PET Bottles (Carbonated Beverage, Water, and Custom Bottles)

The basic design for recycling guideline to consider when making material choices for any attachment to the bottle is to consider its general compatibility with the base resin (PET) or the removal efficiency in conventional water-based separation systems that separate plastics by density. Attachments may include closures, closure liners, base cups, inserts, labels, pour spouts, handles, sleeves, safety seals, coatings, and layers. PET has a density or specific gravity greater than 1.0 (the density of water) and will sink in these separation systems. For efficient separation and removal in conventional sink/float separation systems, attachments should be made from materials with a density less than 1.0 or be otherwise compatible with PET in the reclamation process. Non-adhering materials with a density less than 1.0 will float in these systems and can be separated easily from the PET. (The density range of key plastic materials can be found on page 8).

COLOR
Traditionally, unpigmented PET has the highest value and the widest variety of end-use applications. Transparent, green tinted bottles have the next highest value. Transparent light blue bottles are often included with green or clear streams successfully. PET bottles with other transparent tinted colors may have limited recycling value and may be considered contaminants by many PET reclaimers. Transparent colors other than green may be undesirable. There are some reclaimers, which are able to tolerate transparent, amber, tinted bottles in their systems.

PET Bottles Excerpt from The APR Design™ Guide for Plastics Recyclability
The use of translucent and opaque colors is problematic for many recycled PET end uses because of contamination. In particular, TiO₂ is very detrimental to PET recycling for bottle-to-bottle and engineered resin uses. Although newer sorting technology is capable of identifying white PET from other PET colors, much current sortation capability does not always identify and isolate white opaque PET. Non-TiO₂ opaque and translucent PET bottles are also problematic and should be examined for their impact on the recycling process.

Inclusion of nucleating agents, hazing agents, fluorescers, and other additives for visual and technical effects should be examined specifically by the reclaiming industry for impact on the overall plastic bottle recycling stream. (APR strongly encourages bottle decision makers to test their opaque, translucent, and unusual transparent colors through its Champions for Change™ testing program to determine if the selections of color will act detrimentally on the reclaiming industry and if markets may be available for them.)

**PVC ATTACHMENTS**
The use of PVC attachments of any kind on PET bottles is undesirable and should be scrupulously avoided. These attachments generally include, but are not limited to closures, closure liners, labels, sleeves, and safety seals. Very small amounts of PVC (in the parts-per-million range) can severely contaminate and render large amounts of PET useless for most recycling applications. In addition, PVC is very difficult to separate from PET in conventional water-based density separation systems, due to similar densities (densities greater than 1.0) that cause both to sink in these systems.

**CLOSURES/CLOSURE LINERS**
Plastic closures made from polypropylene are preferred to all others, as they are most easily separated from the bottle in conventional separation systems and create an ancillary stream of recyclable material. Closure systems that contain no liners and leave no residual rings, or other attachments, on the bottle after the closure is removed are also preferred. The use of PVC for closures or closure liners is undesirable and should be scrupulously avoided. While the use of EVA closure liners in plastic closures is acceptable to many reclaimers, EVA liners can cause contamination problems when used in aluminum closures. Although tolerated by many reclaimers, the use of aluminum closures should be avoided, as they are more difficult to separate from PET bottles compared to the preferred closure systems (PP, HDPE, and LDPE) and add both capital and operating costs to conventional reclamation systems. Closures made from PS or thermoset plastics are undesirable and should be avoided. Closures made from steel are undesirable and should be avoided. Silicone polymer closure parts are discouraged as they may present significant technical problems in the process of recycling and to the usefulness of the recycled plastic.
**SLEEVES & SAFETY SEALS**
If tamper resistance is required in specific product applications, it should be an integral design feature of the bottle. The use of tamper-resistant or tamper-evident sleeves or seals is discouraged as they can act as contaminants if they do not completely detach from the bottle, or are not easily removed in conventional separation systems. If sleeves or safety seals are used, they should be designed to completely detach from the bottle, leaving no remains on the bottle. The use of PVC sleeves or safety seals is undesirable and should be scrupulously avoided. Foil safety seals that leave foil or remnants or attaching adhesive on the PET bottle should be avoided.

