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Plastics — Evaluation of compostability — Test scheme and specifications

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National foreword

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Contents

Foreword

This document (EN 14995:2006) has been prepared by Technical Committee CEN/TC 249 "Plastics", the secretariat of which is held by IBN/BIN.

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of an identical text or by endorsement, at the latest by June 2007, and conflicting national standards shall be withdrawn at the latest by June 2007.

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Introduction

This European Standard defines the requirements for plastic materials to be considered organically recoverable. It provides a framework which can be used to support claims of compostability of plastics. The approach of this European Standard is comparable to that of EN 13432 which defines the requirements for packaging materials.

Organic recovery of used plastic materials is one of several recovery options within the overall life cycle of plastic materials.

This European Standard presents a framework for assessment to determine whether the requirements of this European Standard have been met. Its approach is similar to that of systems standards such as the EN ISO 9000 and EN ISO 14000 series.

1 Scope

This European Standard specifies requirements and procedures to determine the compostability or anaerobic treatability of plastic materials by addressing four characteristics:

I) biodegradability,

II) disintegration during biological treatment,

III) effect on the biological treatment process and

IV) effect on the quality of the resulting compost.

NOTE For packaging EN 13432 applies.

2 Normative references

The following referenced documents are indispensable for the application 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 ISO 14851, *Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium - Method by measuring the oxygen demand in a closed respirometer (ISO 14851:1999)*

EN ISO 14852, *Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium — Method by analysis of evolved carbon dioxide (ISO 14852:1999)*

EN ISO 14855, *Determination of the ultimate aerobic biodegradability and disintegration of plastic materials under controlled composting conditions — Method by analysis of evolved carbon dioxide (ISO 14855:1999)*

ISO 16929, *Plastics — Determination of the degree of disintegration of plastic materials under defined composting conditions in a pilot-scale test*

OECD Guidelines for Testing of Chemicals 208*: Terrestrial Plants, Growth Test; Organisation for Economic Co-operation and Development, 2 rue André Pascal, F - 75775 Paris*

3 Terms and definitions

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

3.1
constituent of a plastic material
every pure chemical material or substance of which a plastic material is composed

3.2
disintegration
physical falling apart into very small fragments of a plastic material

3.3
ultimate biodegradation
breakdown of an organic chemical compound by microorganisms in the presence of oxygen to carbon dioxide, water and mineral salts or any other elements present (mineralization) and new biomass or in the absence of oxygen to carbon dioxide, methane, mineral salts and new biomass

3.4
total dry solids
amount of solids obtained by taking a known amount of plastic material or compost and drying at about 105 °C to constant weight

3.5
volatile solids
amount of solids obtained by subtracting the residues of a known amount of plastic material or compost after incineration at about 550 °C from the total dry solids content of the same sample. The volatile solids content is an indication of the amount of organic matter

4 Requirements

4.1 Control of constituents

Constituents known to be, or expected to become, harmful to the environment during the biological treatment process (see Clause 8), in excess of the limits given in A.1, shall not be deliberately introduced into plastic materials intended to be designated as suitable for organic recovery.

4.2 Assessment

4.2.1 General

Except as identified in 4.3, assessment of the biological treatability of plastic materials shall include the following 5 assessment procedures as a minimum:

— characterization (4.2.2);

— biodegradability (4.2.3);

— disintegration including effects on the biological treatment process (4.2.4);

— compost quality (4.2.5);

— recognizability (4.2.6).

4.2.2 Characterization

A plastic material under investigation shall be identified and characterized prior to testing including at least:

— information on, and identification of, the constituents of the plastic material;

— determination of the presence of hazardous substances, e.g. heavy metals;

— determination of the organic carbon content, total dry solids and volatile solids of the plastic material used for biodegradation and disintegration tests.

NOTE Chemical characteristics' pass levels need to be met for volatile solids and heavy metals.

4.2.3 Biodegradability

To be designated as organically recoverable, a plastic material shall be inherently and ultimately biodegradable as demonstrated in laboratory tests (Clause 6) and to the criteria and pass levels given in A.2.

4.2.4 Disintegration

To be designated as organically recoverable, a plastic material shall disintegrate in a biological waste treatment process (Clause 7) to the criteria and pass levels given in A.3, without any observable negative effect on the process.

