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TCEP-D-01.- RECYCLABILITY EVALUATION PROTOCOL FOR PET TRAYS

1.- INTRODUCTION.-

Petcore Europe is the association representing the complete PET value chain in Europe since 1993.

Its mission is to ensure that the entire PET industry is well aligned to enhance its value and sustainable growth, to represent the PET industry before the European institutions and other stakeholders, to ensure that PET is positioned as an outstanding packaging material and recognized as environmentally sound, to support and validate innovative packaging solutions from a recycling perspective, and to work with all interested parties to ensure a continuous increase of PET post-consumer collection and recycling.

To support its mission, Petcore Europe has published the latest PET tray design guidelines to ensure that all PET trays placed in the market are fully recyclable and effectively recycled. These guidelines are and will be as much as possible be aligned with CEN 18120-5 ***(See design for recycling in Annex 1)).***

The guidelines for PET tray design must be used by Sheet Manufacturers, thermoform producers, Packers and Retailers to ensure that the container/tray/packaging is compatible with the collection, sorting and recycling capabilities installed.

The protocol has to be applied to any existing packaging, new design or innovation to be implemented that can affect the recyclability of the packaging after use. It is designed to evaluate the PET solution to be implemented and its recyclability at the end of its life when it reaches the PET collection stream, and its influence on the quality of the recycled product.

Petcore Europe developed this document for testing PET trays based on the knowledge and common practices of recycling processes, and its experience on the impact of the different packaging elements for recycling efficiency. Petcore Europe used its own experts' experiences combined with EPBP, PRE, and APR protocols.

In many cases, PET trays include non-PET components for packaging performance efficiency. These non-PET components may affect the properties of the rPET during all the processes, from collection to sorting, recycling and reprocessing. To prevent the negative impact of these components, the protocol concludes that packaging indications should state that consumer action (remove certain packaging components to avoid their entry in the recycling stream) after use is necessary.

This protocol has the intention to evaluate the impact of the packaging in the recycling stream when considering the option of tray-to-tray recycling. This does not eliminate the useof rPET from trays into other applications such as film, sheet or fibers.

Thermoformed PET containers are made from PET sheet. Even if the use of certain packaging can be relatively local, films/sheet or recycling stream can cross borders and

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have cross countries implication. For that reason, the guidelines must apply to all the EU countries.

This protocol intends to analyze any existing or new thermoformed PET packaging and to verify its impact on the different steps of recycling: sorting, treatment/washing, extrusion and conversion into a new product. This will be applied at a lab scale, with the intention to be verified latter at an industrial level.

2.- SCOPE. -

The scope of the protocol will cover the evaluation of the impact of current design or innovative packaging, consisting of any PET tray or thermoformed packaging to be introduced in the market.

Prior to initiating any test, the applicant has to review and confront his packaging with the Design for Recycling guidelines for PET trays and Thermoformed PET packaging to verify compatibility with the recycling stream.

These guidelines make specific references to the formulation of the material used in the manufacturing of the sheet as well as the rest of the component of a thermoformed packaging:

- *PET resins*
- *Sealing layers*
- *Colors*
- *Barrier materials*
- *Additives*
- *Lidding films*
- *Printing*
- *Labels*
- *Soaking pads*
- *Glues*
- *Other components and inserts on/in the thermoformed packaging.*

The “easy to access” and “easy to empty” indexes have to be considered as important factors for the recyclability of the packaging. This is of high importance as most of the trays and thermoformed products are in contact with food, and leftover materials will lead to impurities in the recycling process.

Due to the complexity of the PET trays and Thermoformed packaging, the feasibility for consumers to separate components such as labels, lidding films or inserts (like soaking pads…) has to be confirmed.

3.- T2T EVALALUATION PLATFORM.

