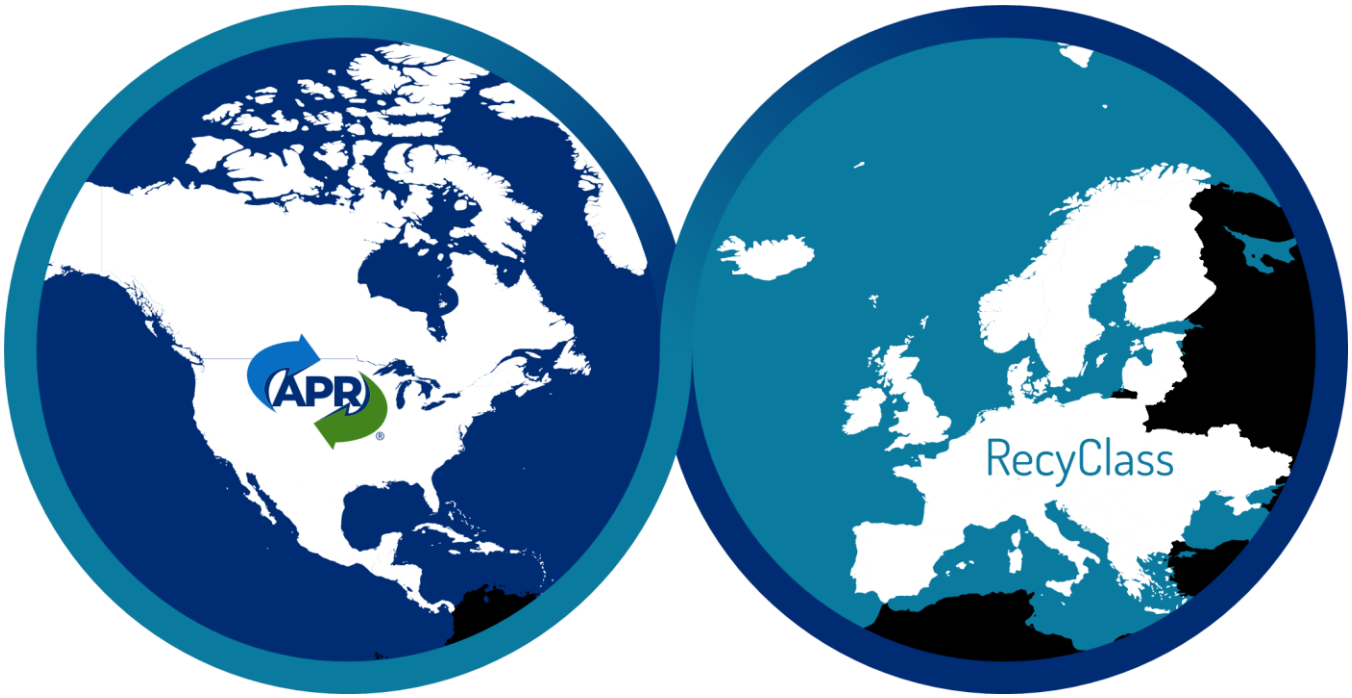
APR-RecyClass Cooperation Report

March 2024



INTRODUCTION

In March 2023, The Association of Plastics Recyclers (APR) and RecyClass signed a cooperation agreement, for a duration of 3 years, with the objective to drive global harmonization on Design for Recycling of plastic packaging. While both organizations represent a different geographical market, there are many similarities between them including a united goal to recycle more plastics to reduce waste and facilitate the transition toward a circular economy. Both organizations are non-profits, representing all stake holders in plastic recycling and are the only organizations in their respective regions representing the entire plastics recycling industry. Both APR and RecyClass strive for elaborating design for recycling guidance for the plastic packaging industry based on scientific findings and following a fact-based approach. Both organizations manage packaging material and format-specific Technical Committees consisting of experts from across the supply chain focused on specific recycling streams.
Further details for each organization include:

