RECYCLABILITY BY DESIGN

CORE PRINCIPLES FOR PLASTIC PACKAGING RECYCLABILITY

A Summary of Recyclability by Design 2024

BPF British Plastics Federation RECOUP

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EXECUTIVE SUMMARY

This document shows how designers and manufacturers can maximise the recyclability of plastic packaging products. It provides detailed guidance for a variety of polymers, with tables summarising best practice for the main component of the packaging, as well as other components such as lids and labels. Readers are encouraged to engage with the detailed advice contained within this report but below we provide five simple guidelines as a summary to bear in mind when designing plastic packaging products.

Use same material

Use mono-materials or mixed materials of the same type wherever possible. If different materials have to be used they should be different densities.

Minimise colour

Non-pigmented plastic is preferred. If colour is necessary, avoid strong colours as much as possible.

Easily separable closures

These should be easy to detach, should leave no attachments once removed and ideally be recyclable themselves.

Avoid full sleeves

If a sleeve must be used, it should be easily removable and there should be clear instructions explaining how to detach it.

Small, easily removable labels

Adhesives should be used sparingly and labels should cover no more than 60% of the product's surface area, as well as being easy to remove.

The 2024 RBD summary has been researched and compiled by Paul East, Head of Packaging Recycling & Design, RECOUP

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.

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.

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.

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

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.

Use of Recycled Material

Specifying recycled material, where possible, has obvious benefits in terms of protecting the future market for recycled products. Use of recycled plastics for packaging is one of a number of potential uses.

The advice is to ask your packaging supplier to include recycled content where possible. This will help ensure a healthy market for recycled plastic in the future.

GENERAL GUIDELINES

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 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.

General Principles for Container / Components

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

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

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

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 plastic items containing carbon black pigment.

The amount of colour to be used should be minimised as much as possible within the constraints set by technical considerations, branding and consumer acceptance. Where use of colour is necessary, designers are encouraged to consider alternative approaches that will further facilitate recyclability. Sometimes using colour may offer other benefits, for example, packaging manufacturers use scrap produced from a mixture of colours by adding black pigment and recycling into black plastic. This also enables a high level of recycled content.

Closures / Closure Liners / Seals

Readily separable attachments allow reprocessors to remove associated contaminants such as pigments, inks and residual adhesives, hereby raising the quality of the recyclate. This is particularly significant when the primary packaging polymer is colourless or 'natural'.

When the primary packaging polymer is pigmented, e.g. coloured HDPE, the reprocessor specification is less sensitive to low levels of ink contamination and in this case the polymer type of the label, cap and other attachments should be matched to that of the container.

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

Full Sleeves

Where a removable sleeve is used on a bottle, instruction to remove the sleeve should be included on the labelling text. If a full sleeve was to be left on, there is a risk that the bottle may not be correctly recognised by modern automated Near Infrared (NIR) sorting equipment, in which case the bottle could be either misread, or at worst possibly rejected and sent to landfill.

In the case of sleeves which are the same polymer as the bottle, full sleeves may also cause issues due to quality of the recyclate. Even if identified correctly, the material produced may be contaminated, or the quality loosened, if the sleeve does not easily separate from the bottle in the reprocessing stage.

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.

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.

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.

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

Material / Material Combinations

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

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

Other types of PET that share the same material identifier may cause problems in separation and conventional recycling. Use of PLA (a biodegradable material) with PET should be avoided as the polymers are incompatible and not readily separable (both have a density > 1g/cm3).

The presence of very low levels of PLA in PET causes haze and a deterioration of physical properties with the recycled PET. In addition, PLA causes processability problems in the drier as it melts at the drier temperature.

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.

Barriers / Coatings

New PET bottles incorporating additives or barrier materials to further improve barrier performance are continuously being developed and will at some time challenge existing recovery schemes. Non-PET multilayers or coatings are not always fully compatible with current recovering technologies. EVOH barriers in particular have a history of causing significant issues during recycling including haze and colour issues at low levels and deterioration of mechanical properties at high residual levels.

Product manufacturers and their suppliers would need to ensure that levels employed are minimised and that data to show that the proposed packaging provides a recyclate that satisfies all technical requirements (especially discolouration and haze) and that recyclers in general can achieve the separation efficiencies required.

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.

Closures / Closure Lines

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

Conventional silicone seals (density >= 1 g/cm3) are neither compatible with PET or easily separable and therefore should not be used in combination with PET.

Labelling

Polypropylene and polyethylene are the preferred label materials. Foil, lacquered and coated labels become contaminants and are undesirable. While PS sleeves 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. < 1g / cm3) such as a foam. Presently all direct printing and decoration contaminates recovered PET in conventional reclamation systems and discolours the base material.

Colour and printing therefore (other than date coding) should be confined to labels.

