Voluntary Design Guidelines for Designated PET Bottles

Appendix 1: Material Evaluation Criteria for Bottles (including Handles)

Revised on March 31, 2023

The Council for PET Bottle Recycling (JAPAN)

Table of Contents

Bottles that do not comply with required items in the Basic Standards may be used as exceptions if they are judged to comply when tested in accordance with the material evaluation criteria for bottles in Appendix 1. In these cases, a report certified by the Council as compliant with the Guidelines is necessary before the bottles are marketed.

1. Evaluation Items and Evaluation Criteria

Where bottles include substances or materials other than the main PET material, including use by adding or compounding, and are treated as exceptions to the Basic Standards in these "Guidelines," the materials used must comply with the requirements A through C below.

However, additives to decrease the molecular weight or promote the decomposition of PET resin, or auxiliaries, additives, and other substances that significantly affect the molding conditions of PET resin must not be used.

A. Confirmation of Food Contact Compliance
- The bottles should be compliant with the "Standards and Criteria for Foods and Additives (Ministry of Health and Welfare Notification No. 370)" set forth in accordance with the "Food Sanitation Act".
- All the materials used should be compliant with the standards set by the Food Contact Material Safety Center of Japan Chemical Innovation and Inspection Institute or with the U.S. FDA regulations, or the absence of hygiene and safety problems is verified on the responsibility of the bottle manufacturer, the material supplier or the company commercializing the bottles.
- Hygienic safety should be maintained, and there should be no hazardous substances generated, in the (bottle-to-bottle (BtoB) decontamination process or the filling process when using chemical or electron beam (EB) irradiation for sterilization.

B. Evaluation of Basic Physical Properties
- The material should meet the evaluation criteria when evaluated in accordance with the attached test methods for the evaluation of the basic physical properties required for recycled flakes.

C. Evaluation of Recycling Suitability
- The material should meet the evaluation criteria when evaluated in accordance with the attached test methods for the evaluation of recycling suitability for fiber, sheet, bottle (molding suitability), or designated PET bottle (BtoB suitability) applications.

Note: The following points apply when material separation is possible using any indication, any sorting equipment and/or visual hand sorting.

(1) When new separation equipment is developed and recyclers install it, evaluations can be carried out on samples after sorting with the newly developed separation equipment.

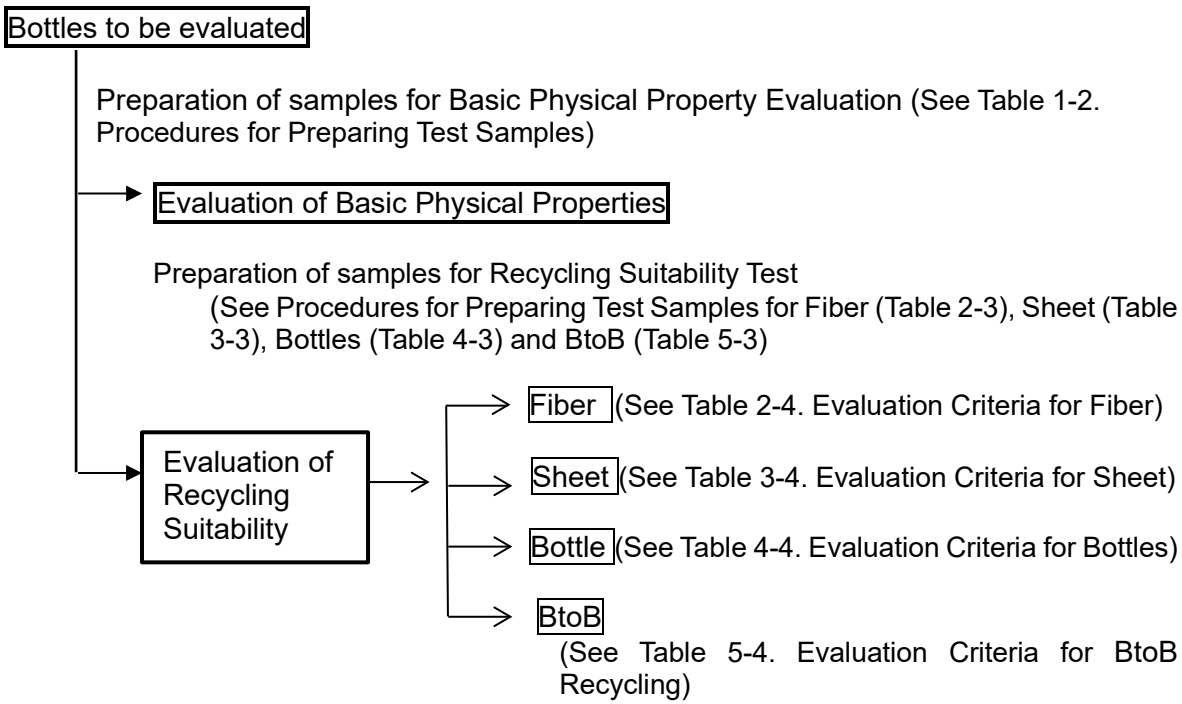
(2) When recyclers can carry out additional separation by visual and hand sorting with any package identification, those sorting can be used for preparing evaluation samples, which have been blended with new material.

