RECOUP
RECycling Of Used Plastics Limited

Plastic Packaging

Recyclability By Design

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

This report has been supplied by:

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This version February 2015

About RECOUP

RECOUP (Recycling of Used Plastics Limited) is a leading authority on plastic packaging resource management, providing expertise and guidance to a wide range of clients across the plastics supply, use and disposal chain. Set up in 1990, RECOUP is now an independent charitable organisation, built on a network of members and project activities.

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.

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 general guidance only. Any details given are intended as a general recommendation based on the best of our knowledge at the time of publication. It does not necessarily guarantee compliance with the different recycling schemes. This is by no means a comprehensive list. Users are therefore advised to make their own enquiries to check for specific and up-to-date information.

While every effort has been made to ensure the accuracy of the contents of this publication, RECOUP can accept no responsibility of liability for any errors or omissions. Opinions expressed and recommendations provided herein are offered for the purpose of guidance only and should not be considered legal advice.

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To access the most recent copies go to: www.recoup.org
ISBN 978-0-9558399-5-5

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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.

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

The objective of this project has been to produce 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. Whilst design guidelines have already been produced by a number of industry associations, this work collates together into one simple document commonly agreed best practice and provides the business case for following the guidelines.

This document is not intended to compete with these existing documents but rather pull the information together and address the issues in a way that will encourage packaging designers and specifiers to follow agreed good practice. This current document is a fifth version, following the original release in 2006, an update in 2008, and two updates in 2013.

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 beginning on page 55 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. This is covered in more depth in the chapter 'Linpac - Product Protection First'.

Introduction

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.

The EFSA (European Food Safety Authority) published in 2008 regulation 282/2008 – 'recycled plastic materials and articles intended to come into contact with foods'. This extended the regulations to cover any recyclable material, rather than specifically PET bottles. This regulation requires traceability of supply chains for food grade recycling and potential future requirements are likely 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.

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. It is recognised also that recycling packaging may not be the most environmentally or economically sound option in all cases. The intention is not necessarily to try and make every piece of plastic packaging recyclable. Each case must be viewed on merit. However, 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.

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 are expected to outline support for a circular economy. The circular economy package will look at how to design and manufacture products that will "better support recycling efforts"

Questions and Answers

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.

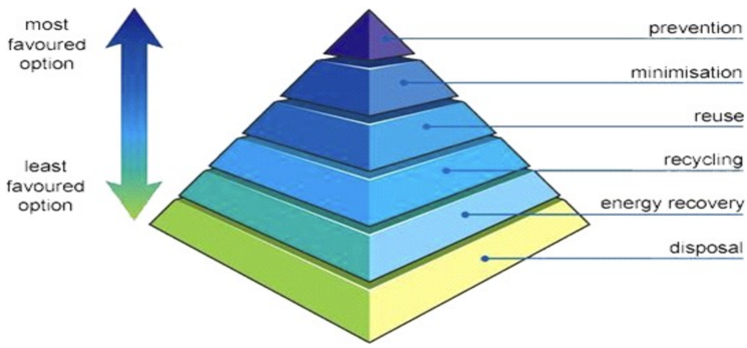
The document gives practical advice and information on environmental considerations to the whole supply chain i.e. designers, packaging technologists, buyers, marketing and retailers but is primarily focused on those responsible for specifying the packaging being used. Any specifier following the guidelines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

This document consolidates and develops information from various sources in Europe and North America to provide a comprehensive guide on plastic packaging design best practice. It is, therefore, particularly relevant to companies selling into markets across Europe and the USA 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.

Defra guidance declares that for most materials recycling is better for the environment than energy from waste (EfW) and that EfW is better than landfill. A review of the current guidance is expected in 2013. This will incorporate latest developments, such as a review of plastics energy recovery vs landfill.



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

Stages	Include
Prevention:	Using less material in design and manufacture. Keeping products for longer; re-use. Using less hazardous materials.
Preparing for re-use:	Checking, cleaning, repairing, refurbishing, whole items or spare parts.
Recycling:	Turning waste into a new substance or product. Includes composting if it meets quality protocols.
Other recovery:	Includes anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat and power) and materials from waste; some backfilling.
Disposal:	Landfill and incineration without energy recovery.

As a result of this guidance and the impact of the Packaging Waste Regulations, UK industry has focused on improving sustainability by reduction of pack weights. The grocery retail sector, in particular, signed up to the Courtauld Commitment in 2005. Phase 1 of this agreement concentrated on the need to reduce the quantity of food, product and packaging going to waste. Included in the three targets were commitments to

Questions and Answers

remove packaging waste growth, and to deliver reductions in packaging waste. WRAP reported at the close of Phase 1 that two of the three targets have been met, while the target to reduce the amount of packaging waste had not been achieved.

Courtauld Phase 2 moved the focus to reduction of carbon impact of packaging, and optimisation of packaging. The target stated was to reduce carbon impact of grocery packaging by 10%, to be achieved by increasing recycling rates and increasing the recycled content for grocery packaging.

Society will expect that a large amount of the plastic packaging that you use is designed for recycling and will be recycled. In addition, legislation in Europe requires that Member States mechanically recycle at least 22.5% of the plastic packaging put onto the market and that you ensure that any plastic packaging you use does not negatively interfere with current recycling streams.

Courtauld Commitment 3

The Courtauld Commitment 3 was launched in May 2013. While Courtauld 1 and 2 focused on reduction of packaging and packaging weight, Courtauld 3 is more focused on finding opportunities to reduce the carbon impact of packaging.

Signatories to CC3 commit to working to reducing food waste. Considerations include improving packaging design to both maximise recycled content and also improve recyclability. This will necessitate working closely with the packaging supply chain to apply new packaging technology, for example looking to longer shelf life, to achieve this.

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.

In cases where plastic products are particularly lightweight and contaminated with other materials, the energy and resources used in a recycling process may be more than those required producing new plastics. In such cases recycling is not the most environmentally sound option. Where recycling is not environmentally or economically justifiable, energy recovery is preferable as the high calorific value of the plastics can be used to generate energy for district heating and power.

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RECOUP and its members are committed to increasing levels of plastics recycling. At the same time we understand that a pragmatic approach to recycling is important. We should be aiming to use available resources as efficiently as possible.

International policy development now places increasing emphasis on the issue of waste in the wider context of product life cycles and resource efficiency. It is clear that current thinking is moving away from 'end of pipe' solutions to waste and towards an integrated product policy approach. This means that Environmental Best Practices will require consideration of increasingly complex trade-offs between impacts and benefits of particular products on the environment during their life cycle. For example, the overall environmental gains achieved by the use of a lightweight or longer life plastics product can make it the best choice environmentally, even though it may not be environmentally sensible to recycle a particular plastic item at the end of its life.

The use of techniques such as Life Cycle Analysis (LCA) are very important to determine which products and waste management systems are most environmentally sound. There has been considerable detailed analysis of the environmental impacts of recycling many different products containing plastics.

Why is Plastics Recycling Important for Plastics Supply Chain Businesses?

Good recycling and environmental performance, combined with the cost savings offered by plastics recycling, combine to offer a strategic approach to risk minimisation.

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.

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Protecting Your Freedom of Material Choice

Industries involved in the packaging industry 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 industry 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.

Why Should I Follow the Guidelines?

Businesses have to deal with continuously more demanding societal expectations in the way that they operate. With the growing awareness of the importance of sustainable development, the environmental impact associated with companies is under ever more scrutiny.

Packaging in general, and plastic packaging in particular, has had a very negative perception with consumers and environmentalists. It has been perceived to be a waste of resources and a significant contributor to the growing levels of waste. In addition it is often also linked to litter issues. Politicians are very aware of this with the result that pressure has been, and continues to be applied on packaging through the introduction of legislation in Europe, the USA, Japan and other countries around the world. In addition, recycling is seen by many as the most important recovery route and, therefore, the one that should take precedence.

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.

Questions and Answers

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.

Packaging Support Recyclability Guidance

Morrisons

To help Courtauld signatories to work towards recycling targets, WRAP invited applications to provide technical support to aid delivery of the packaging target.

RECOUP partnered with Morrisons, a Courtauld signatory, to propose an environmental ready reckoner which will help to develop recyclability guidance for packaging. The aim is to make this part of the design process for suppliers.

Morrisons Packaging Development Manager Steve Jackson commented “Our long term goal is to make the tool web accessible and linked to a database that will also connect the digital assets we hold for each piece of packaging.”

RECOUP supplied relevant information, extracted from RECOUP ‘Recyclability by Design’ guidance and applied to a worksheet. The worksheet highlights the recyclability status of the packaging, including visibility of the effect on overall recyclability that any proposed changes will have.

Information on plastic packaging was taken from ‘Recyclability by Design’, and information on other packaging materials and formats from On-Pack Recycling Label (OPRL) guidelines.

PET Trays	Item 1	Item 2	Item 3	Item 4
Item Name:	PET Tray	PET Tray	PET Tray	PET Tray
Component Weight (g):	30.0g	15.0g	0.0g	0.0g
% of recycled material:	50%	50%	0%	0%
Recycled weight	15.0g	7.5g	0.0g	0.0g
Polymer	PET	multi-polymer		
Colour	strong tint	black		
Barrier / Coatings	none			
Additive	silicone surface coating			
Lidding Film Residue	residue remains			
Lidding Film Material	PET (mono)			
Direct Printing	minimal			
Labels	PP / OPP			
Label Coverage	less than 60% on face			
Adhesive	water soluble in ambient conditions			
Ink	compliant with EuPIA practices			
Inserts	HDPE / LDPE			
Total Score	40	100	0	0
Waste	6.0g	7.5g	0.0g	0.0g
	12	15	0	0

Morrisons' input sheet

MORRISONS

For more information visit http://www.wrap.org.uk/sites/files/wrap/Design%20for%20recyclability%20scorecard%20-%20Morrisons.pdf

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 various sources in Europe and North America 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 web sites dealing with the recyclability and recycling of plastics packaging in both Europe and the USA. You are encouraged to visit the web sites 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 the RECOUP office.

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, together with its lower cost, 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.

Product Protection First
Linpac

Steadily increasing recycling targets, not least the current European commission focus on a circular economy, places great store on the increased recycling of packaging and subsequently the setting of unrealistically high targets for plastic packaging recycling. Potentially, pursuit of these targets could drive an increase in the weight of plastic packaging and a rationalisation into a narrow range of polymers, together with a 'straight-jacket' of design options. This will ultimately stifle innovation in packaging design and materials and lead to environmental outcomes that are negative.

