Material and packaging specifications for beverage containers in the Infinitum deposit return system.

Date: 1st June 2024
Version: 12.3

Material and packaging specification

This document gives the specifications which all beverage containers in the Infinitum deposit return system must adhere to. The document serves as a guide for those who is applying for approval of containers, and is also appendix 2 to Infinitum's RVM Specifications describing what kind of containers the RVMs must be able to handle.

The specifications regulate materials used, thickness, physical shape and dimensions for beverage (and potentially other) containers. Other properties may also influence acceptance in the Infinitum system.

The purpose of the specifications is to ensure that all approved containers can be handled by the RVMs and Infinitum's depot IRVMs, that correct deposit can be paid, and that recycling of the container material is feasible. Containers in the Infinitum system must be designed to facilitate recycling of the container material. Refillable containers are not used in the Infinitum system.

The specifications must be adhered to by producers, fillers and importers when introducing new or changed containers or changing the content of them; and by RVM suppliers to ensure that RVMs are capable of handling the containers. The specifications are also used to assess existing containers in cases where problems have emerged.

Generally, aluminium cans and PET (polyethylene terephthalate) plastic bottles are the preferred materials in the Infinitum system. Some other materials are also accepted, sometimes in limited numbers; refer to details laid out in this document.

New materials and types of packaging may be introduced, refer to section I.

Producers, fillers and importers must always apply to Infinitum for approval of containers before a container can be accepted into the Infinitum system. Refer to section G for details.

A. Metal containers - material specifications

Pure aluminium cans, pure steel cans, as well as cans combining the two materials are allowed. Combined cans have to consist of steel body and aluminium lid / top (those cans will be defined as steel cans in the Infinitum System).
Cans which are thick plated and welded are not allowed. Cans shall be deep drawn. This is to ensure that the compactor in the RVM is able to handle the object; thick or rigid objects are generally difficult for the compactor. Metal containers may have alternative shapes, e.g. bottle shape. Compatibility with RVM compactors will be checked during the approval procedure.

Cans with a "widget" inside, a small plastic gas cartridge containing N_2 (or CO_2 or mixed gas), are generally allowed. However, such cans must be presented by the

producer/importer to Infinitum for special approval, as new unknown types may cause problems.

Cans will generally have print directly on the metal, but label or sleeve of paper or plastic is normally accepted. Label or sleeve material has to be specified in the approval procedure.

B. Plastic bottles - material specifications

Clear PET bottles; and coloured PET bottles except white, black, silver or shiny-pearly variations; are allowed. Bottles made of HDPE are accepted if the volume proportion of such material in the Infinitum system relative to PET material is acceptable; this is evaluated during the approval procedure. Limitations and/or penalties in the form of higher EPR cost (Extended Producer Responsibility cost, previously termed Administration fee) may occur for other than standard clear PET bottles. This could be due to poor environmental properties, low circularity, higher costs in the value-chain, poor recyclability, etc.

All common PET bottle thicknesses are allowed including hot-fill and similar bottles. As a general guide to determine accepted thickness for high-volume brands the following calculation is used:

- For bottles with content up to 0.5 litres a maximum bottle weigh (without closure cap) of 0.8 grams per cl. bottle content.
- For bottles with content more than 0.5 litres a maximum weigh of 0.5 grams per centilitre bottle content.

However, if part of the bottle is particularly thick or rigid, it may be rejected even when within the calculation guide above. This will depend on the specific approval test results for a given object, limited by the capacity of the RVM compacting device, and will be judged when bottles are tested by Infinitum and RVM suppliers for approval. Similarly, bottles with higher weight per litre content than in the calculation guide may be approved if the RVM compacting device is able to handle them.

Thicker bottles such as hot-fill, wine- and sprits, and similar bottles; are generally accepted as outlined in the main RVM Specifications document. However, approval may depend on market volume.

PET bottles should not be very thin. Very thin bottles deteriorate the recycling process. This is assessed during the approval process as described in section G.

Our EPR cost may differentiate between clear, light blue and coloured bottles.

