CPSA 6 (b)(1) Cleared
X 12/9/98
No Mfrs/PrvtLblrs
Products Identified
___Excepted by___________
___Firms Notified,
Comments Processed.

# LOG OF MEETING

# DIRECTORATE FOR ENGINEERING SCIENCES

**SUBJECT:** Attendance of UL 746/UL94 Industry Advisory Group/Industry Advisory Council Meeting

**DATE(S) OF MEETING:** October 14, 1998

**PLACE:** UL, Melville, NY.

**LOG ENTRY SOURCE:** Hammad Ahmad Malik

**DATE OF ENTRY:** October 20, 1998

**COMMISSION ATTENDEES:** Hammad Malik, ESEE

**NON COMMISSION ATTENDEES:**

Walter G. Baumgardt, Occidental Chemical
Mik Breza, M A Hanna Engineered Materials
Rinus de Vos, DSM Research
Stephen J. Harasin, Bayer Corp.
Shuichi Hirashima, Matsushita Electric Works Ltd.
Hiroshi Ishiwata, Mitusbishi Engineering Plastics Corp.
Shirish Mehta, Thomsom Consumer Electronics, Inc.
Charles Mulligan, G.E. (Major Appliance Div.)
Richard L. Pescatore, Hewlett Packard
Catherine Ruiz, Allied Signal Inc.
Inder L. Wadehra, IBM Corp.
Steve J. Watson, DuPont Engineering Polymers
Doug Wetzig, The Geon Company
Kibby White, GE Plastics
Marie-Francoise Bottin, Rhodia
Hans Breuer, BASF Germany
Paul Brown, GE Plastics
Kuniko Ito, Chemitox, Inc.
Mark E. Johnson, AMP Inc.
Gerhard Maurer, BASF Germany
Alyce Mayer, Strategic Technology Resources
Wayne Morris, Association of Home Appliance Manufacturers
Richard Nute, Hewlett Packard
Ed Van Vooren, ELTEK International Labs.
Dieter Vondenhagen, BASF Germany
Jessica Hemond, AMP Inc.
Ted Marks, JVC

Sam Cristy, Product Safety Letter
Elias Arias, UL-Melville
Larry Bruno, UL-Melville
Robert Desa, UL-Melville
George Fechtmann, UL-Melville
Gus Gemmiti, UL-Melville
Steve Giannoni, UL-Mellville
Marie Johnston, UL-Melville
Robert Mayshak, UL-Melville
Joe Salvini, UL-Melville
John Stimitz, UL-Melville
Ray Suga, UL-Melville
Robert Delli Valli, UL-Melville
Don Talka, UL-Melville
Andre Miron, UL-Santa Clara
Craig Allen, BASF
Ned Brause, Dekko Technical Center
Stephen N. Keller, Trace Laboratories
Bob Konsowitz, GIL Technologies
Hiten Pandya, Honywell
David Rackowitz, BASF
Robert C. Srubas, Osterman and Co.
Tena M. Shelton, Chevron Chemical Co.
Larry Stover, M A Hanna, Engineered Materials
Scott Suddoth, M A Hanna, Engineered Materials
Jonas Talandis, Atlas Fire Science Products
Peter Walthers, Omron Electronics
Ron Watson, Raychem
David Wildman, Emerson Tools
Arthur Wong, Honeywell
Ranganath Shastri, Dow Chemical
Charles Garufi, UL-Melville
Dan O' Shea, UL-Melville
Kenneth R. Vessey, Jr., UL-Melville

Mr. George Fechtmann began meeting with brief introductions. Ms. Marie Johnston provided a breifing on various projects of interest to the committee that are being funded through the steering committee. A representative from each of the project teams provided a status report. These projects included improvements on the hot-wire ignition test apparatus, IR spectra, relative traking index, etc. Considerable discussion followed about various projects and fund usage.

Mr. George Fechtmann then provided a brief history of the UL Plastics Flammability Ad-Hoc Committee. Mr. Fechtmann indicated that the committee was formed shortly after Mr. Bill King, CPSC, attended the IAG/IAC meeting at Research Triange Park, NC in 1995. In this meeting Mr. King indicated that the CPSC staff was concerned that household electical product related fires were not showing the same downward trend that residential fires were exhibiting as a whole.

