

UL 746D

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Polymeric Materials – Fabricated Parts



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UL Standard for Safety for Polymeric Materials – Fabricated Parts, UL 746D

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Revisions: This Standard contains revisions through and including December 12, 2003.

Summary of Topics

Editorial changes for paragraph 5.1 and Table 10.1

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Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The revised requirements are substantially in accordance with UL's Bulletin(s) on this subject dated August 8, 2003. The bulletin(s) is now obsolete and may be discarded.

The revisions dated December 12, 2003 include a reprinted title page (page1) for this Standard.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

As indicated on the title page (page1), this UL Standard for Safety has been adopted by the Department of Defense.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if

the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Recognition and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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This Standard consists of pages dated as shown in the following checklist:

Page	Date
1-3	December 12, 2003
4.....	May 28, 1998
5.....	June 14, 2000
6-11.....	May 28, 1998
12-13	December 12, 2003
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UL 746D

Standard for Polymeric Materials – Fabricated Parts

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The most recent designation of ANSI/UL 746D as an American National Standard (ANSI) occurred on November 21, 2003.

This ANSI/UL Standard for Safety, which consists of the Sixth Edition with revisions through December 12, 2003, is under continuous maintenance, whereby each revision is ANSI approved upon publication. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Written comments are to be sent to UL-MEL Standards Department, 1285 Walt Whitman Road, Melville, NY 11747.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

The Department of Defense (DoD) has adopted UL 746D on November 3, 1988. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction which conflict with specific requirements of the Standard cannot be judged to comply with the Standard. A product employing materials or having forms of construction not addressed by this Standard may be examined and tested according to the intent of the requirements and, if found to meet the intent of this Standard, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements cover a program applicable to parts that have been molded or fabricated from polymeric material and describe the material-identity control system intended to provide traceability of the material used for the polymeric parts through the handling, molding or fabrication, and shipping operations. Guidelines are also provided for acceptable blending or simple compounding operations that may affect risk of fire, electrical shock, or injury to persons.

1.2 This program is intended to provide quick verification of material identification by means of an identification marking on the part, or on the carton in which the part is shipped, or in a specification sheet placed within the shipping carton with the part. This program is intended to eliminate the uncertainty of the polymeric material identity in the end-use product and to reduce the possibility of field problems caused by the use of incorrect compounds.

1.3 The polymeric-material identity program covered by this standard is intended to provide traceability for molded finished parts (that is, enclosures, internal equipment parts, and the like) that are to be factory-installed components of other equipment where the acceptability of the combination is to be determined.

1.4 This program is not intended for manufacturing operations that add colorants or other additives to plastic materials using hot-compounding techniques that subject the material to an additional heat history and ship pellets as finished parts. This program is not intended to provide traceability for polymeric materials that are intended for field installation.

1.5 Requirements and methods for the evaluation of metallized or painted parts are contained in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and the requirements for Polymeric Materials – Short Term Property Evaluations, UL 746A. Reference should be made to the applicable individual product standard for performance requirements covering the part or assembly.

1.6 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

1.6 revised June 14, 2000

2 Glossary

2.1 For the purposes of this Standard the following definitions apply.

2.2 CO-MOLDING – The process of injecting or extruding two or more materials into a single mold using two or more plasticizing cylinders or through a single die being fed by separate extruders either simultaneously or in sequence.

2.3 FABRICATOR – Performs such finishing operations as machining, drilling, painting, plating, assembly, hot stamping, and the like.

2.4 GENERICALLY – SIMILAR MATERIALS – Materials having the same basic chemical constituents and structure but differing in the amounts of fillers, modifiers, and/or reinforcements.

2.5 LET-DOWN RATIO – The proportion by weight of additive or concentrate to the base resin material. The maximum let-down ratio is the highest permissible proportion by weight of the additive or concentrate to the base resin material. The minimum let-down ratio is the lowest permissible proportion by weight of the additive or concentrate to the base resin material.

2.6 MOLDER – Performs injection, extrusion, transfer, compression, rotational, co-molding, thermoforming, reaction injection molding, pultrusion, open mold or hand lay-up processes.

2.7 POLYMERIC MATERIAL – A compound formed by chemical reaction that results in large molecules whose molecular weight is a multiple of that of the original substance (monomer). Includes thermoplastic, thermoset, and elastomeric materials.

2.8 RECYCLED PLASTICS – Those plastics composed of post-consumer material or recovered material only, or both, that may or may not have been subjected to additional processing steps of the types used to make products such as recycled-regrind, or reprocessed or reconstituted plastics.