A specific and dedicated structure has been created to:

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- *Evaluate the recyclability of PET thermoformed container technologies / products;*
- *Allow new PET thermoformed container innovations, while at the same time minimizing economic and environmental consequences for the European PET recycling industry;*
- *Promote the recyclability of PET thermoformed containers on the market by:*
    - *Proposing European harmonized guidelines for PET tray (and other thermoformed containers) recyclability that will be accepted across the whole value chain.*
    - *Encouraging industry to test new PET tray concepts and/or materials before market launch according to the harmonized guidelines.*
    - *Giving advice and recommendations to the different stakeholders.*
    - *Sharing information and knowledge across the whole value chain considering competition law rules and respecting confidential information.*

The evaluation platform is structured and managed according to the Petcore Europe PET tray Recyclability Evaluation Platform Modus Operandi Document.

4.- PRODUCT EVALUATION

The producer or the organization bringing the packaging on the market (Packer, Brand Owner, Retailer….), should make an evaluation of the product's recyclability by using as a main reference the Petcore Europe PET tray Design for Recycling Guidelines.

The petitioner should submit an evaluation request to the Petcore Europe PET Tray Recyclability Evaluation Platform Committee to proceed with the different activities to determine the recyclability of the innovation to be implemented and introduced in the market.

As an outcome of the evaluation, individual test programs should be required:

- ***Step 1**. It's very important to get good and complete information about the design of the packaging, and the innovation introduced if any, from both technical and market perspective. This allows the Producer/User to design the most appropriate test program, and select only the relevant tests.*
- ***Step 2**.- If sorting technologies or any other separation techniques have the effect of reducing the impact of the packaging on the rPET stream, an assessment of any specific additional steps (for example, sorting) can be included in the test program.*
- ***Step 3**.- Based on the available information, the producer of the packaging should contact Petcore Europe to determine if one of the properties reflected in table 2 is considered as "**critica**l". If this is the case, this property should be tested.*
- ***Step 4**.- In parallel with Step 3, the packaging producer supported by a Petcore Europe assessment will decide on the full test program, once the packaging passes Step 3. The evaluation of the required tests should help the producer to estimate total costs.*

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For the evaluation, following Chart will be used

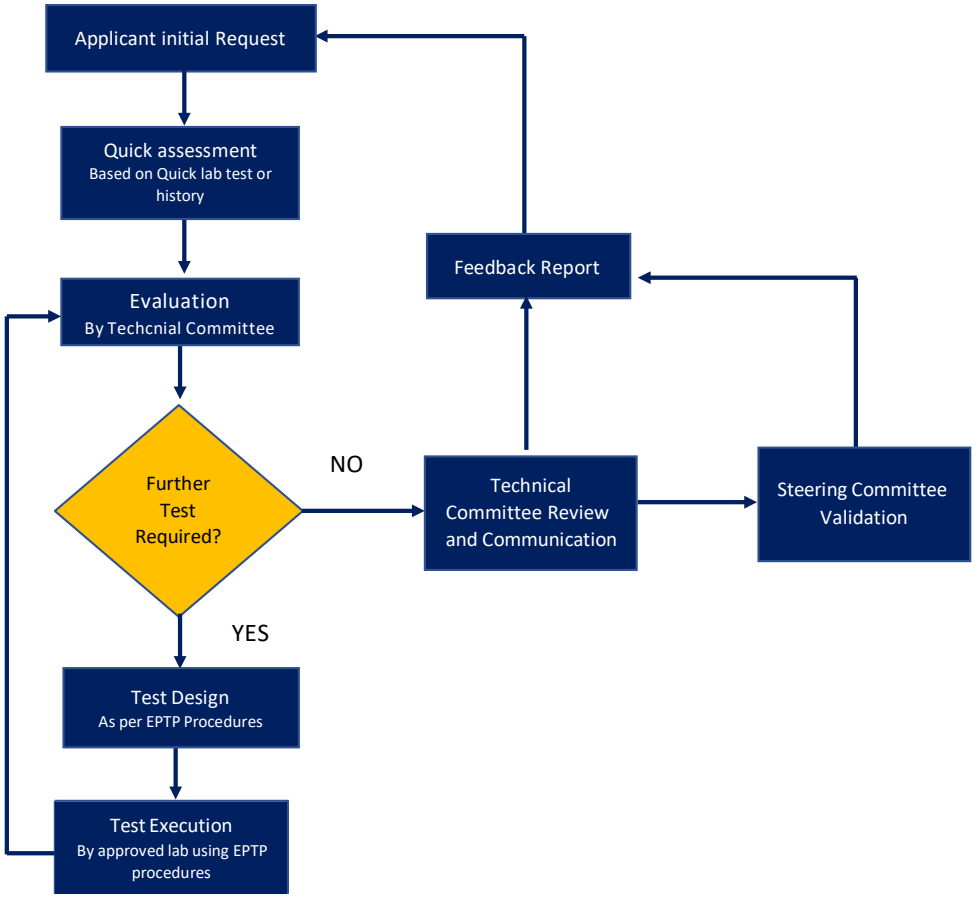


CHART 1.- Evaluation Committee decision making flow

The design of the test based on this protocol, has the objective to highlight all possible effects of the PET packaging on the collection, sorting and recycling processes, the conversion of the rPET into a new product, and the properties of the final product.

Specific test procedures have been stablished and will be under regular review in order to provide consistent measurement methods. Those procedures should be applied by independent laboratories that should be the one providing objective report for final evaluation by the Technical and Steering committee.

5.- LABORATORY EVALUATION. -

Standard Laboratory Processing Practices have been stablished (TCEP-P-00) to assess the compatibility of a new or existing packaging with existing commercial PET recycling processes.

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The procedures should be applied by an independent approved laboratory. An evaluation report with detailed results has to be submitted to the Petcore Europe TCEP Technical Committee for final assessment. This chart shows the flow to be used in the case of full test to be performed.

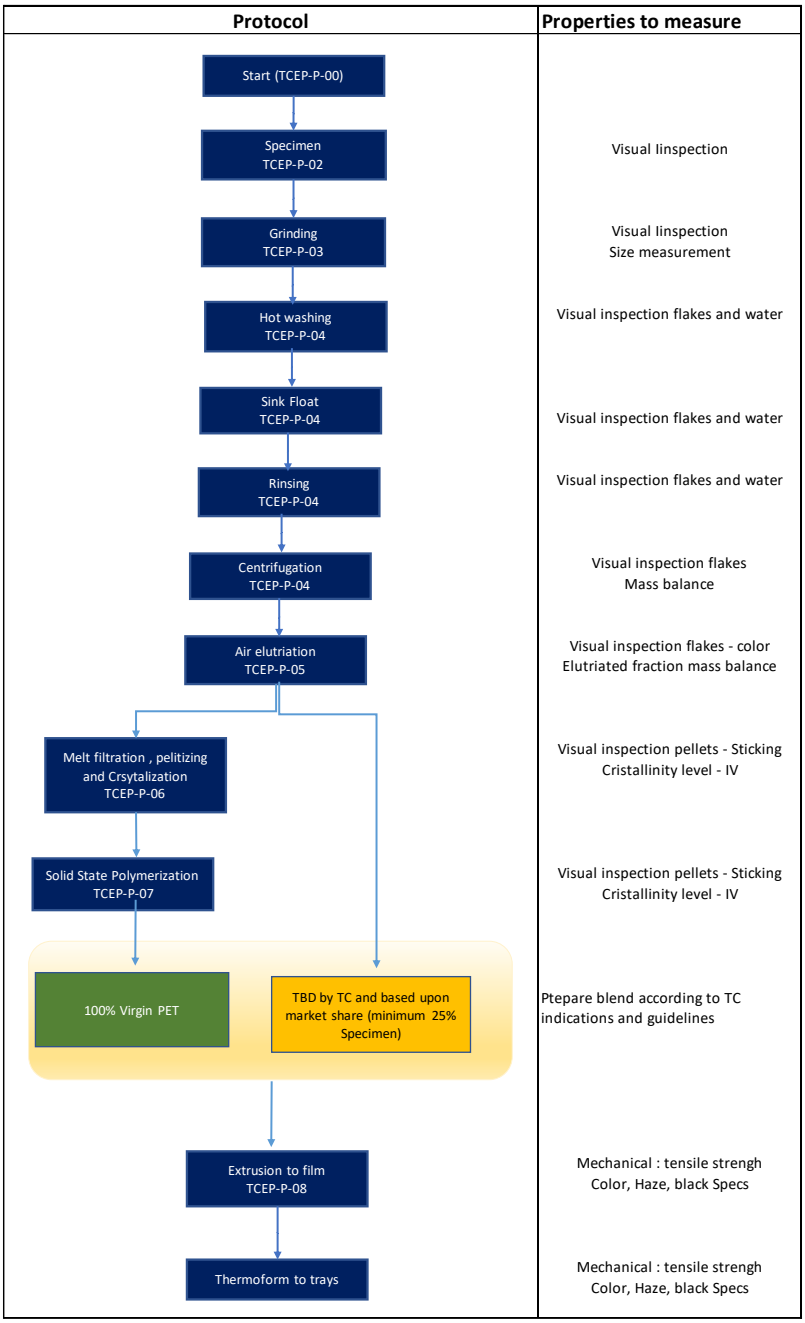


CHART 2.- Standard Laboratory Processing Practices Flowchart

In a case by Case, PET recyclability Evaluation Platform Technical committee, will assess and determine the application of the full or partial procedure based on the potential impact of the evaluated packaging on the recycling system. A percentage indication of the market share compared with the total PET stream in the region is necessary.

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6.- TEST RESULTS. -

The approved evaluation laboratory will submit a report to the Petcore Europe PET Tray Recyclability Platform committees for final evaluation and decision making as indicated in Chart 1.

The laboratory report should be evaluated considering the Recycling Evaluation Protocol Results Thresholds as per Chart 3 here under:

Recycling evaluation protocol	
Step	***Result treshods***
TCEP-P-01.- Resin selection	*Use an aproved resin for the comparative test*
TCEP-P-02.- Specimen, sample preparation	*100% innovation sample*
TCEP-P-03.- Ginding	*Flake size.* *Min- 8mm* *Max- 12mm*
TCEP-P-04.- Hot Washing, Sink Float, Rinsing and Dring	*Final Size .- >4mm ; <12mm* *<2mm.- max 5%*
	bulk density.- > 280 Kg/m3 ; < 400 Kg/m3)
	Weight loss: (to be evaluated depending on packaging composition)
	Total lost weight on TCEP-P-04 application (mass balance) *MAX.-*
TCEP-P-05.- Elutriation	*Total lost weight of the recycling process (mass balance)* *MAX.-*
TCEP-P-06.- Melt filtration, pletizing and Crystalization *25% rPET : 75% Virgin reference resin*	*No fumes odour or residues on die head*
	Pellet size.- 100 chips 2 gr (+/- 10%) *Bulk density.- 800Kg/m3 (+/-10%)*
	L min.- 55* *b*max.- 4*
	Pressure increase (Pf-Pi)/Pi < 0,25 *Screen pack particulate measurement*
TCEP-P-07.- Solid State Polymerization	*No stiking*
	IV.- > 0,7
	L > 65* *b* < 5*
	DSC Evaluation for unmelts
	AA on final product < 5 ppm
TCEP-P-08.- Film Extruion *25% rPET : 75% Virgin reference resin*	*Film Thickness.- 500 +/- 100 microns*
	IV on film > 0,6 dl/g
	Optical poperties meaSured in 2mm thick pack *Haze <15%* *L* > 65* *delta b* < 6 vs control*
	Black spots.- *0,25mm2< >1mm1.- Less than 8 in 10m2* *> 1mm2.- Less than 2 in 10 m2*
	Gels *> 1mm2.- Less than 50 in 10 m2*
	Mechanical properties *Elasic modulus > 1800 Mpa (ISO 527-3)* *Tensile Stress at yield. > 45N/mm2 (ISO 527-3)* *Impact Resilience >175-200 Kj/m2 (ISO 8256)*

