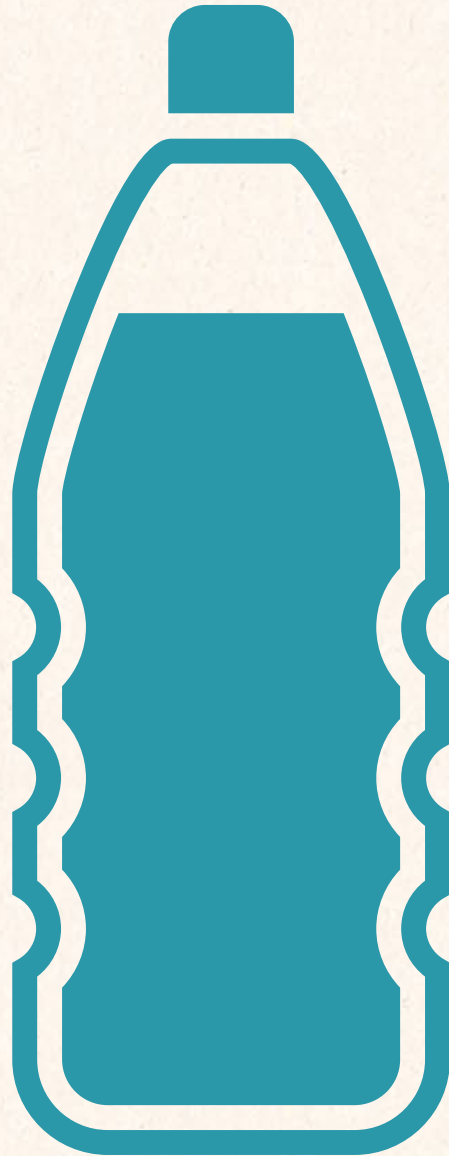


Rigid Plastic Packaging



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Purpose of this Guide

This Design Smart Material Guide for rigid plastic packaging is the third in a series of ten guides published by the Australian Packaging Covenant (APC).

It considers rigid plastic packaging (bottles, tubs, cups etc.), typically for residential consumer use, and manufactured from fossil hydrocarbon-based plastic polymers.

The purpose of this guide is to help you improve the environmental performance of your packaging system, without compromising on cost or functionality. It provides a 'checklist' of sustainability issues to keep in mind when designing and/or specifying your next rigid plastic-based package. The guide will also support your packaging reviews against the Sustainable Packaging Guidelines (SPG), as required by the APC. To facilitate this, the design considerations are grouped under the four principles of the Guidelines.

The information contained in this guide is based on 'life cycle thinking', which considers the sustainability impacts of packaging throughout its supply chain, during use, and at end-of-life. It considers the impacts of the whole packaging system, including primary, secondary and tertiary packaging¹, as well as its performance in delivering the product to the consumer.

You are probably designing your packaging to fulfil a particular function, rather than an intrinsic need to use a rigid plastic as the primary packaging material. If this is the case, then we encourage you to read the first of the guides, which provides information on the comparative environmental and functional performance of the many different packaging material types that are available. Maybe there is another packaging format (such as a flexible plastic format) that will better fulfil your need to optimise cost, function, and environmental performance. Maybe now is the time to consider a bigger change?



¹Primary packaging contains the sales unit product (e.g. 1.5 litre PET water bottles), secondary packaging contains the sales units (e.g. a corrugated board tray box, with shrink wrap holding six bottles), and tertiary packaging is the freight/distribution related packaging (e.g. a pallet, with pallet wrap and a heavy duty corrugated board pallet 'slip').

Purpose of this Guide

The focus of this guide is 'rigid' plastic packaging (bottles, tubs, jars etc.), as distinct from 'flexible' plastic packaging (bags, pouches and film, which are the focus of the fourth guide in this series). Why are we making this distinction? Because most councils in Australia collect rigid plastics packaging for recycling from households, while similar services for domestic consumers of flexible plastic packaging are still in their infancy.

Due to the nature of current packaging recovery systems, if you are designing a rigid plastic package, then one focus is to design it to optimise its material recyclability over multiple life cycles. If you are designing a flexible plastic package, then it is unlikely to be recovered, and the design process should aim to minimise its impacts over a single life cycle.

As a result, this guide has a stronger focus on design considerations to improve the end-of-life recyclability of rigid plastic packaging, within the constraints of current Australian recovery and reprocessing systems. The flexible plastic packaging guide has a stronger focus on design to minimise the single life cycle impacts, with the assumption that the packaging is more likely to be disposed to landfill at end-of-life.



Disclaimer

This document is provided as a general guide only. Aspects relating to material extraction, material processing, transport systems and consumption patterns will impact the environmental, financial and functional performance of packaging systems. Appropriately detailed analyses of specific packaging systems are necessary to confirm the benefits of any of the design considerations outlined in this guide.

The development of this guide has largely relied on the sources listed in the [Useful Further Reading](#) section, as well as targeted consultation to confirm design aspects for the Australian context. The APC will endeavour to review the content of these guides on a regular basis to ensure currency and alignment to industry developments.

If you have any questions about these guides, would like to make comments regarding the guidance provided, or just like to better understand sustainable packaging assessments in general, please contact the APC at apc@packagingcovenant.org.au.

The Life Cycle of Rigid Plastic Packaging

Constituting 12% of packaging used in Australia (by weight), plastic packaging (in both rigid and flexible formats) is the third most common type of packaging used in Australia, after fibre-based (paper/cardboard) and glass packaging.

Australian Packaging Covenant (APC) data shows that in 2011, 530,000 tonnes of all forms of plastic packaging (both rigid and flexible) were sold in Australia. Of this, nearly 200,000 tonnes were recovered and recycled (38%).

Most of the raw materials for polymers are by-products of petroleum refineries. For example, natural gas straight from the ground includes a mixture of gases including ethane, propane and butane. These are removed before the gas (mostly methane) is used in homes and industry for heating and cooking. Ethane and propane are used to make polyethylene and polypropylene respectively.

The hydrocarbons for plastics can also be sourced from renewable sources, such as plant sugars, but production of these polymers is currently limited. The focus of this guide is on packaging manufactured from either mined hydrocarbons or recycled plastics. The ninth guide in this series considers plastics that are made from renewable sources and are also degradable; see the [Degradable Plastic Packaging Guide](#) for further information.

Plastic packaging in Australia is almost entirely made from hydrocarbons sourced from non-renewable sources (i.e. natural gas and crude oil).



The Life Cycle of Rigid Plastic Packaging

While not economically feasible in Australia on a commercial scale, the reuse of rigid plastic packaging would possibly be the most environmentally beneficial outcome, if environmentally efficient technologies were utilised and high return rates could be achieved. Typically, the next best options are to recycle rigid plastic packaging back into the same application (closed-loop recycling) or into other applications (open-loop recycling), particularly where the recycled plastic is used as a substitute for a virgin polymer. For the purposes of this guide, we are using the following definitions for the different generalised recycling systems for recycled plastics:

Closed-loop recycling

Packaging plastics that are recycled back into the original application. In terms of end-of-life fates, closed-loop recycling will typically provide the greatest environmental benefits. At the current time, only polyethylene terephthalate (PET) bottles are recycled back into new PET bottles in Australia on a commercial scale.

Open-loop recycling

Packaging plastics that are recycled into new applications, but importantly, the recycled plastics substitute for, and avoid the use of, virgin polymer in the new applications. Examples of this in Australia include the recycling of PET bottles into fibre for use in clothing and other textiles, and high-density polyethylene (HDPE) milk bottles into mobile garbage bins and milk crates. Open-loop recycling can be as environmentally beneficial as closed-loop recycling.

Down-cycling

Packaging plastics that are recycled into different applications with less stringent performance specifications, and where the recycled plastics are typically substituting for (competing with) materials other than virgin polymer. Examples of this in Australia include the recycling of mixed polymer rigid plastics, e.g. a mixture of HDPE, low-density polyethylene (LDPE) and polypropylene (PP) into timber substitute products (e.g. outdoor furniture, pallets and fencing), where the recovered plastics are competing primarily with timber as the alternative material. Down-cycled plastic products are potentially more difficult to recycle at end-of-life (although they often have long functional lifespans), and are more likely to be disposed to landfill at end-of-life.



