Designation: D 6002 – 96 (Reapproved 2002)ε1

# Standard Guide for Assessing the Compostability of Environmentally Degradable Plastics[1]

This standard is issued under the fixed designation D 6002; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε1 NOTE—Added Note 1 and Summary of Changes section in March 2002.

## 1. Scope *

1.1 This guide covers suggested criteria, procedures, and a general approach to establish the compostability of environmentally degradable plastics.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no similar or equivalent ISO standard.

## 2. Referenced Documents

2.1 *ASTM Standards:*

D 638 Test Method for Tensile Properties of Plastics[2]

D 882 Test Methods for Tensile Properties of Thin Plastic Sheeting[2]

D 883 Terminology Relating to Plastics[2]

D 3593 Test Method for Molecular Weight Averages/Distribution of Certain Polymers by Liquid Size-Exclusion Chromatography (Gel Permeation Chromatography (GPC)) Using Universal Calibration[3]

D 5152 Practice for Water Extraction of Residual Solids from Degraded Plastics for Toxicity Testing[4]

D 5209 Test Method for Determining the Aerobic Biodegradation of Plastic Materials in the Presence of Municipal Sewer Sludge[5]

D 5247 Test Method for Determining the Aerobic Biodegradability of Degradable Plastics by Specific Microorganisms[6]

D 5338 Test Method for Determining Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions[6]

D 5509 Practice for Exposing Plastics to a Simulated Compost Environment[6]

D 5512 Practice for Exposing Plastics to a Simulated Compost Environment Using an Externally Heated Reactor[6]

D 5951 Practice for Preparing Residual Solids Obtained After Biodegradability Standard Methods for Plastics in Solid Waste for Toxicity and Compost Quality Testing[6]

D 5988 Test Method for Determining the Aerobic Biodegradation in Soil of Plastic Materials or Residual Plastic Materials after Composting[6]

E 1440 Guide for an Acute Toxicity Test with the Rotifer Brachionus[7]

E 1720 Test Method for Determining Ready, Ultimate, Biodegradability of Organic Chemicals in a Sealed Vessel $CO_2$ Production Test[7]

G 22 Practice for Determining Resistance of Plastics to Bacteria[8]

2.2 *ORCA Document:*

Guidelines for the Evaluation of Feedstock for Source Separated Biowaste Composting and Biogasification[9]

2.3 *OECD Guidelines:*[10]

OECD Guideline 207 Earthworm, Acute Toxicity Tests

OECD Guideline 208 Terrestrial Plants, Growth Test

## 3. Terminology

3.1 *Definitions:*

3.1.1 *biodegradable plastic*—a degradable plastic in which the degradation results from the action of naturally occurring microorganisms such as bacteria, fungi, and algae. **D 883**

3.1.2 *compostable*—capable of undergoing biological decomposition in a compost site as part of an available program, such that the material is not visually distinguishable and breaks down into carbon dioxide, water, inorganic compounds, and biomass, at a rate consistent with known compostable materials.

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[1] This guide is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.96 on Environmentally Degradable Plastics.

Current edition approved August 10, 1996. Published October 1996.

[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Discontinued*—See 1992 *Annual Book of ASTM Standards*, Vol 08.03.

[4] Discontinued; see *1998 Annual Book of ASTM Standards*, Vol 08.03.

[5] Discontinued; see *1992 Annual Book of ASTM Standards*, Vol 08.03.

[6] *Annual Book of ASTM Standards*, Vol 08.03.

[7] *Annual Book of ASTM Standards*, Vol 11.05.

[8] Discontinued; see *2001 Annual Book of ASTM Standards*, Vol 14.04.

[9] Available from Organic Reclamation and Composting Association, Avenue E. Mounier 83, Box 1, B-1200 Brussels, Belgium.

[10] Available from Organization for Economic Development, Director of Information, 2 rue Andre' Pascal, 75775 Paris Cedex 16, France.

