To: D20.95, Plastics Recycling Subcommittee members

This revision of D7611M-13, authorized as WK52452, provides more specific definitions for the resin identification code categories based on common criteria, examples of code assignment, and a process for adding additional code numbers. The work represents input from many sources including ASTM D20.95 members, postconsumer plastics recyclers, sorting plant operators, brand companies, testing laboratories, resin producers, sheet and molding converters, and two trade associations, the Association of Plastics Recyclers (APR) and the National Association of PET Container Resources (NAPCOR). In addition, these recommendations have been shared with the American Chemistry Council, the Society of the Plastics Industry (SPI) and the Sustainable Packaging Coalition (SPC).

A key intention is for codes on manufactured plastic items to convey basic information about the plastic resin or resins used to make the item. This information is useful for the subsequent processing of the items but does not imply recycling is being done or that the item is recyclable. Similarly, the code does not imply an item is not recyclable solely by the code assigned.

The revision here presented contains the following changes to the existing ASTM D7611 standard, which is a mild revision of the original resin identification code created by the Society of the Plastics Industry, SPI, in 1988.

1. Section 4.1 explains that items with the same code are of similar chemistry, processing properties, and physical properties. The intention is to include families of resins that are similar and that similar is defined by processing behavior and physical properties. Clarity or color appearance is not included as a physical property considered. Materials that are not readily processed together or that have very different properties, such as flexural modulus of HDPE vs. LLDPE, would not have items with the same code.

2. The Section 4.2 explains the Code is for aggregation of manufactured items. The note is included to provide context to how the resin identification code fits into commerce today and in the future. With the increasing use of near infra-red and visible light-based sorting machines, the code is less critical for sorting postconsumer items than it once was. Still, not all sorting is automated and manual identification still is done. The code is useful for training personnel and sorting machines and for understanding the nature of newly-introduced items. The code has value as a default definition for unfamiliar items. The code is also used when commercial transactions are being conducted as a backup reference to the nature of the material used to make items. An offering of material might be characterized as ‘#2 HDPE blow moldings’ and that would have meaning. The code can be a shorthand for communication with the public.

3. New codes. Section 4.5. The new section is added here rather than as part of Section 5, anticipating new codes will be sought. The stakeholders have expressed an interest that additional number codes should be available in an orderly manner for those stakeholders of the resins in question. A new section is added to allow for adding codes.
   a. A new code would not be assigned for a resin that is already a listed number. This would prevent a unique code for a product already coded.
   b. The petition for a new code would come to ASTM D20.95 subcommittee and must come from resin producers and converters of that resin. If those groups do not want a number, assigning such may be seen as unjustified and be opposed. That would put
ASTM into an awkward position particularly as use of the code for many applications is voluntary.

c. A petitioner cannot choose a number, but would be assigned the next available sequential number. In an ideal world the OTHER code would not be in the sequence, but might be “0”. That moment has passed.

d. The petition would be for resins in significant commercial use. A survey of interested stakeholders found that commercial sales for at least three years and sales of over 100 million annual pounds (45,000 annual tonnes) globally was a sufficient definition of significant commercial use. The original SPI code was for bottles and the tonnages for PVC and LDPE bottles in the last decade have averaged 32,000 annual tonnes, making the proposed 45,000 annual tonnes minimum consistent with historical experience.

e. Section 4.5.4 states that labels shall not be coded. While labels may be collected for reprocessing, the placement of a code on a label is very likely to be misinterpreted by the public to imply the item or package is made of the material on the label code. Since creating confusion to those who view the code is contrary to the intent of the standard, the text here does not allow the label to be coded.

4. The stakeholders have expressed a majority view that having a plus sign (+, such as PETE+ or HDPE+) as exists in the current ASTM D7611-13, is confusing to the public, of no usefulness to the reclamation and reprocessing community, and should be deleted. The revision deletes those sections. A statement of another layer being present without defining that layer is incomplete information. Layered items of materials not coded the same or permitted is a #7 unless a new code is sought. The repeated statement in the current text about no existing tooling having to change continues as is in section 4.4.