- APR is a North American based association whose core membership are the plastics recyclers and reclaimers with affiliate members representing of all steps in the plastic packaging supply chain including raw material suppliers, converters, retailers, consumer package groups (CPGs), etc. The APR developed their first APR Design® Guide for Plastics Recyclability in 1994 dedicated to PET and HDPE rigid packaging. Over the years, this document has expanded to include PP rigid and PE flexible packaging and continues to provide guidance to packaging designers to ensure their packaging is compatible with the recycling infrastructure, thereby increasing the quality of recycled plastics and increasing efficiency of the recycling process. The "Design Guide" also integrates testing protocols to allow innovators to test the effect of their packaging innovations on the recycling, sorting, and processing infrastructure.
- RecyClass is a non-profit, cross-industry initiative advancing recyclability, bringing transparency to the origin of plastic waste, and establishing a harmonized approach toward recycled plastic calculation & traceability in Europe. RecyClass develops Recyclability Evaluation Protocols and scientific testing methods for innovative plastic packaging materials which serve as the base for the Design for Recycling Guidelines and the RecyClass Online Tool. RecyClass established Recyclability Certifications for plastic packaging, Recycling Process Certification and Recycled Plastics Traceability Certification for plastic products.

Information developed by APR & RecyClass is essential to helping build a circular economy for plastic packaging. Their guidance and testing protocols help brand owners, converters and other packaging specifiers understand how to optimize plastic packaging design for the recycling industry and maximize circularity. Additionally, this information supports other organizations that are stakeholders in developing a circular economy such as NGO's and policy makers.
To ensure an optimal cooperation and sharing information to avoid duplicating tests/discussions, RecyClass and APR teams agreed to have their staff members in charge of

their respective technical committees participate in the equivalent technical committee of the other organization. New findings were communicated through the Design for Recycling guidelines and via press releases or webinars. In that regard, APR and RecyClass hosted joint webinars, and participated in common panel discussions in multiple conferences to spread the message of a global harmonization effort.
While the recycling supply chain and processes are similar for both regions, the terminology used can differ. To simplify discussions, the two organizations developed the figure below to better enable a common language.

Objectives of the cooperation

APR & RecyClass cooperation is driven by the idea of promoting global harmonization and proposing solutions to the plastic packaging industry on how to design recyclable plastic packaging. The main objectives of this cooperation all begin with the transfer of knowledge and scientific data from one organization to the other to close the gap between the Design for Recycling guidelines. This regroups these following objectives:

- Develop a unified set of design for recycling guidelines to enable plastics circularity.
- Work towards alignment of the Recyclability Evaluation Protocols (RecyClass) and Critical and Application Guidance (APR) based on comparative data obtained by testing identical packaging features and innovations according to APR & RecyClass testing procedures. The long-term objective is to have both organizations delivering approval letter (RecyClass) or recognition letter (APR) based on

both recyclability protocols or a common one.
- Reciprocally utilize positive test results from one organization toward meeting recognition requirements of the other.
- Better align the approach and protocols to evaluate the sorting efficiency of plastic packaging.

Overall comparison APR – RecyClass

It is crucial to understand that both APR & RecyClass follow a similar scientific approach to deliver Design for Recycling Guidelines to the plastic packaging industry. Such an approach needs to be based on a clear definition of "recyclability" of plastic packaging and products. In that regard, APR and Plastics Recyclers Europe (PRE) worked jointly to develop the following definition as an integral step to harmonize the worldwide plastics recycling industry:
Plastics must meet four conditions for a product to be considered recyclable:

1. The product must be made with a plastic that is collected for recycling, has market value and/or is supported by a legislatively mandated program.
2. The product must be sorted and aggregated into defined streams for recycling processes.
3. The product can be processed and reclaimed/recycled with commercial recycling processes.
4. The recycled plastic becomes a feedstock material for the production of new products.

Joint Clear Definition of "Recyclability" of Plastics Packaging

The work done by APR and RecyClass is based on the state-of-the-art of sorting and recycling facilities on each geographical area. In this regard, it is important to highlight that both organizations are relying on mechanical recycling processes which are by far the most developed recycling processes. While mechanical recycling is the focus, it is important to note that collection and sorting of a package into the correct stream is required for any recycling processes. Additionally, while various recycling approaches have varying tolerances to contamination, all processes benefit from increased collection, accurate sortation, and improved design. A mapping of the sorting and recycling processes is frequently done to ensure Design for Recycling Guidelines are aligned with the current practices.

