RecyClass

RECYCLABILITY EVALUATION PROTOCOL

FOR MULTI-PLASTIC COMPONENTS IN AUTOMOTIVE & EEE

STANDARD LABORATORY PRACTICE

REP-MC-A&EEE-01

VERSION 1.0

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RecyClass

CONTENT

GLOSSARY

A.0	100 % control flakes
A.50	Blend 50/50 control/innovation flakes
A.100	Blend 100 % innovation flakes
ASTM	American Society for Testing and Materials
C.0	Injected samples made of A.0 pellets
C.50	Injected samples made of A.50 pellets
C.100	Injected samples made of A.100 pellets
EEE	Electrical and Electronic Equipment
ELV	End-of-Life Vehicle
EN	European Standard
Innovation Sample	Plastic components containing the innovative technology
ISO	International Organization for Standardization
MFI	Melt Flow Index
PP	Polypropylene
ABS	Acrylonitrile Butadiene Styrene
PE	Polyethylene
PS	Polystyrene
PC-ABS	Polycarbonate-Acrylonitrile Butadiene Styrene
PC	Polycarbonate
TC	Technical Committee
TGA	Thermogravimetric Analysis
WEEE	Waste from Electrical and Electronic Equipment
wt%	Weight Percentage

DISCLAIMER

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. The Recyclability Evaluation Protocols promote recyclability by encouraging the industry to test new plastic technologies, materials or products, providing recommendations on improving their recyclability before market launch.

The Recyclability Evaluation Protocols are freely available to download on the *RecyClass website*. Companies developing new plastic concepts are encouraged to use them to self-assess the impact of their solutions on recyclability and highlight potential issues. **However, compliance with a Recyclability Evaluation Protocol is not a replacement for an official assessment and may not be used as a marketing tool.** The RecyClass Steering Board, following the recommendations of the Technical Committees, will decide on the compatibility of the innovation with recycling according to the evaluation results, granting a Recyclability Approval Letter to the Applicant.

All tests must follow the Evaluation Protocols recommended by the RecyClass Technical Committees and be conducted by an independent laboratory recognised by RecyClass which has no legal affiliation to the applicant.

More information is reported in the RecyClass Internal Procedures, available on the *RecyClass website.*

1. INTRODUCTION AND PURPOSE OF THE PROTOCOL

The “RecyClass[1] Recyclability Evaluation Protocol for multi-plastic components in Automotive & EEE referred to in this document as the “Protocol” describes the methodology that the applicant must follow at a laboratory scale to determine if combination of plastic components are compatible with the state of the art of the automotive and EEE recycling stream. The Protocol targets companies responsible for introducing components or equipment into the automotive and EEE markets. The applicant shall proceed with the Protocol as established in the Assessment Process for Applicants of Recyclability Evaluation in the RecyClass Internal Procedures[2] and RecyClass Technology Approval Quality Management & Procedures document[3].

The Protocol analyses whether an innovation will undergo the necessary pre-treatment, extrusion and conversion steps described in this methodology at a laboratory scale without negatively impacting the recycling process and the quality of the recycled material. It aims to prove the recyclability[4] of automotive and EEE plastic components while encouraging innovation in the plastic market. The overall goal is to maintain the functionality of the components without obstructing the proper functioning of the recycling process and ensuring the highest possible quality of the recycled plastics.

This document provides guidance on the testing methodology that shall be followed, including benchmark recommendations to guide the interpretation of the results.

Please note that all units in this protocol are expressed following The International System of Units[5], from the Bureau International des Poids et Mesures.

1 RecyClass assesses the recyclability of a plastic product. and provides specific indications and recommendations on how to improve the design of a plastic product to fit current recycling technologies. More information at https://recyclass.eu/

[2] *RecyClass Internal Procedures*

[3] *RecyClass Recyclability Approval Quality Management & Procedures*

[4] *Recyclability definition according to PRE: 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 raw material that is used in the production of new products.*

[5] SI Brochure - BIPM

2. SCOPE OF THE PROTOCOL

The scope of the Protocol covers any multi-plastic component and assembly introduced to the Electrical and Electronic Equipment or Automotive markets. Equipment or assemblies containing batteries or any hazardous components are not covered by this Protocol.