The Life Cycle of Rigid Plastic Packaging

In reality the distinction between ‘open loop recycling’ and ‘down-cycling’ is often ambiguous, and is more a spectrum than absolute categories. However, a useful rule-of-thumb to help you to maximise the environmental benefits and recoverability of your packaging is to design it for closed-loop or open-loop recycling. The more valuable that plastic recyclate is, the more economically viable higher levels of recovery become.

This guide focuses on design considerations to improve the recovery of rigid plastic packaging into closed-loop and open-loop recycling. For some packaging applications, the best environmental outcome will be achieved by designing packaging that is only suitable for significant down-cycling or disposal to landfill. Hopefully this guide will assist you in avoiding these less environmentally preferred end-of-life fates.

Using recycled plastic, or designing to facilitate the recovery of plastic for reuse, is environmentally beneficial as the impacts associated with the manufacture of virgin polymer are typically much greater than the impacts of manufacture with recycled polymer.

Table 1

Greenhouse gas impacts of virgin polymers versus recycled polymers^{1,2}

Polymer	Polymer Identification Code (PIC)	Virgin (kg CO _{2-e} /kg polymer)	Recyclate (kg CO _{2-e} /kg polymer)
Polyethylene Terephthalate (PET)	1	2.5	1.6
High-Density Polyethylene (HDPE)	2	2.1	1.3
Polyvinyl Chloride (PVC)	3	1.9	0.5
Low-Density Polyethylene (LDPE)	4	1.5	N/A
Polypropylene (PP)	5	1.3	0.7
Polystyrene (PS)	6	2.8	N/A

¹Data is from raw material extraction to resin production only (cradle-to-gate)

²It should be noted that Global Warming Potential (CO_{2-e}) is only one environmental impact indicator

The Life Cycle of Rigid Plastic Packaging

What makes a packaging type 'recyclable'?

Understanding what makes any packaging type 'recyclable' helps to inform the packaging design process. For a packaging format to be recyclable there have to be systems in place for collection, sorting, and reprocessing, and markets available for the recovered recyclate. As a comparative illustration, these systems/markets are generally in place for consumer-generated rigid plastic packaging, but not (with some exceptions) for flexible plastic packaging. To illustrate, the different characteristics between rigid and flexible plastic packaging are:

Collection infrastructure

Like rigid plastic packaging, flexible plastic packaging could be collected through kerbside collection systems, however due to challenges in sorting and processing, it is not currently designated for collection. A proposal to collect flexible plastics through retail stores is being developed.

Sorting infrastructure

Rigid plastic packaging is relatively easy to sort at material recovery facilities (MRFs), mostly due to its three-dimensional shape. Flexible plastic packaging is much more challenging, as it is (among other things) very difficult to sort from paper and cardboard.

Reprocessing infrastructure

Thin films are harder to turn into flake (size reduce), and are more likely to be contaminated with other materials, such as food and paper. Washing and float separation (to separate incompatible polymer types) are more difficult or impossible.

Polymer combinations and compositions

Rigid plastic packaging is more likely (often by design) to be PET or HDPE, which are either compatible or separable during plastics reprocessing. Flexible plastic packaging is more likely to be made up of two or more co-extruded polymer types that are not possible to separate in a commercially viable way with current systems. Whether for rigid or flexible packaging formats, polymer formulations (e.g. fillers, dyes and other functional polymer additives) can significantly impact on recyclate value.

Weight

Rigid plastic packaging is relatively high in weight per unit of packaging, whereas flexible packaging is low in weight. This means that smaller volumes of rigid plastics need to be recovered to make the reprocessing cost-viable.

The Life Cycle of Rigid Plastic Packaging

Value as recovered recyclate

The aspects listed above lead to recovered rigid plastic packaging recyclate having lower recovery costs, along with a higher market value, than recyclate sourced from flexible plastic packaging. It is often economic to recover rigid plastic packaging; it is less economic to recover flexible plastic packaging.

All plastics are 'technically' recyclable if the right recovery and reprocessing systems are in place. However as discussed previously, the recycling systems, or markets for recyclate, are not sufficiently established for many lower volume plastic packaging types to be practically recyclable. Rigid plastic packaging therefore needs to be carefully designed to maximise recyclability, by designing it with the existing recovery chain in mind. Alternatively your organisation could invest in recovery systems designed to capture the packaging you are producing.

However, if you are not in a position to design a rigid plastic package that has a reasonable prospect of being recycled, then consider moving to a flexible format because this may be the best option from an environmental perspective.

Rigid vs. flexible packaging – which is better?

Consider a flexible packaging format that is a quarter of the weight of the equivalent rigid format; lighter packaging generally means less resources have gone into producing and transporting the packaging. The recycling rate of the flexible packaging is 0%, and the rigid packaging is around 40%. In this situation, for every kilogram of rigid packaging sold into the market, 400 grams will be recycled and 600 grams will be disposed to landfill, compared with 250 grams of flexible packaging that will probably all be disposed to landfill. Assuming the age and location of the plant required to produce the two formats are similar, it is reasonable to suspect that the flexible format will have a lower environmental impact than the rigid format.



The Life Cycle of Rigid Plastic Packaging

Collection and sorting

Most domestic rigid plastic packaging in Australia is collected as part of a mixed (commingled) stream, consisting of plastics, glass, paper/cardboard, steel and aluminium. This commingled material is then sorted at a Materials Recovery Facility (MRF) into the different material streams.

After the rigid plastic packaging is sorted from the other material types, a reasonable proportion, but not all, of the rigid plastics are then sorted automatically using optical polymer sorting equipment, usually based on the near-infrared (NIR) spectrum absorbance of different polymer types.

Larger MRFs generally have optical polymer sorting equipment at the same site where the commingled sorting is undertaken, and will typically use a conveyor belt to transport the rigid plastic containers directly to the optical sorting equipment. Alternatively, the MRF (if it doesn't have an optical sorter) will recover all rigid plastics as one stream, which is baled and then transported to another facility for sorting.

Optical polymer sorting equipment can usually sort into three to five polymer streams – usually PET (possibly coloured and clear), HDPE (opaque and coloured), and then all the other rigid containers as a combined stream (i.e. PVC, LDPE, PP and PS-based containers). The plastic containers are then baled and sent to a plastics reprocessor. While there is no specific data on this, probably about half of these baled plastic containers are reprocessed locally in Australia and about half overseas (mainly China).

By this point in the recovery process there is significant diversity in the composition of the bales of recovered rigid plastics, depending on what degree of polymer sorting has been undertaken (from significant sorting to none). There are bales of (mostly) PET and/or HDPE containers, bales of mixed rigid plastics with most PET and/or HDPE removed, and bales of mixed plastics that haven't undergone any polymer sorting. All these bale types will have still have varying degrees of contamination with plastic and non-plastic contaminants.

In general, the bales of sorted PET and HDPE are relatively high in value, and will be transported to a plastics reprocessor for processing into a range of single polymer 'raw materials', which will then be used by a diverse range of plastic product manufacturers (including the reproducers themselves, who are often also product manufacturers), for manufacture into new products that have a recycled content. This material is more likely to be used in closed-loop or open-loop recycling applications.

Locally, the bales of mixed plastic are often processed into mixed polymer products. While the range of applications is limited, the quantity of mixed plastics that some of these applications absorb is significant, particularly in the case of mixed polymer timber substitutes. Mixed plastics are far more likely to be used in down-cycling applications.

A significant proportion of the mixed plastics bales are also exported, where further sorting (primarily by hand) will often be undertaken to add value to the plastics.



The Life Cycle of Rigid Plastic Packaging

Plastics reprocessing

There are a series of processes that convert a bale of used rigid plastic packaging into a usable raw material, which can then be used in the manufacture of new products. Understanding the nature of these processes, and the inherent limitations, is important in understanding the design constraints you should have in mind when designing packaging that is optimised for recoverability. The 'typical' processes that might be undertaken by a plastics reprocessor are outlined below, although all of these steps might not be undertaken.