"This focus on recycling of plastics detracts from the real purpose of packaging, which is to protect, preserve and present the product effectively" says Alan Davey, Innovations Director of LINPAC.

As an example, the use of modified atmosphere packaging (MAP), or more recent innovations such as the vacuum skin pack, leads to meat packaging that can demonstrate a shelf life of up to 28 days whilst also enhancing the flavour of the contents. Unfortunately, these multicomponent pack designs are not always readily recycled. The slavish pursuit of enhanced recyclability can potentially therefore reverse the progress towards better shelf life and reduced food waste.

Without development of innovative packaging, most packed food on shelf today would not last more than a few days, resulting in significant waste of products throughout the supply chain and also an increase in carbon footprint of the packs available. This is especially the case if one considers the carbon footprint embedded in a beefsteak or lamb joint, which outweighs by 20-50 times, the carbon footprint of the packaging.

The considered approach is to design packaging around the end use application or product to be packed and enhance its shelf life. This means seeking to minimise product wastage, presenting the product in an attractive way, delivering brand and product information and minimising a pack's environmental impact. If it can be recycled – great! If we can enhance a pack's design to improve its recyclability, so much the better. But if we seek to constrain its weight, its material and the range of options for pack design too much, we simply stifle innovation and arrive at an environmental outcome, which is ultimately poorer.

General Guidelines

Introduction

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

The goal of improving the recyclability of packaging should not 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. Equally, the authors acknowledge that guidance on designing for recyclability is one component only of a larger and complex sustainability challenge; all resources need to be used efficiently and in the context of packaging this requires that initially the minimum amount of materials are used for purpose and that used materials are ultimately efficiently recovered. It is recognised that recycling packaging may not always be the most environmentally or economically sound option. Sometimes energy recovery or composting may be a more responsible option, depending on the nature of packaging and the local solid waste management infrastructure.

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.

The document 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.

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 (see pages 24-45).

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. The key organisations listed on pages 73-74 have developed testing protocols that can be used to accurately assess the compatibility of packaging designs with a specific material recycling stream. In addition, specific applications (e.g. food contact) may stipulate more demanding requirements than provided in these general guidelines.

General Guidelines

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 containers / film 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.

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.
- Investigate use of non-stick additives 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 (e.g. vapour deposition).

It should be recognised that lightweight plastic laminates (especially those of thickness <100 microns) which are highly engineered and weight effective packaging materials, in general are not cost-effective to recycle. Energy recovery is the optimum recovery route (in Europe at least) for such materials.

General Guidelines

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 non-pigmented plastic. Secondly, heavily coloured (and hence strongly light absorbing) plastic may interfere with automated sorting machinery that uses 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 carbon black plastic items.

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. Where use of colour is necessary, designers are encouraged to consider alternative approaches that will further facilitate recyclability. Sometimes using colour may offer overall resource benefits, for example in the reduced use of energy during bottle blowing. Some soft drinks manufacturers use fast reheat plastic resins that necessarily contain carbon black. Sometimes these resins are coloured to mask containers having an otherwise grey appearance.

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 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.

In the future, these restrictions may be able to be relaxed with the commercialisation of feedstock recycling plants.

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, PP closures are used on PET bottles.

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 and small amounts of aluminium may remain to cause problems. 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.

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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, the bottle may be correctly labelled as recyclable, if the sleeve is removed by the consumer. 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 recognised as PET by modern 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.

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 soluble (or dispersible) 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.

The European Plastics Recyclers (EuPR) have produced a list of hotmelts acceptable for mechanical recyclers that can be found on their web site. This list is not exhaustive and other adhesives may also be suitable. APR in the USA have also 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 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.

General Guidelines

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.

Use of a material of a different type for the sleeve offers the opportunity to colour and decorate the surface of the container to a very high percentage whilst avoiding colour contamination of the main material. This helps to maximise the value of the recycled material (see section on colour of plastic).

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 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. Thus, full bottle sleeves, if desired, need to include sufficient clear area so that automatic sortation equipment can properly identify the polymer resin used to make the bottle.

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

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. APR, NAPCOR and The European PET Bottle Platform have testing protocols to assist label manufacturers to assess whether a label ink will bleed in a conventional PET recycling process.

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.

There is a progressive request, primarily from retailers, for RFIDs (Radio Frequency Identification Devices) to be applied to packaging. While these tags offer potential logistics and other benefits, they are in general undesirable from a recyclability point of view at present as the adhesives and metals reduce efficiencies and / or contaminate the recycling stream. Use of RFIDs on plastic packaging is discouraged and therefore should be avoided unless they can be shown to be compatible with the relevant conventional plastics recycling stream and demonstrated not to create any disposal issues based on their material content.

General Guidelines

Material Identification

To facilitate the visual identification of plastic types during manual separation, major plastic components (container, caps, and lids) should carry a material identifier. Material identification is also of use when recycling industrial waste either internally or externally or where clean waste streams, components or packaging are being recycled from industrial / commercial sources where washing / separation is unnecessary.

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.

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 increasing use of automated sorting for household waste, the recycler's need for material identification is becoming less important. Even so, this should still be used as an aid for consumers when sorting for recycling, as certain polymer products may be collected in certain areas.

General Guidelines

Material Specific Guidelines

These are general guidelines that apply to all plastic materials used for packaging. Specific guidelines have also been produced for plastic packaging where the main material is based on PE, PP, PET, PS or PVC. 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
- **MAYBE SUITABLE** for recycling for some applications
- **NOT SUITABLE** for recycling

The meaning of these three columns is as follows:

COMPATIBLE for recycling for 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 food grade 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 or paper and that any inserts or other minor components are also manufactured from only HDPE.

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 (see Appendix 3) 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 the present 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 - PET

Material Specific Guidelines - PET

General

The recommendations given in this section were originally written to cover PET bottles. As explained earlier, these guidelines are driven by the requirements of the mechanical recycling process. Some of the current restrictions (especially for barriers / opacity / colour) may be relaxed as more recycling plants come into commercial operation. These benefits are likely to be realised first with PET bottles, as these plants are likely to focus first on PET bottles as the source material. 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 > $1g/cm^3$). The presence of very low levels of PLA in PET causes haze and a deterioration of physical properties with the recycled PET.

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 multi-layers or coatings are not always fully compatible with current recovering 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.

The European PET Bottle Platform (of which Petcore is a member) remain against the current use of EVOH as a barrier with PET bottles. This view is also reflected in the USA. Hence EVOH as a potential barrier material with PET is not recommended at this time. As indicated previously, if use of this non-recommended material combination is still desired, the user may arrange for more definitive compatibility evaluation tests to be carried out.

Material Specific Guidelines - PET

Product manufacturers and their suppliers would need to ensure that before launching onto the market that levels employed are minimised and that data to show that the proposed packaging provides both a recyclate that satisfies all technical requirements (especially discolouration and haze) and that recyclers in general can achieve the separation efficiencies required is available. 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. For example, in the past, PEN was becoming progressively more used to provide additional barrier properties. When PEN in varying amounts is reprocessed with PET the composition and physical properties of the recovered material varies, potentially restricting the range of applications for which it may be used and hence the value of the recyclate (e.g. PEN tends to brown on re-heating and fluoresces and this has implications for garments made from recycled PET fibres). Its use in packaging is restricted currently to the reuse market. If recycling is desirable when it eventually reaches the end of its useful life, then a separate recycling stream from PET will be necessary to avoid the issues discussed.

Clear plasma coatings in general cause no recycling issues, although use of high levels of carbon should be avoided. Other external coatings (e.g. O2 or CO2 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 its use should be avoided as much as possible.

The use of opacifiers should be avoided as they significantly reduce the value of the PET recyclate. The presence of TiO2 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/cm^3) 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/cm^3. 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 effect 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. While PS labels are tolerated by many PET recyclers, to ensure that they can be separated easily in the floatation or wind sifting processes, they should only be used where the PS material is of low-density form (i.e. < 1 g / cm3) such as a foam. 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 for most applications	**MAY BE SUITABLE** for recycling for some applications	**NOT SUITABLE** for recycling
BODY	Colour	Clear / Light-blue / Green / light tints	dark blue / dark green / brown / strong tints	Opaque / solid colours Carbon Black
BODY	Barrier / Coatings	Clear plasma coating	External coating / PA - 3 layers	EVOH / PA monolayer blends
BODY	Additives		UV stabilisers / AA blockers / Nanocomposites	
CLOSURE	Caps	PP HDPE, LDPE - Europe only	HDPE, LDPE - USA only	Steel / Aluminium / PS / PVC / Thermosets
CLOSURE	Liner	HDPE / PE+EVA / PP		PVC / EVA with aluminium
CLOSURE	Seals	PE / PP / OPP / Foamed PET	Silicone (density <1 g/cm^3)	PVC / Aluminium / Silicone (density >=1 g/cm^3)
DECORATION	Direct Printing	Minimal direct printing, e.g. production or expiry date laser printing (minimal)		
DECORATION	Labels	HDPE / MDPE / LDPE / PP / OPP less than 60% coverage on face	PET paper over 60% coverage on face	PVC Metalised
DECORATION	Sleeves (incl. tamper resistance)	PE / PP / OPP / EPS (density <1 g/cm^3) Foamed PET / Foamed PET-G	PET	PVC / Full body sleeves PS (density > 1 g/cm^3, / PET-G
DECORATION	Adhesive	water soluble in ambient conditions	water soluble up to 80oC	not removable in water
DECORATION	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 for most applications	MAY BE SUITABLE for recycling for some applications	NOT SUITABLE for recycling
BODY	Colour	Clear / Light-blue / Green / light tints	dark blue / dark green / brown / strong tints	Opaque / solid colours Carbon Black
	Barrier / Coatings	None		PE Barrier Layer EVOH
	Additives	silicone surface coating	O_2 scavengers / UV stabilisers / AA blockers / Nanocomposites / Anti-block	
CLOSURE	Lidding film	No residue after removal by consumer; or; as main polymer (PET)		
DECORATION	Direct Printing	Minimal or moderate direct printing, e.g. production or expiry date laser printing (minimal)	Excessive direct printing	
	Labels	HDPE / MDPE / LDPE / PP / OPP less than 60% coverage on face	PET paper over 60% coverage on face In Mould label	PVC Metalised
	Adhesive	water soluble in ambient conditions	water soluble up to 80oC	not removable in water
	Ink	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye wash-solution
OTHER	Inserts	HDPE / LDPE / PP	PET / paper	PVC / PS/ EPS / PU / PA (Nylon) PC (Polycarbonate) / PMMA (Acrylic) Thermoset plastics / Metallic

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

Barriers

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.

