



Design for Recycling

for packaging and paper
in South Africa

Document prepared by the Recovery Action Group – a division
of the [Packaging Council of South Africa](#)
Issued March 2014

How to use this document...

This is a reference book targetted at packaging designers, sustainability managers, line convertors, printers and students. It is thus not designed to be read from cover to cover, unless the reader wants a comprehensive understanding of all the elements of design for recycling.

Generally the first choice the designer makes is what material is to be used for the primary container or product - i.e. should it be glass, paper, metal or plastic and if the latter, what polymer type.

Once this has been decided please go to the index and click on the guideline table for the container or product you have selected (e.g. PET bottle or PE-HD tray.) This will take you to a chart which will define what combinations of labels etc. will work with your material of choice to optimise recycling.

The tables have a number of cross references identified by being underlined, and if you wish to get more information, simply click on the highlighted areas within the tables and you will be taken to the relevant explanation.

In the case of aluminium, the impact of inks, labels, caps etc is the same irrespective of the type of primary container or product (e.g. beverage or aerosol can), so to save space we have consolidated them onto one chart. You will need to click on the container or product of choice and then on the chart reflecting the impact on inks etc.

For general information go to the index and click on the subjects you wish to read and you will be taken to that subject.



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Who is PACSA

The Packaging Council of South Africa (PACSA)

PACSA represents the interests of its members, of which the converter section represents some 70% of the turnover of packaging produced in South Africa. Other members include raw material suppliers to the packaging industry, brand owners and other affiliated organizations.

Whilst PACSA acts as the spokes-body for its members the primary focus currently is on packaging and the environment.

The Department of Environmental Affairs formally requested PACSA to develop an Industry Waste Management Plan for the packaging and paper industries (i.e. all packaging from metal paper plastic and glass plus all printing and writing papers). The draft was delivered to DEA in August 2011 for their consideration.

The Recovery Action Group (RAG)

In 2006 PACSA formed RAG, which consists of the Material Organisations representing the paper industry and all the major packaging materials (metal, paper, plastic and glass,) namely:

- **Collect-a-Can**
www.collectacan.co.za
zimasa@collectacan.co.za
- **The Glass Recycling Company**
www.tgrc.co.za
sjhetam@tgrc.co.za
- **Hulamin Limited**
www.hulamin.co.za
colin.little@hulamin.co.za
- **Paper Manufacturers Association of SA**
www.pamsa.co.za
jane.molony@pamsa.co.za
- **Paper Recycling Association of SA**
www.pamsa.co.za
(includes Tetra Pak SA (Pty) Ltd)
ursula.henneberry@pamsa.co.za
- **PETCO**
www.petco.co.za
info@petco.co.za
- **Plastics SA**
www.plasticsa.co.za
douw.steyn@plasticsa.co.za
- **POLYCO**
www.polyco.co.za
mandy@polyco.co.za
- **Polystyrene Packaging Council**
www.polystyrenepackaging.co.za
adri@polystyrenepackaging.co.za
- **Printing SA**
www.pifsa.co.za
lmoralee@printingsa.org
- **SA Plastics Recycling Organisation**
www.sapro.biz
annabe@absamail.co.za
- **SA Vinyls Association**
www.savinyls.co.za
delanie@savinyls.co.za

RAG's objectives are:

- To identify where there are opportunities in the waste streams in SA where the members can , within the framework of the law, work together to improve recycling rates of the various packaging materials
- To engage and communicate with key individuals within the Central and local Government to achieve the following;
 - Highlight the key role that packaging plays in the modern world and how packaging helps in the reduction of waste
 - Inform on the impressive initiatives that are in place in the recycling and recovery of used packaging

It is envisaged that, once the Industry Waste Management Plan is accepted and moves to the implementation phase, RAG will be replaced by an independent and permanent body to lead the implementation.

The information contained in 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. A good starting point would be the material organisations affiliated to RAG.

While every effort has been made to ensure the accuracy of the contents of this publication, PACSA can accept no responsibility or 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 as legal advice.

The contents of this guide are free to copy without modification. Ensure that you are working with the most recent version.

To access the most recent copies go to: pacsa@mweb.co.za

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These guidelines focus on
the design of packaging
to facilitate recycling
and aid the journey to
sustainability
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General Introduction

The objective of this project has been to produce a guidance document that is sufficiently detailed to assist designers in all forms of packaging and paper. It will provide packaging and print designers, in particular, with a better understanding of the environmental implications of their design decisions, thus promoting good environmental practices without unnecessarily restricting choice.

This document has been adapted from the 2009 publication by Recoup in the United Kingdom entitled 'Plastics packaging: recyclability by design.' PACSA has obtained Recoup's permission to do this and has adapted it to include all materials in the packaging and paper industries, not just plastics. The text has also been amended to apply to South African conditions as some European solutions are not relevant to this Country at this time.

The recycling industry has been extensively consulted as our objective is to maximize the value of recycle – the layout will allow designers to understand those combinations that effectively make the recycle either valuable or worthless.

It is the intention to update this document from time to time as the packaging market is characterized by innovation, new markets for used packaging materials, changing regulations and developments in the areas of labels, glues and other packaging components.

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

Climate change and sustainability are two of the biggest issues facing society today. It is therefore increasingly important for companies to reduce their environmental impact 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.

Around the world product stewardship or extended producer responsibility has become the requirement for producers. In short this means that the producer (in the case of all packaging and paper this includes all sectors of the supply chain including retailers and consumers) take joint responsibility to deal with the product and all the waste it creates after its commercial life (cradle to cradle). The Waste Act makes this a legal requirement for all.

The Waste Act was promulgated in South Africa in 2008. It defines the waste hierarchy which is:



The Minister does have the power to declare any waste which may be problematic a priority waste. In this instance the Minister will decide what to do with it. The material could be banned, a minimum recycling level regulated or a deposit enforced on the container etc.

PACSA /RAG were instructed to develop an Industry Waste Management Plan, in accordance with the Act. This is currently under consideration at The Department of Environmental Affairs and the draft can be viewed on the PACSA website www.pacsa.co.za



Gold medal winner
IPSA Goldpack Awards 2013

According to a recent Incpen* study , packaging accounts for 8% on average of the carbon footprint of products consumed at home. From an environmental perspective therefore the packaging should be “fit for purpose” and thus:

1. Protect and preserve the contents so that the end user can safely consume the product in the quantity required. This is to ensure that the 92% energy consumed in the product that has been packaged is not wasted. Clearly any over packaging is a waste of resources but inadequate packaging is a far more serious problem.
2. Attract and inform the consumer. If the product does not move off the shelf then it will be discarded and become waste.
3. The designer needs to have considered what can be done with the packaging after it has completed the functions referred to above. It could be re-used (extensively and effectively applied in the beverage sector in SA. The poorer communities also reuse rigid packaging containers for storage and drinking cups) – recycled or converted into energy, depending on the nature of the packaging and the local solid waste infrastructure or sent to landfill.
4. It is recognised that the recycling of packaging is not always the most environmental or economically sound option and thus the intention is not necessarily to make every piece of packaging recyclable. Equally this document does not attempt to imply in any way which packaging is superior from an environmental perspective. It just helps to design for recycling.
5. Packaging is an essential component of the final product and thus should contribute to an overall reduction in the environmental impact of the total product offering. It should not therefore be considered or measured as a separate entity. For a more comprehensive explanation please refer to an article entitled “Sustainable Packaging – Myth or Reality” which is posted on the PWC website www.pwc.co.uk

* Industry Council for Packaging and Environment (UK Based)

Frequently asked questions



Gold medal winner
IPSA Goldpack Awards 2013



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If you select the green option you can mark your packaging as fully recyclable

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Are there any benefits to me if I follow the guidelines?

The guidelines allow you to maximize the opportunity for your packs to be mechanically recycled in SA and if you select the green option you can mark your packaging as fully recyclable. Accepting these guidelines at the start of the design phase will ensure unnecessary difficulties are avoided and hence unwanted project delays and associated costs prevented.

Why should I follow the guidelines?

Businesses will have to deal with continuously more demanding societal expectations in the way that they operate. Such pressures arise both through environmental non-governmental organisations (NGO's) and increasingly demanding legislation. With the growing awareness of the importance of sustainable development, the environmental impact associated with companies is under ever more scrutiny.

Packaging has a negative perception with consumers and environmentalists. It is perceived to be a waste of resources and a significant contributor

to the growing levels of waste, particularly litter. In both cases the perception is not factual as packaging saves far more than it wastes and in SA accounts for below 6% of general waste to landfill. Volume growth in packaging in SA has consistently been below real GDP growth, helped by significant and continuous reductions in packaging mass

In addition discarded packaging can be visible litter, particularly in the developing world.

Politicians are aware of this with the result that pressure has been and continues to be applied to packaging in the form of legislation worldwide. In addition recycling is seen by many as the most important recovery route and therefore one which 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 minimized and that societal expectations and your company practices are matched in the area of packaging recycling.

Why is recycling important?

There are four main reasons why we should increase our recycling rates of all materials (not just packaging) in SA.

- Recycling creates jobs. The mechanical activity of recycling itself is not a big job creator. Collection of waste and separation into the waste streams is estimated to create employment for some 80 000 people in SA¹. The Industry Plan envisages household separation of waste into recyclables and other and the former will be taken to a material recovery facility (MRF) for further separation and sale to the recyclers. This has the potential to create entrepreneurship and divert workers from landfill to better quality and safer jobs. It is envisaged that this will be achieved through public/private co-operation.
- Products made from recycled material have a considerably lower carbon footprint than those produced from virgin materials. Using paper as an example, recycling extends the pivotal carbon storage role that paper plays.
- Recycling saves scarce resources and enables us to use a raw material that would otherwise be landfilled.
- Recycling extends the lives of landfill.

What are you asking me to do?

For existing 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 soon as possible, as the opportunity arises.

For new packaging, you are asked to integrate these guidelines into the design process at the start, to minimize costs and maximize the opportunity for compliance

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 factors are only considered at the end of the design process, then any changes necessary are likely to be costly in terms of both money and project delays. In short it may cost if you don't.

Is there a limit to recycling?

Some believe the solution is to regulate a high recycled content into packaging.

This is neither practical nor possible. There are practical limits to recycling in most packaging materials and we quote a few examples:

- Paper fibre deteriorates each time it is recycled, the realistic life is 5-7 cycles. Virgin fibre injection is then critical. Some paper packaging such as cement sacks require only virgin fibre to provide the necessary strength.
- Recycled polymers also lose properties each time they are recycled.
- Glass can be infinitely recycled. However the colour of the glass is an inhibiting factor as for example coloured cullet cannot be used for flint or clear bottles.
- Metals are also infinitely recyclable. The beverage can, currently made of steel body and aluminium end, has a recycling rate of over 70% but little of this is used to produce new beverage cans for technical reasons. The all aluminium beverage can which is being introduced will be replaced back into new cans, amongst other applications.
- The ideal is thus to optimise the recycled content in a package and then actively support the development of other products for the used packaging where this makes sense.

A good example of this is the wheelbarrow made from recycled plastics which won the PACSA Award at the 2012 SAPRO Best Recycled Product Competition:



Figure 1: Winner of the 2012 PACSA Trophy

What is extended producer responsibility?

Around the world product stewardship or extended producer responsibility has become the requirement for producers.

Product stewardship or extended producer responsibility is an environmental management strategy that means whoever designs, produces, sells or uses a product (including consumers) takes responsibility for minimising the product's environment impact through all stages of the product life cycle.

The greatest responsibility lies with whoever has the most ability to affect the life cycle environmental impacts of the products.

Where can I get more information?

These guidelines provide a good point of entry. This document consolidates and develops information from Europe and America but adapted to South African conditions to provide a simple but comprehensive guide to packaging design best practice for recycling. Any specifier following these guidelines can be reassured that their packaging should not cause recycling issues in SA. This document will be periodically updated and readers can access the most updated version at the PACSA website www.pacsa.co.za

In the chapters that cover each material stream there is reference to the Material Organisation in the recycling industry that provided the information and this is the recommended first departure point.

How much is being recycled in South Africa?

In 2012, 3,68 million tonnes of one way and returnable packaging and paper was placed on the market including returnable packaging injected for the first time (Source BMI Research) . This includes all paper, plastic, metal and glass packaging as well as printing and writing papers (newspapers, offices papers, mail etc.) in terms of the requirements of

DEA. In that year we recycled 1,86 million tonnes or 50.5% of the above, as a result of the many voluntary, industry driven recycling initiatives in SA.

The recycling rates per main raw material stream were:

Glass	39%
Metal	65% (beverage cans 72%)
Paper	60%
Plastics	34% (PET beverage containers 42%)

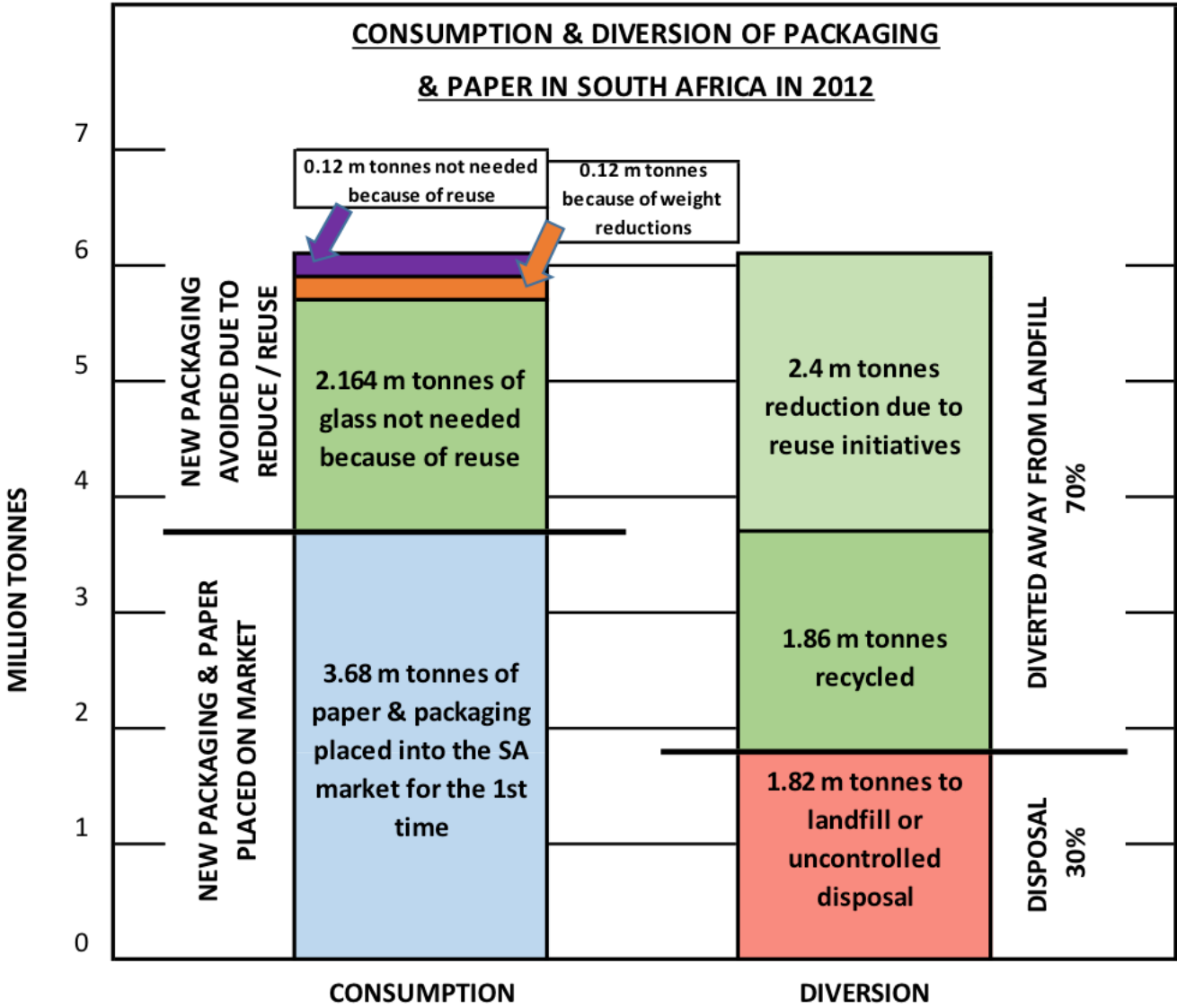
However an equally relevant statistic is how much packaging and paper was diverted from landfill in that year as this includes all the elements of the waste hierarchy. We have a large and important returnable and refillable container sector in South

Africa, notably in beverages and if the impacts of this and the continued efforts to reduce packaging mass are factored in, the overall diversion from landfill was 70% as per the chart below:

Our estimate of 120 000 tonnes saved in 2011 through reduction initiatives is very conservative

The Industry Waste Management Plan will require further growth in recycling and to achieve this we need to improve collection of post- consumer packaging and paper to ensure that there is more uncontaminated recyclable material delivered to the recycling industry. It is also important that markets are developed to deal with the extra recycle collected.

