ACOR
AUSTRALIAN COUNCIL
OF RECYCLING

RECYCLING GUIDE FOR FILLERS IN PET CONTAINERS

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Contents

1. Introduction

Packaging innovation directly affects the availability of Polyethylene Terephthalate (PET) for recycling. To maximise recyclability, it is important to ensure that new designs and the use of packaging materials are compatible with existing PET recycling facilities.

Packaging components, such as adhesives, seals, sleeves and labels may cause negative impacts on the PET recycling process, product and infrastructure. In order to maximise PET container recovery, these guidelines aim to:

- Provide packaging designers and fillers with information on the recyclability of new labels, sleeves, closures, inks, tamper proof seals and other components used to market PET beverages or food containers;
- Encourage due diligence between trading parties;
- Ensure the use of packaging materials, such as labels, sleeves, closures and other components are widely accepted by Australian recyclers.

These guidelines are a benchmark for buyers and suppliers within the Australian recycling industry. ACOR welcomes feedback on all guidelines and specifications at any time to ensure they reflect current industry practice. Individual buyers and sellers can use it as a workbook or a reference for trading and negotiation. It is not compulsory for buyers and sellers to comply with the standards. However, buyers and sellers are strongly encouraged to work together and reach an agreement regarding terms and conditions.

2. Benefits of these Guidelines

Companies are able to gain a number of benefits by adopting these guidelines in product design, manufacturing and recycling. The benefits include:

- Greater stakeholder confidence in the industry;
- Greater transparency in product design, supply chains, product stewardship and recyclability;
- Stronger supply chain alignment between packaging manufacturers and the recycling industry to maximise PET packaging recycling rates;
- Higher standards of quality control.

3. How to use these Guidelines

These guidelines can be used as:

- An in- house working document that provides information for packaging designers and manufacturers to improve material recyclability.
- A reference for brand owners to approve the final design and uses of the new PET containers.

4. Properties and Chemical Components

PET is clear polyester which is strong, lightweight and has excellent wear resistance. It consists of carbon, oxygen and other hydrogen organic elements. Ethylene and paraxylene are the raw materials for PET bottle manufacturing.

PET is popular for use as bottles and food containers. It is safe to human health as the plastic's chemicals do not leak into the contents.

5. Common Abbreviations

Term	Abbreviation
Hazardous Aromatic Printing Solvents	HAPS
High Density Polyethylene	HDPE
Hydrochloric Acid	HCI
Intrinsic Viscosity	IV
Low Density Polyethylene	LDPE

Orientated Polystyrene	OPS
Polyethylene Terephthalate	PET
Poly (Ethylene- co- Vinyl Acetate)	EVA
Polystyrene	PS
Polypropylene	PP
Poly Vinyl Chloride	PVC
Polylactic Acid	PLA
Styrene Butadiene Rubber	SBR
Styrene Isoprene Styrene	SIS
Styrenic resins	ABS
Specific Gravity	SG
Thermoplastic Elastomers	TPE
Ultra Violet	UV

6. Rules of Recycling

1. Plastics Identification Code for Polymers

The plastic identification code is a series of symbols that assist product designers, manufacturing and recycling industries, government agencies and consumers to identify the types of polymers used in the manufacture of the product or packaging. The symbols are normally embossed on the bottom of the plastic containers and bottles, or at the back of packages.

The voluntary Plastics Identification Code ('the Code') was created by the Plastics and Chemicals Industry Association (PACIA) in 1990. The coding system consists of seven symbols (see table below). ACOR supports the use of this Code. However, the current code's artwork can cause confusion among consumers between the code and disposal instructions if not correctly placed in the package. The identification coding symbol for PET is number 1 inserted in a triangle and clearly embossed on the base of PET bottles or the back of packages.

