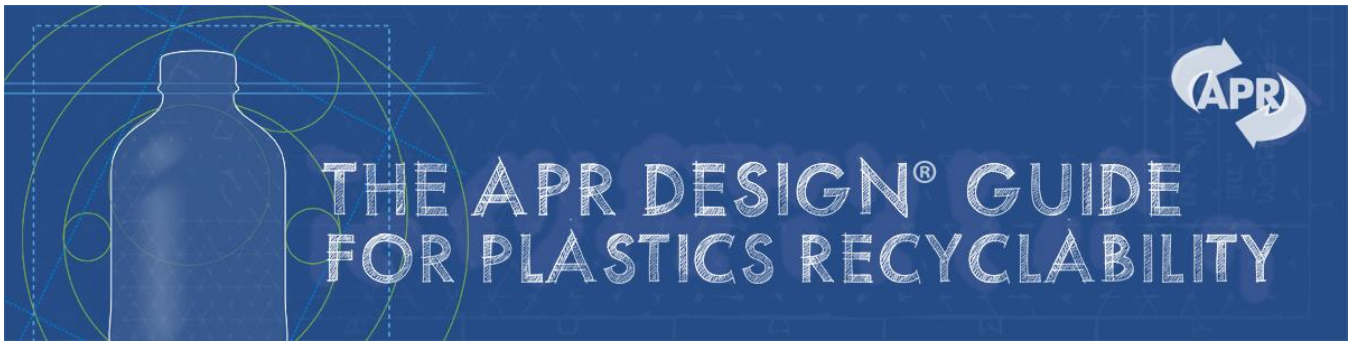

APR Design® Guide for Plastics Recyclability for HDPE (High-Density Polyethylene, Resin Identification Code #2)

Due to its toughness, natural UV barrier properties and chemical resistance HDPE is one of the most widely used packaging resins. It is easily injection molded, blow molded, or otherwise processed into a bottle, canister, pail, tub, squeeze tube or closure. In its natural state, HDPE appears a milky white color. This is due to light reflection on the polymer structure rather than a colorant.

HDPE 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 HDPE in a package must be considered for its effect on the recycling stream. Non-HDPE packaging features should either be economically removed from the HDPE in the typical recycling process or be compatible with HDPE in future uses. Of particular concern are mineral fillers or additives that cause the overall blend to sink in water. The density of HDPE is .94-.96 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. Melt flow is also an important consideration given end uses of PCR. Specific guidance can be found in the HDPE Critical Guidance or other design resource documents.

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 HDPE packaging item in common HDPE reclaiming processes.

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

The APR's 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.

RESIN IDENTIFICATION CODE, RIC

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

➢ BASE POLYMER

PREFERRED

Bio-Based HDPE Resins

Bio-based HDPE resin, in which some components are sourced from biological materials such as sugar cane residue or similar materials, is fully compatible with petroleum-based HDPE in the recycling process. Bio-based HDPE should not be confused with HDPE containing bio- or oxo-degradable additives.

Postconsumer polyolefin content

The use of postconsumer HDPE 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 HDPE 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 HDPE Colored or Natural Bottles with Resin Additives, Barriers, Layers or Closures (HDPE-CG-01)***

➢ COLOR

PREFERRED

Unpigmented (Natural) HDPE

Natural material has the highest value as a recycled stream since it has the widest variety of end-use applications. It can be easily identified for food-grade end use applications.

Translucent and opaque colors

HDPE 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 HDPE. 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 HDPE 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 HDPE 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 oil bottles and 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 HDPE, 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 HDPE containers. However, markets for black HDPE 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 HDPE bottles are more "round" (3-D) than "flat" (2-D) and therefore sort correctly.

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 HDPE stream, non-conforming items that are more "flat" can cause contamination in the paper stream. If items are not captured and directed into the HDPE 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 SLEEVES

PREFERRED

Polyethylene closures

Since polyethylene is the same polymer as the package body, closures and dispensers made of it will be captured and processed with HDPE. 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. While the blending of fractional-melt bottle-grade HDPE with high melt index resins used in closures will alter the MFI of the blend, this is a minor issue today given the limited use of HDPE closures and dispensers on bottles and the relatively low recycling rates for HDPE bottles. In the future these impacts may need more study.