In this scenario it is imperative that designers include, wherever possible, packaging combinations (bottle/label etc) that are compatible from a recycling perspective.





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The design of packaging
is a complex process and
is often a key element of
product change
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General guidelines for packaging in all materials

Introduction

The guidelines have been compiled to help maximize the opportunity for packaging and paper to be mechanically recycled without unnecessarily restricting material choice and to help maximize the value of the post-use material.

It is recognised that in certain instances it is desirable to use multilayer materials for barrier properties etc. Many of these are currently not recyclable. It is important that the efforts of the Multilayer forum are continued to develop markets for this used packaging.

The information contained within the guidelines implies no criticism of any raw material and merely seeks to point out that certain combinations should be avoided to maximize the recyclability of the packaging in question. Matrices summarizing material compatibilities are provided within each material specific guideline in section four.

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.

General principles for container/components

In an ideal world, use of mono materials or mixed materials of the same type is 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 material being recycled and can be sorted and processed as if they were a single material.

It is recognised that to provide both the technical properties needed and to satisfy user needs, sometimes a combination of different types of material is required. The impact on these on the recycling of the primary material will be covered in section four.

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.

Product residues

There is considerably more food waste than packaging waste. In South Africa the CSIR has estimated (February 2013) that over 10 million tonnes of waste is generated in the food chain or about 30% of local agricultural production at a cost to society of R61,5 billion per annum. At the same time 70% of poor urban households in SA live in conditions of food insecurity.

Part of this is product residue in discarded packs which are both an unnecessary waste and a contaminant for the recycler and should be minimised as far as possible.

To help ensure packs are emptied, 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.
- Avoid sharp corners where product residue has a tendency to collect.
- Consider using a pack that can be stood inverted to ease emptying.
- Investigate use of non-stick additives in the pack or product or smooth surfaces to reduce the cling of contents to the container to ease emptying. Such additives should not however affect the ultimate recyclability of the pack.

Composite material/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 recognized that in some cases, lightweight plastic laminates were engineered for specific properties and/or lightweighting. As a result, these may be difficult to recycle. Energy recovery may be the better option.

Colour

Colour impacts on almost all packaging and paper recycling but as the effects differ, the subject will be covered in section four according to each material.

Labels

This subject will be covered in much detail in section four but as a general comment, the use of a label or 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 maximize the value of the recycled material.

Compatibility of the label with the package, from a recycling perspective, is very important and is covered under each material stream.

Other components

There may be requests from retailers for RFID's (Radio Frequency Identification Devices) to be applied to packaging. Whilst these tags offer potential logistics and other benefits, they are in general undesirable from a recycling perspective at present as the adhesives and /or metals can reduce efficiencies and/or contaminate the recycling stream.

Closing the loop

Designers should consider the possibility of including recycled materials in their packaging for both environmental and commercial reasons. The specification of recycled materials in the design of new products supports recycling by providing a market for reprocessed material. Other advantages include a potential cost saving, marketing benefits and reduced environmental impact.



“
Over 10 million tonnes of waste is generated in the food chain
”

Guidelines tables - what do they mean?

The compatibility matrices contained in the material specific guidelines are divided into green, orange and red columns and these are explained below.

Material specific guidelines

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

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

YES | **CONDITIONAL** | **NO**

The meaning of these three columns is as follows:



YES

Generally the materials used in the packaging are compatible with or separable from the main material and is acceptable in industrialised recycling processes in large volumes and the recycle thus has the highest value it can get.

It is collected nationally.

In certain circumstances the authors are aware of new market development. We have included these developments (which will in the next 12 months, result in a material increase in national demand for the recycle) in the green section. If that does not materialise the guidelines will be amended.



CONDITIONAL

Use of material could cause 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.

In this instance the inclusion of the material will reduce the value of the used packaging or paper as further separation processes may be necessary.



NO

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 recycle if present even at low volumes.

It may currently be exported in small quantities.

“
Advantages include
a potential cost saving,
marketing benefits
and reduced
environmental impact
”



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Glass Recycling



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Glass can be recycled infinitely and retains its original characteristics in the process.

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The local Glass Industry has invested some R 245m in highly sophisticated and automated equipment to increase its recycling rate to 40% in 2012 with further investments in the pipeline.

The Recycling Process

Glass can be recycled infinitely and retains its original characteristics in the process. Its performance never degrades and, by recycling glass, savings in energy and carbon emission reductions are achieved in the manufacturing process of new containers.

Waste glass is collected and broken, without further sorting at the collection source, to reduce transport costs and it is delivered in this mixed state to the glass factory cullet processing plants. (Two are in Gauteng and one in Western Cape).

The in-plant separation systems extract contaminants such as metals, labels, ceramics and other foreign matter. The glass is automatically

separated into the three colours –flint (clear), green and amber – as well as a fourth mixed component, which still contains a mix of all three colours. This separated cullet is then taken to storage silos, before being fed into the glass furnaces at pre-determined ratios together with virgin raw materials, where it is melted at temperatures of 1 450 - 1 500 degrees C; any residual flammable material is burned off.

Colour

One of the challenges going forward, when recycling rates exceed 60% will be management of the colour distribution and collection, so that adequate volumes of the correct colour cullet from the reverse supply chains will approximately match regional colour production requirements.

All glass can and should be recycled, however, the cullet returns should ideally be in similar colour proportions to sales and manufacturing requirements, which they would normally be if it were not for the effect of glass exports and imports.

Green is the most flexible and recycling-friendly colour as all the other recycled colours can be used in its production.

Solid Print on Glass

There is no problem recycling bottles with ACL decorating, but colour separation equipment is confused by certain permanent solid labels, which can result in perfect glass being rejected as foreign matter. Giving thought to the size of the label would be helpful; smaller labels equal less wastage. An applied detachable label is preferred and is more recycling friendly. The local industry has moved to lead free inks, so from that point of view, ACL applications are not environmentally harmful.

It is also expected that recyclable separation at source, when enforced, will go a long way to reducing the colour separation system rejections and waste.

Interesting Resources:

www.theglassrecyclingcompany.co.za



“
Green is the most flexible
and recycling-friendly
colour as all other
recycled colours can be
used in its production
”



Labels

Although pressure sensitive labels are enjoying success and growing in market share, PSL labels present a challenge for efficient recycling. This is because they tend to hold the broken glass together which is then rejected by the automatic sorting equipment. This results in high wastage of good recyclable glass. The labels do not present a problem in glass manufacturing as the labels burn off; it is only in the cullet processing where wastage and inefficiency is caused. In an ideal world PSL labels would not stick so aggressively to bottles or would shear or tear with the glass when it is broken. The glass industry together with the label manufacturers are working on solutions to this challenge. Equipment exists to overcome the current issues, but at significant cost.

Metals

Ferrous metals are separated using magnets and do not present a recycling problem. The use of non-ferrous metals for closures and foils can present a problem as they cannot be separated by magnets. However, to this end Eddy Current technology has been implemented, but again at additional cost.

Coatings

Heavily coated bottles complicate recycling because colour separation becomes a problem. These bottles require manual sorting.

Other Glass Types

Finally, in the case of kitchenware, the difference between soda-lime glass (containers) and boro-silicate glass (Pyrex) is not always clear. They are, however, two different products; Boro-silicate glass is not recyclable but it is generally well understood that Pyrex is not recyclable.

Window glass is technically recyclable by glass container manufacturers in a controlled environment, even although it has a different composition to container glass.



Green Guidelines



Orange Guidelines



Red Guidelines

Colour	All colours		
Decoration	Easily detachable/paper labels	100% Coated bottles • solid colours direct print on glass • heavily coated bottles	Heavy metal inks
Closures/Foils	Plastic, paper and metal (including aluminium)	Window glass	Boro-silicate (Pyrex)
Glass	Soda lime glass (bottles)		

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and components](#)



Steel/Tinplate

Since 1993, Collect-a-Can has been at the forefront of minimizing the negative impact of used cans on the environment. As from 2012 the local beverage can manufacturer has started a process of converting all beverage cans from steel to aluminium.

We have subsequently been involved in the recovery of all scrap tinplate generated in the tinplate and can-making processes, including sludge, cut-offs (skeletons), misprints, sub-standard fills, and most importantly the recovery of used metal cans.

The core business of the company is to facilitate the recovery of used beverage cans, although we also recover aerosol, aluminium, food, oil and paint cans, thereby addressing the “cradle-to-cradle” needs of the metal can industry.

While the focus has been on the recovery rate for used beverage cans, the overall metal packaging recovery rate has been estimated at 65% (2012).

The recovery rate for used beverage cans for Southern Africa has grown significantly from a

modest **18% in 1993 to an all - time high of 72% in 2008, dropping slightly to 69% in 2009** because of the economic meltdown. **The Southern African recovery rate for used beverage cans for 2011 is 72%.**

On receipt, cans are crushed into bales at Collect-a-Can's various branches which are then dispatched to steel mills where they are melted to produce “prime” steel. Used metal cans are 100% recyclable and can be recycled over and over without degradation. Collect-a-Can takes care of the conversion of used metal cans into steel briquettes that are used as a separation alloy in cobalt mining processes

Used cans, can be melted on their own or mixed in with other steel scrap. The paint layer on the

outside of the cans burns away and the aluminium on the end of the can contributes to the steel melting process. Aluminium being an exothermic, contributes slightly to energy requirements of the steel making process. Aluminium is an integrated element in the steel making process to produce “clean” steel.

Interesting Resources:

www.collectacan.co.za

A 330ml beverage can weighs 31.5gr and is composed of 93% steel and 7% aluminium. 15% of a new can is made from recycled scrap metal.



“

Used metal cans are 100% recyclable and can be recycled over and over without degradation.

”





[Green Guidelines](#)



[Orange Guidelines](#)



[Red Guidelines](#)

Tinplate scrap handling

While Collect-a-Can's most visible activity is the recovery of used metal cans, its other fields of operation include the recovery of plate scrap used in the manufacturing process of cans.

Collect-a-Can does not itself recycle steel. All cans recovered are sold on the open market to steel mills to produce new prime steel or by adding value by supplying a niche market with briquetted used beverage cans. Briquettes are used as a cheaper alternative to ferrosilicon in the mining industry. The briquetter processes, between 350 and 450 tonnes per month of used beverage cans. The cans are fed into a self-feeding hopper and conveyed to a ring-mill which crushes the cans and conveys this to a storage hopper which in turn feeds it into the feed box of the briquetter.

Steel drums

These are heavy duty containers made of mono materials and they are in great demand after the first trip either for re-use with the original product, or as a container for storage of other liquids or Solids for recycling.

A number of applications of these drums are to contain hazardous liquids and thus these drums need to be cleaned under a controlled operation before they can safely be reconditioned and used again.

For further information on how to recondition please contact SAICR (SA Industrial Container Reconditioners Associations).

Steel Beverage cans	All types		
Steel Food Cans	All types		
Steel Aerosol Cans		Must be punched or ensure that cans are empty as the propellants are inflammable. Printable instructions to the consumer on the aerosol would be a great help.	
Steel Paint Cans	Yes		
Steel Oil Cans	Yes - through the Rose Foundation		
Steel Drums	Yes dependent on content		

Aluminium

Aluminium may be recycled indefinitely without degrading its inherent quality.

The Process

There are two methods used to produce aluminium:

- Primary production, in which an aluminium oxide compound called alumina is extracted from ore (bauxite) and then smelted and alloyed into a useable aluminium primary alloy.
- Secondary production in which collected aluminium scrap is melted and alloyed. If the scrap is segregated properly and the alloying done correctly, then there is no difference whatsoever between the aluminium ingot produced by primary or secondary (from scrap) production.

Aluminium recycling plants are designed to be able to use the energy in inks and lacquers and to process any residue in an environmentally safe manner. Plastics and paper in small amounts

also generate energy for use in the melting and decorating process and so can be tolerated in small quantities.

As the South African economy grows so does the amount of aluminium “end of life” scrap increase and become available for secondary production.

The properties of aluminium are tailored to different applications by alloying it with elements such as copper, zinc, manganese, silicon, and magnesium. Because different applications require different performance characteristics, there are a variety of aluminium alloys that each have a unique combination of material properties such as strength, ductility, and formability

In packaging applications there are three types of alloys that are most commonly used: the 3000-series, 5000-series, and 1000-series. The 3000-series alloy, of which aluminium beverage

can bodies are constructed, is the most common alloy type in recycled aluminium packaging. Manganese is the primary alloying element in the 3000-series alloy.

The second most common alloy in packaging, the 5000-series alloy, contains magnesium for hardness and is used to make beverage can lids, pull tabs, and other rigid containers. The 1000-series alloy is a high-purity aluminium containing less than 1% total alloying elements. It is used to make aluminium foil packaging applications.

“
The aluminium beverage can is the most recycled item worldwide.
”

Interesting Resources:

www.collectacan.co.za

www.hulamin.co.za





Inks and Lacquers on Aluminium Packaging

Most aluminium containers, and nearly all aluminium beverage containers, are labelled by applying different colours of ink directly to the metal surface. For aluminium beverage containers, inks and lacquers are typically applied to the walls of the container body and then baked on in a furnace. Clear protective lacquers are usually applied to both the inside and the outside of aluminium container.

Inks and lacquers are not problematic in aluminium recycling operations. After a load of collected aluminium scrap arrives at a reprocessing plant, it is shredded and then heated in a furnace to burn off the inks and lacquers. The inks and lacquers will in fact contribute energy to the de-coating process as they burn off. Any coating that does not burn off in the de-lacquering kiln will be separated from the aluminium melt in the melting furnace, where the coating will migrate to a layer of impurities that floats atop the metal. This layer, termed “black dross” once it solidifies, generally does not have any beneficial uses.

Radio Frequency Identification (RFID) Tags

Radio frequency identification tags are affixed to packaging and used for automatic identification and data collection purposes. Similar in purpose to a bar code used to track inventory, a RFID tag consists of layers of paper, plastic (PET), and adhesive sandwiching a metal foil antenna or conductive ink (aluminium, copper, or silver) and may even include a computer chip or battery.

RFID tags should not be problematic in aluminium recycling. The antennae are typically made from aluminium or copper, which are metallurgically compatible with the 3000-series aluminium alloys (the 3000-series aluminium alloy uses copper as an alloying element). Any paper or plastic component of an RFID tag will be thin enough to flash off in the melting furnace.

Beverage Cans

Structurally, they consist of three parts: the bottom and walls, all made from a single piece of 3000-series alloy; the top, made from a punched-out circle of 5000-series alloy; and the pull tab, also made with the 5000-series alloy.