Even small deviations from clear PET can result in a bottle being classified as light blue or coloured; refer to the limitation details outlined in section 2). Consult Infinitum for advice in this matter.

Bottle material with metallic colours (containing metallic pigments) is not allowed.

1) Overview of plastic bottle- and associated material requirements

Please refer to the following table showing allowed and not allowed materials:

Object	**Clear PET**	**Coloured PET**	**HDPE**	**Not allowed**
Bottle material	PET	PET	HDPE, LDPE, PE	PLA, PVC, PS, PETG, PEN, PEF. Certain PET properties (refer to details in following sections)
Colour	Transparent, light blue transparent (refer to details in following sections)	All colours, less those not allowed.	All colours.	White, black, silver and shiny-pearly colours. Metallic colours or metallic additives. In PET TiO_2 or Carbon Black.
Barriers	Not allowed (exceptions exist).	Allowed to some extent, must be applied for.	Not allowed (exceptions exist).	EVOH, PVDC, PEN
Label and sleeve material	Most materials with density < 1 g/cm^3 (e.g., OPP, EPS, PE, PP, light/foam PET).			Density >= 1 g/cm^3 (e.g. PVC, PS, PET, PETG, OPS, PLA). Metallic materials. Non-laminated paper.
Ink (label print)	According to EuIPA guideline.			Water soluble inks, inks on EuIPA[1] exclusion list, inks with heavy metal content.
Glue	Water/alkaline soluble at 65℃			Re-activating glues.
Closure cap/valve	PE, PP, metal crown.	PE, PP, PET, metal crown.	PE, PP, PET, metal crown.	Metal screw-on caps.
Liner	PE, EVA, TPE			PVC, silicon, metal.

Note: all containers in the Infinitum system must be applied for. Refer to section G.

If you are uncertain whether your container is meeting the requirements or not, please contact Infinitum for advice.

2) Colour requirements for plastic bottles

Clear, light blue and coloured PET bottles are generally accepted. Clear PET is the standard basic bottle type, and other colours may have additional EPR imposed.

Definition of clear (transparent) PET

To be accepted in the clear PET bottle category, a bottle must have to certain colour properties. The following colour values must be adhered to in order to be regarded as clear PET:

[1] Exclusion list + lower limits for certain metals. Also refer to http://www.eupia.org/uploads/tx_edm/2016-11-17_Exclusion_Policy_for_Printing_Inks_and_Related_Products_3rd_ed_corrig_Dec2018.pdf

Colour a:	min. – 0.7 to max + 2.0
Colour b:	min. – 2.0 to max + 2.0
Colour L:	min. 93.0

This, and all colour measurements in this document, are according to a "CIE L a b" photo-spectrometer testing procedure[2] through an approx. 0,3 mm thick layer taken from the bottle wall.

Definition of light blue colour PET

To be accepted in the light blue colour PET bottle category, a bottle will have to adhere to the following values:

Colour a:	min. – 4.0 to max + 2.0
Colour b:	min. – 3.0 to max + 2.0
Colour L:	min. 89.0

Light blue bottles may have a higher fee (EPR) imposed, than EPR for clear bottles.

Definition of coloured PET

PET bottles which are not within the bounds defined for clear and light blue colour above, are regarded as coloured PET (with the limitations outlined in section 1) on page 4). Coloured bottles may have a higher fee (EPR) imposed, than EPR for clear and light blue bottles.

Review of colour properties

Colour limitations for bottles in the clear and light blue categories may change from time to time, depending on changes in feedstock properties and proportion of light blue relative to clear. A revision to this document will then be published.

3) Special material requirements for plastic bottles

Clear PET bottles with well-functioning material properties are the standard basic bottle type. However, Infinitum may temporarily accept unwanted material properties even if it is damaging for the circular recycling system, has poor environmental properties, gives higher costs in the value-chain, etc. Such bottles will have additional EPR imposed. In this section we list the currently temporarily accepted, unwanted material properties.

[2] Using an approved and standard testing procedure for CIE L a b properties, e.g. the Konica Minolta CM-5 photo-spectrometer method. Colour is measured through the section (translucent test), not by reflection.