2.9 REGRIND – A noncontaminated product or scrap such as sprues and runners that have been reclaimed by shredding and granulating for use in-house.

2.10 RECONSTITUTED PLASTIC – A material made by chemical or thermal breakdown of plastic waste into components followed by their conversion into a final composition by chemical action.

2.11 REPROCESSED PLASTIC – Regrind or recycled-regrind material that has been processed for reuse by extruding and forming into pellets or by other appropriate treatment.

3 References

3.1 General

3.1.1 Any undated reference to a code or standard appearing in the requirements of this Standard shall be interpreted as referring to the latest edition of that code or standard.

3.2 Related Standards

3.2.1 The requirements for tests for flammability of plastic materials for parts in devices and appliances, UL 94, covers flammability of polymeric materials used for parts in devices and appliances. The Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, contains short-term test procedures to be used for the evaluation of materials used for parts intended for specific applications in electrical end products. The Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, contains long-term test procedures to be used for the evaluation of materials used for parts intended for specific applications in end products. Test procedures are provided in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, for the evaluation of polymeric materials in specific applications in end products. The test procedures include reference to the data obtained from the standard property tests in UL 746A, as well as other practical means of evaluation.

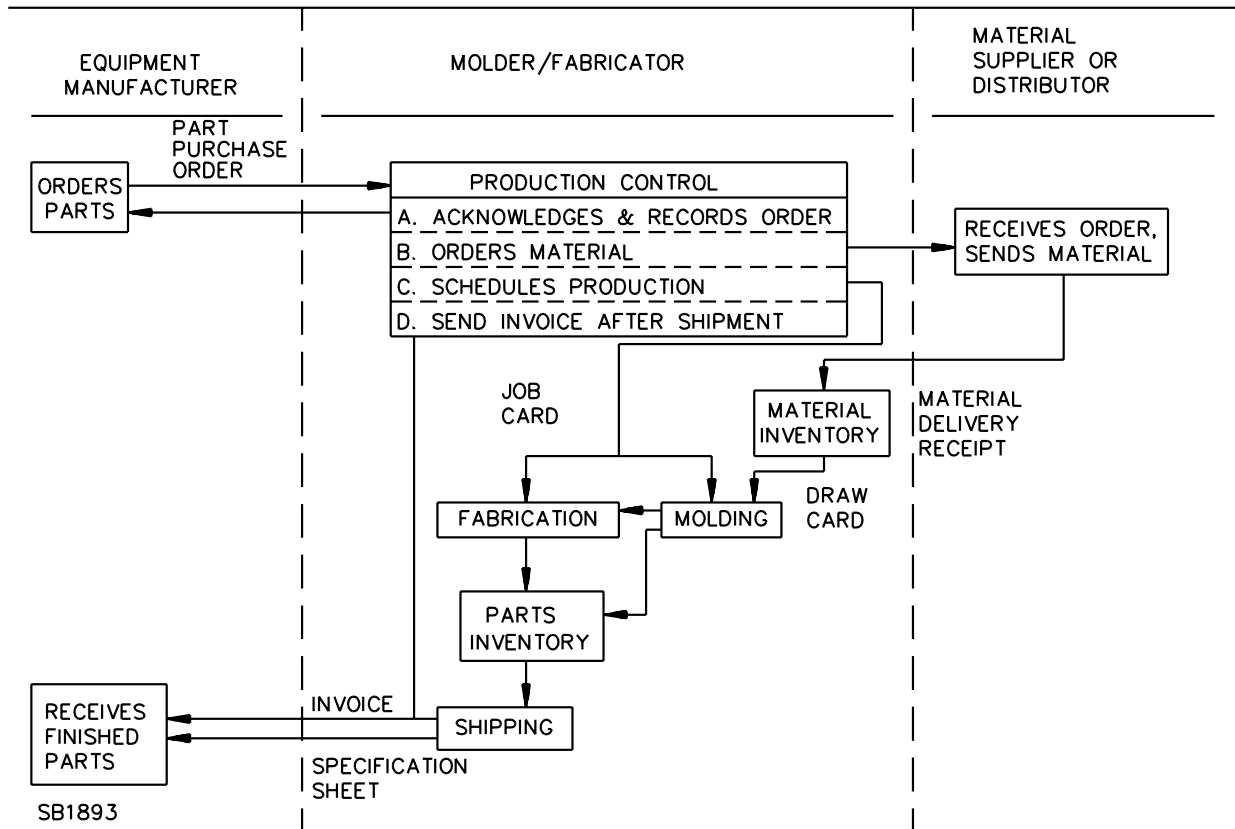
3.2.2 Requirements for materials that have been modified to match the requirements of a specific application, including the use of recycled and regrind materials, the use of additives and colorants, and the blending of two or more materials, are described in this Standard.