Aluminium beverage cans are highly recyclable and form the basis of the recycling system for aluminium packaging. They are collected in nearly every recycling program. Used Beverage Cans (UBCs) are a major category of aluminium scrap and are reprocessed to create new sheets of the 3000-series alloy used in aluminium beverage can construction. Most other collected aluminium packaging intermingled with a load of UBCs will be included in this reprocessing operation.

As from 2012, the local beverage can manufacturer has started a process of converting steel beverage cans to aluminium.



“Inks and lacquers are not problematic in aluminium recycling operations.”

Bottles

Aluminium bottles are necked containers shaped similarly to glass bottles. They are formed from a single piece of aluminium sheet and use either re-sealable aluminium screw tops, plastic pumps, or pry-off crown closures. These are not currently produced in south Africa

Rigid Containers

An aluminium rigid container consists of a tray with raised walls and a removable lid. For food applications, the lid may be “peel back” style, in which case it will have a pull tab attached that punctures one edge of the lid to initiate its removal. Alternatively, the lid may include a “church key” device that is used in lieu of an attached pull tab. For other applications the container may be given a screw lid or simply a fitted lid. Extensively used for sardines and ham, as examples.

Collapsible Squeeze Tubes

Aluminium collapsible squeeze tubes are not problematic in the aluminium recycling process. They are constructed from a 1000-series alloy, which, due to its high purity, permits the tube to flex and imparts a soft texture. While the 1000-series alloy is fully compatible with the aluminium reprocessing operation, the thin end sections of an aluminium squeeze tube may oxidize too quickly in a furnace and flash off instead of melting. However, the thicker sections near the tube opening probably contribute some of their aluminium to the melt. If an aluminium squeeze tube features a plastic closure, it should be removed before the tube is recycled.



Aerosol Can

Aerosol cans are used to contain and dispense a variety of different liquids, creams, and gases. Aluminium aerosol cans are made using an impact extrusion process to create the can body from a single slug of aluminium. The top of the container is given a wide mouth opening to which the spray valve is affixed. The spray valve is a composite piece consisting of plastic and metal components, and functions to regulate, direct, and dispense the contents. In order to force the contents out of the spray valve, aerosol cans are pressurized with a propellant, which may be one of several available types. There are two general classifications of propellants: hydrocarbon-based propellants such as propane, and compressed gasses such as carbon dioxide. The product may be separated from the propellant by using an inner bag to contain the product, or by placing a piston in between the liquid product and the gaseous propellant.

Aerosol cans are compatible with the aluminium recycling process, although they are not often included in recycling programs because of safety concerns. When aluminium recyclables are compacted and baled at a material recovery facility (MRF), an aerosol can may rupture and allow the propellant to escape and expand rapidly. If a hydrocarbon-based propellant is used, it may ignite during this process. For these reasons, some recycling programs prohibit aerosol cans from collection systems and remove any aerosol cans that are unintentionally collected. Furthermore, some aluminium reprocessors are hesitant to purchase a bale of aluminium scrap that contains aerosol cans, due to the safety concern of a pressurized aerosol can creating an explosion when added to the furnace.

Because most aluminium aerosol cans are used for personal care products that are intended for use near or on a person's face, they usually do not contain flammable hydrocarbon-based propellants.

“
Aerosol cans are often
not included in recycling
programs because of
safety concerns.
”

Most aerosol cans are constructed from a 1000-series alloy and are compatible with the reprocessing operation in which 3000-series aluminium is created. It is very important that the valve and cap are removed from the aerosol can, as they usually contain plastic and steel components that would be problematic in the reprocessing operation.

Screw Tops

Aluminium screw tops create some problems in the aluminium recycling process.

The 5000-series alloy of which they are constructed is very similar to the alloy used in aluminium beverage can tops and pull tabs, so the reprocessing operation is designed to accommodate them. However, due to their small size, loose caps may be screened out of co-mingled recyclables and may never reach the reprocessing plant.

In addition, the plastic insert which aids cap sealing is seldom extracted and this “composite” nature creates problems in the control of the aluminium melting process.

Trays and Foil Containers

Aluminium trays are semi-rigid structures that are made from aluminium sheet by a type of impact extrusion process. They are usually designed for use in conjunction with a lid. They may be constructed for use with a plastic snap-on lid or a metalized piece of rigid paperboard as a lid.

Because aluminium trays are usually made from a 1000-series or 3000-series alloy, they are metallurgically compatible with the aluminium reprocessing operation. However, because they are fairly flat and are susceptible to becoming flattened during the collection process, they are often mistakenly sorted with paper products. Also, depending on the thickness of the tray, an aluminium tray may oxidize and reduce their contribution to a melted batch of recycled aluminium.

Foil Wrappers and Household Foil

Aluminium foil is simply defined as any aluminium sheet that is less than two millimetres thick

Aluminium foil is made from the 1000-series alloy, which is entirely compatible with the reprocessing operation. Nevertheless, aluminium foil is too thin to melt in many furnaces. Because of this, some reprocessors are hesitant to buy bales of collected aluminium containing appreciable amounts of aluminium foil.

Furthermore, because aluminium foil is commonly used in contact with food, it may be rejected from recycling programs on the basis of health concerns. It is recommended that foil is wadded together in a ball of at least two inches before it is collected.

Composite Blister Packs

A composite blister pack consists of a flat thermoformed piece of plastic that contains a number of shallow, single-serving reservoirs, backed by a thin layer of aluminium foil. To dispense a serving, the user pierces the aluminium backing and peels it off, exposing one of the reservoirs.

Metallised Film and Paper

Metallizing is a process in which an extremely thin layer of vaporized aluminium is applied to a substrate (paper or polymer) in a vacuum using either the vacuum or the transfer metallizing process. For vacuum metallised paper, the aluminium is deposited onto paper treated with a thin coat of lacquer, and then sealed with a top coat of primer.

Metallizing may also be applied on plastic film (oriented polypropylene [OPP] or polyester) to create metallised films. Metallised films may commonly be referred to as met-poly film or OPP metallised film. Because the addition of aluminium to the polymer layer in these metallised films provides both barrier properties and enhanced decorative options, metallised films are frequently combined with paper packaging to form a laminate package. Multiple sandwiched layers of polymer film and aluminium are used in chocolate and sweet wrappers.



Guideline Table for Aluminium



[Green Guidelines](#)



[Orange Guidelines](#)



[Red Guidelines](#)

Beverage can	World's most recycled packaging		
Bottle	As for beverage can	Closures should be removable and removed prior to recycling	
Rigid container (sardine type)	Recycles well even when mingled with beverage cans		
Collapsible squeeze tubes	Recycles well even when mingled with beverage cans	If a plastic closure is used it should be removed prior to recycling	
Aerosol can		Valve and caps must be removed and containers depressurised – if this is done it as “green” product	
Trays and foil containers	Recycles well		
Foil wrappers and household foil	Recycle well in the heavier grades	Very thin foils provide excellent ‘reduce’ benefits but are not easily recycled	
Composite packaging types using aluminium – multi laminate cartons		Refer to Product supplier as these products can only be recycled with dedicated facilities	
Composite blister packs			The aluminium component cannot be recovered in an aluminium recycling operation
Metalised film and paper			The aluminium component cannot be recovered in an aluminium recycling operation
Plastic beverage cans (aluminium end)			As the plastic is dominant it is sorted as plastic and the aluminium is unlikely to be recycled

Guidance on labels, inks and components



Green Guidelines



Orange Guidelines



Red Guidelines

Inks and Lacquers	No problem – aluminium is de-coated before melting and inks and lacquers contribute their own energy to the process		
Rigid plastic		Beer ‘widgets’, pumps, nozzles, resealable can closures should be used with caution as collection rates drop because of the lower price offered by dealers	
Plastic shrink labels		The plastic will not be recovered – it will add some energy to the recycling process	
Screw top closures	Plain caps when separated fully recyclable		
Wine Bottle Capsules and screw tops	Modern glass recycling deals with these so no problem		Caps with plastic inserts
Peel away closures laminated with paper/plastic			Aluminium component is unlikely to be recovered



Paper

48	General Introduction
50	Process
50	Uses for recovered paper
53	General guidelines
54	Guideline table for newspapers, magazines, envelopes, etc
54	Guideline table for corrugated boxes
54	Guidelines table for other packaging
56	Appendix for paper grade definitions



General introduction

“There aren’t many industries around that can aspire to being genuinely sustainable. The pulp and paper industry is however one of these. It is inherently sustainable”

Johnathan Porrit Chairman 2000-2009 UK Sustainability Development Commission

For more information supporting this remarkable statement from an eminent person in Sustainability, please visit the PAMSA website www.pamsa.co.za.

PAMSA (Paper Manufacturing Association of SA) promotes the interests and efforts of the SA pulp and paper industry and concentrates on three broad areas – forestry paper and paper recycling www.pamsa.co.za

PRASA (Paper Recycling Association of SA) is allied to PAMSA. It seeks to promote a culture of recycling and drives education awareness campaigns aimed at informing the public about the sustainability of paper.

Paper Recycling started in SA way back in 1920 and has consistently reflected a growth trend to over

one Million tonnes per annum as per the chart alongside. In 2012 the recycling rate of paper in SA was 60% of paper that can be recycled.

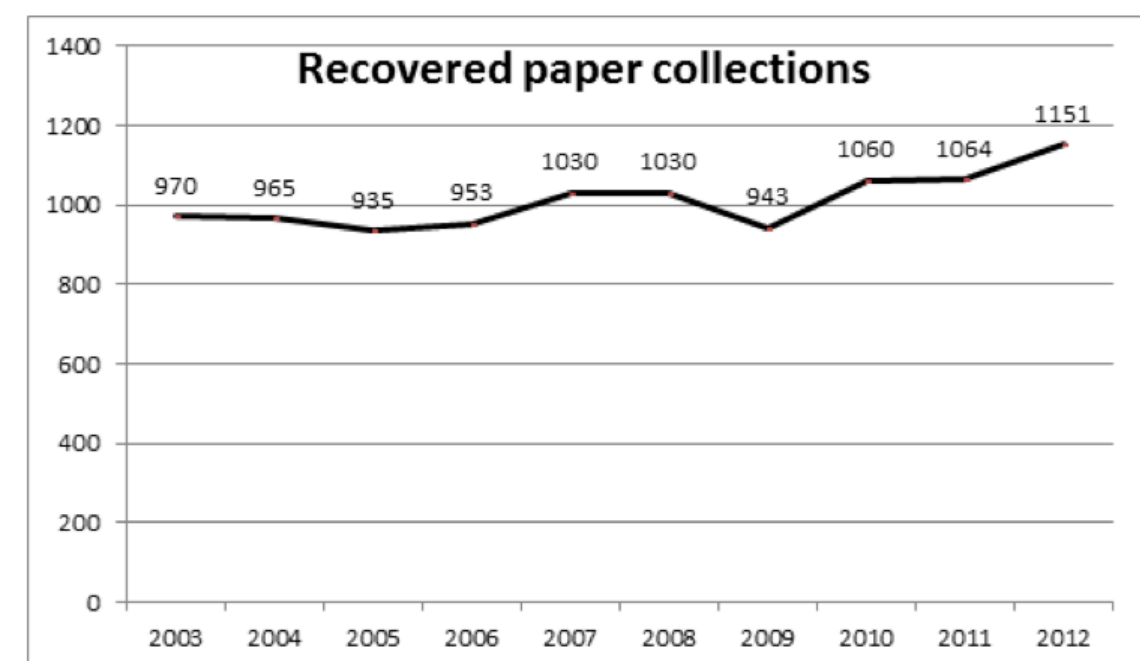
To support this, the paper industry has invested over R600m in infrastructure (excluding paper machines to make waste paper) and annual collection and support costs for recycling of close to R1.5 billion

Interesting Resources:

www.pamsa.co.za

www.prasa.co.za

“
Paper waste is separated into 16 different categories which are listed in the Appendix at the end of this section.
”



The process

All manufactured paper is 100% recyclable, such as:

- white office papers, shredded papers
- magazines, including glossy magazines
- brochures
- newspapers
- corrugated cardboard
- cardboard boxes such as cereal boxes
- liquid board packaging – milk and juice cartons

Paper only becomes non-recyclable when:

- heavy foils are added to it (e.g. gift wrap)
- glues are added e.g. ‘stick-it’ notes
- wax coating, foil linings or laminates are added to boxes
- plastic protective layers are added e.g. cement bags, dog food bags, disposable nappies

Contaminants or more importantly “non-recyclable materials” such as those indicated above can affect the reprocessing of the paper and it is for this reason that ideally paper should be kept free from such materials.

Considerable research is being done in SA to try to deal with some of these materials. Ideally all players within the paper chain including packaging converters and printers, should be mindful of the current constraints.

Uses for recovered paper

Generally, recovered paper is used to make different grades of paper.

Paper waste is separated into 16 different categories which are listed in the [Appendix](#) at the back of this section. This sequence may vary from time to time. To optimise the waste supply chain it is recommended that larger paper users separate the paper into these streams.

The separated waste paper is fed onto conveyors where obvious contaminants (e.g. metals, rubber etc) are removed. The waste paper is then fed into a hydropulper to produce pulp which is then passed through a variety of screens to extract other contaminants before being delivered to the paper machine.

Paper fibre tends to shorten each time it is recycled and after 5 to 7 times this will pass through the sieves. It is possible however, that some recovered paper will be re-processed more than 7 times without any negative impact.



Grades	Recycled Into
Corrugated boxes	New corrugated boxes
Newspapers and magazines	Newspaper
Office paper, newspaper, magazines, printer off-cuts	Bath tissue products, kitchen and industrial paper towelling
Office paper, corrugated boxes, newspaper, carton board trims, printer off-cuts	Carton board – cereal boxes, soap carton
Newspaper, carton board trims	Moulded paper products i.e. egg boxes



Sorted and shredded paper being fed onto conveyor belts



Pulp



Finished product on conveyor





Ink Coverage

For white paper which is largely used for tissue products or blended into fine paper production, the mills have de-inking plants which can deal with a normal amount of ink coverage. As with other contaminants, excessive ink coverage can cause bottlenecks or interruptions in production. Heavily inked papers will be recycled but as a lower grade paper.

Adhesives

The system deals with water-based adhesives without difficulty, but latex/hotmelt adhesives can stick to the cylinders on the paper machines, causing holes in the paper produced. Such contaminants are known as 'stickies'. This is more serious for lightweight papers and tissue.

Some of the paper mills have upgraded their equipment to deal with the adhesives (hotmelt glues) found in spines of magazines but these could be a problem for smaller paper producers.

Wet-strength Additives

Certain papers (eg. potato sacks) contain additives to prevent the paper breaking up in moist conditions. These are not recyclable as the fibres cling together in the hydropulper and are avoided by South African paper mills.

Liquid Board Packaging

Milk, juice and certain food cartons are made up of a combination of paper board, polyethylene and aluminium. In most cases paper board is the dominant component comprising at least 75% of the laminated board packaging. The packaging is being recycled through a hydro pulping process whereby the fibre is separated from the Poly/Al. The fibre is then used to manufacture recycled paper board for various end uses. The Poly/Alu, including the closures and straws, is processed further into various plastic injection moulded products.

Free Film Liners/Wax and other Laminations

These are not recyclable in the normal process and most mills will not buy this material. Tetra Pak, in partnership with Gayatri Paper Mills has started recycling liners and wax materials. Other polylined materials are exported. Extensive research by the various centres of innovation for packaging design (e.g. University of Stellenbosch and UKZN) is continually being done to replace liners and wax with recyclable barrier coatings e.g. banana boxes.



Guideline Table for newspapers, magazines, envelopes, etc

This chart is a guide only as specifications of acceptability do differ from mill to mill.