Additives

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 c/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 multi-layer 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-soluble 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

Material Guidelines - HDPE

		COMPATIBLE for recycling for most applications	MAY BE SUITABLE for recycling for some applications	NOT SUITABLE for recycling
BODY	Colour	Natural	Light-blue / Green / light tints	Opaque / solid colours
			dark blue / dark green / brown / strong tints	Carbon Black
	Barrier / Coatings	None	EVOH / PA (incl. MXD6)	PVDC
	Additives			talc / CaCO3 / other fillers that increase the density of HDPE above 0.995 g/cm3
CLOSURE	Caps	HDPE / LDPE / PP		Steel / Aluminium / PS / PVC /
				Therrmosets
	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	Excessive direct printing	
		laser printing (minimal)		
	Labels	HDPE / MDPE / LDPE / LLDPE	PET / PS (except US) / Paper	PVC / Aluminum / Metallised
		PP / OPP / PS (US only)		
		less than 60% coverage on face	over 60% coverage on face	
			In Mould label	
	Sleeves (incl. tamper resistance)	PE / PP		PVC / PS
	Adhesive	water soluble in ambient conditions	water soluble up to 80oC	not removable in water
	Ink	EuPIA good manufacturing		Inks that bleed and dye
		practices (for non food applications)		wash- solution
OTHER	trigger sprays	PP / HDPE / LDPE		Glass components
				Metal springs / ball bearings

The Infini Bottle
Nampak

Nampak Plastics is well known as the UK's leading producer of high density polyethylene (HDPE) milk bottles, and as the creators of the multi-award-winning Infini bottle.

As the world's lightest and strongest plastic milk bottle, the Infini bottle broke two world records last year. Firstly, Nampak created a four-pint Infini bottle weighing only 32g, a 20% material saving on the standard version. Secondly, Nampak created a version of Infini which includes up to 30% recycled HDPE, double that of any other milk bottle on the market. This achievement means that the target of reaching the 30% mark by 2015 – set by Dairy UK and Defra in the Dairy Road Map – was reached two years ahead of schedule. These two moves combined will result in 35,000 tonnes of material saved every year and will herald significant carbon savings across the industry.

To add to its already impressive credentials, Nampak recently announced significant new developments in its blow moulding techniques at its UK Headquarters in Milton Keynes. After three years of research and development, the first ever All Electric Quick Change Reciprocating Blow Mold Machine has been installed and is up and running. This is capable of processing record amounts of bottles per minute, whilst also using considerably less energy.

It is developments such as these, and the success of the Infini bottle, which has propelled Nampak to the forefront of the UK's milk packaging market. Furthermore, it is anticipated that the Infini bottle will be responsible for significant international growth for the business over the coming months. Nampak's Infini bottle is expanding into other sectors, such as the detergent sector, as well as moving abroad into Australian & New Zealand markets later in the year, with discussions in progress with licensing partners in the US, European, Asian and African markets.

Nampak Plastics
packaging excellence

Eric Collins, MD of Nampak, commented: "Since its launch in 2012, the Infini bottle has been recognised as using considerably less virgin material and increasing quantities of recycled material. Infini's achievements have meant it has been recognised for numerous national and international awards, and we're looking forward to reaching the billion bottles sold mark very soon. Added to this, recent technological developments at Nampak have consolidated our position as pioneers in our field. We're very proud to have come this far and look forward to an exciting future ahead."

The Colour of Bottle Caps
Closed Loop Recycling

More observant shoppers may have noticed a subtle change in the colour of milk bottle tops.

The vivid green colour used for semi-skimmed milk bottle tops had become an issue for the reprocessing and recycling industry. The green pigment used affected the recyclability of the cap and the bottle.

But a subtle change to the colour has made a huge impact in the recycling stream.

The benefits of HDPE for bottles, in place of glass, are obvious, due to the lightweight nature of the HDPE and cutting the costs of transportation while retaining all of the strength. In addition, the material is highly recyclable, because it can withstand the stresses involved in being collected, sorted, chopped up into flake and then recycled in large quantities.

At Closed Loop Recycling in Dagenham, used bottles are sorted, chopped and washed to form HDPE flakes. These flakes are sorted by optical sensors to separate white from coloured, before they are extruded to produce pellets.

However, as the flake passes through the reprocessing facility at high speed, even a small proportion of the green coloured flake can affect the quality, and therefore the value of the pellet produced by the reprocessor.

So, since in the UK the majority of the milk we use is semi-skimmed, the result was green tinted HDPE pellets.

A project team including Closed Loop Recycling worked to persuade the supermarkets to improve the colour of the bottle tops, which would in turn help to improve the percentage of recycled material used in milk bottles.

While the supermarkets would not agree to white bottle tops, there was a compromise reached, and the tops are now less intensely coloured. This slight change in colour, while retaining the colour code that distinguishes full fat from semi skimmed and skimmed, has allowed more HDPE milk bottles to be economically recycled.

closed loop recycling

Material Specific Guidelines - PVC Bottles

Material Specific Guidelines - PVC Bottles

General

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

Material Combinations

The use of PET components of any kind on PVC bottles is undesirable and should be scrupulously avoided. Very small amounts of PET (in the parts per million range) can severely contaminate the recyclate and make it useless for most applications. In addition, PET and PVC both sink (densities are similar and >1 g/cm3) and thus are very difficult to separate in conventional water-based density separation systems.

PVC Bottles - Closures

Plastic closures made from HDPE, LDPE or PP are preferred. The use of PET closures and closure liners is undesirable and should be scrupulously avoided.

Labels

The preferred label systems are those that incorporate the label on the closure, followed by shrink sleeve labels that require no adhesive. The use of PET should be scrupulously avoided.

Other Components

The use of other attachments on the bottle is discouraged but when required, HDPE and clear PVC should be used.

Material Guidelines - PVC Bottles

		COMPATIBLE for recycling for most applications	**MAY BE SUITABLE** for recycling for some applications	**NOT SUITABLE** for recycling
CLOSURE	Caps	PVC / HDPE / LDPE / PP / EVA	PU	PET / PS (density >1g/cm3 Thermo-set plastics / Aluminium / Steel
	Liner		EPS (density<1g /cm3)	PET
DECORATION	Direct printing	Minimal or moderate direct printing, e.g. production or expiry date	Excessive direct printing	
		laser printing (minimal)		
	Labels	HDPE / MDPE / LDPE / LLDPE / PP / OPP / PVC / PVDC	Paper / EPS	PET / PS / Metallised
	Adhesive	water soluble in ambient conditions	water soluble up to 80oC	not removable in water
	Ink	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye wash- solution
OTHER	Inserts	HDPE / LDPE / PP Unpigmented PVC	PA (Nylon) / PC (Polycarbonate) PMMA (Acrylic) / EVA	PS / EPS / PU / Thermo-set plastics

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/cm^3.

PP Bottles - Materials / Material Combinations

The use of unpigmented PP bottles is preferred to pigmented bottles 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.

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

Material Guidelines - PP

		COMPATIBLE for recycling for most applications	MAY BE SUITABLE for recycling for some applications	NOT SUITABLE for recycling
BODY	Colour	Clear / natural, or lightly tinted	Heavy colours	Opaque / solid colours Carbon Black
	Barrier / Coatings	None	EVOH / PA (incl. MXD6)	PVDC
	Additives		Clarifier	
CLOSURE	Caps	HDPE / LDPE /PP	HDPE / LDPE	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 / PS (US only) less than 60% coverage on face	PET / PS (except US) paper over 60% coverage on face In Mould label	PVC / Metallised
	Sleeves (incl. tamper resistance)	PP / PE	PET	PVC
	Adhesive	water soluble in ambient conditions	water soluble up to 80oC	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

No Barrier To Plastic Recyclability

RPC

Barrier plastic recyclability is just part of their good news story says Katherine Fleet, RPC Group Sustainability Manager

Packaging provides a reflection on how we live. It responds to market trends and consumer demands. In the food sector, for example, our busy lifestyles are contributing to the continuing popularity of on-the-go eating, while at home, time-pressed consumers are increasingly seeking the convenience of pre-prepared foods – either complete meals or ready-to-use ingredients to speed up the cooking process.

Barrier plastics offer excellent opportunities for the development of a variety of convenience pack solutions. Barrier technologies can be allied to different plastic manufacturing techniques – blow moulding, injection moulding and thermoforming – so that packaging manufacturers and designers can tailor a solution to precise product and brand requirements. Therefore, whether the focus is on the need for reclosability, intricate eye-catching designs, or a large family-size pack, plastic has the flexibility – in both materials and processes – to meet any or all of these requirements.

At RPC, for example, customer requirements have ranged from a thermoformed pack to resemble a traditional French cooking pot to large-size containers with indented handles for easy handling in the busy food service sector.

However, there is still a common misconception that barrier plastic packaging is not recyclable and for this reason some designers tend to focus only on monolayer packs in the development stages.

The fact is that barrier plastics are recyclable and can form part of a mixed plastics recycling stream. The current use of barrier material, such as EVOH, is minimal and for this reason does not act as a major contaminant in a bale of PP or mixed plastic to be recycled. Current PP recycling systems, for example, can tolerate the use of EVOH, particularly if the layers are readily separated from the PP in conventional reclamation systems. This helps to maximise the PP yield.

And there is high demand for this material – from re-use in non-food packaging, such as paint containers, to second life applications including fencing and benches. So it is vital that manufacturers and retailers continue to promote the recycling message and that more local authorities make facilities available to recycle plastics.

At the same time, a sustainable pack design needs to take into account more than just the recyclability of the pack. It is important to consider the entire lifecycle, covering factors such as the manufacture and transportation of the pack, and its ability to provide product protection and reduce food waste.

Food waste, in particular, is currently generating a lot of coverage. The SAVE FOOD initiative, a joint campaign organised by the Food and Agriculture Organisation of the United Nations and Messe Düsseldorf GmbH to highlight and fight global food loss and waste, says that each year, worldwide, a third of all food is thrown away or lost, while at the same time around 842 million people are suffering from hunger. Excessive food waste also has a negative impact on the environment, a point underlined in the UK by WRAP's 'Love Food, Hate Waste' campaign.

The advent of barrier plastic technologies is one way in which we can reconcile the demand for convenience and the need to preserve food and minimise waste. They enable many different products to enjoy extended shelf lives – up to 24 months and in some cases even beyond this – while maintaining their freshness, quality and taste.

Barrier portion packs offer another solution to minimising food waste by ensuring the right amount of product for individual servings.

