The APR Design® Guide for Plastics Recyclability is the most comprehensive resource outlining the plastics recycling industry’s recommendations in the marketplace today. The content is regularly updated to ensure APR’s Recyclability Categories represent today’s North American plastics recycling infrastructure. Although it is designed as an online resource, with links to all relevant information, a PDF of the complete document can be downloaded as well.

The APR Design® Guide specifically addresses plastic packaging, but the principles can be applied to all potentially recycled plastic items.

APR encourages package designers to utilize The APR Critical Guidance and Responsible Innovation programs, as well as the APR Design® Guide to create the most recyclable packaging. Assistance is available through APR or one of the APR member, independent laboratories found in the member directory.

The intended audience for the APR Design® Guide for Plastics Recyclability is the package design engineer for use in designing packaging that complies with the capabilities of the recycling infrastructure. Before accessing the APR Design® Guide for Plastics Recyclability the user should thoroughly understand the fundamentals of its concept as described in the scope, definition of recyclability and recyclability categories outlined below.

SCOPE

This guide covers plastic items entering the postconsumer collection and recycling systems most widely used in industry today. Collection methods include single stream and dual stream MRF’s, deposit container systems, mixed waste facilities, and grocery store rigid plastic and film collection systems. The impact of package design on automated sortation process steps employed in a single stream MRF, as well as high volume recycling processes is of primary consideration.

Items recovered in recovery systems where they are source-selected and sent to a recycler specializing in this particular item are specifically excluded from this guide.

APR’s DEFINITION OF RECYCLABLE

An item is “recyclable per APR definition” when the following three conditions are met:

- At least 60% of consumers or communities have access to a collection system that accepts the item.
- The item is most likely sorted correctly into a market-ready bale of a particular plastic meeting industry standard specifications, through commonly used material recovery systems, including single-stream and
dual stream MRFs, PRF’s, systems that handle deposit system containers, grocery store rigid plastic and film collection systems.

- The item can be further processed through a typical recycling process cost effectively into a postconsumer plastic feedstock suitable for use in identifiable new products.

APR’s RECYCLABILITY CATEGORIES

The APR Design® Guide is itemized by design features commonly used with packaging applications. The recycling impact of each design feature is discussed within the Guide. The APR’s guidance on the design feature is developed considering this impact and broken down into four categories which should be thoroughly understood:

- **APR Design Guide® Preferred**: Features readily accepted by MRFs and recyclers since the majority of the industry has the capability to identify, sort, and process a package exhibiting this feature with minimal, or no, negative effect on the productivity of the operation or final product quality. Packages with these features are likely to pass through the recycling process into the most appropriate material stream with the potential of producing high quality material.

- **Detrimental to Recycling**: Features that present known technical challenges for the MRF or recycler’s yield, productivity, or final product quality but are grudgingly tolerated and accepted by the majority of MRFs and recyclers.

- **Renders Package Non-Recyclable per APR Definition**: Features with a significant adverse technical impact on the MRF or recycler’s yield, productivity or final product quality. The majority of MRFs or recyclers cannot remove these features to the degree required to generate a marketable end product.

- **Requires Testing**: In order to determine compatibility with recycling, testing per an APR testing protocol is required.

DISCLAIMER

This document has been prepared by the Association of Plastic Recyclers as a service to the plastic industry to promote the most efficient use of the nation’s plastic recycling infrastructure and to enhance the quality and quantity of recycled postconsumer plastic. The information in this document is offered without warranty of any kind, either expressed or implied, including WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, which are expressly disclaimed. APR and its members accept no responsibility for any harm or damages arising from the use of or reliance upon this information by any party. Participation in the Recognition Program is purely voluntary and does not guarantee compliance with any U.S. law or regulation or that a package or plastic article incorporating the innovation is recyclable or will be recycled.
APR Design® Guide for Plastics Recyclability
for
LDPE, LLDPE, HDPE Film

Film is used for many applications requiring a variety of properties. The vast majority of film is polyethylene and polypropylene but currently, only polyethylene is routinely collected and recycled postconsumer.