	 Green Guidelines	 Orange Guidelines	 Red Guidelines
Tinted Paper		Pastel Colour	Heavily dyed
Inserts in Magazines	Same Paper	Different paper types	
Inks		Excessive coverage	Heavy Metal Metallic
Adhesives	Water Based		Latex/Hotmelt Self-Adhesive
Envelopes Laminates		Window carbonless papers Non-cellulose envelopes	Wax Label backing papers

Corrugated Boxes

Adhesives	Water Based Latex/Hotmelt Self Adhesive labels		
Inks		Containing heavy metallic	
Laminations			Polycoat Wax

Other Packaging

Adhesives	Water based	Latex/Hotmelt Self Adhesive labels	
Laminates/additives	Liquid Packaging Board Cartons	Wet strength paper Polycoat* Wax* Foil lined papers coated	Sacks containing free film
Features		Windows	
Ream Wrap			Polycoat*



“
Tetra Pak, in partnership
with Gayatri Paper Mills
has started recycling liquid
board packaging.
”



Paper Grade Definitions for Recycling

This list of South African Standard Grades of Recovered Paper and Board gives a general description of the standard grades by defining what they do and do not contain.

It is recognised that specific deals between buyer and supplier for standard grades with special specifications will still be necessary to meet individual requirements.

Collected paper segregated from refuse sorting stations is not suitable for use in the paper industry, due to it being contaminated by other refuse, which affects the quality.

It is recommended that the standard is used at all industry levels. It secures the quality of the recovered paper supply to the paper mills.



“

If you select the green option you can mark your packaging as fully recyclable

”

Out-throws

The term out-throws is defined as all papers that are so manufactured or treated or are in such a form as to be unsuitable for consumption as the grade specified.

Prohibitive Materials

Anything which is not paper or paperboard and if included in the recovered paper may during processing cause damage to machines or interruptions to production.

Specific examples include :
Metal, Plastic, Glass, Textiles, Wood, Sand and building materials, Synthetic materials and Synthetic paper.

Moisture Content in Recovered Paper & Board

Recovered paper and board will in principal be supplied with moisture of not more than the naturally occurring level – where the moisture content is higher than 10% on paper and 12% on kraft/board (of air dried weight), the additional weight in excess of the allowed percentage may be claimed back.

Method of Testing & Sampling

The equipment to be used for testing is either :

- Emco AP 500 hand gauge (or equipment with similar specifications).
- Oven dry method.
- Aquabouy

In both cases a random representative sample will be taken and subject to testing by one or other of the above methods as agreed between buyer and seller.

When new or advanced technology becomes available these procedures may change and will be communicated by way of revised schedule.

Paper Grade Definitions

Mixed Paper [CMW]

A mixture of various grades of paper and board without restriction on fibre content.

Prohibitive materials allowed - 1%.
Total out-throws may not exceed - 10%.

Cartonboard Cuttings [IMW]

Consists of new cuttings of paperboard as are used in the manufacture of folding paper cartons and similar boxboard products.

Prohibitive materials allowed - 1%
Total out-throws may not exceed - 2%

Mechanical Grades

Special News [SN]

Consists of newspaper, magazines and sorted graphic paper from Kerbside and other post consumer collections. All kraft paper must be removed.

Prohibitive materials allowed - 1%
Total out-throws may not exceed - 3%

Over Issue News [FN]

Consists of over run unsold newspapers containing not more than the normal percentage of inserts, no flexographic printed material allowed.

Prohibitive materials allowed - none permitted
Total out-throws may not exceed - 1%

Magazine [SBM]

Consists of unsold magazines and trims from magazine printers including catalogues, brochures with or without latex bindings. May contain up to 10% of uncoated news type paper.

Prohibitive materials allowed - none permitted
Total out-throws may not exceed - 2%

Special Magazine [SSBM]

Unsold magazines and trims from magazine printers, including catalogues, brochures without latex bindings. May contain a small percentage of news type paper.

Prohibitive may not exceed - none permitted
Total out-throws may not exceed - 2%

High Grades

White One [W1]

Consists of unprinted white woodfree paper or board, off cuts or shavings free from water insoluble matter.

Prohibitive may not exceed - none permitted
Total out-throws may not exceed - none permitted

Heavy Letter One [HL1]

Consists of white printed or unprinted sheets, shavings originating from printers or office records. This grade must be free of heavily printed or coloured stock and non water soluble adhesives.

Prohibitive may not exceed - none permitted
Total out-throws may not exceed - 2%

Heavy Letter Two [HL2]

Consists of pastel coloured printed or unprinted sheets, shavings and cuttings originating from printers or office records. This grade must be free of heavily printed or coloured stock and non water soluble adhesives.

Prohibitive may not exceed - 1%
Total out-throws may not exceed - 2%

Super Mix [SMW]

Consists of mix of HL1 / HL2 in ratio 50% HL1, 50% HL2. This grade must be free of non water soluble adhesives.

Prohibitive materials may not exceed - 1%
Total out-throws may not exceed - 2%

Sorted Office Paper [SOP]

Consists of paper as typically generated by offices, containing primarily white and coloured groundwood free paper, free of unbleached fibre. May include a small percentage of carbonless paper.

Prohibitive materials may not exceed - 1%
Total out-throws may not exceed - 5%

Kraft Grades

Corrugated Containers [K4]

Consists of corrugated containers having liners of kraft or test liner.

Prohibitive materials may not exceed - 1%
Total out-throws may not exceed - 5%

New Corrugated Kraft Waste [K3]

Consists of new corrugated cuttings, sheets and unused boxes as generated by corrugating convertors having liners of kraft or test liner.

Prohibitive materials may not exceed - none permitted
Total out-throws may not exceed - 2%

Unused Kraft Bags [K1]

Consists of new kraft multi wall bag cuttings, sheets and misprint bags, free of stitched papers, poly liners and wet strength paper.

Prohibitive materials may not exceed - none permitted
Total out-throws may not exceed - 2%

Special Grades

Liquid Board Packaging [LBP]

Used or unused liquid packaging boards including used PE – coated liquid packaging board (with or without aluminium content). Containing a minimum of 50% by weight of fibres and the balance being aluminium or coatings.

Prohibitive materials may not exceed - none permitted
Total out-throws may not exceed - 3%

Telephone Directories [TD]

Consists of clean telephone directories printed for or by telephone directory publishers.

Prohibitive materials may not exceed - none permitted
Total out-throws may not exceed - 2%

Plastics

62	General principles for plastics recycling
66	(PET) Poly (Ethylene Terephthalate)
74	High Density Polyethylene (PE-HD)
88	Poly (vinyl chloride) (PVC)
96	Low density polyethylene (PE-LD)
100	Polypropylene (PP)
112	Polystyrene (PS)
116	Bio-degradable Plastics
120	Appendix for plastics material identification
121	Appendix for plastics density range
122	Appendix for plastics compatability matrix
123	Appendix for plastics systematics



General principles for plastics recycling

Sorting, processing and recycling systems make a significant difference to the efficacy of plastics recycling and these differ around the world. For example, in the case of sorting, techniques which facilitate material identification according to the kind of plastic with the aid of the near-infrared process (NIR spectroscopy) are being used with increasing frequency in other parts of the world. In South Africa, sorting is mainly done by hand and this section reflects SA conditions.

Shredding and granulating equipment is used to reduce the size of the product. The flakes are separated in the water-based washing process. The objective is to clean and separate the different material fractions or types of plastics. These processes rely on the differences in the density of the materials for separation in water. Magnetic and inductive metal separators are also used. Materials which cannot be separated, or which can only be separated partially, impair the quality of the recycle, leading to lower proceeds.

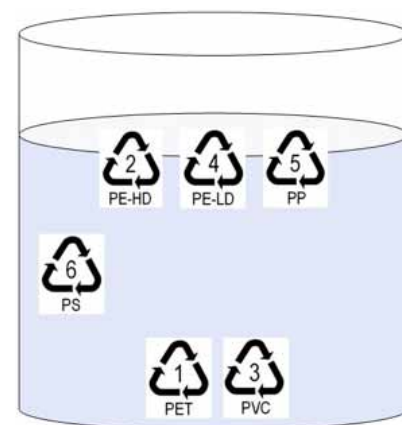


Figure 1: PE-HD, PE-LD and PP float on clean water, PS is supported and PVC and PET sink

Special requirements

Sorting, processing and recycling requirements are based, amongst others, on the following criteria:

- Material combination and selection,**
- Separability of composite materials,**
- Ease of emptying and**
- Labels, printing inks and adhesives used.**

Material combination and selection

The use of one sort of plastic for a pack is the optimum solution. The recycling industry understands “sorting” as separating a PE-HD from a PE-LD product, for example. Such packs can be separated homogeneously during sorting and prepared in the subsequent processing steps.

If a combination of different kinds of plastics is necessary, plastics with different densities (a plastic with a density of less than one and a plastic with a density of more than one) are acceptable for recycling since they can easily be separated in water during the standard recycling process.

If a plastics pack consists of different types of plastics which cannot be separated with water, the plastics types should at least be compatible. [A matrix for evaluating compatibility is attached and explained in Appendixes at the end of this section.](#)

The combination of different types of plastics within the same density range, e.g. PE and PP or PET and PVC, is not favouring recycling. [See Appendixes at the end of this section for more information on densities.](#)

[See Appendixes at the end of this section for an explanation of the plastic systematics](#)

“All plastics must be marked with the correct material identification code.”

Separability of composite materials

If a piece of packaging consists of several parts, these should be manufactured all from the same plastic material wherever possible. If this is not feasible, it is preferable to select designs which disintegrate into components of different density during mechanical shredding or granulating which can subsequently be separated in the washing stage.

Designs with different materials that cannot be separated mechanically should be avoided wherever possible. If a composite material is necessary on account of the function to be fulfilled by the packaging (e.g. to achieve certain barrier properties), thin layers should be given preference, for instance, vapour-deposition. Vapour-deposition does not impair recyclability. However, thicker layers lead to coating residue which impairs the quality of recycle.

Ease of emptying

It should be possible to empty a pack so that only very little product residue is left. This simplifies processing and recycling of the plastic packaging. Suitable design measures can help to promote ease of emptying. These include smooth surfaces, flexible packs that can be squeezed until they are completely empty, such as those already in use as refill packs, or packs that are suitable for upside-down storage.

Chemical containers should be triple rinsed and cut in half before being transported to recyclers to ensure that the recycler doesn't have to deal with any substantial amounts of hazardous chemicals on site.

General principles for plastics recycling continue...



Labelling, printing and adhesives

In general, labels should be manufactured from the same sort of plastic as the main component of the pack. If the materials or the plastics used for the labels and sleeves differ from those of the body of the container, combinations of plastics are acceptable if their densities differ sufficiently for technical separation. Sleeves and wraparound or collar labels which are only stuck to the container at a few points and not over a large area, are optimum solutions for bottles. They can be separated without any residue if water-soluble adhesives are used. If the products frequently come into contact with water (sanitary sector), in mould processes are optimal as long as the same type of plastic is used.

Paper labels are acceptable if they are attached with water-soluble adhesives.

Paper labels should not delaminate or pulp in the washing process. Some paper label fibres can be carried over into the recycled plastic causing problems such as surface defects and pinholes during the subsequent product manufacturing process.

Use of decorative or protective finishes like foil, lacquers and coatings, should be minimised.

Hazardous substances should be avoided in printing inks in the interest of good manufacturing practice. These include inks containing heavy metals.

Material identification

Identify the polymer(s) in use clearly. To facilitate the visual identification of plastics during manual separation, the plastic components should carry a material identification code. The symbol should be clear and ideally moulded into the container. For consistency, material identification codes should be embossed on the base of the container. Exceptionally, the code can be located close to the base or printed on the label. In the case of printed films, the symbol should be lightly and repeatedly printed.

The triangle with chasing arrows is used merely as an identifier for the predominant plastic type and does not necessarily imply that the material is recyclable, [see Appendixes at the end of this section](#).

This is a very important issue and is the joint responsibility of the Brand Owner and Packaging Converter.



Colour

Un-pigmented polymer has the highest recycling value and therefore the widest variety of end uses – therefore use of un-pigmented film and containers is preferred to pigmented packaging.

Strongly coloured plastics have a much lower value for recycling than non-pigmented plastics. Solidly printed plastic films and films with high ink coverage cost more to recycle and the recycle have a lower value.

The amount of colour 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 should consider alternative approaches such as sleeves or wrap around labels that can be removed prior to recycling. Avoid direct printing onto un-coloured plastics.

Sleeves

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.

More details are given in the Exclusion List for Printing Ink and Related Products which is used by the national association members of the European Council of Paint, Printing Ink and Artists' Colours Industry (CEPE). A frequently updated list is available in English, German and French on the Internet at www.cepe.org.

Laminated films or multilayer packaging

In some cases, lightweight laminates were engineered for specific properties and/or light weighting of the pack. Laminates are very difficult to recycle. Only very specialised recycled products can make use of laminates. Energy recovery would be an option but is not yet available in South Africa.

Laminated and multi-layer packaging should only be considered if all other options were exhausted.

Multi-layer packaging should be marked with a number 7 material identification code with the relevant acronyms underneath. For example, a multi-layer film consisting of PP and PE-LD should be marked as:



Multi-material packaging are some times required for extensive shelf life or very high barrier properties and consists of various combinations of paper, plastics and aluminium. These multi-material combinations cannot always be recycled in South Africa. Composite packs should only be used if no other simpler option is available.

PET

Poly (Ethylene Terephthalate)

General



PET is extensively used for bottles but is also used in other packaging formats, e.g. thermoformed sheet for trays and punnets, strapping tapes and transit packaging in the form of glass reinforced pallets.

As explained earlier, these guidelines are driven by the requirements of the mechanical recycling process. In the future, some of the current restrictions (especially for barriers, opacity and colour) may be relaxed as new plants come into commercial operation.

Materials of different densities are to be used to facilitate the separation of incompatible materials during the washing process. Different types of plastic with the same density ranges should be avoided. Components of the pack that are not compatible with PET should have a density of less than 1 g/cm³.



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PET packaging must be marked with a number 1 material identification code.

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Interesting Resources:

www.petco.co.za

www.plasticsinfo.co.za

www.sapro.biz



PET bottles and jars



Material and 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 (ca 50 – 200 ppm) 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, e.g. PETG. There is some confusion in the market place about the material identification code for PETG and it is sometimes marked with a number 1 as well. PETG should be listed under the number 7 materials.

Use of PLA (a biodegradable material) with PET should be avoided as the polymers are incompatible and not readily separable (both have a density of more than 1 g/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 temperature at which PET is dried.

Blends of PET with other polymers are undesirable unless they are compatible with PET recycling.

Inclusion of nucleating agents, hazing agents, fluorescences; 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 or cause haziness should be avoided unless means are readily and economically available to minimise their effect.

Barriers and Coatings

Where a composite material is necessary, consideration should be given to the use of thin layers (e.g. Nylon or vapour deposition). EVOH as a potential barrier material is not recommended.

As indicated previously, if use of any non-recommended material combination is still desired, the user may arrange for more definitive compatibility evaluation tests to be carried out. Product manufacturers and their suppliers would need to ensure that, before launching onto the market, levels employed are minimised and that they have data to show that the proposed packaging provides a recycle that satisfies all technical requirements (especially discolouration and haze) and that recyclers in general can achieve the separation efficiencies required.

Alternatively, where performance enhancing barrier layers are used which could interfere with current recycling, for example in PET beer- and wine bottles, it is important to ensure that the container is easily distinguished and sorted from conventional PET bottles.

Clear plasma coatings in general cause no recycling issues, although use of high levels of carbon should be avoided. Other external coatings (e.g. O₂ or CO₂ barriers) can cause issues. To be acceptable the barrier needs to flake off the PET and be efficiently removed during reprocessing. Designers and converters need to select the correct combinations.

Colour

Clear bottles have the highest value. Light blue bottles are also acceptable as they can be blended in small amounts with clear bottles. Green and brown bottles are also recycled but have a much

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For PET recycling, different types of plastic with the same density ranges should be avoided.