Design for Recycling Guidelines

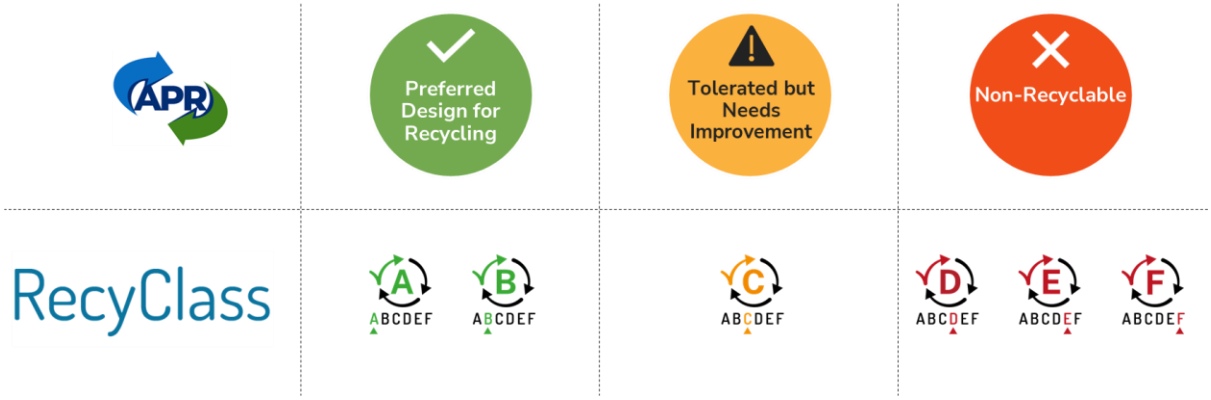
According to our similar definition of recyclability, both APR and RecyClass developed Design for Recycling Guidelines. Both are based on a green, orange, & red traffic-light color to represent the different levels of compatibility with recycling of each plastic packaging feature. The descriptions of the categories are given in the following table. While they are quite similar, subtle differences exist which translate to differences within our respective guidance. Elucidating and narrowing these minor differences is within scope of the cooperation.

Comparison of Feature Assessments – APR & RecyClass

APR	RecyClass
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.**	**Full compatibility: Preferred design features**, that guarantee the **best recyclability and quality of the recyclate**. Packaging with such features does not pose any recyclability issues and the recycled plastics can potentially feed a closed-loop scheme to be used in the same quality application.
Detrimental: 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.** A plastic item may be considered Recyclable with Detrimental features with the understanding that package manufacturers **should use the detailed guidance provided by APR to change their design and achieve Preferred status.**	**Limited compatibility: Second choices** for each packaging feature, that **slightly impact the recycling process and/or the quality of the recyclate**. Packaging containing such features presents some recyclability issues that affect the quality of the recycled plastics or lead to material losses during recycling. In the first case the recycled plastic could be used in a cascade open-loop scheme, whereas in the latter case the plastic could potentially feed a closed loop scheme.
Non-recyclable: The majority of MRFs or reclaimers **cannot remove these features** to the degree required to generate a marketable end product, or the package **cannot be captured at a majority of MRFs** or reclaimers due to typical machinery settings or equipment capabilities. Ultimately, a package exhibiting this design feature **will be completely discarded even if it has other Preferred features**.	**Low compatibility:** Detrimental features that **should be avoided** when designing packaging, as these **strongly impact the recycling process and/or the quality of the recyclate.** Packaging containing such features has significant design issues that highly affect its recyclability or imply large material losses. In both cases the recycled plastic can only be fed into low-value applications at best (i.e. the packaging will be downcycled). **Non-compatibility:** Disqualifying features that **must be avoided** when designing packaging. Substances/materials that **completely compromise the packaging recyclability**. *Note that low and non-compatibility are both in APR's guidelines, since it is impossible to obtain an APR recyclability certification with these features.*

Both organizations utilize the categorization of each design feature to build full plastic packaging assessments. RecyClass developed a European methodology to certify recyclability based on the recyclable plastic content and Design for Recycling guidelines, where the class grading (A to F) indicates the level of recyclability which can be impacted by each individual factor of a packaging design. A packaging with class "A" (all features are fully compatible) can be recycled in closed-loop systems, for instance "bottle-to-bottle" or "film-to-film". Note here that the only option to obtain a class A or B is to follow a mono-material approach with at least 90% of recyclable plastic content, no matter the recycling stream. Similarly, APR has full package self-assessment using a green, orange, & red traffic-light color scheme with a Preferred Design for Recycling classification indicating the best opportunity for circular applications. While there is some overlap with RecyClass's B, C, & D across APR's "Tolerated but Needs Improvement" the approximate alignment between the two whole package assessments is shown in the figure below.

