Designation: D 7209 – 06

Standard Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products[1]

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1. Scope

1.1 This guide provides information for the development of standards (guides, practices, terminology, test methods, or specifications) relating to plastics recycling and other means of waste reductions and resource recovery.

1.2 This guide is directed to consumer, commercial, and industrial sources of thermoplastics and thermoset polymeric materials.

1.3 This guide addresses terminology, performance standards, specifications, quality assurance, separation or segregation of product by classes, identification and marking of generic classes, contaminants, fillers, designing for recycle, degradable products, reconstituted products, biobased resins, certification and percentages of recycled products, and other methods of waste reduction and resource recovery.

1.4 This guide does not address parameters or factors involving the original manufacture of virgin polymers or the fabrication of consumer products from these virgin polymers.

1.5 This guide is intended to replace Guide D 5033.

1.6 *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 equivalent ISO standard. ISO/DIS 15270 is similar in scope and content.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 883 Terminology Relating to Plastics

D 1600 Terminology for Abbreviated Terms Relating to Plastics

D 1972 Practice for Generic Marking of Plastic Products

D 2665 Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

D 5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics

2.2 *Federal Standards:*[3]

16 CFR Part 260 Guides for the Use of Environmental Marketing Claims

2.3 *ISO/IEC Standards:*[4]

ISO/DIS 15270 Guide for Recovery

3. Terminology

3.1 *Definitions:*

3.1.1 *agglomerate*, *n*—shredded or granulated plastics material or both in the form of particles that cling together.

3.1.2 *bale*, *n*—plastics waste that is compacted and secured as a bundle to facilitate handling, storage, and transportation.

3.1.3 *batch*, *n*—quantity of material regarded as a single unit and having a unique reference.

3.1.4 *biobased resin*, *n*—resin in which carbon is derived from a renewable resource by means of biological processes and the environmental benefits of the biobased resin are demonstrated and this includes resins derived from plant resources (such as starch or cellulose) or those produced by microbial fermentation.

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

3.1.6 *biodegradation*, *n*—degradation caused by biological activity, especially by enzymatic action leading to a significant change in the chemical structure of a material.

3.1.7 *certificate of composition disclosure*, *n*—certificate describing certain properties of a recycled material from an external source, its formulation and source, and the specific material shipment to which it applies.

3.1.7.1 *Discussion*—Examples include polymer, molecular weight, percentage of inorganic material, contamination type

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

and level, strength, modulus, impact, and other mechanical properties; code or designation identifying the formulation and source information.

3.1.8 *chemical recycling*, *v*—processing of waste material, with significant change to the chemical structure of the material (such as cracking, gasification, and depolymerization), but excluding energy recovery or incineration.

3.1.9 *chips*, *n*—see *regrind*.

3.1.9.1 *Discussion*—Chips is a deprecated term.

3.1.10 *collection*, *n*—logistical process of moving (plastics) waste from its source to a place where it can be recovered.

3.1.11 *commingled plastics*, *n*—mixture of materials or products consisting of different types of plastics.

3.1.12 *compostable plastic*, *n*—plastic that undergoes degradation by biological processes during composting to yield carbon dioxide, water, inorganic compounds, and biomass at a rate consistent with other known, compostable materials and leaves no visually distinguishable or toxic residue.

3.1.13 *contaminant*, *n*—unwanted substance or material defined according to the intended use.

3.1.14 *converting*, *v*—shaping plastics raw material to make a usable semifinished or finished product.

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

3.1.15.1 *Discussion*—Types of degradable plastics include biodegradable, hydrolytically degradable, oxidatively degradable, and photodegradable. Refer to Terminology D 883 for definitions.

3.1.16 *depolymerization*, *n*—chemical reversion of a polymer to its monomer(s) or a polymer of lower relative molecular mass.

3.1.17 *energy recovery*, *n*—use of combustible waste as a means to generate energy through direct incineration with or without other waste but with recovery of the heat.