4.2.5 Compost quality

To be designated as organically recoverable, a plastic material submitted to a biological waste treatment process, shall not have a negative effect on the quality of the resulting compost (Clause 8).

4.2.6 Recognizability

A plastic material which is intended for entering the biowaste stream shall be recognizable as compostable or biodegradable by the end user by appropriate means.

4.3 Exemption for the equivalent form

A plastic material demonstrated to be organically recoverable in a particular form, shall be accepted as being organically recoverable in any other form having the same or a smaller mass to outer surface ratio and maximum wall thickness.

4.4 Recording of assessment outcome

4.4.1 Check list

For each plastic material the result of each assessment or test undertaken as required in 4.2.1, shall be recorded on an assessment check list and their outcome used to determine whether a plastic material is biologically treatable and therefore suitable for organic recovery. The check list shall provide data for the identification of any supplementary information.

4.4.2 Supporting documentation

The check list, together with any other information, including externally sourced technical data, necessary to support the conclusions reached in the assessments, shall be retained and made available for inspection if required.

5 Organization of a test scheme

In view of the relative complexity of some of the procedures involved, it is essential that assessment and testing be undertaken in a formal and organized way. Whilst this European Standard does not attempt to specify such organization, a flowchart of a recommended scheme is provided in Annex B.

Where required, the disintegration test may also be used to obtain information on any negative effects that the plastic material could have on the composting process.

Compost is not only the final product of the aerobic composting process but also the aerobically stabilized product of the anaerobic biogasification process. Where appropriate, an anaerobic disintegration test may be performed additionally.

NOTE It is important to recognise that it is not necessary that biodegradation of a plastic material is fully completed by the end of biological treatment in technical plants but that it can subsequently be completed during the use of the compost produced.

6 Laboratory tests on biodegradability

Only biodegradation tests that provide unequivocal information on the inherent and ultimate biodegradability of a plastic material or its significant organic constituents (see A.2.1.1) shall be used.

The controlled aerobic composting test according to EN ISO 14855 shall be used unless inappropriate to the type and properties of the material under test.

In the event that alternative methods are necessary an internationally standardized biodegradability test method (see e.g. ISO/TR 15462) shall be used, in particular EN ISO 14851 and EN ISO 14852 which are designed for polymeric materials.

NOTE 1 Information on how to handle poorly water soluble test materials for use in aquatic biodegradation tests may be obtained from EN ISO 10634.

NOTE 2 For the purpose of this European Standard it is sufficient to test biodegradability under aerobic conditions. If in a special case additional information on biogasification is required, a method with a high-solids test environment such as ISO 15985 should preferably be used.

For screening anaerobic biodegradability for example ISO 14853 or EN ISO 11734 may be used.

7 Determination of disintegration

Unless technically impossible, the plastic material shall be tested for disintegration in the form in which it will ultimately be used. The controlled pilot-scale test according to ISO 16929 shall be used as the reference test method. A test in a full-scale treatment facility may, however, be accepted as equivalent. The pilot-scale test simulates, as closely as possible, the real conditions of a high-level aerobic composting facility whereas a full-scale facility (technical composting plant) has always by definition real conditions and treatment periods.

In practice plastic specimens of a given material are tested and from the laboratory results the disintegradability of any plastic product produced with that material, having equal or minor thickness, is inferred.

Due to the nature and analytical conditions of the disintegration test (ISO 16929) the test results cannot differentiate between biodegradation and abiotic disintegration but they are required to demonstrate that a sufficient disintegration of the plastic material is achieved within the specified treatment time of biowaste. By combining these observations with the information obtained from the laboratory tests it can be concluded whether a plastic material is sufficiently biodegradable under the

known conditions of biological waste treatment and whether complete biodegradation will happen with the use of the compost.

Pilot-scale composting tests are also suitable instruments for investigating any negative effects of the plastic material on the composting process if sufficient plastic material is introduced. This can be achieved by direct comparison of process parameters in reactors with and without plastic material.

The compost obtained at the end of the disintegration test may be used for analytical and biological quality control testing. When tests on ecotoxicity are performed it is important to use compost from disintegration tests which have been run with and without the plastic material to compare the test results directly and to find out any relative ecotoxic effects (see Clause 8).