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lower value than clear bottles. Designers are encouraged to consider alternatives (i.e. sleeves) if colour is necessary.

Avoid direct printing onto PET. Presently all direct printing and decoration contaminates recycled PET in conventional recycling methods and discolours the base material. Colour and printing (other than date coding) should therefore be confined to labels.

Closures and closure liners

Ideally, all closures and closure lines should be recycled as well. No PET closures on PET bottles, ideally PP or PE-HD closures to be used. Avoid metal caps as they are difficult and costly to remove.

Labelling and label adhesives⁵

Sleeves and safety seals should be designed to completely detach from the container.

Adhesives that are water soluble (or dispersible) at 60 - 80 degrees Celsius and hot melt alkali soluble adhesives are the most readily removed during the recycling process. Paper labels should not delaminate in the washing process. PE and PP labels are preferred. The use of PET sleeves and labels with PET bottles is also to be avoided. Although made of the same material, PET sleeves and labels are usually highly pigmented and cannot be easily separated.

⁵ If the adhesive or any residual adhesive is not removed from the plastic surface, small particles such as plastic dust, paper, fibres, sand, etc. may stick to the plastic and cause impurities in the recycled material. Furthermore, residual adhesive can decompose during the subsequent melting process, leading to discolouration of the material and undesirable changes in the mechanical properties. Both factors limit the use of recycled material to low grade final applications and consequently reduce its economic value.

Guideline Table for PET Bottles and Jars



Green Guidelines



Orange Guidelines



Red Guidelines

1. Main issue is for recycling back into bottles. Less of an issue when recycle is being reprocessed into fibre. In general fibre production is not affected with up to 500 ppm TiO₂ or mica present (average particle size less than 50 microns). TiO₂ and mica-based opacifying master batches, however, significantly disrupt PET recycling into

strapping and bottle applications. Opaque bottles containing these master batches are systematically removed by recyclers from the part of the coloured stream intended for strapping and bottle applications.

2. At present direct printing (generally black) is not acceptable. It is very difficult to fully remove black ink pigment resulting in pinholes during reprocessing. Residual solvent can also lead to yellowing.

3. Acceptable provided they are attached using water soluble adhesives and are not coated in a manner that prevents separation and removal during recycling.

4. Provided metallisation is 'light' metal detectors should not be triggered and recycle acceptable.

Colour	Clear; light-blue; green	Other transparent colours	Opaque/fully absorbent colours ¹ ; fluorescent; Strong colours
Labels	Materials with densities less than 1 g/cm ³ like PE, PP, BOPP, PS-E;	Paper ³ labels; Metallised labels ⁴	Materials with densities more than 1 g/cm ³ like PVC, PS, PET;
Sleeves, including tamper evident sleeves	Materials with densities less than 1 g/cm ³ like PE, PP, BOPP, PS-E;	Paper ³ labels; Metallised labels ⁴	Materials with densities more than 1 g/cm ³ like PVC, PET; PS; PETG;
Barriers and Coatings	Thin layers	External Coating; PA (3 layers); Clear plasma coating	EVOH or PA monolayer blends; Dual layer combinations of different polymers
Additives	Materials with densities less than 1 g/cm ³ like PE, PP, BOPP or PS-E, foamed PET, foamed PETG;	O ₂ scavengers; UV stabilisers; Acetaldehyde blockers; Nanocomposites	Oxo-biodegradable additives
Caps & Closures	Materials with densities less than 1 g/cm ³ like PP, PE-HD, PE-LD;		Materials with densities more than 1 g/cm ³ like steel, Al, PS, PVC, PET; Thermosets, e.g. PF
Cap Liners	Materials with densities less than 1 g/cm ³ like PE-HD, PE-LD; PE-E;		Materials with densities more than 1 g/cm ³ like PVC, EVA, Al
Seals	Materials with densities less than 1 g/cm ³ like PE, PP, PS-E, foamed PET	Silicone (provided the density is less than 1 g/cm ³)	Materials with densities more than 1 g/cm ³ like PVC, Al, Si
Direct Printing	Avoid direct print onto PET bottles or jars unless production or expiry date	Printing onto darker materials	Other direct printing ²
Adhesives	No adhesives on body; Water-soluble adhesives; Hot melt alkali adhesives		Non-water soluble adhesives; Hot melt adhesives;
Inks	Good manufacturing practice – excluding heavy metal containing inks		
Residual content	Residual content of less than 1 vol.-% (up to 1 litre); Residual content of less than 0.5 vol.-% (larger than 1 litre)	Residual content of more than 1 vol.-% (up to 1 litre); Residual content of more than 0.5 vol.-% (larger than 1 litre)	Inks that bleed and dye wash solution
Other components, e.g. handles, dispensers, etc.		PE-HD; PP; uncoloured PET	PVC; RFID tags; Non-plastic components



PET trays and blister packs

NOTE*: Trays: Because of great difficulties in identifying and separating the different substrates, there is very little recycling of this form of post consumer packaging in SA. From a recycling perspective, moulds that have a specific polymer logo should not be used to make products with other substrates.

PET trays and blister packs represent approximately 10% of the PET waste stream, but are not currently recycled in South Africa. Small volumes are collected and baled for export to the East. This will be addressed in the near future.

Material and Material Combinations

One particular immediate difficulty that will need to be faced for increased recycling levels 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. As with other PET packaging formats, it is vitally important that contamination by PVC is avoided. PVC trays and blister packs contaminate the PET tray and blister stream and every effort needs to be made to try and ensure that such contamination is avoided either at design stage and/or at the recycling stage.

Closures and closure liners

The plastic lid must be an integral part of the tray or at least the same plastic as the main body. In principle, aluminium lids are acceptable on PET tubs and trays as long as they peel off the container with the adhesive sticking to the lid. Coated paper lids make separation very difficult.

Colour

Ideally, tubs and trays should be clear or colourless. Barriers and coatings can be introduced via thin vapour-deposition coatings. EVOH and PA barriers are undesirable for recycling.

Labelling and label adhesives⁵

Labels have a negative effect on recycling especially if they cannot be removed easily in water. Even if the labels can be separated, adhesive residue that is difficult to remove significantly impairs the quality of the recyclate. Combinations of different plastic kinds with a similar specific density, such as the combinations PET and PVC, and combinations of plastics with non-plastics render the recycling unfriendly.



Green Guidelines

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The plastic lid must be an integral part of the tray or at least the same plastic as the main body.

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Orange Guidelines



Red Guidelines

- 2. At present direct printing (generally black) is not acceptable. It is very difficult to fully remove black ink pigment resulting in pinholes during reprocessing. Residual solvent can also leads to yellowing.
- 4. Provided metallisation is 'light' metal detectors should not be triggered and recyclate acceptable.
- 5. If the adhesive or any residual adhesive is not removed from the plastic surface, small particles such as plastic dust, paper, fibres, sand, etc. may stick to the plastic and cause impurities in the recycled material. Furthermore, residual adhesive can decompose during the subsequent melting process, leading to discolouration of the material and undesirable changes in the mechanical properties. Both factors limit the use of recycled material to low grade final applications and consequently reduce its economic value.

Colour	Clear	Transparent colours, e.g. light-blue; light-green, etc.	Opaque or fully absorbent colours; fluorescent; Strong colours
Barriers and Coatings		Thin, vapor deposition layers	EVOH and PA coating;
Lids	Integral with container	Peel-off lids if adhesive layer remains with lid	Peel-off lids where adhesive remains on container
Press-on lids	PET	Materials with densities less than 1 g/cm ³ including PP; PE-HD; PE-LD	PVC; PLA
Direct Printing	Avoid direct print onto PET trays unless production or expiry date		Other direct printing ²
Labels	Materials with densities less than 1 g/cm ³ like PE-HD, PP, BOPP, PS-E;	Paper ³ labels; Metallised labels ⁴	Materials with densities more than 1 g/cm ³ like PVC, PS, PET;
Sleeves, including tamper evident	Materials with densities less than 1 g/cm ³ like PE, PP, BOPP, PS-E;	PET	Materials with densities more than 1 g/cm ³ like PVC, PS; PETG; foamed PETG
Adhesives	No adhesives on body;	Water-soluble adhesives; Hot melt alkali adhesives	Non-water soluble adhesives; Hot melt glues;
Inks	Good manufacturing practice – excluding heavy metal containing inks		Inks that bleed and dye wash solution
Other components, e.g. Inserts	PE-LD film and bubble-wrap; PP; PE-HD	Paper	PVC; PLA;

High Density Polyethylene (PE-HD)

General



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

For efficient separation and removal in conventional recycling with water-based separation processes, parts of the packaging system that are not compatible with PE-HD should have a density of more than 1 g/cm³.

Some applications require the use of additional barrier layers for specific applications. The use of non-polyethylene layers should be minimised (to maximise polyethylene yield and reduce potential contamination and separation costs), but when required they should be compatible with or easily separable from polyethylene in conventional recycling systems. Current PE-HD recycling systems can tolerate the use of low levels of EVOH layers. Nylon-based barrier layers cannot be tolerated, particularly if the layers cannot be readily separated

from the PE-HD in conventional recycling systems. In all such cases their content should be minimised to the greatest extent possible to maximise PE-HD yield and reduce potential contamination and separation costs. PVDC barriers should be avoided.

PE-HD packaging must be marked with a number 2 material identification code.

Additives

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

Other Components

Components should be made of PE-HD or PE-LD or should be designed in such a way that they separate from the PE-HD during granulation and can be removed during the washing process, i.e. the density should be more than 1 g/cm³.

When components are made from polyethylene, they need to be unpigmented or at least the same colour as the main pack to be optimum recycling friendly.

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Applications using clear, colourless polyethylene have the highest recycling value

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Interesting Resources:

www.plasticsinfo.co.za
www.sapro.biz



PE-HD bottles and jars

Material and Material Combinations

PE-HD bottles should be unpigmented, single polymer without any multi-layer construction.

The principal polymer contaminant of recycled PE-HD is PP from bottle caps and bottles. Both PE-HD and PP are opaque and less dense than water and consequently difficult for recyclers to separate. PP has a higher melting point (160 - 170°C) than PE-HD at 130°C and does not disperse readily in the PE-HD recycle mix. PP contamination can limit the recycled PE-HD to lower value applications. In general, a level of PP contamination up to 5% can be tolerated in the total mix. Higher levels can only be tolerated for some lower specification applications and then it should be limited to below 10%. When designing packaging, it is recommended that PP components are restricted to a maximum of 5% of the overall pack weight to avoid potential end use issues.

PE-HD is very susceptible to contamination from the contents, e.g. pesticides, motor oil, etc. which

can result in colour and odour problems. Whilst recycle derived from milk bottles can result in malodour issues, this should be avoidable using hot wash recycling. PE-HD containers used for mineral oil based products (e.g. motor oil) will smell but more importantly, the oil migrates into the plastic and is not removed during normal recycling. Therefore, recycled oil containers have limited applications in the agricultural market only.

Colour

Unpigmented bottles are preferred. In multi-layer PE-HD bottles, 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 colours 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 of adhesive on the PE-HD bottle should be avoided.

Labelling

In applications using unpigmented PE-HD, all direct printing other than date coding, used either for product labelling or decoration, presently contaminates the recycled unpigmented PE-HD in conventional recycling systems.

Adhesives that are water soluble (or dispersible) at 60 - 80 degrees Celsius and hot melt alkali soluble adhesives are the most readily removed during the recycling process.

Paper labels should not delaminate in the washing process.

Polyethylene and polypropylene labels are preferred.

Other attachments

The use of any other attachments is discouraged, as they reduce base material yield and increase separation costs. If attachments are added to a bottle, they should be made from either materials that are easily separable from PE-HD in conventional recycling or are compatible e.g. PP, PE-LD or preferably, unpigmented PE-HD.

Use of PP or PE-LD attachments, if necessary,

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PE-HD is very susceptible to contamination from the contents
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should be limited to less than 5% of the total bottle weight wherever possible as higher percentages can contaminate the PE-HD for many recycling applications.

Where an attachment is essential, like a neck ring on a tamper evident closure, the neck ring must be the same colour as the bottle or must be designed in such a way that it is being removed with the closure.

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.

Guideline table for PE-HD bottles and jars



Green Guidelines



Orange Guidelines



Red Guidelines

Colour	Colourless; White	Transparent colours; Coloured; Black inner layer; Paper ³ labels; Metallised labels ⁴	
Labels	PE-HD; PE-MD; PE-LD; PE-LLD; PP or BOPP ¹ ; sleeves and wraparound or collar labels manufactured from PE-HD	Paper ³ ; PET; PETG; PS; PVC ²	Al; Metallised labels
Sleeves, including tamper evident sleeves	PE-HD; PE-MD; PE-LD	PP ¹ ; PVC ² ; Paper ³ ; BOPP	PS; PS-E
Barriers and Coatings		EVOH; PA	PVDC
Additives	PE-HD; PE-LD	Limited amounts of additives as long as the overall density remains below 0.995 g/cm ³	Talc; CaCO ₃ ; Other fillers that increase the density of PE-HD above 0.995 g/cm ³ ; Oxo-biodegradables
Caps & Closures	Materials with densities less than 1 g/cm ³ like PE-HD, PE-LD;	PE-HD multi-piece caps with sealing rings ; PP ¹ ; PVC ²	Steel; Al; PS; Thermosets
Cap Liners	PE-HD; PE-LD; PE+EVA; PP	PVC ²	PS; EVA; Al
Seals	PE-HD; PE-LD; PP; BOPP	Al; PVC ²	Silicone with density less than 1 g/cm ³
Direct Printing	No direct printing on bottle unless it is production or expiry date		Other direct printing
Adhesives	Water-soluble adhesive or alkali soluble adhesives up to 80°C; No adhesive residue on body	PP ¹	Non-soluble adhesive in water or alkali at 80°C; Hot melt glues;
Inks	Good manufacturing practices, i.e. no heavy metals containing inks		Inks that bleed and dye wash- solution
Residual content	Residual content of less than 1 vol.-% (up to 1 litre); Residual content of less than 0.5 vol.-% (larger than 1 litre)	Residual content of more than 1 vol.-% (up to 1 litre); Residual content of more than 0.5 vol.-% (larger than 1 litre)	Inks that bleed and dye wash solution
Other components, e.g. handles, dispensers, etc.	PE-HD of the same colour	PE-HD of different colour; PE-LD; PP ¹ ; PVC ³	RFID tags; Non-plastic components

1. The total level of PP should be kept below 5%.
2. A limited number of recyclers can tolerate PVC components and for this reason its use is permitted.

3. Acceptable provided labels are attached using water soluble adhesives and are not coated in a manner that prevents separation and removal during reprocessing and secondly. They do not pulp in the wash tank. Paper labels that do not satisfy these criteria should be avoided.

Notes:
The content may have an impact on the recycling. Packaging of products such as mineral oil, silicone or silicone based products, pesticides, herbicides, hazardous chemicals have limited applications. Recyclers specialising in chemical containers are equipped to deal with the residual contents only if the containers have been triple rinsed and cut in half prior to transporting them to the recycler.



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Excessive paper content
can cause issues during
recycling and thus use
of paper labels is less
desirable
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Green Guidelines



Orange Guidelines



Red Guidelines

1. The total level of PP should be kept below 5%.
2. A limited number of recyclers can tolerate PVC components and for this reason its use is permitted.
3. Acceptable provided labels are attached using water soluble adhesives and are not coated in a manner that prevents separation and removal during reprocessing and secondly. They do not pulp in the wash tank. Paper labels that do not satisfy these criteria should be avoided.

PE-HD tubs, trays and cups

NOTE*: Trays: Because of great difficulties in identifying and separating the different substrates, there is very little recycling of this form of post consumer packaging in SA. From a recycling perspective, moulds that have a specific polymer logo should not be used to make products with other substrates.