SCOPE: The following guidance provided for film plastics diverges from the scope outlined in the Design Guide introduction because it does not consider the single stream MRF the primary collection source. The film plastic guidance must address a different supply chain in which single stream curb side collection systems are a very minor part. Single-stream recovery of film, and film sortation in MRFs, does exist but the technology and logistics are in their infancy.

Collection and source selection of plastic film is an extremely important part of film recycling and is discussed at depth in the design guide resources section of the APR website.

Residential postconsumer film is primarily collected at retail locations, mostly grocery stores, and thus may include a mix of materials including LDPE, LLDPE, HDPE, PP and a growing number of multi-layer packaging. Depending on the contamination present and the desired application the recycler may use a wet or dry system to process this material. This guide considers both processes. Each modification and addition to a single clear base polyolefin polymer in a film or film package must be considered for its effect on the recycling stream.

Plastic film is used in a wide number of industrial applications and postindustrial film is an important source of film that is collected and recycled. The APR Design® Guide can be a reference when designing industrial applications with film, but not all guidance may be applicable when collection and recycling of such commercially used film is in a dedicated, closed loop system.
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PE FILM PACKAGING
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BASE POLYMER

Postconsumer polyethylene (PE) content is preferred. The use of postconsumer PE in all packages is encouraged to the maximum amount technically and economically feasible.

BARRIER LAYERS, COATINGS & ADDITIVES

The use of non-PE layers and coatings can be detrimental to recycling of PE film if not implemented according to APR test protocols. When used, their content should be minimized to the greatest extent possible to maximize yield, limit potential contamination, and reduce separation costs.

Non-PE layers and coatings require testing to determine the appropriate APR recyclability category. Layers and coatings are not removed in the film recycling process. They enter the extrusion stage of the process with the base material where they are either melted and blended with the PE or remain solid and are filtered from the melted product. A filterable coating is rare due to its extremely thin profile. Testing must show that unfilterable layers and coatings have no adverse effect on the recycled PE in future uses. Some coatings such as EVOH may be acceptable at small weight percentages of the total film but only testing can determine this. Several compatibilizers are available on the market that may, if used correctly allow a non-compatible material to blend with the PE without negative effects. This can also be demonstrated by testing the specific formulation of the film.

Benchmark Test: APR Benchmark Polyethylene (PE) Films and Flexible Packaging Innovation Test Protocol

PVC and PVDC layers and coatings render the package non-recyclable per APR definition. PVC and PVDC degrade at low temperatures rendering large portions of the recycled PE unusable.

Metalized layers are detrimental to recycling. Metalized layers are extremely thin layers of metal deposited on the film as a vapor. They should not be confused with actual metal layers addressed as “foil” in this document. Metalized layers are not removed in the recycling process and are melted and blended with the PE. This causes material discoloring. In many cases a metalized film will be detected early in the recycling process by metal detectors designed to protect machinery from catastrophic damage. Metal detectors are unable to differentiate between a metalized film and a solid metal part so the entire package is normally discarded rather than accept the risk.

Workhorse additives historically used without issue are preferred. Most PE films contain 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 PE. 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**
• **Slip agents**
• **Fillers** – note that many fillers are dense, so particular attention should be paid to the overall blend density
• **Pigments**
• **Impact modifiers**
• **Chemical blowing agents**
• **Tackifiers**

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

**Degradable additives (photo, oxo, or bio) require testing to determine the appropriate APR recyclability category.** Recycled film 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 film. 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 film, 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 film that includes the additive. Testing must show that these additives will either separate and be removed from the film in the recycling process or have no adverse effects on the recycled film in future uses. When used, their content should be minimized to the greatest extent possible.