Crystallisation temperature, crystallinity, and cold crystallisation peak

PET bottles should have material properties within certain values linked to crystallisation properties:

- Crystallisation temperature (Tc), measured by DSC at 10℃/min during the first cooling cycle, of a maximum of 189℃ (includi ng instrument accuracy and standard deviation).
- Total crystallinity measured during the first heating cycle of DSC on the bottles must be greater than 7%.
- A higher melting peak height at 247℃ compared to a peak shoulder height at 240℃ during the second heating cycle.

The above properties are to be determined using the Differential Scanning Calorimetry methodology, DSC, according to ISO11357-3- 2013 (determination of temperature and enthalpy of melting and crystallization). Refer to section K for test procedure details.

Bottles which are out of bounds on these properties may have a higher fee (EPR) imposed on them.

The limits on crystallisation temperature, crystallinity, and crystallisation peak are imposed to ensure well-functioning and efficient recycling of the used bottles into recycled PET material.

Amount of mechanically recycled material in PET bottles

Bottles with a maximum of 80% mechanically recycled material (rPET) content will normally be within the limits on crystallisation temperature, crystallinity, and crystallisation peak as specified above. Limiting the use of rPET will therefore normally be sufficient to conform.

However, a higher than 80% rPET content has other challenges too:

- Microparticles will accumulate in the recycled PET over time. Such particles stem from impurities in the material due to its content and the environment in general, and is not possible to totally remove in the recycling process. Over time, with at too high rPET content and no dilution from virgin or virgin-like PET, accumulated microparticles lead to discolouring (greying) of the material.
- In its own, a too high content of microparticles will also increase the risk of a nucleating effect during recycling, leading to higher crystallisation temperature.
- A certain proportion of bottles are not returned, and there is a loss of material in the recycling process. The share of PET material put on the market being recycled into available rPET is therefore limited. In a closed loop circular system this mass balance also determines a maximum rPET content.

To ensure a stable, balanced, and high-quality recycling system; the following limitation is therefore imposed on PET bottles:

- Bottles should not have more than 80% rPET content. This limit refers to mechanically recycled PET. Chemically recycled PET, which has virgin PET properties, does not count towards the % limit

A maximum of 80% rPET content must be documented by producers. Refer to section H for details.

Bottles which are out of bounds for rPET content may have a higher fee (EPR) imposed on them.

4) Other requirements for plastic bottles

In this section we list additional properties for plastic bottles which must be fulfilled.

Barriers

Barriers in clear PET and HDPE are generally not allowed. However, certain barriers and UV-blockers have been tested and may be accepted. Contact Infinitum for information about such barriers.

For coloured PET the tolerance for barriers are higher. Contact Infinitum for information about such barriers.

Label requirements

The density of the label/sleeve must be such that it is floating in water (density must be < 1 g/cm^3).

Paper labels are in general not permitted. However laminated paper label (without fibre loss) may be allowed if the relative proportion of such labels in the Infinitum system is sufficiently low. This is evaluated during the approval procedure.

Bottle-to-bottle recycling documentation is needed when applying for other materials than listed in the table on page 4.

Label vs. sleeve

If surface of label/sleeve covers less than 75 % of bottle surface area, it is regarded as a “small” label/sleeve. If equal or more than 75 % it is regarded as “large”.

In terms of material approval, there is no difference between large or small label/sleeve. But different EPR cost may apply as “large” is sorted as coloured.

Ink (label and sleeve print)

Water soluble inks (“bleeding ink”), inks containing heavy metals, or bleed labels are not accepted. Ink must not increase density of label/sleeve to > 1 g/cm^3.

Direct print on bottle is not accepted (“tattooed” bottles).

Inks have to be within the EuIPA guidelines, except for heavy metal content which is forbidden regardless of the EuIPA guidelines.

Glue and adhesive for labels

Glue or adhesives are not used on sleeves. Sleeves wrap around and enclose the bottle, eliminating the need for glue/adhesive.

The bottle must complete its cycle from production until received in the RVM without losing its label; therefore the glue must be strong.

