APR Design® Guide for Plastics Recyclability
for
PP (Polypropylene, Resin Identification Code #5)

Due to its balance of impact, heat and chemical resistance, along with stiffness and close dimensional tolerance, PP is one of the most widely used packaging resins. It is easily injection molded, blow molded or thermoformed into a bottle, canister, pail, squeeze tube, tray, tub or closure. Unlike some other polymers, the versatility of PP allows all components (label, body and closure) of many PP packages to be made of PP. This practice is beneficial to recycling.

PP properties are commonly enhanced with colorants, additives and fillers, or it is placed alongside other polymers in a multi-layer package. Each modification and addition to the natural PP in a package must be considered for its effect on the recycling stream. Non-PP packaging features should either be economically removed from the PP in the typical recycling process or be compatible with PP in future uses. Of particular concern are mineral fillers or additives that cause the overall density of the blend to be greater than 1.00. The density of PP is .90-.92 so it floats in water. Density is an important property as reclaimers typically rely on float-sink tanks to separate polymers and to remove contaminants.

Per the scope outlined in the Design Guide introduction, the following guidance is focused on postconsumer packaging items that are typically picked up in single stream curb side collection systems. Further the guidance considers the impact on sortation at a modern automated MRF or PRF, as well as the compatibility of a PP packaging item in common PP reclaiming processes. This guidance will also be applicable to other postconsumer household items such as toys.

PP is used widely in industrial applications and postindustrial PP is an important source of PP that is collected and recycled. The APR Design® Guide can be a reference when designing industrial applications with PP, but not all guidance may be applicable when recyclability of such items is being considered.

The APR Recognition Program encourages consumer product, plastic package and bottle component manufacturers to work with the APR protocols to determine whether new modifications to a regularly recycled plastic package will negatively impact the recycling process prior to introducing the modification.

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APR encourages the use of the correct Resin Identification Code symbol of the proper size as detailed in ASTM D7611.
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➢ BASE POLYMER

PREFERRED
Postconsumer polyolefin content
The use of postconsumer PP in all packages is encouraged to the maximum amount technically and economically feasible.

DETRIMENTAL
None specified

RENDERS NON-RECYCLABLE
None specified

REQUIRES TEST RESULTS
Blends of PP and other resins designed to enhance properties in the intended first use with unknown residual effects in future uses of the recovered resin.

Definitive Test: Critical Guidance Protocol for PP (PP-CG-01)

➢ COLOR

PREFERRED
Unpigmented (Natural) PP
Natural material has the highest value as a recycled stream since it has the widest variety of end-use applications. It is the most cost effective to process through the recycling system.

Translucent and opaque colors
PP is commonly colored so volumes and markets exist for colored material and it is economical to process.

DETRIMENTAL
Optical brighteners
Optical brighteners are not removed in the recycling process and can create an unacceptable fluorescence for next uses of recycled PP. It is difficult to identify material with this negative effect until extremely late in the recycling process where a great deal of added cost has been imparted into a material of low value due to the additive.

Also see “Requires Test Results” section

RENDERS NON-RECYCLABLE
None specified
**REQUIRES TEST RESULTS**

*Colors with an L value less than 40 or an NIR reflectance less than or equal to 10 percent*

Sortation testing for dark colors will result in either a Detrimental or a Renders Non-Recyclable ruling. Dark colors cannot be Preferred at this time.

There is no mechanical property inherent in dark PP that makes it unrecyclable. The problem lies in sorting and the physics behind polymer identification. NIR (near-infrared) sorting technology used in MRFs is not capable of identifying many dark polymers since the colorant absorbs light. There are dark shades that may be detected by NIR, and a PP label of a different color on a package might aid in detection by NIR. It is not feasible to use manual sorting to separate one dark polymer from another since they cannot be distinguished by sight.

Although the APR encourages and anticipates development in capturing dark plastics at the MRF this technology is not widely available today. It should be noted that dark colors used in industrial items fall outside the scope of the design guide since they are not typically collected through curbside collection that is the focus of this guidance. Non-NIR sortable PP, if collected in a source separated or postindustrial stream, can be reclaimed.

Recent innovations in both black colorants and sortation technology have created the possibility of sortable black PP containers. However, markets for black PP containers remain limited for curbside material as referenced above. Therefore, testing results are limited to Detrimental and Non-recyclable only.