**Screening Test:** HDPE/PP Degradable Additives Test

**Additive concentration causing the overall blend to sink renders the package non-recyclable per the APR definition.** Many of the additives and fillers used with PE 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 film reclaimers who use a wet wash process. Therefore, a sinking material will be considered waste by such a film reclaimer. Film reclaimers using a dry process are normally able to process this material but there is no way to determine if a particular film will be processed by a dry or wet system. The APR test protocol should be consulted to determine if a blend sinks.
Additives not listed require testing to determine the appropriate APR recyclability category.
The APR recognizes that other types of additives may be required for the performance of a particular package but are not addressed in this document. Of particular concern are additives which cause the recycled PE to discolor, gel or change viscosity after remelting, or dense additives that increase the density of the blend making it sink, thus rendering the package unrecyclable per APR definition. The APR encourages users to test the additive according to the appropriate test protocol before implementing. Testing must show that additives have no adverse effect on the recycled PE in future uses.

The APR is developing a test protocol to determine an additives compatibility with PE in film applications.

COLOR

Unpigmented PE is preferred.
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.

White, buff or lightly colored colors are preferred.
It is not common for film to be sorted by color in the recycling process. Therefore, the resulting recycled material is a blend of all the colors present. Light colors blend well with little effect.

Dark colors, particularly blues and greens are detrimental to recycling.
It is not common for film to be sorted by color in the recycling process. Therefore, the resulting recycled material is a blend of all the colors present. Dark colors have a great effect on a lot of material. Since the standard material is a light blend and dark colors are relatively rare, the reclaimer normally hand selects dark colors and processes them separately. In some cases, the dark colors are discarded. The recyclers are adapting to this issue by building processes that are more accepting of dark colors, while at the same time, brand names are replacing dark colors with light colors for their packaging films.

LABELS, INKS AND ADHESIVES

Direct printing is preferred.
Of the available labeling methods direct printing adds the least amount of potential contamination. Small levels of the correct inks disperse in the final polymer without having much of an impact on quality. Heavily printed film of dark colors can be problematic since the dark colors affects a large amount of polymer, limiting its potential for reuse. The amount of printing should be limited since heavy levels of ink volatize in the extruder and may cause gels in the final product even if most recyclers use vented extruders. Large amounts of printing can overwhelm the capacity of these extruders to remove the volatile components.
Polyethylene labels are preferred.
Labels made of the same or compatible polymer as the film do not become contaminants and are recycled with the film.

Paper labels are detrimental to recycling.
Paper labels pulp and become a water filtration and contamination problem if they are processed through a wet recycling process. Individual paper fibers are very difficult to remove and attach themselves to the film creating specks and irregularities in the products made from recycled film. Furthermore, in either a wet or dry process they degrade in the extruder creating an undesirable burnt smell that cannot be removed from the recycled plastic. This significantly limits its reuse.

Metal foil labels and layers render the package non-recyclable per APR definition.
These labels should not be confused with metalized film. Metal foil labels are extremely problematic in two areas. First, they alarm metal detectors that are employed at the beginning of the recycling process to protect machinery. When this occurs, the entire package containing the offending part is discarded and landfilled. Secondly, if they happen to pass through the process into the extruder they can quickly blind a melt filter causing a pressure upset which automatically shuts down the process for safety.

ATTACHMENTS

Non-PE attachments require testing to determine the appropriate APR recyclability category.
Attachments enter the film recycling process along with the film they are attached to. They enter the extrusion stage of the process with the base material where they are either melted and blended with the PE or remain solid and are filtered from the melted product. Testing must show that the material is removed from the PE stream or has no adverse effect on the recycled PE in future uses.

Benchmark Test: APR Benchmark Polyethylene (PE) Films and Flexible Packaging Innovation Test Protocol

Metal and metal-containing attachments render the package non-recyclable per APR definition.
Metal parts are extremely problematic in two areas. First, they alarm metal detectors that are employed at the beginning of the recycling process to protect machinery. When this occurs, the entire package containing the offending part is discarded and landfilled. Secondly, if they happen to pass through the process into the extruder they can damage the extruder or quickly blind a melt filter causing a pressure upset which automatically shuts down the process for safety.

RESIN IDENTIFICATION CODE, RIC
Use the correct Resin Identification Code symbol of the proper size as detailed in ASTM D7611