***A Summary of Changes section appears at the end of this standard.**

3.1.3 *composting*—a managed process that controls the biological decomposition and transformation of biodegradable material into a humus-like substance called compost; the aerobic mesophilic and thermophilic degradation of organic matter to make compost; the transformation of biologically decomposable material through a controlled process of bio-oxidation that proceeds through mesophilic and thermophilic phases and results in the production of carbon dioxide, water, minerals, and stabilized organic matter (compost or humus). Composting uses a natural process to stabilize mixed decomposable organic material recovered from municipal solid waste, yard trimmings, biosolids (digested sewage sludge), certain industrial residues, and commercial residues **(1)**.[11]

3.1.4 *degradable plastic*—a plastic designed to undergo a significant change in its chemical structure under specific environmental conditions, resulting in a loss of some properties that may be measured by standard methods appropriate to the plastic and the application in a period of time that determines its classification. **D 883**

3.1.5 *mesophilic phase*—the phase of composting that occurs between 20 and 45°C (68 and 113°F) **(1)**.

3.1.6 *plastic*—a material that contains as an essential ingredient one or more organic polymeric substances of large molecular weight, is solid in its finished state, and, at some stage in its manufacture or processing into finished articles, can be shaped by flow. **D 883**

3.1.7 *polymer*—a substance consisting of molecules characterized by the repetition (neglecting ends, branch junctions, and other minor irregularities) of one or more types of monomeric units. **D 883**

3.1.8 *thermophilic phase*—the phase in the composting process that occurs between 45 and 75°C (113 and 167°F); it is associated with specific colonies of microorganisms that accomplish a high rate of decomposition **(1)**.

## 4. Summary of Guide

4.1 This guide uses a tiered criteria-based approach to assess the compostability of environmentally degradable plastic products (processed material containing polymeric materials, processing additives, and other additives required to meet performance requirements).

4.1.1 This guide includes methods that simulate mesophilic and thermophilic conditions that are representative of composting processes and compost end use.

4.1.2 The tiers progress from rapid screening of polymeric materials and other organic components to relatively longterm, more complex/higher cost evaluations. This guide will allow one to focus the correct level of resources on materials of greatest interest and potential.

4.1.3 Each tier in this guide includes objectives and a summary that presents potential test methods, method principles, test duration, implication of results, and suggested priority.

NOTE 2—The availability of other test methods appropriate for this guide is acknowledged.

NOTE 3—See Fig. 1 for a description of this guide in flow-chart form.

## 5. Significance and Use

5.1 Plastics that are designed to degrade after use have been developed. These materials are intended to enhance existing solid waste landfill diversion programs by allowing difficult to recycle materials to be collected and processed in alternative solid waste disposal systems. Composting has emerged as a viable approach to process these materials and the organic fraction of municipal solid waste (MSW). A comprehensive testing program is needed to establish the compostability (for example, fragmentation rate, biodegradation rate, and safety) of these materials.

5.2 This guide can be adapted to generate product-specific evidence for the substantiation of compostable claims to obtain classification as a compostable product.

NOTE 4—State and local regulations should also be considered.

## 6. Tier 1: Rapid Screening Tests

6.1 In this tier, rapid screening level studies are performed, under mesophilic conditions, to obtain information unavailable from literature review. The objectives are as follows:

6.1.1 To determine whether biodegradation of polymeric materials and other organic components in the plastic product can occur. Biodegradation is based on carbon dioxide production.

6.1.2 To expand understanding of the degradation mechanism.

NOTE 5—A positive result in Tier 1 tests is not required to demonstrate the compostability of product components. Components which fail Tier 1 tests might prove successful in Tier 2 composting tests. If a component fails Tier 1, but is still considered promising, it should advance to Tier 2. Likewise, a promising component could enter the test strategy directly at Tier 2.

NOTE 6—Chemical analysis, (for example, regulated heavy metals) of product component may be appropriate prior to initiation of testing.

6.2 The following test methods are suggested for initial screening of polymeric materials, monomeric subunits of the polymer, and other organic components.

6.2.1 *Test Method D 5209 (Sturm Test)*—This aqueous test method uses a fresh sample of activated sewage sludge that has been aerated, homogenized, and settled. The supernatant is used as the inoculum. It contains primarily a mixed bacterial population that promotes rapid biodegradation under mesophilic conditions. The metabolism of test materials produces $CO_2$, which is trapped in alkali solution and quantitated by titration. The test length is typically 30 days, but it can be extended if the medium is reinoculated. A positive result (recovery of 60 % + of theoretical $CO_2$) usually indicates that the material will also biodegrade in a composting environment. A negative result should be confirmed by a laboratory thermophilic composting test such as Test Method D 5338. The contribution of nonmicrobial degradation can be quantified by including sterile or poison controls and comparing changes in molecular weight or mass.