Approximate Whole Package Alignment



A difference between APR and RecyClass lies in the end application for recyclate where RecyClass targets closed-loop circular applications as a benchmark, like bottle-to-bottle, while APR is more open to consider as recyclable a package that can be technically recycled and the recyclate can be used in an equivalent packaging application or in non-packaging applications (i.e. pipes, fibers).

Testing Protocols

Both APR and RecyClass rely on standardized testing procedures managed by recognized testing facilities both in Europe and North America. APR and RecyClass are jointly working on the cross recognition of new testing facilities with the capabilities to perform both testing procedures based on high level standards. Lab scale testing protocols exist for each recycling stream addressed by each organization and are combined with simplified tests to cover only specific steps of the recycling process. In this cooperation, the work is focusing on the comparison of RecyClass Recyclability Evaluation Protocols and APR Critical and Application Guidance. Other testing programs like the Preferred Design Recognition, and Responsible Innovation Recognition from APR or the Quick Tests from both organizations are not currently covered within the scope of the cooperation. When comparing RecyClass Recyclability Evaluation Protocols and APR Critical and Application Guidance, some differences have been identified between both organizations regarding sample preparation/recipes, processing temperatures, benchmarks, or converting conditions, but the protocols remain generally equivalent. For instance, RecyClass protocols always require converting the pellets via a closed-loop converting process, which is only mandatory by APR in the PE Film Critical Guidance and as Application Guidance but not in Critical Guidance for the other formats. A summary can be found in the following sections, presenting the differences and similarities between APR and RecyClass protocols.

HDPE and PP Rigid Packaging

When discussing HDPE and PP rigid packaging, APR and RecyClass have already achieved a commendable level of harmonization regarding protocols and design for recycling guidelines before entering into this cooperation agreement. Nonetheless, certain gaps still require attention, necessitating the generation of scientific information to bolster efforts in closing these gaps.

For HDPE and PP container recycling streams in North America and Europe, the main differences are found in the collection and food contact status for the recyclate produced, which vary significantly from one region to another. However, regarding the recycling process itself, the procedures applied are quite similar and therefore the similarities between APR's Critical and Application Guidance and RecyClass Recyclability Evaluation Protocols for this type of packaging already exist.

In recent years, RecyClass has diligently directed its efforts towards defining the compatibility of barrier technologies with HDPE and PP rigid packaging, such as EVOH, one of the components where the focus of this cooperation was put. Additionally, RecyClass has explored the acceptable levels of PP and PE content in the PE and PP streams, respectively. RecyClass focus has extended to understanding the compatibility of thermoplastic elastomers, adhesives for labels, and the impact of various types of decorations on sorting behavior, among numerous other topics. These components have been studied by testing via the Recyclability Evaluation Protocols in the context of recyclability approval procedures and in design-specific test campaigns funded by RecyClass.

APR has been similarly focused on improving guidance to increase quality and yield for the polyolefin rigid packaging stream. Efforts have included guidance on all plastic dispensers (i.e. removing metal components such as springs), closures, and base resin compositions. One emerging packaging format that has received recent attention is polyethylene tubes. Since the first construction received APR recognition in 2019, over 30 constructions have been recognized by RecyClass and/or APR. As the proliferation of tubes has increased, APR has focused on improving tube-specific guidance. This began with guidance on MFI for the shoulder and closure and is progressing with standardization of elutriation testing to ensure lab-scale testing replicates industrial processes.