4 Details

4.1 The molder/fabricator of the polymeric-material parts shall maintain records that facilitate tracing the identity of the polymeric material used in the molding/fabrication of the parts from its receipt from the material supplier, through storage, handling, molding, finishing operations, and shipping. See Figure 4.1.

Exception: Records covering subcontracted fabrication processes are not required if the markings described in Details, Section 11 are permanently molded into, or applied to the part, and the integrity of the marking is intact after all fabrication processes.

Figure 4.1
Example of a material-identity control system as described in section 4



4.2 The following is an example of the records that may be maintained by the molder/fabricator to comply with the requirements in 4.1.

a) Purchase Order – Orders part or assembly from a molder/fabricator. This form generally is to include the following entries:

- 1) Name of end-product manufacturer or designated party (consignee).
- 2) Purchase order number.
- 3) Part (assembly or drawing) number and/or name. This item is to specify the material to be used for production of the component.
- 4) Quantity ordered.
- 5) Date.

b) Internal Record of Purchase Order – Transfers information from purchase order to molder's/fabricator's in-house records. This form is to include the following entries:

- 1) Name of end-product manufacturer or designated party.
- 2) Purchase order number.
- 3) Internal work order number. See 4.3
- 4) Part (assembly or drawing) number and/or name.
- 5) Quantity ordered.
- 6) Date.

c) Material Delivery Receipt – Records receipt of material from which finished parts are molded/fabricated. The following entries are to correlate with like entries on the Material Inventory:

- 1) Material manufacturer's name or trade name.
- 2) Material designation.
- 3) Quantity delivered.
- 4) Date delivered.

d) Material Inventory (See 4.6) – Records quantity of material in storage as well as receipts and withdrawals. The following entries are to correlate with like entries on the Material Delivery Receipt and Material Draw:

- 1) Material manufacturer's name or trade name.

- 2) Material designation.
- 3) Quantity delivered.
- 4) Date delivered.
- 5) Quantity withdrawn.
- 6) Date withdrawn.

e) Material Draw – Records withdrawal of material from inventory for part molding/fabrication. The following entries are to correlate with like entries on the Material Inventory. The date of withdrawal is to approximate the molding/fabrication date on the Parts Identification.

- 1) Material manufacturer's name or trade name.
- 2) Material designation.
- 3) Quantity withdrawn.
- 4) Date withdrawn.

f) Job Card – Records details regarding molding/fabrication of finished parts. The following entries are to correlate with like entries on the Purchase Order, Internal Record of Purchase Order, and Parts Inventory. The date of molding/fabrication is to approximate the molding/fabrication date on the Parts Identification.

- 1) Part (assembly or drawing) number and/or name.
- 2) Internal work order number. See 4.3.
- 3) Material manufacturer's name or trade name.
- 4) Material designation. See 5.2 for material modifications and 8.4 for parts containing regrind.
- 5) Quantity of parts produced.
- 6) Date produced.

g) PARTS INVENTORY – Records quantity of finished parts in storage as well as additions and shipments. The following entries are to correlate with like entries on the Job Card (additions) and Invoice (shipments). The added date is to approximate the molding/fabrication date on the Parts Identification:

- 1) Part (assembly or drawing) number and/or name.
- 2) Internal work order number. See 4.3.
- 3) Quantity added.

- 4) Date added.
 - 5) Quantity withdrawn.
 - 6) Date withdrawn.
- h) Invoice – Records shipment of finished parts. The following entries are to correlate with like entries on the Purchase Order, Internal Record of Purchase Order, Job Card, and Parts Inventory:
- 1) Name of end-product manufacturer or designated party.
 - 2) Part (assembly or drawing) name and/or number.
 - 3) Quantity shipped.
 - 4) Date shipped.
- i) Parts Identification – See 4.4 and Marking, Section 11.
- 1) Molder's/fabricator's name.
 - 2) Assigned designation. See 4.5.
 - 3) Part (assembly or drawing) number and/or name.
 - 4) Molding/fabrication date.
 - 5) Material manufacturer's name or trade name.
 - 6) Material designation.