6.2.2 *Soil Contact Test (Test Method D 5988)*—This static test uses a defined sand/soil/mature compost matrix to provide a consortium of mesophilic and thermophilic bacteria and fungi. Biodegradation is measured in a manner similar to the

[11] The boldface numbers in parentheses refer to the list of references at the end of this guide.

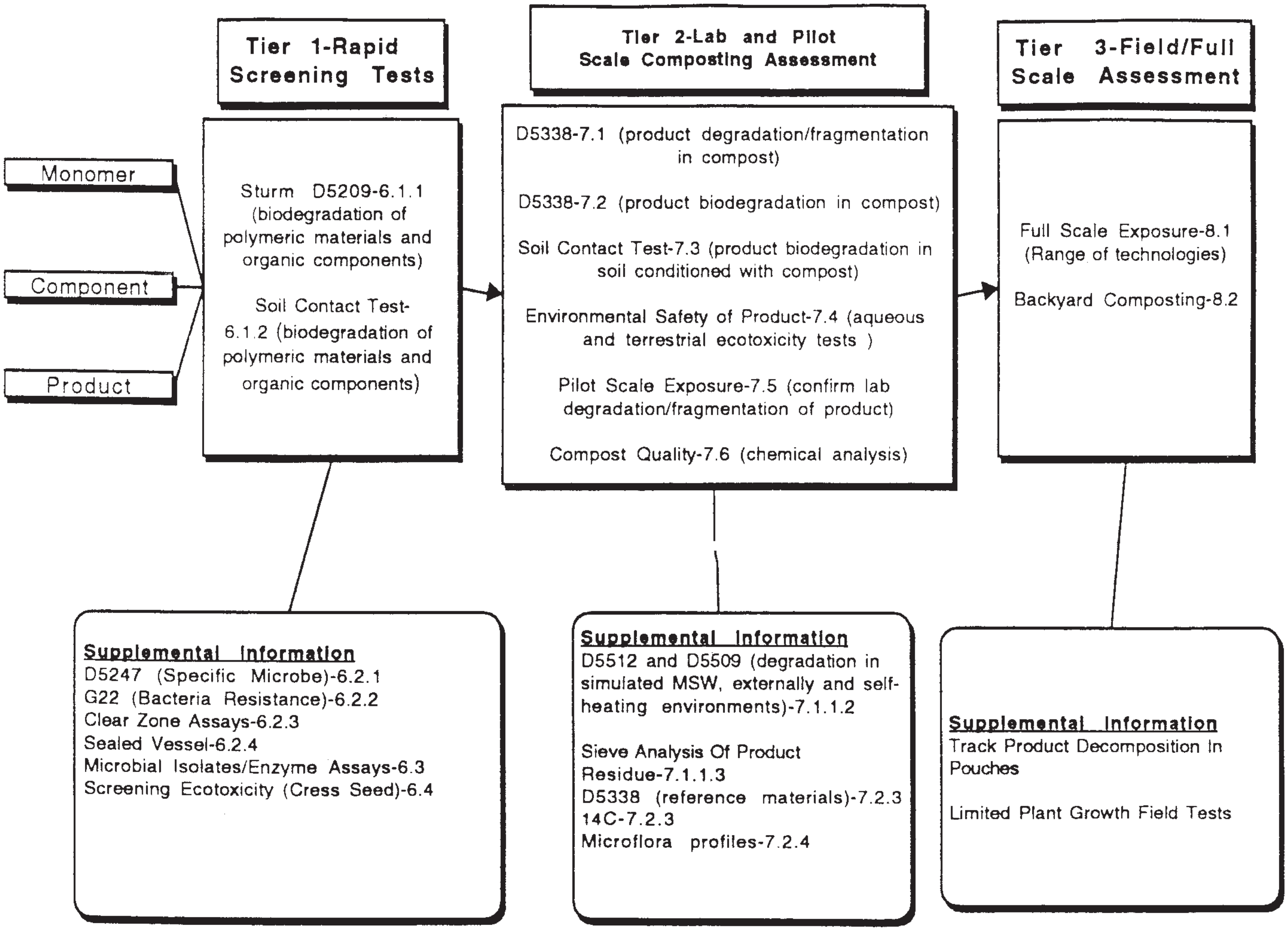


FIG. 1 Flow-Chart of Guide D 6002

Sturm test, based on the amount of material carbon converted to gaseous carbon ($CO_2$). Readily biodegradable materials can be screened in 30 to 60 days. A negative result should be confirmed under thermophilic composting conditions (Test Method D 5338).

6.3 The following test methods can be used to obtain additional information regarding the inherent biodegradability or degradability of materials.

6.3.1 *Test Method D 5247 (Specific Microbe Test)*—This aqueous test method uses pure microbial cultures to assess the biodegradability of materials under mesophilic conditions, based on weight loss or molecular weight changes. The test duration is 7 to 14 days. Microbes indigenous to the composting or soil environment can be evaluated with this test method.

6.3.2 *Practice G 22 (Bacteria Growth Resistance)*—With this test, solid materials are placed in inoculated molten agar, and the extent of microbial growth is rated. The test duration is approximately 14 days. A positive result indicates that the test material is potentially biodegradable.

6.3.3 *Clear Zone Assays*—Opaque test material is dispersed into solid agar. A given quantity of microorganisms is applied to form a lawn. Degradation of a material is indicated by the formation of clear zones in the solid medium. The test duration is 3 to 14 days. A positive result indicates that the test material is potentially biodegradable. Microbes indigenous to the composting or soil environment can be evaluated with this test method. The biodegradability of nonopaque organic materials can be assessed by adding the indicator 2,3,5-triphenyltetrazolium chloride (TTC) to the media. If microbial colonies can oxidize the material, their electron transport pathways will reduce the TTC. Reduced TTC is detected by its deep red color, whereas oxidized TTC is colorless **(2)**.