3.1.18 *environmental aspects*, *n*—element of an organization's activities, products, or services that can interact with the environment.

3.1.19 *environmental impact*, *n*—any change to the environment, whether adverse or beneficial, wholly or partially, resulting from an organization's activities or products.

3.1.20 *feedstock (chemical) recycling*, *v*—processing of plastics material resulting in significant change to the chemical structure of the material (such as cracking, gasification, and depolymerization), excluding energy recovery or incineration.

3.1.21 *flake*, *n*—plate-like regrind.

3.1.21.1 *Discussion*—The shape of regrind depends on the shape of the product being processed and the regrind process used.

3.1.22 *fluff*, *n*—filament-like regrind.

3.1.22.1 *Discussion*—Common usage of the term fluff also includes shredder residue fractions produced in the commercial recycling of durable goods such as automobiles.

3.1.23 *heterogeneity*, *n*—degree to which a constituent or a property or both is not uniformly distributed throughout a relevant quantity of plastics material.

3.1.23.1 *Discussion*—A material may be homogeneous with respect to one constituent or property but heterogeneous with respect to another.

3.1.24 *homogenizing*, *v*—processing to improve the degree to which a constituent or property or both is uniformly distributed throughout a quantity of plastics material.

3.1.25 *hydrolytically degradable*, *adj*—degradable plastic in which the degradation results from hydrolysis.

3.1.26 *impurity*, *n*—see *contaminant*.

3.1.26.1 *Discussion*—Impurity is a deprecated term.

3.1.27 *industrial rework*, *n*—rework generated by a different company or manufacturing plant from the company or manufacturing plant producing the products to this specification and the composition is known by the industrial source of the material.

3.1.27.1 *Discussion*—The material shall not be purchased from a third party (for example, grinding, repackaging facility) unless there is a documented system in place to ensure that the material is clean, free of contamination, and is of a single source and single material compound. Postconsumer recycled material is not industrial rework and is prohibited from use in products within Specification D 2665.

3.1.28 *landfill*, *n*—waste disposal site for the deposit of waste onto or into land under controlled or regulated conditions.

3.1.29 *lot*, *n*—definite quantity of some commodity manufactured or produced under conditions that are presumed uniform.

3.1.29.1 *Discussion*—Lot is primarily a commercial term.

3.1.30 *material recovery*, *n*—material processing operations including mechanical recycling, feedstock (chemical) recycling, and organic recycling, but excluding energy recovery.

3.1.30.1 *Discussion*—see also *recovery*.

3.1.31 *mechanical recycling*, *v*—processing of plastics waste into secondary raw material or products without significantly changing the chemical structure of the material.

3.1.31.1 *Discussion*—Plastics secondary raw material is a synonym of recyclate.

3.1.32 *micronizing*, *v*—process by which plastics material is finely ground into powder.

3.1.33 *off-grade material*, *n*—polymer or plastics material of composition that is not represented to meet its manufacturer's specification.

3.1.34 *organic recycling*, *n*—aerobic, that is, composting, or anaerobic (biomethanization) treatment of biodegradable plastic under controlled conditions using microorganisms to produce stabilized organic residues, methane, and carbon dioxide.

3.1.35 *oxidatively degradable plastic*, *n*—degradable plastic in which the degradation results primarily from oxidation.

3.1.36 *photodegradable plastic*, *n*—degradable plastic in which the degradation results primarily from the action of natural daylight.

3.1.37 *plastics recycling*, *n*—process by which plastic materials or products that would otherwise become solid waste are collected, processed, and returned to use in plastic products

that have fulfilled their intended purpose or can no longer be used; this includes material returned from within the distribution chain.

3.1.38 *plastics waste*, *n*—any plastics material or object that the holder discards, or intends to discard, or is required to discard.