Granulation

The bales of plastic packaging are chopped into flakes, usually around 4–8 mm across, in large shredding machines. The flake is often also referred to as regrind or recyclate.

Air classification (elutriation)

Granulation shreds the entire container, and so loosens and shreds plastic and paper labels, and can be followed by an air classification (blowing air) step to separate flake with a high surface area to weight ratio (e.g. labels) from flake with a (relatively) low surface area to weight ratio (e.g. the thicker container flake).

Washing and float separation

The washing and float separation process is used to both wash the flake to remove water soluble contaminants, and also act as a sink-float separator for plastics that have a higher or lower density than water. Float separation systems (including hydro-cyclones) are typically used to separate the container polymer from potential contaminants, such as labels, caps and attachments. This separation process is limited, in the sense that it can only separate into two streams, plastics with densities that are either higher or lower than water. This is why it is important to select polymer types that are either compatible (e.g. HDPE bottle with a HDPE cap and LDPE label), or float-separable (e.g. PET bottle with a PP cap and LDPE label). Densities are shown in Table 2 below.

Drying

Flake is dried using hot air in an evaporation unit, or potentially using a centrifugal-based drying system to remove most of the water, which can then also be finished by hot air drying.

Flake sorting

If required, optical colour sorting equipment can be used to sort polymer contamination from the main product (e.g. remove PVC and PS from PET), and to sort clear flake from coloured flake. Colour sorting equipment is relatively expensive, and is suitable more as a "polishing" stage to remove relatively low levels of coloured flake. It is economically viable for higher-value recyclate (e.g. clear PET flake).



The Life Cycle of Rigid Plastic Packaging

Extrusion and pelletising

This value-adding step involves melting the flake in an 'extruder', which then pushes the melted plastic through one or more filters to remove any contaminating material that doesn't melt at the temperature the extruder is operating at. For example, wood fibre from pulped paper labels might be removed by this step. The filtered liquid plastic is then pushed through a die (like spaghetti), cooled back to a solid, and pelletised (chopped into cylindrical pellets).

The outline of collection, sorting, and particularly, plastics reprocessing systems, provided here will help you to interpret and apply the specific design considerations discussed later in this guide in the context of your particular design requirements and constraints.

Table 2

Specific gravities of polymers

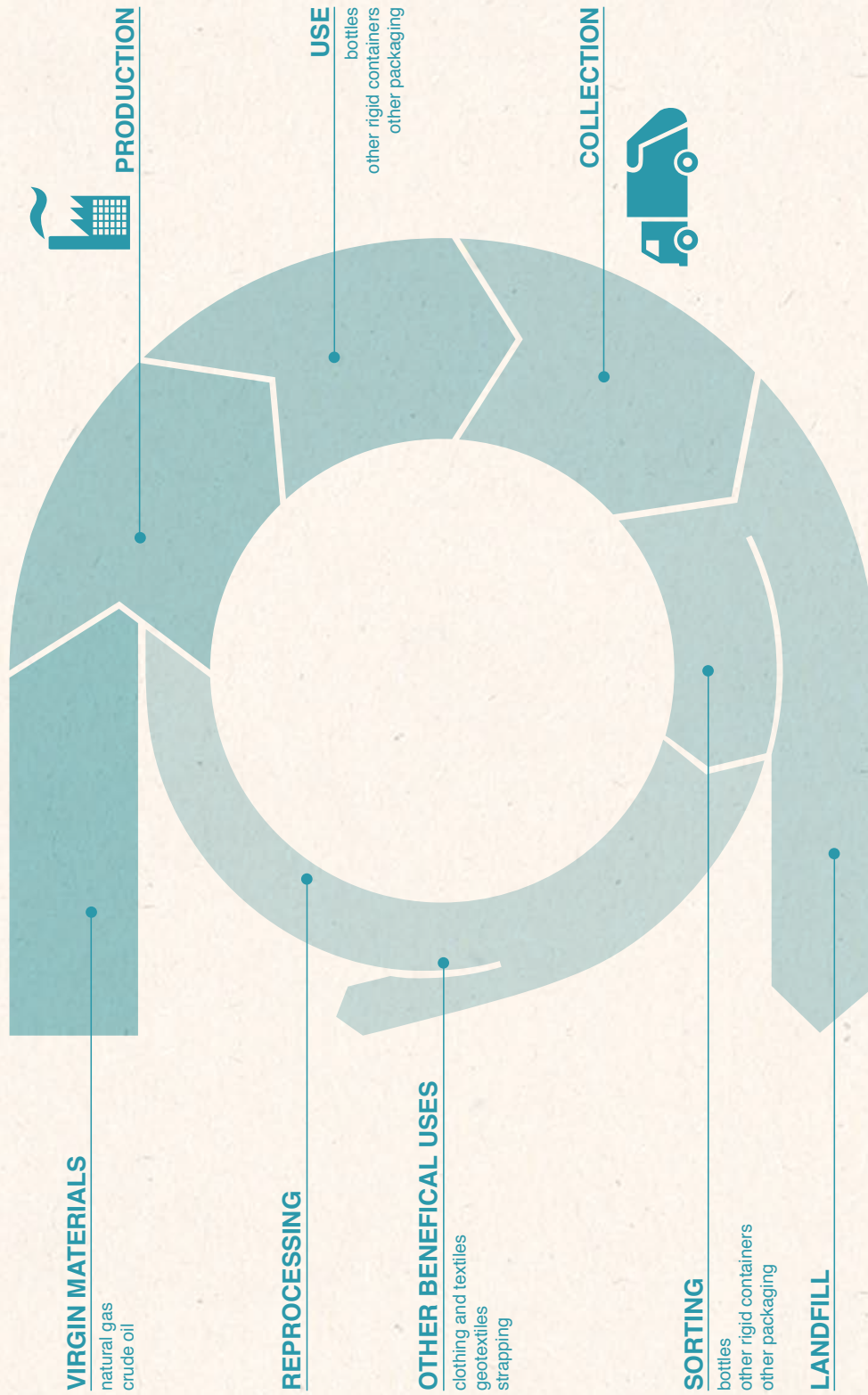
Polymer	Abbreviation	Specific Gravity
Polyethylene	PP	0.90
Poly (Ethylene-Co-Vinyl Acetate)	EVA	0.92
Low-Density Polyethylene	LDPE	0.92
High-Density Polyethylene	HDPE	0.96
Water	H ₂ O	1.00
Acrylonitrile Butadiene Styrene	ABS	1.05
Polystyrene	PS	1.06
Polyvinyl Chloride	PVC	1.35
Polyethylene Phthalate	PET	1.38

The Life Cycle of Rigid Plastic Packaging

Figure 1

Life cycle of rigid plastic packaging

Adapted from diagrams developed by GreenBlue (2009)



The Life Cycle of Rigid Plastic Packaging

In favour

Life Cycle Related Considerations in Favour of Rigid Plastic Packaging

- Rigid plastic packaging can be highly recyclable, if designed appropriately, and if appropriate collection, sorting and reprocessing systems are available.
- Rigid plastic packaging can theoretically use a high recycled content (well over 50%), although there may be some loss in functional performance. Reuse in food contact applications has specific restrictions.
- Plastic packaging has high strength-to-weight ratios, and can provide excellent packaging-to-product-weight ratios.
- Plastic packaging manufacturing usually generates little solid or liquid waste.
- There is a moderate level of diversion of rigid plastic packaging into recycling at end-of-life.
- Good quality rigid plastic packaging recyclate is a high value material, and demand for recyclate is strong, with established and large scale local reprocessing facilities, and with good international markets.
- Rigid plastic packaging reprocessing is a robust process, which can tolerate reasonable levels of contamination.
- Rigid plastic packaging is theoretically 100% recyclable, although in practice there are normally unavoidable reprocessing losses due to polymer contamination (pigments, additives, adhesives, labels, etc.).
- The production of rigid plastic packaging using recovered polymer requires significantly less energy and chemicals (but more water) than using 100% virgin materials.
- In general, life cycle studies comparing the use of rigid plastic based beverage containers, compared with fibre, glass or metal alternatives, have found that the plastic containers perform as well or better across most areas of environmental impact.
- Rigid plastic packaging is versatile, inexpensive and provides good product protection.
- Rigid plastic packaging can be formed into a wide variety of shapes, and some forms of empty packaging (e.g. PET and HDPE bottles) can be delivered to packaging lines as low volume pre-forms, reducing transport impacts.
- There is a low risk of food contamination from the packaging. However, the use of recycled plastic is avoided for some food contact applications out of caution.
- Rigid plastic packaging formats are generally straight forward to sort from commingled kerbside recycling streams at Materials Recovery Facilities (MRFs).
- Plastic packaging, if disposed to landfill, will not decompose. This results in the continuing long-term sequestration (storage) of the fossil carbon in the plastic, rather than this being released to the atmosphere as a greenhouse gas.