6.3.4 *Sealed Vessel Test (Test Method E 1720)*—Ready aerobic biodegradability of organic materials is assessed in small, sealed vessels inoculated with sewage microbes. Gaseous $CO_2$ is monitored by head space analysis. This test method represents a simpler approach relative to Test Method D 5209 (Sturm). A positive result (60 % + ) usually indicates that the material will also biodegrade in a composting environment.

6.4 If it appears that a material is being colonized or used as a growth substrate by microorganisms, a more fundamental understanding of the degradation process can be obtained. This typically involves the preparation of purified microbial cultures capable of using the material as a carbon source. The pure cultures can then be used for the isolation and characterization of cellular enzyme systems contributing to degradation of the material **(3)**.

6.5 The potential effect of materials on plant germination may be assessed with the cress seed test. This step may be especially valuable for screening processing additives used at 1 % or less in the plastic. Soils from the above soil contact test (6.2.2) may be evaluated at the beginning and end of the test to establish the potential effect of microbial degradation products. In the cress test, soil or compost is extracted with water and filtered. The supernatant is used for the germination test. Various dilutions of the supernatant are prepared, and aliquots are added to petri dishes lined with filter paper. Cress seeds are placed on the wet paper and left to germinate in the dark over 4 days at room temperature. The percentage of germinated seeds is determined after 4 days and compared to a water control. Soils containing test materials should not be significantly different from the blank soil at 95 % confidence interval.

## 7. Tier 2: Laboratory and Pilot Scale Composting Assessment

7.1 The objectives of this tier are as follows:

7.1.1 To establish the degradation rate (change in chemical structure, decrease in mechanical strength, fragmentation, or weight loss) of the polymeric material or plastic product under laboratory-scale thermophilic composting conditions.

7.1.2 To confirm the biodegradability of the plastic product and other organic components in the product under laboratory scale thermophilic composting conditions.

7.1.3 To determine whether organic residues continue to biodegrade in a laboratory-scale simulation of compost-amended soil.

7.1.4 To obtain additional evidence with regard to a plastic product's or component's environmental safety using compost obtained from laboratory-scale studies.