3.1.39 *postconsumer material*, *n*—plastics material, generated by the end users of products that has fulfilled its intended purpose or can no longer be used, this includes material returned from within the distribution chain.

3.1.39.1 *Discussion*—Postconsumer material is part of the broader category of recovered material. Postconsumer plastics may come from households or commercial, industrial, and institutional facilities in their role as end users of a product. Some entities use the term "postcommercial" to identify substantial amounts of similar or identical postcommercial material from a nonhousehold source. Another term for postconsumer plastic is "postconsumer resin."

3.1.40 *preconsumer plastics material*, *n*—plastics material that has been diverted from the waste stream before reaching the consumer, but excluding reutilization of material such as rework, regrind, or scrap generated in the process and capable of being reclaimed within the same process.

3.1.41 *purge material*, *n*—material resulting from the passing of polymer through plastics processing equipment for the purpose of cleaning the equipment or when changing from one polymer to another or from one color or grade of polymer to another.

3.1.42 *reconstituted plastic*, *n*—material made by chemical or thermal breakdown of plastics scrap into basic components followed by their chemical conversion into a suitable composition.

3.1.43 *recovered material*, *n*—(plastics) materials and by-products that have been separated, diverted, or removed from the solid waste stream, but not including those materials and by-products generated from and reused within an original manufacturing process.

3.1.43.1 *Discussion*—This definition includes postconsumer and preconsumer material only, whether or not plastic material has been commingled, reprocessed, reground, or reconstituted. Wide-spec virgin plastics as well as reworked, reprocessed, and regrind plastic and purge from the same manufacturing process are excluded.

3.1.44 *recovery*, *n*—processing of (plastics) waste material for the original purpose or for other purposes including energy recovery.

3.1.45 *recyclate*, *n*—plastic material resulting from the recycling of plastics.

3.1.45.1 *Discussion*—Plastics secondary raw material and recycled plastics are synonymous of recyclate. The term, regenerate, is also used.

3.1.46 *recycled content*, *n*—percentage by weight of recyclate in a material or product.

3.1.47 *recycled plastic*, *n*—see *recyclate*.

3.1.48 *recycling*, *v*—processing in a production process of (plastics) waste materials for the original purpose or for other purposes, but excluding energy recovery.)

3.1.49 *regrind*, *n*—shredded or granulated recovered plastics material reclaimed by shredding and granulating sprues and runners for use in houses.

3.1.49.1 *Discussion*—The term regrind is frequently used to describe plastics materials in the form of scrap generated in a plastics processing operation and used in-house.

3.1.50 *resource recovery*, *n*—recovery of material or energy.

3.1.51 *reuse*, *n*—use of a product more than once in its original form.

3.1.51.1 *Discussion*—In view of the fact that a reused product has not been discarded, reuse does not constitute a recovery option.

3.1.52 *shredding*, *v*—any mechanical process by which plastics waste is fragmented into irregular pieces of any dimension or shape.

3.1.52.1 *Discussion*—Shredding usually signifies the tearing or cutting of materials that cannot be crushed by fragmentation methods applicable to brittle materials, as typically carried out in a hammer mill or similar process.

3.1.53 *source reduction*, *n*—process that reduces the waste from any step, such as design, manufacturing, packaging, acquisition, and provision for reuse of material.

3.1.54 *virgin plastic*, *n*—plastic material in the form of pellets, granules, powder, floc, or liquid that has not been subjected to use or processing other than that required for its initial manufacture.

3.1.55 *waste*, *n*—any substance or object that the holder discards or intends or is required to discard.

3.1.56 *wide-spec resin*, *n*—resin that deviates from the manufacturer's virgin resin specification in one or more properties.

3.1.56.1 *Discussion*—Also known as utility grade. Obsolescent terms include "off-spec" or "off-grade virgin resin" previously defined as resin that does not meet the manufacturer's specification.