The light weight of plastic packs also makes an important environmental contribution in terms of energy savings during transportation. Barrier packs offer a further energy-saving advantage since products can be hot filled, pasteurised or sterilised in the pack (like other more traditional materials) to enable them to be stored at ambient temperatures without the need for chilling.   In addition, these products do not need preservatives to deliver long shelf life, enhancing their quality.

For pack designers, barrier plastics' versatility gives them the flexibility to create a pack that meets both brand objectives – in terms of on-shelf image and appeal, and practicality and functionality – while being tailored to the precise characteristics of individual products. And the packs' recyclability is just one element in a strong environmental profile that can make an important contribution to a company's sustainable image.

Ultra Clear Polypropylene for Recyclable Pots, Tubs and Trays

Milliken

Consumers like to see what they are buying. Therefore, for a lot of goods there is an understandable preference for transparent packaging. The sometimes perceived milky appearance of polypropylene has meant that it has not been able to satisfy the requisite for transparency in many packaging designs; until now.

Millad® NX™ 8000 gives polypropylene (PP) a clarity boost that overcomes the undesirable milky appearance of PP in thermoforming and injection molding, creating highly-attractive transparency similar to polyethylene terephthalate (PET) and Polystyrene (PS) for sheet and finished applications such as pots, tubs, trays, clamshells and containers.

As the kerbside collection of plastic pots, tubs and trays (PTTs) becomes increasingly common in the UK, it is just as important to have commercially viable end markets for this material to be recycled, thus helping build collection networks. Engagement is essential across the whole supply chain, particularly among retailers and brand owners who would like to consider materials which can be recycled economically. They are also being encouraged to specify more recycled content in their non-food packs.

A great example of this is the RPC paint pot, containing post-consumer PP as recycled content, as outlined in the case study on page 60. This pioneering and forward-thinking project should act as a benchmark for others to follow. Within the UK there is also a demand for recycled PP in non packaging applications such as automotive, containers and appliances.

Feedback from the plastics recycling industry addresses some of the common assumptions that exist with regards to the recycling of Pots, Tubs and Trays.

Millad NX 8000 Ultra Clear PP in a Pot

Millad NX 8000 Ultra Clear PP in a Thermoformed

A view from the recycling industry

Dan Jordan, Business Development & Commercial Manager, Boomerang Plastics (specialist contaminated plastics recycling).

"Many retailers and packaging designers assume PET is a fantastic material for PTTs because of its 'recyclability'. This is not currently the case. Yes they can be produced from recycled food-grade bottle material which may tick one box. However that represents a linear economy, not a circular one.

Polypropylene is welcomed by almost every plastics recycler in the UK. It is stable, easy to sort and has a strong second hand commodity value. It can be separated, using density, from bottle grades and other sinking fractions, then sold on at good steady prices, ending up being made into new products such as paint containers and plant pots in the UK and Europe.

We want to help packaging designers make the right polymer choice for their packaging requirements but also one that is compatible with current UK recycling systems. A simple start would be to opt for single polymer packaging designs in pots, tubs and trays and one that uses PP or High-density polyethylene (HDPE) where possible as a preferred polymer. We understand this is not always possible due to limitations of certain pack designs and product requirements, but if there is a choice for recyclability of PTTs in the UK, PP or HDPE are the best options.

Please also keep in mind that a PET bottle is recyclable here in the UK and we have a fantastic network of companies pioneering the PET and HDPE bottle stream, whereas PET trays tend to cause quality issues from contamination of bottle streams to devaluing mixed plastic bales, dragging down the value of other types of plastics that normally have a good secondhand value. For example, a local waste management firm can get price penalties on the percentage of non-bottle PET in a mixed plastics bale.
We are aware of projects within the UK and mainland Europe which are trying to address the issues associated with PET tray recycling. This is commendable and yes everything is sortable, but it also has to be commercially viable which is still a major challenge for PET PTTs."

Polypropylene PTTs are commercially viable to recycle, and high clarity should no longer be an obstacle in choosing PP for many pots, tubs and trays applications. In addition, PP has excellent sealing properties to help prevent food spillage/wastage, it is low density, and microwaveable. It also uses the least amount of energy during production and produces the lowest carbon dioxide (CO_2) emissions when compared to other transparent plastics in packaging.

boomerang plastics
SPECIALIST CONTAMINATED PLASTICS RECYCLING

Material Specific Guidelines - PS

Material Specific Guidelines - PS

PS

Applications using clear, colourless polystyrene have the highest recycling value. Therefore use of unpigmented containers is preferred. Coloured transparent containers are acceptable however, but their recyclability and the value of the recyclate are reduced.

In principle aluminium lids are acceptable on PS, especially peel-off ones.

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.

Material Guidelines - PS

		COMPATIBLE for recycling for most applications		MAY BE SUITABLE for recycling for some applications	NOT SUITABLE for recycling
CONTAINER					Multi-layer material (unless based on PS with polymers of the same type in limited quantities)
	Colour	Clear / natural, or lightly tinted		Heavy colours	Opaque / solid colours
					Carbon Black
LID	Lidding film	No residue after removal by consumer			
		Lightweight ;			
			Metallised OPET	Lightweight Aluminium foil	Heavyweight Aluminium foil
			Metallised OPP	PE	PET / Heavy paper
			PBT / PS	PP	PET / PS
			PET / light paper		
			PS		
			PS with PE insert		
			PS with EVA insert		
			OPS		
DECORATION	Direct Printing	Minimal or moderate direct printing, e.g. production or expiry date		Excessive direct printing	
		laser printing (minimal)			
	Labels	PE / PP / OPP / PS		Paper	PET
		PS / OPS			PVC
		less than 60% coverage on face		over 60% coverage on face	Metalised
				In Mould label	
	Adhesive	water soluble in ambient conditions		water soluble up to 80oC	not removable in water
	Ink	EuPIA good manufacturing practices (for non food applications)			Inks that bleed and dye wash- solution

Challenges in Recycling of Expanded Polystyrene
Renmar/Artec

Austrian Recycling Technology ARTEC primarily develops and manufactures plants for processing film waste, fibers and ground stock into pellets at throughput capacities ranging from 200 to 2500 kg/h. ARTEC's innovative modular plant concept achieves new levels of economic efficiency and flexibility. All ARTEC recycling plants can be adapted quickly and cost-effectively to changing recycling materials over the entire life span of the product. The individual modules can be interchanged simply on demand.

Underlying challenges in EPS Recycling require a mature recycling technology. The Austrian recycling specialist ARTEC delivered its first EPS recycling line more than ten years ago and can revert to a treasure trove of experience in this difficult environment.

The peculiarities at EPS recycling already start at waste material sourcing. Finding suppliers able to deliver adequate amounts of EPS waste often results in a material mix with different material qualities. Beside of low bulk densities EPS processing gets more difficult through inhomogeneity occurring when dry and dusty material encounters very humid material.

ARTEC's especially for high degrees of residual humidity developed cutter compactor meets these requirements through size reduction, drying, homogenizing and densifying of the feeding material in one process step. The necessary thermal energy for drying is solely generated through friction, thus represents an outmost power-saving drying method. An efficient suction unit to extract dust and humidity enables to manage humidity degrees up to 25 percent.

Reliable metal separators and metal detectors as well as permanent filter systems ensure to cope with high contaminations such as screws, nails, wood, paper or mortar. The inherent hardness of EPS pellets resulting in high amounts of fines require a fine filtration system of the process water which tops off the perfect machine technology for EPS recycling.

Guidelines - Other Plastic Packaging

The term ‘mixed plastics’ can be 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, other 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 and there are signs that plastic packaging collection streams in the USA are expanding beyond rigid bottles / jars to cover all plastic packaging.

Sorting and handling issues are a particular challenge, as films and rigid plastic packaging are historically difficult to separate into marketable fractions.

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 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.

While there are markets for all major individual polymer types once separated, there is an under developed market at the present time for a mixed plastics stream. The mixed polyolefin stream is often used to make, for example, insulation and furniture while the PET material is used in applications that can utilise lower quality compounded PET flake.

Given the relative newness in pots, tubs and trays recycling, guidelines for designers are currently limited. Nonetheless, this document includes some basic guidelines that designers can use to try and ensure that the potential for recycling is maximised. It must be appreciated that this recycling is very much in its infancy and designers cannot assume that their packaging will necessarily be recycled at this time. However, following these guidelines will further help with the development of this important but as yet relatively untapped resource stream.

Guidelines - Other Plastic Packaging

General

The basic design principles for mixed plastics packaging are no different to those given in the general guidelines section and in the specific polymer sections for bottles. However, the processes used for the recycling of other forms of plastic packaging are not identical to those used for plastics bottle and hence exactly the same rules may not apply. This is likely to become particularly apparent in the future when more experience is gained with the recycling of various mixed plastics.

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 for mixed plastics. Mixed plastics however very often require the use a variety of plastic materials to provide both the technical properties required and to satisfy user needs. In the absence of any other specific guidance, designers should follow the recommendations provided for the corresponding polymer bottle material when designing a mixed plastic rigid container. Alternatively, components that were known to be readily separable could be used.

Colour

Wherever possible use of dark rigid mixed plastics packaging (e.g. black, dark grey, and any heavily pigmented colour) should be avoided. Black plastic remains invisible to NIR detectors and thus will be rejected. In addition any black / dark material entering the plastic recycling stream will further reduce the value of the recyclate.

Contamination

Mixed plastics 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

Rigid PET packaging represents a significant fraction by weight of the domestic plastic waste stream. One particular immediate difficulty that will need to be faced 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 to switch from PET/PE blends to monolayer PET for trays should further facilitate the recycling of this mixed plastic. 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.

Guidelines - Other Plastic Packaging

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.

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.

Guidelines - Other Plastic Packaging

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. Recognising this need, and in the absence of any other specific guidance, designers should follow the recommendations provided for the corresponding polymer material. In the case of films, however, this is less important as some film recyclate is used in applications that have a more tolerant specification e.g. furniture, bin liners, etc. In these cases 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 - Labels

Labels manufactured from materials that float in water while the film sinks (e.g. PET) or vice versa and attached with water-soluble adhesive are acceptable. Paper labels also can be used, provided they too are easily removed in water and leave no adhesive residue that is difficult to remove and do not reduce to pulp in the washing process.

Bioplastics

General

In response to the global focus on climate change and sustainability, there is a growing interest in the use of bioplastics in packaging applications. In Europe, consideration has been given by individual member states to promote the use of this type of packaging: Germany currently has derogation from recovery fees to provide time for a suitable waste infrastructure to be developed and France had considered introducing a law to promote the use of bioplastic carrier bags. In the Netherlands, packaging made from EN certified materials also enjoys a lower packaging tax tariff.