2. Evaluation Method

2-1 Overview of Evaluation Method

Overall evaluation consists of evaluations of basic physical properties and evaluations of recycling suitability. The latter evaluations consist of testing and evaluation for use in various applications; fiber, sheet, bottle (molding suitability), or designated PET bottle (BtoB suitability) products.

All tests and evaluations should be performed and the results should meet the criteria.



2-2 Test Equipment and Test Samples Equipment

Equipment

Since the purpose of the evaluation is to confirm that the materials to be evaluated will give no significant impact on current recycling stream, it would be desirable to use industrial recycling equipment.

However, if there is any difficulty in conducting the evaluation with industrial equipment, laboratory equipment may be used as a substitute. In such a case, the equipment and conditions used must correlate with those used in actual recycling facilities.

Preparation of the Samples (Recycled and Reference Materials)

Samples for evaluation should be prepared by molding bottles and then grinding them into flake material to be evaluated as the raw material for each end-application.

The type of the bottles to be evaluated should be, in principle, that for the intended application (e.g. the new material system intended for soy sauce application should be molded into soy sauce bottles).

The procedures for preparing the samples are shown in Procedures for Preparing Test Samples.

The reference sample should be prepared from the same bottles containing only PET.

2-3 Test Details

(1) Evaluation of Basic Physical Properties

1) Testing Method

Table 1-1: Test Overview, Equipment and Conditions

Evaluation Items			Evaluation Methods
Flakes	Appearance	Shape	Compare the shape of the flakes with that of the reference material flakes visually.
		Color	Compare the color of the flakes with that of the reference material flakes visually.
	Fine powder generation		Sift the flakes using 50-mesh sieve and compare the amount of the fine powder generated during crushing with that of the reference material.
Recycled Pellets	Intrinsic viscosity retention		Compare IV value for the pellets with that for the reference material pellets.
	Color		Measure the differences of L, a, and b values between the pellets of the sample and those of the reference material with color measuring equipment.
	Drying test		Place 200 g of the recycled pellets that have been crystallized at 130ºC for 60 minutes in a cylindrical tube of 80 mm diameter, apply a load of 10 kg, and introduce flowing nitrogen gas heated up to 150ºC into the tube for three hours. Then, observe agglomeration of the pellets on the plate.
Molded plates	Haze		Measure the haze of a point on the plate with a thickness of 3 mm using a haze meter.
	Appearance		Observe flow marks, sink and other defects.
	DSC measurements		Conduct sampling from a point on the plate with a thickness of 3 mm, and measure glass transition temperature (Tg), crystallizing temperature at heating (Tc1), melting temperature (Tm) and crystallizing temperature at cooling (Tc2) with a differential scanning calorimeter.

Table 1-2: Procedures for Preparing Test Samples

Test Material	Reference Material	Remarks
Test Materials	Pure PET	Use the PET of the same grade
↓ Bottle molding	↓ Bottle molding	Mold the bottles of intended use.
↓ Crushing	↓ Crushing	Crush the bottles into flakes 8 mm in size or less.
↓ Flake washing	↓ Flake washing	Strongly stir the flakes in 1.5% caustic solution between 85ºC and 90ºC for 15 minutes.
↓ Rinsing	↓ Rinsing	Rinse the flakes that were washed with the caustic solution by stirring them in fresh water and remove the caustic solution.
↓ Flakes for the Evaluation ↓ Re-pelletization	↓ Flakes of the reference material ↓ Re-pelletization	Repelletize the amount required

2) Evaluation Criteria

Table 1-3: Specifications for Basic Physical Properties of the Recycled Materials