4. Significance and Use

4.1 This guide is intended for use by committees or agencies concerned with the development of standards related to recycling, waste reduction, and resource recovery. Such standards are expected to provide uniform, standardized approaches by specifiers, codes, authorities having jurisdiction (AHJs), and consumers.

4.2 It is anticipated that more specific guides or standards are being or will be developed to address specific requirements.

5. Factors

5.1 *Overall Objectives*

5.1.1 The inclusion of recycled plastics in standards relating to material and product specifications is encouraged to reduce problems relating to waste disposal and to conserve energy when it is shown to be advantageous by life-cycle analysis.

5.1.2 Standards activities should concentrate on providing guidance for the increased use of recycled plastic and not try to address modifications relating to "regrind," "reprocessed," or "reconstituted" plastics that are intermediate materials generated in the initial manufacturing steps.

5.1.3 Standards should reference appropriate ASTM International standards where available.

5.1.4 Where possible, standards shall provide for identifying or labeling products that contain recycled plastics or other recovered materials, or both.

5.2 *Revisions to Specifications/Standards*

5.2.1 Recycled plastics can be used as a feedstock unless a specification specifically restricts their use justified on functional or regulatory requirements.

5.2.2 A specification or standard that currently restricts the use of recycled plastic, or implies the restriction by specifically mentioning the nonacceptability of reworked plastic (or other similar materials), shall be reviewed and, if necessary, revised. If the restriction is valid for known performance reasons, the justification shall be stated.

5.3 *Terminology*—To have maximum effect and reduce confusion, the terms related to recycled plastic should be clearly defined and identical terms used for the same concept in all standards.

5.4 *Use of Performance Standards*

5.4.1 Standards related to recycling shall be based upon performance standards that provide specific methods of evaluating end-use performance, including test methods and specification of levels of end-use criteria. Use of design standards that require a specific material are discouraged.

5.4.2 Performance requirements in standards shall be maintained and not be downgraded to permit the use of recycled plastic. If feasible for individual products, a second and lower level of performance shall be specified if the requirements are separated and clearly defined.

5.4.3 Efforts shall be made to resist adding additional testing requirements (and expense) when modifying standards to accommodate recycled plastics.

5.5 *Designing for Recyclability*—Designers and manufacturers of plastic products shall include durability, source reduction, reuse, and recyclability in design considerations. Components shall be recyclable per se or be readily dismantled for separation in a typical reclamation process.

5.6 *Quality Assurance*—Standards for recycled materials shall address quality assurance provisions to ensure consistent product quality. Where there is a lack of product history, tighter and more frequent controls may be required.

5.7 *Identification of Plastics*

5.7.1 Material identification by proper labeling of plastic parts is necessary to achieve effective separation and segregation of components to enhance the value of the recovered materials. Refer to Practice D 1972.

5.7.2 Terminology D 1600 should be used to identify the generic classes.

5.8 *Separation and Segregation*

5.8.1 Standards for recycling plastic materials shall address problems relating to separation of various plastics or initial segregation to prevent mixing. Refer to Appendix X1 for pertinent standards.

5.8.2 Cost-effective methods of recycling polymers generally exist when there is an abundant source of uniform feed stock, that is, polyester drink bottles. The lack of a uniform feed has hindered specific recycling effort. The additional cost and technical problems of sorting mixtures is generally excessive, and in many cases, the effort to separate products into generic components is not cost-effective (that is, multi-layer film). These products are better recovered by resource/energy recovery (see 5.13).

5.9 *Contaminants*

5.9.1 Because of previous fabrication or use, recycled plastics may contain one or more contaminants. Standards shall address identification, quantification, and removal or analysis of contaminants.

5.9.2 Standards shall address known methods for removal of contaminants. ASTM International subcommittees are developing practices that describe ways to separate contaminants or to analyze for contaminants. Appendix X2 lists pertinent documents.

5.10 *Fillers*—Recycled plastics of one generic class may be used as fillers in an alternate generic class. Other recovered materials (such as glass and ash) may also be used as fillers.

