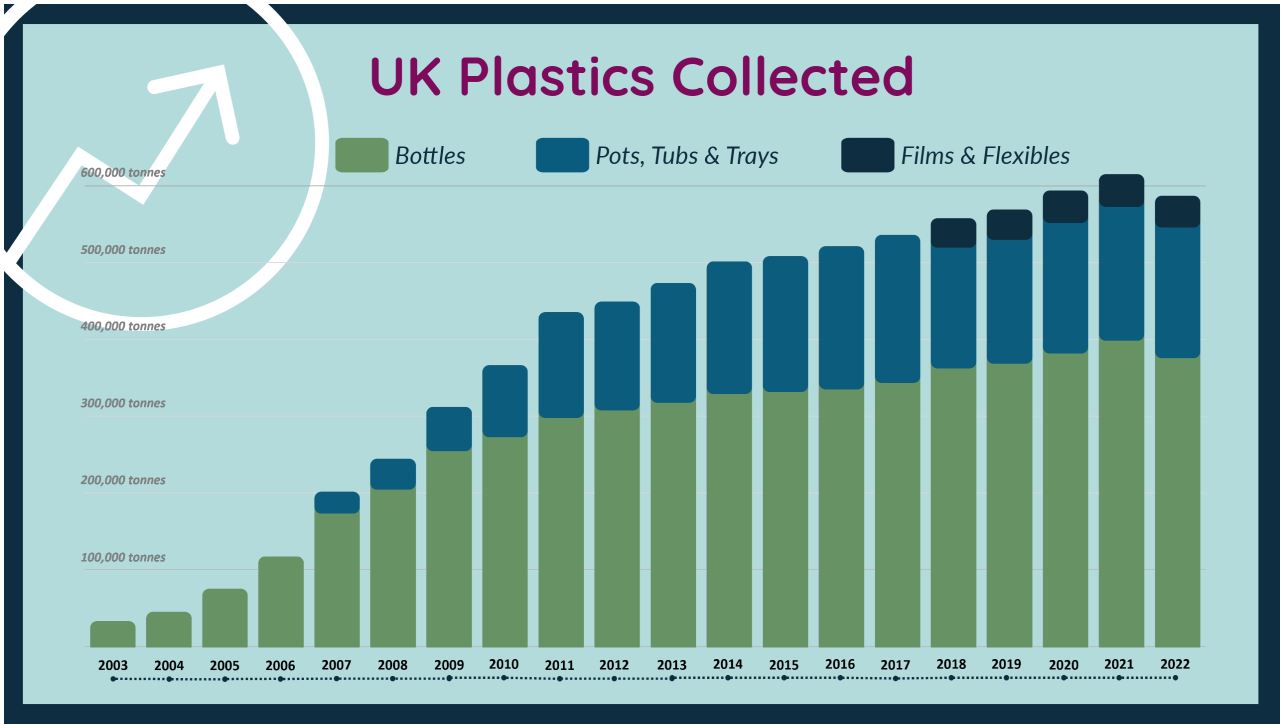
Separate waste collection streams have existed for some time for commercial & industrial waste, as recycling of such materials is traditionally more commercially favourable (e.g. cleaner materials, bulk collection). In terms of domestic plastic waste recycling, which is the focus of the current document, the technology and processes for recycling have been designed for rigid plastic packaging, focusing on plastic bottles and PTTs.

Target materials in the UK waste stream are PET, HDPE, LDPE, and PP. All bottles of a given type of polymer are usually compatible and so may be mechanically recycled together. Technical incompatibilities between a number of these different polymers, however, prevent them being directly mixed and mechanically recycled as high specification products. However, they can be readily separated, provided the simple guidelines given in this document are followed.

Packaging design should facilitate the separation of non-compatible polymers and avoid the risk of them being left unseparated by visual or mechanical recognition systems.

A typical plastics mechanical recycling process involves several distinct steps, these are indicated in the following sections.

Recycling of Plastic Packaging



Household Plastic Collection Data (RECOUP Houseold Plastic Collection Survey 2023)

Collection

There is a wide variety of collection methods used to receive recyclable materials from households. Most of these methods identify particular material types and products that should be deposited. These products are typically newspaper and magazines, cardboard, glass, steel and aluminium cans and plastic packaging.

The two household recyclables collection methods used by Local Authorities are kerbside and bring schemes. Originally most household plastic packaging recycling collections were achieved by asking the public to place their materials into containers placed in public locations such as supermarket sites and car parks. These are termed bring sites.

Since 2003, there has been a significant growth in the use of kerbside collection systems which provide a recyclables collection service on the householders' doorstep, and the landscape of household plastic packaging collection rates began to change. This is illustrated by the graph above. The householder is provided with a bin, box or bag which is then collected every week or fortnight.