(1) Flakes

Evaluation Items		Unit	Specifications	Importance Level	Remarks
Appearance	Shape		Equivalent to the reference material	Reference	In visual comparison with the reference material
	Color		Equivalent to the reference material	Reference	In visual comparison with the reference material
Fine powder generation		%	120 ≧	Important	Relative value to the reference material

(2) Evaluation of Physical Properties of Recycled Pellets

Evaluation Items		Unit	Specifications	Importance Level	Remarks
IV retention		%	90 ≦	Important	Relative value to the reference material
Color	L(ΔL)		5 ≧	Reference	Difference from the reference material
	a(Δa)		2 ≧	Reference	Difference from the reference material
	b(Δb)		3 ≧	Important	Difference from the reference material
Haze		%	5 ≧	Important	3 mm thick plate (stepped plate)
Appeara	Flow marks		No flow mark	Reference	(plates)

nce	Sink		No sink	Reference	(plates)
DSC (See Note below)	Tg	°C	70 ≦	Reference	(plates)
	Tc1	°C	130 ≦	Reference	(plates)
	Tc2	°C	205 ≧	Reference	(plates)
	Tm	°C	230 ≦	Reference	(plates)
Drying test	Agglomeration		No agglomeration of the pellets	Important	

Note: DSC conditions: Increase from room temp. to 300°C at rate of 10°C /min. (Tg, Tc1, Tm), keep for 3 min. at 300C, and cool to room temp. at rate of 10°C /min. (Tc2).

3) Judgment Criteria

Evaluation of basic physical properties is in accordance with 3. Judgment Criteria for Evaluations of Basic Physical Properties and Recycling Suitability.

(2) Evaluation of Recycling Suitability: Fiber Application Test

1) Testing Method

Table 2-1: Evaluation Overview

Evaluation Items		Evaluation Methods
Process-ability	Filtration	Observe the increase in filtering pressure with the passage of time at the specified spinning conditions and filter configuration.
	Spinning	Count the number of times of yarn breakage, during winding the yarn at the specified speed.
	Drawing	Measure the maximum draw ratio (MDR) when drawing the yarn. Count the number of times of yarn breakage when the yarn is drawn to an elongation of 30±5%.
Sheet Properties	Yarn quality	Measure thickness (dtex) and intrinsic viscosity (IV) for the undrawn yarn. Measure thickness (dtex), tensile strength, thermal shrinkage rate and toughness for the drawn yarn. Measure the color (L, a, b) of circular knit made of the drawn yarn.
	Dyeability	Evaluate uptake rate, dyeing speck and color fastness to light of the dyed circular knit made of the drawn yarn.

Table 2-2: Equipment and conditions to be used

Items	Equipment and conditions
Filtration -Equipment -Filter configuration -Filtration rate -Spinning temperature -Testing time	 Spinning machine (single screw) #50/#100/#2300-2400/#100 (mesh) 260 g/cm^2/hr 280 to 285ºC 3 hours
Spinning -Equipment -Winding rate -Undrawn yarn thickness	 Spinning machine (single screw) 700 m/minute 64±2 dtex/8 filaments (equivalent to 8 dtex/filament)
Drawing -Equipment -Hot roller temperature -Hot plate temperature -Elongation -Draw ratio -Drawing rate -Drawn yarn thickness	 Drawing machine (hot roller: 100 φ, hot plate: 300 m/minute) 80ºC 150ºC 30±5% 3 to 4 times (to be set based on elongation factor) 600 m/minute 15 to 20 dtex/8 filaments (equivalent to 2 dtex/filament)
Dyeing -Equipment -Refining -Pre-setting -Dyeing -Reduction cleaning	 Circular knitting machine, miniature color dyeing machine, thermo setter etc. Treat the circular knit at 60 to 70ºC for 20 minutes with standard chemicals and auxiliaries at a bath ratio of 1:30 to 1:50. at 150 to 200ºC, for 30 to 60 seconds Treat the circular knit with blue disperse dye for polyester (such as Dianix Blue and Resoline Blue) and auxiliaries at a bath ratio of 1:30 to 1:50 at 130ºC for 30 minutes. Treat the circular knit with standard reducing agents and auxiliaries at a bath ratio of 1:30 to 1:50 at 70 to 80ºC for 20 minutes.

