RECOUP

RECycling Of Used Plastics Limited

Plastic Packaging

Recyclability By Design

Updated polymer specific tables

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

General Guidelines

General Guidelines

Introduction

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

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

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

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

Following the recommendations provided in these guidelines should avoid the necessity to evaluate component compatibility. However, if use of non-recommended material combinations is desired, then the user may arrange for more definitive compatibility evaluation tests to be carried out. 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 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.

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

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

Residues

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

For example:

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

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

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

Composite Materials / Barrier Layers

Where a composite material is necessary to provide the requisite properties (e.g. provide a barrier function) and cannot be designed in such a way that the different types of materials can be separated mechanically or are compatible with the recycling stream, consideration should be given to the use of thin layers (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 currently recycled. In mainland Europe, at present energy recovery is the optimum treatment route for such materials. In the UK, there are alternatives, such as the system developed by Enval for laminates which include an aluminum layer. The Enval system will segregate any constituent aluminum for recycling. Details of this system are outlined on page 64.

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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 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, 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.

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 intended to be 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 correctly recognised 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 hot melts 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 only a few points are optimum.

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

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

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

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.

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

PET

HDPE

PVC

LDPE

PP

PS

OTHER

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

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 2) 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

General guidelines 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
- MAY BE 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 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.

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 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 affect the quality of this stream.

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

Material Specific Guidelines - PET

Labelling

Polypropylene and polyethylene are the preferred label materials. Foil, lacquered and coated labels become contaminants and are undesirable. While PS sleeves re 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 / 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 / PS / PVC / Thermosets
	Seals	PE / PP	Silicone (density <1 g/cm³)	PVC / Aluminium / Silicone (density > ~1 g/cm³)
DECORATION	Direct Printing	None / Embossed / laser printing (minimal)	Minimal direct printing, e.g. production or expiry date	
	Labels	HDPE / LDPE / PP / OPP less than 60% coverage on face	PET paper over 60% coverage on face	PVC Metalised
	Sleeves (incl. tamper resistance)	PE / PP / OPP / EPS (density <1 g/cm³) Foamed PET / Foamed PET-G	PET	PVC / Full body sleeves PS (density > 1 g/cm³) / PET-G
	Adhesive	removeable water soluble in 60 - 80oC		not removable in water
	Ink	EuPIA good manufacturing practices (for non food applications)		Inks that bleed and dye wash-solution
OTHER	trigger sprays	PP / HDPE / LDPE		Glass components Metal springs / ball bearings

Material Specific Guidelines - PET

Material Guidelines - PET Trays

		COMPATIBLE for recycling 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	None		PE Barrier Layer EVOH
	Additives	Minimal silicone surface coating (de-nest)	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	None / Embossed / laser printing (minimal)	Minimal direct printing, e.g. production or expiry date	
	Labels	HDPE / LDPE / PP / OPP less than 60% coverage on face	PET paper over 60% coverage on face In Mould label	PVC Metalised
	Adhesive	removeable water soluble in 60 - 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	Carbon Black
			Opaque / Heavy colours	
	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 /
				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	Excessive direct printing	
		laser printing (minimal)		
	Labels	HDPE / MDPE / LDPE / LLDPE	Paper	PVC / Aluminum / Metallised
		PP / OPP / PS (US only)	over 60% coverage on face	PET / PS (except US)
		less than 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

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 laser printing (minimal)	Excessive direct printing	
	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	Opaque / Heavy 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	paper over 60% coverage on face In Mould label	PVC / Metallised PET / PS (except US)
	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

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 Aluminium foil	Heavyweight Aluminium foil
		Lightweight ;	PE	PET / Heavy paper
		Metallised OPET	PP	PET / PS
		Metallised OPP		
		PBT / 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

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.

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. 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 in the corresponding polymer table 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 Trays

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