Sortable colorants are commercially available. Companies that are considering such colorants and are unsure of their compatibility with recycling should ask their suppliers to provide APR test results. An item may meet the technical specifications for sorting, but may still not be considered recyclable in many communities.

**Definitive Test:** 
*Evaluation of the Near Infrared (NIR) Sorting Potential of a Whole Plastic Article (SORT-B-01)*

> **DIMENSIONS**

**PREFERRED**

*Items whose dimensions are clearly more 3-dimensional than 2-dimensional (CASS > 20)*

Early in the MRF sorting process, 3-dimensional items (containers) are separated from 2-dimensional items (paper). It is important that they sort property and do not cross-contaminate. Most PP bottles are more “round” (3-D) than “flat” (2-D) and therefore sort correctly. However, trays and tubs may not meet this guidance.

*Items greater than or equal to 7.5 liters (2 gallons) in volume*

Recycling machinery, particularly automatic sorting equipment, is not large enough to accept items larger than two gallons. Because larger containers jam the systems, most MRFs employ manual sortation before the automatic line to remove the large items. These items are recovered in a stream of bulky rigid containers that are sold and processed as polyethylene since the vast majority of bulky rigid items are comprised of this polymer. Other polymers including PET either negatively affect or are lost by the polyethylene processing.

*Items that measure larger than five centimeters (2 inches) in two dimensions*

Small size boundaries are of concern because the industry standard screen size potentially loses materials less than 5 cm to a non-plastics stream, causing contamination in that stream, or directly to waste. Testing can determine the impact of the size and shape of a container on sortability.
DETRIMENTAL
None specified

REQUIRES TEST RESULTS

Items more 2-dimensional than 3-dimensional (CASS > 11 but < 20)
Aside from not being captured for the PP stream, non-conforming items that are more “flat”, such as trays or small cups, can cause contamination in the paper stream. If items are not captured and directed into the PP stream, they are not recycled. Items should have a minimum depth of two inches for proper sortation.

Definitive Test:
**Evaluation of 2D/3D Sorting Potential for Articles (SORT-B-0X)**

Items smaller than five centimeters (2 inches) in 2 dimensions
The industry standard screen size potentially loses materials less than 5 cm to a non-plastics stream, causing contamination in that stream, or directly to waste. Testing can determine the impact of the size and shape of a container on sortability.

Definitive Test:
**Evaluation of Size Sorting Potential for Articles with at least 2 Dimensions Less than 2 Inches (SORT-B-02)**

➢ CLOSURES, SPRAY DISPENSERS, AND PUMPS

CLOSURES & CLOSURE LINERS; SAFETY SEALS

PREFERRED

*Polypropylene closures*
Since polypropylene is the same polymer as the package body, closures and dispensers made of it will be captured and processed with PP. This increases the reclaimers yield and reduces possible waste. The APR encourages the industry to innovate toward widespread use of same-polymer closures on bottles.

*Closure systems without liners*
Due to size and thickness, most liners are lost in the recycling process thereby slightly decreasing yield. Closures without liners do not experience this loss.

*EVA and TPE liners*
EVA and TPE float in water and will not be separated in the recycling process. However, they are compatible with PP and in fact enhance its properties so they are preferred.

*Closures or Safety seals made of Polymers with density >1.0 that sink in water*  
*(Specifically, PS, silicone, nylon, acetal, thermosets)*
Silicone, polystyrene, thermoset plastics, nylon and acetal are expected to sink in the float-sink tank, thereby separating from the PP. They also do not damage or wear cutting machinery in the recycling process. Small amounts of these materials that make it through the float-sink process can be melt filtered from the recycled PP in the extrusion step. However, these materials are lost to the waste stream in the recycling process and are considered less preferable than an alternative floating attachment that is compatible with PP.
Shrink film safety sleeves that are designed to be completely removed before the package can be opened

Regardless of material, designs that require complete removal by the consumer of the safety sleeve are Preferred, as the material will not be introduced into the recycling stream.

Polypropylene or polyethylene tamper evident safety sleeves

PP safety sleeves are the same polymer as the final product, and PE at the very small levels expected from safety sleeve residue has a very minimal negative impact. Such attachments that remain with the PP throughout the recycling process increase yield and have minimal negative quality impact for the reclaimer.

PETG or PLA tamper evident safety sleeves

PETG and PLA both sink in the float sink tank where they are removed from the PP. Unlike PVC, small amounts of PETG or PLA entering the extrusion process with the PP are not catastrophic since both can be removed in the melt filtering stage.