5. PET. Code 1. Section 5.7
   a. The proposed revision has PET used for manufactured items to have a limit on monomer content essentially identical to ASTM D5047 which requires 90 % homopolymer (meaning 90 weight percent composed of terephthalic acid, or dimethyl terephthalate, and monoethylene glycol). The nature of PET is that some monoethylene glycol will dehydrate to form diethylene glycol. As such, the restriction is on the materials used to make PET, not necessarily the composition of the glycols in the polymer. PET used to make bottles, for instance, is usually a copolymer of terephthalate and monoethylene glycol with other glycols or diacids deliberately added.
   b. The definition of composition of items made of PET copolymers is followed by a second definition. The code as here modified requires PET to exhibit a minimum melting point of at least 225°C by a defined test procedure. This is important as PET is frequently solid state polymerized after synthesis and terephthalate polymers that melt or become tacky at that temperature violate the principle of similar processing. Similarly, all PET must be dried before melting and materials that fail to exhibit a sharp melting point which means have crystallized in a short period of time often become sticky at commonly practiced PET drying temperatures. Such sticking fouls the equipment, violating the principle of similar processing. Depending on the type of dryers used, 0.5% sticking/melting material can foul the equipment. Polytetraphthalate polymers that melt above 255°C represent another violation of the similar processing criteria and are generally a contaminant to PET items.

6. HDPE. Code 2. Section 5.8

\[2\] Available from ASTM International Headquarters.
a. Manufactured items of nominal high density polyethylene often include other polyolefins such as blends of various grades of polyethylene or other thermoplastic polyolefins. To adopt here the ASTM D883 definition for polyethylene plastics as essentially solely made from ethylene is to ignore commercial practice even though ASTM D883 allows no less than 85% ethylene to be essentially the sole monomer. Thus, blends of polyolefins are allowed for the definition of high density polyethylene plastics items here with HDPE in the mass majority. Mass majority reflects ASTM practice as there is no clear percentage non-HDPE polyolefin plastic that renders that blend not similar in processing and properties with HDPE. Future data may justify a definitional minimum limit on HDPE; no such data are seen today.

7. V. Code 3. Section 5.9
   a. The language has been changed to more appropriately reference PVC. No further definition of PVC was requested by stakeholders.

8. LDPE. Code 4. Section 5.10
   a. Manufactured items of nominal low density polyethylene often include other polyolefins such as blends of various grades of polyethylene or other thermoplastic polyolefins. To adopt here the ASTM D883 definition for polyethylene plastics as essentially solely made from ethylene is to ignore commercial practice even though ASTM D883 allows no less than 85% ethylene to be essentially the sole monomer. Thus, blends of polyolefins are allowed for the definition of low density polyethylene plastics items here with LDPE in the mass majority. Mass majority reflects ASTM practice as there is no clear percentage non-LDPE polyolefin plastic that renders that blend not similar in processing and properties with LDPE. In commercial practice LDPE is referenced as exhibiting a density of 0.91 to 0.94 g/cc, as shown in Wikipedia, while per ASTM 4976 linear and branched low density and medium density polyethylene are all defined within that density range. Rather than violating either common practice or other ASTM standards, the language allows MDPE and LLDPE to be included as LDPE. While not obviously fully interchangeable, the materials, LDPE, LLDPE, and MDPE, do exhibit broad overlap of processing conditions and properties along with related chemistry.
   b. The proposed standard explicitly includes LLDPE as a #4 at this time.
   c. At some future time parties may seek a separate code number for either MDPE or LLDPE.