The Life Cycle of Rigid Plastic Packaging

Against

Life Cycle Related Considerations Against Rigid Plastic Packaging

- Rigid plastic packaging is generally made from non-renewable gas and oil resources.
- The extraction of non-renewable hydrocarbons results in the direct emission of greenhouse gases, and is a significant source of risk of pollution of the local environment (e.g. from oil spills).
- The closed-loop recycling of rigid plastic packaging in food applications is challenging (only for PET in Australia at the current time).
- The current reprocessing infrastructure in Australia is unable to recover separately all of the polymer types and combinations currently in use for packaging.
- The many different types and combinations of polymers used for packaging make consumer education about recycling more complex.
- With some minor exceptions, rigid plastic packaging is not degradable, increasing the hazard that littered items can present to wildlife, and litter-related amenity issues.
- Virgin polymer production is energy- and chemicals-intensive. Plastics reprocessing is water-intensive (due to the washing and float separation process step).
- Rigid plastic packaging forms a significant part of the observed litter stream.



Design Considerations for Rigid Plastic Packaging

Packaging design should be guided by the resource efficiency design hierarchy¹.

The hierarchy of preferred packaging design changes is: avoid, minimise, reuse, recycle, recover (energy) and dispose.

The robustness of this general hierarchy is backed by a very significant body of evidence, based on packaging life cycle assessments (LCAs).

Embedded across the resource efficiency design hierarchy are the requirements to maintain or improve the packaging system functionality (fitness for purpose), and to minimise product losses. The environmental impacts associated with the packaged product are usually much greater than the packaging itself. Don't compromise functional performance (e.g. through down-gauging) to reduce the environmental impacts of the packaging, if it could lead to greater overall environmental impacts due to product loss and wastage.

More specifically, the key design aspects to keep in mind to minimise the environmental impacts of rigid plastic packaging are:

- Lightweight as much as possible to minimise material consumption.
- Design for the effective reprocessing of your packaging. Minimise the use of multiple polymer types (use mono-materials if possible) and resin additives, and carefully consider your use of caps, seals, inks, dyes and labels. Design for ease of polymer separation during reprocessing.
- Use recycled content if possible.
- Minimise manufacturing inputs (e.g. energy and water).

As with all other packaging materials, rigid plastic packaging systems have specific design constraints, which may limit the application of the resource efficiency design hierarchy. With this in mind, we have outlined the general design considerations for rigid plastic packaging in Figure 2. During material selection and packaging system design all of the aspects in Figure 2 should be considered.

Each of these design considerations is then discussed in more detail in Table 3.

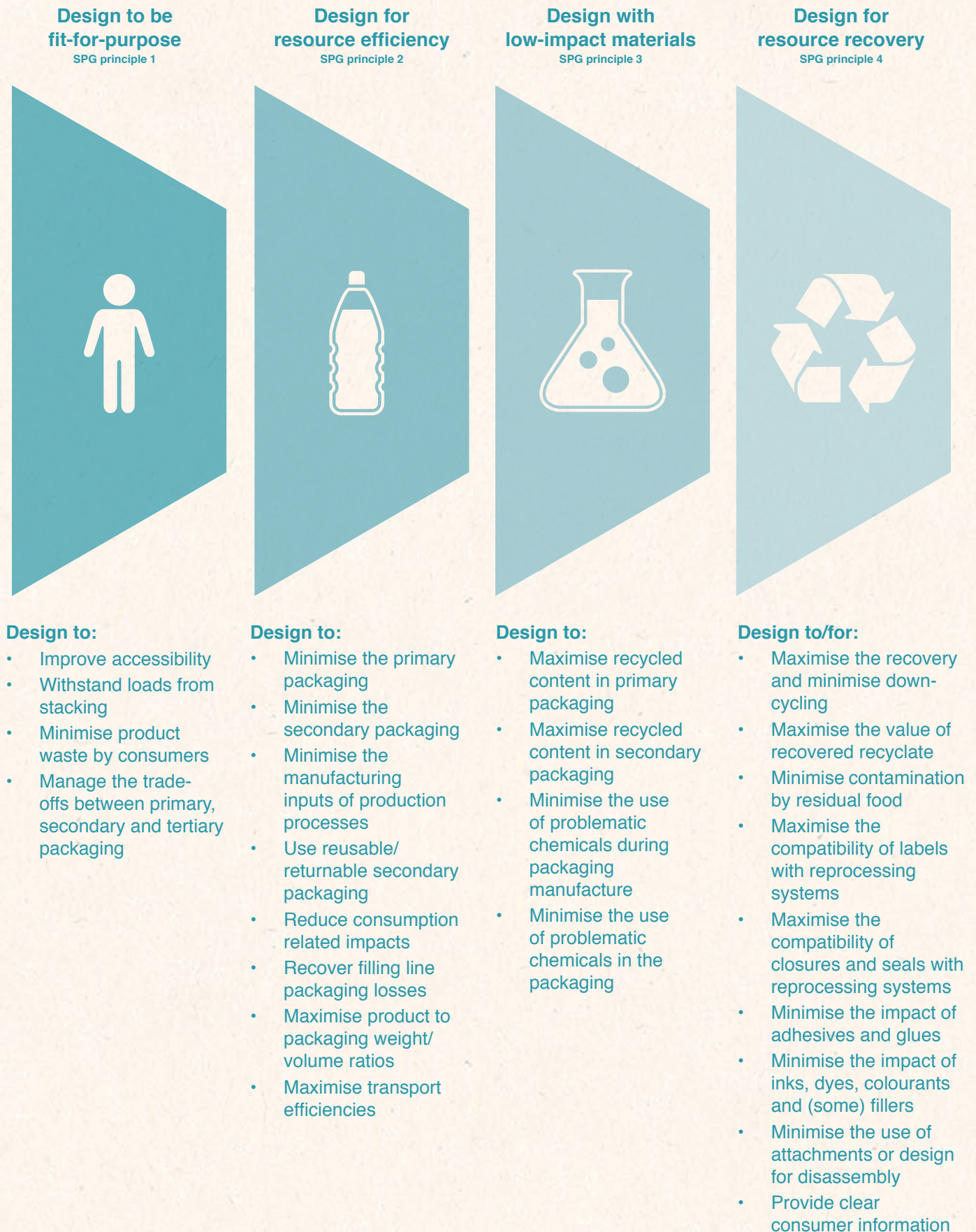
¹The resource efficiency design hierarchy is also often referred to as the waste hierarchy.



