

Irish Standard I.S. EN 17410:2021

Plastics - Controlled loop recycling of PVC-U profiles from windows and doors

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I.S. EN 17410:2021

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Northwood, Santry

Dublin 9

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F +353 1 857 6729

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1 Swift Square,	F +353 1 8	807 3838 T +353 1 857 6730

Údarás um Chaighdeáin Náisiúnta na hÉireann

E standards@nsai.ie

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National Foreword

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Plastics - Controlled loop recycling of PVC-U profiles from windows and doors

Plastiques - Recyclage en boucle contrôlée de profilés de fenêtres et portes en PVC-U Kunststoffe - Geregelter Recyclingkreislauf von Fenster- und Türprofilen aus PVC-U

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European foreword

This document (EN 17410:2021) has been prepared by Technical Committee CEN/TC 249 "Plastics", the secretariat of which is held by NBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2022, and conflicting national standards shall be withdrawn at the latest by March 2022.

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Introduction

Recycling of plastics pre- and post-consumer waste is a material recovery process aiming to save resources such as raw materials, water and energy, thus minimizing emissions into air, water and soil and hence contributing to human health and environmental protection.

For a huge number of plastic products, individual recycling schemes have been established. Regarding PVC windows and doors made of un-plasticized PVC, they are subject to an advanced recycling scheme, i.e. a so-called controlled loop. In this particular case, the used windows and doors are collected, the PVC frame separated, shredded and treated. The recyclate obtained therefrom then goes back to the manufacturing of new window and door profiles. To ensure a high quality level of both plastic recycling and finished products in a single market, the control of the recycling process is recommended to be standardized, with regard to (i) process steps such as collection, identification, sorting, cleaning and (ii) sub-process steps such as testing, quality assurance, and traceability.

In that respect, this document forms, together with EN 12608-1, and EN 14351-1, EN 14351-2 and EN 16034 a unique and consistent standardization framework enabling the value chain to act in a circular manner.

NOTE In this document, only EN 12608-1 will be mentioned. However, whenever this is the case reference is made to all subsequent parts of EN 12608, once published as well.

1 Scope

This document specifies the controlled loop and the definition of those material transformation steps which are relevant for product quality, in particular recycling input and output and profile manufacturing input and output.

Traceability tools are specified to characterize this loop as a controlled loop.

This document references existing quality and test methodologies for recycled PVC to be used in PVC-U profiles for windows and doors.

This document establishes the controlled loop treatment of PVC profiles in line with the general understanding of life cycles as outlined in EN 15804.

NOTE 1 With regard to PVC waste treatment, the present document relates to existing standards EN 15343, EN 15346 and EN 15347.

NOTE 2 With regard to semifinished and/or finished products, it refers to the European Standard PVC-U window profiles (see EN 12608-1) and to the European Standards for windows and doors (see EN 14351-1, EN 14351-2 and EN 16034).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12608-1, Unplasticized poly(vinyl chloride) (PVC-U) profiles for the fabrication of windows and doors — Classification, requirements and test methods — Part 1: Non-coated PVC-U profiles with light coloured surfaces

EN 15343, Plastics — Recycled Plastics — Plastics recycling traceability and assessment of conformity and recycled content

EN 15346, Plastics — Recycled plastics — Characterization of poly(vinyl chloride) (PVC) recyclates

EN 15347, Plastics — Recycled Plastics — Characterisation of plastics wastes

EN 17213, Windows and doors — Environmental Product Declarations — Product category rules for windows and pedestrian doorsets

EN 514, Plastics — Poly(vinyl chloride) (PVC) based profiles — Determination of the strength of welded corners and T-joints

EN ISO 60, *Plastics* — *Determination of apparent density of material that can be poured from a specified funnel (ISO 60)*

EN ISO 306, Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST) (ISO 306)

EN ISO 178, Plastics — Determination of flexural properties (ISO 178)

EN ISO 3451-5, *Plastics — Determination of ash — Part 5: Poly(vinyl chloride) (ISO 3451-5)*

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3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

ISO Online browsing platform: available at https://www.iso.org/obp

3.1

material

PVC-U compound in a form of granules or powder for the production of PVC-U profiles intended to be used for the fabrication of a window or door

[SOURCE: EN 17508:2021, 3.1]

3.2

defined formulation

formulation which is a specified composition of polymer, additives and pigments

[SOURCE: EN 17508:2021, 3.2]

3.3

virgin unplasticized polyvinylchloride

virgin PVC-U

material of a defined formulation, which has not been used or processed other than required for its manufacture and to which no rPVC-U (3.6) has been added.