7.1.5 To establish the degradation rate of a plastic product or finished article under pilot scale composting conditions prior to the full-scale composting studies described in Tier 3.

7.2 The following test methods are suggested for establishing the degradation rate of polymeric materials or plastic products under laboratory-scale composting conditions.

7.2.1 The degradation rate of test materials under laboratory thermophilic composting conditions may be obtained by performing Test Method D 5338 without the $CO_2$ trapping component. The test materials are exposed to an inoculum that is derived from stabilized compost from municipal solid waste.

7.2.1.1 Aerobic composting occurs in an environment in which temperature, aeration, and humidity are monitored and controlled closely. The degradation rate of materials may be established with the current Test Method D 5338 temperature profile or constant 58°C, which has been adopted by the European standards organization, CEN. The test duration is 45 days, but it may be extended to simulate field conditions. At various time intervals, materials may be removed from the compost, cleaned, and dried.

7.2.1.2 Changes in material chemical structure may be quantitated based on molecular weight distribution (Test Method D 3593). More sophisticated techniques such as Fourier transform infrared (FTIR) and nuclear magnetic resonance may also be appropriate **(4)**.

7.2.1.3 Loss of material integrity due to material degradation may be quantitated by using Test Methods D 882 for thin films or Test Method D 638 for sheet. Material degradation may also be established based on weight loss. Surface damage may be evaluated using tools such as Scanning Electron Microscopy (SEM).

7.2.1.4 Degradation rates of materials may also be established using simulated MSW matrixes in externally heated and self-heating controlled laboratory-scale composting environments in accordance with Practices D 5509 and D 5512.

7.2.1.5 Sieve analysis can be included in the above tests to obtain additional fragmentation information. Compost containing fragmented material may be passed through a U.S. Standard Sieve[12] with a ⅜-in. (9.51-mm) opening. This simulates the final screening step used to produce high-quality compost products. National, state, and local regulatory requirements should also be consulted.

NOTE 7—Agitation from compost turning equipment at full-scale facilities may give faster fragmentation rates relative to laboratory-scale methods.

7.3 The following test methods are suggested for establishing the biodegradation rate of a plastic product, polymeric materials in the product, and other organic components in a composting environment.

7.3.1 Test Method D 5338 is suggested for establishing the biodegradability of organic components in a plastic product in a composting environment. Material biodegradability is based on the amount of material carbon recovered as gaseous carbon ($CO_2$) relative to the amount of material carbon originally added to the compost. Product organic components, at levels of 1 % or less, generally do not require retesting in this step if a positive result was obtained in Tier 1 (6.2). This test can be performed separately or concurrently with (7.2). Biodegradation rates or end points should meet national, state, or local regulations or be compared to the reference materials described in 7.3.2.

7.3.1.1 If a negative result is obtained, check the controls described in the test method or repeat the test method with a lower dose closer to field-use levels (assuming that an acceptable signal:noise ratio is possible).

7.3.2 Products or components may be compared under identical conditions to natural reference materials known to be biodegradable in a composting environment (for example, cellulose or starch (see Guidelines for the Evaluation of Feedstock for Source Separated Biowaste Composting and Biogasification)). Other materials regarded as biodegradable in a composting environment are oak, maple, and corn leaves and kraft paper **(5)**. Unmodified polyethylene film, typically used to collect yard trimmings, is generally considered a negative reference material.

7.3.3 The recovery of all material carbon as gaseous carbon ($CO_2$) may be impractical due to the incorporation of material carbon into microbial biomass or stable humic substances.[14] Carbon labelled materials may allow carbon to be partitioned into $CO_2$-C, residue-C, water soluble-C, and microbial biomass-C to obtain a complete mass balance. The use of radio-labelled materials allows testing at field-use levels in

[12] Available from W. S. Tyler Co., Cleveland, OH.

composts with high background $CO_2$. However, these definitive studies are comparatively expensive.

NOTE 8—An ASTM standard method for $^{14}$C-labelled materials is not available.

7.3.4 The effect of a material on compost microorganisms may be evaluated as described by Schwab, et al **(6)**.

7.4 The following test methods are suggested for establishing the rate at which plastic product organic components continue to biodegrade in compost conditioned soil.