Material and Material Combinations

Tubs and dishes are often made of injection grade PE-HD, exhibiting higher melt flow rates than blow moulding grade of PE-HD. Mixing the two types of PE-HD together decreases the value of the mixture. Do not mix PE-HD bottles with PE-HD tubs or dishes. The recycler needs to keep injection- and blow moulding grades separate for optimum results.

Closures

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

PE-HD tubs, trays and cups that have a clear or colourless body and where the printed information is presented on the lid are particularly suitable for recycling.

Labelling

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

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 should not pulp in the washing processes. Water soluble adhesives to be used.

PE-LD, PP and BOPP labels are preferable.

Colour	Colourless; White	Coloured; Black	
Additives		Limited amounts of additives as long as the overall density remains below 0.995 g/cm ³	Talc; CaCO ₃ ; Other fillers that increase the density of PE-HD above 0.995 g/cm ³ ; Oxo-biodegradables
Lids	PE-HD integral lids; PE-LD	PP ¹ ; PVC ² ; Paper ³ ;	Al; PS;
Direct Printing	No direct printing unless production or expiry date		Other direct printing
Labels	PE-HD; PE-MD; PE-LD; PE-LLD; PP or BOPP ¹ ; sleeves and wraparound labels	Paper ³ ; PET; PETG; PS; PVC ²	All
Adhesives	Water-soluble adhesive or alkali soluble adhesives up to 80°C; No adhesive residue on body		Non-soluble adhesive in water or alkali at 80°C; Hot melt glues;
Inks	Good manufacturing practices, i.e. no heavy metals containing inks		Inks that bleed and dye wash-solution
Residual Content	Residual content of less than 1 vol.-% (up to 1 litre); Residual content of less than 0.5 vol.-% (larger than 1 litre)	Residual content of more than 1 vol.-% (up to 1 litre); Residual content of more than 0.5 vol.-% (larger than 1 litre)	

Notes:

The content may have an impact on the recycling. Packaging of products such as mineral oil, silicone or silicone based products, pesticides, herbicides, hazardous chemicals have limited applications. Recyclers specialising in chemical containers are equipped to deal with the residual contents only if the containers have been triple rinsed and cut in half prior to transporting them to the recycler.



PE-HD tubes

Material and Material Combinations

Only a small percentage of PE-HD flexible packaging tubes are used in South Africa. Caps and tubes should be manufactured from the same type of plastic and ideally from the same polymer (in this case PE-HD). An elevated percentage of PP lowers the quality of the recycled plastic.

Labelling

Paper labels also can be used, provided they are easily removed in water and leave no adhesive residue.

Due to consumer preference, most flexible tubes contain high levels of printing inks which are difficult to remove during recycling. Together with high levels of residual content, flexible tubes are only recycled in rare occasions.

PE-HD caps and closures

Closures

It is unlikely to have unpigmented closures which would be most suitable for recycling.

The principal polymer contaminant of recycled PE-HD is PP closures.

PE-HD closures from soft drink bottles are about 1 mm shorter than equivalent PP closures and sorting is done by hand. The closure should at least be marked with the material identification code to assist in sorting when there is doubt.

PE-HD crates

Due to brand owner requirements, it is highly unlikely to get unpigmented, colourless crates. A number of closed loop, large volume returnable crates (eg. Brewery crates) have their own recycling system and colour is not a problem in these instances.

Material and Material Combinations




The principle polymer contaminant of recycled PE-HD is PP crates. Both materials have density of less than 1 g/cm³ and cannot be separated in conventional recycling processes with water-based separation.

The material identification code will make the PE-HD crates slightly more desirable for recycling.

Agricultural crates are often used and stored out of doors where they are exposed to Ultraviolet rays. Crates need to be suitably UV stabilised to prevent UV degradation during 1 to 2 seasons. Damaged, but unweathered crates are suitable for recycling.



Guideline table for PE-HD crates, tubes, caps and closures

	 Green Guidelines	 Orange Guidelines	 Red Guidelines
Colour	Colourless; Caps and neck rings the same colour as the container;	Coloured;	
Labels	PE-HD in-mould labels;	PE-HD; PE-MD; PE-LD; PE-LLD; PP or BOPP ¹ ; Paper ³ ;	PET; PETG; PS; PVC ² ; Al
Additives	UV stabilisers in crates and pallets	CaCO ₃ (limited quantities as to still render product density below 1 g/cm ³)	Talc; CaCO ₃ ; Other fillers that increase the density of PE-HD above 0.995 g/cm ³ ; Oxo-biodegradables;
Cap Liners	PE-HD; PE-LD; PE+EVA	PP ¹ ; PVC ²	PS; EVA;
Direct Printing	No direct printing unless production or expiry date		Other direct printing
Inks	PE-HD of the same colour	Good manufacturing practices, i.e. no heavy metals containing inks	Inks that bleed and dye wash- solution



1. The total level of PP should be kept below 5%.
2. A limited number of recyclers can tolerate PVC components and for this reason its use is permitted.
3. Acceptable provided labels are attached using water soluble adhesives and are not coated in a manner that prevents separation and removal during reprocessing and secondly. They do not pulp in the wash tank. Paper labels that do not satisfy these criteria should be avoided.



“
The biggest challenge in recycling PE-HD bags remains the residual contents from its secondary use.
”

PE-HD film and bags

Material and Material Combinations

The majority of vest type bags are made from PE-HD. Unpigmented bags and coloured, unprinted bags have the highest recycling value.

The biggest challenge in recycling PE-HD bags remains the residual contents from its secondary use. Consumers use shopping bags as refuse- and waste bags. The remains of the “waste” is often more than the 7 g of the average PE-HD shopping bag and renders the bag unsuitable for recycling. Where shopping bags are included in the recyclables from Separation-at-Source processes and generally less contaminated, they are recycled.

Black refuse bags normally contain recycled content already, up to 100% in some cases. The film producer also manufactures refuse bags “fit for purpose” and blend in PE-LD, EVA and PE-MD to achieve optimum mechanical properties. These films can only be used for lower specification applications.

Virgin refuse bags can be recycled if the residual content does not make the bag undesirable to collect and recycle.

It is therefore challenging to design PE-HD film for recycling as such.

Additives

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



Green Guidelines



Orange Guidelines



Red Guidelines

Colour	Colourless; White	Coloured; Black	
Additives		Limited amounts of additives as long as the overall density remains below 0.995 g/cm ³	Talc; CaCO ₃ ; Other fillers that increase the density of PE-HD above 0.995 g/cm ³ ; Oxo-biodegradables
Direct Printing	Little or no printing	Solid printing: limit printing to less than 50% of the pack weight	
Labels		PE-HD; PE-MD; PE-LD; PE-LLD; PP or BOPP ¹ ; Paper;	PET; PETG; PS; PVC; Al
Adhesives		Water-soluble adhesive or alkali soluble adhesives up to 80°C; No adhesive residue on body	Non-soluble adhesive in water or alkali at 80°C; Hot melt glues;
Inks		Good manufacturing practices, i.e. no heavy metals containing inks	Inks that bleed and dye wash- solution
Residual Content		Residual content of less than 1 vol.-% (up to 1 litre); Residual content of less than 0.5 vol.-% (larger than 1 litre)	Residual content of more than 1 vol.-% (up to 1 litre); Residual content of more than 0.5 vol.-% (larger than 1 litre)

Poly (Vinyl Chloride) (PVC)

General



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

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 recycle and make it useless for most applications. In addition, PET and PVC both sink (densities are similar and larger than 1 g/cm³) and thus are very difficult to separate in conventional water-based density separation systems.

PVC packaging must be marked with a number 3 material identification code.

“
The use of PET components of any kind on PVC bottles is undesirable and should be scrupulously avoided.
”

Interesting Resources:

www.savinyls.co.za

www.plasticsinfo.co.za

www.sapro.biz





“
Sleeves and safety
seals should be
designed to completely
detach from the
container.
”

PVC bottles and Jars

Closures

Plastic closures made from PE-HD, PE-LD or PP is preferred.

Labels

Shrink sleeve labels that require no adhesive and can be removed prior, or during recycling, are preferred. The use of PET should be scrupulously avoided. Sleeves and safety seals should be designed to completely detach from the container.

Adhesives that are water soluble (or dispersible) at 60 - 80 degrees Celsius and hot melt alkali soluble adhesives are the most readily removed during the recycling process.

Paper labels should not delaminate in the washing process. Polyethylene and polypropylene labels are preferred.

Other Components

The use of any attachments on the bottle is discouraged but when required; PE-HD and clear PVC should be used.



Colour	Clear, unpigmented	Transparent colours; coloured	
Caps and Closures	PE-HD; PE-LD; PP; EVA	PVC	PET; PS; Thermosets; Al; Steel
Cap liners	PE-LD	PS-E	PET; EVA; Paper ² ;
Seals	Unpigmented PVC; BOPP		PS
Direct Printing	No direct printing except production or expiry date	Other direct printing ¹	
Labels	PE-HD; PE-MD; PE-LD; PE-LLD; PP or BOPP; PVC;	PS-E	Paper ² ; PET; PS; Metallised labels
Sleeves (incl. tamper evidence)	Clear PVC; BOPP; PP	Printed PVC	PS; PET
Adhesives	Water-soluble adhesives; No residual adhesives on body		Non-water soluble adhesives; Hot melt glues;
Inks		Good manufacturing practices, i.e. no heavy metals in inks	Inks that bleed and dye was solution
Residual content	Residual content of less than 1 vol.-% (up to 1 litre); Residual content of less than 0.5 vol.-% (larger than 1 litre)	Residual content of more than 1 vol.-% (up to 1 litre); Residual content of more than 0.5 vol.-% (larger than 1 litre)	
Other components, e.g. spouts, dispensers, etc	PE-HD; PE-LD; PP; Unpigmented PVC	EVA	PA; PC; PMMA; PS; PS-E; TPU; Thermosets; Metal; Al; Glass

1. At present direct printed (generally black) is not acceptable. It is very difficult to fully remove black ink pigment resulting in pinholes during reprocessing. Residual solvent can also leads to yellowing.

2. Paper labels will sink with the PVC during water-based separation processes and cannot be separated from the PVC.

PVC tubs and trays

NOTE*: Trays: Because of great difficulties in identifying and separating the different substrates, there is very little recycling of this form of post consumer packaging in SA. From a recycling perspective, moulds that have a specific polymer logo should not be used to make products with other substrates.

PVC trays, blister packs and die-cut packaging represent a significant fraction by weight of the domestic plastics waste stream. PVC is very popular for recycling if it can be distinguished amongst other trays and successfully separated.

Colour

Ideally, tubs and trays should be clear or colourless. Barriers and coatings can be introduced via thin vapour-deposition coatings. EVOH and PA barriers are undesirable for recycling.

Closures

The plastic lid must be an integral part of the tray or at least the same plastic as the main body. In principle, aluminium lids are acceptable on PVC tubs and trays as long as they peel off the container with the adhesive sticking to the lid or tray. Coated paper lids make separation very difficult.

Labels

Labels have a negative effect on recycling especially if they cannot be removed easily in water. Even if the labels can be separated, adhesive residue that is difficult to remove significantly impairs the quality of the recycle. Adhesives that are water soluble (or dispersible) at 60 - 80 degrees Celsius and hot melt alkali soluble adhesives are the most readily removed during the recycling process. Polyethylene and polypropylene labels are preferred.

Material and Material Combinations

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

1. At present direct printed (generally black) is not acceptable. It is very difficult to fully remove black ink pigment resulting in pinholes during reprocessing. Residual solvent can also leads to yellowing.
2. Paper labels will sink with the PVC during water-based separation processes and cannot be separated from the PVC.



Green Guidelines



Orange Guidelines



Red Guidelines

Colour	Clear, unpigmented	Transparent colours; coloured	
Lids	Integral with container	Peel-off lids if adhesive layer remains with lid	Peel-off lids where adhesive remains on containerPET; EVA; Paper ² ;
Press-on lids	PVC	Materials with densities less than 1 g/cm3 including PP; PE-HD; PE-LD	PET; PS; PLA; Paper ² ; Al
Direct Printing	No direct printing except production or expiry date	Other direct printing ¹	
Labels	PE-HD; PE-MD; PE-LD; PE-LLD; PP or BOPP; PVC;	PS-E	Paper ² ; PET; PS; Metallised labels
Sleeves (incl. tamper evidence)	Clear PVC; BOPP; PP	Printed PVC	PS; PET
Adhesives			Non-water soluble adhesives; Hot melt glues;
Inks		Good manufacturing practices, i.e. no heavy metals in inks	Inks that bleed and dye was solution
Residual content	Residual content of less than 1 vol.-% (up to 1 litre); Residual content of less than 0.5 vol.-% (larger than 1 litre)	Residual content of more than 1 vol.-% (up to 1 litre); Residual content of more than 0.5 vol.-% (larger than 1 litre)	
Other components, e.g. inserts, etc	PE-HD; PE-LD; PP; Unpigmented PVC	EVA	Paper ² ; PA; PC; PMMA; PS; PS-E; TPU; Thermosets; Metal; Al; Glass



PVC Film

The use of PVC film is widespread but small and primarily in butcheries and delicatessens.

The low gauge and lightweight material makes it almost impossible to recover and recycle.



Low Density Polyethylene (PE-LD)

General



PE-LD films and bags form the single biggest component of all packaging recycled in South Africa.

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.

However, plastics films often requires the use 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 strive to keep the film clear, unprinted and single polymer use as much as possible.

Thicker PE-LD film and bags are more cost effective to recycle and therefore preferable to thin films.

Use of aluminium foil in bags for frozen food should be avoided.

PE-LD packaging must be marked with a number 4 material identification code.

“

Thicker PE-LD film and bags are more cost effective to recycle and therefore preferable to thin films.

”

Interesting Resources:

www.plasticsinfo.co.za

www.sapro.biz



“
The same sort of polymers can be recycled but different kinds of materials create a problem for recycling.
”

1. Sort refers to the materials as listed in Appendixes at the end of this section.
2. Acceptable provided labels are attached using water soluble adhesives and are not coated in a manner that prevents separation and removal during recycling and secondly they do not pulp in the wash tank. Paper labels that do not satisfy these criteria should be avoided.

PE-LD film, wrap and bags

Labels

Labels manufactured from materials that sink in water while the film floats (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.

Printing should be kept to the bare minimum and where the printing surface exceeds 50% of the film, the final recyclate will have a lower value. Packaging designer requirements in shrink film applications demand 100% printing in some cases which reduces the value of the end-of-life films.

Additives

Tackifiers are added to stretch- and pallet wrap and addition levels should be kept at the bare minimum. The recycled film sticks together and it is costing more to recycle and will be less popular as a result.

Barriers and Coatings

PE-LD film is often co-extruded or laminated with other materials to provide both the technical properties required and to satisfy user needs like extended shelf life, for example. It is then no longer a single polymer construction. The same sort of polymers can be recycled but different kinds of materials create a problem for recycling. (See Appendixes at the end of this section for the Systematics.)

Attachments

Metal staplers can be removed with metal detectors but it needs to be separated first from the film. Avoid any attachments.



Green Guidelines



Orange Guidelines



Red Guidelines

Colour	Clear	Coloured	
Barriers and Coatings		EVOH; Co-extruded films of plastics of the same sort, i.e. PE-LD, PE-LLD, PE-MD and PE-HD.	Co-extruded and laminated with different sorts of materials
Additives		Slip additives and anti-block additives; Tackifiers;	CaCO ₃ and other fillers that increase the film density to more than 1 g/cm ³ ; Oxo-biodegradables
Direct Printing	Little or no printing	Limit printing to less than 50% of the film weight	Solid printing
Labels		PE-HD; PE-MD; PE-LD; PE-LLD; PP or BOPP; Paper ² ;	PET; PETG; PS; PVC; AI
Adhesives		Water-soluble adhesive or alkali soluble adhesives up to 80°C; No adhesive residue on body	Non-soluble adhesive in water or alkali at 80°C; Hot melt glues;
Inks		Good manufacturing practices, i.e. no heavy metals containing inks	Inks that bleed and dye wash- solution
Residual content		Residual content of less than 1 vol.-% (up to 1 litre); Residual content of less than 0.5 vol.-% (larger than 1 litre)	Residual content of more than 1 vol.-% (up to 1 litre); Residual content of more than 0.5 vol.-% (larger than 1 litre)

Polypropylene (PP)

General



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

PP packaging must be marked with a number 5 material identification code.