Note 1 to entry: Material can be UV resistant, non-UV resistant, or reduced UV-resistant.

[SOURCE: EN 17508:2021, 3.3]

3.3.1 UV resistant material UVM material of a defined formulation which fulfills weathering resistance

Note 1 to entry: Weathering resistance shall be defined in the referring standard.

[SOURCE: EN 17508:2021, 3.3.1]

3.3.2

reduced-UV resistant material

RUVM

material of a defined formulation which fulfills reduced weathering resistance

Note 1 to entry: Weathering resistance shall be defined in the referring standard.

[SOURCE: EN 17508:2021, 3.3.2]

3.3.3 non-UV resistant material NUVM

material of a defined formulation which does not necessarily satisfy the requirements of the resistance to weathering

Note 1 to entry: Weathering resistance shall be defined in the referring standard.

[SOURCE: EN 17508:2021, 3.3.3]

3.4

internally reused material

IRM

reused material from internally extruded, virgin material; this includes mismeasured, unused products and offcuts

Note 1 to entry Different defined formulations cannot be mixed.

Note 2 to entry: Material can be UV resistant, non-UV resistant, or reduced UV-resistant.

Note 3 to entry: "Internally" refers to the same profile manufacturing company group even if located at different sites.

[SOURCE: EN 17508:2021, 3.4]

3.5

PVC-U waste

PVC-U profile material which the holder discards or intends or is required to discard

[SOURCE: EN 17508:2021, 3.5]

3.5.1

PVC-U pre-consumer waste

material diverted during a manufacturing process of profiles and/or windows/doors and which the holder discards or intends or is required to discard

Note 1 to entry: The term post-industrial waste is sometimes used synonymously.

[SOURCE: EN 17508:2021, 3.5.1]

3.5.2

PVC-U post-consumer waste

material, generated by the end-users of products, that has fulfilled its intended purpose or can no longer be used and which the holder discards or intends or is required to discard (including PVC-U waste from installation)

[SOURCE: EN 17508:2021, 3.5.2]

3.5.3

PVC-U waste from installation

material which the holder discards or intends or is required to discard generated during the installation process of the window or door into the building

[SOURCE: EN 17508:2021, 3.5.3]

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3.6 PVC-U recyclate recovered PVC-U rPVC-U recycled or recovered, unplasticized polyvinylchloride

Note 1 to entry: Material can be UV resistant, non-UV resistant, or reduced UV-resistant.

Note 2 to entry: Table 1 lists products commonly recycled into rPVC-U of a quality for use in the end applications as outlined.

Table 1 — Products commonly recycled into rPVC-U for profiles in windows and doors

PVC-U product (PVC-U pre-consumer waste and PVC-U post- consumer waste) ^a		
1)	window profiles	
2)	door profiles	
3)	roller shutter profiles	
4)	roller shutter boxes	
5)	blinds	
6)	claddings	
7)	window boards	
8)	building profiles	
^a Non listed PVC products with the same material quality as those listed may likewise be used.		

3.7

component

part of a window and/or door such as hardware, glass and gaskets, including profiles.

4 Methodology, Procedures and Requirements

4.1 Life cycle stages of PVC windows and doors

4.1.1 General



[SOURCE: EN 15804:2012+A2:2019, Clause 5.2, Figure 1]

Figure 1 — Life cycle stages and modules for the building assessment

4.1.2 Production stage of PVC-U windows and doors

- A1, the forming of raw material, virgin and recycled material into PVC window or door profiles;
- A2, raw material, profiles and components are transported in the course of the production process;
- A3, the assembling of components such as profiles, glass and hardware to windows and doors.