3. DISCLAIMER

The Protocol is created to represent as accurately as possible how the current Automotive & EEE recycling process works at industrial scale. The RecyClass Automotive & EEE Technical Committee (TC) reserves the right for further testing, if necessary, to issue a final decision on the recyclability of the tested multi-plastic component.

4. LABORATORY TEST METHODOLOGY

This methodology aims to reproduce the recycling process at a laboratory scale to determine the suitability of a multi-plastic component for the automotive and EEE recycling stream. The methodology described below shall be followed precisely and any modifications or problems during the testing phase must be noted. A Laboratory Evaluation Report compiling objectively all the results obtained shall be prepared to report to the Automotive & EEE TC which will interpret the results. Any remarks during the laboratory tests described in the Protocol shall also be noted down.

See below in Figure 1 a diagram describing the methodology of the pre-treatment steps.

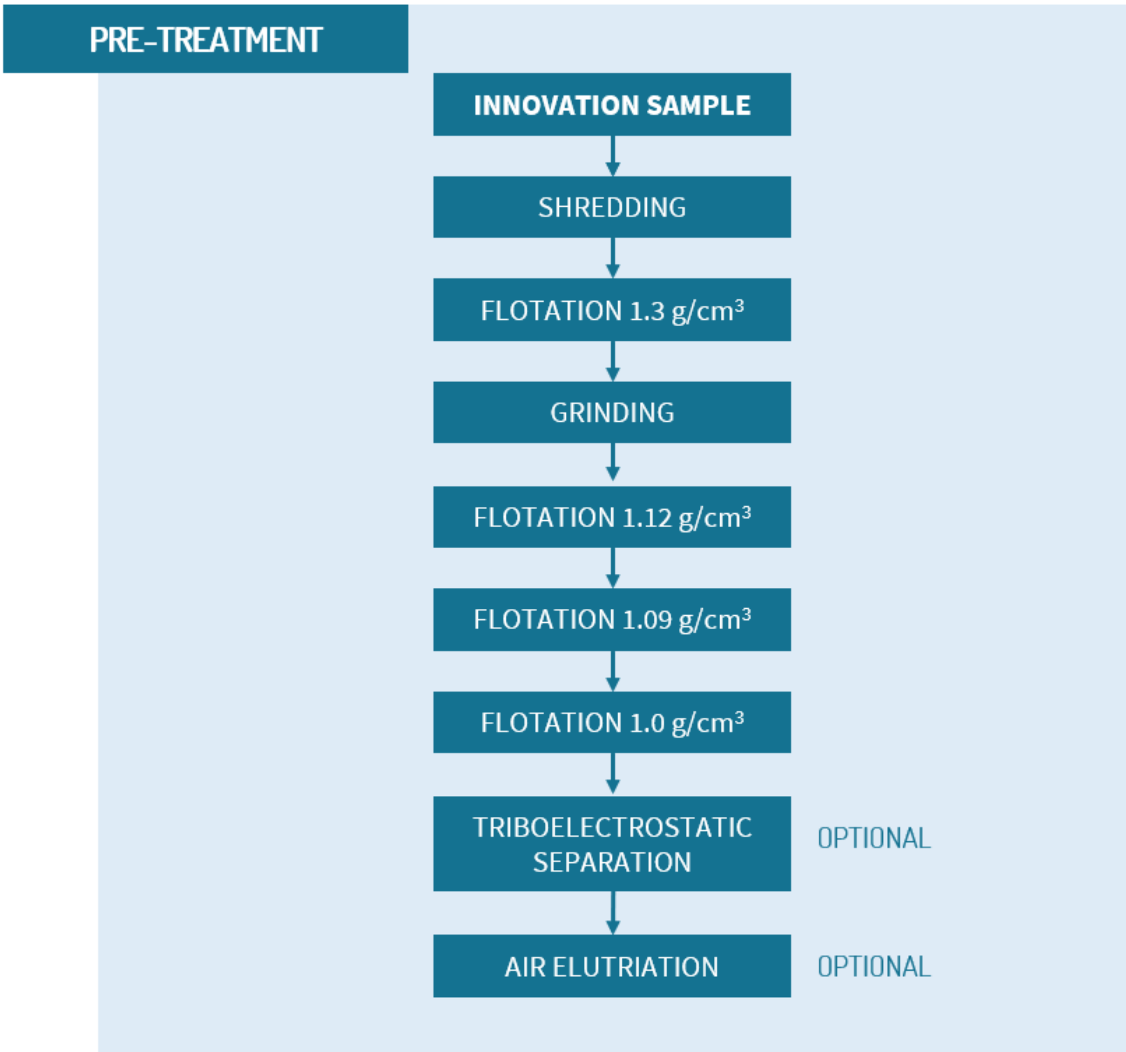

Figure 1. Methodology Diagram of the pre-treatment phase.

5. LABORATORY TESTING PROCEDURES

5.1 PRE-TREATMENT STEPS

5.1.1 SHREDDING

Innovation samples are shredded to separate the different materials present in the equipment or assembly. This step is done with a coarse screen (about 30 mm) that will allow a first rough separation of the main components of the product under study.

Procedure:

- Report the mass of each sample before shredding as m_0.
- Shred innovation samples. Report the mass of each sample after shredding as m_1.

5.1.2 FLOTATION TEST - 1.3 G/CM³

The flotation process assesses the density of the plastic components and ensures that the plastic will be correctly separated in an industrial recycling line. The flotation at 1.3 g/cm^3 intends to separate

Procedure:

- Fill a vessel with tap water at a 1:6 ratio (5 kg washed material vs 30 l water). This ratio is a minimum requirement; some equipment might use more water share due to their configuration.
- Repeat the steps as many times as needed
- Gradually add about 30 % of potassium carbonate to the water until the density of the solution is increased to 1.30 g/cm^3.
- Introduce the sample in the water and stir at 750 rpm for 2 minutes.
- Stop the stirrer and allow the water to rest for 2 minutes.
- Remove all the material that float at the surface with a sieve. Rinse the flakes in the strainer with cold running tap water and stir vigorously for 5 minutes using a manual stirring bar.