5.11 *Thermosets/Rubber*—Thermosets and nonthermoplastic elastomers (rubber) are suitable for use as fillers in some thermoplastics recycling operations.

5.12 *Reconstituted Products*—Reconstitution of polymers is an ideal method of recycle/recovery. The postconsumer or preconsumer recycled product is depolymerized by chemical/thermal breakdown to its monomer(s) or to a polymer of lower molecular weight followed by conversion back to the original generic class of polymer by chemical action.

5.13 *Degradable Products*

5.13.1 Standards can consider “degradable products” and identify and classify those degradable plastics and additives that stimulate degradation. In some cases, these need to and should be separated from other recycled plastics. Types of degradable plastics include: biodegradable, hydrolytically degradable, oxidatively degradable, and photodegradable. Paragraph X2.2 lists pertinent ASTM International standards.

5.13.2 Systems using color coding or the labeling of specific degradable products can be considered as an aid to prevent unintentional mixing.

5.14 *Resource/Energy Recovery*—Some recycled products are so difficult to separate into meaningful generic classes that the only effective method of recovery is to incinerate the product and recover its heat energy.

5.15 *Percentages and Certification of Products Containing Recycled Plastics*

5.15.1 A product manufacturer shall specify percentages by weight of recovered plastic material, either preconsumer material or postconsumer material, or both, in a finished plastic product.

5.15.2 The percentage of recycled content in a finished product is based on weight, not volume.

5.15.3 If only plastics materials are used in the product, the percentage of recycled content is based on the total weight.

5.15.4 If the product contains nonplastic materials, only the total weight of the plastics portion is used as the basis to determine the percentage of recycled content.

5.16 *Certification*

5.16.1 The product or material purchaser may require certification of the percentage and type (preconsumer material or postconsumer material or both) of recycled content.

5.16.2 Certifications of recycled content should be supported by feedstock purchasing records and manufacturing records for finished products.

5.16.3 Procedures to collect supporting data for certifications of recycled content can be incorporated in quality assurance, formulation, and quality control records.

5.17 *Misuse/Deceptive Labeling*—Recycled/reclaimed materials shall be properly labeled and identified. The product shall identify the percentage and source, that is, as to postconsumer or preconsumer categories or both. Improper identification of regrind or rework material is illegal in some jurisdictions.

5.18 *Product and Material Manufacturers' Responsibility*—The manufacturer has full responsibility to insure a uniform quality product with proper labeling and identification to meet the required specifications.

6. Keywords

6.1 plastics recycling; polymeric material; reconstituted plastics; resource recovery; waste reduction

APPENDIXES

(Nonmandatory Information)

X1. ADDITIONAL ASTM INTERNATIONAL STANDARDS

X1.1 Recycle

D 1883
D 3460
D 3935
D 4397
D 4432
D 4552
D 4674
D 4801
D 4887
D 5033
D 5203
D 5359
D 5476
D 5491
D 5505
D 5577
D 5663
D 5676
D 5814
D 5833
D 5834
D 5989
D 5991
D 6098
D 6149
D 6155
D 6261
D 6262
D 6263
D 6288
D 6341
D 6358
D 6471
D 6779
F 1732

X1.2 Degradable

B 812
D 3826
D 4674
D 5247
D 5271
D 5272
D 5510
D 5511
D 5526
D 5819
D 6002

X1.3 Biodegradable

D 3826
D 5210
D 5338
D 5509
D 5512
D 5525
D 5529
D 5951
D 5988
D 6003
D 6400
D 6691
D 6692

X1.4 Photodegradable

D 4646
D 5208
D 5272

X2. PERTINENT STANDARDS FOR USE WITH THIS GUIDE

X2.1 ASTM International Standards Related to Separation and Contaminants

D 5577 Guide for Techniques to Separate and Identify Contaminants in Recycled Plastics
D 5814 Practice for Determination of Contamination in Recycled Poly(Ethylene Terephthalate) (PET) Flakes and Chips Using a Plaque Test
D 5991 Practice for Separation and Identification of Poly(Vinyl Chloride) (PVC) Contamination in Poly(Ethylene Terephthalate) (PET) Flake