Harmonization steps done in 2023

Efforts in 2023 were focused on harmonizing specific features where both organizations had slight misalignments. One of these features was EVOH, used as a barrier material in both HDPE and PP containers as the acceptable thresholds and tie layer requirements of these materials were not aligned between APR and RecyClass. In that regard, information was exchanged between the parties to close the gap. RecyClass shared proprietary testing results

of different EVOH grades on HDPE and PP containers, tested via the Recyclability Evaluation Protocols. APR presented this data set in their Olefins Technical Committee which approved the thresholds and tie layer requirements based on RecyClass's guidance and testing results. Similarly, APR shared with RecyClass the approach taken when using a PE closure on HDPE containers based on APR's experience and guidance on tubes, where some conditions should be considered regarding the MFI of the grades used, in order to avoid further problems when blow molding a bottle out of the generated recyclates. RecyClass HDPE TC analyzed this data and decided to endorse APR's approach and reflect that in the Design for Recycling Guidelines and a Technical Review.

APR adopted EVOH Guidance for PP and HDPE Rigids Based on on RecyClass testing.

Finally, after approval by their Olefin technical committee, APR adopted the density maximum of 0.97 g/cm^3 for Preferred categorization for polyolefin rigid packaging established by RecyClass in their Guidelines.

Work in progress

While the differences in testing protocols are believed to be minimal, there are differences that must be evaluated. Thanks to several member companies, work is progressing on the joint test program to analyze where the main gaps are when applying RecyClass and APR testing protocols in parallel on the same innovation and the same laboratory. There are currently 5 companies that have confirmed their interest in supporting these testing efforts aimed at achieving harmonized testing procedures between both organizations. As we consider dual testing protocols, APR is also currently in the process updating its HDPE testing protocol to combine Applications Guidance with Critical Guidance to better align with the RecyClass's as well as APR's PO film Critical Guidance.
Finally, with the emergence of RFID tags in the North American market, APR has invited, RecyClass to participate in APR's-led working group for RFID tags on plastic packaging ensuring that proper design considers European recycling impact.

Challenges and opportunities for future harmonization

The exchange of information is also on the agenda. RecyClass will share with APR technical reports regarding the acceptable amounts of PP and PE in the PE and PP streams respectively as well as the effect of olefin-based thermoplastic elastomers in both PP and

HDPE streams. Efforts on harmonizing the approach over foamed olefinic parts and metallized labels are also under discussion. The removability of pressure sensitive labels from HDPE and PP packaging might be tackled as well, considering RecyClass' latest efforts to develop a robust testing procedure to assess this topic.
A final topic that may remain un-aligned without regulatory changes in Europe is the optional hot wash temperatures in the APR Critical Guidance Protocols. Higher wash temperatures are sometimes used in North America as required for processes that have received an US Food and Drug Administration (FDA) Letter of No Objection (LNO) and/or Bureau of Chemical Safety within the Food Directorate of Health Canada's Letter Of No Objection (LONO) for food contact applications. As there are currently no postconsumer mechanically recycled polyolefins that have received food contact approval by EFSA, the wash temperatures used in Europe are lower to conserve energy.

PE and PP Flexible Packaging

When comparing the different types of plastic packaging available on the market, it is relatively clear that the toughest challenges in terms of Design for Recycling are for flexible packaging due to their diverse applications and constructions. Indeed, the lightweight of the PE and PP bags, flow-wraps, or pouches leads to a high share of non-polyolefin substances used in these packaging, such as barriers, inks, or adhesives. These contaminants can therefore play a significant role in lowering the quality of the recyclate, thus underlying the need to be designed in a way to be compatible with PE or PP film recycling.
The cooperation of APR and RecyClass on flexible packaging begins with the exchange of information and data collected to deliver a clear message to the industry on how to design the next generation of recyclable plastic flexible packaging. Today, APR Design for Recycling program focuses only on PE flexibles, while RecyClass includes PP flexibles as well, since the collection, sorting and recycling of PP mono-material film stream are more advanced in Europe.
At inception of the cooperation agreement, some significant differences were visible in both Design for Recycling guidelines and testing protocols. Regarding the Design for Recycling Guidelines, RecyClass guidance on barrier materials and laminating adhesives was better developed and more detailed than APR's, but in parallel, APR was already giving well-defined recommendations on EVA, ethylene copolymers, or ionomers. Recyclability Evaluation Protocols were also slightly different, in particular the type of extruders to be used, the material used for blending (virgin vs. processed control) and the converting phase (blown film) conditions. Indeed, even if both organizations were proposing the same converting process, the film thickness (25 µm for RecyClass and 35-65 µm for APR) as well as the second dilution with virgin PE requested by RecyClass could lead to different results.