4.1.3 Construction stage of PVC-U windows and doors

- A4, the transport of windows and doors to the building site;
- A5, the installation of windows and doors into the building

4.1.4 PVC-U windows and doors use stage related to the building fabric stage

- B1, the use of windows and doors;
- B2, their maintenance;
- B3, repair;
- B4, replacement; or
- B5, refurbishment.

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4.1.5 PVC-U windows and doors use stage related to the operation of the building stage

- B6, the operational energy use (e.g. operation of heating system and other building related installed services);
- B7, the operational water use.

4.1.6 PVC-U windows and doors end of life stage

- C1, de-construction, demolition;
- C2, transport to waste processing;
- C3, waste processing for reuse, recovery and/or recycling;
- C4, disposal.

4.1.7 Benefits and loads beyond the system boundary

Module D includes reuse, recovery and/or recycling potentials, expressed as net impacts and benefits

4.2 Controlled Loop Model and Life Cycle Stages

Life cycle stages as described in 4.1., Figure 1 refers to a linear model. Conceptually, when using PVC-U recyclate (rPVC-U) from stage C for the manufacturing of new PVC window or door profiles, the linear model turns into a circular one and forms a controlled loop, as described in Figure 2.



Figure 2 — Controlled Loop (schematic), material flow (left) and life cycle stages (right)

4.3 Material Flow along the loop

4.3.1 General

NOTE Figure A.1 visualizes the material flows throughout the life cycle of a window profile.

4.3.2 Production stage A1 - A3

The loop starts with the production stage (A1 \rightarrow A3), where raw materials are converted into finished products. The production stage outlined here comprises first the manufacturing of PVC profiles and then their assembly to PVC windows and doors.

According to the EN 12608 series, the raw material used for the profile production (extrusion) can be characterized as described in Table 2.

Authorized Material	Sight surface	non-sight visible surface	non visible surface
UV resistant material (UVM)	Yes	Yes	Yes
UV resistant internally reused material (IRM)	Yes	Yes	Yes
Reduced-UV resistant virgin material (RUVM)	Yes, if covered with UV resistant surface layer as described in the EN 12608 series	Yes	Yes
Non-UV resistant material (NUVM)	No	No	Yes
PVC-U recyclate (rPVC-U)	No	No	Yes

Table 2 — Use of materials on surfaces of profiles

While incoming virgin PVC-U compound usually is ready to use, rPVC-U might have to be mixed with additives such as fillers, pigments, stabilizers, etc. to prepare a compound ready for extrusion.

PVC-U window and door profiles are semi-finished products. They will leave product stage A3 as they are assembled to windows or doors. Processing waste and off-cuts (pre-consumer waste) preferably remain in the production stage (while internally reprocessed) or go to the recycling stage.

4.3.3 Construction stage A4 – A5

Windows and doors produced in A3 are brought to the building and installed there (A4 \rightarrow A5).

4.3.4 Use stage B1 – B7

4.3.4.1 General

The service life of windows is defined in EN 17213. Conceptually, no profile material will leave this life cycle stage, because maintenance and repair are possible and are foreseen.

Material will leave this stage when the window or door is dismantled and disposed of.

4.3.5 End of life stage C1 – C4

4.3.5.1 General

There are two potential scenarios for the end of life phase, because removal of windows and doors can take place as an individual measure or in the scope of a building refurbishment. In both cases the dismounted windows and doors can be collected and recycled. Yet, removal of windows and doors can also take place in the scope of deconstruction or demolition of a building. This entails waste processing including sorting into building materials or building products like windows, doors and/or its components such as plastic profiles, glass and hardware, disposal and supply to the recycling unit (C1–C4). Materials that leave stage C will go to recycling stage.

4.3.5.2 End of life of the building

The removal of windows and doors can take place in the scope of deconstruction or demolition of a building. In this case windows and doors shall be removed beforehand and properly disposed to maintain the controlled loop.

4.3.5.3 End of life of the window or door only

A replacement of a window or door can take place as an individual measure or in the scope of a building refurbishment. The dismounted unit shall be collected, transferred either to a collection point or directly to a recycling unit and recycled.