Industry Coding for Polymers	**Symbol**	**Polymer**	**Applications**
		**Polyethylene Terephthalate (PET)**	**Beverage bottles, food containers, sheeting applications (e.g. cake and sandwich trays), textile fabrics**

			and garment fibres, etc.
		High Density Polyethylene (HDPE)	Bottle caps, 'singlet' shopping bags, freezer bags, household chemical bottles or containers, milk jags, etc.
		Plasticized (PPVC) or Unplasticised (UPVC) Polyvinyl Chloride	Plumbing pipes, garden hoses, blister packs, label, seals, etc.
		Low Density Polyethylene (LDPE)	Garbage bags and bins, recycling bins, bottle closure, bottle labels, etc.
		Polypropylene (PP)	Drinking straws, microwave ovenware, plastic hinged lunch boxes, bottle closures, household chemical containers, labels, etc.
		Polystyrene or Expanded Polystyrene (PS)	Yoghurt containers, plastic cutlery, foam hot drink cups, etc.
		---	All other resins and multi-blended plastic materials that are not listed from the above.

Note: If the container is manufactured using a blend of plastics, e.g. two or more plastics (PET and any other polymers), the container should be identified with the plastic industry code number 7 inserted in a triangle.

6.2. Floatation

Flotation is commonly used to separate adhesives and other plastics that are attached to PET containers.

If the specific gravity of a polymer is **lower than 1** (the specific gravity of water), it floats on water and can be easily separated during the flotation stage. However, some polymers', such as PVC, PS, ABS, OPS and PLA with specific gravities **higher than 1,** cannot be removed easily once it has been granulated.

The table below lists a range of special gravity of different polymers.

Polymer	Abbreviations	Specific Gravity	Softening or Melting Range (°C)
Polypropylene	PP	0.90	160- 170
Poly (Ethylene-co- Vinyl Acetate)	EVA	0.92	40- 60
Low- Density Polyethylene	LDPE	0.92	110
High- Density Polyethylene	HDPE	0.96	130
Thermoplastic Elastomer	TPE	0.98	95-110
Water	H_2O	1.00	---
Acrylonitrile-butadiene-styrene	ABS	1.05	90- 110
Orientated Polystyrene	OPS	1.06	80- 95
Polylactic Acid	PLA	1.24	173- 178
Poly Vinyl Chloride	PVC	1.35	70- 90
Polyethylene Terephthalate	PET	1.35-1.40	240- 260