The identified differences in film testing protocols resulted in prioritizing the joint evaluation study with the objective to generate and compare test data for the same film samples based on the RecyClass and Critical Guidance testing protocols. The expected outcome of this study should provide a better understanding of the effect of different test conditions in two protocols, if any, on the results of the evaluation of recyclability of select flexible packaging and provide additional data for guidance harmonization.

Harmonization steps done in 2023

Already significant progress can be seen after 1 year of cooperation. Among the harmonization or better alignment, one should mention the following achievements:

- On testing protocol:
  - RecyClass is now recommending producing both 50 and 25 µm films. Like APR, the 50 µm film will be used for mechanical performance characterization.
  - On Gels & Specks characterization, RecyClass now also recommends following APR procedure to evaluate the quality of PE films, through their FAR Rating approach.
  - Washing steps, which was mandatory for RecyClass assessments in the past, became optional depending on the nature of the innovative feature to evaluate. Since APR does not request a washing step for PE films, this allows for similar pre-treatment steps.
- On Design for Recycling guidelines:
  - After test campaigns and consultation with the entire value chain, APR and RecyClass are now providing the same recommendations related to EVA, Ethylene-based copolymers, and ionomers.

RecyClass adopted FAR Rating Approach to Match APR's PE Film Critical Guidance Protocol

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In 2023, RecyClass and APR exchanged extensive data generated through their testing program, on laminating adhesives, inks, metallization, and on EVOH, which can then be the starting point for a future harmonization.

Work in progress

Like all the other recycling streams, APR and RecyClass launched their harmonization testing program at the end of 2023, aiming at generating comparative data obtained via both APR and RecyClass protocols. PE flexible packaging was the stream receiving the highest interest for this harmonization program and multiple tests are currently being carried out and will be used to better understand if testing protocols are comparable, or if a common procedure could be developed.

APR is also progressing on laminating adhesive, thanks to their dedicated Working Group. While RecyClass had a similar Laminating Adhesive WG since 2021, information is shared from one group to the other, to avoid duplicating testing and to fill any formulation or data gaps that became evident in the original study. In 2024, both groups will be generating new scientific-based data, which will be used to align or close the gap on design for recycling recommendations.
A collaboration and information exchange on inks is underway, with similar objectives.

Challenges and opportunities for future harmonization

Based on the complexity of PE flexible packaging, a lot of work still needs to be done to support the industry in the development of future recyclable packaging. Both APR and RecyClass align on the fact that features such as inks, barrier materials or adhesives will all be challenging components to address, and that they should be prioritized to deliver better, more aligned, Design for Recycling recommendations. Additionally, with the growth of consumer and industrial packaging with integrated plastic fitments, spouts, dispensers, closures, etc. developing harmonized guidelines from the beginning will enable packaging formats utilizing these features to grow in a manner that supports the recycling industry and circularity and not become disruptors.
PP flexible packaging has not been collected in North America due to a lack of infrastructure, regulations supporting its collection, and markets for the recycled output. With the emergence of new regulations and EPR programs, these formats will begin to be collected in Canada and will require detailed design guidance for recycling. As recycling systems for these packaging formats do not currently exist in North America, APR reached out to RecyClass for support based on their experience in recycling these materials at scale. RecyClass shared their detailed design guidance and a working group within APR's Film Technical Committee has been formed to review and use as a basis for North American guidance. Following the guidance development, the Films Technical Committee will then focus on studying RecyClass's PP flexible testing protocols.

PET Packaging

Few differences could be observed regarding how APR and RecyClass approach Design Guidance and testing for PET bottles. Indeed, apart from the technical aspects of recyclability, different legislative frameworks from one continent to the other can also lead to different Design for Recycling recommendations. This is true for PET beverage bottles, where the development of Deposit Return Systems (DRS), mandatory incorporation of recycled content or generation of food-contact compliant PCR are addressed differently via local legislations.