DETRIMENTAL

Polyethylene closures

Since polyethylene floats in water like polypropylene it is not separated in the reclaimers float-sink tank. When blended with PP it negatively affects the impact properties and can render the material brittle. Although very small amounts of Pe, such as that contributed by labels, are regularly accepted by PP reclaimers, closures and dispensers comprising a larger weight percentage of the package have a greater negative affect.

Closure Liners that are composites of Aluminum and Paper

These materials will contaminate wash water, will contribute to waste disposal costs, or will stick to the valuable PP and reduce quality and value of the final products.

Closures containing floating silicone polymer

This material passes through the float-sink tank along with the PP and is difficult to remove with other methods, thereby causing contamination in the final product. Sinking silicone does not experience this issue.

PVC closures and PVC tamper evident safety sleeves that are not completely removed when package is opened

PVC is relatively easy to remove in the float-sink tank since it sinks while the PP floats. However, the float-sink tank is imperfect and even a very small amount of PVC with the recycled PP renders large amounts of it unusable as the PVC degrades at lower temperatures than those at which PP is processed.

Also see “Requires Test Results“ section

RENDERS NON-RECYCLABLE

None specified
REQUIRES TEST RESULTS

Dispensers, closures or lidding with metal components

Sortation testing for metal components will result in either a Detrimental or a Renders Non-Recyclable ruling. Metal components cannot be Preferred at this time.

Metal contamination is highly undesirable in recycled PP. Metals create wear in process machinery, increase operation costs and yield loss, and are a primary source of defects in products made with recycled PP. MRFs and PP reclaimers use magnets, eddy current separators and metal detectors to keep packages with metal components out of the process stream. Any metal components, such as pump springs, valves, safety seals, or lidding that trigger the metal detector will cause the entire plastic item to be removed from the stream and not recycled.

Although metal is easily removed in the float-sink process, most reclaimers have metal detection equipment designed to protect their cutting machinery. Therefore, the container never makes it to the float-sink tank. Large metal items attached to PP packages may cause the package to be directed to the metal or waste stream in the recycling process, causing yield loss.

Definitive Test: Evaluation of Sorting Potential for Plastic Articles Utilizing Metal; Metalized or Metallic Printed Components (SORT-B-03)

Shrink film safety sleeves that are NOT designed to be completely removed before the package can be opened
If a shrink film safety sleeve is designed such that pieces of it may not detach from the package when opened, the material must be tested to determine its compatibility with PP recycling. Specifically, such materials should either sink and be separated from the PP, or if they float, they must be compatible with PP.

Definitive Test: Critical Guidance Protocol for PP (PP-CG-01)

SPRAY DISPENSERS AND PUMPS

PREFERRED
Dispenser seals made of Polymers with density >1.0 that sink in water
(specifically PS, silicone, nylon, acetal, thermosets)
Silicone, polystyrene, thermoset plastics, nylon and acetal are expected to sink in the float-sink tank, thereby separating from the PP. They also do not damage or wear cutting machinery in the recycling process. Small amounts of these materials that make it through the float-sink process can be melt filtered from the recycled PP in the extrusion step. However, these materials are lost to the waste stream in the recycling process and are considered less preferable than an alternative floating attachment that is compatible with PP.

DETRIMENTAL
Polyethylene dispensers
Since polyethylene floats in water like polypropylene it is not separated in the reclaimers float-sink tank. When blended with PP it negatively affects the impact properties and can render the material brittle. Although very small amounts of PE, such as that contributed by labels, are regularly accepted by PP reclaimers, closures and dispensers comprising a larger weight percentage of the package have a greater negative affect.
Also see “Requires Test Results” section

RENDERS NON-RECYCLABLE
None specified

REQUIRES TEST RESULTS
Valves containing Silicone (density and floatability will vary)
Check valves in spray dispensers or pumps may be made of silicone as an alternative to metals. While polymers are generally preferable to metals, the composition of a silicone part may cause it to be incompatible with PP recycling. It should sink in the sink/float system or be compatible with PP if it floats.

Companies that are considering such components and are unsure of their compatibility with recycling should ask their suppliers to provide APR test results.

Definitive Test: Critical Guidance Protocol for PP (PP-CG-01)

Valves or Springs made of Metal
Sortation testing for metal components will result in either a Detrimental or a Renders Non-Recyclable ruling. Dark colors cannot be Preferred at this time.