9. PP. Code 5. Section 5.11
   a. Manufactured items of nominal polypropylene often include other thermoplastic polyolefins such as blends of various grades of polypropylene, copolymers and/or other polyolefins. To adopt here the ASTM definition for polypropylene as solely made from propylene is to ignore commercial practice. Thus, blends of polyolefins are allowed for the definition of polypropylene items with polypropylene resin in the mass majority. The revision explicitly includes various grades of homopolymer and copolymer polypropylene.

    a. Polystyrene can be presented as homopolymer or many different combinations of copolymers or terpolymers. A restriction to 60% by mass of the monomer being styrene allows those polymers so conforming to process similarly and produces consistent

\[2 \text{ Available from ASTM International Headquarters.}\]
properties. After discussions between resin producer and converter the 60% value was agreed upon and the explicit inclusion made of amorphous homopolymer of styrene and styrene butadiene block copolymers and styrene butadiene graft copolymers and expanded polystyrene and HIPS to be #6s. The text excludes styrene butadiene rubber, a thermoset polymer. These inclusions and exclusions are considered sufficient to define similar processing and physical properties for similar chemistry.

11. OTHER. Code 7. Section 5.13
   a. Metal components that are integral to an item cause the item to be #7s. But adhered seals and closures do not. Materials that are part of a lidding system, such as a seal layer, are not included as a cause for #7 as explained in the examples.
   b. Blends of #1-6 plastics mean #7 except for the allowed blends meeting the definitions for #1, 2, 4, 5, and 6.
   c. The term OTHER may be replaced by the appropriate abbreviation from the ASTM list on ASTM D1600. The choice of OTHER or the abbreviation is at the discretion of the stakeholders as requiring listings from uninterested parties will likely generate resistance due to complexity that could be present. Market forces will determine where the complexity would allow specific resin listing. There are some resins in use that are not listed in ASTM D1600. Replacing OTHER with an abbreviation rather than listing both OTHER and the abbreviation lessens the burden on the mold design and loses no usefulness.
   d. The term OTHER can also be replaced with the listing of two resins such as a bottle with a barrier layer or a specific blend. Listing more than two resins is not disallowed, but not requested in deference to space limitations where the code is placed on an item.

12. APPENDIX X2. Examples
   a. The first example for CPET shows #1 is appropriate if the composition and melting point requirements are met. Typically, CPET would qualify as #1, but a definitive statement to that end is not included because of other features of the manufactured item which might be present. The nucleator to facilitate crystallization is considered an additive and additives are not limited. Also a non-crystallizing polyterephthalate is a #1 if it exhibits a melting point per the melting point requirement. Non-crystallizing materials do not exhibit a DSC melting point and are expected to not be #1 but could become a new number. The foamed example shows density is not a criterion for definition.
   b. The second example shows a mixture of polyolefins can be coded for the mass majority polyolefin used.
   c. The third example shows that the incorporation of a layer or blend of a non-polyolefin with a polyolefin, such as HDPE, means the designation for a polyolefin, such as #2, is not appropriate.
   d. The fourth example shows that combining two coded resins may not result in either codes being appropriate.
   e. The fifth example describes the effect of integral metal in the definition and that a bottle closure does not necessarily result in the item being a #7.
   f. The sixth example shows that color carriers do not constitute a blend that would result in #7 being appropriate nor do additives or colorants included with the resin to make an item result in #7 being appropriate. The text defines an additive as a material added for functional effect. A lidding system does not result in #7 being appropriate.

\(^2\) Available from ASTM International Headquarters.
Designation: D7611/D7611M – 13

Standard Practice for Coding Plastic Manufactured Articles for Resin Identification

This standard is issued under the fixed designation D7611/D7611M; 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.

1. Scope

1.1 This practice stipulates the types, names, and sizes of Codes for those material types specified in Table 1.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are likely not to be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems is likely to result in nonconformance with the standard.

1.3 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 known ISO equivalent to this standard.

2. Referenced Documents

2.1 ASTM Adjuncts:
   - Adjunct to D7611/D7611M Standard Practice for Coding Plastic Manufactured Articles for Resin Identification
   - D883 Standard Terminology Relating to Plastics
   - D1600 Standard Terminology for Abbreviated Terms Relating to Plastics
   - D3418 Standard Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry

3. Terminology

3.1 Definitions:

3.1.1 Resin Identification Code (RIC; Code)—a molded, imprinted or raised symbol or wording that consists of an equilateral triangle, a Resin Identification Number, an Abbreviated Term for polymeric material in compliance with Fig. 1 and Table 1.