Bioplastics are not a single class of polymer but rather a family of products which can vary considerably one from the other. Whilst a generally recognised definition of the concept does not exist, European Bioplastics, like many other associations, regards bioplastics as having two differentiated classes:

- Plastics based on renewable resources.
- Biodegradable polymers which meet all criteria of scientifically recognised norms for biodegradability and compostability of plastics and plastic products (EN13432 in Europe, D6400-04 in the USA and more recently ISO 17088).

In both classes, a high percentage of renewable resources is used in the polymer production. Whereas products from the first group do not necessarily have to be biodegradable or compostable, those from the second group do not necessarily have to be based on renewable materials in order to meet the EN 13432 / D6400- 04 / ISO 17088 criteria.

Bioplastics offer the potential to provide an infinitely renewable source of packaging raw materials and biodegradable bioplastics an additional recovery route, namely organic recycling. Some biobased polymers can go into the normal recycling stream (see note 2). In addition, if enough products enter the market, recycling (in some cases chemical recycling i.e. chemical depolymerisation to monomer) can be considered an option for such homogeneous recovery streams. Also, both types of bioplastic can be incinerated with energy recovery with minimal net CO_2 emissions: the CO_2 produced simply reversing the photochemical uptake of carbon from the atmosphere by the plants during the cultivation of the raw materials.

Such materials are not without their own potential issues. Competition with land for agricultural use and use of fossil fuels during production are two of the issues currently under debate at present.

The balance between biodegradable and biobased polymers is changing. While most conventional plastics (e.g. polyolefins, PET, etc.) are neither biodegradable nor compostable there are some synthetic polymers which are certified biodegradable.

In the context of designing for recyclability, conventional polymers derived from either natural resources or fossil fuels will behave no differently from each other and thus need no special mention in this context. Bio-based polymers that are relatively new to the packaging market do require special mention. Although some biobased polymers are biodegradable most developments are now centred on non-biodegradable biobased polymers.

Bioplastics

There are currently three main bio-based polymer types on the market: starch materials, polylactic acid (PLA, polyester) and cellulose materials. It is also worth noting that although renewable raw materials dominate the production of current bioplastics, many bioplastics are however mixes or blends containing synthetic components. Synthetic polymer types and additives are frequently used, albeit in small quantities, to improve the functional properties of the finished product and to expand the range of applications. Use of this material for film and tray applications predominates (especially for packaging organic produce) but bottle applications are also found on the market.

The pros and cons as to whether a biobased or fossil fuel derived plastic should be chosen for a particular application is complex and certainly well beyond the scope of the current document. What is pertinent is the fact that compostable packaging based on renewable materials can now be found on the shelves of almost all European supermarkets and in many other countries of the world. Of particular importance in the current context is their use to package fresh foods and hygiene products. It is therefore opportune to highlight the implications of the use of these materials on packaging recycling. Two aspects have to be considered, firstly the recyclability of the materials themselves and secondly, the effect the use of bioplastics might have on existing material (in this case plastic) commercial recycling streams.

Recyclability of Bioplastics

As indicated earlier in this document, it should not be automatically assumed that every piece of packaging necessarily should be recycled and bioplastics are no different. Incineration with energy recovery and, in many cases, organic recovery may be a more attractive and environmentally beneficial option.

Organic (food) waste, as a result of the landfill directive, will need to be diverted from landfills and will ideally be processed in industrial composting units or turned into energy by anaerobic digestion.

Packaging recovery schemes are often very different across the EU. The reason being that waste management systems are optimised to take account of local infrastructures for collection and recycling, local and regional regulations, the total volume on the market available and the composition of waste streams. Most countries have set up systems to recover and recycle plastic bottles, but for most other types of packaging, the results are more fragmented and not always very well developed.

In many cases, mixed fossil-based plastic waste fractions are being incinerated and by doing so, energy is being recovered. Packaging from bioplastics that would end up in these waste fractions (e.g. films) will also be incinerated with energy recovery, but will generate renewable energy instead, since the carbon is renewable resource based.

Bioplastics can be recycled, but care should be taken when mixing with traditional plastics as they are not always compatible with each other. In addition, incompatibilities between different types of bioplastics, as with traditional polymers require them to be sorted by type before being recycled. However, use of bioplastics in packaging is still in its infancy and applications still evolving.

For this reason market volumes have not yet reached sufficient critical mass for the recycling of individual bioplastic packaging streams to be considered commercially viable or for current waste management systems that are optimised to recycle conventional plastics (PE, PET, etc.) to be modified. Over time, recycling may become the best option for certain bioplastics once critical volumes are achieved in the waste stream and where a homogeneous stream separate from conventional plastic streams / other bioplastics can be organised.

Bioplastics

Effect of Bioplastics in Current Plastic Waste Streams

As previously mentioned, mixing of bioplastics with traditional plastics may sometimes affect recycling. At present, such issues are relatively limited because of the current low market penetration of bioplastics but given the growing interest in such materials then this situation may change sooner rather than later. Bottle recyclers often have robust systems in place to sort contaminants out from current waste streams. As volumes grow, it will become more effective to start to identify and recover bioplastics from these streams.

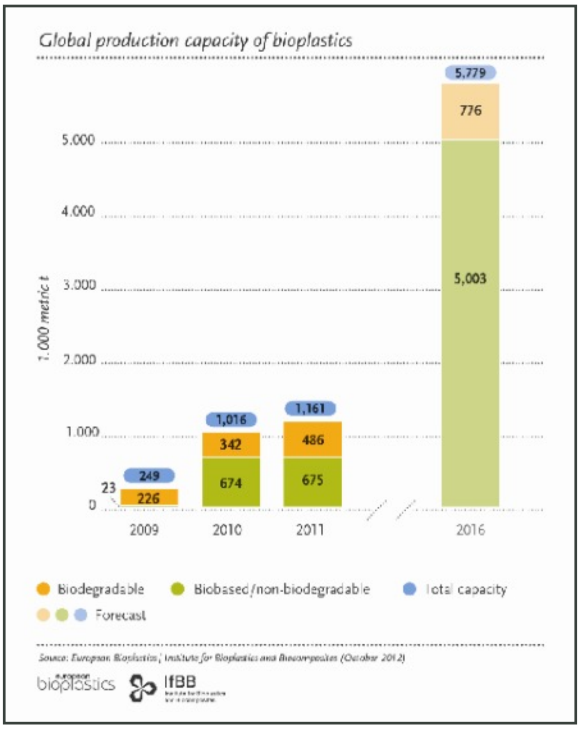
The risks associated during this transition period with existing recovery schemes should be monitored. It will be important for users of bioplastics packaging to be able to anticipate which conventional material stream a bioplastic packaging application is likely to go into if not separated out.

An assessment of the relative compatibility of the bioplastic with the material stream (from knowledge of material compatibilities and anticipated total levels in waste stream) would then allow any risk of undermining the conventional recycling stream to be assessed. Such monitoring and analysis would be best achieved through close collaboration of bioplastic producers, packaging user and recyclers.

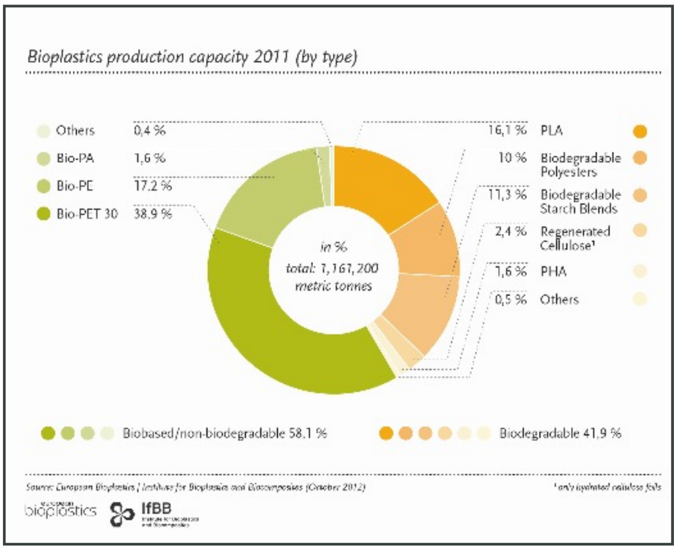
Consideration should be given to developing a separate infrastructure for the collection of the bioplastic where risks are foreseen and sufficient market uptake achieved. An alternative option which could be used regardless of market volume, but where a risk is anticipated, would be to develop a mechanism to ensure that the levels of the bioplastic reaching the conventional stream are kept acceptably low through extraction of the bioplastic from the conventional material stream using either manual or automatic sortation.

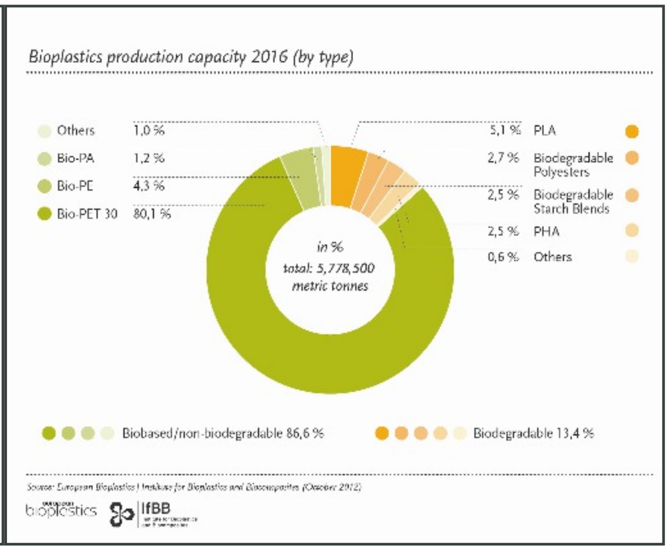
Notes

1. Changes in Market Proportions of Biodegradable and Biobased from European Bioplastics



Bioplastics





2. Recyclability of Biobased Polymers

Some of the new developments in biobased biopolymers can be recycled in the normal plastic recycling stream with no effect on virgin plastics. Research and development of new materials is also geared towards bioplastics that are structurally identical to conventional polymers. The following quotations support this statement:

“Some bioplastics can be easily recycled in the existing recovery systems due to their structural identity with conventional plastics” (Policies for Bioplastics, 2012).

“Products made with biobased equivalents of conventional polymers do not differ from fossil based products when it comes to mechanical recycling. Other innovative biopolymers can also be recovered with mechanical recycling, especially when sufficient volumes of homogenous waste material streams are available, either through separate or through sorting routines” (European bioplastics mechanical recycling factsheet, 2012).