“

Foil safety seals that leave foil or remnants of the attaching adhesive on the PP bottle should be avoided.

”

Interesting Resources:

www.plasticsinfo.co.za

www.sapro.biz



PP bottles and jars

Material and 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.

The principal polymer contaminant of recovered PP is PE-HD from bottles, closures and attachments. PP and PE-HD are both opaque and less dense than water and consequently difficult for recyclers to separate.

Since PE-HD has a lower melting point (ca 130°C) than PP (160 - 170°C) the overall PP mix will be more tolerant to PE-HD contamination than the converse. Nonetheless, when designing packaging, it is recommended that PE-HD components are restricted to a maximum of 5% by weight of the total pack to avoid potential end use issues.

Barriers

Current PP recycling systems can tolerate the use of EVOH layers. Similarly nylon-based barrier layers are tolerated, particularly if the layers are readily separated from the PP in conventional recycling 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, caps and cap liners

The use of closures that are unpigmented or the same colour as the bottle is desirable (although not essential).

Foil safety seals that leave foil or remnants of the attaching adhesive on the PP bottle should be avoided.

“

Paper labels should not delaminate in the washing process.

”

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 recycling systems.

Adhesives that are water soluble (or dispersible) at 60 or 80 degrees Celsius and hot melt alkali soluble adhesives are the most readily removed during the recycling process.

Paper labels should not delaminate in the washing process.

Polyethylene and polypropylene labels are preferred.

Other components

The use of any other attachments is discouraged, as they reduce base material yield and increase separation costs. If attachments are added to a bottle, they should be made from either materials that are easily separable from PP in conventional recycling or are compatible e.g. PE-HD, PE-LD or preferably, unpigmented PP.

Use of PE-HD or PE-LD attachments, if necessary, should be limited to less than 5% of the total bottle weight wherever possible as higher percentages can contaminate the PP for many recyclate applications.

Where an attachment is essential, like a neck ring or a tamper evident closure, the attachment must be the same colour as the bottle or must be designed in such a way that it is being removed with the closure.

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.

Guideline table for PP bottles and jars⁵



Green Guidelines



Orange Guidelines



Red Guidelines

1. Clarified PP is acceptable when bottles are shown to be compatible with end uses for recycle
2. A limited number of recyclers can tolerate PVC components and for this reason its use is permitted.

3. Acceptable provided firstly labels are attached using water soluble adhesives and are not coated in a manner that prevents separation and removal during reprocessing; and secondly they do not pulp in the wash tank. Paper labels that do not satisfy these criteria should be avoided.

4. The total level of PE-HD should be kept below 5% by weight.

5. Also see Appendix 7

	Green Guidelines	Orange Guidelines	Red Guidelines
Colour	Unpigmented; White	Coloured	
Barriers and Coatings		EVOH; PA	PVDC
Additives		Clarifier ¹ ; Limited amounts of additives as long as the overall density remains below 0.995 g/cm ³	Fillers like CaCO ₃ that will increase the product density to more than 1g/cm ³ ; Oxo-biodegradables;
Caps and Closures	PE-LD; PP	PE-HD	PS; Thermosets; Al; Steel
Cap liners	PE-HD; PE-LD; PE+EVA; PP	PVC ²	PS; EVA; Al
Seals	PE-HD ⁴ ; PE-LD; PP; BOPP	Al; PVC ²	Silicone with density less than 1g/cm ³
Direct Printing	No direct printing on bottle unless it is production or expiry date		Other direct printing
Labels	PE-HD ⁴ ; PE-MD; PE-LD; PE-LLD; PP or BOPP ¹ ; sleeves and wraparound or collar labels manufactured from PE-HD ⁴ ; PP in-mould labels	Paper ³ ; PET; PETG; PS; PVC ²	Al; Metallised labels
Sleeves (incl. tamper evidence)	PP; BOPP; PE-MD; PE-LD	PE-HD ⁴ ; PVC ² ; Paper ³ ;	PS; PS-E
Adhesives		Water-soluble adhesive or alkali soluble adhesives up to 80°C; No adhesive residue on body	Non-soluble adhesive in water or alkali at 80°C; Hot melt glues
Ink		Good manufacturing practices, i.e. no heavy metals containing inks	Inks that bleed and dye wash- solution
Other components, e.g. spouts, dispensers, etc	PE-LD; Uncoloured PP	PE-HD ⁴ ; PVC; EVA; Coloured PP;	PS; PS-E; TPU; PA; PC; PMMA; Thermosets; Metallic



“
Residual content in tubs, e.g. yogurt, margarine, etc, is problematic to the recyclers.
”

PP tubs, trays and cups



PP tubs, trays and cups are the most widely recycled plastics in the tray family.

NOTE*: Trays: Because of great difficulties in identifying and separating the different substrates, there is very little recycling of this form of post consumer packaging in SA. From a recycling perspective, moulds that have a specific polymer logo should not be used to make products with other substrates.

Closures, caps and cap liners

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

Colour

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

Labeling

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 should not pulp in the washing processes. Water soluble adhesives to be used.

PE-LD, PP and BOPP labels and sleeves are preferable.

Residual Content

Residual content in tubs, e.g. yogurt, margarine, etc, is problematic to the recyclers. Where relatively clean tubs are part of the recyclables collected in Separation at Source projects, they are recycled.

- 1. The total level of PE-HD should be kept below 5% by weight
- 2. Acceptable provided labels are attached using water soluble adhesives and are not coated in a manner that prevents separation and removal during reprocessing and secondly. They do not pulp in the wash tank. Paper labels that do not satisfy these criteria should be avoided.
- 3. A limited number of recyclers can tolerate PVC components and for this reason its use is permitted.



Green Guidelines



Orange Guidelines



Red Guidelines

Colour	Colourless; White	Transparent colours; coloured	
Additives		Limited amounts of additives as long as the overall density remains below 0.995 g/cm ³	Talc; CaCO ₃ ; Other fillers that increase the density of PP above 0.995 g/cm ³ ; Oxo-biodegradables
Lids	PP integral lids; PP; PE-LD	PE-HD ¹ ; PVC ² ; Paper ³ ; Al	PS;
Press-on lids	PP; PE-HD ¹ ; PE-LD	Materials with densities more than 1 g/cm ³ including PVC, PS, PET, Paper ² , Al;	
Direct Printing	No direct printing unless production or expiry date	Other direct printing	
Labels	PE-HD ¹ ; PE-MD; PE-LD; PE-LLD; PP or BOPP sleeves and wraparound labels;	In-mould PP labels; Paper ³ ; PET; PETG; PS; PVC ²	Al
Adhesives		Water-soluble adhesive or alkali soluble adhesives up to 80°C; No adhesive residue on body	Non-soluble adhesive in water or alkali at 80°C; Hot melt glues;
Inks		Good manufacturing practices, i.e. no heavy metals containing inks	Inks that bleed and dye wash- solution
Residual content	Residual content of less than 1 vol.-% (up to 1 litre); Residual content of less than 0.5 vol.-% (larger than 1 litre)	Residual content of more than 1 vol.-% (up to 1 litre); Residual content of more than 0.5 vol.-% (larger than 1 litre)	



PP tubes

Residual content in PP tubes often make the tubes undesirable for recycling.

Closures, caps and cap liners

Caps and tubes should be manufactured from the same type of material and ideally from the same polymer (in this case both from PP). Co-extruded tubes are used to improve the barrier properties for more demanding materials to be packaged in flexible tubes. EVOH as a barrier material is acceptable but will render the recyclate less valuable.

Labeling

Paper labels also can be used, provided they are easily removed in water and leave no adhesive residue that is difficult to remove.

Direct printing is acceptable for marking tubes. Due to consumer preferences, most flexible tubes contain high levels of printing inks which are difficult to remove during recycling. Together with high levels of residual content, flexible tubes are only recycled in rare occasions.

PP film, bags and wraps

Orientated and bi-axially orientated PP (BOPP) films are widely used in the packaging industry. They are chosen for the excellent barrier properties and gloss. Their mechanical properties include high tensile strength and puncture resistance.

Metallised BOPP films are very popular for the confectionary and sweets industry.

The metallised films are often laminated to clear, reversed printed PP films. Metallised films can be recycled but are less popular than clear, as well as clear and printed films. It is very difficult to remove the printing inks as they are captured between two layers of film.

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 recycling systems. BOPP films for sweets and confectionary are printed more than 100% in some cases which is not recycling friendly.

The consumer preferences and the brand owners marketing utilises PP films as marketing tools and printing and metalizing are part of the value adding appearance of the merchandised product.



[Green Guidelines](#)



[Orange Guidelines](#)



[Red Guidelines](#)

Colour	Clear; Pearlescent; White	Coloured; Metallised;	
Additives		Limited amounts of additives as long as the overall density remains below 0.995 g/cm ³	Talc; CaCO ₃ ; Other fillers that increase the density of PP above 0.995 g/cm ³ ; Oxo-biodegradables
Direct Printing		Solid printing: limit printing to less than 50% of film weight	
Labels		PP or BOPP; PE-HD; PE-MD; PE-LD; PE-LLD; Paper;	PET; PETG; PS; PVC; Al
Adhesives		Water-soluble adhesive or alkali soluble adhesives up to 80°C; No adhesive residue on body	Non-soluble adhesive in water or alkali at 80°C; Hot melt glues;
Inks		Good manufacturing practices, i.e. no heavy metals containing inks	Inks that bleed and dye wash-solution
Residual content		Residual content of less than 1 vol.-% (up to 1 litre); Residual content of less than 0.5 vol.-% (larger than 1 litre)	Residual content of more than 1 vol.-% (up to 1 litre); Residual content of more than 0.5 vol.-% (larger than 1 litre)



“
Residual contents lower the value of the PP tapes recycle considerably.
”

PP woven tapes, bags and sacks



Colour

Unpigmented tapes would be optimum.

The woven or knitted bag is colour coded for various marketing strategies and product identification and unpigmented PP tapes are unheard of.

Residual Content

PP tapes used in bulk packaging are normally contaminated with the powdery contents of the bags, especially in the agricultural industry.

Residual contents lower the value of the PP tapes recycle considerably.

Other Components

Coating should be limited to PE-LD or PP coatings to be compatible with the PP main pack. In making up the bags, yarn and webbing for stitching should also be selected to be compatible with the main material.



Green Guidelines



Orange Guidelines



Red Guidelines

Colour	Clear; White;	Coloured;	
Additives		Limited amounts of additives as long as the overall density remains below 0.995 g/cm ³	Talc; CaCO ₃ ; Other fillers that increase the density of PP above 0.995 g/cm ³ ; Oxo-biodegradables
Direct Printing	Little or no printing	Solid printing: limit printing to less than 50% of film weight	
Labels		PP or BOPP; PE-HD; PE-MD; PE-LD; PE-LLD; Paper;	PET; PETG; PS; PVC; Al
Adhesives		Water-soluble adhesive or alkali soluble adhesives up to 80°C; No adhesive residue on body	Non-soluble adhesive in water or alkali at 80°C; Hot melt glues;
Inks		Good manufacturing practices, i.e. no heavy metals containing inks	Inks that bleed and dye wash- solution
Residual content		Residual content of less than 1 vol.-% (up to 1 litre); Residual content of less than 0.5 vol.-% (larger than 1 litre);	Residual content of more than 1 vol.-% (up to 1 litre); Residual content of more than 0.5 vol.-% (larger than 1 litre) Sugar, grain and cement residue;
Other components, e.g. webbing, handles, stitching	PP		PET; PA;

Polystyrene (PS)

General



Applications using clear, colourless polystyrene have the highest recycling value. Therefore use of unpigmented containers is preferred. Coloured containers are acceptable however, but their recyclability and the value of the recyclate are reduced. Black PS-E recyclate has a minimum value and is less preferred.

Perforated PS-E trays are designed to absorb the juices from the product packaged. The impregnated trays are not suitable for recycling. In principle aluminium lids are acceptable on PS, especially peel-off ones.

Tubs and caps that have a clear or colourless body and where the information presented can be restricted to the removable 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.

Packaging designed for proper emptying will always be better preferred for recycling, i.e. smooth internal surfaces, no undercuts where product gets stuck. PS packaging must be marked with a number 6 material identification code.

“

Black PS-E recyclate has a minimum value and is less preferred.

”



Interesting Resources:

www.polystyrenepackaging.co.za

www.plasticsinfo.co.za

www.sapro.biz



“
Contamination of the PS-E containers often make them undesirable for recycling
”



General Purpose Polystyrene (PS), High Impact Polystyrene (PS-HI) and Expanded Polystyrene (PS-E)

Foaming agents are added to PS to improve its impact strength, insulation properties and reduce its weight. PS-E and PS can be recycled together.

Contamination of the PS-E containers often make them undesirable for recycling. However, relatively clean PS-E is widely recycled when available in large quantities.

1. Acceptable provided labels are attached using water soluble adhesives and are not coated in a manner that prevents separation and removal during reprocessing and secondly. They do not pulp in the wash tank. Labels should not exceed more than 20% of product surface area. Paper labels that do not satisfy these criteria should be avoided.



	Green Guidelines	Orange Guidelines	Red Guidelines
Colour	Clear; White	Coloured; black	
Lids	PS integral lids; PS; PS-E; PP; PE-LD; PE-HD;	Paper ¹ ;	PET; Al;
Press-on lids	PS; PS-E; PP; PE-HD; PE-LD	Paper ¹ ;	Materials with densities more than 1 g/cm ³ including PVC, PET, Al;
Direct Printing	No direct printing unless production or expiry date		Other direct printing
Labels	PS-E; PE-HD; PE-MD; PE-LD; PE-LLD; PP or BOPP sleeves and wraparound labels;	Paper ¹ ;	PET; PETG; PVC; Al
Adhesives		Water-soluble adhesive or alkali soluble adhesives up to 80°C; No adhesive residue on body	Non-soluble adhesive in water or alkali at 80°C; Hot melt glues;
Inks		Good manufacturing practices, i.e. no heavy metals containing inks	Inks that bleed and dye wash- solution
Residual content	Clean containers from Separation at Source projects;	Residual content of less than 1 vol.-% (up to 1 litre); Residual content of less than 0.5 vol.-% (larger than 1 litre); Oil, fat and sugar residue;	Residual content of more than 1 vol.-% (up to 1 litre); Residual content of more than 0.5 vol.-% (larger than 1 litre); Perforated trays with blood residue;

Bio-degradable Plastics

Bio-degradable Plastics

“
Oxo-biodegradable additives are not recommended.
”

Position paper by Plastics SA/SAPRO

Published February 2014

According to the official position paper on this topic, the association's Executive Director, Anton Hanekom says they welcome and support any innovations that enable plastic products to meet the required high quality performance standards.

“However, a lot of confusion still exists around the environmental claims made by the manufacturers of degradable plastics. The general perception is that degradable plastics will dissolve and disappear over time versus conventional plastics that will be around forever. Unfortunately, it is not that simple”, Hanekom says.

Seeing the wood from the trees...

Plastics | SA stresses the importance of understanding that bio-based plastics are not always biodegradable and that biodegradable plastics are not always bio-based. “It is possible

to make biodegradable polymers from fossil raw materials. It is essential to make this distinction in order to avoid confusion when addressing different societal and environmental concerns of bioplastics. It is also essential that those who use the additives consider the sustainability implications of these additives on the recyclability of plastics,” Hanekom warns.

What's in a name?