4.3 The molder/fabricator may elect to represent the name of the end-product manufacturer or designated party; purchase order number; assembly, part or drawing number; and/or part name, by an internal code or work-order number on the molder/fabricator in-house records.

4.4 When an assembly consists of two or more polymeric parts, complete material identification is to be provided for each component part.

4.5 If subassemblies of the complete device are manufactured at locations where traceability cannot be evaluated, the assigned designation shall not be used (see 11.1).

4.6 A material may be used for products not covered by the material-identity traceability system as well. The quantities necessary for these products may be ordered or withdrawn on the same records as the material necessary for the products that do fall under the traceability system.

4.7 The records indicated in 4.1 are to be maintained on a ready-access basis for at least 3 months and in storage for at least 2 years.

MATERIAL MODIFICATIONS

5 Additives

5.1 The molder/fabricator shall not employ colorants, flame retardants, fillers, mold-release lubricants, color concentrates, dyestuff, chemical blowing agents or reinforcements or any combination in conjunction with the polymeric material unless the additive or concentrate is tested and found not to adversely affect the critical properties of the material. If an additive or concentrate of unknown performance is employed, the assigned designation mentioned in 11.1 shall not be used.

Exception No. 1: Mold-release lubricants that are applied directly to the mold die may be employed without additional tests for materials that have been classed HB in accordance with the requirements for tests for flammability of plastic materials – for parts in devices and appliances, UL 94. A mold-release lubricant may be used with a material classed V-2 or better provided that the results of testing indicate that UL 94 flammability classification remains unchanged when the lubricant is applied to either molded bar specimens or molded parts of material from the same generic material type.

Exception No. 2: Chemical blowing agents may be employed to eliminate sink marks on finished parts if the specific gravity of the finished part is not less than 95 percent of the specific gravity of the unfoamed material. This exception does not apply to rigid foamed materials that generally result in a much lower density than the unfoamed material.

Exception No. 3: Dyestuff that is suspended in water may be used by a molder/fabricator to apply color to the outer surface of a molded part made from materials classed HB or from unpigmented nylon that has been classed HB or V-2 in accordance with the requirements for tests for flammability of plastic materials for parts in devices and appliances, UL 94.

Exception No. 4: Color concentrates, colorants and dyestuff that have been classed HB or better when used in a generic material category, may be dry-blended without additional tests with polymeric materials that have been classed HB from the same generic material category. The molder/fabricator may dry-blend a color concentrate, colorant or dyestuff with a material classed V-2 or better provided that the UL 94 flammability classification remains unchanged when the color concentrate, colorant or dyestuff is let-down into the specific grade of base resin material. The molder/fabricator may dry-blend color concentrate, colorant or dyestuff in a let-down ratio that is equal to or less than the maximum let-down ratio maintained and reported for the pigmented molded bar specimens or parts that are subjected to the UL 94 flammability test.

Exception No. 5: The molder/fabricator may dry-blend a flame retardant concentrate into a specific grade of a base resin material in a let-down ratio that is equal to or greater than the minimum let-down ratio maintained and reported for the samples that were subjected to the UL 94 flammability test to obtain the indicated flammability classification.

5.1 revised December 12, 2003

5.2 If acceptable additives are employed, the job card described in 4.2(f) shall describe the nature and quantity of the additive or concentrate.

6 Rework

6.1 The molder/fabricator shall not employ any compounds or other materials to repair voids, cracks, deficiencies or other defects in molded parts, unless the repair compound or material and the repair process have been evaluated and found not to adversely affect the critical properties of the material or molded parts.