- Remove the sinking material. Rinse the flakes in the strainer with cold running tap water and stir vigorously for 5 minutes using a manual stirring bar.
- Dry the flakes collected after flotation with air at room temperature without applying vacuum or heat sources until 1 % moisture content is reached. If the moisture content cannot be reached under these conditions, mild heat can be used with prior notification and approval from RecyClass.
- Report the mass of the innovation sample after sink-float separation as m_2f and m_2s for floating and sinking fractions, respectively.
- Take photos of the floating and sinking fractions separately.
- Save the water for visual evaluation.

5.1.3 GRINDING

Innovation samples are ground in order to fit the feeding hopper of a standard laboratory extruder.

Select the floating fraction from step 5.1.2 to perform this step.

Procedure:

- Report the mass of the sample before grinding as m_3.
- Grind innovation samples with a screen containing holes between 10 – 15 mm. Report the mass of the sample after grinding as m_4 and average flake sizes.
- Take a picture of the flakes alongside an appropriate measurement scale.

5.1.4 FLOTATION TEST - 1.12 G/CM³

The flotation process assesses the density of the plastic components and ensures that the plastic will be correctly separated in an industrial recycling line.

Procedure:

- Fill a vessel with tap water at a 1:6 ratio (5 kg washed flakes vs 30 l water). This ratio is a minimum requirement; some equipment might use more water share due to their configuration.
- Add about 17 % of sodium chloride to the water solution (or any other salt) to increase the water density up to 1.12 g/cm^3.
- Introduce the sample in the water and stir at 750 rpm for 2 minutes.
- Stop the stirrer and allow the water to rest for 2 minutes.
- Remove all the material that float at the surface with a sieve. Rinse the flakes in the strainer with cold running tap water and stir vigorously for 5 minutes using a manual stirring bar.
- Remove the sinking material. Rinse the flakes in the strainer with cold running tap water and stir vigorously for 5 minutes using a manual stirring bar.
- Dry the flakes collected after flotation with air at room temperature without applying vacuum or heat sources until 1 % moisture content is reached. If the moisture content cannot be reached under these conditions, mild heat can be used with prior notification and approval from RecyClass.
- Report the mass of the innovation sample after sink-float separation as m_4f and m_4s for floating and sinking fractions, respectively.
- Take photos of the floating and sinking fractions separately.
- Save the water for visual evaluation.