When talking about the recycling of PET packaging, collection systems can vary from region to region and state to state. For instance, DRS are in place in some countries/states/provinces whereas in other locations PET bottles are collected with other household packaging, sometimes only plastic packaging, sometimes including glass or cardboard. For instance, some European countries produce individual bales of separated clear, light blue, colored, opaque PET bottles bales and clear PET trays bales. In North America for non-DRS bales, bottles and trays of all sortable colors are comingled in the bale requiring additional separation steps at the reclaimer for producing high quality recyclate.
Once bales arrive at the reclaimer for processing, the processing steps in European and North American are close to being identical with only minor differences in terms of delabelling units, washing treatment, and wastewater treatment. For the rest, similar processes are used.

Harmonization steps done in 2023

Comparison of APR Critical Guidance and RecyClass Recyclability Evaluation Protocols
In 2023, RecyClass developed new Recyclability Evaluation Protocols for PET bottles and for labels & adhesives applied on PET bottles, based on the State-of-the-art of European PET recycling processes. For these new testing methods, RecyClass utilized APR's Critical Guidance testing protocols as a starting point in the development of their Recyclability Evaluation Protocols for PET bottle packaging. In that regard, both Critical and Application Guidance of APR and RecyClass Recyclability Evaluation Protocols are very much aligned, with only few differences, such as stirring speed during washing, benchmarks for characterization, or small variations in processing temperatures. As these are minor deviations, both organizations strongly believe that through common testing, and data-based discussions, these protocols will continue to get closer in the future.

RecyClass utilized APR's Critical Guidance testing protocols as a starting point in the development of their Recyclability Evaluation Protocols for PET bottle packaging.

Comparison of Design Guidance given by RecyClass and APR
A review of PET guidance documentation from each organization reveals in most cases that the factual content and topics covered are very similar. There are differences in editorial style and level of detail given. There are only a couple of cases where divergent information is given.

Following there are three summary comparisons to illustrate the guidance given by each organization for PET containers:

- Container material – RecyClass calls out use of PET and gives guidance that PET should make up at least 90 wt% of the package. APR calls for PET resins that meet a few specific criteria and currently has no guidance speaking to minimum PET content.
- Closures and liners – RecyClass provides a concise listing of materials that can be used in closures, liners and dispensing valves. This list includes floating silicone materials that are considered as limited compatible with PET recycling. APR provides a broader definition of olefin and other materials that are acceptable, based on their density, but this list does not include floating silicones specifically.
- Labels and Inks – While much of the guidance is similar, the level of detail is substantially different, and there are some important details where APR and RecyClass guidance are not in agreement due to differences in regulations between North America and Europe over NIAS and wastewater disposal.

Work in progress

This collaboration has identified four technical programs that will be especially impactful for any region engaged in PET container recycling. APR and RecyClass will look for opportunities to co-invest in these four technical areas.

1. Reducing color deterioration and haze in recycled PET.
2. Better managing the impact of labels, adhesives, and inks when PET is recycled.
3. Creating tests to evaluate the recycling impact of additives commonly used in PET.
4. Supporting advances in automated sorting technology.

Challenges and opportunities for future harmonization

The MRF sortation and reclaiming process steps associated with PET packaging are virtually equivalent in Europe and North America. So, it is logical that design guidance and recycling evaluation tests can be similar, if not exactly the same, for each region. But today's guidance and test methods do have some distinct differences that must be resolved in a harmonization effort. One such difference is RecyClass's specific design guidance for PET thermoforms/trays. As thermoforms are collected in thermoforms specific bales in Europe, the guidance varies from the North American case where thermoforms are comingled in PET bottle bales. This will be a future point for discussion and harmonization.

Recommendations – There are three recommendations impacting PET packaging:

1. A first focus will be developing test method for clear PET bottles that is harmonized and compliments and supports design guidance. With guidance and test methods for clear PET bottles successfully in place, guidance and testing for other PET packaging segments can be tackled.

2. Based on the development of these testing methods, both organisations should try to close the gap on the Design for Recycling guidelines. The initial focus of this harmonisation will be on clear PET bottles.
3. An additional recommendation is for APR and RecyClass staff to identify any steps that can be taken to co-invest in the four technology topics listed in the section immediately above. Can we create a development program and fund high value technical programs?