7.4.1 If incomplete biodegradation is indicated in 7.3, the biodegradability of product or component residue in soil may be established with the soil contact method cited in 6.2.2. The test duration should be a minimum of 6 months or until a regulatory specification is attained or results support the calculation of a rate as indicated by the lack of a plateau.

7.4.2 Materials from 7.3.2 can also be evaluated in soil to obtain additional comparative data.

7.4.3 Composts should be prepared in accordance with the Bridging Practice of Practice D 5951 prior to the soil studies.

7.5 The plastic product should not cause any negative ecotoxilogical effects on the resulting compost. The following terrestrial and aquatic ecotoxicity tests are suggested for obtaining evidence regarding product effects on plant and animal life. National, state, and local regulatory requirements should be considered.

NOTE 9—The test material dose specified in laboratory methods, such as Test Method D 5338, is much higher than levels expected to be released into the environment. Ecotoxicity is concentration dependent. If a negative effect is observed, additional testing is suggested based on predicted exposure levels.

7.5.1 Compost from 7.3 should be prepared in accordance with Practice D 5152 or D 5951 prior to performing ecotoxicity tests.

7.5.2 The following ecotoxicity tests are suggested as a minimum prior to proceeding to pilot and full-scale testing:

7.5.2.1 Aquatic toxicity test with rotifer Brachionus in accordance with Guide E 1440. The test duration is one day.

7.5.2.2 Plant germination as described by the cress seed test in 6.5. The test duration is four days.

7.5.2.3 Plant growth test as described by OECD Guideline 208. This procedure determines phytotoxicity by mixing the compost containing the material with soil. The plant emergence survival and growth is evaluated. Three plant species are generally tested. The test duration is approximately 1 month. The results from compost containing material are compared to compost without material and a soil control.

7.5.2.4 Earthworm test in accordance with OECD Guideline 207. This procedure determines possible toxicity by mixing the compost containing the material with a specified soil. The earthworm weight change and survival are measured. The results from compost containing material are compared to compost without material and soil controls.

7.6 Pilot-scale investigations are intended to confirm the results from laboratory-scale composting tests. These tests may be used to evaluate the practical processibility, at anticipated field use levels, of a plastic product or full-sized article by simulating larger-scale operating conditions (see Guidelines for the Evaluation of Feedstock for Source Separated Biowaste Composting and Biogasification). Pilot-scale tests may also be used to establish the impact of different waste matrixes on the degradation of a material **(6)**.

7.6.1 A standard ASTM pilot-scale test method has not been developed. Pilot-scale systems ranging from relatively simple to complex have been constructed by industry **(6)** and commercial testing laboratories. Some systems include rotating drums (manual or mechanical) to simulate full-scale feedstock homogenization and composting process initiation. Some systems control feedstock aeration and temperature. Vessel sizes range from 30 to 200 L. All systems are self-heating. The duration of the thermophilic composting phase ranges from a few days to a few weeks.

7.6.2 Externally heated pilot-scale systems may be required to simulate thermophilic conditions characteristic of full-scale processes.

7.6.3 Product degradation, safety, and microflora changes may be measured with the techniques described in 7.2, 7.3.4, and 7.5.

7.7 In addition to ecotoxicity, a product may not have a negative effect on the quality of the compost based on standard chemical and physical tests. National, state, and local regulation should be consulted.

7.7.1 The quality of pilot-scale composts containing degraded plastic should be compared to pilot-scale plastic-free composts based on chemical analysis. Suggested analyses include Environmental Protection Agency (EPA) 503 heavy metals, pH, compost maturity, density, porosity, and conductivity as described in Refs **(1, 7)**.

## 8. Tier 3: Field/Full-Scale Assessment

8.1 In this tier, the compostability of products in the field is established based on full-scale composting studies and backyard composting environments. The backyard studies have been included in response to current Federal Trade Commission (FTC) marketing guidelines **(8)**.

8.2 The field assessment of products in full-scale systems should include a range of technologies. Technologies range from unmanaged piles (municipal yard waste) to turned aerated static piles with temperature control to tunnel/agitated bay systems with temperature control. Consult Ref **(9)** to obtain descriptions of facility technologies in the United States. The need for full-scale assessment may be reduced as composters, solid waste managers, and degradable plastic product suppliers gain experience with their products.