4. Significance and Use

4.1 Resin Identification Codes are used solely to identify the primary thermoplastic plastic resin used in a manufactured article. The intended manufactured articles include, but are not limited to, packaging. The codes group materials of similar chemistry that exhibit similar processing requirements and similar physical properties not including clarity, color, or opacity.

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Available from ASTM International Headquarters.
4.2 The Resin Identification Code is used to characterize resin when manufactured items are aggregated for sale and for quick reference to manufactured items. Resin Identification Codes are not “recycle codes”. The use of a Resin Identification Code on a manufactured plastic article does not imply that the article is recycled or that there are systems in place to effectively process the article for reclamation or re-use. The term “recyclable” or other environmental claims shall not be placed in proximity to the Code.

Note: The Resin Identification Code’s use for identification relative to postconsumer recycling is less used than before automated sorting equipment allowed for rapid sorting. Some sorting continues to be manual and the Code aids in training.

4.3 This practice is based upon the system developed in 1988 by the Society of the Plastics Industry, Inc. (SPI). It is possible that some states or countries will have incorporated the original SPI practice into statute or regulation. In those situations, that statute or regulation takes precedence over this standard.

4.4 This practice shall only apply to new tooling. Existing molds that already incorporate older versions of the SPI RIC may be modified, but modification is not required.

4.5 Assignment of additional Resin Identification Code numbers shall follow these requirements:

4.5.1 New numbers shall not be assigned for resins already included as members of a previous number code other than “7”.

4.5.2 Numbers shall be assigned by ASTM D20.95 subcommittee sequentially from the last assigned number at the request of stakeholders for that resin. Stakeholders are defined as producers and fabricators of the resin.

4.5.3 Numbers shall be assigned only for commercial, not developmental, resins that have been in commerce for at least three (3) consecutive years with total annual global sales over 100 million pounds (45,000 metric tons)

4.5.4 Numbers shall be assigned for manufactured items, not for adhesives or coatings. Labels shall not be coded for resin of the label.

5. Requirements

5.1 The Code is to be molded, formed or imprinted on the manufactured article.

5.2 The Code shall be clear and legible.

5.3 The size of the Code shall normally equal or exceed 12 mm [1/2 in.] in height and width.

NOTE 2—For small parts or components, it is not always possible to conform to these size requirements. In these cases, it is important to maximize the size and legibility of the Code.

5.4 The Code shall be placed in an inconspicuous location on the manufactured article, such as the bottom or the back, where it will not be obvious to the consumer at the point of purchase so it does not influence the consumer’s buying decision.

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2 Available from ASTM International Headquarters.
5.5 The Code shall be as shown in Table 1. Option A is commonly found in North America. Option B is often found internationally. Either option is acceptable.

5.6 The numbering system within the equilateral triangle shall correspond to the generic class of resins shown in Table 1.

5.7 The Code with the Resin Identification Number “1” and the Abbreviated Term “PETE” is reserved for manufactured articles produced from Poly(ethylene terephthalate) polyethylene terephthalate resins. Polyethylene terephthalate items referenced are derived from terephthalic acid (or dimethyl terephthalate) and monoethylene glycol wherein the sum of terephthalic acid (or dimethyl terephthalate) and monoethylene glycol reacted constitutes at least 90 percent of the mass of monomer reacted to form the polymer. Polyethylene terephthalate resins must exhibit a melting peak temperature between 225°C and 255°C as identified during the second thermal scan in procedure 10.1 in ASTM D3418 when heating the sample at a rate of 10°C/minute.

5.7.1 The Code with the Resin Identification Number “1” and the Abbreviated Term “PETE+” is reserved for manufactured articles produced from Poly(ethylene terephthalate) that also contain at least one additional layer of a different material. This Code does not require the modification of existing tooling. This Code shall apply to all new tooling.