-Final setting	at 160ºC for 30 to 60 seconds
Color fastness to light -Equipment -Irradiation	(To be carried out in accordance with the procedures specified in JIS L-0842) UV fade meter at 63ºC for 20 hours

Table 2-3: Procedures for Preparing Test Samples
Prepare using the method (A) or (B) shown below.
(A)

Test Material	Reference Material	Remarks
Test Material	Pure PET	Use the PET of the same grade.
↓ Bottle molding	↓ Bottle molding	Mold the bottles of intended use.
↓ Crushing	↓ Crushing	Crush the bottles into 8 mm mesh flakes.
↓ Flake washing	↓ Flake washing	Strongly stir the flakes in 1.5% caustic solution between 85ºC and 90ºC for 15 minutes.
↓ Rinsing	↓ Rinsing	Rinse the flakes that were washed with the caustic solution by stirring them in fresh water and remove the caustic solution.
↓ Flakes for the evaluation ↓ Re-pelletization	↓ Flakes of the reference material ↓ Re-pelletization	Reference (*) pellet dimension: Length ×Long axis x Short axis ＝3 x 3 x 2 (mm) (*) Because small pellets have penetration issues with the recommended testing device.

(B)

Test Material	Reference Material	Remarks
Test Material	Pure PET	Use the PET of the same grade.
↓ Re-pelletization (1st time)	↓ Re-pelletization (1st time)	To make the number of times of thermal history the same as (A), use an extruder to re-pelletize instead of molding bottles from materials and crushing them.
↓ (Pellet washing)	↓ (Pellet washing)	Strongly stir the flakes in 1.5% caustic solution between 85ºC and 90ºC for 15 minutes.
↓ Rinsing	↓ Rinsing	Rinse the flakes that were washed with the caustic solution by stirring them in fresh water and remove the caustic solution.
↓ Re-pelletization (2nd time)	↓ Re-pelletization (2nd time)	Reference (*) pellet dimension: Length ×Long axis x Short axis ＝3 x 3 x 2 (mm) (*) Because small pellets have penetration issues with the recommended testing device.

(1) It was found in preliminary investigations that contamination that occurs during the

process of preparing test samples makes the evaluation difficult when a laboratory spinning machine is used. The test material, therefore, may be melt processed directly into pellets of the mixture of starting materials to simulate the effect of thermal history, skipping the process of bottle molding, crushing, and flake washing.

(2) In the evaluation of the recycled materials to be processed into fiber, the effect of the IV value cannot be ignored. It is, therefore, important to re-pelletize the materials under conditions in which the IV value becomes between 0.55 and 0.70 dl/g.

2) Evaluation Criteria

Table 2-4: Evaluation Criteria for Fiber

Evaluation Items		Evaluation Details		Unit	Specifications	Importance Level	Remarks
Process-ability	Filtration	Increase in filtration pressure (after three hours of continuous run)		kg/cm^2	20 ≧	Important	Filter configuration #50/100/ 2300 ~ 2400/100
	Spinning	Yarn breakage at spinning (during three hours of continuous run)		Times	1	Important	900g
	Drawing	MDR		%	90≦	Reference	Relative value to the reference material
		Yarn breakage at drawing		Times	1	Important	300g
Physical properties	Yarn quality	Toughness			20 ≦	Important	Tf=DT√DE
		Thermal shrinkage rate	Shrinkage in boiling water	%	80 ~ 120	Reference	For 30 minutes in boiling water
			Dry shrinkage rate	%	80 ~ 120	Reference	At 100ºC for 10 minutes
		Color (Δb)			2 ≧	Important	Circular knit
		Thickness		%	80 ~ 120	Reference	Relative value to the reference material
		Tensile strength		%	80 ~ 120	Reference	Relative value to the reference material
		Tensile elongation		%	30 ± 5	Important	Setting condition
		Intrinsic viscosity (IV)			0.55 ~ 0.7		See Note 1
	Dyeability	Dyeability	Uptake rate	%	90 ≦	Reference	Relative value to the reference material
			Spots		No spot	Important	Dyeing evenness
		Color fastness to light		Class	4 ≦	Important	

Note 1. In the evaluation of the recycled materials to be processed into fiber, the effect of the IV value cannot be ignored. It is, therefore, important to re-pelletize the materials under conditions in which the IV value becomes between 0.55 and 0.70 dl/g.

3) Judgment Criteria

Evaluation of recycling suitability is in accordance with 3. Judgment Criteria for Evaluations of Basic Physical Properties and Recycling Suitability.