Kerbside collection schemes are now the predominant method for the collection of plastic packaging in the UK, with bring schemes used alongside kerbside schemes to form part of the recyclables collection infrastructure which Local Authorities offer. There are a number of variations in kerbside schemes in terms of collection container, service frequency, and communications, and depending on the specific requirements for each Local Authority.

Recycling of Plastic Packaging

Sorting and Separation

Once the recyclable materials have been collected the various material types need to be segregated at the Materials Recovery Facility (MRF), and then bulked or baled ready for delivery to material reprocessors. The plastic packaging is separated either using automated NIR optical equipment for higher volumes and throughputs, manually by picking operatives, or a combination of the two.

Sorting Techniques

Automated optical scanners are used to separate materials by polymer type, using NIR (near infrared) sensors, which are installed above the conveyor and ejecting the targeted material using compressed air jets at the end of the conveyor. This technology is frequently used to separate plastic containers into different fractions, as the market requires clean streams of specific resins and colour types. Typical automatic sort rates are up to 40,000 bottles/hour or 11 bottles per second. Although not without its limitations, auto-sorting greatly improves the quality and efficiency of the separation process.

Many countries still rely on the manual sorting of whole plastic bottles by visual inspection. However, automatic bottle sorting is widespread in Europe, where the larger MRFs have throughputs sufficient to offset the capital cost of the equipment. Manual bottle sorting is based primarily on the physical characteristics of the bottle (e.g. shape, colour and product recognition) and experience. Although this method can lead to inaccurate identification and separation due to human error or distorted containers.

In addition, complications arise when bottles of the same design are made using different polymer types. Although most plastic bottles carry a Material Identification Code, this coding system has limited value to sorting personnel. Manual sort rates are typically 1200+ bottles/hour. Thus sorters have less than three seconds to pick up, identify and sort the bottle. This precludes looking for the code on every bottle.

Sorting Techniques - Plastic Bottles

Dependant on the scale of operation and throughputs being handled the plastics fraction will be sorted either manually or using automated NIR equipment. In the case of plastic bottles these can be segregated by polymer and colour to achieve higher sales values. Typical bottle fractions are clear HDPE, coloured HDPE - sometimes referred to as Jazz HDPE, clear PET, and coloured PET. Once the bottles have been segregated they are baled and are then ready to be delivered to plastics reprocessor.

Sorting Techniques - Pots, Tubs and Trays

The sorting of PTTs has increased significantly over the past few years with more and more councils opting to collect these materials at the kerbside. Similar to plastic bottles these materials are segregated using optical equipment into specific polymer streams and colours. Typically at large scale MRFs these materials are baled as a ‘mixed plastic’ grade where they are then further segregated into individual polymer grades at a Plastic Recovery Facility (PRF). At smaller scale MRFs PTTs are sometimes separated manually by negative picking where, after the plastic bottles have been removed, all remaining plastic materials are baled together as a mixed grade. The picking operatives clean the PTTs material by removing any remaining waste or contaminates before it is baled, however this material is usually low quality, low value. Due to the small size and varying polymer types which are difficult to distinguish, automated equipment is usually favoured as manually picking PTTs is a very inefficient process.

Recycling of Plastic Packaging

Reprocessing - Label Removing and Washing

Once the plastic packaging has been segregated into individual polymers and colours, the material is then shredded into 5-10 mm flake to begin the label removing and washing stage. The intense friction and cutting action in the presence of circulating water provides the first washing stage, removing most labels and residual contents. Hot water, alkali solution and detergents are then frequently used during further washing stages to remove more difficult to separate contaminants such as residual labels and adhesives.

Separation by Flotation

Density based sorting, such as sink/float tanks, hydrocyclones and air classification separate contaminants on the basis of density. Use of float tanks is very common (e.g. PET recycling) as they are much simpler and cheaper. The ability to separate materials is much more limited however and restricted to two types, namely those that sink and those that float in water. Thus any mix of plastic types that sink together / float together in water are not capable of being separated. The key density difference is now not so much that between the polymers themselves than the density difference between the individual polymer and water. The density ranges of plastics commonly used for packaging are given in Appendix - Polymer Densities. This table provides intrinsic plastic densities and also indicates how the polymer behaves in a float tank.

Drying Stage

After the wash and flotation processes excess water is removed by, for example, a centrifuge spin drier system. Heat from this is then used to dry the plastic flake. The dried plastic flakes are then transferred to plastic sacks, bulk bags or silos and are either then sold to convertors or further reprocessed into pellets.

Recycling - Plastic Sales and End Products

The values for plastics will fluctuate over time and are dependent on a number of conditions, with a particular focus always on quality levels, and are based on baled material delivered to a plastic reprocessor.