5.1.5 FLOTATION TEST - 1.09 G/CM³

The flotation process assesses the density of the plastic components and ensures that the plastic will be correctly separated in an industrial recycling line.

Select the floating fraction from step 5.1.4 to perform this step.

Procedure:

- Fill a vessel with tap water at a 1:6 ratio (5 kg washed flakes vs 30 l water). This ratio is a minimum requirement; some equipment might use more water share due to their configuration.
- Add about 13 % of sodium chloride to the water solution (or any other salt) to increase the water density up to 1.09 g/cm^3.
- Introduce the sample in the water and stir at 750 rpm for 2 minutes.
- Stop the stirrer and allow the water to rest for 2 minutes.
- Remove all the material that float at the surface with a sieve. Rinse the flakes in the strainer with cold running tap water and stir vigorously for 5 minutes using a manual stirring bar.
- Remove the sinking material. Rinse the flakes in the strainer with cold running tap water and stir vigorously for 5 minutes using a manual stirring bar.
- Dry the flakes collected after flotation with air at room temperature without applying vacuum or heat sources until 1 % moisture content is reached. If the moisture content cannot be reached under these conditions, mild heat can be used with prior notification and approval from RecyClass.
- Report the mass of the innovation sample after sink-float separation as m_5f and m_5s for floating and sinking fractions, respectively.
- Take photos of the floating and sinking fractions separately.
- Save the water for visual evaluation.

5.1.6 FLOTATION TEST - 1 G/CM³

The flotation process assesses the density of the plastic components and ensures that the plastic will be correctly separated in an industrial recycling line.

Select the floating fraction from step 5.1.5 to perform this step

Procedure:

- Fill a vessel with tap water at a 1:6 ratio (5 kg washed flakes vs 30 l water). This ratio is a minimum requirement; some equipment might use more water share due to their configuration.
- Introduce the sample in the water and stir at 750 rpm for 2 minutes.
- Stop the stirrer and allow the water to rest for 2 minutes.
- Remove all the material that float at the surface with a sieve. Rinse the flakes in the strainer with cold running tap water and stir vigorously for 5 minutes using a manual stirring bar.
- Remove the sinking material. Rinse the flakes in the strainer with cold running tap water and stir vigorously for 5 minutes using a manual stirring bar.
- Dry the flakes collected after flotation with air at room temperature without applying vacuum or heat sources until 1 % moisture content is reached. If the moisture content cannot be reached under these conditions, mild heat can be used with prior notification and approval from RecyClass.
- Report the mass of the innovation sample after sink-float separation as m_6f and m_6s for floating and sinking fractions, respectively.
- Take photos of the floating and sinking fractions separately.
- Save the water for visual evaluation.

5.1.7 TRIBOELECTROSTATIC SEPARATION (OPTIONAL)

The triboelectrostatic separation divides different polymeric fractions based on their different conductivity, ensuring that the plastic will be correctly separated in an industrial recycling line. It is usually used to separate ABS, PS and PP filled fractions.

Depending on the plastic present in the equipment or assembly under assessment, the Automotive & EEE TC may request this additional step to ensure that the plastic flakes will be correctly separated during the recycling process. In case this method is applied, properly record the masses of the different targeted fractions before and after processing.

5.1.8 AIR EILUTRATION (OPTIONAL)

The air elutriation is performed to separate possible rubber, foam or light materials still present in the fraction, which will be assessed for recyclability. Depending on the case under assessment the Automotive & EEE TC may request this additional step.

Record the mass before and after air elutriation.

5.1.9 MASS BALANCE

The data of the different steps needs to be filled out in Table 1. All the weights measured after each flotation step must be done on rinsed and dried flakes.