**LABELS**
PP, OPP, PE, or other label materials that float in water are preferred to all other label materials. Label materials should not delaminate in the reclaimer’s wash system. Paper labels are undesirable and should be avoided as they increase contamination in the PET due to fiber and adhesive carry-over through the reclamation process. Similarly, metallized labels increase contamination and separation costs and should be avoided. In general, the use of plastic labels with a specific gravity of less than 1.0 are preferred for easy removal in conventional water-based density separation systems. Label systems that sink in water because of the choices of substrate, inks, decoration, coatings, and top layer should be avoided. While PS labels are tolerated by many PET reclaimers, PS has been identified as causing serious processing and end-use problems by others, and should only be used if it can be easily and completely removed from the PET in conventional separation systems, such as expanded PS foam, where the PS density is much less than 1.0 gm/cm³ and can be easily separated from PET. The use of PVC labels is undesirable and should be scrupulously avoided. Full bottle sleeves should be so designed that automatic sorting equipment can properly identify the resin used to make the bottle.

**INKS & ADHESIVES**
Some label inks bleed color when agitated in hot water and can discolor PET regrind in the reclamation process, diminishing or eliminating its value for recycling. The APR and NAPCOR have developed a testing protocol to assist label manufacturers in evaluating whether a label ink will bleed in conventional PET reclaiming systems. Label inks must be chosen that do not bleed color when tested under this protocol. The use of label inks that bleed should be scrupulously avoided.

Pressure sensitive labels should separate from PET regrind in the hot caustic water wash step. Label adhesives should be water soluble or dispersible at temperatures between 140 °F to 180 °F in order to be removed in conventional washing and separation systems. If adhesives are not removed efficiently, they may disperse on the PET.
PET regrind and embed unwanted contaminants. The use of other adhesive types is discouraged and should be avoided. (The APR has developed a testing protocol for adhesive manufacturers to evaluate the impact of adhesive products in conventional PET reclamation systems). Adhesive usage and surface area covered should be minimized to the greatest extent possible to maximize PET yield and avoid contamination.

DIRECT PRINTING/DECORATION
Direct printing other than date coding, either for product labeling or decoration, contaminates recycled PET in conventional reclamation systems and should be avoided. Experience has shown that the inks used in direct printing may bleed ink or otherwise discolor the PET during processing, or introduce incompatible contaminants. In either case, the value of the PET for recycling is diminished or eliminated.

Anticipating innovation in direct printing technology, direct printing on a specific bottle can be acceptable when APR Guidance Tests are used to demonstrate the direct printing has no impact on recycling. The tests to employ are both the Critical Guidance Test for PET Bottles as well as the Applications Guidance Test for PET Bottle to Bottle Recycling where results meet the strictest guidance called for in the test methods.

BARRIER LAYERS, MONOMERS, COATINGS & ADDITIVES
Some PET bottle designs require the use of barrier layers, additional monomers, coatings or additives to meet the requirements of specific product applications. Additives to PET bottles, including scavengers, which cause the PET to discolor and/or haze after remelting and solid stating, should be avoided unless means are readily and economically available to minimize the effects. Similarly, blends of PET and other resins are undesirable unless they are compatible with PET recycling. This includes not melting or softening at PET dryer operations temperatures of up to 175°C (350°F).