Once the plastic packaging has been dried into a flake or pellet format by the reprocessor the material can be converted into new products. These include food grade plastics such as bottle to bottle and fresh food trays, non-food packaging such as paint pots, and other applications such as building site screens, garden furniture, stationary, and using yarn to produce clothing such as t-shirts, fleeces and jeans.

Appendix - Polymer Densities

The table below shows the density ranges of plastics commonly used to make plastic packaging and components.

Polymer	Density g/cm³	Behaviour in float process*
Ethylene vinyl acetate (EVA)	Less dense than water	Float
Polypropylene (PP)	0.90 - 0.92	
Low density polyethylene (LDPE)	0.91 - 0.93	
High density polyethylene (HDPE)	0.94 - 0.96	
Polystyrene (PS)	1.03 - 1.06	Variable
Nylon (PA)	1.13 - 1.14	Sink
Acrylic (PMMA)	1.17 - 1.20	
Polycarbonate (PC)	1.2	
Polyethylene terephthalate (PET)	1.30 - 1.38	
Polyvinyl chloride (PVC)	1.32 - 1.45	

Densities are approximate and relate to virgin unpigmented and unfilled polymer. Colouring with a 4% pigment can raise density by 0.03 g/cm³ which may cause further overlaps of polymer densities.

Hydro cyclones can be fine-tuned to separate plastic materials provided their densities differ by ca > 0.05 g/cm³. The densities of flake derived from PP and HDPE packaging overlap and are difficult to separate. The density difference between PS and HDPE whilst sufficient to permit separation in a hydro cyclone, is not sufficiently large from water to ensure that is fully separable with either the light or heavy fractions and thus can cause recycling issues with for example, PET.

A density difference between the polymer and water of ca>=0.05g/cm³ is required to ensure that the material will either sink or float in a sink/float tank.

Care should be taken with any application which requests the use of foamed or blown plastics as this process will affect the density.

Recyclability By Design - Versions

Core Principles - A summary of Recyclability by Design

RECOUP and the British Plastics Federation (BPF) launched guidance to help packaging designers create easy-to-recycle plastic packaging. The guide outlines which combination of closures, seals, labels and materials ensure recycling plants can easily separate and recycle the plastics.

Big brands are being encouraged to use the guidance to ensure their packaging products can be easily processed at the end of their lives to avoid going to landfill, and instead be recycled into new products in an important move towards developing a circular economy.

Rigid Plastic Packaging - Design Tips for Recycling

This document explains to all who have an involvement in packaging the simple steps which can be taken to maximise the recyclability of rigid plastic packaging products. This version includes detailed guidance from Recyclability By Design; including best practice and tables for PET Bottles, PET Trays, HDPE Bottles, PP and PS containers.

All documents are available to download on the RECOUP website.

Glossary of Terms

APR	The Association of Post Consumer Plastic Recyclers
CEN	The European Committee for Standardisation
CEPE	The European Council of Paint, Printing Ink and Artists' Colour Industry
COTREP	Comite Technique de Recyclage des Emballages Plastiques
EPS	Expanded Polystyrene
EuPC	European Plastics Converters
EuPIA	The printing ink group within the European Council of Paint, Printing Ink and Artists' Colour Industry
EuPR	Plastics Recyclers Europe
EUROPEN	The European Organisation for Packaging and the Environment
EVA	Ethylene vinyl acetate
EVOH	Ethylene vinyl alcohol
FTIR	Fourier Transform Infrared Spectroscopy
HDPE	High density polyethylene
HCI	Hydrochloric acid
HIPS	High-impact polystyrene
IPP	Integrated Product Policy
IR	Infrared (radiation)
ISO	International Standards Organisation
LDPE	Low density polyethylene
LLDPE	Linear low density polyethylene
MDPE	Medium density polyethylene
MRF	Material reclamation facility
NAPCOR	National Association for PET Container Resources
NIR	Near infrared (radiation)
OPET	Oriented PET
OPP	Oriented polypropylene
OPS	Oriented polystyrene
PA	Polyamide (nylon)
PBT	Polybutylene terephthalate
PC	Polycarbonate
PCR	Post-consumer recycled material
PEN	Poly (ethylene 2,6 napthalate)
PET	Polyethylene terephthalate
PETG	Polyethylene terephthalate glycol
PLA	Polyactic acid
PMMA	Polymethyl methacrylate
PP	Polypropylene
PPWD	The European Packaging and Packaging Waste Directive
PRS	PET recycling schweiz
PS	Polystyrene
PU	Polyurethane
PVdC	Polyvinylidene chloride
PVC	Polyvinyl chloride
REPA	Service organisation for all recovery organisations in Sweden (except glass)
RPET	Recycled Polyethylene Terephthalate
SPI	Society of plastics industry
6EAP	European Union sixth environmental action program

Useful Organisations

EuPC
European Plastic Converters
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