(3) Evaluation of Recycling Suitability: Sheet Application Test

1) Testing Method

Table 3-1: Evaluation Overview

Evaluation Items		Evaluation Methods
Process-ability	Filtration	Observe increase in filtering pressure with the specified extruding conditions and filter configuration.
	Sheet Forming	Form a sheet of 0.30±0.02 mm thick, and observe the appearance to check for sink, flow marks and other defects, and count the number of fisheyes.
	Thermo-forming Test	Mold the sheet into cups and compare the contour and haze with those made from the reference material.
Sheet properties		Form a sheet of 0.30±0.02 mm thick, and evaluate properties of the sheet including IV value, transparency (haze), color, impact strength, tensile yield strength, fracture point and tensile modulus.

Table 3-2: Equipment and conditions to be used

Items	Equipment and conditions
Filtration -Equipment -Filter configuration -Filtration rate -Melt temperature -Testing time	 Extruder #60/#750-800/#60 (mesh) 200 g/cm^2/hr 280 to 290ºC 120 minutes
Sheet Forming -Equipment -Melt temperature -Sheet thickness -Sheet width	 Sheet forming machine 280 to 290 ºC (standard condition for PET) 0.30±0.02 mm 250 mm or wider
Thermoforming -Equipment -Forming temperature -Mold diameter -Draw ratio -Number of molds	 Air pressure or vacuum thermoformer 90 to 100ºC (standard condition for PET) 80 to 100 mm φ or equivalent (rectangular or circular) 0.5 or more Two or more rows in the widthwise direction

Table 3-3: Procedures for Preparing Test Samples

	Test Material	Reference Material	Remarks
Common procedure for both bottles and sheet	Test Material	PET only	Use the PET of the same grade.
	↓ Bottle molding	↓ Bottle molding	Mold the bottles of intended use.
	↓ Crushing	↓ Crushing	Crush the bottles into 8 mm mesh flakes.
	↓ Flake washing	↓ Flake washing	Strongly stir the flakes in 1.5% caustic solution between 85ºC and 90ºC for 15 minutes.
	↓ Rinsing	↓ Rinsing	Rinse the flakes that were washed with the caustic solution by stirring them in fresh water and remove the caustic solution.
	↓ Flakes for the Evaluation	↓ Flakes of the reference material	(To be used for sheet forming)
For sheet application			Use as flake for test.

For sheet application, the evaluation may be conducted with the re-pelletized materials. The caution against IV dropping during the re-pelletization process would be necessary.

2) Evaluation Criteria

Table 3-4: Evaluation Criteria for Sheet

Evaluation Items		Evaluation Details		Unit	Specifications	Importance Level	Remarks
Process-ability	Filtration	Increase in filtration pressure (after two hour continuous run)		kg/cm^2	10 ≧	Important	Filter configuration #60/750-800/60
	Sheet Forming	Appearance	Sink		No sink	Reference	
			Flow marks		No flow mark	Reference	
		Number of fisheyes		$/m^2$	2 ≧	Reference	0.5 mm or larger
	Thermo-forming	Contour			Equivalent to the reference material	Reference	
		Whitening			No whitening	Reference	
Sheet properties		Haze		%	3 ≧	Important	At 0.3 mm thick
		Color (Δb)			2 ≧	Important	Difference from the reference material
		Impact strength		%	85 ≦	Important	Relative value to the reference material
		Tensile yield strength		%	85 ≦	Reference	Relative value to the reference material
		Fracture point		%	85 ≦	Important	Relative value to the reference material
		Tensile modulus		%	85 ≦	Reference	Relative value to the reference material

3) Judgment Criteria

Evaluation of recycling suitability is in accordance with 3. Judgment Criteria for Evaluations of Basic Physical Properties and Recycling Suitability.

(4) Evaluation of Recycling Suitability: Bottle Application Test (Molding Suitability)

1) Testing Method

Table 4-1: Evaluation Overview

Evaluation Items		Evaluation Methods
Process-ability	Injection molding	Mold preforms of 3-4 mm thick under the standard settings and observe the appearance (for sink, transparency, etc.).
	Blow molding	Blow mold the above preforms into bottles under the standard settings and observe the appearance of the bottles (for sink, off-centering, shape, etc.).
Bottle properties		Properties of the standard bottles Evaluate properties of the bottles including IV retention, brimful capacity, thickness distribution, tensile strength, color-b, haze, and acetaldehyde content.