Metal contamination is highly undesirable in the PP reclaiming process. Metals create wear in process machinery, and increase operation costs and yield loss. While metals sink in the float/sink tank and are therefore easily separable from PP flakes, they contribute wear to size reduction machinery. MRFs and PP reclaimers use magnets, eddy current separators and metal detectors to keep packages with metal components out of the process stream. Any metal components, such as pump springs, valves, safety seals, or lidding that trigger these devices will cause the entire plastic item to be removed from the stream and not recycled.

Definitive Test: Evaluation of Sorting Potential for Plastic Articles Utilizing Metal; Metalized or Metallic Printed Components (SORT-B-03)

➢ BARRIER LAYERS, COATINGS & ADDITIVES

PREFERRED
EVOH up to 5%, with a minimum of 32 mol% ethylene
Ethyl Vinyl Alcohol (EVOH) is a common layer material used to increase the barrier properties of PP. It is not separable in the recycling process and therefore will become part of the recycled PP. APR guidance is that a package containing up to a 5% layer by weight of PP with a minimum of 32 mol% ethylene can be compatible with the residential postconsumer PP recycling stream. Package with a thicker EVOH layer or lower mol% ethylene may be tested according to APR Critical Guidance tests for compatibility in the PP recycling stream.

Workhorse additives historically used without issue
Most PP in a package contains some form of additives. The “workhorse” additives commonly used have not been shown to cause significant issues with the recycling process or further uses of the recycled PP. Commonly acceptable workhorse additives include:
• **Thermal stabilizers** - These additives typically enhance the further processing of the polymer and are therefore preferred for recycling.

• **UV stabilizers** – These additives typically enhance the further processing of the polymer and are therefore preferred for recycling

• **Nucleating agents**

• **Antistatic agents**

• **Lubricants**

• **Fillers** – note that many fillers are dense, so particular attention should be paid to the overall blend density

• **Pigments**

• **Impact modifiers**

• **Chemical blowing agents**

Additive usage should be minimized to maintain the best performance of recycled PP for future uses.

**DETRIMENTAL**

_Note: None specified_

**REQUIRES TEST RESULTS**

*Non-PP barrier materials other than EVOH*

Testing must show that layers and coatings will either separate and be removed from the PP in the recycling process or have no adverse effects on the recycled PP in future uses. When used, their content should be minimized to the greatest extent possible. Some layers and coatings have been found compatible with PP or are easily separated in conventional recycling systems.

Companies that are considering such barrier materials and are unsure of their compatibility with recycling should ask their suppliers to provide APR test results.

**Definitive Test:** Critical Guidance Protocol for PP (PP-CG-01)

_Additive concentration causing the overall blend to sink in water_

Many of the additives and fillers used with PP are very dense and when blended with the polymer increase the overall density of the blend. When their weight percentage reaches the point that the blend density is greater than 1.00, the blend sinks in water rather than floats. Density is an important property and float-sink tanks are critical separation tools used by reclaimers. Therefore, a sinking material will be considered waste by a polypropylene reclaimer and any PP in the blend will be lost.

**Screening Test:** Polyolefin Packaging Articles Sink or Float Evaluation (O-S-01)

**Degradable additives (photo, o xo, or bio)**

Recycled PP is intended to be reused into new products. The new products are engineered to meet particular quality and durability standards given properties of typical recycled PP. Additives designed to degrade the polymer by definition diminish the life of the material in the primary use. If not removed in the recycling process, these additives also shorten the useful life of the product made from the recycled PP, possibly compromising quality and durability.

Degradable additives should not be used without testing to demonstrate that their inclusion will not materially impair the full-service life and properties of any product made from the recycled PP that includes the additive. Testing must show that these additives will either separate and be removed from the PP in the recycling process.
or have no adverse effects on the recycled PP in future uses. When used, their content should be minimized to the greatest extent possible.

Screening Test: **HDPE/PP Degradable Additives Test (HDPE-S-03)**

➢ **LABELS, INKS AND ADHESIVES**

**LABELS AND INKS**
Label selection should be considered carefully to find the solution most compatible with the recycling process that also provides the necessary performance characteristics. At a minimum, labels must be designed so NIR sorting machinery can identify the bottle polymer with the label attached, and labels should use adhesives that release from the bottle. Removing adhesives is a significant component to the cost of recycling so the packages using the lowest quantity of appropriate adhesive are the most compatible.