The general term “bioplastics” is wrongly used to describe different concepts, which often leads to confusion. The biodegradability and compostability as material properties are regulated by international standards.

Plastics | SA and SAPRO say they distinguish between the following:

Biodegradable plastics are degradable due to the action of micro-organisms and enzymes. The aerobic or anaerobic decay of biodegradable

plastics by micro-organisms is the conversion of the organic matter into carbon dioxide (or methane); mineral salts and water under specific environmental conditions, either through processes in nature or man-made (degradation in industrial composting plants, anaerobic digestion plants, etc.). Compostable plastics are degradable due to a biological process occurring during composting and are converted into carbon dioxide, water, mineral salts and biomass. There are no toxic side effects like toxic residue for water, soil, plants or living organisms. Not all biodegradable materials meet compostable criteria.

“Materials which do not fulfil these criteria may still be biodegradable under specific environmental conditions. To ensure that waste treatment facilities work properly, only plastic waste which is compliant with the standards and requirements of the respective facility enters composting streams,” Hanekom explains.

Bio-based plastics are plastics derived entirely or partially from renewable resources, such as vegetable fats and oils, corn or starch. Fossil-fuel plastics are derived from petroleum. The use of renewable resources as feedstock in the production of bio-based materials is seen as a way of educating the dependency on oil.

Explains Hanekom: “Bio-based plastics made from renewable resources can be used in a variety of applications and complement currently used fossil based products. Bio-based plastics can offer similar, additional or even better functionality depending on its composition”.

Making the case for plastics

Whilst it agrees that there are certain uses and applications that could potentially be ideally suited to degradable plastics, Plastics | SA warns that it introducing bioplastics to the country's burgeoning and well-developed recycling industry, would contaminate the recycling streams with disastrous and costly consequences.

“Plastics don't litter. People Do. Biodegradable plastic should not be seen as a quick-fix solution to our country's litter problem. Instead, we are calling for more money and resources to be spent on educating the public about recycling and putting proper recycling infrastructures in place to support the plastics recycling industry has in recent years become an integral part of South Africa's economy. Last year alone, 264 758 tonnes of plastic was collected and recycled, providing formal jobs to 5 047 people and informal employment to more than 44 000 people,” Hanekom explains.



“
A major concern about degradable, biodegradable and oxo-biodegradable packaging, is that the product is composed of non-renewable fossil fuel
”

Of real concern to the plastics industry and its recycling sector, is the impact degradable materials will have once this plastic is recycled and used in second and successive applications.

“As an industry, our concern is what will happen when the polymer molecules used in degradable, biodegradable and oxo-biodegradable plastics break down during the expected service life? Recycled plastic waste is used to make many new long-term plastic products such as refuse bags, agricultural- and building products (such as water pipes, builder’s film, fencing and decking), as well as carpeting, to geo-textiles, strapping, plastic timber - all products that are made to last for many years to come. Introducing biodegradable plastics that are meant to decompose after a certain amount of time, would have disastrous consequences if introduced into the recycling stream,” Hanekom explains.

A second major concern about degradable, biodegradable and oxo-biodegradable packaging, is that the product is composed of non-renewable fossil fuel based inputs and there is little difference in regards to energy and resource usage when compared to conventional disposable packaging. If biodegradable and oxo-biodegradable packaging are meant to break down in a landfill environment, the products will not be recovered through waste management and recycling initiatives, resulting in a loss of resources (the calorific value of plastics) in the same way these resources are lost if they are not recycled.

Looking ahead. Quo Vadis?

The association and its members recommend that oxo-biodegradable products do not be used as packaging alternatives to traditional plastic, as these would contaminate the recycling waste stream and reduce the value and recycling rates of plastic. If, however, further scientific evidence shows that there are other benefits to the use of oxo-biodegradable products, Plastics | SA will reconsider its position.

“One of the challenges faced by the plastics recycling sector over the past decade has been that of building confidence in recycled material and demonstrating its ability to perform as a viable alternative to virgin plastics. We have worked very hard to address these concerns by improving the quality and standards of recycled plastic material. Today, recycled plastics are in huge demand in South Africa and recyclers cannot produce enough material to meet the demand. Recycled plastic is finally enjoying the recognition it deserves and is seen as a top quality material that is a consistent and reliable raw material source”. Plastics | SA and SAPRO recommend that any product environmental impact should be measured against comprehensive Life Cycle Assessments together with costs evaluations. As such, it is not correct to assume that oxo-biodegradable or bio-based plastics have by definition a lower environmental impact.

It is crucial that any environmental claims are backed by sound science and standards. All environmental claims such as biodegradability, compostability or the bio-based content are in compliance with appropriate standards such as ISO 14021. It must be emphasised that market requirements will remain a determining factor in choosing the plastic grade with the desired property profile. The choice is therefore directly related to the functionality and not to the raw material base of the plastic which can be either fossil or bio-based.

Plastics | SA seeks to build confidence in the technical integrity of recycled material that is able to demonstrate its ability to perform as a viable alternative to virgin plastics. If a proportion of recycled plastic contains oxo-biodegradable material, it could change the characteristics of the material and may lead to a failure of products as degradation occurs, resulting in the hindering of market acceptance which will lead to reduced value of recycled material in South Africa.

Conclusion:

“As a result of insufficient or incorrect information, consumers often base their decisions on foreign, poorly researched or emotional articles. Each country needs to find its own unique solutions to litter, municipal solid waste and poor human behaviour”, Hanekom concluded.

Plastics Material Identification

In South Africa material identification currently is voluntary, we believe that all responsible brand owners will make it mandatory for their packaging

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 USA for plastics, seems also to be acceptable (Appendix 1).

Article 8.2 of Directive 94/62/EC requires that “to facilitate collection, reuse and recovery including recycling, packaging shall indicate for purposes of its identification and classification by the industry concerned the nature of the packaging material(s) used” and that “the European Commission determine the numbering and abbreviations on which the identification system is based and shall specify which materials shall be subject to the identification system”.

The European Commission published its Decision on Material Identification in January 1997 (97/129/EC) . The system proposed is a detailed one, based on numbers and abbreviations, and covers an extensive range of material types including paper, plastics, steel, aluminium and individual composite materials. The use of the Commission system remains voluntary.



The Commission's material identification system for plastics is very similar to the existing and well-established SPI material identification code already developed by the plastics material sector . The SPI system uses a triangle made of chasing arrows with the number of the polymer placed inside and the polymer abbreviation placed outside the base. The numbers and abbreviations used for the major plastics are indicated above.



All other plastics are allocated the number '7' with the appropriate abbreviation underneath the triangle. Where more than one material is used in the construction of the packaging, both materials are listed, e.g. a polyethylene and nylon co-extrusion film would be identified with PE+PA.

Further examples of number 7 materials include PETG; EVOH and laminates like PP+met. PP, etcetera.



Density Range of Plastics

Polymer	Polymer abbreviation	Density (g/cm ³)	Behaviour in clean, soapy water
Ethylene vinyl acetate	E/VAC	0.925 – 0.950	float
Polypropylene	PP	0.90 – 0.91	float
Low density polyethylene	PE-LD	0.91 – 0.925	float
Linear low density polyethylene	PE-LLD	0.926 - 0.940	float
High density polyethylene	PE-HD	0.941 – 0.965	float
Polystyrene	PS	1.04 – 1.11	Variable
Nylon	PA	1.13 – 1.14	sink
Polyethylene terephthalate	PET	1.34 – 1.38	sink
Poly(vinyl chloride)	PVC	1.30 – 1.58	sink

The above table shows the density ranges of plastics commonly used in plastics packaging. Densities are approximate and relate to virgin, unpigmented and unfilled polymer. Colouring with 4% pigment can raise density by 0.03 g/cm³ which may cause further overlaps of polymer densities.

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



7. http://www.ekokom.cz/uploads/attachments/English/97-129_eng.pdf

8. <http://plastics.americanchemistry.com/Plastic-Resin-Codes-PDF>

Plastics Compatibility Matrix

In general, different plastics cannot be mixed at “molecular-homogenous” level. This thermodynamically justifiable fact leads to a relatively poor property profile for materials recycled from mixed plastics.

The following table shows to what extent a recyclable mixture of different plastics can be achieved.

Compatibility matrix (Nickel*, 1996)								
Base material	PE	PP	PS	PVC	PET	PC	PA	
PE	1	3-4	4	4	4	4	2-4	
PP	2-4	1	4	4	4	4	2-4	
PS	4	4	1	4	3	2-4	3-4	
PVC	4	4	2-4	1	4	3-4	4	
PET	4	4	4	4	1	1	3-4	
PC	4	4	2-4	4	1	1	3-4	
PA	4	4	3-4	4	3	4	1	
PBT	4	4	2-4	4	3-4	1	3-4	

Source: Designing Recycling-friendly Plastic Sales Packaging, Deutsche Gesellschaft für Kunststoff Recycling mbH
Key:
1 = good compatibility
2 = mixable to approximately 20%
3 = mixable to approximately 5%
4 = non-compatible

* Nickel, W. (Hrsg.): Recycling-Handbuch, Strategien-
Technologien-Produkte. VDI-Verlag GmbH, Düsseldorf, 1996



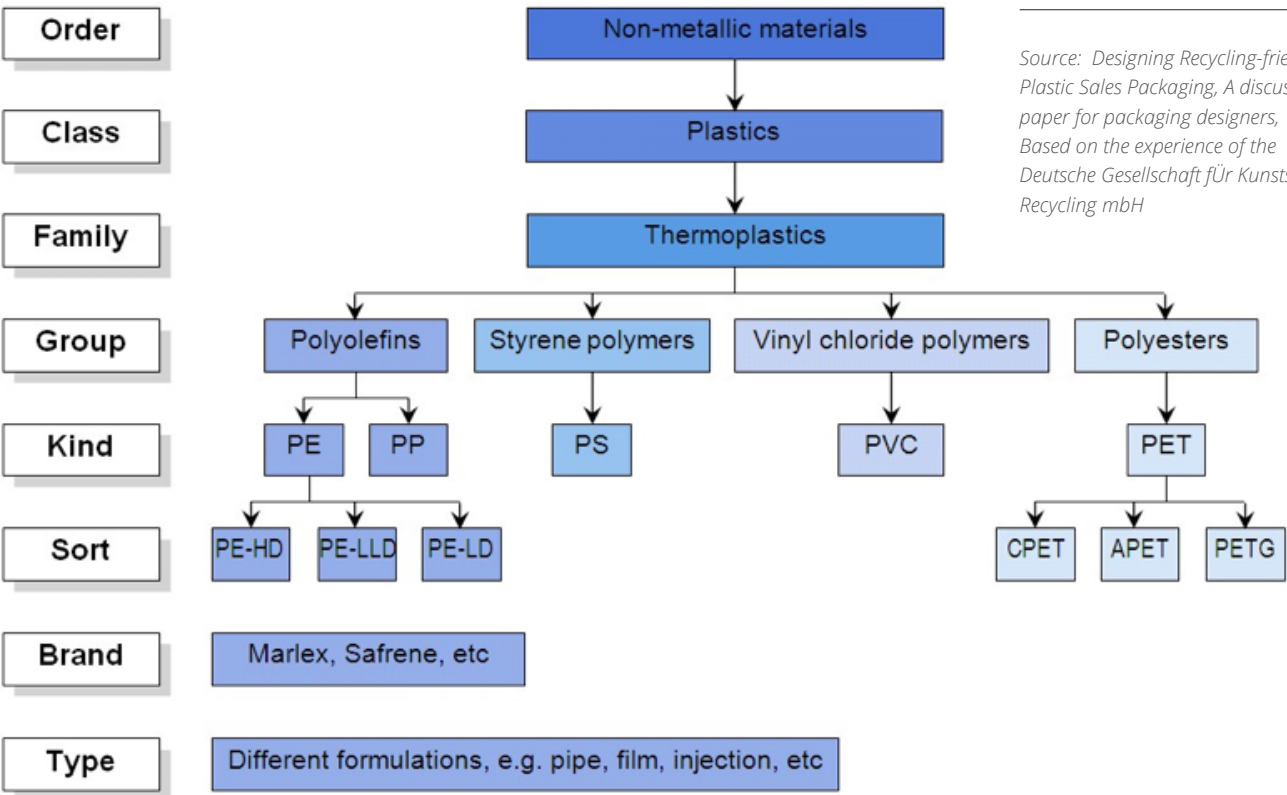
Plastic Systematics

The use of one sort of plastic for a pack is the optimum solution. Such packs can be separated during sorting and prepared in the subsequent recycling processing steps.

If a combination of plastic kinds is necessary, plastics with different density ranges are acceptable for recycling since they can be easily separated in water with normal processing techniques.

The combination of different plastic kinds with the same density ranges, e.g. PE and PP or PET and PVC are unfavourable.

More information is available under each type of packaging.



Source: Designing Recycling-friendly Plastic Sales Packaging, A discussion paper for packaging designers, Based on the experience of the Deutsche Gesellschaft für Kunststoff-Recycling mbH

Glossary of terms

A	
ABS	Acrylonitrile/butadiene/styrene
B	
Blister Pack	Flat plastic containing shallow single serving reservoirs backed by a thin layer of aluminium foil, board or plastic
C	
Coating	The application of dispersion paint, aqueous solutions, varnish and molten or sintered masses to packaging material in order to produce adhering layers with a higher density. The layers normally have a thickness of between 1 and 100 µm.
Composite Materials	Packaging made from a variety of different materials to utilise their unique characteristics to improve the performance of the packaging; also called multi-material packaging
Cullet	Waste glass
D	
Detinning	Extracting the tin content from steel cans
DEA	Department of Environmental Affairs
E	
E/VAC	Ethylene/vinyl acetate (also referred to as EVA)
E/VAL	Ethylene/vinyl alcohol (also referred to as EVOH)
F	
FTIR	Fourier Transform Infrared Spectroscopy
G	
GRC	The Glass Recycling Company
H	
HCl	Hydrochloric acid
I	
Incpen	Industrial Council for Packaging and Environment (UK)
IR	Infrared (radiation)
ISO	International Standards Organisation
J	
K	
L	
M	
MRF	Materials recovery facility
N	
O	
OPET	Oriented PET
OPP	Oriented polypropylene
OPS	Oriented polystyrene
P	
PA	Polyamide (also referred to as nylon)
PACSA	Packaging Council of South Africa
PAMSA	Paper Manufacturing Association of SA
PBT	Poly(butylene terephthalate)
PC	Polycarbonate

PE-HD	High density polyethylene
PE-LD	Low density polyethylene
PE-LLD	Linear low density polyethylene
PE-MD	Medium density polyethylene
PEN	Poly (ethylene 2,6 naphthalate)
PET	Poly(ethylene terephthalate)
PETG	Poly(ethylene terephthalate) glycol modified
PF	Phenol-formaldehyde
PLA	Poly(lactic acid)
PMMA	Poly(methyl methacrylate)
PP	Polypropylene
PRASA	Paper Recycling Association of SA
PSPC	Polystyrene Packaging Council
PS	Polystyrene
PS-E	Expanded polystyrene
PS-HI	High-impact polystyrene
PVC	Poly(vinyl chloride)
PVDC	Poly (vinylidene chloride)
R	
RAG	Recovery Action Group
Recycling	Reprocessing waste to produce another product
RFID	Radio Frequency Identification devices which are affixed to packaging to identify the product
S	
SAPRO	South African Plastics Recycling Organisation
Stickies	Hotmelt adhesives that are problematic in papermaking
T	
TPU	Thermoplastic polyurethane
U	
V	
Vapour-deposition	Process for producing layers of metals, oxides or salts on metals, plastics and similar materials by means of thermal vaporisation in a vacuum. The layers normally have a thickness of between 0.1 and 1 µm.
WX	
Wetstrength	Chemical additive mixed with paper fibres to improve strength and bonding moist conditions.
YZ	





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