		COMPATIBLE for recycling for most applications	MAY BE SUITABLE for recycling for some applications	NOT SUITABLE for recycling
BODY	**COLOUR**	Clear / Light-blue / light tints	Dark blue / dark green / brown / strong tints	Opaque / solid colours Carbon Black
	BARRIER / COATINGS	Clear plasma coating	External coating / PA - 3 layers	EVOH / PA monolayer blends
	ADDITIVES		UV stabilisers / AA blockers	Nanocomposites
CLOSURE	**CAPS**	PP HDPE LDPE - Europe only		Steel / Aluminium / Silicone (density >= 1g/cm3)
	SEALS	PE / PP	Silicone (density < 1g/cm3)	PVC / Aluminium / Silicone (density > = 1g/cm3)
DECORATION	**DIRECT PRINTING**	None / Embossed / laser printing (minimal)	Minimal direct printing e.g. production or expiry date	Steel / Aluminium / Silicone (density >= 1g/cm3)
	LABELS	HDPE / LDPE / PP /OPP less than 60% coverage on face	Paper over 60% coverage on face	PET / PVC / Metallised
	SLEEVES (INCL. TAMPER RESISTANT)	PE / PP / OPP / EPS (density <1g / cm3) Foamed PET / Foamed PET-G		PET PVC / Full body sleeves PS (density > 1g/cm3 / PET-G)
	ADHESIVE	Removable Water releasable in 60–80°C		Not removable in water
	INK	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye-wash solution
OTHER	**TRIGGER SPRAYS**	PP / HDPE / LDPE		Glass components Metal springs / ball bearings

		COMPATIBLE for recycling for most applications	MAY BE SUITABLE for recycling for some applications	NOT SUITABLE for recycling
BODY	**COLOUR**	Clear/Uncoloured	NIR Detectable	Non-NIR detectable colours, e.g. containing carbon black*
	BARRIER/ COATINGS	None		PE seal layer EVOH PA (Nylon)
	ADDITIVES	Minimal silicone surface coating (de-nest)*	O2 scavengers / UV stabilisers / AA blockers / Anti-block	
CLOSURE	**LIDDING FILM**	Easily removed by end user or easily removed early in the recycling process; or; as main polymer (PET)	Removed later in the recycling process (washing process)	
DECORATION	**DIRECT PRINTING**	None / Embossed / laser printing (minimal)	Minimal direct printing, e.g. production or expiry date Printing inks that do not lead to NIAS after the washing process	Extensive colour printing with printing inks that result in NIAS
	LABELS	HDPE / LDPE / PP / OPP Less than 60% coverage on face Labels that are removed in or before the wash step*	Paper over 60% coverage on face In Mould label	PET PVC Metalised Labels that cannot be removed Labels that result in detection error
	ADHESIVE	Removable Water releasable in 60–80°C		Not removable in water
	INK	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye wash-solution
OTHER	**INSERTS**	Must be fully removable without leaving a trace*	HDPE / LDPE / PP / PET / paper	PVC / PS / EPS / PU / PA (Nylon) PC (Polycarbonate) / PMMA (Acrylic) Thermoset plastics / Metallic

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

Rigid PET packaging represents a significant fraction by weight of the domestic plastic waste stream. One particular difficulty is the widespread use of PET/PE multi-layers (e.g. in the processed meat sector). As already indicated, use of mono-materials or mixed materials of the same type are the materials of choice from a recycler's point of view. Hence the current efforts by some producers to switch from PET/PE blends to monolayer PET for trays should further facilitate the recycling of this 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.

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 > 1g / 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

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.

When designing packaging, it is recommended that PP levels are restricted to a maximum of 5% to avoid potential end use issues. Higher levels may be possible but this would require the difficult task of investigating the likely effects on the total mix during recycling.

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.

		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 / Heavy colours	Carbon Black
	BARRIER / COATINGS	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 / Thermosets
	LINER	HDPE / LDPE / PE+EVA / PP		PS / PVC / EVA with aluminium
	SEALS	PE / PP / OPP	Aluminium	PVC / Silicone
DECORATION	**DIRECT PRINTING**	Minimal or moderate direct printing, e.g. production or expiry date laser printing (minimal)	Excessive direct printing	
	LABELS	HDPE / MDPE / LDPE / LLDPE / PP / OPP Less than 60% coverage on face	Paper over 60% coverage on face In Mould label	PVC / Aluminium / MetallisedPET / PS
	SLEEVES (INCL. TAMPER RESISTANT)	PE / PP		PVC / PS
	ADHESIVE	Water releasable in ambient conditions	Water soluble up to 80°C	Not removable in water
	INK	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye-wash solution
OTHER	**TRIGGER SPRAYS**	PP / HDPE / LDPE		Glass components Metal springs / ball bearings

General

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

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.

Barriers

Current PP recycling systems can tolerate the use of EVOH layers.

Material Combinations

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

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.