Design Considerations for Rigid Plastic Packaging

Figure 2

Summary of design considerations for rigid plastic packaging



Design Considerations for Rigid Plastic Packaging

Table 3

SPG Principle	Design to	Design Considerations	Life Cycle Importance
1 - Design to be Fit-for-Purpose	Improve accessibility	<p>Minimise the rotational force requirement for breaking the initial seal on screw-top containers. Rotational forces greater than 1.1 Nm (newton metre) often exceed the functional capabilities of the frail, elderly and those living with arthritis.</p> <p>Ensure that screw top caps fit in the hand. Their removal should require no more than ¼ turn for each angular movement, and no more than two angular movements should be required. Use steep rather than gradual threading to prevent over-tightening of the cap.</p> <p>Require a grip span of no more than 71 mm for products required to be gripped in one hand, and incorporate serrations in plastic caps to make them easier to grip.</p> <p>If using closures or seals with rigid plastic packaging, check the required removal force. The force required to pull or puncture the seal should not exceed 22 newtons. Avoid seals that require a tool to puncture.</p> <p>Check Arthritis Australia's Food Packaging Design Accessibility Guidelines (see Useful Further Reading list) for more suggestions to improve the accessibility of your packaging.</p>	HIGH
	Withstand loads from stacking	<p>If considering the down-gauging of your rigid plastic packaging or secondary packaging, confirm with suppliers that the finished packaging will be sufficiently robust to tolerate the required stacking loads for your product. Transit test thinner/lighter weight packaging to prevent product loss through packaging failure.</p>	HIGH
	Minimise product waste by consumers	<p>Ensure that the contents can be fully dispensed, e.g. by avoiding square shoulders and grooves that make it very difficult for consumers to remove the last bit of product. Product waste left behind in the packaging may also increase reprocessing costs, and decrease the value of the recovered recyclate. The loss of your product as waste is also the loss of a valuable resource with a potentially significant environmental impact. Consider using designs with wide (but short) necks, or packs that can be stored inverted so the product is dispensed at the bottom. For the packaging of liquids, consider designs that will allow consumers to pour the contents with good control, to minimise the risk of spillage or excessive use.</p> <p>Another approach to consider is modifying the flow characteristics of your product, so it is more easily dispensed. Obviously, there is a trade-off here, as concentrating a product (and potentially reducing its flowability) leads to a reduction in the packaging requirement. Speak to your suppliers about balancing flowability and product concentration.</p>	MEDIUM
Manage the trade-offs between primary, secondary and tertiary packaging	<p>Consider primary, secondary and tertiary packaging as a total system. In particular avoid functional overlap between the primary and secondary packaging levels. For example, many rigid plastic packaging formats are weight-bearing, so secondary packaging is required to provide little, if any, load-bearing functionality.</p> <p>Consider possibilities for minimising the tertiary packaging components that are required to secure loaded pallets, which include the use of: strapping, down-gauged and perforated stretch films, sleeves, 'lock-'n-pop' low-residue adhesives, returnable plastic crates that lock into place on pallets with minimal strapping, or pallet boxes.</p>	MEDIUM	

Design Considerations for Rigid Plastic Packaging

2 - Design for Resource Efficiency

Minimise the primary packaging

Avoid long necks, flat shoulders, sudden transitions in shape, square shoulders/heels and deep dimples (punts) at the bottom of bottles and containers, which usually add extra plastic into the design to maintain container structural strength and internal volume. Consider shifting excess material from where thickness is not critical (e.g. the neck of bottles), to the areas where it is needed most. A high proportion of a bottle's weight is often in the neck, so design the thinnest neck profile possible, and try to avoid over-specifying just to 'play it safe'. From a distribution system perspective, do the load tolerance specifications match the requirements for your current distribution system? Check with your suppliers if you are unsure.

HIGH

Computerised design techniques, such as Finite Element Analysis, can help minimise plastic use. In addition, container manufacturing (e.g. blow moulding) is an area where technologies are always improving. Speak to your suppliers about different design and manufacturing techniques that can reduce material usage.

Consider designing your packaging to reduce packaging surface area per unit volume, as compact round shapes use less material than flattened 'display' formats. For example, avoid flattened bottles, which have a larger surface-to-volume ratio, and so use more material to contain the same volume of product. Flattened bottles are also more prone to deforming outwards under loads. These shape changes might have an impact on the amount of secondary/tertiary packaging that is required, so keep this in mind as some degree of trade-off might be required.

Indented handle features, rather than 'right through' integrated handles reduce material usage, and may still offer the same amount of user control.

PET bottle down-gauging has been achieved in the UK using shortened pre-forms, with thicker side walls. Ask suppliers if newer pre-form designs are available that will reduce material usage in your bottle, while still meeting your functional requirements.

The movement towards concentrating products (e.g. double or triple concentrated laundry detergents) is now well established in Australia. Concentrated products require less primary, secondary and tertiary packaging, and are also more efficient to transport. Is reformulating your product to reduce its water content (or volume in general) a viable possibility?

Consider using in-store shelf-ready packaging more effectively for product communication rather than relying on additional primary packaging components. For example, consider whether it is possible to reduce the label size by providing more promotional material on the shelf-ready packaging. Explore the options for novel display shippers or other shelf communication approaches that minimise the primary packaging.

Finally, more packaging is often used to signal a premium product. Consider alternative approaches to signal product quality to consumers through reduced printing and primary packaging. For example, consider the use of shelf-ready secondary packaging that allows the reduction or elimination of primary packaging. Potentially these types of changes can also lead to less in-store labour as well. The secondary packaging can incorporate elements such as shelf communication tools (e.g. external and internal printing) to aid brand recognition, while controlling and presenting products consistently.

Design Considerations for Rigid Plastic Packaging

2 - Design for Resource Efficiency

<p>Minimise the secondary packaging</p>	<p>Optimise your use of corrugated board in secondary packaging by minimising flap overlaps (even to the point that the box contents are visible). Also consider moving the flaps to the smallest end of the box (so there is less overlapping flap material). Discuss the possible options with your supplier and/or converter.</p> <p>You might be using a double-walled corrugated container (with two corrugated medium layers) to fulfil a structural strength requirement. Consider if adequate strength can be achieved with a single-walled corrugated container through the use of thicker gauge liners, but while still achieving a reduction in overall weight. Ask your supplier to assist with identifying the lightest weight corrugated board that will fulfil your functional requirement.</p> <p>Shelf-ready packaging is becoming an important supply chain value-add for many food and grocery items, and this shift may increase the packaging-to-product ratio. When moving to shelf-ready packaging, look for opportunities to minimise material use.</p> <p>Down-gauge secondary packaging as much as possible, while ensuring that the integrity of the primary pack is not compromised. The exception to this is if you are considering moving to a higher level of recycled content in the fibre-based secondary packaging, in which case a degree of 'up-gauging' could well be justified. See the second guide in this series (Fibre-based packaging), for more details on optimising the environmental performance of corrugated board-based secondary packaging.</p>	<p>HIGH</p>
<p>Minimise the manufacturing inputs of production processes</p>	<p>Electricity is usually the primary energy input during the manufacture of rigid plastic packaging, used both for powering equipment and for generating the heat used in forming the packaging. Ask your suppliers about their energy procurement practices, in particular for electricity. Do they source a proportion of their electricity from GreenPower™ accredited sources? What are the measures they have in place to improve energy efficiency? Do they purchase any greenhouse gas offsets?</p> <p>Compared to virgin polymer production, the production of recycled polymer can be significantly more water-intensive (due to the washing requirement). Ask your recycled content packaging suppliers about the activities they undertake to manage and minimise water use in the recycling process, or in their supply chain if they purchase recycle from other companies.</p> <p>Source your polymers from suppliers with a documented environmental management system and a strong commitment to best practice, e.g. as a signatory to PACIA's Sustainability Leadership Framework.</p>	<p>MEDIUM</p>
<p>Use reusable/returnable secondary packaging</p>	<p>Returnable plastic crates/trays (RPCs) that are collapsible or nesting are now seeing much broader use in the market, particularly by the major supermarket chains. The life cycle environmental and cost benefits of using returnable plastic crate systems, instead of corrugated boxes, are significant. Supply chain product losses are also reported to be significantly lower when using returnable plastic crate systems. However this currently relates more to fresh foods, such as fruit and vegetables, than more robust products commonly found in rigid plastic packaging. The market is moving in this direction, so consider if your product could be supplied in RPCs.</p> <p>Reusable packaging can be particularly suitable for short distribution chains, loose or manually packed products, easily damaged high value products, and large volume fast moving products.</p>	<p>MEDIUM</p>