4.3.6 Recycling/ Reuse/ Reprocess stage

4.3.6.1 General

PVC window and door recycling shall deliver either shredded PVC window profile pieces entailing reprocessing or not, or granules, ready-to-use for the (co-)extrusion process of new PVC window or door profiles. Hence, the relevant stages where PVC material shall be characterized (in line with Figure 2) are (stage II) recycling input, (stage III) recycling output = profile manufacturer input and (stage I) extrusion process input.

NOTE Profile manufacturer input and extrusion process input can be the same.

4.3.6.2 Incoming material, recycling input (stage II)

Next to windows and doors, recyclers shall only accept re-processable and recyclable PVC material as shown in Table 1.

4.3.6.3 Outgoing material, recycling output (stage III)

EN 15346 (PVC) and EN 15347 (plastics) define quality characterization parameters which serve as the guiding baseline for agreements on specifications between recyclers and profile manufacturers.

The outgoing material can be specified according to the relevant target applications. For PVC-U window and door profiles, these specifications shall fulfill the requirements as defined in EN 12608-1, if fit-for-extrusion compound for PVC profiles is delivered.

Recyclable components, other than PVC, such as hardware and glass are recycled elsewhere in certain proportions according to the current market situation, whereas non-recyclable waste may be landfilled or incinerated, depending on the legislation of a given member state.

4.4 Definition of quality relevant stages in the controlled loop

In order to define material and product characteristics along the loop (see Figure 2), the methodology chosen focus on those quality relevant process stages where material is transformed, most notably

- Stage I (A1 \rightarrow A3): From raw material to profile and window manufacturing;
- Stage II (C1/C4 \rightarrow Recycling stage): From end-of-life to recycling; and
- Stage III (Recycling stage \rightarrow A3): From recycling to profile and window or door manufacturing.

4.5 Requirements, material characteristics and related test methodologies

4.5.1 General

Requirements for each stage of the material are outlined in the sections here below (Table 3).

\Purpose Available Parameters			Recycling Output Material ^a	Extrusion Input Material ^b	Traceability ^c
Characteristic	Unit	Test Method			
Origin					optional
Type of waste		Visual inspection	mandatory ^d	irrelevant	optional
Ash content	%	EN ISO 3451-5 Method A	optional	optional	
Bulk density	kg/m ³	EN ISO 60 (EN 15346:2014, Annex B)	optional	optional	
Colour		Visual inspection	optional	optional	
Impurities	%	EN 15346:2014, Annex C	optional	optional	
Particle size and distribution	g, %	EN 15346:2014, Annex D and Annex E	optional	optional	
Shape		Visual	optional	irrelevant	
Vicat temperature	°C	EN ISO 306, Method B	<u>Optional</u> in case of later compounding/ <u>mandatory</u> in case of fit-for-extrusion material acc. to EN 12608-1	mandatory	
E- Modulus	N/ mm ²	EN ISO 178	<u>Optional</u> in case of later compounding/ <u>mandatory</u> in case of fit-for-extrusion material acc. to EN 12608-1	mandatory	
Strength of welded corners	N/ mm ²	EN 514	<u>Optional</u> in case of later compounding/ <u>mandatory</u> in case of fit-for-extrusion material acc. to EN 12608-1	mandatory ^e	

Table 3 — Material requirements for rPVC-U for PVC window and door profiles

^a If the recycler delivers fit-for-extrusion material, the column "Extrusion Input" applies. Otherwise, specification shall be done according to EN 15346 as a guiding baseline (see Table B.1, Annex B).

^b Extrusion input material is specified according to EN 12608-1.

^c Additional information for traceability purposes may be given based on Table C.1 (see Annex C).

^d Compare Table 2.

 On mono-extruded or co-extruded profiles with PVC-U recyclate (rPVC-U) – with a maximized proportion of recycled PVC or a larger % share of recyclate material than of virgin material

4.5.2 Stage II – Recycling Input Material

In view of different end-of-life scenarios and a likely pre-selection done by demolition companies, various types of incoming waste material are possible. Such a mix of PVC-U waste may consist either of complete PVC windows and doors (mono-stream), or PVC profile and related building product material or mixtures of PVC-U waste. Recyclers generally accept material as listed in Table 1 with regard to the target application. In some countries, the composition of construction waste is defined by standards and/or technical guidelines.