7 Combined Resins

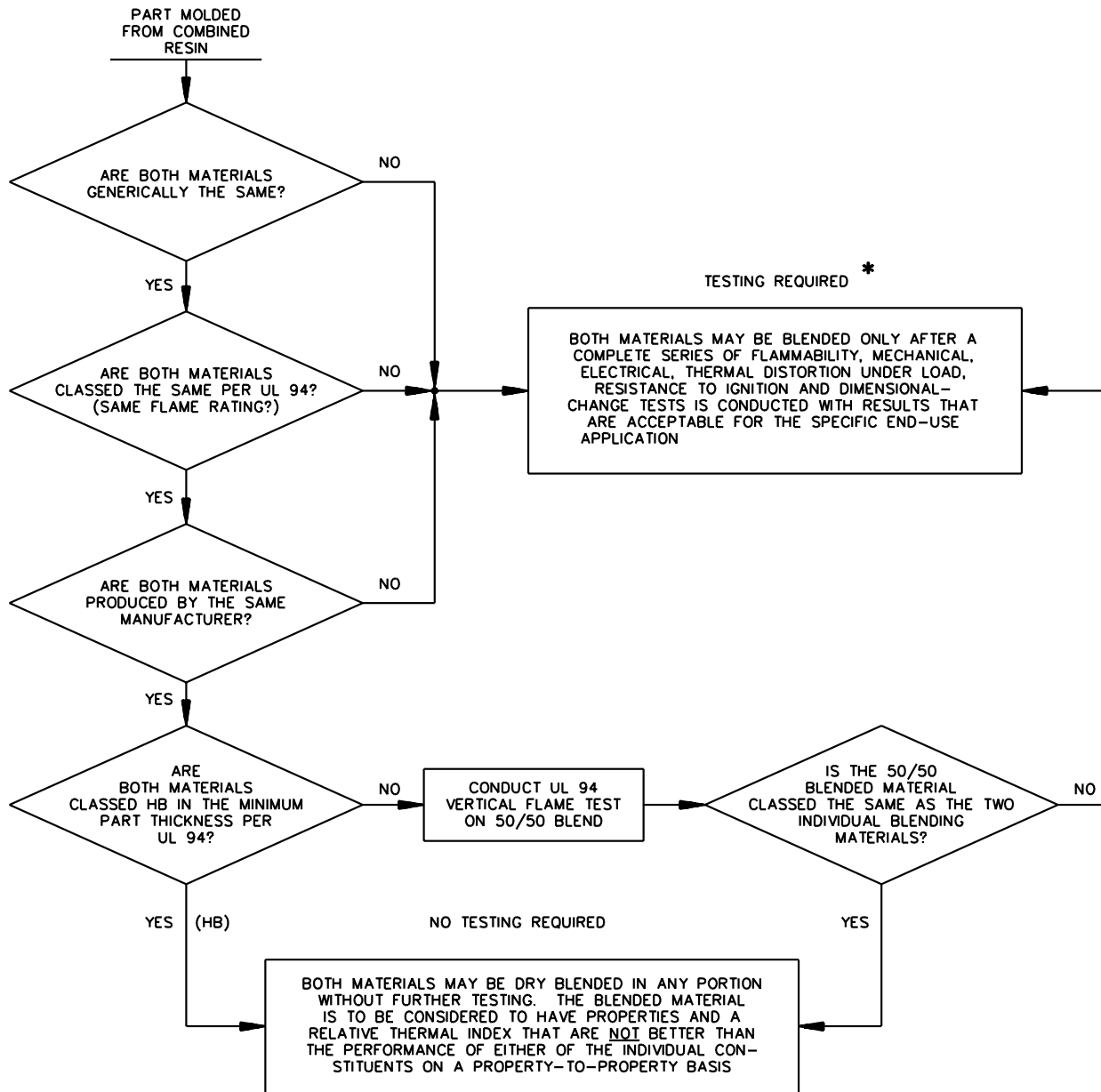
7.1 Materials can be formulated to match the requirements of a specific application. Tumble blending of two materials of the same approximate particle size is a method that a molder/fabricator may employ to customize the compound for the specific application. The requirements of this section cover particulate blending of molding powders and pellets by dry, cold compounding techniques. Figure 7.1 illustrates the requirements described in 7.4 – 7.6.

7.2 These requirements do not apply to co-molding materials. Co-Molding, Section 9, describes requirements for co-molding operations.

7.3 This Section provides guidelines on the development of criteria that may be used to evaluate combined materials if small-scale-test data is available using the methods described in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. The finished part shall possess minimum property levels and a relative thermal index that is considered acceptable for the application as described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C; Polymeric Materials – Long Term Property Evaluations, UL 746B; or as described in the specific product standard.

7.4 Two generically similar materials produced by the same manufacturer that are classed HB in the minimum part thickness when tested in accordance with the requirements for tests for flammability of plastic materials for parts in devices and appliances, UL 94, may be dry blended in any portion by the molder/fabricator without further testing. The blended material is to be considered to have properties and a relative thermal index that are not better than the performance of either of the individual constituents on a property-to-property basis.

Figure 7.1
Test considerations for combined resins



***EXCEPTION:** TWO GENERICALLY SIMILAR MATERIALS OR POLYSTYRENE AND STYRENE/BUTADIENE COPOLYMER BLENDS CLASSED HB THAT ARE PRODUCED BY DIFFERENT MANUFACTURERS MAY BE DRY BLENDED IN ANY PORTION WITHOUT FURTHER TESTING. THE BLENDED MATERIAL IS CONSIDERED TO HAVE PROPERTIES NOT BETTER THAN THE INDIVIDUAL CONSTITUENTS.