Table 1. Mass balance

Step	Description	Mass before [kg]	Mass after [kg]	Floating fraction [kg]	Sinking fraction [kg]	Losses [kg]
5.1.1	**Shredding**	m_0	m_1			$m_1 - m_0$
5.1.2	**Flotation at 1.3 g/cm³**			m_2f	m_2s	$m_1 - (m_2f + m_2s)$
5.1.3	**Grinding**	m_3	m_4			$m_3 - m_4$
5.1.4	**Flotation 1.12 g/cm³**	m_4		m_4f	m_4s	$m_4 - (m_4f + m_4s)$
5.1.5	**Flotation 1.09 g/cm³**	m_4f		m_5f	m_5s	$m_4f - (m_5f + m_5s)$
5.1.6	**Flotation 1 g/cm³**	m_5f		m_6f	m_6s	$m_5f - (m_6f + m_6s)$
5.1.7	**Triboelectrostatic (optional)**					
5.1.8	**Air elutriation (optional)**					

5.1.10 CONTAMINATION ASSESSMENT

Based on the mass balance, analyse the theoretical contamination of the different fractions. Do not consider the losses in such calculations.

The objective is to sort at least 85 % of the targeted polymers (PE, PP, PP filled, ABS, PS, PC-ABS) in the right stream, and to sort at least 85 % of the non-targeted materials in the fractions with densities over 1.12 g/cm³. Some case studies can be found in ANNEX I – CASE STUDIES.

Once the final fraction of the targeted polymer is obtained, a further contamination analysis with analytical techniques should be performed by the laboratory. Flake analysers are preferred in this case, even though the Technical Committee may accept methodologies via sampling of flakes followed by FTIR analysis.

The test should proceed to step 5.2 in the following cases:

- The targeted polymer represents more than 10 % of the total plastic content of the multi-component.
- The level of contamination in the recovered fraction is over 2 %.
- The recovered material is not covered by existing DfR guidelines, it has not been previously tested and may impact the recycling process.

5.2 EXTRUSION

5.2.1 FLAKE BLENDS PREPARATION

For each sample obtained after the pretreatments in the recovered fractions and that represents more than 10 % in weight of the total plastic content in the multi component part, a set of flake blends is prepared as described in Table 2.

The control material will be defined by the Technical Committee based on the polymer grades that are present in the multi-plastic component or assembly.

Keep separate the control and innovation flakes obtained following the previous steps. Then, according to the values reported in Table 2 prepare two different blends with 100 % control (and 0 % innovation), and 50 % control – 50 % innovation and tag them respectively as A.0 and A.50.

For the purpose of the tests, the Applicant should provide enough innovation and control materials to allow for the blend preparations. At least 4 kg of recovered plastic for testing shall be ensured.

Table 2. Flakes blends composition for the production of pellets

BLEND	COMPOSITION	% CONTROL	% INNOVATION
A.0	100 % Control	100	0
A.50	50 % Control 50 % Innovation	50	50
OPTIONAL A.100	100 % Innovation	0	100

Control and innovation sample should follow the pathway described in Figure 2.

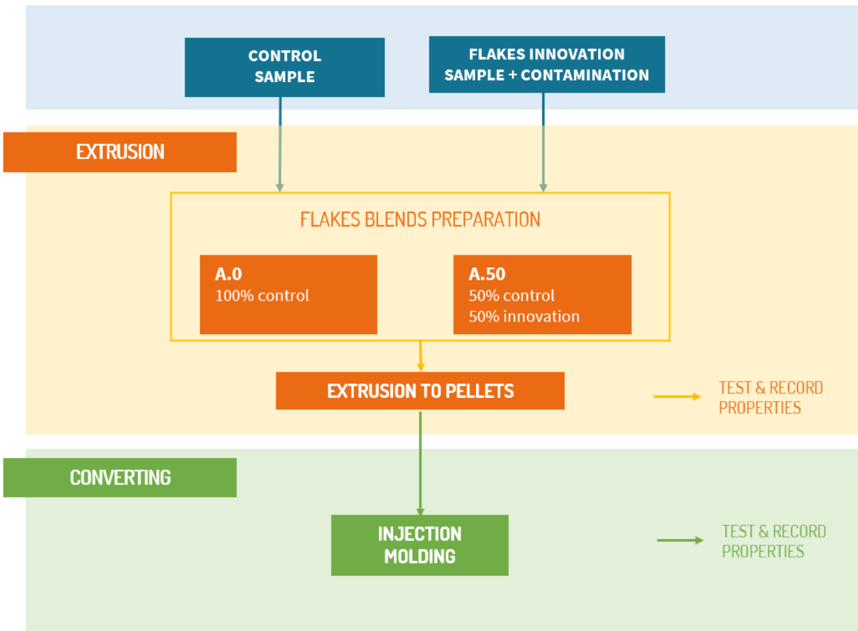

Figure 2. Flowchart indicating the pathway for control and innovation samples.