Table 4-2: Equipment and conditions to be used

Items	Equipment and conditions
Injection molding -Equipment -Mold -Melt temperature -Molding conditions -Testing time	 Injection molding machine Preform molds for 500 to 2,000 ml bottles (molds with two or more cavities are recommended.) 280 to 300 ºC (setting) To be set using the reference material 3 hours
Stretching blow molding -Equipment -Mold -Molding conditions	 Stretch blow molding machine Blow molds for 500 to 2,000 ml bottles To be set using the reference material

*Describe the weight and capacity of the bottles used for the test and the draw ratio between preform and bottles in a report.

Table 4-3: Procedures for Preparing Test Samples

	Test Materials	Reference Material	Remarks
Common procedure for bottles, including BtoB	Test Material	PET only	Use the same grade PET resin for bottle as reference.
	↓ Bottle molding	↓ Bottle molding	Mold the bottles of intended use.
	↓ Crushing	↓ Crushing	Crush the bottles into flakes 8 mm in size or less.
	↓ Flake washing	↓ Flake washing	Strongly stir the flakes in 1.5% caustic solution between 85ºC and 90ºC for 15 minutes.
	↓ Rinsing	↓ Rinsing	Rinse the flakes that were washed with the caustic solution by stirring them in fresh water and remove the caustic solution.
	↓ Draining	↓ Draining	Remove attached water by air drying at 50°C for 3 hours.
	↓ Flakes for the Evaluation	↓ Flakes of the reference material	Execute pneumatic separation if necessary. (Refer to the following table)
For bottle application	Re-pelletization ↓	Re-pelletization ↓	Re-process the flakes into pellets.
	Blending (50%)	Blending (50%)	Mix the re-processed pellets with the same amount of virgin PET pellets.

Note: As it is generally difficult to mold bottles normally with 100% recycled material due to a decline in the IV value, use a 50/50 mixture of the recycled material and virgin PET in the evaluation for bottle application.

Pneumatic separation: Overview, Equipment and Test Conditions

Evaluation	Evaluation Methods
Pneumatic separation conditions	Use pneumatic separation conditions that achieve 5% loss or less for the reference material flakes. If possible, measure contamination removal ratio.
Pneumatic separator	Recommendation: Model CFS-150 separator by ACO Co., Ltd.

Note: Include the following information in reports when executing the pneumatic separation.

Evaluation Items		Unit	Criteria	Importance Level	Remarks
Pneumatic separation	Yield	%	95≦	Include in report	Only when executing pneumatic separation
	Contamination removal	%		Include in report	Only when measurable

2) Evaluation Criteria

TABLE 4-4: Evaluation Criteria for Bottles

Evaluation Items		Evaluation Details		Unit	Specifications	Importance Level	Remarks
Process-ability	Injection molding	Appearance of the preforms			Equivalent to the reference material	Important	In visual comparison with the reference material
	Blow molding	Appearance of the bottles			Equivalent to the reference material	**Important**	In visual comparison with the reference material
Bottle properties		IV retention		%	90≦	Reference	Relative value to the reference material
		Acetaldehyde		%	110≧	Reference	Relative value to the reference material
		Bottle dimensions	Brimful capacity	%	1.0≧	Important	Relative value to the reference material
			Height	%	1.5≧	Reference	Relative value to the reference material
		Thickness distribution	Average wall thickness	%	90≦	Reference	Relative value to the reference material
			Thickness fluctuation	%	110≧	Reference	Relative value to the reference material
		Tensile yield strength		%	90≦	Reference	Relative value to the reference material
		Fracture point		%	90≦	Reference	Relative value to the reference material
		Color (Δb)			3≧	Important	In visual comparison with the reference material
		Haze		%	5≧	Important	
		Drop impact strength		Times	1<	Reference	1.2 m in an upright position at 5°C
		Whitening from drop impact			No whitening	Reference	Drop once from a height of 1.2 m in an upright position at 5°C

3) Judgment Criteria

Evaluation of recycling suitability is in accordance with 3. Judgment Criteria for Evaluations of Basic Physical Properties and Recycling Suitability.