7.5 Two generically similar materials produced by the same manufacturer, each classed V-0, or V-1, or V-2 in the minimum part thickness when tested in accordance with the requirements for tests for flammability of plastic materials for parts in devices and appliances, UL 94, may be dry blended in any proportion by the molder/fabricator provided that the results of testing the 50/50 percent by volume blend indicate that the UL 94 flammability classification remains unchanged. The blended material is to be considered to have properties and a relative thermal index that are not better than the performance of either of the individual constituents on a property-to-property basis.

7.6 Two materials that are generically different (this includes the blending of materials where one or both components are copolymers, alloys, terpolymers, and the like), or have different UL 94 flammability classifications, or have the same UL 94 flammability classification but are produced by different manufacturers, may be blended by a molder/fabricator only after a complete series of flammability, mechanical, electrical, thermal distortion under load, resistance to ignition, and dimensional-change tests are conducted with results that are acceptable for the specific end-use application.

Exception: Two generically similar materials or polystyrene and styrene/butadiene copolymer blends classed HB that may be produced by different manufacturers are to be evaluated in accordance with the requirements in 7.4.

7.7 The material identity required in 11.2(c) shall include each material manufacturer's name or trade name, material designation, and approximate percentage or ratio of each component material.

8 Regrinds

8.1 Thermoset regrind shall not be employed in the molding/fabrication of parts, unless the results of a separate investigation indicate acceptable performance for the specific part that contains regrind.

8.2 Parts shall not be molded from material that contains more than 25-percent thermoplastic regrind by weight, that has been dry blended by the molder with the same grade of virgin material, unless the results of a separate investigation indicate acceptable performance for the specific part.

8.3 Any increase in the amount or change of the type of regrind shall require a separate investigation to determine the effects of the modification.

8.4 The job card required in 4.2(f) shall include the maximum amount of regrind that the parts contain in situations where the regrind content exceeds the limits specified in 8.1 and 8.2.

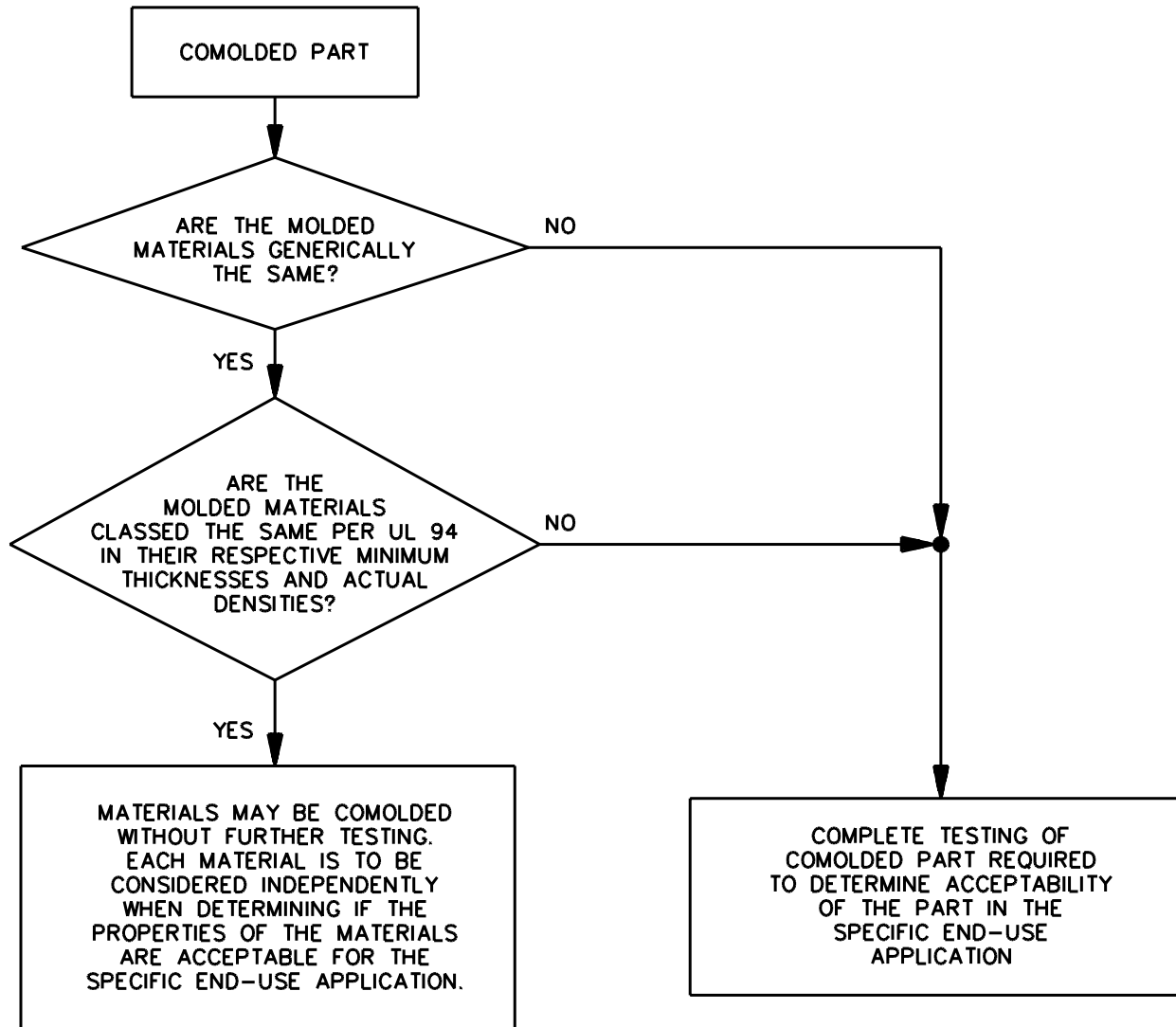
8.5 The separate investigation mentioned in 8.2 and 8.3 shall include an analysis of the part function; establishment of minimum performance levels for characteristics involving risk of fire, electric shock, or injury to persons; determination of the need for thermal aging and the establishment of a manufacturer's production control plan to maintain a minimum performance level. Specimens of the part shall be made from repeated blending of virgin and reground materials of the specified percentages until the residue of the material used in the first molding cycle is less than 1 percent of the total material in the part being tested (or the 20th molding cycle whichever comes first).