For other materials the recyclability will develop as a result of market growth and having economies of scale to allow the development of a bioplastic recycling infrastructure.

Recycling of Plastic Packaging

Plastic Packaging Recycling Overview

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

Following the success and interest in recycling plastic bottles other forms of plastic packaging recycling are now being 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.

Six main types of plastic are found in the domestic waste stream: PET, HDPE, PVC, LDPE, PP and PS. 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.

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 plastics 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.

Over the past 10 years 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. 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 reclamation 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 Reflective Near Infrared (NIR) sensors, which are placed on the top of the conveyor and ejecting the targeted material using air jet at the end of the conveyor. This technology is frequently used to separate plastic containers in different fractions, as the market requires clean stream of specific resins and colour type. 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 becoming more widespread both within Europe and especially within the USA, 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 (see page 19), 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 all segregated into a single bottle stream, baled and sold as mixed polymer bottles. Alternatively, the bottles 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 ‘mixed plastic’ grade where they are then further segregated into individual polymer grades at a PRF or reprocessing facility. 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 type of material is usually low quality and difficult to sell. 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

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, hydro-cyclones 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 4. 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.

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. The collection and recycling of plastics entering the UK household waste and recycling systems remains primarily focused on plastic bottles, with markets and values for pots, tubs and trays developing slowly.

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.

End Products

The Use of Recycled Material in New Products

Awareness of value and versatility of used plastics packaging needs to be developed further. Whether it be post-consumer or post-industrial, the opportunity to recycle this valuable resource into new products and applications is expanding and should be recognised.

Recycled plastics can not only replace or partly replace virgin material and reduce manufacturing costs, but can also add to a companies' environmental credentials and / or deliver an environmentally enhanced product, such as in carbon footprint reductions, lifecycle analysis benefits or in developing its corporate social responsibility agenda.

There are a wide range of products now produced which contain recycled plastics, and these include food grade applications such as bottle to bottle and fresh food trays, and non-food applications such as in construction (e.g. pipes and building site screens), garden furniture, pens and kitchen utensils, paint pots and using polymer yarn and fibres to produce clothing such as t-shirts and fleeces.

Case Studies

Super lightweight mono material protein trays from LINPAC Packaging utilising a novel patented flange sealant technology to replace the laminated base film.

Proprietary adhesive technology applied to flange for top sealing of complementary lidding films.

Super lightweight mono material rPET tray designed using LIFE® principles.

The new Rfresh® Elite range of rPET trays are 100% recyclable at the end of their service life and the removal of the traditional PE sealing layer, historically the most secure method of hermetic sealing, will delight recyclers and help the UK meet ambitious new recycling targets.

Alan Davey, Innovations Director at Linpac Packaging said 'the ingenious new sealing system can be removed in the hot wash process employed by Europe's PET recycling companies meaning a recycled Rfresh® Elite tray will yield 100% crystal clear PET after recycling, in the same way as a clear bottle. This benefits the packaging and food retailing industries by helping to meet the targets set by the European Packaging and Packaging Waste Directive.'

Case Studies

How Recycled content helped Dulux achieve a perfect finish

In 2011 Dulux Matt and Silk Colours became the first paint brand to market in 2.5 and 5 litre paint cans from RPC Containers Oakham that boasted a 25 per cent recycled post-consumer waste content.

With an increasing focus across all retail markets for more sustainable packaging solutions, brand owner AkzoNobel wanted to respond to both retailer and consumer concerns to minimise the effect of its packaging and had already committed to introducing a lower weight container; the potential also to include an element of PCR material in the pack added further sustainable benefits.

The challenge for RPC Oakham was to incorporate the recycled material with no loss of container performance, particularly in terms of its robustness and reliability in protecting the product. It was also essential that brand image and consumer perceptions were not compromised in any way.

RPC Oakham worked closely with its PCR supplier Regain Polymers to identify a reliable source for the material that was sustainable and of a consistent quality. The next stage was to ascertain the correct balance of PCR and virgin material so that the physical properties of the materials were maximised in respect of impact strength and stiffness.

The pack developed was based on RPC Oakham's Supertainer lightweight container. This offered additional benefits in terms of weight savings along with the recycled content. Once the PCR material had been selected, tests focused on the amount to be used in each container, ensuring that the successful pack could still perform properly. The thinner wall section in particular requires good control of the moulding processes and materials. While 25% PCR content was deemed the most appropriate in order to ensure that performance can be maintained, RPC is continuing to work on increasing this amount in the future.

Inevitably the use of PCR can affect the colour of a pure white container; however, the development of a striking charcoal-black colour for the Dulux pack has provided a beneficial marketing angle by helping to create on-shelf impact and brand differentiation.

This project demonstrates the excellent potential for recycled plastics and how they can make an important contribution to companies' sustainability objectives. The use of PCR provides a diversion of waste plastic from landfill while the material can be incorporated into new containers without any reduction in packaging performance.

For the Dulux Colours range the combination of a lighter weight paint can with the 25% PCR content has led to a 19% reduction in carbon footprint.

Improving Recyclability
Enval

Laminated Packaging Recycling:
Process description and plant datasheet

- Aluminium recycling from flexible laminate packaging
- Compact modular design allowing local treatment
- Minimal emissions
- Advanced thermal treatment on microwave induced pyrolysis

Laminated Packaging

Flexible laminated packaging consists of layers of aluminium and plastic and/or paper and is widely used in food pouches, toothpaste and cosmetic tubes, drink cartons and many other products.

The waste material generated from the use of this packaging is currently not recycled and, with volumes constantly increasing, a solution is needed.

The Enval Process for Laminated Packaging

Developed from research carried out at the University of Cambridge, Enval's proprietary process for treating laminated packaging is a proven technology based on a concept known as Microwave Induced Pyrolysis.

The process involves mixing shredded waste with carbon, a highly microwave-absorbent material. The energy from the microwaves is transferred to the waste by thermal conduction from the carbon, providing both a very efficient energy transfer mechanism and a highly reducing chemical environment.

The process recovers 100% of the aluminium present in the laminate clean and ready to recycle, and produces oils and gases suitable for fuel for steam/electricity generation or for use as chemical feedstock in other processes.

The Enval Process enables the recycling of laminated packaging, recovering valuable resources that would otherwise end up in landfill.

Recovered aluminium from the Enval

For more information visit the website

www.enval.com

enval
VALUE FROM WASTE

Appendix 1

Legislative & Environmental Change

Packaging has a very negative perception with consumers and environmentalists. It is sometimes perceived by the public to be a waste of resources and a significant contributor to the growing levels of waste. In addition it is often also linked to litter issues.

Politicians are very aware of this with the result that pressure has been and continues to be applied on packaging through the introduction of legislation in Europe, the USA, Japan and other countries around the world. The general approach to packaging legislation traditionally has been very much 'command and control' for example regulating how much packaging needs to be recovered, recycled, what percentage of packaging needs to be refillable, etc. rather than dictating the overall desired environmental goal and leaving industry with the flexibility of deciding how this might best be achieved. Encouragingly, less heavy-handed incentive-based mechanisms (e.g. emissions trading) are beginning to be looked upon more favourably appear to work well.

In addition, legislators and environmentalists continue to encourage the application of a strict waste hierarchy where the order of priorities is:

Prevention > Reuse > Recycling > Energy recovery > Landfill

This is exemplified in the recent review of the Waste Framework Directive in Europe. The revised Directive requires that this waste hierarchy be applied as a priority in waste prevention and management legislation and policy. Such a rigid interpretation is not supported by Industry. This has been recognised at least to some extent within the review of the European Waste Framework Directive as the revised Directive allows a departure from this hierarchy when justified by life cycle thinking on the overall impact of generation and management of specific waste streams.

Regardless of technical correctness however, recycling is seen by many as the most important recovery route and, therefore, the one that should take precedence.

The European Packaging and Packaging Waste Directive (PPWD) sets the current framework for National packaging legislation across the European Union and acts as a model for many other parts of the world. The basic legislation (Directive 94/62/EC) came into force in 1994 and required amongst other things, that by 2001 Member States achieve packaging recovery levels of 50-65% and recycling levels of 25-45%. In addition, no individual material (e.g. plastic) was to have a recycling rate <15%. The revision of this legislation in 2004 (Directive 2004/12/EC) further increased the recovery and recycling targets to >60% and 55-80%, respectively and by so doing increased the relative importance of recycling over general recovery. In addition, differentiated material specific recycling targets were introduced with the level set for plastic being a minimum of 22.5%.

The direction of the new European Commission Circular Economy proposals will represent a necessary shift towards better long term use of resources and the development of circular economy models. The circular economy package will look at how to design and manufacture products that will "better support recycling efforts."

Proposals were withdrawn at the end of 2014, to be replaced with a more "ambitious proposal" by the end of 2015, according to the Commission. But it is unknown whether the specific recycling targets will be amended.

Any alternative approaches are very likely to be similar or more ambitious than those already proposed. This will filter down into UK legislation, with a high expectation that there will be further long term increases in recycling targets and additional pressure on industry to implement and demonstrate more recyclable packaging. Even with a possible introduction of a landfill ban on plastics, this approach means that energy from waste will also only be viewed as an acceptable option where all feasible actions to improve recycling have been exhausted.

Appendix 1

The Directive also mandates that packaging must satisfy certain essential requirements, one of which is that any packaging being put on the market must be recoverable. Recovery can be by recycling, energy recovery or organic recovery. However as indicated previously and despite what the legislation allows, consumers, environmentalists and politicians consider recycling as the preferred recovery route.

The European Packaging and Packaging Waste Directive has been followed by European directives for other products (e.g. End of Life Vehicles, Waste Electrical and Electronic Equipment) using a similar approach.

In 2000, the European Union adopted a revised programme for the environment up to 2010. This, the Sixth Environmental Action Program (6EAP), established four environmental priorities, one of which included preserving natural resources and managing waste. The thematic strategy on the Sustainable Use of Natural Resources and the thematic strategy on Prevention and Recycling of Waste were established to progress this priority.

At that time, Integrated Product Policy (IPP) was seen as an important tool towards aiding the objectives of the 6th Environmental Action Programme (6EAP). The original objective of IPP was to promote the environmental performance (eco-efficiency) of a broad range of products through their life cycle and to stimulate demand for greener products. Subsequently, with concerns over European competitiveness, this was modified to reducing the environmental impact from products throughout their life cycle, harnessing, where possible, a market-driven approach, within which competitiveness concerns are integrated.

In recognition of the additional importance of tackling consumption if the goal of sustainability is ever to be attained, the priority of the European Commission has now moved to Sustainable Consumption and Production. The earlier thinking and work carried out within IPP and the Thematic Strategies has not been lost however, but rather integrated into this new and broader policy framework.