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 HDPE and in fact enhance its properties so they are preferred.

Closures or safety sleeves 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 HDPE. 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 HDPE 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 HDPE.

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

HDPE 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 HDPE 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 HDPE. Unlike PVC, small amounts of PETG or PLA entering the extrusion process with the HDPE are not catastrophic since both can be removed in the melt filtering stage.

DETRIMENTAL

Polypropylene closures

The APR recognizes that polypropylene is perhaps the most commonly used material for closures. Complete HDPE packages with PP closures are considered recyclable (as long as all other components are Preferred), but with a Detrimental feature. Since polypropylene floats in water like polyethylene it is not separated in the reclaimers float-sink tank. When blended with HDPE it negatively affects the impact properties and can render the material brittle. Although very small amounts of PP, such as that contributed by labels, are regularly accepted by HDPE 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 HDPE 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 HDPE 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 HDPE floats. However, the float-sink tank is imperfect and even a very small amount of PVC with the recycled HDPE renders large amounts of it unusable as the PVC degrades at lower temperatures than those at which HDPE 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 HDPE. Metals create wear in process machinery, increase operation costs and yield loss, and are a primary source of defects in products made with recycled HDPE. MRFs and HDPE 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 sleeves, 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 HDPE 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 HDPE recycling. Specifically, such materials should either sink and be separated from the HDPE, or if they float, they must be compatible with HDPE.

Definitive Test: ***Critical Guidance Protocol for HDPE Colored or Natural Bottles with Resin Additives, Barriers, Layers or Closures (HDPE-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 HDPE. 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 HDPE 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 HDPE.

DETRIMENTAL

Polypropylene dispensers

The APR recognizes that polypropylene is perhaps the most commonly used material for dispensers. Complete HDPE packages with PP dispensers are considered recyclable (as long as all other components are Preferred), but with a Detrimental feature. Since polypropylene floats in water like polyethylene it is not separated in the reclaimers float-sink tank. When blended with HDPE it negatively affects the impact properties and can render the material brittle. Although very small amounts of PP, such as that contributed by labels, are regularly accepted by HDPE 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 HDPE recycling. It should sink in the sink/float system or be compatible with HDPE 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 HDPE Colored or Natural Bottles with Resin Additives, Barriers, Layers or Closures (HDPE-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 HDPE 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 HDPE flakes, they contribute wear to size reduction machinery. MRFs and HDPE 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 HDPE. It is not separable in the recycling process and therefore will become part of the recycled HDPE. APR guidance is that a package containing up to a 5% layer by weight of EVOH with a minimum of 32 mol% ethylene can be compatible with the residential postconsumer HDPE 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 HDPE recycling stream.

Workhorse additives historically used without issue

Most HDPE 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 HDPE. 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 HDPE for future uses.

DETRIMENTAL

None specified

REQUIRES TEST RESULTS

Non-HDPE barrier materials other than EVOH

Testing must show that layers and coatings will either separate and be removed from the HDPE in the recycling process or have no adverse effects on the recycled HDPE in future uses. When used, their content should be minimized to the greatest extent possible. Some layers and coatings have been found compatible with HDPE 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 HDPE Colored or Natural Bottles with Resin Additives, Barriers, Layers or Closures (HDPE-CG-01)***

Additive concentration causing the overall blend to sink in water

Many of the additives and fillers used with HDPE 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 HDPE in the blend will be lost.

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

Degradable additives (photo, oxo, or bio)

Recycled HDPE 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 HDPE. 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 HDPE, 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 HDPE that includes the additive. Testing must show that these additives will either separate and be removed from the HDPE in the recycling process or have no adverse effects on the recycled HDPE 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

HDPE labels are the same polymer as the final product and PP at the very small levels expected from label residue has a very minimal negative impact. Therefore, these labels that remain with the HDPE 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 though the recycling process with the HDPE and be blended with the recycled HDPE. 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 HDPE 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 HDPE bottle to another material stream where it is lost to the process. Furthermore, some incompatible sleeve materials that cannot be separated from the HDPE in the float-sink tank can contaminate the recycled HDPE 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 HDPE 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 HDPE 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 HDPE travels with the HDPE to the extruder where the material carbonizes and causes color defects. Even after melt filtering, the burned smell and discoloration remain with the recycled HDPE 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.