X2.2 ASTM Standards Related to Degradability

D 3826 Practice for Determining Degradation End Point in Degradable Polyolefins Using a Tensile Test
D 5071 Practice for Operating Xenon ARC-Type Exposure Apparatus with Water for Exposure of Photodegradable Plastics
D 5152 Practice for Water Extraction of Residual Solids from Degraded Plastics for Toxicity Testing
D 5208 Practice for Operating Fluorescent UV and Condensation Apparatus for Exposure of Photodegradable Plastics
D 5209 Test Method for Determining the Aerobic Biodegradation of Plastic Materials in the Presence of Municipal Sewer Sludge
D 5210 Test Method for Determining the Anaerobic Biodegradation of Plastic Materials in the Presence of Municipal Sewer Sludge
D 5247 Test Method for Determining the Aerobic Biodegradability of Degradable Plastics by Specific Microorganisms
D 5271 Test Method for Determining the Aerobic Biodegradation of Plastic Materials in an Activated-Sludge-Wastewater-Treatment System
D 5272 Practice for Outdoor Exposure Testing for Photodegradable Plastics
D 5338 Test Method for Determining Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions
D 5437 Practice for Weathering of Plastics Under Marine Floating Exposure
D 5510 Practice for Heat Aging of Oxidatively Degradable Plastics

X3. ORGANIZATIONS CONCERNED WITH THE USE OF RECYCLED PLASTIC

X3.1 The recycled content in products has been addressed by other organizations. Their work may be relevant to producers and users of recycled plastic feedstocks and products.

X3.1.1 *International Organization for Standardization (ISO)*[4]

X3.1.1.1 There is no ISO standard that addresses the range of issues covered by this guide. ISO, however, is developing terminology related to recycled materials in task groups and subcommittees. Drafts from the following technical committees and documents were consulted:

(1) ISO/TC 61, Plastics

(2) ISO/TC 207, Environmental Management

(3) ISO/CD 472 DAM, Plastics—Vocabulary, developed by the ISO/TC 61, SC 1 Subcommittee for Terminology

(4) ISO/FDIS 14020, Environmental Labels and Declaration—General Principles

(5) ISO/DIS 14021.2, Environmental Labels and Declaration—Self-Declared Environmental Claims

(6) ISO/FDIS 14041, Environmental Management—Life Cycle Assessment–Goal and Scope Definition and Inventory Analysis

(7) ISO 14024, Environmental Labels and Declaration—Type I Environmental Labeling, Principles and Procedures

(8) ISO/DIS 15270 Guide for Recovery

X3.1.1.2 Current information may be obtained by contacting the ASTM International Committee D20 staff manager who serves as the administrator of the Technical Advisory Group.

X3.1.2 *U.S. Federal Trade Commission (FTC)*

X3.1.2.1 The FTC issued 16 CFR Part 260, "Guides for the Use of Environmental Marketing Claims," July 1992. The guides were revised in October 1996 and May 1998. The most recent revision was published in the Federal Register on May 1, 1998.[3] According to the FTC, the guides are intended to reduce consumer confusion and prevent the false or misleading use of environmental terms.

X3.1.3 *Association of Postconsumer Plastic Recyclers (APR)*[5]

X3.1.3.1 A document from APR, "Design Guidelines for Plastic Bottle Recycling," provides much information related to recycling of packaging products.

X3.1.4 *U.S. Environmental Protection Agency, Office of Solid Waste*

[5] Available from the Association of Postconsumer Plastic Recyclers, 1300 Wilson Blvd., Arlington, VA 22209.