Mr. Fechtmann then introduced Mr. Larry Bruno and Mr. John Stimitz as the presentors of the UL Ad-Hoc Plastics Flammability Committee report. Mr. Larry Bruno and Mr. John Stimitz then gave a presentation of the proposals found within the report (attached). Members of the IAG/IAC raised concerns about how large stationary tools would be handled by the proposal.

Mr. Hammad Malik gave an overview of the CPSC staff involvement in with plastics flammability issues and the part taken in the Ad-Hoc Committee. Mr. Malik then passed out copies of the plastics flammability project report "Assessment of Flammability of Plastic Materials Used as Electrical Appliance Enclosures."

Mr. George Fechtmann indicated that the proposed changes to UL 746C are not envisioned to have an effective date of less than five years.

The meeting then broke for lunch. After lunch Mr. Hammad Malik was excused from the meeting. Mr. Kenneth Vessey provided Mr. Malik with demonstrations of the ball-pressure test and a new fully automated Comparative Traking Index (CTI) apparatus.

Subjects 746 (94)
(In reply, refer to Subject 746)

1285 Walt Whitman Road
Melville, NY 11747-3081
September 24, 1998

**TO:** Industry Representatives on the Industry Advisory Group of UL for Plastic Materials
Subscribers to UL's Standards Service for
Polymeric Materials – Short Term Property Evaluations, UL 746A,
Polymeric Materials – Long Term Property Evaluations, UL 746B,
Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C,
Polymeric Materials – Fabricated Parts, UL 746D,
Polymeric Materials – Industrial Laminates, Filament-Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring Boards, UL 746E,
Tests for Flammability of Plastic Materials, UL 94

**SUBJECT:** Industry Advisory Group Meeting Agenda

As announced in the Subject 746 (94) bulletin dated July 10, 1998, a meeting of the Industry Advisory Group of UL for Plastic Materials is scheduled for:

**October 14, 1998**
**UL's Melville Office**
**1285 Walt Whitman Road**
**Melville, NY 11747**
**(516) 271-6200**
**Conference Room #5**
**9:00am – 5:00pm**

**SUMMARY OF TOPICS**

The following topics will be discussed at the meeting:

1. Plastics Steering Committee Update
2. Activities Update on ASTM D.09 and D.20, IEC TC15, TC61, and TC89, and ISO TC61
3. The Client Interactive Program (CIP)
4. Flammability Ad Hoc Committee Report
5. Consideration of Rapid RTI Methodologies – UL 746B

(Continued)

**SUMMARY OF TOPICS** (Cont'd)

6. International Draft of UL 746C
7. Revision of Table 8.1 – UL 746A
8. Protocol for Consideration of Increased RTI for PPHOX – UL 746B/746C
9. Testing of Annealed Samples – UL 746B
10. Metallized Parts Ad Hoc Committee
11. Adding PTI (Proof Tracking Index) Test to UL 746C
12. Downrating Guidelines – UL 94/746A/746B
13. Inclusion of ISO/UL Comparable Data Base (Mechanical and Electrical)
14. Standardized Wall-Thickness Representation for Glow-Wire Test
15. Development of Generic Ball-Pressure Temperature Indices
16. Harmonization of Long Term Heat Aging Tests with ISO Methods
17. Gas-Assisted Injection Molding
18. New Product Category "Concentrates"
19. Editorial Revision to Table 10.1 of UL 746B
20. Re-Evaluation of Follow-Up Service Testing Program

Attached is the agenda for the meeting.

This meeting is intended for industry representatives to meet with UL to discuss proposed requirements and/or other standards issues. Space permitting, others may attend as observers. Anyone not on the Group who would like to attend the meeting is requested to contact UL for permission to do so. Such a request should be made by October 5, 1998. This practice is necessary and desirable to maintain the size and effectiveness of the meeting. Please keep in mind that those receiving a copy of this agenda will also receive a copy of the meeting report.

**Hotel Accommodations**

As stated in the July 10, 1998 announcement bulletin, rooms have been reserved at the Melville Marriott Long Island for October 13, 1998. Rooms have not been guaranteed; therefore, should you elect the use of these accommodations, it is suggested that you contact the Melville Marriott to confirm your reservations. The rate for these rooms is $159, subject to availability . Please mention that you will be attending the UL "IAC 746" meeting when making your reservations. A free shuttle bus to the UL building, which is within walking distance, will be available to hotel guests.