(5) Evaluation of Recycling Suitability: Designated PET Bottle Application Test (BtoB)

1) Testing Method

Table 5-1 Evaluation Overview

Evaluation Items		Evaluation Methods
BtoB processed pellets	IV	Measure and compare IV value for the pellets with that for the reference material pellets.
	Color	Measure L*, a* and b* values using the reflection method. Use the equivalent of a D65 fluorescent lamp as the light source in the measurement apparatus.
Plates	Color	Measure L*, a* and b* values of a 3-mm thick plate in the thickness direction using the transmission method, and find the difference between it and the reference material. Use the equivalent of a D65 fluorescent lamp as the light source in the measurement apparatus.
	Haze	With a haze meter, measure a 3-mm thick plate using a method that complies with the JIS K 7136 standard.

Table 5-2 Equipment and conditions to be used

Items	Equipment and conditions
BtoB processing test -Recommended equipment -Testing time -Sample weight -Heating condition -Degree of vacuum	 Recommendation: 20L rotary evaporator with oil bath heater Maintain material at 205°C or higher for 7 hours or longer 5. 50 kg or more No unevenness in thermal history of material 1 torr or less ; inert gas flow method is also acceptable
Injection molding -Equipment -Injection plate -Injection temp.	 Injection molding machine with chilled mold 3 mm thickness 280 to 300 °C (as set value)

Table 5-3 Procedures for Preparing Test Samples

1) Procedure for Preparing Flake Test Samples

Test Material	Reference Material	Remarks
Test Materials	Pure PET	Use the PET of the same grade.
↓ Bottle molding	↓ Bottle molding	Mold the bottles of intended use.
↓ Crushing	↓ Crushing	Crush the bottles into flakes 8 mm in size or less.
↓ Flake washing	↓ Flake washing	Strongly stir the flakes in 1.5% caustic solution between 85ºC and 90ºC for 15 minutes.
↓ Rinsing	↓ Rinsing	Rinse the flakes that were washed with the caustic solution by stirring them in fresh water and remove the caustic solution.
↓ Draining	↓ Draining	Remove attached water by air drying at 50°C for 3 hours.
↓ Flakes for the Evaluation	↓ Flakes of the reference material	Execute pneumatic separation if necessary. (Refer to the following table)

2) Pneumatic separation: Overview, Equipment and Test Conditions

Evaluation Items	Evaluation Methods
Pneumatic separation conditions	Use pneumatic separation conditions that achieve 5% loss or less for the reference material flakes. If possible, measure contamination removal ratio.
Pneumatic separator	Recommendation: Model CFS-150 separator by ACO Co., Ltd.

3) Procedure for Preparing Re-pelletized Test Samples

	Test Material	Reference Material	Remarks
Re-pelletization	Flakes for the evaluation	Flakes of the reference material	Use prepared flakes after pneumatic separation. If separation is not executed, use flakes obtained by crushing bottle into 8 mm mesh flakes and rinsing.
	↓ Crystallization and drying	↓ Crystallization and drying	Recommended: 140°C for 4 hours
	↓ Blending	↓ Blending	Blend flakes with the same weight of virgin PET pellets.
	↓ Re-pelletization	↓ Re-pelletization	Use a single-screw extruder or co-rotating twin-screw extruder.

4) Procedure for Preparing Test Samples for BtoB Processing Evaluation

	Test Materials	Reference Material	Remarks
BtoB processing	Recycled pellet test material	Recycled pellet test material	Use prepared pellets.
	↓ Crystallization and drying	↓ Crystallization and drying	Recommended: 140°C for 4 hours
	↓ Solid state polymerization	↓ Solid state polymerization	205°C or higher for 7 hours or longer
Plate molding			Mold 3 mm thickness plates at 280-300°C

2) Evaluation Criteria

Table 5-4: Evaluation Criteria for BtoB
BtoB Processability

Evaluation Items		Unit	Criteria	Importance Level	Remarks
BtoB processed pellets	L*			Include in report	
	a*			Include in report	
	b*			Include in report	
	IV increase ratio	%	Rank A: 90≦, 120≧ Rank C: 90>, 120<	Required	Difference from the reference material (ΔIVs/ΔIVr)
Injection molding Plates	Flow marks		Rank A: No flow mark Rank C: Flow mark	Required	
	Sink		Rank A: No sink Rank C: Rank C:	Required	
	Haze	%	Rank A: 5≧ Rank C: 5<	Required	
	L*			Include in report	
	a*			Include in report	
	b*		Rank A: 12≧ Rank C: 12<	Required	
	ΔL*			Include in report	Difference from the reference material
	Δa*			Include in report	Difference from the reference material
	Δb*		Rank A: 2≧ Rank B: 2<Δb*≦5 Rank C: 5<	Required	Difference from the reference material

ΔIVs: Variation between IV of test material before and after solid state polymerization.
ΔIVr: Variation between IV of reference material before and after solid state polymerization.