Design Considerations for Rigid Plastic Packaging

2 - Design for Resource Efficiency	Reduce consumption-related impacts	If your product doesn't require refrigeration, make sure that this is prominently communicated on the label, to avoid consumers unnecessarily refrigerating the product. Refrigeration during distribution can be avoided by shifting to aseptic fill packaging if this is a viable option for your product.	MEDIUM
	Recover filling line packaging losses	While plastic packaging losses in the filling line will be low, confirm with line operators that they have an appropriate plastics recycling collection system in place.	LOW
	Maximise product-to-packaging weight/volume ratios	<p>Many products packaged in rigid plastic packaging already have close to ideal product-to-packaging weight and volumetric ratios. However, consider doing some 'back of the envelope' calculations on these ratios as part of your packaging system design process.</p> <p>Pre-settling or vacuum packing loose fill product is not feasible for many less dense products. However, consider if one of these techniques is viable for your product. Reducing the product volume reduces the primary, secondary and tertiary packaging requirement, and also reduces the transport requirements.</p>	LOW
	Maximise transport efficiencies	Have a look at your palletisation (volumetric) efficiencies; improving these can significantly reduce the costs associated with product storage and distribution.	LOW
3 - Design with Low-Impact Materials	Maximise recycled content in primary packaging	<p>Post-consumer PET recyclate is recycled back into food contact applications in Australia; however this is not currently the case for any other polymer types (although a new facility is being established to manufacture recycled HDPE for food contact packaging). Consider specifying a proportion of rPET (recycled PET) in your next packaging. A range of 25–50% rPET content should be manageable from a packaging performance perspective, while making a meaningful contribution to the rPET market demand. Using rPET could also help to manage fluctuating resin costs.</p> <p>Ask your packaging suppliers about the potential to incorporate some post-consumer recycled material in your packaging. Another aspect to keep in mind is that the use of recyclate presents more of a risk than virgin resin, for the migration of problematic chemicals from packaging to food. Using recyclate as a non-contact layer between two layers of virgin polymer may be possible for your application.</p>	HIGH
	Maximise recycled content in secondary packaging	Specify the highest possible level of post-consumer content in corrugated broad or polyethylene over-wraps and shelf-ready packaging, while maintaining the required functional and strength performance of the secondary packaging.	MEDIUM

Design Considerations for Rigid Plastic Packaging

3 - Design with Low-Impact Materials	<p>Minimise the use of problematic chemicals during packaging manufacture</p>	<p>Inks and lacquers are applied to labels and to some forms of secondary packaging, among other packaging components. Often these coatings involve the use of high VOC (volatile organic compounds) chemicals, particularly in the solvents. These chemicals can be locally toxic to human health (e.g. to the shop-floor workers) and the environment, and their use requires the operation of significant (and expensive) pollution control measures, such as gas-fired after-burners. Discuss with your packaging material supplier whether alternative low-VOC or water-based inks and lacquers are available that will fulfil your requirement. This type of change may reduce emission management-related costs, improve the health of the local environment, and will assist your supplier in maintaining a healthy work environment.</p>	MEDIUM
	<p>Minimise the use of problematic chemicals in the packaging</p>	<p>Bisphenol A (BPA) is often used as a precursor chemical (a primary ingredient) in the synthesis of polycarbonate and epoxy plastics. BPA is a weak endocrine disruptor that appears to interfere with normal hormone function, and can migrate into the contents of packaging, particularly foods that are high in fats. Food Safety Australia and New Zealand (FSANZ) advise that BPA is not a health or safety risk at the levels to which most people are exposed. This is a developing (and contested) area, so it would be worthwhile undertaking a risk assessment of potential BPA migration into your product, particularly if it is intended for consumption by small children. That said, prior to shifting away from plastics containing BPA, ensure your suppliers can provide a reasonable level of evidence that the alternative (non-BPA-containing) plastic is known to be safer in your application.</p>	MEDIUM
4 - Design for Resource Recovery	<p>Maximise recovery and minimise down-cycling</p>	<p>Rigid plastic containers made from PET and HDPE are the most likely to be recovered in any quantity in Australia, with strong end markets available for large quantities of these recycled polymer types, and could therefore be considered the most recyclable. Preferably use one of these two polymer types for the base resin of your packaging to support local reprocessors. Most forms of rigid plastic packaging are now widely collected at kerbside (particularly PP); however, the reprocessing is more likely to be done overseas, and the recovered packaging is of lower value and more likely to act as a contaminant in plastics reprocessing systems.</p> <p>In general terms, PET as a polymer has relatively low absorbance of contaminants (and also has lower levels of additives added during manufacturing to modify the properties of the polymer); PP has medium absorbance; and PE has high absorbance, with subsequent potential for diffusion of absorbed contaminants back into packaging contents from the recycled plastic. That said, PP and PE can be recycled back into food contact packaging applications, but need to be either rigorously purified, or used as a centre layer between layers of virgin material. HDPE bottles are already recycled back into food contact applications overseas, and a facility will soon be available to do this in Australia.</p> <p>Avoid using a combination of different polymer types, as this inhibits recyclability. If more than one polymer is necessary for your application, then try to use polymers with different densities so that they can be easily separated during the float/sink separation step that is common during reprocessing. As a general rule of thumb, design to keep the sum of the other components to less than 5% of the main primary packaging component. This still assumes that the other components are 'compatible' with reprocessing.</p>	HIGH

Design Considerations for Rigid Plastic Packaging

4 - Design for Resource Recovery

Coloured plastics are almost invariably 'down-cycled' into lower value, longer term applications, from which they are less likely to be recycled at end-of-life (e.g. timber substitutes, pallets and builder's film).

It is often very difficult to determine the recoverability of rigid plastic packaging without specific information from your supplier or from recyclers. If in doubt, consider asking your suppliers for third-party certified information on the recyclability of the packaging that they are supplying. If you can't get this information from your suppliers, then check with recyclers (both sorting facility operators and plastic reprocessors) on the recoverability of your packaging. Some recyclers operate technical facilities that can answer these types of questions, or they may have already done the tests.

Maximise the value of the recovered recyclate

As much as is possible, consider using only one polymer type in your packaging. Match minor components such as labels, closures, and seals to the polymer type of the container to ensure that they are compatible in reprocessing (see Table 4). Avoid multi-layer containers if possible, as they generally produce a lower value recyclate that will need to be down-cycled.

HIGH

Unpigmented rigid plastic packaging (e.g. bottles) produce higher value recyclate than coloured bottles. Unpigmented PET and HDPE bottles, in particular, are also much more likely to be recycled in high value closed- and open-loop recycling applications. Consider avoiding or minimising the use of pigments in the primary packaging as much as possible. Could you print more information on the lid rather than the body of the packaging?

Avoid or minimise the use of 'fillers' (e.g. calcium carbonate, talc, and titanium dioxide) that change the density of the plastic. Fillers cause reprocessing issues and lower the value of the recovered recyclate.

Metal (particularly aluminium seals and caps) and paper components can be problematic in plastics recycling, and will not be recovered. As much as possible, metal or paper components should be avoided or minimised, or designed to be easily separable by consumers, to improve the recyclability and value of the plastic packaging.

Minimise contamination by residual food

Product contamination of rigid plastic packaging can represent a significant proportion by weight of the collected material (e.g. residual yoghurt in a yoghurt tub). Provide the consumer with clear instructions to 'rinse and recycle' if your product is one for which food residues are likely to be significant.

MEDIUM

Maximise the compatibility of labels with reprocessing systems

Labels can have a significant impact on the recycling process and the value of recovered recyclate. As a general approach, consider matching the polymer type used for the label to that of the container (e.g. a PET label with a PET container, and a PE label with an HDPE container). Consider using label adhesives that will readily allow label separation during the float separation and washing steps of reprocessing (adhesives are discussed in more detail below). If in doubt, speak to your suppliers about the properties of the adhesives you are using. It is possible that changes to labels and adhesive, that will make little or no difference to your costs or consumer perception of your product, may significantly improve the quality or value of the recovered flake.