6.3. Due diligence in packaging

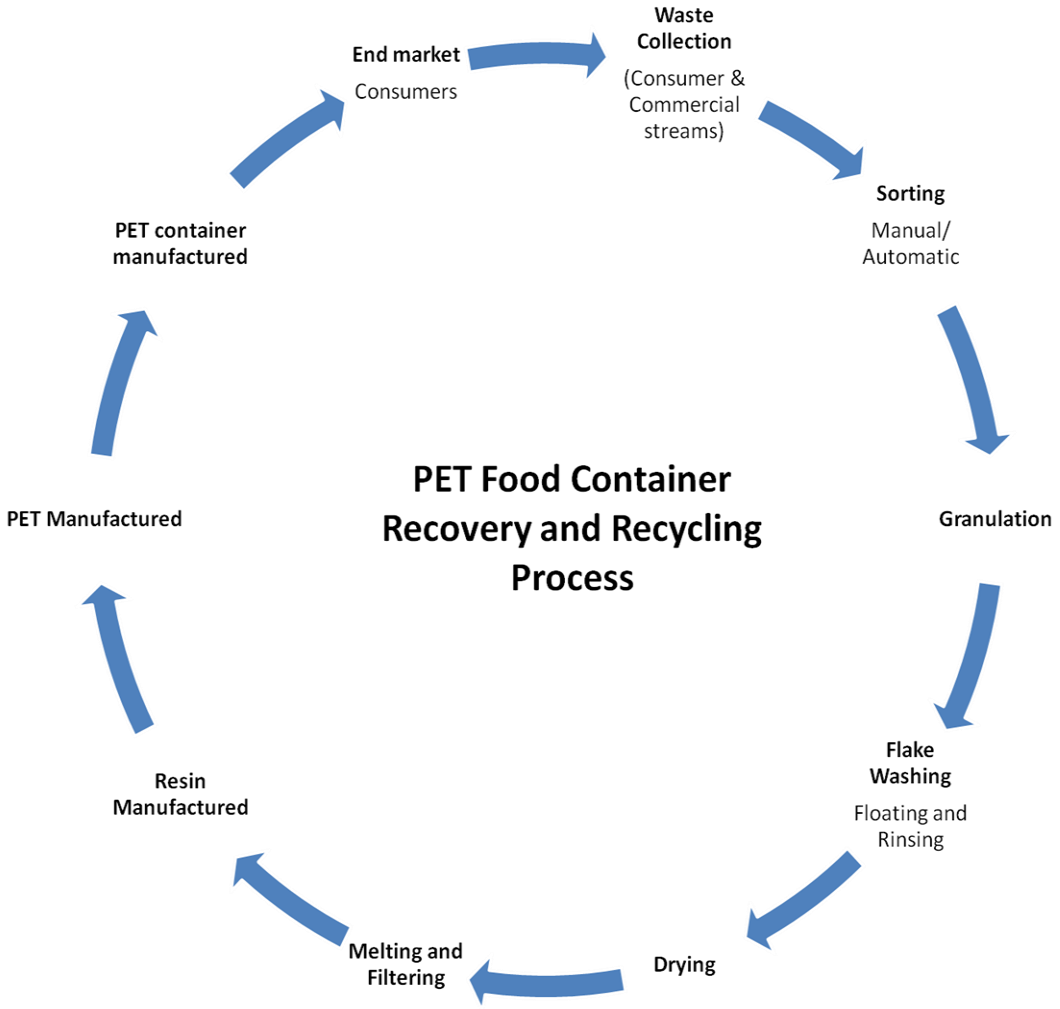
Packaging designers and manufacturers should exercise due diligence to ensure PET containers are accepted by Australian recyclers and should not make false or misleading claims. Packagers could consider conducting a recyclability test prior to launching.

7. Recovery & Recycling Process

The recovery and recycling process includes six steps, including:

1. Kerbside collection program
2. Sorting and baling
3. Granulation
4. Washing
    1. Floatation
    2. Rinsing and drying
5. Melt filtering
6. End market

This process is illustrated graphically below:



1. Collection

Most of the PET bottles and containers are collected from kerbside collection programs and drop off facilities. Once the plastic bottles and containers are collected, they will go through sorting and reclamation processes.

2. Sorting and baling

A material recovery facility (MRF) sorts PET manually (visual) and automatically. Manual sorting is based on shape, size, and colour of PET bottles and containers. However, this method is not completely effective or efficient. Some advanced MRFs use automated sorting that employs detective sensors to analyse the physical and chemical properties (e.g. colour and resin type) of plastic bottles and containers. Sorted PET containers are then baled and sent to recycling plants.

3. Granulation

Granulation is the initial step of the reclamation process. Bottles and containers are grounded into small pieces, called flake. Through granulation, some adhesives such as sleeves and paper labels are loosened and detached from PET bottles and containers. However, excessive glue on labels or attachments may contaminate the granulation process.

4. Washing

The washing process generally involves two parts: floatation and rinsing.

1. Floatation

Non- PET materials can be easily separated from PET flake if the densities are higher and lower than water specific gravity (water specific gravity is equal to 1). However, some plastics, such as PVC and OPS with similar or the same densities cannot be separated by this method.

2. Rinsing and Drying

This step is to remove residual dirt and chemical detergents from PET flake. The rinsed PET flake is then dried for remanufacturing applications.

5. Melting and Filtering

This step is to remove non- melting materials that cannot be removed from the washing process. Washed PET flake is then sent to an extruder that melts and filters the plastic regrinds through screening. The regrinds are then converted to pellets as feedstock for remanufacturing applications.