**Ground Transportation Arrangements**

UL has arranged with the Executive Limousine Service in Coram, New York, to provide ground transportation from JFK and Laguardia Airports to UL Melville (and hotels located in Melville). The standard one-way fare is $50 when the car has just one occupant. The rate can be shared if some attendees are traveling together. Cash or credit card payment will be required, to the driver, at the time of service. Reservations to and from the airports should be made directly with Executive Limousine by calling (516) 696-8000 (800-736-4512 outside of New York) or faxing (516) 696-4845 and asking for the "UL meeting-746 IAC rate" which will be honored from October 12-15.

**Attire**

To make the meeting more comfortable, it will be appropriate to wear casual business attire.

If you have not already done so, please complete the attached attendance form and return it no later than October 5, 1998. If you have already sent in the completed form, no further action is necessary.


UNDERWRITERS LABORATORIES INC.

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SR:LS;
0746BUL.R04;RS;mc

Subjects 746 (94) September 24, 1998

ATTENDANCE FORM

OCTOBER 14, 1998 IAG MEETING IN
MELVILLE, NEW YORK
PLASTICS, UL 746(94)

(Please Print or Type)

NAME: ______________________________
(As you would like it to appear on your name tag/table tent)

COMPANY: ______________________________

☐ I am an IAG member who will be attending the meeting.

☐ I am an IAG member who will not be attending the meeting.

IAG members that want to bring another person or send a substitute who can contribute substantially to the discussion are requested to contact UL for permission to do so. Such a request should be made as early as possible prior to the meeting.

* * * * * * * * * * * * * * * *

IMPORTANT: If you are not a current member of the IAG but want to attend, and have received this agenda because you are a subscriber to UL's bulletin service, you must complete the following:

☐ I am not on the IAG but wish to attend the meeting as an observer.

NAME:______________________________
COMPANY:______________________________
ADDRESS:______________________________
PHONE/FAX/E-MAIL______________________________
INDUSTRY BACKGROUND/WHY YOU WANT TO ATTEND______________________________
______________________________
______________________________
______________________________

Please send the completed form no later than
October 5, 1998 to:

Underwriters Laboratories Inc.
1285 Walt Whitman Road
Melville, New York 11747-3081

Attention: Raymond M. Suga (Ext. 22593)
Senior Engineering Associate

Standards Department
516-271-6200
516-439-6021 (Fax)
E-mail sugar@ul.com

PROPOSED REQUIREMENTS ARE OF A TENTATIVE AND EARLY NATURE AND ARE FOR REVIEW AND COMMENT ONLY. CURRENT REQUIREMENTS ARE TO BE USED TO JUDGE A PRODUCT UNTIL THESE REQUIREMENTS ARE PUBLISHED IN FINAL FORM.

# APPENDIX A

## AGENDA

MEETING OF THE
IAG OF UL FOR PLASTIC MATERIALS

For your convenience in review, proposed additions to existing requirements are shown underlined and proposed deletions are shown ~~lined-out~~. Proposed new requirements are identified by (NEW). In the case of extensively revised paragraphs, the original text is identified by (CURRENT) and is ~~lined-out~~, followed by the proposed text identified by (PROPOSED). A paragraph that is proposed to be deleted is identified by (DELETED) and is shown ~~lined-out~~.

## 1. PLASTICS STEERING COMMITTEE UPDATE

### DISCUSSION

UL will present an update on the research projects being conducted under this program. The following is a list of the specific projects that are currently active:

1. HAI - Phase II
2. Update IR Spectra for Industrial Laminates
3. Performance at Temperature
4. Comparison of CTI Methods
5. LTHA - Effect of Air Changes*
6. Automated UL 94 Test
7. Relational Database for Plastics Data
8. Rigorous Protocol for Establishing New Generic RTI(s)
9. UL 746C Based International Guidance Document
10. 1997 UL Representation on the IEC TC15, TC 61 and TC89 and ISO TC61 Committees
11. Preliminary Evaluation of the Rapid RTI Methodology Proposal and the Feasibility of General Rapid Analytical Methods for RTI Determination
12. Round Robin for ASTM D 635*
13. Risk of Fire Hazards - Phase I
14. UL 94 Training Video
15. Client Test Data Program and ISO Guide 25 (ISO 9000)
16. Correlation of HWI vs. Glow Wire Ignition Temperature for the Pre-Selection of Plastic Materials

* These projects are now concluded and a final report will be available for inspection at the meeting for anyone interested.

## 2. ACTIVITIES UPDATE ON ASTM D.09 AND D.20, IEC TC15, TC61, AND TC89, AND ISO TC61

### DISCUSSION

UL staff will present a summary of their participation on various plastics related working groups and technical committees.

## 3. THE CLIENT INTERACTIVE PROGRAM (CIP)

### DISCUSSION

At the previous meeting, industry representatives asked that UL consider evaluating compliance with ISO 9002, or conversely, to take ISO 9002 compliance into account when conducting UL's Witnessed Test Data Program/Client Test Data Program (WTDP/CTDP) investigations. Industry had perceived a duplication of effort since their facilities are visited separately by different UL personnel for activities having some apparent degree of similarity. UL agreed to identify the common activities of the programs and look into the possibility of eliminating, or reducing, any duplicated efforts.

A subsequent review by UL of the issues has revealed that the scope of ISO 9002 facility registration and WTDP/CTDP laboratory accreditation are in fact different, requiring independent UL personnel having expertise keyed to the particular programs. While ISO 9002 registration is an assessment of corporate integrity, WTDC/CTDP accreditation programs evaluate the ability of laboratories to perform testing resulting in UL product compliance certifications. Although there appears to be no significant duplication of activities, UL would be willing to establish an industry/UL Ad Hoc Committee to further research specific issues.

## 4. FLAMMABILITY AD HOC COMMITTEE REPORT

### DISCUSSION

There has been a great deal of activity, since the last meeting, concerning the Flammability Ad Hoc Committee. An attempt has been made to develop requirements that will increase the resistance to ignition from internal sources within the product, such as electrical connections or faulty components. An approach similar to that used in IEC 60335-1 (Safety of Household and Similar Electrical Appliances, Part 1, General Requirements) is currently under consideration. In this testing scheme, the use of a less flame retardant material (i.e., HB- or V-2- rated) would result in a relatively extensive investigation of the ignitability characteristics of any plastic material in close proximity to potential sources of ignition in the end product. Conversely, when more flame resistant materials are used (such as V-0 and V-1), the testing level on the end product could be considerably lessened.

UL has prepared proposed revisions for UL 746C to be discussed at the meeting. Since this proposal complements the present ignition/flammability evaluation method, UL anticipates making a thorough presentation at the meeting to explain the necessity for these changes as well as to discuss the potential impact for users of UL 746C and various end-product and component manufacturers.

A copy of the report on the most recent Ad Hoc Committee meeting is attached as Appendix B. For brevity, the attachment pages have been left off the report.

### RATIONALE

UL considered the input of the Ad Hoc Committee in deciding that some revisions to UL 746C would be necessary to address the possible ignition and fire caused by the malfunction of internal components and connections. After reviewing a number of suggested approaches, UL decided an approach similar to that used in IEC 60335-1 would be both effective and beneficial.

### IMPACT

These changes in requirements would result in a possible review and retesting of currently Listed or Recognized products; therefore, if adopted, they would have a significant effect upon manufacturers.

### PROPOSAL

See Appendix C for UL's proposal for UL 746C.

## 5. CONSIDERATION OF RAPID RTI METHODOLOGIES – UL 746B

**DISCUSSION**

At the previous meeting, a presentation was made of the Fixed Time Frame Method of investigating the long-term thermal properties of Recognized materials. UL indicated it was willing to develop a proposal at a future date based on the positive industry response and the promising initial results in a side-by-side comparison of the present UL 746C test method versus the new Fixed Time Frame Method (FTFM). Since then, UL has contracted to conduct additional confirmation tests to further demonstrate the equivalency of these two Long Term Heat Aging (LTHA) methods.

The FTFM format is, overall, essentially similar to the present 746C LTHA requirements as it is based on the same fundamental principles; however, instead of using the test temperature as the independent (selected) variable and time (length of test) as the dependent (to be determined) variable, the FTFM utilizes the time as the independent variable and the temperature as the dependent variable. The FTFM places a great emphasis on the first 500 hours of testing (referred to as the Screening Test) to determine what test temperatures will produce a 50% loss of properties at the 5,000 hour point. One cited advantage of the FTFM is that, under normal circumstances, testing concludes at the 5,000 hour point whereas it is relatively common for the existing test method to go substantially beyond 5,000 hours.

Based on the comparisons done to date, UL considers the Fixed Time Frame Method to be a viable alternative to the present UL 746C test format for the evaluation of many plastic materials; however, the FTFM method may not be appropriate for all materials - such as when the degradation of properties does not occur in a straight line manner or when degradation only occurs within a relatively narrow temperature band width. It is therefore anticipated that the new sampling method would be used only with materials that, from experience, are known to degrade in a predictable manner and does not warrant special consideration - such as with polypropylenes, nylons, and acrylics.

UL intends to hand-out a tentative proposal for UL 746B revisions at the meeting which will indicate how the alternate test method will be incorporated into the standard.

## 6. INTERNATIONAL DRAFT OF UL 746C

**DISCUSSION**

UL has been doing preliminary work to develop a standard that would be roughly equivalent to UL 746C but intended for use in a global marketplace. To maximize this harmonization effort, UL studied other harmonized documents that cover end-products (that would be used in similar environments as UL 746C products) such as IEC 60335-1 (Safety of Household and Similar Electrical Appliances, Part 1, General Requirements) and IEC-60950 (Safety of Information Technology Equipment, Including Electrical Business Equipment, Part I, General Requirements). UL anticipates having a working draft available for discussions at the upcoming meeting.

UL plans to use the feedback from the industry representatives in generating a complete draft that will be circulated for industry review within the next year.

## 7. REVISION OF TABLE 8.1 – UL 746A

### DISCUSSION

UL is developing revised requirements for UL 746A to address the situation where a variation of an existing Recognized material is investigated. Such revisions were previously implemented in Table 19.1 in UL 746B (regarding Long Term Heat Aging evaluations). The Ad Hoc Committee that previously developed the UL 746B proposal is now working to create a similar proposal for Table 8.1 in UL 746A. To date, three teleconferences have been held to work out the specific details. Due to the complexity of the characteristics covered by the table, it has proven more difficult to develop the table than initially planned and the Ad Hoc anticipates that a formal proposal should be ready by the year's end.

## 8. PROTOCOL FOR CONSIDERATION OF INCREASED RTI FOR PPHOX – UL 746B/746C

### DISCUSSION

UL has established a research project to develop guidelines for assigning new or upgraded (higher temperature generic RTIs) for plastics. Tentative guidelines have been developed where the generic RTI could be set at three standard deviations below the mean of normally distributed RTIs determined from full conventional aging programs. UL has received requests to raise the generic thermal index for PPHOX (polyphenylene oxide), and has attempted to utilize the tentative guidelines to determine a suitable generic RTI for PPHOX materials. In this effort, several concerns were identified regarding the minimum size of the data sampling and a suitable measure of the normalcy of the distribution. The existing data base for RTIs was unsuitable for the required analysis and further work was deferred pending completion of a state-of-the-art data base and search engine which is in the final stages of implementation. A status report will be presented.

## 9. TESTING OF ANNEALED SAMPLES – UL 746B

### DISCUSSION

At last year's meeting, several manufacturers volunteered to provide UL with comparative study data that could be used to evaluate whether it is appropriate to anneal samples prior to conducting LTHA test programs. Not enough data was received for UL to reach any definitive conclusion. As this issue is often raised by industry, and since there is both strong support and opposition to annealing samples (to minimize the effects of short-term property changes at the start of aging programs), UL is going to propose to the Plastics Steering Committee that a research project be established to conduct a formal study. The status of that proposal will be discussed at the meeting.

## 10. METALLIZED PARTS AD HOC COMMITTEE

### DISCUSSION

At the last meeting, UL identified several suggestions for improving the requirements for metallized parts that have resulted from the activity of the Ad Hoc Committee since it was created in 1996. UL has now developed the proposal shown below. As there are further revisions to UL 746C that could be made to standardize and clarify various test methods, UL intends to present an update on the activities of the Ad-Hoc Committee and discuss other potential changes.