Sorting

The American and European collection and sorting processes may differ significantly. These differences primarily occur when source selection (initial sorting by the consumer) takes place. Source selection allows for more pure streams that do not require as much downstream sorting as with comingled material. In some European countries consumers are required to separate recyclables into many different fractions (glass, paper, plastics, ...), while the Americans typically utilize single stream collection (all recyclables in one bin). Since it is not possible to develop a standard testing method based on different collection models, both APR and RecyClass have chosen to align their guidance based on common processes instead of common composition of the waste stream. The thought around this approach is if a package is compatible with the general collection process it will also be compatible with the source-segregated process. The models upon which the APR and RecyClass systems are designed are very similar, with the notable difference that the European model includes flexible plastics via curbside collection, while the American one does not.

Comparison of APR's Sorting Potential Protocol and RecyClass Recyclability Evaluation Protocol

Both regions consist of a series of independent steps as described below. While the order of the steps may vary in practice, a plastic packaging must pass through all of the steps in each protocol. The primary difference between the protocols is that RecyClass uses a combined, continuous, pilot or industrial-scale process whereas APR uses individual lab-scale processes. Both protocols have been designed to cover all the steps of the industrial process used by MRF's and reclaimers.

- Compaction: APR's method utilizes a specially designed device to apply a determined pressure to individual packages while RecyClass's protocol uses a commercially available baler to reduce the package size by a defined percentage to simulate truck compaction.
- Small size sortation: RecyClass's protocol utilizes a vibratory screen or sieving drum of 45mm circular holes whereas APR's protocol uses a tumbling box with 37mm x 50mm rectangular holes.
- Metal separation: Recyclass protocol uses both a commercial scale eddy current separator and a

magnet, whereas APR's protocol uses a magnet and a metal detector to model the combination of MRF and reclaimer removal.

- Wind sifting: APR's protocol does not include this step since films and flexibles are not commonly included in the curbside recycling stream, while RecyClass' protocol does include this step.
- 2d/3d sortation: Both protocols use the same machine, a commercial scale ballistic separator. The RecyClass protocol has the ballistic separator in-line with the additional sortation steps whereas the APR protocol has it as a stand-alone evaluation.
- NIR detection: While both protocols use similar machines, RecyClass utilizes NIR in-line and APR utilizes NIR as a stand-alone process similar to ballistic separation.

Challenges and opportunities for future harmonization

While slight differences exist in the protocols the individual steps are very similar so it is likely that the results could be similar with the exception of flexible film. Actual samples of packaging that both pass and fail each protocol will be processed through each protocol in the future so that the results can be compared and contrasted. Identifying sorting facilities that can conduct both protocols in the same location will facilitate this process.

Next Steps of the Cooperation

This first year of cooperation highlighted that similar challenges are faced in both continents regarding Design for Recycling, and that harmonization is necessary to deliver more consistent guidance to the industry. Even if the exchange of information and data already enabled us to close the gap on some topics, it remains evident that there is still a lot of work to do to better align design for recycling recommendations, in particular for flexible packaging. Both organizations remain optimistic about delivering a common message to the industry in the coming years, and therefore avoiding duplication of recyclability tests in Europe and North America. Nevertheless, this cooperation can also be improved to gain efficiency and avoid contradictory recommendations in the future. In that regard, APR and RecyClass will be paying attention to improving communication between respective technical committees or working groups, ensuring both organizations are aware of the tests performed by the other. As this cooperation needs to remain fact-based and rely on recyclability tests data sharing, both APR and RecyClass will work on better coordinating their testing programs to support the industry with more harmonized design for recycling recommendations.

Both organizations remain optimistic about delivering a common message to the industry.

Acknowledgments

APR and RecyClass teams would like to thank our combined membership organizations for their support in this effort, especially those that have volunteered to test their products in the parallel testing streams. We would also like to thank our Working Groups and Technical Committees that have spent countless hours reviewing and approving guidance changes based on research and data collected by the other organization. We would also like to thank our teammates within our organizations for their support in the development of this report.

APR & RecyClass Ambassadors

Alexei Kazakov (APR) – Films
Augusto Bruno (RecyClass) – Polyolefin rigids
Curt Cozart (APR) – Sorting
Fabrizio Di Gregorio (RecyClass) - Sorting
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