6. End Market

The resin recovered from post- consumer PET containers can be used for closed loop or open loop recycling applications. PET resin can be used to manufacture the same product or other products.

8. Labels & Shrink Sleeves

1. Size

In order to maximise the efficiency of PET screening, the design of labels and/or shrink

sleeves should be as small as possible. Labels and/or shrink sleeves that cover more than a quarter of the container or the surface of the container are less acceptable. The design of packaging should have at least more than 25mm without being covered by label materials.

Acceptable

Less acceptable

2. Contaminants

Packaging labels and sleeves lead to different levels of contamination in the PET recycling process. The level of contamination is classified as:

- Recycle- friendly
- Hazard
- Problematic and critical contaminant

1. Recycle- friendly

Polymer type	Specific Gravity	Characteristics
PP	0.90	Can be removed during the

labels and sleeves		washing process by a counter- current flow of water.
HDPE labels and sleeves	0.96	Can be removed during the washing process by a counter- current flow of water
LDPE labels and sleeves	0.92	Can be removed during the washing process by a counter- current flow of water
Clear PET labels and sleeves	1.38	• Retain the same characteristics as PET flake. • Small- to medium-sized PET shrink sleeves are ideal for PET recycling process.
TPE shrink sleeves	0.98	• Can be removed during the washing process by counter- current flow of water. • The absence of adhesive is ideal.

2. Hazard

Polymer Type	Specific Gravity	Recycling Issues and Impacts
Paper labels and	—	• Can be problematic if a large volume of paper

sleeves		labels and sleeves enter the recycling process ● Pulp will be generated when coming in contact with water. It damages the facility as the pulp blocks filters, creates caking of the heat exchangers and binding of the filters. ● The ink used in the labels can create problems such as bleeding, which leads to discolouration of the PET flake during the recycling process.

3. Problematic and Critical Contaminants

Polymer Type	Specific Gravity	Recycling Issues and Impacts
OPS labels and sleeves	1.06	● Sink and cannot be separated during the washing process. ● Not compatible with PET and cause serious contamination during the recycling process ○ Cloudy streaks

		form if OPS is injected in PET bottles ○ Loss of PET bottle recovery
PVC labels and sleeves	1.35	• Not recyclable if bottles contain or are made of PVC. • Cannot be removed during the washing process. • Once both PET and PVC have been granulated, the existing recycling technology cannot remove or separate the two polymers. • Black specks will be generated in the resin as PVC and PET are heated together.
Metallic impregnated labels and sleeves	---	Black specks or metallic flake are produced in the PET resin.
Coloured PET labels and	1.38	Bleeding will occur as a result of the ink from the labels or sleeves. It

sleeves		contaminates the recycling process.
Wet strength paper labels and sleeves	---	• Do not disintegrate to pulp during the washing process. • Black specks and carbonised strands are generated in the resin when they are heated.

9.

9. Recyclability of Attachments

1. Adhesives

The general compatibility of any attachments of the bottles or containers with PET resin and the removal of efficiency in water- based separation systems are the critical criteria that should be taken into consideration in packaging design and manufacturing.

To reduce the potential risk of contamination, it is recommended packaging designers, manufacturers and brand owners to consider the following criteria in their packaging design:

- Minimise the amount of adhesive and surface coverage attached on the containers.
- Minimise the use of glue and the glue layer should be as thin as possible.
- Use water- or alkali- soluble adhesives rather than pressure sensitive adhesives or thermoset polyurethane adhesives.
- Avoid using adhesives that are completely soluble in the caustic washing process. Once the PET flake is dried, it will be coated in a fine layer of glue residue which turns the PET flake to yellow or brown due to oxidation during the heating process.
- Avoid using glues that cannot be softened by hot caustic, such as pressure sensitive adhesives.