Glue or adhesive must be completely soluble (miscible) in water, or water with 1 % NaOH alkaline solution, at 65° C. Glue is allowed to not dissolve but may remain on the label, provided the label wash of the bottle in the water or alkaline solution; and provided glue does not re-activate, re-tack or agglomerate.

Generally, glues that re-activate, re-tack or agglomerate are not allowed. Infinitum has defined a test procedure to determine if glue can be approved. Consult Infinitum.

Closure cap, closure valve and liner

Refer to table on page 4. Liners made of silicon is generally not accepted, but may be approved if silicon has low density (floating in water) and is coloured; and volume (number of units put to market) is low. Any silicon content must be specified in application procedure.

Other material that is documented recyclable may be approved by Infinitum.

Peel of aluminium film and seal may be accepted if documented that it separates from the bottle when it is opened (as a metal crown cap will do).

C. Type of content

Certain types of content may harm the recycling process, even if only small residual amounts are left in the container when being returned. Infinitum therefore needs to assess and approve / disapprove a container depending on the content it will be used for.

Generally, these content types are not allowed:

1. Chemical substances not intended for human consumption. Organic, high-viscosity cleaning liquids may be exempt.
2. Liquids with a high content of fats or oils. E.g. some milk products, most cooking oils.

Documentation on the type of content used may be required by Infinitum as part of the approval process, including volume (number of annual container units) forecasts.

D. Physical dimensions and shape

The general limitation for shape and dimensions of the containers will be defined by the Reverse Vending Machines and Infinitum's depot machines (Industrial RVMs). Minimum and maximum sizes (diameter and length) are given in the following table.

Infinitum will test the feasibility of all new beverage containers as described in section G. Hence, there may be exemptions to the following dimensions guide:

Container dimensions

Cans and plastic bottles:		
- Diameter:	minimum: 45 mm,	maximum: 130 mm
- Height:	minimum: 100 mm	maximum: 370 mm
- Diameter must not exceed height.		
- Volume:	125 - 4900 ml (provided dimension requirements are fulfilled)	

Dimensions of non-round objects are measured at their maximum, i.e. using the dimensions for a virtual cylinder that most closely fits outside the non-cylinder object when it is lying on its side. Height is measured without closure cap.

Required shape

General

The general limitation for shape, measures and dimensions of the containers is defined by the reverse vending machines (RVMs). Each bottle, with an undamaged and correctly designed barcode (see section for bar code design below) must generally be readable in all currently installed RVMs (including industrial RVMs).

However, Infinitum may exempt certain containers with properties that can pose problems for some RVMs, in cooperation with the RVM suppliers. This will be done if only a limited number of old RVMs are unable to handle the container in question.

Ability to roll not a requirement

Beverage containers need not be round and need not be able to roll. Infinitum's RVM Specifications now states that the RVM must be able to read barcode and recognise container type without depending on the object being round. This is a requirement that was introduced in January 2018; as outlined in the main RVM Specifications document. Machines already in the market will be allowed until replaced by new models, hence the exemption mentioned above.

Note: the specifications do not require that objects may be placed in any orientation when being fed to the RVM; hence it is acceptable that the RVM requires objects being placed in a certain manner by the user (e.g. with barcode facing up). However, Infinitum recommends that RVMs allows maximum flexibility for how objects should be placed by the user.

E. Deposit symbol and bar-code position and specifications

The deposit symbol and bar-code size and position must follow the guidelines found on www.infinitum.no.

The bar-code can be either EAN-code (EAN-13 or EAN-8) or UPC-code. All codes must also be registered in GS1 and approved by them (the international body allocating and maintaining the codes), refer to www.gs1.no.

Generally, the barcode size should adhere to this minimum format:

Factor	EAN-13	EAN-8	UPC-A	UPC-E
	Width x height in mm	Width x height in mm	Width x height in mm	Width x height in mm
0.8	29,8 x 20,7	21,4 x 17,0	29,8 x 20,7	21,4 x 17,0
1.0	37,3 x 25,9	26,7 x 21,3	37,3 x 25,9	26,7 x 21,3

Infinitum recommends using factor 1.0. Factor 0.8 is a minimum.