Remark. - None of this test reflect any food contact safety elements

CHART 3.- Evaluation Protocol Results Thresholds

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6.- FINAL REPORT. -

The Technical Committee can recommend the use of communication tools (e.g., designguidelines, press releases, fact sheets, etc.), considering the publication guidelines. All external communication must be validated by the Steering Committee

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Annex 1

Design Guidelines for PET trays in contact with food and non-food trays - TCEP

	YES Full compatibility – materials that passed the testing protocols with no negative impact OR materials that have not been tested (yet), but are known to be acceptable in PET recycling	CONDITIONAL Limited compatibility – materials that passed the testing protocols if certain conditions are met OR materials that have not been tested (yet), but pose a low risk of interfering with PET recycling	NO Low compatibility – materials that failed the testing protocols OR materials that have not been tested (yet), but pose a high risk of interfering with PET recycling
Material	PET		PLA; PVC and other halogenated compounds; PS; PETG; Other opaque and colour material (not detectable); Expanded PET, PET/PE
Colours	Transparent clear; transparent light blue		Metallic
Barrier for monolayer	None; PET based oxygen Barriers or Scavenger with no yellowness effects after TCEP oven test.	PET based oxygen Barriers or Scavenger with limited yellowness effects after TCEP oven test	EVOH; PA; any other barrier; any other oxygen scavenger
Barrier for multilayer	Barrier material laminated and incorporated to the polyolefin liner		Barrier material laminated or incorporated to the main PET layer. PVCD and other halogenated compounds as barrier
Additives	Silicone surface coating (on coating area); Antilocking masterbatch; None of them should affect clarity	Any other additive (UV stabilisers; AA blockers; optical brighteners; antilocking; anti-stat agents; anti-fogging (on coating area)) With Limited effect on clarity to be measured	Bio/Oxo/Photodegradable additives; Nanocomposites, any BPA containing material
UNPRINTED Lidding films - Closure systems (with glue not harming the recycling process)	PET; OR Floating combination of plastics with density < 0,95 g/cm3 ; NO glue residuals; If no PET, no lidding film residual on the tray. SiOx, AluOx plasma for barrier.		any other sinking film with density > 1 g/cm3 (to be proven with sink/float test)
PRINTED Lidding films - Closure systems (with glue not harming the recycling process)	NO PRINITNG PREFERED. OR plastics/combination of floating plastics with density < 0,95 g/cm3; NO glue residuals; foamed PET based films where foamed structure is not getting destroyed @ 90°C ; If no PET, no lidding film residual on the tray. SiOx and AluOx plasma for barrier		any other film, any BPA containing material
Labels (with adhesive not harming the recycling process - see labels adhesive section)	NO LABEL PREFERED. Plastic labels where label has a density < 1 g/cm3 in the more heavily printed and adhesive area	BPA-Free Paper labels not loosing fibbers (pulping) and floating	Plastic labels where label has a density > 1 g/cm3 in the more heavily printed and adhesive area - Paper labels loosing fibbers (pulping) - Paper containing BPA - non floating paper labels, any BPA containing material
Adhesives for: 1.Sealing layer, 2.Labels/other components, 3.Lamination	Adhesives with 100% removing ratio and no adhesive residuals on flakes @ 70°C testing temperature Water or alkali soluble in 60-80°C. Peelable films not leaving not leaving residuals on the flakes	adhesives with 100% removing ratio and no adhesive residuals on flakes @ 85°C testing temperature	Bi-component solventless adhesives, any BPA containing material