Also see "Requires Test Results" Section

RENDERS NON-RECYCLABLE

None Specified

REQUIRES TEST RESULTS

Label inks

Some label inks bleed color in the reclamation process, discoloring the HDPE in contact with them and possibly diminishing its value for recycling. Since most recycled HDPE 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 HDPE 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: ***HDPE Bleeding Label Test (HDPE-S-01)***

Definitive Tests: ***Critical Guidance Protocol for HDPE Natural Bottles with Labels (HDPE-CG-02)***
Critical Guidance Protocol for HDPE Colored Bottles with Labels (HDPE-CG-03)

Metal foil, metalized and metallic printed labels

Sorting equipment in the recycling process is designed to detect and eliminate metal from HDPE. Even very thin metallized 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 HDPE 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)***

Full bottle sleeve labels

Full bottle sleeve labels must be tested for both bottle surface coverage and compatibility with HDPE.

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 HDPE 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 HDPE. This material cannot be removed in the recycling process and can contaminates the recycled HDPE produced if not compatible with HDPE.

Definitive Tests: ***Critical Guidance Protocol for HDPE Natural Bottles with Labels (HDPE-CG-02)***
Critical Guidance Protocol for HDPE Colored Bottles with Labels (HDPE-CG-03)

Direct printing other than date coding

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

Direct printing technologies for HDPE 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 Tests: ***Critical Guidance Protocol for HDPE Natural Bottles with Labels (HDPE-CG-02)***

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 HDPE 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 HDPE. 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 HDPE 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 HDPE and enters the extruder where it is blended with the HDPE. PS is not compatible with HDPE and may cause splay or reduce impact toughness for the recycled HDPE user. PS label material, when used with an adhesive that releases in the wash, detaches from the HDPE 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 HDPE where they are incompatible. When used with an adhesive that releases in the wash, the PLA detaches from the HDPE 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 HDPE where they are incompatible. PVC degrades at HDPE extrusion temperatures and renders large amounts of the recycled HDPE 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

None specified

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 HDPE in the recycling process or be compatible with HDPE. Since typical HDPE recycling process conditions are not aggressive enough to remove all adhesive material, a certain amount of residual adhesive is to be expected in recycled HDPE. Such adhesive residue that is not removed from HDPE during the wash step is a source of contamination and discoloration when HDPE 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 HDPE, or non-wash friendly and incompatible with HDPE. 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 Tests: ***Critical Guidance Protocol for HDPE Natural Bottles with Labels (HDPE-CG-02)***
Critical Guidance Protocol for HDPE Colored Bottles with Labels (HDPE-CG-03)

➢ 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 HDPE 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 HDPE 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 HDPE 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 HDPE. Because the float sink tank is imperfect and even a very small amount of PVC entering the extruder causes sever quality and yield problems, this material is detrimental. PVC degrades at HDPE extrusion temperatures and renders large amounts of the recycled HDPE unusable.

Polypropylene attachments

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

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 HDPE recycling in the same ways as metal labels or other attachments. The use of RFID's is discouraged as may limit HDPE 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-HDPE 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: HDPE Benchmark Test *This test is currently being developed.

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 HDPE 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 HDPE in order to protect cutting machinery. Large items, or items adhesively bonded to the HDPE, 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 HDPE.

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 HDPE in the recycling process. These attachments may cause recycled HDPE contamination and yield loss issues in both cases: when the ground section containing both polymers sinks and carries the HDPE with it, or when the ground section floats and carries an incompatible material with the HDPE 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 HDPE in the float-sink tank, and that it is compatible with HDPE in the extrusion process.

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

Definitive Test: : ***Critical Guidance Protocol for HDPE Colored or Natural Bottles with Resin Additives, Barriers, Layers or Closures (HDPE-CG-01)***