Exception: For processes that include only one blending of regrind material, from which no additional material is reclaimed for further regrind, then specimens of the part may be made from only one blending of virgin and reground materials of the specified percentages.

9 Co-Molding

9.1 Co-molded parts that are produced on a molding machine are to be evaluated with respect to the test considerations indicated in Figure 9.1

Figure 9.1
Test considerations for co-molding operations



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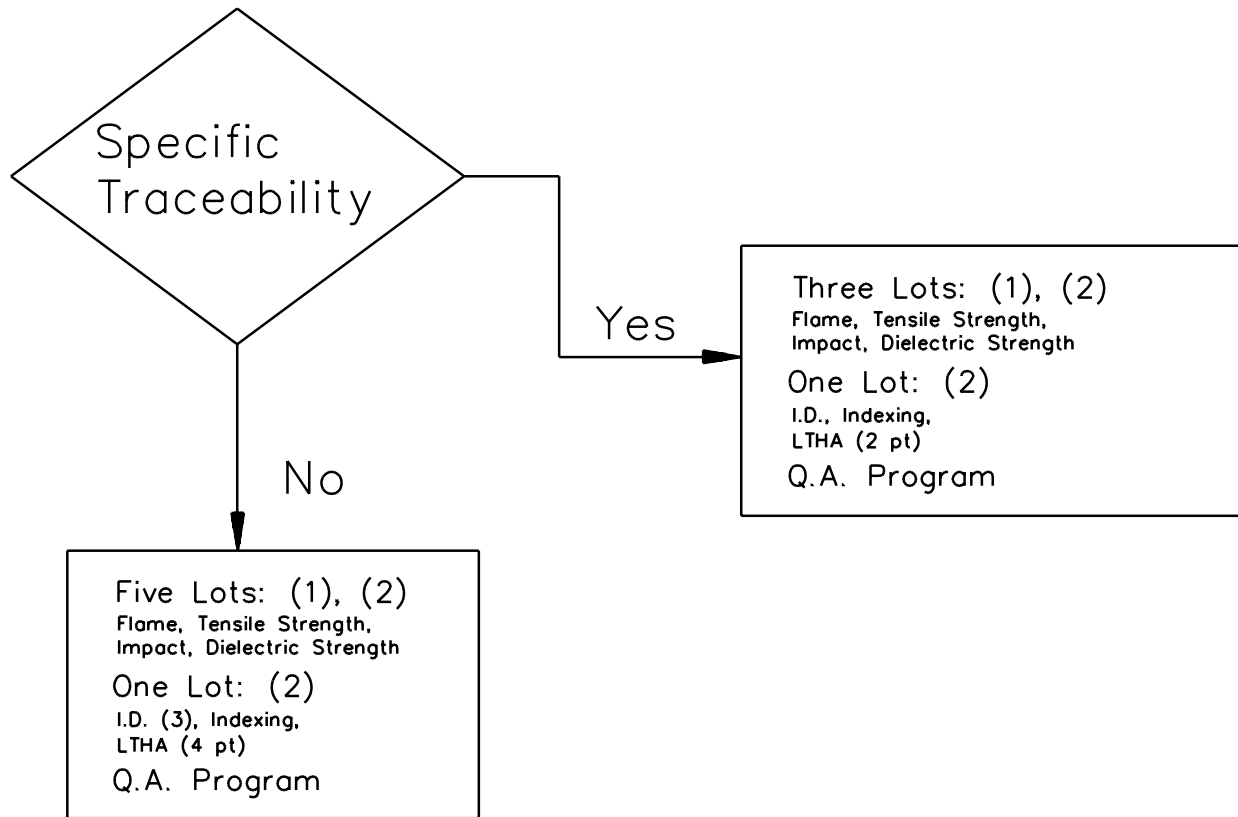
10 Recycled Plastic