8.2.1 Ideally, product should be added to the feedstock at anticipated exposure levels and be exposed to the entire process to establish the compatibility with turning equipment and to ensure that the product is not screened off early in the process. Other goals are to ensure that the product does not have an adverse effect on the process (that is, biological activities, litter, odor, pH, etc.) and that the product is not visually distinguishable after curing and final processing is completed.

8.2.2 A useful technique for quantitating the degradation rate in full-scale systems that do not grind feedstock is the placement of fiberglass pouches containing the product in the feedstock. The pouches may be removed periodically to measure the fragmentation rate and quantify product degradation as described in 7.2.

8.2.2.1 A full-scale procedure that includes use of the pouches has been developed by the ASTM Institute for Standard Research Degradable Polymer Advisory Committee. The procedure may be submitted to ASTM for standardization.

8.2.3 Limited plant growth studies are also suggested using compost containing degradable products. The intent of these studies is to confirm previous laboratory/pilot-scale results.

8.3 According to the FTC marketing guidelines **(8)**, an unqualified compostable claim is considered deceptive if the product is not compostable in a "home" or "backyard" environment.

8.3.1 The compostability of products in backyard composting environments can be established if desired. The composting process tends to be slower due to a relatively short thermophilic composting phase. Loss of heat due to the relatively small pile or bin size is a significant factor. The approach described in 7.6 and 7.7 will probably provide sufficient evidence.

8.3.2 The compostability of products should be established in both bins and freestanding piles based on typical home composting practices.

NOTE 10—Guidelines for best management practices under backyard composting environments can be obtained from the Composting Council **(1)**.

## 9. Report

9.1 The report should summarize the results from all three tiers. The report should contain a conclusion regarding the compostability (fragmentation, biodegradation, and safety) of the product based on the "weight of evidence."

## 10. Keywords

10.1 biodegradation; compostable; composting; degradable; plastic; polymer; strategy; toxicity

## REFERENCES


(**1**) *Compost Facility Operating Guide*, Composting Council, Alexandria, VA, 1995.

(**2**) Skipper, H. D., et al, "Microbial Degradation of Herbicides," *Research Methods in Weed Science*, 1989, pp. 457–462.

(**3**) Jendrossek, D., et al, "Degradation of Poly(3-hydroxybutyrate), PHB, by Bacteria and Purification of a Novel PHB Depolymerase from *Comamonas* sp.," *Journal of Environmental Polymer Degradation*, Vol 1, 1993, pp. 53–63.

(**4**) Seal, K. J., "Test Methods and Standards for Biodegradable Plastics," *Chemistry and Technology of Biodegradable Polymers*, G. L. Griffin, ed., Blackie Academic and Professional, Bishopbriggs, Glasgow, 1994, pp. 116–134.

(**5**) "Toward Common Ground," *Proceedings of the International Workshop on Biodegradability*, Institute for Local Self-Reliance, Washington, DC, 1992.

(**6**) Schwab, et al, "Characterization of Compost from a Pilot Plant-Scale Composter Utilizing Simulated Solid Waste," *Waste Management and Research*, Vol 12, 1994, pp. 289–303.

(**7**) *Recommended Test Methods for the Examination of Compost and Composting*, Composting Council, Alexandria, VA, 1993.

(**8**) *Guidelines for the Use of Environmental Marketing Claims*, Federal Trade Commission, Washington, DC, 1992.

(**9**) *U.S. Solid Waste Composting Facility Profiles*, Vol II, National Composting Program, United Conference of Mayors, Washington, DC, 1993.

(**10**) Zucconi, et al, "Cress Seed Germination Bioassay," *Bicycle*, March/April 1981.


## SUMMARY OF CHANGES

This section identifies the location of selected changes to this guide. For the convenience of the user, Committee D20 has highlighted those changes that may impact the use of this guide. This section may also include descriptions of the changes or reasons for the changes, or both.

*D 6002 – 96 (2002)$^{\epsilon 1}$:*

(*1*) Added Note 1.

(*2*) Added Summary of Changes section.