In general, the use of non-PET layers and coatings are undesirable and should be avoided, unless they are compatible with PET or are easily separable from PET in conventional recycling systems. The use of EVOH, nylon-based (e.g., nylon-6, MXD6), epoxies, amorphous or “diamond-like” carbon, and silicon oxide barrier layers or coatings is currently tolerated by most reclaimers provided the layers/coatings readily separate and can be isolated or have been shown not to be a problem for the reclaiming process or reclaimed product. When used, their content should be minimized to the greatest extent possible to maximize PET yield, limit potential contamination, and reduce separation costs. The use of non-PET layers and coatings can drastically reduce the recyclability of PET.

Based on public product performance claims, it appears that the use of degradable additives may result in shortening the useful life of the bottles of which they are a part.
and therefore affect the ability of such bottles to be recycled. Of equal or greater concern, the effect of having degradable additives in the recycling stream on reclaiming processes and the technical performance of recycled resin is currently unclear. Degradable additives should not be used without an evaluation confirming that their expected use will not materially impair the full service life and properties, including successful recycle and durability, for the next use of the recycled bottle. The APR’s Champions for Change™ Program invites consumer product, plastic bottle and bottle component manufacturers to work with the APR protocols to determine whether new modifications to a regularly recycled plastic bottle will impact conventional recycling systems prior to introducing the modification. The APR Guidance Documents form a necessary, but not sufficient, basis for test program design for degradable additives. Aging under specific environmental exposure is needed for the technical assessment of the initial postconsumer bottle. Additionally, the next use applications must be tested under conditions of specific aging and environmental exposure to assure full service life and subsequent next use recycling. Testing should be conducted per APR’s Degradable Additives and PET Recycling Technical Compatibility Testing Guidance.

BASECUPS/ADHESIVES
The use of base cups is undesirable and should be avoided, as they reduce PET yield and increase separation costs. If base cups are used, the use of unfilled HDPE or clear PET is preferred to all other materials. If glued on, base cup adhesives should be water soluble or dispersible at 140°F to 180°F in order to be removed in conventional washing and separation systems. If adhesives are not removed efficiently, they may disperse on the PET regrind and embed unwanted contaminants. The use of other adhesive types is discouraged and should be avoided. (The APR has developed a testing protocol for adhesive manufacturers to evaluate the impact of adhesive products in conventional PET reclamation systems). Adhesive usage and surface area covered should be minimized to the greatest extent possible to maximize PET yield and avoid contamination.

OTHER ATTACHMENTS
The use of any other attachments is discouraged, as they reduce base resin yield and increase separation costs. If any other attachments to a bottle are used, they should be made from HDPE or clear PET. The use of welded attachments should be avoided. The use of non-PET attachments, such as handles, should not be adhesively bonded to the bottle and should readily separate from the bottle in conventional PET reclamation systems. If adhesives are used to affix attachments, they should be water soluble or dispersible at 140°F to 180°F in order to be removed in conventional washing and separation systems. If adhesives are not removed efficiently, they may disperse on the
PET regrind and embed unwanted contaminants. The use of other adhesive types is discouraged and should be avoided. *(The APR has developed a testing protocol for adhesive manufacturers to evaluate the impact of adhesive products in conventional PET reclamation systems).* Adhesive usage and surface area covered should be minimized to the greatest extent possible to maximize PET yield and avoid contamination.

The use of RFID’s (radio frequency identification devices) on bottles, labels or closures is discouraged and should be avoided unless they are compatible with PET recycling and are demonstrated not to create any disposal issues based on their material content. The use of RFID’s is discouraged as it limits PET yield, introduces potential contamination, and increases separation costs.

Silicone polymer closure parts are discouraged as they may present significant technical problems in the process of recycling and to the usefulness of the recycled plastic.

**NON-DETACHING COMPONENTS**

The use of non-detaching bottle components, including monomers, which are not made from PET, must be either compatible with or easily separable from PET in conventional recycling systems, and must not adversely affect end-use product performance.

**POSTCONSUMER CONTENT**

The use of postconsumer PET in bottles is encouraged, whenever possible.

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**PET Bottles Excerpt from**
**The APR Design™ Guide for Plastics Recyclability**