Width and height is measured inclusive of bars and numbers in the graphical barcode design, but exclusive any area outside such graphics. An empty "noise-free" zone of 3 mm, i.e. a decoration- and text-free area, must be found at each end of the barcode (i.e. to the left and right of the barcode bars' reading direction). This area is not counted in the width and height measurements above. Without a "noise-free" zone recognition in the RVM may fail.

Barcode should be placed on an even part of the container, with as few shape-irregularities as possible.

For technical requirements of print, contrast, colour and size, please refer to GS1. The bar code must follow the requirements set for automated reading systems. Bar Codes must also comply with ISO/IEC 15416 "Bar code print quality test specification for linear symbols" for quality measures, contrast and readability.

In cases where the same bar-code is used in different markets ("international/standard codes") there will be a risk that containers sold outside Norway without Norwegian deposit, will be taken to Norway and deposit claimed. In such cases Infinitum will assess the risk involved. A separate agreement will have to be made, and compensation may have to be paid by the producer / importer.

The container may have at most two bar-codes registered to GS1, but only one of them should be present in Infinitum's data record used for identification by the RVM. Each individual barcode must still fulfil the general barcode requirements.

The label or sleeve with the bar-code and deposit-mark must follow the container until returned through the RVM. Tear off sections, e.g. for marketing reasons, is only accepted if a section with bar-code and deposit-mark remains on the container.

F. Tilt angle

The readability of the barcode in the RVM will generally deteriorate if the barcode is non-parallel with the RVM orientation. Therefore, when a bottle rests on its surface, the bar code on the bottle must be presented with a tilt angle relative to this surface plane of maximum 30 degrees (360° system). This imp roved angle acceptance is a requirement that was introduced in January 2018; as outlined in the main RVM Specifications document.

When an object is allowed to tilt, it will rise higher from its resting surface than its diameter. Therefore, a tilt angle higher than a few degrees may influence the maximum dimensions allowed (refer to section D above). Similarly, the length-height ratio limit of 1:1 set in the table in section D ("diameter must not exceed height") may for some objects have to be considerably higher in order to keep the object within the tilt limit.

The tilt angle measurement and the corresponding maximum dimensions will depend on individual testing by the RVM suppliers, and must be approved by Infinitum.

G. Application procedure for containers

Producers, fillers and importers must apply to Infinitum for approval of containers before a container can be accepted into the Infinitum system. The application must be registered at least 6 - 8 weeks (depending on type of container) before the product enters the market and must be accompanied with the documentation required (refer to section H). Applicants must be a member of the Infinitum deposit system and must use the online registration made available at www.infinitum.no for the application procedure.

For containers that differ substantially from previous containers by e.g. shape, thickness, or material; suppliers are strongly recommended to involve Infinitum as early as possible in the product development process. Contact Infinitum for details regarding sample presentation. If the application reveals that material, glue or other

properties needs special investigation, the application procedure will require more time.

Infinitum involves RVM suppliers in the approval procedure, to ensure that products / containers being applied for will be handled satisfactorily by the RVMs.

H. Documentation

The applicant shall present documentation for the material used (container material, material properties, recycled content of such material, cap, label, glue etc.). Applicants can request such documentation from the packaging manufacturer. Data-sheets with specifications are required by the recycling industry, to ensure safe and efficient recycling. The applicant shall also present documentation on the dimensions, and if requested by Infinitum documentation of the type of content that will be filled in the container.

I. Introduction of new beverage container properties and new material types

Other types of beverage containers than those currently listed in this document may be introduced as follows:

1. By application. A producer or importer may apply for approval of a container with deviating material- or physical properties. Infinitum may approve such containers with limitations; e.g. a limit on the number of containers allowed in the market.
2. By generally approving a new container type, introduced by Infinitum. Examples are containers of a new material (e.g. glass bottles) or dimension (e.g. smaller size). In such cases, Infinitum will work with the producers/importers and the RVM suppliers to ensure compatibility, and if needed plan an introduction timeline. Generally approved new containers will be available for all producers, and will have no limitations on numbers accepted in the market.