Note: Include the following information in reports when executing the pneumatic separation.

Evaluation Items		Unit	Criteria	Importance Level	Remarks
Pneumatic separation	Yield	%	95≦	Include in report	Only when separation is executed
	Contamination removal	%		Include in report	Only when measurable

3) Judgment Criteria

Evaluation criteria for BtoB recycling suitability are judged on “Required” evaluation items.

The results are, in principle, judged with relative values to the reference material except for certain items which are judged with absolute values.

The judgment of evaluation results should be made as follows.

Table 5-5: Evaluation Criteria for BtoB Recycling Suitability

Rank	Evaluation result of required item	Judgment
A	All “Required” items are ranked A	Can be used
B	All “Required” items are ranked B or higher	Can be used for only 3 years from the date of accreditation. However, this limitation does not apply if Rank B is improved to Rank A.
C	“Required” items include one or more items ranked C	Must not be used

3. Judgment Criteria for Evaluations of Basic Physical Properties and Recycling Suitability

Evaluation items are classified as either “Important” or “Reference” depending on the level of importance.

The results are, in principle, judged with relative values to the reference material except for certain items which are judged with absolute values.

The overall judgment of evaluation results for basic physical properties and recycling suitability, for use in fiber, sheet and bottle applications, should be made as follows.

Rank	Number of items that do not meet the specification		Estimated Impact on Recycling Stream	Judgment
	Important	Reference		
AA	0	3≧	There is very little possibility of having negative impact on current recycling stream.	Can be used
A	1≧	3≧	There is little possibility of having negative impact on current recycling stream.	Can be used
B	3≧	5≧	There is a slight possibility of having a negative impact on current recycling stream.	Can be used if attention is paid to market trends Recommended to be improved to A or higher ranks
C	4≦	6≦	There is a possibility of having negative impact on current recycling stream. Reconsideration is required.	Must not be used

4. Overall Judgment Criteria

The following matrix combines judgement criteria for evaluating BtoB recycling suitability and judgement criteria for evaluating basic physical properties and recycling suitability, and should be used as the overall material evaluation criteria.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="4">Judgment Criteria for Evaluating Basic Physical Properties and Recycling Suitability</td></tr>
<tr><td>AA</td><td>A</td><td>B</td><td>C</td></tr>
<tr><td rowspan="3">Judgment Criteria for Evaluating BtoB Recycling Suitability</td><td>A</td><td colspan="2">Can be used</td><td>Can be used if attention is paid to market trends.
Improvements should be made to improve ranking to A or higher.</td><td rowspan="2">Must not be used</td></tr>
<tr><td>B</td><td colspan="3">Can be used for only 3 years from the date of accreditation.
However, this limitation does not apply if Rank B is improved to Rank A.</td></tr>
<tr><td>C</td><td colspan="4">Must not be used</td></tr>
</table>

5. Making a Report

1) Submit to: The Council For PET Bottle Recycling
   2F, Nikkei Build. 7-16 Nihonbashi-Kodemma-cho, Chuo-ku, Tokyo 103-0001, Japan
   Tel: +81-3-3662-7591 Fax: +81-3-5623-2885
2) Format: A4 size, stapled lengthwise on the left
3) Information to be included
   (1) Submitter (company, division and company stamp) and date of submission
   (2) Material name (tradename and/or substance name)
   (3) Manufacturer of the material
   (4) Intended use and limitations (such as soy sauce, CSD applications etc.)
   (5) Method of use (such as monolayer, blend, multi-layer, coating, etc.)
   (6) Upper limit of the content of the material that complies with these “Criteria”.
   (7) Documents verifying compliance with hygienic standards (such as the Food Sanitation Act, US FDA regulations and voluntary standards)
   (8) Name of the PET resin material used for comparison
   (9) Evaluations of basic physical properties performed according to these “Evaluation Criteria”
   (10) Evaluation results of recycling suitability performed based on these “Criteria” (fiber/sheet/bottles)
   (11) Evaluations of BtoB recycling suitability performed according to these “Evaluation Criteria”
   (12) Brief information about the fiber, the bottles and the sheet used for evaluations according to these “Evaluation Criteria”

   Material name (2) and/or the manufacturer (3) are not always required to be specified as it may result in disclosure of intellectual properties.