Furthermore with any new packaging design or label adhesive development, manufacturers or brand owners are recommended to conduct glue separation tests.

1. Standard Hot Melt Adhesive (Recycle- friendly)

Standard hot metal adhesives based on SBR or SIS, and containing tackifiers and hydrocarbon extenders are compatible with the process.

2. Pressure Sensitive Adhesives (Problematic)

Pressure sensitive adhesives are hard to remove and separate during the washing process as they are not softened by hot caustic washing. If the adhesive mixes with

PET resin, chars will generate during the heating and extrusion process. As a result, black specks are created in reformed containers.

2. Tamper Proof Seals

The design of tamper proof seal can be very problematic to PET recycling as the seal is broken away at the release point of the cap, leaving the film on the shoulder or the neck of PET bottles or containers. It is recommended that the new packaging design should avoid PVC tamper proof seals and make sure that seals can be easily removed from the bottle or container.

1. PET tamper proof seals (Recyclable friendly)

PET seals are accepted by Australian recyclers as the inks used on the seal can be removed and do not create contamination.

2. PVC tamper proof seals (Problematic)

PVC seals cannot be removed in the washing process. They are problematic to the following processes:

Process	Issues and problems
Washing	Cannot be separated and removed as PET and PVC possess similar characteristics in the washing stage. Both sink during the float- sink process.
Heating and extrusion	Black specks will generate in the resin.
	PVC degrades to carbon char, giving off hydrochloric (HCI) acid in the process. The HCI acid breaks down the polymer chain length or the Intrinsic Viscosity of PET.

3. Inks

The inks used on direct printing, labels and sleeves potentially result in bleeding and discolouring of PET flake. It is recommended that direct printing on PET containers should be avoided. If direct printing is considered, the designer should ensure the ink is removable under hot caustic washing process at 90^{O}C with 0.3% aqueous sodium hydroxide solution for 10 minutes.

Furthermore, inks that are used in PET packaging design should not be water- soluble.

Types	Accepted (Y/N)
UV- curable inks with photo-initiators	Y
Inks containing heavy metal pigments	N
Hazardous aromatic printing solvents (HAPS)	N
Water- soluble inks	N

4. Closures and Liners

Closures with no liners are preferred in new product design and development. If liners are used in the design, they should be retained within the closure and the specific gravity should be less than 1. Polymers such as PE, EVA and PP are preferable as their specific gravities are less than one.

Recycle- friendly

- PP closures and liners
- HDPE and LDPE closures and liners
- EVA closures and liners

Problematic

- PVC closures and liners
- Aluminium closures and liners

- Metal inserts and liners

5. Handles and Sport Caps

Handles and sports caps that are manufactured from polymers (e.g. ABS, OPS and PVC) with higher specific gravity than water should not be used. These polymers cannot be removed or separated during the washing process as they increase the potential risk of contamination in PET recycling.

Only those polymers with specific gravity less than one are regarded as 'acceptable' in the recycling process. The summary of the specific gravity of each polymer is listed in section 6.2.

Sport caps such as silicone valve, formed silicone rubber or any grades of silicone with specific gravity less than one are accepted in recycling.

10. Household Chemical PET Bottles and Containers

Household chemical PET bottles and containers are compatible with the recycling process. However, correct handling procedures must be in place for the recycling process. In general, the recycled materials generated from household chemical PET bottles and containers cannot be used in food container however they may be used in fibre and strapping markets.

The PET household chemical containers must fulfil the following criteria:

- Must not be used in food container applications
- Must not be placed in the recycling stream for processing new PET food containers
- Must not use clear transparent bottles to market and store the chemicals
- Must be identified separately to food containers
- Must be manufactured using distinctive colours and clear labelling

PET bottles and containers used to store poisons or household chemicals, such as Citronella lamp oils, mineral Turpentine, Kerosene, Methylated Sprits, and any mineral or chemical solvents are unacceptable to be recycled back into direct- food- contact containers.