HIGH

Design Considerations for Rigid Plastic Packaging

4 - Design for Resource Recovery

Some label materials are more compatible with plastics reprocessing processes than others. This compatibility is dependent on both the label material in relation to the polymer type of the container (e.g. the use of PVC labels/seals on PET containers), and the potential contamination issues that can arise from the label itself (e.g. water-resistant paper labels).

Confirm that your chosen label material will not delaminate during float separation and washing, as this also causes problems.

For PET a range of contaminants exist, including PVC (a particularly serious contaminate), rosin (derived from pine resin, and used as a paper sizing agent or label adhesive) and EVA cap liners. These will all result in discolouration of the recovered PET resin when it is melted for manufacturing of new containers. Rosin also imparts water resistance to paper labels (which can be part of its intended function) so its use should be minimised for this reason as well. On PET bottles, consider using label materials that float (PP and PE), as these are more easily separated during reprocessing, and avoid using orientated PS (OPS) labels if possible.

Pressure sensitive labels (which have adhesive across the complete back of the label) can be used on PET containers, provided they separate from PET regrind in a typical PET hot caustic water wash step (at 60–80 °C).

Avoid the use of OPS and PVC labels with both HDPE and PET containers, as any residual OPS and PVC will degrade at the reprocessing temperatures of these materials. PP labels will float, so they are more likely to present as a (minor) contaminant in HDPE containers.

LDPE labels are compatible with HDPE containers, but heavily coloured LDPE will discolour unpigmented HDPE recyclate during reprocessing. See more below in Minimise the use of inks, polymer colourants and fillers on the impacts of inks in general.

HDPE labels with a minimal amount of colouring are most compatible with HDPE recycling. Inks and dyes are always going to be an issue, so minimise these as much as possible.

HDPE flake is often washed at ambient temperatures, at which many of the adhesives used for pressure sensitive labels will not release. Check with your supplier that the pressure sensitive label adhesive you are using (on a HDPE container) will release at ambient wash temperatures. Also consider using self-peeling labels that fully adhere at normal temperatures, but readily peel free at typical flake washing temperatures during reprocessing. Speak to your suppliers about the availability/applicability of these approaches.

Optical polymer sorting systems are generally unable to accurately sort bottles and other containers that have full-body shrink sleeves or stretch sleeves (of a polymer different from the bottle). Ensure you select a sleeve polymer type that is the same as the container polymer, so the container gets sorted into the correct polymer stream. Also keep in mind that if your product uses labels that fully wrap around the container, consider designing the packaging so that the adhesive is on the label, not on the container. Consider using shrink fit sleeves that can be removed by consumers, and provide consumers with clear instructions on how to remove the sleeve.

Design Considerations for Rigid Plastic Packaging

4 - Design for Resource Recovery

Paper labels are acceptable provided they are attached to the container using water soluble adhesives, and aren't water resistant (but still consider using the minimum amount of adhesive – see more on adhesive selection in the section Minimise the impact of adhesives and glues). However avoid the use of wet-strength paper labels, or paper labels that are coated with water-resistant decorative (e.g. metallic) or protective finishes, such as lacquers or coatings. It is preferable for the paper label to break-up during the wash phase, so the fragments are more likely to be removed with the wash-water, rather than staying in larger pieces and being retained with (and contaminating) the flake.

Avoid using in-mould labelling where the label (commonly made from paper, PP or PS) is heat fused to the container. This permanently attaches the label and inks to the container, and can also interfere with optical polymer sorting systems if the label is made of a different polymer to the container.

Direct printing with ink doesn't usually interfere with optical polymer sorting systems; however the ink may discolour the recyclate during subsequent reprocessing, so consider minimising coverage and dark colours as much as possible.

Opaque bottles and thick, full-coverage, heavily printed labels are more likely to reduce the accuracy of optical sorting. Optical polymer sorting systems cannot identify polymers that are pigmented black. Where plastic containers cannot be 'positively' sorted into clean polymer streams, for whatever reason, they will mostly be recovered into a mixed polymer, lower value recyclate stream, which is likely to be down-cycled into long-life products, or disposed to landfill.

Maximise the compatibility of closures and seals with reprocessing systems

Closures and seals can have a significant impact on the recycling process and the value of recovered recyclate. As a general approach, try to match the polymer type used for the closure and seal to that of the container.

HIGH

Avoid using metal cap and seals on plastic containers, as they are difficult to remove and residual metal fragments cause high rejection rates in plastics reprocessing.

Design tamper-evident sleeves and seals to detach completely from the container, and provide consumers with clear instructions on how to do this. Alternatively, ensure that they have a different density from the container resin. Consider designing safety seals as an integrated function of the bottle.

As a general rule of thumb, consider avoiding the use of PVC wad liners. Ethylene-vinyl acetate (EVA) wad liners are less problematic during reprocessing. Speak to your supplier if you are unsure about the compatibility of your wad liner with your packaging and current reprocessing systems.

Minimise the impact of adhesives and glues

Minimise the use of adhesives as much as possible. This will lead to less contamination of the recovered flake or less adhesive to screen out. Adhesives will not be recovered during plastics reprocessing, so use the smallest amount that fulfils your functional requirement.

HIGH

Adhesives will either breakup or disperse during washing, and subsequently either leave a residue on the recovered flake or solid pieces in the recovered flake, both of which will impact on the quality of the recyclate. Once the use of adhesives has been minimised, consider using adhesives that are partially water soluble and will soften at 60–80 °C, so that the majority of the adhesive is removed in the wash water, and can be separated due to density differences.

Design Considerations for Rigid Plastic Packaging

4 - Design for Resource Recovery

Avoid the use of adhesives that are not softened by the hot wash water, such as some types of pressure sensitive adhesives. Pressure sensitive adhesives also cover the entire back of the label, and so are difficult to remove and will contaminate the recovered flake.

HDPE is washed in water at lower temperatures, generally around ambient, so consider using water soluble glues that are dissolved and diluted during washing. Although these will leave some residue on the flake, this is less of an issue than it is for PET.

Pressure sensitive and cold-seal adhesives (which usually contain a natural latex component) can be problematic in plastics recycling, primarily in terms of impacting on recyclate quality and value. Consider speaking to your suppliers about formulations that are compatible during reprocessing with your container.

If in doubt, consider checking directly with plastics reprocessors that any adhesives, inks or colourants you intend on using are compatible with their process.

Minimise the impact of inks, dyes, colourants and (some) fillers

Minimise your use of inks on labels as much as is practicable. Inks, particularly those that bleed, will lead to discolouration of recovered flake. Also consider speaking to your label manufacturer about the bleeding characteristics of the label inks that you are currently using, and if low- or non-bleeding (but still low VOC) inks are available for your application.

HIGH

As recovered PET polymer, unpigmented PET has the highest value, followed by green-tinted transparent bottles. Other transparent colours are less desirable. Opaque containers are also much less desirable, and in particular TiO₂ (white) coloured containers are highly problematic, and will prevent the PET from being recycled into new bottles or fibre.

If you are using a pigmented plastic, then the recyclate specifications are less sensitive to ink contamination, so printing directly on the container is less of an issue.

Additives to plastics, such as oxygen scavengers in PET, can cause discolouration after melt processing. Check what additives are added to the base plastic you are using, and speak to your suppliers about minimising any reprocessing issues associated with them.

Keep in mind that the use of fillers such as calcium carbonate, talc, or other fillers, if in sufficient concentrations, can alter the density of the polymer to greater than that of water (e.g. causing HDPE flake to sink in water), or alter other properties the recovered flake. Try to minimise the use of fillers.

Minimise the use of attachments or design for disassembly

Avoid the use of attachments as much as possible, unless they are made from the same polymer type as the base polymer (and are unpigmented). If the use of attachments is required consider approaches to aid the separability of the components. Avoid the use of adhesives, or use adhesives that are either water soluble or disperse at temperatures of 60–80 °C (if on a PET container).

MEDIUM

Minimising the number of separable components also helps to reduce the risk of littering.