While the action plan is still being developed, it is clear that this strategic policy approach encouragingly is embracing the more holistic concept of life cycle thinking and seeks to better integrate economic, social and environmental aspects. The policy developers' thinking is thus beginning to move closer to that of Industry giving hope that in the future a more holistic approach to policy will evolve.

Regardless of how policy progresses into the future it is clear that packaging recycling targets will remain in Europe for the foreseeable future. Even with the introduction of new and broader policies derived from the Sustainable Consumption and Production Action Plan it is likely that existing targets will be integrated into any new framework rather than removed, to ensure that the current recycling achievements with packaging are maintained and social and political issues avoided as far as possible.

Appendix 2

Packaging and Packaging Waste Directive (Directive 94/62/EC)

The European Packaging and Packaging Waste Directive sets the current framework for national legislation across the European Union and is progressively being used as the legislative model in other countries across the world. The basic legislation (Directive 94/62/EC) came into force on December 20, 1994 and was updated in 2004 (Directive 2004/12/EC).

Scope and Aims

The European Packaging and Packaging Waste Directive (94/62/EC) covers all packaging placed on market within EU i.e. all household, commercial and industrial packaging waste with only minor exceptions (e.g. hazardous household packaging).

The stated aims are twofold:

- To bring national measures closer together and remove obstacles to trade such that packaging and packaged goods can circulate freely throughout the European Union.

- To minimise the environmental impact of packaging by reducing the amount of waste going to final disposal by promoting minimisation, reuse, recycling and other forms of recovery of packaging.

Like any other European Union Directive, the Packaging and Packaging Waste Directive is not directly binding legislation. It is an instruction to Member States to transpose it into their national law and to take the action required to ensure that its provisions are complied with. Individual companies are simply responsible for complying with whatever legal requirements are laid down at national level.

In addition, it is a 'New Approach' directive and therefore instead of being very precise and requiring Member States simply to translate it into national law, 94/62/EC is a framework directive that provides room for interpretation by Member States.

Main Requirements

The directive requires Member States to:

1. Set up Systems for Return / Collection of Used Packaging

The Directive requires Member States to take the necessary measures, covering the whole of their territory, to ensure that systems are set up for the return or collection of used packaging, so that the notified national packaging material recovery and recycling targets are achieved. It is up to national governments to decide what legislation is necessary; industry then has some freedom to decide how to structure and fund any recovery organisations set up to co-ordinate efforts. Companies will generally have a choice between joining a collective organisation that will take over their legal responsibilities or choosing direct compliance with the legal requirements.

2. Achieve Recovery and Recycling Targets

Member States need to set and achieve recovery and recycling targets within a defined range set out in the Directive. The targets currently in force (which represent an increase over those originally set out in Directive 94/62/EC) are given in Directive 2004/12/EC. Targets (by weight) are;

- Minimum of 60% packaging waste recovery

- 55-80% packaging recycled

Appendix 2

- Individual material recycling rates of:
    - 60% glass
    - 60% paper and board
    - 50% metals
    - 22.5% for plastics
    - 15% for wood

After a review of the implementation and effectiveness of the directive in 2005/2006 the commission decided against any increases in these targets at the present time and hence they remain currently in force

“Recycling” for plastics exclusively counts material that is recycled back into plastics. “Recovery” includes all forms of recycling (material recycling, feedstock recycling and composting) plus energy recovery. Member States had to adopt national legislation to ensure that these targets are met.

Individual Member States can set targets beyond those indicated within the Directive, provided they do not distort the internal market and do not hinder compliance by other Member States with the Directive. The Commission and Member States have to be notified and agree, however, to any such proposals.

3. Set up Databases to Provide all Necessary Information at National Level.

The reporting of all packaging placed on the market, the quantity of packaging waste arising and recovered and the overall totals for material (i.e. glass, plastic, paper & fibreboard, metal and wood), recycling and recovery within Member States are mandatory. The split-up of plastics (PET, PE, PVC, PP, PS, others), metals (steel, aluminium) and the reporting of composites is voluntary. Composites can be classified according to the predominant material or separately specified.

Reporting of all packaging placed on the market within a member state is mandatory but reporting of reusable packaging is voluntary.

4. Ensure Packaging Complies with 'Essential Requirements'

Under the “New Approach”, the EU institutions speed up agreement on technical harmonisation issues by agreeing “Essential Requirements” which define the results to be attained and the risks to be dealt with, and delegate to CEN (the European Committee for Standardization) or CENELEC (the European Committee for Electrotechnical Standardization) the task of specifying the technical solutions needed. Members States are required (article 9) to ensure that packaging placed on the market complies with the essential requirements defined in the Directive.

Annex II to Directive 94/62/EC lays down the Essential Requirements that all packaging placed on the market within the European Economic Area must comply with. These Essential Requirements can be summarised as follows:

- Packaging weight and volume must be minimised to the amount needed for safety and acceptance of the packed product;
- Noxious and other hazardous constituents of packaging must have minimum impact on the environment at end of life; and
- Packaging must be suitable for material recycling and/or energy recovery and/or composting, or for reuse if reuse is intended.

The EU Commission mandated CEN to draw up a set of standards on packaging prevention, reuse, material recovery, energy recovery and organic recovery.

Appendix 2

These were initially developed in 2000 but needed to be revised to further meet the requirements of the Commission and the Member States. The updated versions were adopted in 2004. With this latter update, an additional umbrella standard that explains the interlinks between the other standards was included.

Use of the standards is voluntary, but the Packaging and Packaging Waste Directive provides that there is a presumption of conformity with the Essential Requirements when packaging has been produced in accordance with harmonized standards whose references have been published in the Official Journal of the European Communities.

On 19 February 2005 the Commission published the references to the full set of standards in the Official Journal as recognition of their status as “harmonised standards”. This means that packaging which complies with the standards is deemed to be in conformity with the Essential Requirements, and cannot be denied access to any country in the European Economic Area on grounds of non-conformity with the Directive.

Adoption of these harmonised standards also means that the burden of proof now resides with the enforcement authorities - they need to prove that packaging has not been produced in conformity with the relevant standards. Hence whilst the use of the CEN standards to show compliance is not mandatory and companies are allowed to use other methods to demonstrate compliance, there are major benefits to be had by using the CEN standards approach.

In addition, adoption of the CEN management (checklist) approach ensures that packaging designers and specifiers keep potential environmental improvements under continuous scrutiny, as well as giving added value in developing the European Single Market for packaging and packaged goods.

The standard on material recycling (EN13430) requires that:

- A certain percentage of the packaging materials can be claimed to be recyclable.
- A declaration is made of the percentage by weight of the functional unit available for recycling and the identification of the intended material recycling stream(s).
- A written statement of compliance is prepared.

The annexes in the standard identify the criteria that need to be considered when assessing the recyclability of packaging.

These include:

- Consideration of aspects significant for the recycling of the materials from which it is produced.
- Control of the selection of raw materials to ensure that the recycling processes are not negatively affected.
- Ensure that the design of packaging makes use of materials and combinations of materials which are compatible with known, relevant and industrially available recycling technologies.

These guidelines provide a useful aid towards satisfying the requirements of this standard.

France and the UK have been enforcing the Essential Requirements legislation since the late 1990s and have adopted detailed regulations explaining what companies must do to comply.

Appendix 2

The other Member States have done no more than transpose the text of the Essential Requirements into their National legislation more or less word-for-word with no indication of how they should be enforced. It had been anticipated that more Member States would start to enforce the legislation once harmonised standards became available and the Commission's progress report on implementation of the Directive which included an evaluation of the effectiveness, implementation and enforcement of the Essential Requirements was published. This does not appear to have happened as yet, despite the standards gaining their "harmonised status" in 2005 and the Commission report being released in December 2006, It is clear however, that unless the workability of the standards can be demonstrated both in their use by companies and enforcement by Member States there is likely to be a call for a tightening up of the Essential Requirements in order to make them more prescriptive and leave less freedom for companies to make their own decisions.

5. Ensure Packaging Complies with Heavy Metal Requirements

The Directive (article 11) requires that Member States (original EU-15) ensure that the sum of concentration levels of lead, cadmium, mercury and hexavalent chromium present in packaging and packaging components shall not exceed 100ppm by weight.

With specific exception for packaging made with lead crystal. The Commission also granted an exemption for recycled plastic crates operated within a closed loop.

The date that the 100ppm target level came into force was 1st July 2001 and hence the maximum level for the sum of these four heavy metals in packaging is now 100ppm. Although the newer EU Member States were granted derogation on achieving the lower limit, this has now passed. Hence the 100ppm heavy metal limit now applies in all EU Member States.

Although while not strictly correct, the heavy metal limits are commonly treated as part of the Essential Requirements.

6. Reuse of Packaging

The Directive states that Member States may encourage environmentally sound reuse system and use of recycled materials. Economic instruments may also be adopted to promote the objectives of the Directive.

Appendix 3

Business Case

Two important types of qualitative commercial benefit can be identified:

(a) Minimise the Cost of (Legal) Compliance

In Europe, the PPWD mandates that Member States achieve a minimum level of plastic packaging recycling. In general, through adoption of producer responsibility, industry funded recovery organisations have been established to ensure this target is achieved.

Following these guidelines will be a very important contributor in helping to maximise process efficiency and thereby minimise the associated levies charged by recovery organisations to companies to fund the process.

The PPWD also requires that companies design their packaging to be recoverable. For packaging where mechanical recyclability is desirable, adoption of these guidelines at the start of the design phase will ensure unnecessary difficulties are avoided and hence unwanted delays and associated oncosts prevented. In general, the cost of getting it right will be marginal, provided these considerations are built in at the start of the design process. Using the CEN standard on material recovery to demonstrate compliance (recommended method) also requires demonstration that material combinations being used will not adversely interfere with current recycling. These guidelines have been developed specifically as an aid to avoid such issues. Further, administrative costs for compliance will also be minimised if the guidelines are integrated into Environmental Management Systems and New Product Innovation processes.

Outside of Europe, Japan, Taiwan and Korea have introduced legislation on broadly similar principles to the PPWD. In addition many states within the countries of Latin America have adopted selected elements of the PPWD into their state legislature.

The above commercial benefits would still apply to any country or state where recycling targets for plastics exist through legislation or voluntary agreements. In addition the EU Essential Requirements legislation also applies to packaging imported into the EU and de facto is becoming a global standard for suppliers. The benefits indicated when designing for mechanical recyclability are therefore also globally relevant in this context.