10.1 Recycled plastic shall be evaluated to determine whether the variations between production batches have significantly affected critical material properties. A complete series of flammability, mechanical, electrical, thermal distortion under load, thermal endurance (aging), resistance to ignition, and dimensional-change tests shall be conducted on specimens from a minimum of 5 production batches. Figure 10.1 illustrates the test program for recycled thermoplastic materials.

10.2 The manufacturer shall establish a production control plan to maintain a minimum performance level for recycled plastic material. This production control plan shall include identification tests (such as ash content and specific gravity), electrical property tests (such as dielectric strength), and physical property tests (such as tensile strength, elongation and impact strength) as appropriate.

Figure 10.1
Recycled thermoplastic material test program

Figure 10.1 revised December 12, 2003



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1) For end-product applications, the following end-product test on one lot shall be performed: flame, mold-stress, impact, hot wire ignition, or other tests appropriate for the product.

2) On flame only investigations, only UL 94 flammability tests are required.

3) If identification tests cannot be performed for follow-up, the following tests can be substituted: flame, tensile strength, impact, heat deflection temperature, hot-wire ignition.

QA Program: The program is to include flammability (UL 94), hot-wire ignition, identification tests (relative viscosity, ash content, specific gravity), and mechanical property tests (tensile strength, impact), as appropriate.

MARKING

11 Details

11.1 Polymeric-material parts that comply with these requirements are to be identified by a designation that is assigned to the molder/fabricator.

11.2 The required markings shall consist of all of the following:

- a) Part identification – end-product-manufacturer or designated-party part number or name or both.
- b) Date of molding or fabrication – may be approximate to the nearest month. A date code repetition time cycle shall not be less than 10 years.
- c) Material identity – material manufacturer's name or trade name and material designation. See 7.7 for combined resins, and 4.4 for assemblies consisting of two or more polymeric parts.
- d) Molder's/fabricator's name or trade name.
- e) Assigned designation.
- f) Molder/fabricator factory location – distinctive marking, which may be in code, used to identify the part as a product of a particular factory. The factory identification is to be marked in close proximity to the assigned designation.

Exception No. 1: The material identity may be in a traceable code:

- a) If the material is identified by the name, brand name or trademark of a private labeler; or*
- b) If the code is mutually agreed upon between the end-product or designated-party manufacturer and the molder/fabricator.*

Exception No. 2: The date of manufacture may be abbreviated, or in a nationally accepted conventional code, or a date code affirmed and used by the manufacturer.

Exception No. 3: The molder/fabricator factory location is not required if the part is molded or fabricated or both in one location.

Exception No. 4: The markings are not required to be applied at subcontracted factory locations that perform fabrication operations on parts if the required markings are permanently molded into, or applied to the part, and the integrity of the marking is intact after all fabrication processes.

11.3 The required information described in 11.2 shall be displayed in one or more of the following locations:

- a) On the part.
- b) On each carton in which the parts are shipped.
- c) On a specification sheet or invoice placed in each shipping carton with the parts.

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