Design Considerations for Rigid Plastic Packaging

4 - Design for Resource Recovery

Provide clear consumer information

Ensure that the PIC (Plastics Identification Code) is clearly embossed on the container, preferably on the base. Avoid printing the PIC on the label, as it may confuse consumers as to which component of the packaging it refers (e.g. the label itself or the container).

HIGH

Ensure that any other recycling messages are visible and provide clear guidance to consumers. The Mobius loop recycling symbol is recommended, plus the words 'Please recycle'. Provide a clear anti-littering message for products that are more likely to be consumed away from home. Consider providing information on the post-consumer recycled content of the packaging. Make it clear to which components of the packaging this relates.

See the [Introductory Guide](#) for more on labelling.



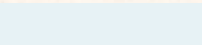


Design Considerations for Rigid Plastic Packaging

Table 4 provides some additional detail on the compatibility of different polymers during plastics reprocessing in Australia. A much more detailed table is also available in the PACIA Quickstart 5 – Design for recovery at end of life (see the Useful further reading section for more details).

Table 4
Guide to compatibility of polymers during reprocessing in Australia

	PET (1)	HDPE (2)	PVC (3)	LDPE (4)	PP (5)	PS (6)
PET (1)	Not compatible or separable	Fairly compatible or separable	Fairly compatible or separable	Fairly compatible or separable	Fairly compatible or separable	Fairly compatible or separable
HDPE (2)	Not compatible or separable	Not compatible or separable	Fairly compatible or separable	Fairly compatible or separable	Fairly compatible or separable	Fairly compatible or separable
PVC (3)	Not compatible or separable	Fairly compatible or separable	Not compatible or separable	Fairly compatible or separable	Fairly compatible or separable	Fairly compatible or separable
LDPE (4)	Not compatible or separable	Not compatible or separable	Fairly compatible or separable	Not compatible or separable	Fairly compatible or separable	Fairly compatible or separable
PP (5)	Not compatible or separable	Fairly compatible or separable	Fairly compatible or separable	Not compatible or separable	Not compatible or separable	Fairly compatible or separable
PS (6)	Not compatible or separable	Fairly compatible or separable	Not compatible or separable	Fairly compatible or separable	Fairly compatible or separable	Not compatible or separable
OTHER (7)	Not compatible or separable	Not compatible or separable	Not compatible or separable	Not compatible or separable	Not compatible or separable	Not compatible or separable

The table above assumes that an effective float separation step is undertaken. HDPE, LDPE and PP are incompatible with PET, PVC and PS during melt processing. However HDPE, LDPE and PP are all less dense than water, and PET, PVC and PS are all more dense than water, so these two polymer groups can be separated during the float separation process undertaken as part of the typical overall reprocessing process.

	Fairly compatible or separable
	Highly compatible or separable
	Not compatible or separable

Design Example

This design example illustrates some of the sustainability design aspects that could be considered during a packaging development or review. The product is a new personal care product in a 450 mL plastic bottle. Similar products are generally packed in a rigid HDPE or PET bottle, with a pump dispenser for ease of use. The bottles are packaged in a corrugated broad box for transport.

Sustainable design considerations



Designing the cap

The existing pump contains a metal spring, which may impact recyclability (check with recyclers). An alternative design incorporates a fully plastic pump. Ensure that the dispenser allows for the consumer to fully dispense the product.

Some pumps are difficult to unwind and engage before use. Make sure your pump is easy to use for consumers with limited strength or flexibility, and provide clear instructions for use if necessary.

Material selection

Rigid plastic containers are generally recyclable in Australia so the selection of material is not critical for recyclability. However, important considerations are:

- PET and HDPE are most recyclable in Australia (others are mostly exported)
- Clear or natural resins are easier to recycle
- Degradable polymers may contaminate recycling systems – check with recyclers
- Incorporating some recycled material if possible – check with suppliers

Bottle shape and thickness

Reduce the wall thickness of the bottle as much as possible within the constraints of filling, transport and use requirements.

The shape of the bottle and design of the pump should allow almost 100% of the product to be dispensed. Test different options to find the best combination.

Design the bottle to optimise efficiency in transport, e.g. a small change in bottle height could increase the number of containers per truck.

Label materials and adhesives

Labels and adhesives can cause problems in the recycling process. Options to improve recyclability:

- Use a material compatible in-mould label
- Avoid hot melt or pressure sensitive labels
- Use a compatible material for plastic labels, or a label material that has a different specific gravity to the base packaging material

Design Example

Consumer labelling

Include the relevant Plastics Identification Code on the bottom of the pack.

Include the Mobius loop and instructions on how to recycle, e.g.:

“This bottle is recyclable, please dispense all product and put it in your recycling bin.”

More innovative ideas that could be explored

- A container that relies on gravity rather than a pump to dispense the product
- An attractive, durable and refillable bottle combined with a lightweight refill pack (e.g. a stand-up pouch)
- A self-dispensing packaging system – for information on related UK trials. See www.wrap.org.uk/content/store-dispensing-systems-ids-retail-trial



Useful Further Reading

Reference

ACOR, 2012. Recycling Guide for Fillers Marketing in HDPE, Australian Council of Recycling. 23 pages.

What is it?

This ACOR document provides a great deal of detailed information on the main reprocessing and contamination issues for HDPE containers, and on approaches to avoiding these issues. The document also provides a good overview of HPDE reprocessing. If you are designing an HDPE container this document is well worth reading. Also see the related document for PET. Free download from:
www.acor.org.au

APC, 2010. Sustainable Packaging Guidelines, Australian Packaging Covenant. 30 pages.

The SPG is the key document for APC signatories and others to use in framing APC-compliant packaging reviews. The objectives of these reviews are to optimise resources and reduce environmental impact, without compromising product quality and safety. Free download from:
www.packagingcovenant.org.au/

Arthritis Australia, 2012. Food packaging design accessibility guidelines. 31 pages.

This document provides more detailed guidance on accessibility principles and strategies to improve accessibility of food packaging; prepared in conjunction with NSW Health. For a complimentary copy of the Food Packaging Accessibility Guidelines and several other packaging design reports contact Arthritis Australia at: design@arthritisaustralia.com.au

Association of Postconsumer Plastic Recyclers, 2008. Design Guidelines for Plastic Bottle Recycling. 28 pages.

The US-based Association of Postconsumer Plastic Recyclers (APR) prepared this guidance document to aid packaging designers and manufacturers in designing and manufacturing plastic containers to maintain or improve recyclability. The document provides extensive detail on the reprocessing and contamination issues for each plastic polymer type. Free download from:
www.plasticsrecycling.org/technical-resources/apr-design-for-recyclability-guidelines

Useful Further Reading

Plastics and Chemicals Industries Association, 2008–2009. Quickstart Issues 1, 5, 7 and 11. 6–7 pages.

The PACIA Quickstart documents provide lots of great information on sustainable packaging design, using recycled plastics and potential applications. Of particular note, Quickstart Issue 11 is aligned with the four principles of the APC's Sustainable Packaging Guidelines (fitness for purpose, resource efficiency, low-impact material use and resource recovery). These documents are valuable resources for plastic packaging designers. Free download from:

www.pacia.org.au/programs/quickstartpublications

Recoup, 2009. Plastics Packaging – Recyclability by Design, United Kingdom: Recycling Of Used Plastics Limited. 46 pages.

This guidance document was produced by Recoup (RECYCLING OF USED PLASTICS LIMITED), a UK-based plastics waste management research organisation, with funding by Reckitt Benckiser (UK). The document provides a great deal of detailed guidance on designing plastic packaging to facilitate mechanical recycling at end-of-life. If improving the recyclability of your packaging is a primary focus, then this document is recommended reading. Free download from:

www.recoup.org/business/default.asp?goto=eco_recydesign

Verghese, K., Lewis, H. & Fitzpatrick, L., 2012. Packaging for Sustainability. 1st ed. Boston: Springer. 384 pages.

This life cycle thinking-based reference book provides extensive detail on just about every aspect of sustainable packaging design. Beyond design, it also contains detailed information on marketing, regulatory and labelling aspects. Order from:

www.springer.com/engineering/production+engineering/book/978-0-85729-987-1

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