

The APR Design® Guide for Plastics Recycling Guidance Addendum for PP Packaging

January 22, 2024

New Guidance impacting PP packaging has been recently approved for inclusion in the APR Design® Guide for Plastics Recycling. This new guidance is shown below and is available for immediate use. There are three sections presented below:

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Labels PP bottles

BRIEF DESCRIPTION - This section speaks to the design of labels for PP.

ADDITIONAL INFORMATION - Before PP bottles are granulated, complete packages with labels and closures are likely to be sorted by a NIR optical sorter and run through a sensitive metal detector. These situations create the need for testing to evaluate the impact of a label on NIR optical sortation or metals detection:

1. If a label does not allow the package to be positively identified as PP by NIR sorters, the container will go to the waste stream and not be recycled.
2. If metal decoration used on a label is detected by a metal detector, the package will be ejected and sent to waste. Metal decoration can include: vapor deposited films, metal foils, and metallic flake inks.

During the reclaiming process, PP packages are most likely washed in water near room temperature and with mild detergents. These wash conditions will have negligible impact on inks and adhesives and in most cases labels, inks and adhesives are expected to become included in the recycled PP product.

Preferred guidance

Automated sorting performance criteria

For containers with a brimful volume of 550 ml or less, the surface area coverage of the label is no more than 55%, and no metal decoration is employed on the label.

ADDITIONAL INFORMATION - Surface area is defined as the area of the label divided by the area of the side wall and shoulder of the container. The area of the neck ring, threaded finish and base are not included in the area calculation. Metal decoration includes vapor deposited metal films, metal foils, or inks with metallic pigments.

Containers with no more than 55% surface area coverage by a label are expected to sort accurately through NIR optical sorters. Labels with metal decoration can be tested for any impact on sorting performance using SORT-B-03.

For containers with a brimful volume of over 550 ml, the surface area coverage is no more than 75%, and no metal decoration is employed on the label.

ADDITIONAL INFORMATION - Surface area is defined as the area of the label divided by the area of the side wall and shoulder of the container. The area of the neck ring, threaded finish and base are not included in the area calculation. Metal decoration includes vapor deposited metal films, metal foils, or inks with metallic pigments..

Containers with no more than 75% surface area coverage by a label are expected to sort accurately through NIR optical sorters. Labels with metal decoration can be tested for any impact on sorting performance using SORT-B-03.

When higher surface area coverage than detailed above is employed, a label can be categorized as Preferred when meeting guidance criteria of SORT-B-01 for NIR detection of the PP container.

ADDITIONAL INFORMATION - Labels with high surface area coverage may interfere with detection of the PP container. The label substrate (film or paper), inks, and metal decoration can interfere with NIR detection when the label covers a high surface area of the container.

When metal decoration is employed.

ADDITIONAL INFORMATION – A label can be categorized as Preferred with respect to sorting performance when the metal detection criteria presented in APR-SORT-PR-02 are met. A summary of the starting points for spherical equivalent and maximum surface area coverage by decoration technology are shown in the tables below. Any label coverage below the Preferred surface coverages listed would be considered to be Preferred (for metal sortation). Any packages that have surface areas above these starting points would need to be tested using SORT-B-03 to verify they are below the spherical equivalent thresholds. Without further testing, metal foils with surface areas above the starting points in the table are categorized as detrimental due to a higher probability of being removed by the metal detector during sortation. Solid foils will continue to render the package non-recyclable per APR's definition.