5.8 The Code with the Resin Identification Number “2” and the Abbreviated Term “HDPE” is reserved for manufactured articles produced from High density polyethylene resins. High density polyethylene items referenced are based on polymers made with ethylene as the primary monomer and that may contain other long-chain thermoplastic polyolefin plastics and wherein high density polyethylene is the mass majority resin present in the plastic item.

5.8.1 The Code with the Resin Identification Number “2” and the Abbreviated Term “HDPE+” is reserved for manufactured articles produced from high density polyethylene that also contain at least one additional layer of a different material. This Code does not require the modification of existing tooling. This Code shall apply to all new tooling.

5.9 The Code with the Resin Identification Number “3” and the Abbreviated Term “V” is reserved for manufactured articles produced from Poly(vinyl chloride) vinyl chloride resins generally referred to as poly(vinyl chloride) or PVC.

5.9.1 The Code with the Resin Identification Number “3” and the Abbreviated Term “V+” is reserved for manufactured articles produced from poly (vinyl chloride) that also contain at least one additional layer of a different material. This Code does not require the modification of existing tooling. This Code shall apply to all new tooling.

5.10 The Code with the Resin Identification Number “4” and the Abbreviated Term “LDPE” is reserved for manufactured articles produced from low density polyethylene resins. Low density polyethylene items referenced are based on polymers made with ethylene as the primary monomer and that may contain other long-chain thermoplastic polyolefin plastics and wherein low density polyethylene, linear low density polyethylene, and/or medium density polyethylene is the mass majority resin present in the plastic item.

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2 Available from ASTM International Headquarters.
5.10 The Code with the Resin Identification Number “4” and the Abbreviated Term “LDPE+” is reserved for manufactured articles produced from low density polyethylene plastics that also contain at least one additional layer of a different material. This Code does not require the modification of existing tooling. This Code shall apply to all new tooling.

5.11 The Code with the Resin Identification Number “5” and the Abbreviated Term “PP” is reserved for manufactured articles produced from Polypropylene propylene plastics resins. Propylene plastic items referenced are based on polymers made from propylene as the primary monomer and that may contain other long-chain thermoplastic polyolefin plastics and wherein polypropylene is the mass majority resin present in the plastic item and can be homopolymer, random copolymers and/or heterophasic copolymers. 5.11.1 The Code with the Resin Identification Number “5” and the Abbreviated Term “PP+” is reserved for manufactured articles produced from polypropylene that also contain at least one additional layer of a different material. This Code does not require the modification of existing tooling. This Code shall apply to all new tooling.

5.12 The Code with the Resin Identification Number “6” and the Abbreviated Term “PS” is reserved for manufactured articles produced from Polystyrene styrene plastics resins and blends of styrene plastics resins. Styrene plastics items referenced are made from at least 60 percent by mass styrene monomer and include amorphous homopolymer of styrene, expanded polystyrene, styrene butadiene block copolymers, styrene butadiene graft copolymers, and HIPS, but not including styrene butadiene thermoset rubber.

5.12.1 The Code with the Resin Identification Number “6” and the Abbreviated Term “PS+” is reserved for manufactured articles produced from polystyrene that contain at least one additional layer of a different material. This Code does not require the modification of existing tooling. This Code shall apply to all new tooling.

5.13 The Code with the Resin Identification Number “7” and the Abbreviated Term “OTHER” is reserved for manufactured articles produced from any polymer chemistry not described by any other Code.

5.13.1 Inclusion of an integral metal component as part of the manufactured article shall cause that item to coded “7”. Adhered metal seals, closures, or other easily separated metal parts do not cause the item to be coded “7”. 5.13.1 Combinations of polymer chemistries described by different Codes and not otherwise allowed shall be coded “7”.

5.13.3 Users of Resin Identification Number “7” are encouraged to list the Abbreviated Term for the resin used in place of the term “OTHER”. The Abbreviated Term must be listed in ASTM D1600. At the discretion of the item maker, an item made of one resin not otherwise coded may be coded with “Resin 1” in place of the term “OTHER” and an item made of two different resins as layers or blends may be coded with “Resin 1 Abbreviated Term + Resin 2 Abbreviated Term” in place of the term “OTHER”.