		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	Opaque / Heavy colours	Carbon Black
	BARRIER / COATINGS	EVOH	PA (incl.MXD6)	PVDC
	ADDITIVES		Clarifier	
CLOSURE	**CAPS**	HDPE / LDPE / PP		Steel / Aluminium / PS / PVC / Thermosets
	LIDDING FILM	No residue after removal by consumer; or; as main polymer (PP)		PS / PVC / EVA with aluminium
DECORATION	**DIRECT PRINTING**	Minimal or moderate direct printing, e.g. production or expiry date laser printing (minimal)	Excessive direct printing	
	LABELS	HDPE / MDPE / LDPE / LLDPE / PP / OPP Less than 60% coverage on face	Paper over 60% coverage on face In Mould label	PVC / Metallised PET
	SLEEVES (INCL. TAMPER RESISTANT)	PE / PP		PVC / PS
	ADHESIVE	Water releasable in ambient conditions	Water soluble up to 80°C	Not removable in water
	INK	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye-wash solution
OTHER	**INSERTS**	PP	HDPE / LDPE	PVC / PS / EPS / PU / PA (Nylon) PET (Heavy) PC (Polycarbonate) / PMMA (Acrylic) Thermoset plastics / Metallic
	TRIGGER SPRAYS	PP / HDPE / LDPE	Paper PET (light)	Glass components Metal springs / ball bearings

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.

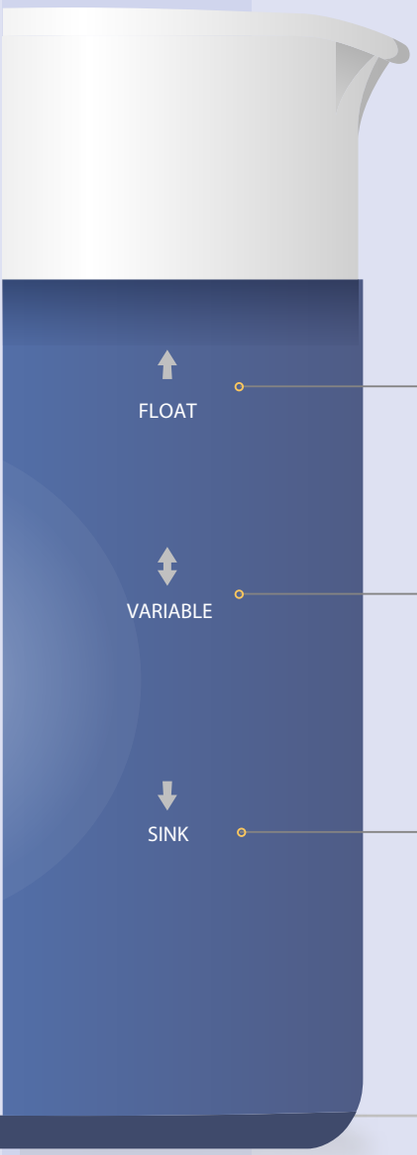
		COMPATIBLE for recycling for most applications	MAY BE SUITABLE for recycling for some applications	NOT SUITABLE for recycling
CONTAINER				Multi-layer material (unless based on PS with polymers or the same type in limited quantities)
	COLOUR	Clear / natural, or lightly tinted	Heavy colours	Opaque / solid colours Carbon Black
LID	**LIDDING FILM**	No residue after removal by consumer Lightweight; PS PS with PE insert PS with EVA insert OPS	Lightweight Aluminium foil PE PP	Heavyweight Aluminium foil PET / Heavy paper PET / PS
DECORATION	**DIRECT PRINTING**	Minimal or moderate direct printing, e.g. production or expiry date laser printing (minimal)	Excessive direct printing	
	LABELS	HDPE / MDPE / LDPE / LLDPE / PP / OPP Less than 60% coverage on face	Paper over 60% coverage on face In Mould label	PET / PVC / Metallised
	ADHESIVE	Water releasable in ambient conditions	Water soluble up to 80°C	Not removable in water
	INK	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye-wash solution

Polymer Density

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

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

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



POLYMER	DENSITY g/cm^3
ETHYLENE VINYL ACETATE (EVA)	LESS DENSE THAN WATER
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
NYLON (PA)	1.13 — 1.14
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 verlaps of polymer densities.

This work has been published by RECOUP and the British Plastics Federation (BPF) in consultation with experts in the plastic packaging industry, recycling industry and members of the BPF and RECOUP.

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 contact RECOUP 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 and the BPF can accept no responsibility of liability for any errors or omissions. Opinions expressed by external contributors may not reflect the positions of RECOUP or the BPF.

Recommendations provided herein are offered for the purpose of guidance only and should not be considered legal advice.

The 2024 RBD summary has been researched and compiled by Paul East, Head of Packaging Recycling & Design, RECOUP in consultation with the BPF.

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 a registered charity, 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.

British Plastics Federation

For over 80 years the British Plastics Federation (BPF) has been the leading voice for the UK plastics industry. The BPF represents almost 600 member sites from across the plastics industry supply chain, including polymer producers and suppliers, additive manufacturers, plastics processors, recyclers, services providers, end users and machinery manufacturers.

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