There are also a number of national trends across Europe that seek to reward packaging that conforms to specific design rules and / or penalise those that don't:

A further voluntary agreement on Packaging Sustainability between the Austrian government and industry has been completed and will run for a period of 10 years. The focus is now on supporting investments made in PET bottle to bottle recycling and not on maintaining a supply of refillable drinks containers. From 2008, at least 55% of PET bottles have to be recycled or recovered (up from the previous target of 50%).

In addition, minimum tonnage targets have been set for the amount of post-consumer PET to be used in the production of PET bottles annually.

This new agreement is also much broader than the Sustainability Agenda for Beverage Containers that it replaces as it includes a commitment to reduce greenhouse gas emissions along the PET supply chain.

In France, the national Green Dot organisation (Eco-Emballages) doubles the recycling fee for new packaging materials or applications if rigid packaging currently recycled is replaced by rigid packaging without a recycling channel.

(This provision does not apply to specialist applications where the packaging is not economic to recycle).

Appendix 3

The recycling fee is reduced by 10% for packaging with over 50% recycled content. The Swedish recovery organisation REPA has removed the concept of the same fee being paid for all packaging of the same material and for plastic packaging has introduced a 10% lower fee for carrier bags, point of sale and produce packaging over other plastics packaging because they are more readily separable.

Similarly in Norway, recovery fees are 88% more for dark blue versus light blue PET bottles or for bottles where the sleeve covers more than 75% of the surface.

Finally, in France (COTREP) and Switzerland (PRS), technical committees evaluate the recyclability of plastic packaging (PET bottles only in Switzerland). While these judgements are advisory both in France and Switzerland, a positive evaluation will facilitate the marketing of the product.

b) Satisfy Societal Expectation

Societal pressure continues to build for companies to become more sustainable and therefore lower their resource use and environmental impact. Adoption of eco-design principles will help reduce the risk of further regulatory intervention impacting on the products being produced.

Enabling the sustainable recovery of packaging waste is seen as an important contributor towards maximising resource efficiency and minimising environmental impact. Although recovery includes a variety of legitimate and legally allowed processes (e.g. mechanical recycling, energy recovery, composting, etc.), at present society still places a high priority on mechanical recycling over the others; in the case of bottles and a range of commonly recycled plastic items this is likely to remain the position for some time in the future.

Appendix 4

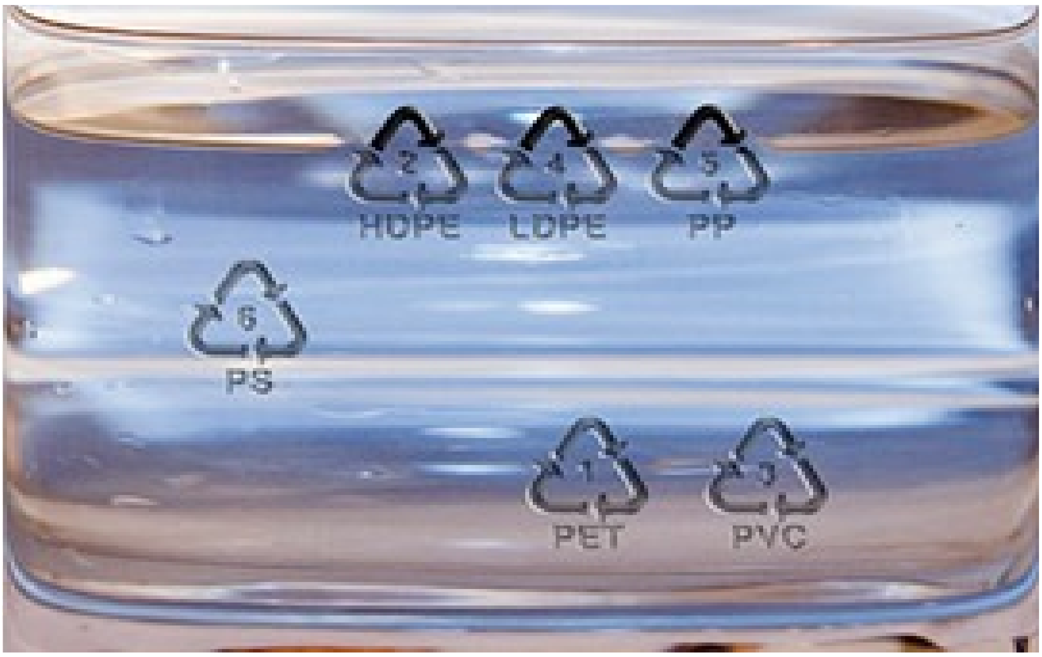
The table below shows the density ranges of plastics commonly used to make plastic packaging and components.

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/cm^3 is required to ensure that the material will either sink or float in a sink/float tank



Appendix 5

Process to Generate Document

For the formation of this document, a program of engagement with experts, supporters and key industry associations was undertaken to obtain broad acceptance for the document, and more specifically for the recyclability tables. Contacts included Recoup members and other industry contacts from both the recycling industry and the packaging industry.

RECOUP are extremely grateful to the following companies for their help and advice in the formation of the recyclability tables:

Contributors to Recyclability Tables

BSDA Technical Packaging Committee
Boomerang Plastics
Closed Loop
GSK
Peter Behrendt Consultancy
Regain Polymers
RPC
SITA
Solocup
Viridor

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
HCl	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)
SPI	Society of plastics industry
6EAP	European Union sixth environmental action program

Useful Organisations

These organisations encourage the concept of appropriate design for recyclability in the broader context of designing for minimum environmental impact of the packaging system. As such they encourage designers and specifiers of plastic packaging to build the considerations identified in this document into their packaging design process.

The European PET Bottle Platform

ABC
Alliance for plastic Beverage Containers Sustainability

Boulevard Louis Schmidt 119 - box 2
B-1040 Brussels
Belgium

(t)+32 2 559 26 67
(f)+32 2 559 22 96
vandongen@eur.ko.com

EPRO
European Association of Plastic Recycling & Recovery Organisations

Rue de Commerce 31/Handelsstraat 31
B-1000 Brussels
Belgium

(t)+32 2 238 97 81
(f)+32 2 238 99 98
epro@epro-plasticsrecycling.org

Petcore
PET Containers Recycling Europe

Ave E van Nieuwenhuyse 4
1160 Brussels
Belgium

(f)+32 2 675 39 35
petcore@btconnect.com
www.petcore.org

Plastic Recyclers Europe

Avenue de Cortenbergh 71
Brussel 1000
Belgium

Tel: +32 2 742 96 82
Fax: +32 2 732 63 12
info@plasticsrecyclers.eu
www.plasticsrecyclers.eu

epbp@epbp.org
http://www.epbp.org/

COTREP

Chambre Syndicale des Emballages en Matiere Plastique

5, Rue de Chazelles
75017 Paris

(t)+33 (0)1 46 22 33 66
(t)+33 (0)1 46 22 02 35
infos@packplast.org
www.packplast.org

Eco Emballages

44 Avenue Georges Pompidou
92300 Levallois-Perret

(t)+33 (0)1 40 89 99 99
(f)+33 (0)1 40 89 99 88
infos@packplast.org
www.ecoemballages.fr

Valorplast

14 Rue de la Republique
92800 Puteaux

(t)+33 (0)1 46 53 10 95
(f)+33 (0)1 46 53 10 90
infos@packplast.org

Useful Organisations

EuPC
European Plastic Converters

Avenue de Cortenburgh , 66
P.O. Box 4
1000 Brussels - Belgium

(t)+32 2 732 41 24
(f)+32 2 732 42 18
info@eupc.org
www.plasticsconverters.eu

Plastics Recyclers Europes

Avenue de Cortenbergh 71
Brussel 1000
Belgium

Tel: +32 2 742 96 82
Fax: +32 2 732 63 12
info@plasticsrecyclers.eu
www.plasticsrecyclers.eu

APR
Association of Post Consumer Plastic Recyclers

1001 G Street NW, Suite 500
Washington, DC 20001

(t)+1 202 316 3046
info@plastics recycling.org
www.plasticsrecycling.org

EPRO
European Association of Plastics Recycling and Recovery Organisations

Rue de Commerce
31/Handelsstraat 31
B-1000 BRUXELLES / B-1000
BRUSSEL

(t)+32 (0) 2 456 84 49
(f)+32 (0) 2 456 83 39
epro@epro-plasticsrecycling.org

NAPCOR
National Association for PET Container Resources

PO Box 1327
Sonoma, CA 95476

(t)+1 707-996-4207

Recoup
RECycling Of Used Plastics Ltd

1 Metro Centre, Welbeck Way,
Woodston, Peterborough, PE2 7UH (UK)

(t)+44 (0)1733 390021
(f)+44 (0)1733 390031
enquiry@recoup.org
www.recoup.org

BSDA
British Soft Drinks Association

20-22 Stukeley Street
London WC2B 5LR

(t)+44 (0) 20 7430 0356
(f)+44 (0) 20 7831 6014
bsda@britishsoftdrinks.com
www.britishsoftdrinks.com

PACSA
Packaging Council of South Africa

PO Box 131400
Bryanstan 2021
South Africa

(t)+27 11 463 9909
(f)+27 11 463 9587
pacsa@mweb.co.za
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Recoup gratefully acknowledge the help of the following in the production of this document;

Boomerang Plastics

Enval

RPC

Linpac Packaging

Closed Loop Recycling

Renmar

Nampak Plastics

Morrisons

Measom Freer

Milliken

Does Your Pack Have What It Takes?

Want to run packaging recycling trials to test whether your current or future packs actually make it through existing systems? RECOUP can complete comprehensive, independent and confidential packaging recycling testing activities.

Just because a consumer has put your plastic pack into a recycling bin, this is not a guarantee that it will actually be recycled.

There are a number of collection, sorting and reprocessing techniques in the UK that can turn waste plastic packaging from the consumer into a recycled end product. We can help you understand these systems by running your packs through these processes and analysing the flows of material.

Trials are regularly conducted at a range of recyclables handling facilities that operate with different sorting methods and equipment. The opportunity to then recycle the resulting plastic is also dependent on a range of reprocessing parameters.

- Better insight into your pack recyclability performance.
- Test new innovations or pack designs for recyclability before market introduction.
- Independent RECOUP certification of pack recyclability to support sales.
- Helping to realise producer responsibility for your organisation.

RECOUP have helped a range of members and other clients to better understand the real recyclability of their packaging through practical trials, and explore opportunities to change processes or the packs themselves to improve recycling credentials. In some cases this has included bespoke system solution development where existing systems cannot process the packs effectively.

RECOUP

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