6. Keywords
6.1 plastics; Resin Identification Code

2 Available from ASTM International Headquarters.
APPENDIX

(Nonmandatory Information)

X1. ADDITIONAL BACKGROUND INFORMATION

X1.1 This practice is based upon the original system developed in 1988 by the Society of the Plastics Industry, Inc. (SPI), which offered a means of identifying the resin content of bottles and rigid containers commonly found in the residential waste stream. In 2014, SPI reports 39 states in the United States have legislation in force regarding the use of resin identification codes consistent with the original SPI code. It also is in use in China, and the U. K. and is now recommended by the British Plastics Federation and PlasticsEurope (formerly the Association of Plastics Manufacturers in Europe).

X1.2 The Resin Identification Code system has become one means by which interested parties identify the resins used in various manufactured articles. Alternative resins and more selective end-of-life options (such as retailer take back programs) for manufactured articles have also emerged since 1988. Because of these changes, the RIC system as defined in this ASTM standard requires periodic updating. British Plastics Federation and PlasticsEurope (formerly the Association of Plastics Manufacturers in Europe).

Figures and Tables

\[ \text{Equilateral Triangle} \]

\[ \text{Resin Identification Number} \]

\[ \text{HDPE} \]

\[ \text{Abbreviated Term for Polymeric Material} \]

\[ \text{FIG. 1 Example of a Resin Identification Marker} \]

\[ ^2 \text{Available from ASTM International Headquarters.} \]
<table>
<thead>
<tr>
<th>Resin Identification Number</th>
<th>Resin</th>
<th>Resin Identification Code – Option A</th>
<th>Resin Identification Code – Option B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Poly(ethylene terephthalate)</td>
<td>1 PETE</td>
<td>01 PET</td>
</tr>
<tr>
<td>2</td>
<td>High density polyethylene</td>
<td>2 HDPE</td>
<td>02 PE-HD</td>
</tr>
<tr>
<td>3</td>
<td>Poly(vinyl chloride)</td>
<td>3 V</td>
<td>03 PVC</td>
</tr>
<tr>
<td>4</td>
<td>Low density polyethylene</td>
<td>4 LDPE</td>
<td>04 PE-LD</td>
</tr>
<tr>
<td>5</td>
<td>Polypropylene</td>
<td>5 PP</td>
<td>05 PP</td>
</tr>
<tr>
<td>6</td>
<td>Polystyrene</td>
<td>6 PS</td>
<td>06 PS</td>
</tr>
<tr>
<td>7</td>
<td>Other resins</td>
<td>7 OTHER</td>
<td>07 O</td>
</tr>
</tbody>
</table>

\(^2\) Available from ASTM International Headquarters.
X2. EXAMPLES

1. A tray made of crystallized PET, CPET, or an article of non-crystallizing polyterephthalate or an article of foamed PET is a #1 only if the composition requirement and the melting point requirement are met.

2. An article with a mass majority amount of HDPE and lesser amount of PP is a #2 because mass majority is HDPE and other polymeric component is a polyolefin which is allowed.

3. An article with a mass majority amount of HDPE and a lesser amount as in a layer, of EVOH is not #2 as EVOH is not a polyolefin.

4. An article with a blend of polyethylene and polystyrene is not a #2 or #4 or #6 as polystyrene is not a polyolefin and polyethylene is not a styrene plastic. An article with a blend of a #1 to #6 resin and a non-polyolefin #7 resin is properly coded #7.

5. A plastic article with an imbedded steel reinforcement is a #7 as the metal component is integral to the article. A plastic bottle with a metal closure is not a #7 due to the closure as the closure is not integral to the bottle.

6. A plastic item with a colorant or additive dispersed in a carrier resin or with a neat additive is not a #7 because of the carrier resin or additive. An additive is included for functional effect. A plastic item with a sealing layer that is part of a lidding system is not a #7 because of the lidding system.

2 Available from ASTM International Headquarters.