NOTE 1 For the purpose of this European Standard it is sufficient to determine disintegration under aerobic composting conditions. If in a special case information on anaerobic treatability is required an anaerobic pilot-scale test or a test in a full-scale facility for solid waste treatment should be used.

NOTE 2 Special attention should be given to the visual aspects of compost. Visual contamination of compost, as evidenced by reduced aesthetic acceptability, should not be significantly increased by any post composting residues of plastic materials introduced.

8 Quality of the final compost

8.1 Rationale

As the quality of compost may be influenced by plastic materials added, it is preferable that evaluation of any possible environmental risk attaching to such compost, should be based upon the best criteria on compost quality available. This may be achieved, for example, by determination of the ecotoxicological effects of the biodegradation products of plastic materials or by performing ecotoxicological tests with compost produced with and without plastic materials and comparison of the test results (see A.4). Other methods for equal purpose and the pass levels required for the evaluation of the test results are, however, not yet established and need to be elaborated before they can be specified as reference methods for the purpose of this European Standard. Test methods and limit values based on such tests may be introduced into future revisions of this European Standard as more experience is gained.

The final compost has to fulfil European or in absence national requirements for compost quality which include analytical and biological tests.

8.2 Determination of negative effect

The supplier of a plastic material, designated as organically recoverable, on the market shall as a minimum establish by a process of direct comparison that the quality of compost produced by a given ”controlled waste treatment” process, as defined by the criteria listed below, is not negatively affected by the addition of that plastic material.

Physico-chemical parameters by which the compost quality shall be defined are:

- volumetric weight (density);
- total dry solids;
- volatile solids;
- salt content;
- pH;
- the presence of total nitrogen, ammonium nitrogen, phosphorus, magnesium and potassium.

Ecotoxic effects to 2 higher plants shall be determined by comparing compost produced with and without addition of plastic materials. The plant growth test OECD 208 shall be used with the modifications described in Annex D.

Annex A
(normative)

Evaluation criteria

A.1 Chemical characteristics

A.1.1 Volatile solids

Plastic materials shall contain a minimum of 50 % of volatile solids which exclude largely inert materials.

A.1.2 Heavy metals and other toxic and hazardous substances

The concentration of any substance listed in Table A.1, present in plastic materials, shall not exceed the value given in that table.

Table A.1 - Maximum element content of plastic materials

Element	mg/kg on dry substance	Element	mg/kg on dry substance
Zn	150	Cr	50
Cu	50	Mo	1
Ni	25,0	Se	0,75
Cd	0,5	As	5
Pb	50	F	100
Hg	0,5		

NOTE 1 It is assumed that 50 % of the original weight of the plastic material will remain in compost after biological treatment together with the complete original amount of hazardous substances. The limit values are based on ecological criteria for the award of the Community eco-label to soil improvers (EC OJL, 219, 7.8.98, p. 39) and are set at 50 % of the maximum concentration of those requirements.

NOTE 2 The table A.1 is not a exhaustive list of heavy metals in plastics, so it shall be fulfil always with the limits established in Directive 67/548 of 27 June 1967 on classifications, packaging an labelling of dangerous substances.

A.2 Biodegradability

A.2.1 Significant organic constituents

A.2.1.1 Given that biodegradability shall be determined for each plastic material, significant shall mean any organic constituent present in more than 1 % of dry weight of that material.

A.2.1.2 The total proportion of organic constituents, not tested on biodegradability, shall not exceed 5 %.

A.2.2 Aerobic biodegradation tests

A.2.2.1 The period of application for the test specified in the test methods shall be a maximum of 6 months.

A.2.2.2 For the plastic material the percentage of biodegradation shall be at least 90 % in total or 90 % of the maximum degradation of a suitable reference substance after a plateau has been reached for both plastic material and reference substance.

NOTE The limit value for biodegradation is based on conversion of the carbon of the test material into carbon dioxide and biomass. The details of calculation depend on the test and analytical methods used. The reference substance, a micro-crystalline cellulose powder, for example "Avicel", has to be degraded according to the validity criteria stated in the respective test methods.