HDPE Rigid Article				
	Solid Foils	Metallized Transfer Product	Filmic Metalized Label	Metallic Ink
Preferred Surface Area	N/A	310 cm ² (48 in ²)	194 cm ² (30 in ²)	310 cm ² (48 in ²)

SPHERICAL EQUIVALENT (B)					
PP Rigid Article					Applicable APR Recyclability Category for "NIR Sorting Potential"*
Rigid metal or Attachment	Solid Foils	Metallized Transfer Product	Filmic Metalized Label	Metallic Ink	
0 - 2 mm		0 - 12 mm	0 - 12 mm	0 - 12 mm	APR Design Guide Preferred
> 2 - < 12 mm					Detrimental to Recycling
≥ 12 mm	All	≥ 12 mm	≥ 12 mm	≥ 12 mm	Renders Package Non-Recyclable per APR Definition

*See category definitions in APR Design® Guide for Plastics Recyclability Home Page

Preferred guidance for labels that meet NIR sorting and metals testing guidance

Polyolefin film labels

ADDITIONAL INFORMATION - Polyolefin labels are commonly expected to be PP films or PE films. This includes film labels for each of conforming, adhered, and in-mold style of labels. Some additional considerations:

- If the label is designed to remain with the granulate (an adhered or in-mold label) and adhere to the granulate, or is molded in, the label should not interfere with the ability of the granulate to float in water.
- If the label is designed to separate from the PP container, it is desirable that the label floats so that the label might be recovered for recycle value.
- Those committed to developing a circular economy for PP containers will favor labels with either of these characteristics:

- Labels have been shown to be compatible with PP recycling using the APR Critical Guidance Test for PP containers.

Direct printed as well as heat transfer inks labels

Shrink or stretch labels that sink in water, and which are not made with PVC film.

ADDITIONAL INFORMATION - When a label is liberated from a PP package during the granulation step used in recycling, labels that sink in water will be separated from the PP during the sink/float step. Labels that sink in water go to waste, but do not interfere with the reclaiming process.

Detrimental

Paper labels

ADDITIONAL INFORMATION - Managing the paper pulp that is generated from washing containers with paper labels adds to the complexity of the recycling operations and increases waste disposal costs. When paper is not fully removed from the container, paper blinds melt filter screens and contributes to waste and process down-time. That said, a paper label and adhesive that can be washed cleanly from the PP and not discolor the PP flake is more desirable than a label used with no test evaluation.

Labels made with PVC film.

ADDITIONAL INFORMATION - The low thermal stability of PVC makes its use in any PP recycling process undesirable.

Closures, fitments, liners, and safety seals

Preferred

Primary material employed to make a closure shell, fitment, or spout

Polyethylene closures that are less than 10 wt% of the package weight.

ADDITIONAL INFORMATION - Polyethylene can be a contaminant in PP. When PE and PP are melt mixed in an extruder the PE exists as a second phase which can dramatically reduce the impact toughness that is a valuable property of recycled PP.

To evaluate the 10% limit, APR guidance is to employ as numerator the sum all the PE employed on a closure, fitment, pour spout, or over-cap employed on a package. Then the denominator is the sum of the PE just mentioned along with the weight of the PP used to make the package. Any PE from labels or attachments is ignored in this evaluation.

An allowance for up to 10 wt% PE from closures reflects that the PP recycling stream routinely contains PE and reclaimers can manage and accept some PE content in the PP stream.

Liners and over-molding employed with closures

Any floating olefin-based polymer, or polymer compound, may be employed to make a liner or employed to make an over-molding on a closure shell.

ADDITIONAL INFORMATION - These materials are within the scope of floating olefin-based polymers:

- The finished polymer compound with any additives and color concentrate has a density less than 0.985 g/cm³, or can be shown to float in water using APR's test O-S-01
- Ethylene polymers and copolymers including EVA copolymers and ionomers.
- Thermoplastic elastomers based on olefinic constituents. The more common elastomers are ethylene and/or propylene based plastomers/elastomers as well as olefin block copolymers including SEBS.
- Foamed olefin-based materials.

PP base resin and Articles

Preferred

PP control resin

There are hundreds of PP materials available in the North American market that can be used to make rigid PP packaging articles. These differ in melt flow rate, may contain comonomers which vary by type and content, flexural modulus, impact resistance, and additives. Thus, the selection of a universal virgin control resin for use in comparing and blending with the Innovation test article is not practical.