APR provides an overview of labels and their compatibility with specific portions of the recycling process in our **Label Summary Table**.

**PREFERRED**

*Polypropylene or polyethylene labels*
PP labels are the same polymer as the final product and PE at the very small levels expected from label residue has a very minimal negative impact. Therefore, these labels that remain with the PP throughout the recycling process, whether they detach or not, increase yield and have minimal negative quality impact for the reclaimer.

*In-mold labels of a compatible polymer*
In-mold labels are not removed in the recycling process since they are bonded with the wall of the package. They will flow through the recycling process with the PP and be blended with the recycled PP. The lack of adhesive is beneficial to recycling since it cannot affect color or other mechanical properties. The label polymer and ink should be compatible with PP so as not to negatively affect its properties.

*Full bottle sleeve labels designed for sorting*
A positive aspect of sleeve labels is the lack of adhesive requiring removal in the recycling process. However, full bottle sleeve labels cover a large amount of the bottle surface with a polymer that is not the same as the bottle body. Because of this, a sleeve label designed without considering sorting may cause an automatic sorter to direct a PP bottle to another material stream where it is lost to the process. Furthermore, some incompatible sleeve materials that cannot be separated from the PP in the float-sink tank can contaminate the recycled PP produced. Sleeve labels that are designed for automatic sorting and sink in water are preferred, with the exception of PVC, where even small residual amounts that make it through the float-sink process will destroy the recycled PP in the extrusion process. Polyolefin sleeve labels that are designed for automatic sorting are also preferred since the small levels of completely incompatible material expected from label residue has a very minimal negative impact.

**DETRIMENTAL**

*Paper labels*
The PP reclamation process involves water and agitation. The paper that detaches from the container when subjected to these conditions becomes pulp, which does not sink intact but remains suspended in the liquid,
adding load to the filtering and water treatment systems. Paper remaining adhered to the PP travels with the PP to the extruder where the material carbonizes and causes color defects. Even after melt filtering, the burned smell and discoloration remain with the recycled PP thereby negatively affecting its potential reuse. Non-pulping paper labels used with non-releasing adhesives compound the problem since the entire label enters the extruder. Non-pulping labels, heavy enough to sink and durable enough to withstand the washing process that are used with releasing adhesives may alleviate this issue.

**RENDERS NON-RECYCLABLE**

None Specified

**REQUIRES TEST RESULTS**

*Label inks*
Some label inks bleed color in the reclamation process, discoloring the PP in contact with them and possibly diminishing its value for recycling. Since most recycled PP is colored, the impact of bleeding inks may not be significant; however, since the end use is not known beforehand, label inks should be chosen that do not bleed color when recycled. If inks redeposit on natural PP flake, this discoloring may diminish its value for recycling. Inks should remain adhered to the label and not bleed into wash water to avoid this potential discoloration. The APR test protocol should be consulted to determine if an ink bleeds.

Companies that have developed new, innovative laminated label substrates are encouraged to pursue APR Critical Guidance Recognition for their materials as well. Guidelines for the program are available [HERE](link).

Companies that are considering label inks and are unsure of their compatibility with recycling should ask their suppliers to provide APR test results.

*Screening Test: [PP/HDPE Bleeding Label Test (HDPE-S-01)](link)*

*Definitive Test: [Critical Guidance Protocol for PP (PP-CG-01)](link)*

*Metal foil, metalized and metallic printed labels*
Sorting equipment in the recycling process is designed to detect and eliminate metal from PP. Even very thin metalized labels may be identified as metal by the sorting equipment and cause the entire bottle to be rejected as waste, thereby creating yield loss. If not detected, metals may go into grinding equipment, causing damage and premature wear.

Metal foil labels that pass through sorting and remain with the PP are Detrimental, and the package is considered Recyclable with Detrimental Features. Very thin vacuum-deposited metal layers may pass through sortation and be considered Preferred. If a bottle is lost in the metal sortation process, it is rendered non-recyclable as it does not enter the stream and is discarded as waste.

*Definitive Test: [Evaluation of Sorting Potential for Plastic Articles Utilizing Metal, Metalized or Metallic Printed Components (SORT-B-03)](link)*

*Full bottle sleeve labels*
Full bottle sleeve labels must be tested for both bottle surface coverage and compatibility with PP.
Surface area: Some sleeve labels cover a large amount of the bottle surface with a polymer that is not the same as the bottle body. The label may then cause a false reading on an automatic sorter and direct a PP bottle to another material stream where it is lost to the process.