A.2.3 Anaerobic biodegradation tests (optional)

A.2.3.1 Where required, the period of application for the test specified in the test methods shall be a maximum of 2 months.

A.2.3.2 The percentage of biodegradation based on biogas production shall be 50 % or more of the theoretical value for the plastic material.

NOTE The lower percentage of biodegradation is justified because in all commercially available biogasification plants the process scheme provides a second aerobic stabilization phase in which the biodegradation can further continue.

A.3 Disintegration

A.3.1 Aerobic composting

Following submission to the composting process for a maximum of twelve weeks, not more than 10 % of the original dry weight of the plastic material shall fail to pass through a < 2 mm fraction sieve.

A.3.2 Anaerobic biogasification (optional)

A.3.2.1 Where required, the test duration shall be a maximum of 5 weeks as a combination of anaerobic digestion and aerobic stabilization.

A.3.2.2 Following submission to the composting process as specified in A.3.2.1, not more than 10 % of the original dry weight of the plastic material shall fail to pass through a > 2 mm fraction sieve.

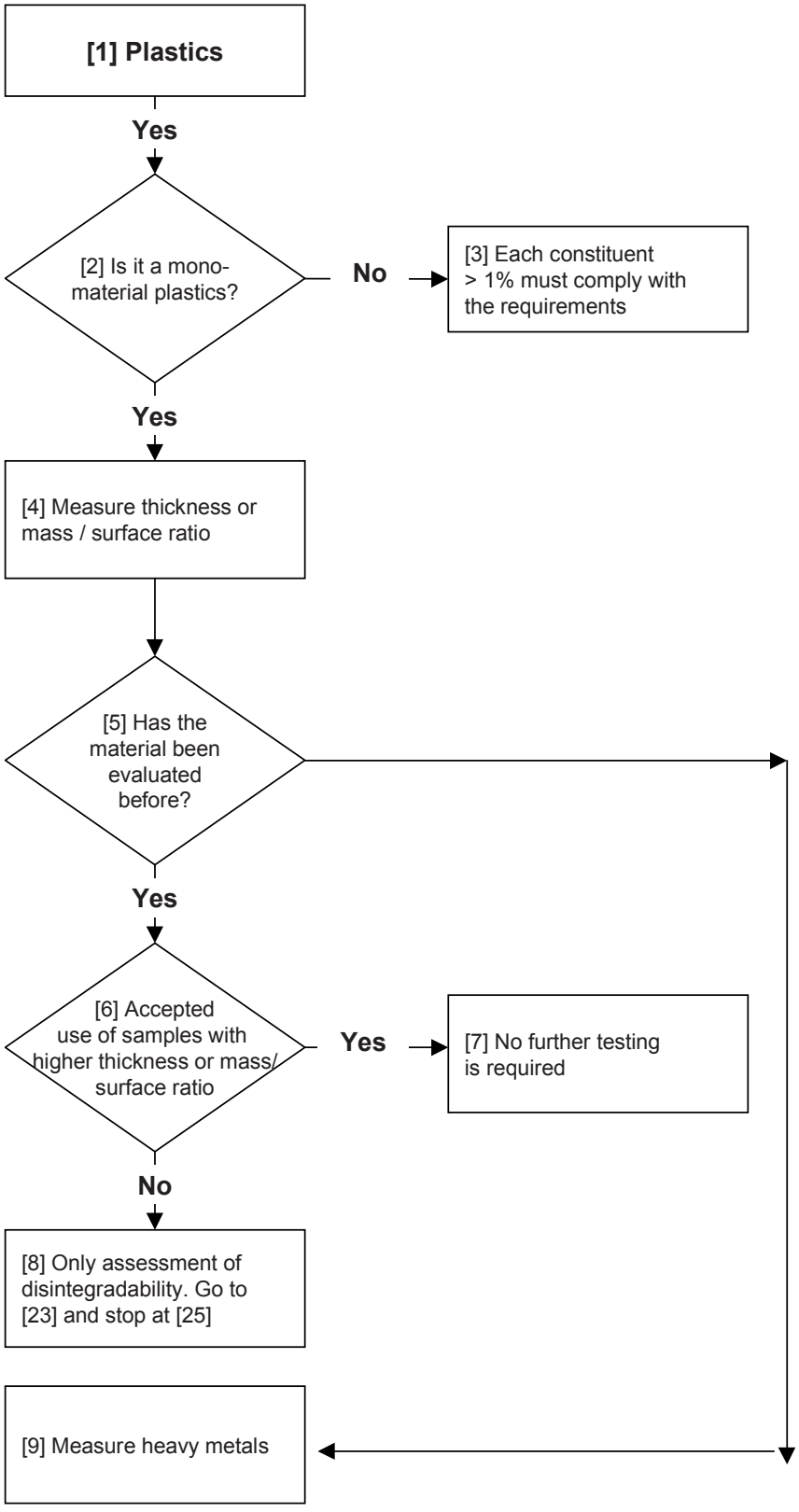
NOTE The limit values for disintegration and the test duration are based on present experience. It is anticipated that these may be confirmed or modified as necessary as a result of testing currently being carried out.