4.5.3 Stage III - Recycling Output Material (= Profile Manufacturer's Incoming Material)

As mutually specified between recyclers and profile manufacturers, various appearances of PVC-U recyclate (rPVC-U) may be provided; it may be either recycled post-consumer or pre-consumer PVC or, as in most of the cases, a mixture of both.

Upon mutual agreement of the above parties, the material of the PVC-U recyclate may be compounded in line with the requirements of the profile manufacturer.

rPVC-U should be supplied against a product specification. The 'required characteristics' in EN 15346:2014, Table 1, on the characterization of plastic recyclates serve as a guiding baseline for such specifications. It can be found in Annex B. For rPVC-U to be used in PVC windows and doors, the requirements of Table 3 including its normative footnotes a to e are used for specification.

Together with PVC-U recyclate (rPVC-U), a product data sheet may give information on the required characteristics as listed in Table 3.

4.5.4 Stage I – Extrusion input material (PVC compound/dryblend ready to use)

PVC-U recyclate might have to be mixed with additives such as fillers, pigments, stabilizers, etc. to prepare a compound ready for extrusion according to the EN 12608 series.

4.6 End of Waste status

Based on the process described in 4.3.5 and the transformation stages as described in 4.4, the point where waste from windows and doors reaches the end of waste status will be at the end of the recycling stage (stage III). This point can be defined as follows:

Once the PVC-U waste has undergone a recovery process, the following conditions are met:

- The outgoing pellets or shredded material are ready for being re-used in the fabrication of new window/door profiles.
- The material will have undergone all tests which are mandatory
- No adverse environmental or human health impacts will be caused.

Accordingly, the PVC-U recyclate shall reach the end of waste status once the recycling process has been completed.

4.7 Definition of traceability instruments

Traceability of PVC recyclates for windows/doors is a quality relevant item, because EN 17508:2021 allows the use of recycled PVC according to Table 1 (see 3.6 and 4.5.2.).

To ensure traceability relevant to the intended application, the supplier of recycled PVC shall provide a data sheet, for the identification and the recording of the data according to Table 3. The purchaser confirms the level of traceability is suitable for the intended application.

For matters of traceability, EN 15343 shall apply. When providing information, suppliers of recyclates shall do so based on Table 3 (normative) potentially supplemented by Table C.1 (informative).

4.8 Quality assurance

4.8.1 General

The quality of rPVC-U is fulfilled via compliance with EN 12608-1. In that respect, in-house production control shall ensure the quality of input material on both material origin and mechanical properties.

The collection and sorting schemes shall be properly designed to deliver recyclable plastics waste fractions fitting reasonably well with the available recycling technologies and with the needs of the identified market outlets.

Even if listed as "control at recycler" (4.8.2) or "control at manufacturer" (4.8.3.) the location of verification may differ depending on local market conditions. Bilateral agreements shall specify which party carries out the verification.

4.8.2 Manufacturing control at the recycler

A control of the recycling process is required to guarantee its proper functioning, in line with state of the art manufacturing practice. This includes but is not limited to:

- Recording of the process settings;
- Visual control of incoming material, visual control of the material flow and product quality control according to:
 - Table 1
 - Batch identification.

Recyclate suppliers shall provide technical information about the material properties as required in Table 3.

4.8.3 Manufacturing control in the extrusion process at the profile manufacturer

Based on Table 3, profile manufacturers and recyclers can jointly define specifications based on EN 12608-1 for the supply of rPVC-U; these specifications are part of the related product data sheets.

Control of the input materials shall be carried out according to Table 3, including homogeneous batch identification. This applies also when profile manufacturers buy post-industrial waste such as off-cuts directly from window and door manufacturers or dealers.

Alternatively, all tests related to the quality of PVC-U recyclate (required and optional) can be carried out at the finished PVC window profile.



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