To assess the effectiveness of the innovation, the natural-colored base polypropylene without the innovation present should be used as the control. This polypropylene must be consistent with the ASTM D4101 definition of polypropylene.

Control articles

The control resin is typically used to make extruded or molded control articles that are used in testing.

These articles may include:

- Bottles or containers made by blow molding
- Containers made by thermoforming sheet
- Containers made by injection molding
- Pellets for testing resins and resin blends that incorporate the innovation being tested but have not been converted into package form (PP-CG-01 Path 2)

PP resin density

BRIEF DESCRIPTION - This section speaks to the density of filled PP resins.

Package or packaging component density

Density is an important property and float-sink tanks are critical separation tools used by reclaimers. Many fillers, pigments and additives used with PP have higher densities and when incorporated into PP can increase the density of resulting PP blend causing it to sink in the float-sink tank. When a PP item sinks during reclamation, the item is lost as waste reducing yield, increasing cost, and thus will be categorized as non-recyclable. The density of an item can be calculated or measured via ASTM D792, ASTM D1505 or ISO 1183-1.

Preferred

PP blend density is $\leq 0.97 \text{ g/cm}^3$.

Requires Testing

PP blend density is $> 0.97 \text{ g/cm}^3$ and $< 1.0 \text{ g/cm}^3$.

- If $\geq 95 \text{ wt\%}$ of the PP item floats when tested via [APR O-S-01 PO Sink Float Screening](#), then the item is classified as **Preferred**.
- If $\geq 51 \text{ wt\%}$ to 95 wt\% of the PP item floats when tested via [APR O-S-01 PO Sink Float Screening](#), then the item is classified as **Detrimental**.
- If $< 51 \text{ wt\%}$ of the PP item floats when tested via [APR O-S-01 PO Sink Float Screening](#), then the item is classified as **Non-Recyclable**.

Renders the package not recyclable

PP blend density is $\geq 1.0 \text{ g/cm}^3$ or $< 51 \text{ wt\%}$ of the PE item floats when tested via [APR O-S-01 PO Sink Float Screening](#).

Additives

BRIEF DESCRIPTION - This section speaks to the use of degradable additives in PP containers.

Please refer to APR's Position on Degradable Additives Used in Plastic Bottles, Thermoforms, and Films.

Barrier layers

EVOH Barriers

Ethylene Vinyl Alcohol copolymer (EVOH) is a common layer material used to increase the barrier properties of PP packaging. It is not separable in the recycling process and therefore will become part of the recycled PP. Malleated polypropylene (PP-g-MAH) tie layers are commonly used in combination with EVOH to improve the adhesion between PP and EVOH and have been shown to improve compatibility during the recycling process.

Preferred

EVOH \leq 6.0 wt% + PP-g-MAH tie layers with MAH $>$ 0.1 wt% and EVOH:tie layers ratio \leq 2

APR guidance is a package containing up to a 6 wt% layer by weight of EVOH + PP-g-MAH tie layers with MAH $>$ 0.1 wt% and EVOH:tie layers ratio \leq 2 can be compatible with the residential postconsumer PP recycling stream.

Detrimental

EVOH $>$ 6.0 wt% + PP-g-MAH tie layers with MAH $>$ 0.1 wt% and EVOH:tie layers ratio \leq 2

Renders the package not recyclable

EVOH $>$ 1% with any other tie layers

Packages falling outside the PREFERRED range can be shown to be compatible with the PP recycling stream via APR's Recognition Programs.

DOCUMENT VERSION HISTORY

Version	Publication Date	Revision notes
1	03-23-2023	Creation of addendum with updated metallization and additives.
2	05-22-2023	Added spherical equivalence table, PP base resin and control articles.
3	10-27-2023	Updated EVOH Barrier Layer
4	01-22-2024	Updated density guidance, APR Logo, font colors and aligned verbiage