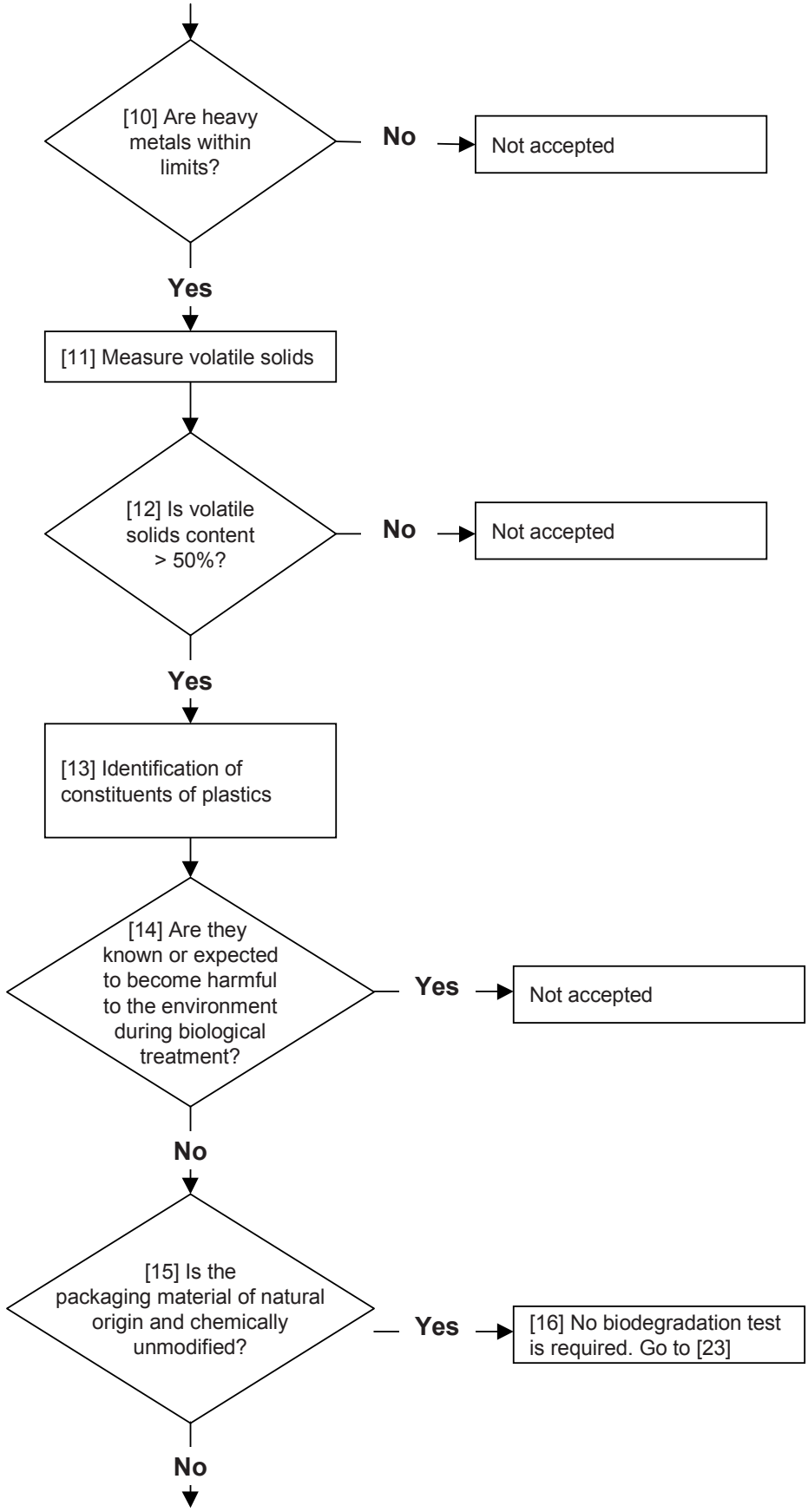
A.4 Ecotoxicity

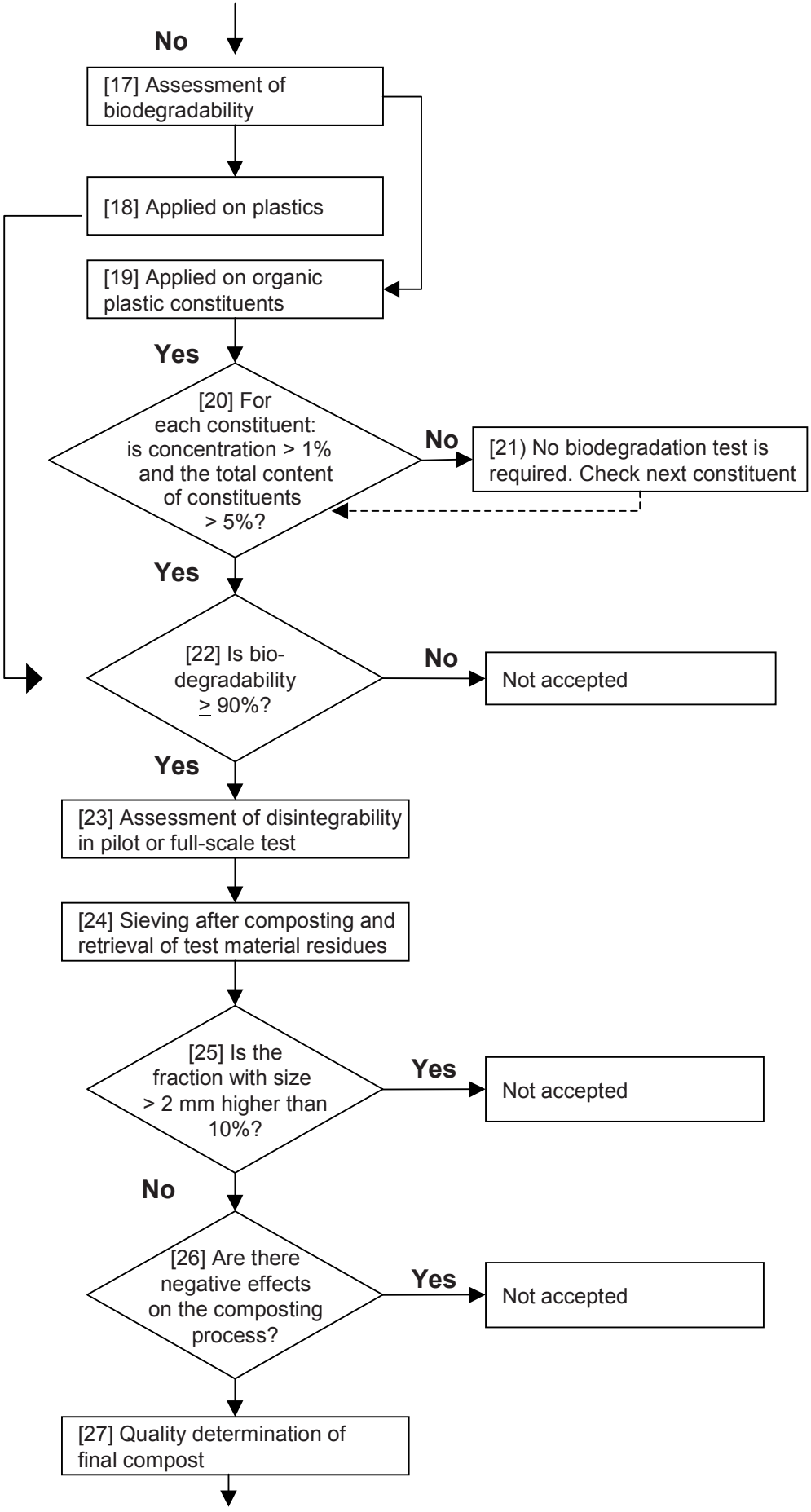
The germination rate and the plant biomass of the sample composts of both plant species should be more than 90 % of those from the corresponding blank compost (see Annex D).

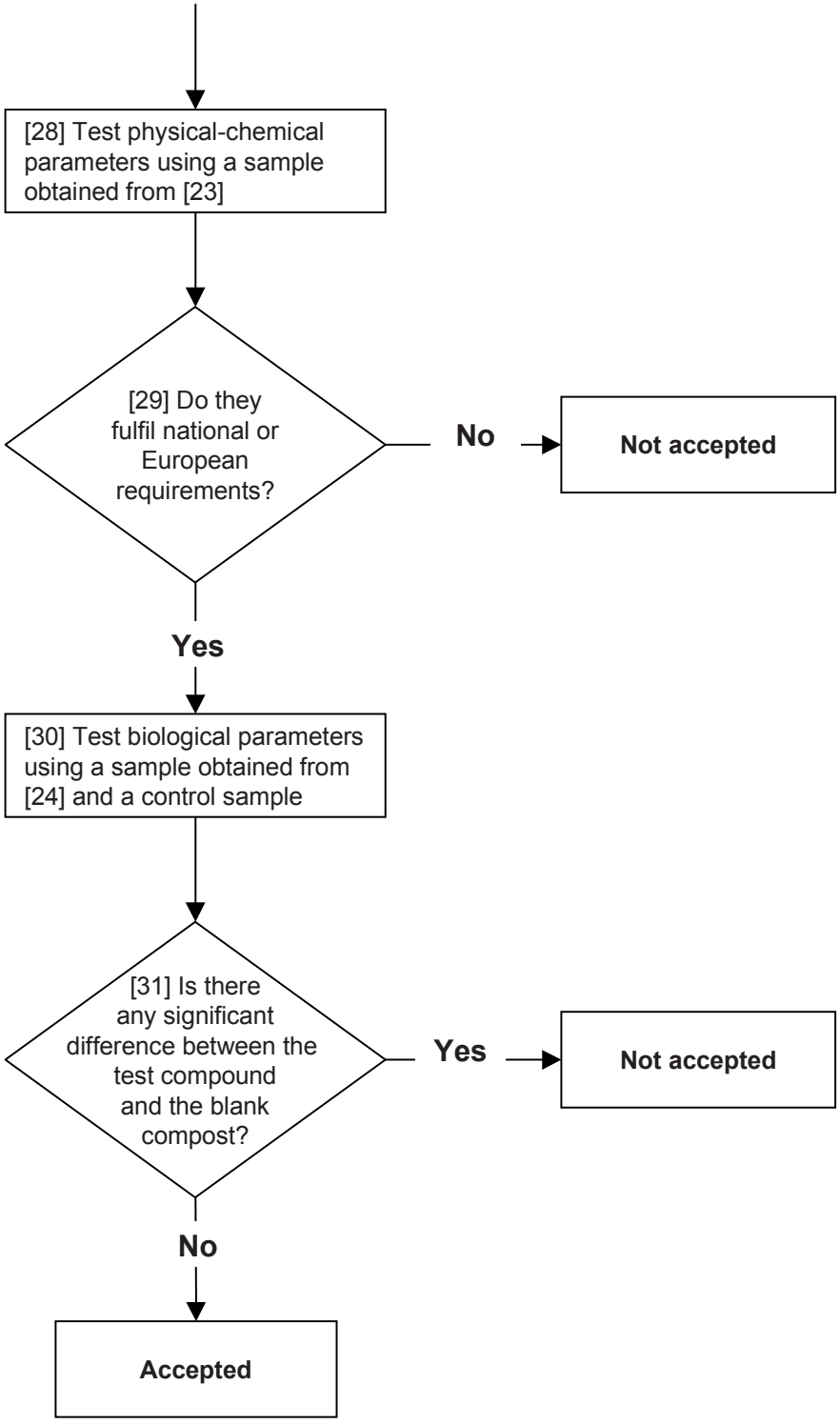
Annex B
(informative)

Flow chart of evaluation of organic recoverability of plastic materials









Annex C
(informative)

Prerequisites and quality of compost for evaluating composting of plastic materials

C.1 General

This annex describes prerequisites for plastic materials, from use to collection, prerequisites of compost and composting plants for the biological treatment of organically recoverable plastic materials. These prerequisites should be considered in advance of the market release of plactics intended for entering the biowaste stream even if they are not part of the analytical test procedure.

C.2 Prerequisites for composting of plastic materials

C.2.1 Composition

The plastic material should be biodegradable and in the final shape be compostable, meeting the criteria in this European Standard.

NOTE The fulfilment of the quality criteria for compost input material alone will not necessary lead into production of quality compost.

C.2.2 Products and their residues

If a compostable plastic material is used in close contact with other substances or products e.g. as packaging, in any case this substance or product could remain in parts or as a whole in the compostable plastic material after the normal use, the substances or products themselves should be compostable and not toxic or hazardous.

C.2.3 Grinding/shreeding

The shredding of used plastic material with machinery and procedures, commonly used in composting plants, should not be disturbed and should lead to particle sizes of less than 10 cm in the longest dimension, suitable for the composting process.

Annex D
(normative)

Determination of ecotoxic effects to higher plants

D.1 General

Basis for the determination is the OECD Guideline for testing of chemicals 208 "Terrestrial Plants, Growth Test". The principles of the standard test method have to be followed as well as the modifications given in this annex which are required to meet the special needs for testing compost samples.

D.2 Properties of the reference substrate

Any reference substrate is suitable if it allows a normal seed germination and plant growth. It should preferably have a composition and structure similar to the compost samples. Fertilisers shall not have been added.

Suitable reference substrates are all those which are defined by European national standards for analysis of compost quality, for example: standard soil EE0 (Bundesgütegemeinschaft Kompost e. V., Germany), mixtures of culture substrate with backed clay granules (ÖNORM S2023) or mixtures of peat and siliceous sand.

D.3 Preparation of samples

Prepare mixtures of the reference substrate with 25 % and 50 % (m/m or v/v, documented in the report) of compost. Use the compost obtained after disintegration of the plastic material (sample compost) and the blank compost, obtained from the parallel process without addition of plastic material.

D.4 Selection of plant species

Use at least 2 plant species from 2 of the 3 mentioned categories of OECD 208. Regard in addition summer barley (Hordeum vulgare) as 4th category.

D.5 Performing the tests

Fill each tray with a minimum of 200 g of the samples (D.3) and add as a minimum 100 seeds (D.4) on the top. Cover the seeds with a thin layer of inert material, such as siliceous sand or perlite. Perform the tests in three parallels for each mixture. Add water until 70 % to 100 % of the water holding capacity is reached. Supply evaporated water periodically during the whole test duration as needed.

NOTE It is of advantage to keep the trays at a dark place or cover them during the germination period.

D.6 Evaluation of the results

The germination numbers (number of grown plants) and the plant biomass of the sample compost and the blank compost are compared in all mixing rates. Germination rate and biomass are both calculated as per cent of the corresponding values obtained with the blank compost.

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[7] ÖNorm S 2201, *Compostable waste — Quality requirements*

[8] EN 13432*, Packaging — Requirements for packaging recoverable through composting and biodegradation — Test scheme and evaluation criteria for the final acceptance of packaging*

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[10] ISO/TR 15462, *Water quality — Selection of tests for biodegradability*

[11] ISO 15985, *Plastics — Determination of the ultimate anaerobic biodegradation and disintegration under high-solids anaerobic-digestion conditions — Method by analysis of released biogas*

[12] EN ISO 11734:1998, *Water quality — Evaluation of the "ultimate" anaerobic biodegradability of organic compounds in digested sludge — Method by measurement of the biogas production (ISO 11734:1995)*

[13] ISO 14853:2005, *Plastics — Determination of the ultimate anaerobic biodegradation of plastic materials in an aqueous system — Method by measurement of biogas production*

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