5.2.2 PELLET PRODUCTION

Both control and innovation flakes can be mixed manually before extrusion for blend preparation. If extrusion is not carried out directly after the previous drying stage, the flakes need to be dried and extruded using a co-rotative twin-screw extruder by following the indication in Table 3. The extrudate will be melt filtered with the mesh size indicated in the table below. Control flake sample A.0 must be extruded first. Further size reduction before extrusion is acceptable if necessary to allow good feeding of the material into the extruder. Nevertheless, the flake size should be kept constant between all samples.

The extruder has to be cleaned before starting the extrusion process. This involves pulling the screws out of the barrel and then mechanically cleaning them with brass brushes until they reach a glossy finish. The barrel also has to be mechanically cleaned with round brass brushes from the mandrel to the run-out zone.

Table 3. Drying and extrusion conditions for the different resins

	DRYING CONDITION		EXTRUSION CONDITION	
Resin	***Temperature [°C]***	***Time [hour]***	***Temperature [°C]***	***Mesh Size [µm]***
ABS	80	4	230 ± 10	150
PE	60	2	220 ± 10	250
PP	60	2	220 ± 10	250
PP with Mineral Fillers	60	2	230 ± 10	400
PS	80	3	220 ± 10	150
PC-ABS	90	4	260 ± 10	150

Procedure:

- Dry pellets or flakes at the condition reported in Table 3. Any agglomeration of flakes must be reported.
- Extrude the pellets with the corresponding melt temperature and melt filter conditions reported in Table 3 for no less than 30 minutes. Melt residence time should be less than 6 minutes.
- Recommended throughput is between 5 and 10 kg/h and rotation speed between 100 and 200 rpm.
- Monitor the extrusion process for heat stability.
- If the process doesn't reach steady state conditions (i.e. pressure and/or temperature increase), extrude for no less than 1 hour.
- Rapidly cool the extrudate in a water bath and fed into a pelletizer.
- The pelletizer speed has to be controlled to get a final pellet with a diameter of 3 mm.
- Monitor pressure build-up during pelletizing and report significant differences.
- Randomly select the pellets to perform all the characterizations reported in Table 4.
- Change the melt filter pack between samples for visual examination.
- Be sure to produce enough pellets for all the tests, including the conversion tests.

Record the resulting properties in Table 5. A small amount of each sample (50 g) will be retained for the RecyClass TC and the Applicant. The extruded pellets will be tested for pellet properties characterisation (Table 4). Pellets should meet the requirements reported in Table 5.

5.2.3 PELLET PROPERTIES CHARACTERISATION

Samples preparation and testing conditions for the following characterisations must be done according to:

For ABS pellets for the following characterisations must be done according to ISO 19062-2:2019 (Acrylonitrile-butadiene-styrene (ABS) moulding and extrusion materials —Part 2: Preparation of test specimens and determination of properties).

For PE pellets for the following characterisations must be done according to ISO 17855-2:2016 (Polyethylene (PE) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties).

For PP pellets for the following characterisations must be done according to ISO 19069-2:2016 (Polypropylene (PP) moulding and extrusion materials —Part 2: Preparation of test specimens and determination of properties).

For PS pellets for the following characterisations must be done according to ISO 19063-1:2016 Plastics - Impact-resistant polystyrene (PS-I) moulding and extrusion materials - Part 2: Preparation of test specimens and determination of properties).

For PC-ABS pellets for the following characterisations must be done according to ISO 21305-2:2019 (Polycarbonate moulding and extrusion materials —Part 2: Preparation of test specimens and determination of properties).

Table 4. Pellet properties characterisation

ASSESSMENT	STANDARD	BENCHMARK RECOMMENDATION
Density (kg/m^3)	ISO 1183-1	ABS, PS, PP with filler lower than 1.09 g/cm^3 PP and PE lower than 1 g/cm^3
Volatiles (wt%)	Heat 10 g blends (before extrusion) and pellets (after extrusion) exposed to 220 °C for 10 minutes	No increase higher than 0.5 wt% respect A.0
Melt Index (g/10 min)	ISO 1133 - PE: 190 °C/2.16kg - PP: 230 °C/ 2.16 kg - PS: 200 °C/5 kg - ABS: 220 °C/ 10 kg - PC/ABS: 260 °C/ 5 kg - PC: 300 °C/ 1.2 kg	No more than the following deviations respect to A0 - MFI up to 2 → ± 75 % - MFI 2 to 5 → ± 50 % - MFI 5 to 15 → ± 30 % - MFI 15 to 40 → ± 15 % - MFI > 40 → ± 10 %
Ash content (%)	ISO 3451-1 (muffle) up to 750 °C	Record
Surface appearance	Visual inspection	Record
Filtration (µm)	Visual inspection. In case of the presence of build-ups, an FTIR analysis is recommended to identify the origin of the deposit.	No build-up on the screen
Pressure Variation (MPa)	($P_{25\text{-}30 minutes}$ - $P_{5\ first\ minutes}$)	No increase higher than 25 % compared to start in 30 minutes
Extrusion process	Unusual sticking, fumes, odour, and any build-up	Record

5.3 CONVERTING

The pellets must be tested for injection moulding to evaluate mechanical and thermo-mechanical properties, as well as defects. The Protocol aims to assess the highest value application.

5.3.1 INJECTION MOULDING

Pellets A.0 and A.50 must be tested for injection moulding to evaluate tensile properties, colours, as well as defects.

Procedure:

- Dry the samples according to the condition reported in Table 3.
- Mould sample A.0 and A.50 to multipurpose specimens' type 1A according to EN ISO 527-2 and to plaques with measures of about 60 x 60 x 2 mm^3. Sample C.0 and C.50 will be obtained.
- The specimens should be completely filled without any shrinkage, overspray, or inclusions.
- Variations in operating conditions could be acceptable but must be documented in the report.
- Monitor the injection pressure, the heating zone temperature, mould temperature, closing force, injection time and maximum holding pressure (time)

Record the resulting properties in Table 5. Mechanical data must be analysed on the 1A or 1B specimen, possible inclusions and surface appearance of the specimens should be reported.

5.3.2 INJECTION MOULDED PARTS PROPERTIES CHARACTERISATION

Samples preparation and testing conditions of samples for the following characterisations must be done according to:

- For PP samples, ISO 19069-2:2016 (Polyethylene (PP) moulding and extrusion materials - Part 2: Preparation of test specimens and determination of properties).
- For HDPE samples, ISO 17855-2:2016 (Polyethylene (PE) moulding and extrusion materials - Part 2: Preparation of test specimens and determination of properties).
- For PS samples, ISO 24022-2:2020 (Polystyrene (PS) moulding and extrusion materials - Part 2: Preparation of test specimens and determination of properties).
- For ABS samples, ISO 19062-2:2019 (Acrylonitrile-butadiene-styrene (ABS) moulding and extrusion materials- Part 2: Preparation of test specimens and determination of properties).
- For PC-ABS samples, ISO 21305-2:2019 (Polycarbonate moulding and extrusion materials - Part 2: Preparation of test specimens and determination of properties).

Table 5. Injection moulded parts properties characterisation

ASSESSMENT	STANDARD	BENCHMARK RECOMMENDATION
Heat Deflection Temperature (°C at 1.8 MPa) or Vicat (°C) only applicable for automotive assessment	ISO 75 or ISO 306 VST B50	No more than a 15 % delta decrease compared to C.0
Flexural Modulus (MPa)	ISO 178	No more than a 20 % delta decrease compared to C.0
Tensile Modulus (MPa)	ISO 527	
Tensile Stress at Yield (MPa)	ISO 527	
Elongation at Yield (%)	ISO 527-2	
Charpy Impact Strength – Notched (kJ/m²)	ISO 179-1 ISO 179-2 (optional)	
Surface appearance/ Inclusion of materials	Visual inspection	Record

* ABS and PC-ABS samples for HDT or Vicat need to be annealed according to the following conditions: 90 °C for 60 min.

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DOCUMENT VERSION HISTORY

VERSION	PUBLICATION DATE	REVISION NOTES
1.0	March 2026	Release of the Recyclability Evaluation Protocol for Multi-Plastic Components in Automotive & EEE

ANNEX I – CASE STUDIES

Example: Considering a coffee grinder that weighs 100 g, as the one in Figure 3.

Figure 3. Coffee grinder

Where the composition is specified in Table 6.

Table 6. BOM of the coffee grinder

Component	Material	Grade	Weight [g]	Density [g/cm^3]	wt% total
Case	*Plastic*	*PP*	*60*	*< 1*	*60*
Motor component	*Plastic*	*POM*	*10*	*1.4*	*10*
Motor component	*Plastic*	*PA*	*2*	*1.14*	*2*
Bean hopper	*Plastic*	*PC*	*5*	*1.2*	*5*
Cable	*PVC + Cu*		*0.5*	*>1.3*	*0.5*
PCBA	*Mixed*		*2.5*	*>1.3*	*2.5*
Metal components	*Metal*		*20*	*>1.3*	*20*
Total weight [g]			*100*		*100*

Considering that about 10 kg is needed for the assessment, a total of 100 appliances will be processed following the protocol.

The targeted polymer to be recovered is PP, which should be recovered by at least 85 % in weight. POM, PA and PC components are expected to be separated in the 1.12 g/cm³ flotation bath with at least 85 % of efficiency. The cable, PCBA and remaining metal components should be separated in the 1.3 g/cm³ flotation step.

No triboelectrostatic or air elutriation processes will be applied in this case.

By applying the mass balance, following is obtained:

Table 7. Mass balance after pre-treatment.

Step	Description	Mass before [kg]	Mass after [kg]	Floating fraction [kg]	Sinking fraction [kg]	Losses [kg]
5.1.1	**Shredding**	*10*	*9.9*			*0.1*
5.1.2	**Flotation 1.3 g/cm³**			*6.6*	*3.1*	*0.2*
5.1.3	**Grinding**	*6.6*	*6.5*			*0.1*
5.1.4	**Flotation 1.12 g/cm³**	*6.5*		5.9	*0.6*	0.1
5.1.5	**Flotation 1.09 g/cm³**	*5.9*		5.7	0.05	0.15
5.1.6	**Flotation 1 g/cm³**	*5.7*		5.5	0.1	0.1
5.1.7	**Triboelectrostatic (optional)**					
5.1.8	**Air elutriation (optional)**					

Total losses: 0.75 kg → 0.75/10 * 100 = 7 %

Sorting of cable, PCBA, metal components and POM: 3.1 kg are sorted out at the 1.3 flotation step, without considering the losses up to this step (0.3 kg) → 3.1/9.7 *100 = 31.9 % of a theoretical 33 % share of these elements.

Following the 85 % rule → 31.9/33 *100= 97 % → Passes the threshold.

Sorting of PA and PC: 0.6 kg are sorted as sinking fraction at the 1.12 flotation step, without considering the losses up to this step (0.5 kg) → 0.6/9.5 * 100 = 6.3 % of a theoretical 7 % share of these elements.

Following the 85 % rule → 6.3/7 * 100 = 90.2 % → Passes the threshold.

Sorting of PP: 5.5 kg are sorted in the floating fraction at the 1 flotation step, without considering the losses up to this step (0.75 kg) → 5.5/9.25 *100 = 59.5 % of a theoretical 60 % share of this element.

Following the 85 % rule → 59.5/60 * 100 = 99 % → Passes the threshold.

Once all fractions meet the threshold, check whether an extrusion step is required, as outlined in section 5.1.10.

In this case, the PP represents more than 10 % of the plastic content in the device but does not contain any element that might disturb the recycling process and that needs to be tested. Moreover, the level of contamination is below 2 %. Therefore, no testing via extrusion will be required in this case.

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