J. List of abbreviations

EPS	Expanded polystyrene
EuPIA	The European Printing Ink Association
EVA	Ethylene-vinyl acetate
EVOH	Ethylene vinyl alcohol
HDPE	High-density polyethylene
IRVM	Industrial reverse vending machine (depot RVMs)
OPP	Oriented Polypropylene
OPS	Oriented polystyrene
PA	Polyamide, nylon
PE	Polyethylene/polyethene
PEF	Polyethylene furanoate

PEN	Polyethylene naphthalate
PET	Polyethylene terephthalate
PETG	Polyethylene terephthalate glycol-modified
PLA	Polylactic acid
PO	Polyolefin
PP	Polypropylene
PS	Polystyrene
PVC	Polyvinyl chloride
PVDC	Polyvinylidene chloride
RVM	Reverse vending machine (used to return containers and claim deposit)
TPE	Thermoplastic elastomers

K. Differential Scanning Calorimetry (DSC) test procedure

DSC is a technique to verify the melting and crystallization behaviour of a material subjected to heat under controlled temperature program and atmosphere. There are two crucibles in the furnace; one with sample and one empty, and the difference in heat flow between these is the response of the material being analysed.

Instrument	TA DSC 250, or compatible
Specimen type	Cut directly from application (see "sample requirements" on next page) Weight: 9 -11 mg (0,7mm) Pan: Tzero with hermetic lid punched with three holes (using a needle 0,78mm diameter to allow for water and CO2 to escape during first heating).
Test conditions	1. Heating: 25 – 280 ℃ Cooling: 280 – 20 ℃ 2. Heating: 20 – 300℃ Heating / Cooling rate 10℃/min Parallels: 3
Definitions	Tm: Temperature of melting; Peak of melting Tc: Temperature of crystallization; Peak of crystallization T_{cc}: Temperature of cold crystallization; Peak of cold crystallization DH_{cc}: Enthalpy of cold crystallization; Integrated area from 100℃ (or lower if cold crystallization temperature is much lower- matching the baseline of the DSC as a standard practice) to end of cold crystallization. ΔHm: Enthalpy of melting; Integrated area from 200℃ to end of melting. T_g: Midpoint temperature are measured half the height between the two extrapolated baselines. ΔCp: At glass transition the specific heat will increase and cause a step in the DSC curve. This change in specific heat is defined as ΔCp (Tg). For semi crystalline polymers the glass transition step height (ΔCp (Tg)) is proportional to the amorphous content.
Equipment Precision	Temperature precision: +/- 0,008℃ Temperature accuracy: +/- 0,05℃ Enthalpy precision: +/- 0,08%

Crystallinity Calculation from first Heating cycle

The crystallinity from the first heating cycle is calculated by following equation:

$$\%\chi = \frac{(\Delta H_m - \Delta H_{cc})}{\Delta H_{m-100\%\ crystalline}} x\ 100$$

Where
%c = Percentage crystallinity
DH_m = Enthalpy of the melting peak during first heating cycle
DH_{cc} = Enthalpy of the cold crystallization peak during first heating cycle
$DH_{m\text{-}100\%\ crystalline}$ = Enthalpy of melting of 100% crystalline PET (theoretical = 140 J/g)

Sample requirements:

3 or more samples from the same batch of bottles should be tested individually, and the average of results used to determine adherence.
Bottles are emptied, and the cap shut tight. Bottles are left for 16-18 hour before sample cutting and starting the test in the DSC instrument. The analysis shall be completed within the next 24 hours.

All samples are to be cut with a punch of 4mm in diameter from the middle part of the bottle thread, as illustrated below. The 4mm sample is sliced to a thickness of ~0,7 mm and the sample is placed with the inner surface of the bottle facing up in the DSC pan.

Melting peak hight illustration:

Illustration of higher melting peak height at 247℃ compared to a peak shoulder height at 240℃ during the second heating cycle; examples showing “out of” and “in” specification: