

Preliminary Evaluation of the Near Infrared (NIR) Sorting Potential of a Whole Plastic Article

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The APR [Sort-B-01 benchmark test](#) is the only “must-pass” test to prove sortation is viable at production scale.

Introduction – Scope, significance and use - This test is one in the series of “Sorting Potential Test Methods” developed by the Association of Plastics Recyclers (APR). This method was developed to enable small scale learnings on NIR detectability prior to investing more significant timecost into the full APR Sort-B-01 Evaluation of the Near Infrared (NIR) Sorting Potential of a Whole Plastic Article benchmark test. **The [Sort-B-01 benchmark test](#) is the only “must-pass” test to prove sortation is viable at production scale.**

The first screening test uses an established baseline of a known NIR detectable virgin polymer by scanning a reference sample using a handheld or benchtop spectrophotometer. The second test is a static test that can be performed on the test article by scanning under the NIR sorter and checking for detectability under standard settings/classifiers. Then, a dynamic test can be performed on an individual candidate article by running the item through the NIR sorter without other waste material on the conveyor. - To confirm that a package can be effectively detected and sorted by an NIR optical sorter, the full APR Sort-B-01 protocol must be conducted to evaluate the performance with master mix of material waste.

This series of test methods is designed to range from a rapid scan to dynamic testing. Method I is a lab scale test that provides a quick evaluation; Methods II and III will provide more indicative evaluation results. It is not necessary to perform all three Snap Tests, although performing at least two of three offers the most robust preliminary evaluation.

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1. Spectrophotometer Reading

Reference Documents:

[APR Sort-B-01 Evaluation of the Near Infrared \(NIR\) Sorting Potential of a Whole Plastic Article](#)

NIR Spectrophotometer Owner's Manual / SOP

Equipment required:

NIR Spectrophotometer (Portable or Benchtop with a minimum NIR capability range of 4500-7000 cm⁻¹ or the equivalent of 1400 – 2200 nm).

Examples of equipment that has been used for evaluation: Jasco V-770, Metrohm/Foss XDS Rapid Content Analyzer, Perkin Elmer Lambda 900, Shimadzu UV-3600i, and TrinamiX Mobile NIR Spectroscopy Solutions.

Materials required:

1. Reference Article for Baseline Measurement (if needed)
2. Unlabeled Article for Evaluation. It is recommended to reference the APR Design Guide for further information on how label material and surface coverage can affect results.

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Methods:

I. Preliminary Portable or Benchtop NIR evaluation

This step enables anyone with access to a portable or benchtop scale NIR Spectrophotometer to conduct a quick comparison of a test article to a reference material, confirming feasibility of correct polymer identification. In general, if the test article is not identified correctly in this test it is not likely that subsequent methods will be successful.

1. Obtain a baseline measurement for target polymer from a reference library or suitable sample. It is recommended to use a polymer with no additives for best results.
 - a. Measure virgin resin reference bottle using the spectrophotometer. A 5 cm X 5 cm swatch cut from the bottle wall, or other suitable sized sample for the equipment aperture can be used. A flat injection molded or compression molded sample can also be used and provide the benefit of being flat and easier to position under the NIR unit's aperture.
 - b. Generate a spectrum displayed as reflectance values.
2. Obtain the wavelength measurement for the test variable.
 - a. Prepare a sample for scanning by cutting a 5 cm X 5 cm swatch cut from the bottle wall, or other suitable sized sample for the equipment aperture can be used. Alternatively, a flat color chip molded from the resin and color concentrate of interest can be used.
 - b. Scan the sample swatch using the spectrophotometer and generate a spectrum in reflectance.
 - c. Use APR Design Guide recommendation of 10% average or greater reflectivity across range of 4500-7000 cm^{-1} , or the equivalent of 1400 – 2200 nm NIR spectrum.
3. Compare the spectrum of the variable tested to the standard or reference value defined based on 1a. Test article must be accurately identified as the correct polymer resin using range of 4500-7000 cm^{-1} or the equivalent of 1400 – 2200 nm NIR spectrum. This comparison can be done visually to compare the major features of the spectrum. Most NIR spectrophotometers employ software that will provide a comparison and determine if the test material can be identified as made with the standard virgin resin.

II. Static Snap Test for Test Article

This step ensures NIR detectability of the article without any other variables introduced. It is conducted at a production scale sorting facility or equipment manufacturer on their respective equipment. This method provides a higher-level confidence of NIR detectability since production scale equipment and settings are used. Static and empty conveyors enable the best-case detectability with this equipment and provide confidence to continue moving to step III Dynamic Snap Test (One Test Article).

1. Using the manufacturer's operating procedure, set the sorter to positively sort the polymer which represents the test article.
2. Take one test article to location on the NIR optical sorter where NIR detector can be safely accessed.

3. Place test article on the un-moving conveyor belt (or as needed) and position it under the light source and detector.
4. Assess the result to determine if candidate article was identified correctly. Record as YES or NO.

III. Dynamic Snap Test (One Test Article)

This step is similar to **Method II Static Snap Test for Test Article** with the addition of movement by conveying the test article through the NIR equipment. The conveyor is still empty of other articles but helps demonstrate moving NIR detection and successful sortation that typically occurs via air blasts at the end of the conveyor.

1. May be performed separately or after passing Step II, using the same equipment to conduct Step III.
2. Compress the test article according to the [APR Compression Practice for Sorting](https://plasticsrecycling.org/images/Design-Guidance-Tests/APR-SORT-PR-01-compression-practice.pdf) found at: <https://plasticsrecycling.org/images/Design-Guidance-Tests/APR-SORT-PR-01-compression-practice.pdf>
3. Adjust conveyor speed to nominal setting and record values.
4. Set equipment to positively sort polymer using base classifier/program that has been deployed in the commercial marketplace. Confirm the equipment is performing as expected by running a control article of known composition.
5. Place the test article on the conveyor where it will have enough time to settle. Verify it was sorted correctly or positively ejected to the correct bin. Repeat 3 times.
6. If the article can be sorted correctly three repeat times, that result provides support that the article is a candidate to progress to the full [Sorting Potential Test Method \(Sort B-01\)](#).
7. If there is not successful repeat detection or sortation, make an effort to determine why not, and take corrective action if possible. Consider impact of: label material, closure material, air jet failure, color (L*) or the size/shape of the article.

DOCUMENT VERSION HISTORY

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1	May 27, 2021	