Definitive Test: Evaluation of the Near Infrared (NIR) Sorting Potential of a Whole Plastic Article (SORT-B-01)

Compatibility: Some sleeve label materials have a density of <1.0, and thus float in the float/sink tank and remain with the PP. This material cannot be removed in the recycling process and can contaminates the recycled PP produced if not compatible with PP.

Definitive Test: Critical Guidance Protocol for PP (PP-CG-01)

Direct printing other than date coding
Inks used in direct printing may bleed or otherwise discolor the PP during the recycling process or introduce incompatible contaminants that reduce the value of the recycled PP. The specific ink must be tested to determine its effect.

Direct printing technologies for PP bottles that have received Critical Guidance Recognition are commercially available. A list of recognized innovations can be found HERE (link to CG letters). Companies that have developed new, innovative laminated label substrates are encouraged to pursue APR Critical Guidance Recognition for their materials as well. Guidelines for the program are available HERE (link).

Companies that are considering direct printing technologies and are unsure of their compatibility with recycling should ask their suppliers to provide APR test results.

Definitive Test: Critical Guidance Protocol for PP (PP-CG-01)

LABEL/ADHESIVE COMBINATIONS
The classification and recyclability of label substrates is dependent on the type of adhesive that is used with them. In general, a label substrate that sinks in water and is used with an adhesive that releases in the reclaimers wash system is preferred since the substrate will be removed in the float-sink tank. A label substrate that is compatible with PP is also preferred no matter what the adhesive. Therefore, recyclability of certain label substrates is conditional upon the type of adhesive used with them.

CONDITIONALLY PREFERRED
Metal foil labels that pass sorting requirements are preferred when used with an adhesive that releases in the wash and detrimental to recycling when used with an adhesive that does not release in the wash.
Even very thin metallized labels may be identified as metal by the sorting equipment and cause the entire bottle to be directed to the metal stream, thereby creating yield loss. Sorting equipment in the reclaiming process is designed to detect and eliminate metal from PP. If small, not detected, or allowed to pass, these labels, when used with an adhesive that does not release in the wash, either cause the attached PP to sink where it is lost in the float-sink tank or pass into the extruder where they can blind melt filters. When used with an adhesive that releases in the wash, these labels quickly sink in the float sink tank where they are removed.

Polystyrene labels are preferred when used with an adhesive that releases in the wash and detrimental...
to recycling when used with an adhesive that does not release in the wash.
PS, when used with an adhesive that does not release in the wash, remains with the PP and enters the extruder where it is blended with the PP. PS is not compatible with PP and may cause splay or reduce impact toughness for the recycled PP user. PS label material, when used with an adhesive that releases in the wash, detaches from the PP before the float sink tank where it sinks and is removed.

PLA labels are preferred when used with an adhesive that releases in the wash and render the package non-recyclable per APR when used with an adhesive that does not release in the wash.
PLA label material, when used with an adhesive that does not release in the wash, enters the extruder with the PP where they are incompatible. When used with an adhesive that releases in the wash, the PLA detaches from the PP before the float-sink tank where it sinks and is removed. Even though the float-sink process is imperfect, the small amounts of PLA entering the extrusion process are not catastrophic.

CONDITIONALLY DETRIMENTAL
PVC labels are detrimental to recycling when used with an adhesive that releases in the wash and render the package non-recyclable per APR when used with an adhesive that does not release in the wash.
PVC, when used with an adhesive that does not release in the wash, enters the extruder with the PP where they are incompatible. PVC degrades at PP extrusion temperatures and renders large amounts of the recycled PP unusable. When used with an adhesive that releases in the wash, these labels sink in the float-sink tank where they are removed. But because the float-sink tank is imperfect, and even a very small amount of PVC entering the extruder causes severe quality and yield problems, this material is detrimental.

RENDERS NON-RECYCLABLE
See section above and “Requires Test Results” section

REQUIRES TEST RESULTS
Label/Adhesive combinations where adhesive release and substrate float/sink behavior are not known.
Testing must show that adhesives will either wash off cleanly from the PP in the recycling process or be compatible with PP. Since typical PP recycling process conditions are not aggressive enough to remove all adhesive material, a certain amount of residual adhesive is to be expected in recycled PP. Such adhesive residue that is not removed from PP during the wash step is a source of contamination and discoloration when PP is recycled. For these reasons, minimal adhesive usage is encouraged.