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recycling process - see labels adhesive section)	YES Full compatibility – materials that passed the testing protocols with no negative impact OR materials that have not been tested (yet), but are known to be acceptable in PET recycling	CONDITIONAL Limited compatibility – materials that passed the testing protocols if certain conditions are met OR materials that have not been tested (yet), but pose a low risk of interfering with PET recycling	NO Low compatibility – materials that failed the testing protocols OR materials that have not been tested (yet), but pose a high risk of interfering with PET recycling
Adhesives for: 1.Sealing layer, 2.Labels/other components, 3.Lamination	Peelable films not leaving not leaving residuals on the flakes		
Inks	Non toxic, follow EUPIA Guidelines		Inks that bleed; toxic or hazardous inks, any BPA containing material
Direct Printing	Laser marked for traceability (production or expiry date)		Any other direct printing,any BPA containing material
Other Components	NO other components are preferred	Inserts in HDPE / LDPE / PP, Soaker pads, bubble pads and paper & carboard - all inserts should be completely removable and leave no traces	PVC and other halogenated compounds / PS / EPS / PU / PA (Nylon); PC / PMMA Thermoset plastics / metals; non compliant soaker pads
Liners for multilayer packaging, seals and valves	PET/PE; PE/EVOH/PE; PE+EVA; EVA;EMA;PP;TPO;EPE; and EPP all with density<1gr/cm3. TPS with density <0,95gr/cm3	Floatable silicon; PET/PE	Materials with density >1gr/cm3 (eg. PVC and other halogenated compounds, silicon, metals, silicone (even with density <1g/cm3), Foamed PET. Any other floatable or non floatable materials made of wood or cellulosic materials
Sleeves and wraps	Sleeves with partial coverage and wraps with full coverage of the package in PO, PE, PP, OPP. All with density <1g/cm3	Full sleeves or wraps in PO,PE,PP, OPP all with density <1g/cm3. PET based sleeve with density <1g/cm3	Materials with density >1g/cm3 (eg metal, PVC and other halogenated compounds, PS, PETG)metallized materials. Foamed PETG (even with density <1g/cm3)
Tamper evidence wrap	PE, PP,OPP all with density <1g/cm3		Materials with density >1g/cm3 (eg metal, PVC and other halogenated compounds , PS, PETG)metallized materials. Foamed PETG (even with density <1g/cm3)
Colours for coloured PET thermoforms	Light and opaque NIR detectable colours		Fluorescent colours, metallic, non detectable colours
Direct Printing for coloured PET thermoforms	Laser marked for traceability (production or expiry date)	Any other direct printing on the main component of the packaging	

This work has been published by the Tray Circularity Evaluation Platform with experts in the plastics packaging and recycling industry. The information contained in this document is ***for general guidance*** *only. Any details given are intended as a general recommendation based on the best of our knowledge at the time of publication. It does not necessarily guarantee compliance with the different recycling schemes. This is by no means an exhaustive list. Users are therefore advised to make their own enquiries with TCEP, local recyclers or recycling organisations to check for specific and up-to-date information.*

It is important to note that this is a ***living or dynamic document*** *which will be continually edited, updated and expanded by our panel of experts as more information becomes available. This means that a certain product and/or material classification may change in future. Users are therefore advised to check the TCEP website for the latest information* (https://www.tcep-europe.org/)

We value your ***feedback*** *because it will help us to develop this publication even more and to make it a useful tool for you and other actors in the PET value chain. We appreciate you taking the time to let us know what you think about TCEP's Design for Recycling Guidelines, so please send your comments and/or additional information to:* https://www.tcep-europe.org/

We call upon all companies developing new resins, additives, technologies and novel processes for PET trays to bring their products

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Version	Publication Date	Revision notes
V0	Sept-21	NEW DOCUMENT
V1	April-23	Platform, document name and logo changes.
V2	July - 26	Updated D4R Guidelines and logo changes

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