The APR is developing a screening PP/HDPE Adhesive Test to classify adhesive as either wash friendly, non-wash friendly and compatible with PP, or non-wash friendly and incompatible with PP.

Non-wash friendly, incompatible adhesive is detrimental to recycling.

Label adhesives that have received Critical Guidance Recognition are commercially available. A list of recognized innovations can be found HERE (link to CG letters). Companies that have developed new, innovative laminated label substrates are encouraged to pursue APR Critical Guidance Recognition for their materials as well. Guidelines for the program are available HERE (link).

Companies that are considering label adhesives and are unsure of their compatibility with recycling should ask their suppliers to provide APR test results.
Definitive Test: *Critical Guidance Protocol for PP (PP-CG-01)*

➢ **ATTACHMENTS**

**PREFERRED**

*Plastic attachments with a density > 1.00 except for PVC*

These items sink in the sink-float tank where they are removed from the PP and small residual amounts do not severely affect the final product since many of them are melt filtered. PVC is detrimental as discussed elsewhere in this document.

**DETRIMENTAL**

*Paper attachments*

The PP reclamation process involves a wash step that removes adhesives and other components. This process renders paper into a pulp which is very difficult to filter from the liquid, adding significant load to the filtering and water treatment systems. Some of the small individual paper fibers will remain with the PP and carbonize when the material is extruded, causing unacceptable quality degradation.

*PVC attachments*

PVC sinks in the float sink tank where the majority of it is removed from the PP. Because the float sink tank is imperfect and even a very small amount of PVC entering the extruder causes severe quality and yield problems, this material is detrimental. PVC degrades at PP extrusion temperatures and renders large amounts of the recycled PP unusable.

*Polyethylene attachments*

Because polyethylene floats in water, it is not separated in the reclaimers float-sink tank. When blended with PP it negatively affects stiffness and impact properties. Although very small amounts of PE, such as that contributed by labels, are regularly accepted by PP reclaimers, some attachments comprise a larger weight percentage of the package and therefore a greater negative effect.

*RFID’s (radio frequency identification devices) on packages, labels or closures*

RFID’s are printed on silver metal, which may create costly waste disposal issues. While RFID’s are small, they may affect PP recycling in the same ways as metal labels or other attachments. The use of RFID’s is discouraged as may limit PP yield, introduce potential contamination, and increase separation and waste disposal costs.

*Also see “Requires Test Results” section*

**RENDERS NON-RECYCLABLE**

*None Specified*
REQUIRES TEST RESULTS

Non-PP attachments
Testing must show that these attachments are not adhesively bonded to the package and are made from materials that sink in water so they readily separate from the package when ground and put through a float-sink separation. If adhesives are used to affix attachments, their selection should consider the adhesive criteria within this document.

Screening Test: Polyolefin Packaging Articles Sink or Float Evaluation (O-S-01)
Benchmark Test Protocol: PP Benchmark Test (PP-B-01)

Metal, metalized and metal-containing attachments
Sortation testing for metal components will result in either a Detrimental or a Renders Non-Recyclable ruling. Metal components cannot be Preferred at this time.

Metal or metal-containing attachments may cause NIR sorters in MRFs to misidentify a PP container as metal and direct it to a metal stream, from which it is then discarded. Sorting equipment in the reclaiming process is designed to detect and eliminate metal from PP in order to protect cutting machinery. Large items, or items adhesively bonded to the PP, can damage the machinery and render the entire package non-recyclable. If small, not detected, or allowed to pass, metals, when used with wash friendly or no adhesive quickly sink in the float sink tank where they are removed from the PP.

Definitive Test: Evaluation of Sorting Potential for Plastic Articles Utilizing Metal, Metalized or Metallic Printed Components (SORT-B-03)

Welded attachments
A certain amount of a welded attachment cannot be separated from the PP in the recycling process. These attachments may cause recycled PP contamination and yield loss issues in both cases: when the ground section containing both polymers sinks and carries the PP with it, or when the ground section floats and carries an incompatible material with the PP into the extrusion process. Testing must show that the blend is of a density less than 1.0 so that it floats along with the PP in the float-sink tank, and that it is compatible with PP in the extrusion process.

Screening Test: Polyolefin Packaging Articles Sink or Float Evaluation (O-S-01)
Definitive Test: Critical Guidance Protocol for PP (PP-CG-01)