### RATIONALE

UL has become aware of the need to clarify various test methods and procedures which are used to evaluate metallized parts – for example, the evaluation of coating cohesion strength. In addition, editorial changes are needed to promote consistency in the evaluation of these products.

### IMPACT

As these revisions clarify present testing practices, a file review is not anticipated.

### PROPOSAL

See Appendix D for the proposal for UL 746C.

## 11. ADDING PTI (PROOF TRACKING INDEX) TEST TO UL 746C

### DISCUSSION

At the last meeting, UL announced that it would add the Proof Tracking Index Test to UL 746C to enable evaluation of enclosure tracking resistance where the material used has not already been rated for CTI on a pre-selection basis. The Proof Tracking Test in IEC 112 is already in widespread use by multi-national end-product manufacturers and enclosure/part molders. UL is now proposing the specific wording of the revision of UL 746C.

### RATIONALE

The addition of the Proof Tracking Index Test would provide more flexibility for evaluations under UL 746C. The PTI test would be run at the temperature specified in the end-product standard to demonstrate compliance with the end-product requirements.

### IMPACT

The addition of this test would not require a review or retesting of current products. This test would only be appropriate when the enclosure materials have not been evaluated for tracking resistance by the CTI test in UL 746A; therefore, UL does not anticipate that it will have a significant effect upon manufacturers.

**PROPOSAL**

11.4 As indicated in Table 8.1, an insulating material that is in contact with or close proximity to less than 0.8 mm (1/32 inch) uninsulated live parts or such parts and dead metal parts that may be grounded in service or any surface exposed to contact, shall have a maximum CTI PLC of 4 for indoor equipment in a relatively clean environment; a maximum CTI PLC of 3 is required for most outdoor and indoor equipment that may be exposed to moderate contaminate environments; a maximum CTI PLC of 2 is required for equipment that is likely to be subjected to severe contaminate environments.

Exception: In lieu of demonstrating compliance through the use of pre-selection test, The Proof Tracking Test, described in IEC 112, can be conducted on a portion of the product enclosure to determine compliance with the specified Proof Tracking Index (PTI) specified in the end-product standard

11.4 revised Date of Publication

## 12. DOWNRATING GUIDELINES – UL 94/746A/746B

**DISCUSSION**

UL has set an objective of formulating guidelines to cover those rare situations where plastics manufacturers may downrate an existing material. Under nearly all circumstances, it is not possible to downrate a material and the manufacturer would have to assign a new or modified material designation to the material in question. This is done to protect end-product manufacturers from using materials with lower performance levels without their knowledge. But there are some very limited instances where downrating may be possible due to factors such as: the original ratings were not yet published in the Recognized Component Directory, none of the material was shipped from the plastic manufacturer's facilities, or the material has a very limited, and easily identifiable, list of customers that can be contacted.

UL will discuss the status of formalizing the guidelines and explain why it is not generally acceptable to downgrade plastic materials once they are available in the marketplace and can be used by an indeterminate number of end-product manufacturers.

## 13. INCLUSION OF ISO/UL COMPARABLE DATA BASE (MECHANICAL AND ELECTRICAL)

**DISCUSSION**

As part of the complete Recognition test program, UL conducts a number of mechanical and electrical pre-selection tests on plastics. These tests may include: tensile strength and impact, Izod impact, flexural strength, dielectric strength, volume resistivity and heat deflection. The main use of this data is for comparison purposes in the event of material substitution.

Although the tests are conducted in accordance within ASTM/UL guidelines, concerns have been raised about the comparability of this test data. For example: ASTM D 638 tests for Tensile Strength allow for five different sample configurations. Each configuration could yield slightly different results. While UL recommended the use of Type I samples, they were not always available for testing. Other issues such as: molding conditions, specimen thickness, allowable variations in test methods, and sample conditioning can also affect test results.

UL is considering a proposal for the inclusion of ISO comparable test data. This testing better controls the variables mentioned above, and will result in improved comparability between material properties. A presentation will be made at the meeting.

### 14. STANDARDIZED WALL-THICKNESS REPRESENTATION FOR GLOW-WIRE TEST

**DISCUSSION**

UL is considering a standardized wall thickness for the Glow-Wire Testing (GWT). The IEC data for Glow Wire Tests are represented in 1 and 2 mm thicknesses. New indices for this data could be established for this data and noted as GW1 or GW2. This data could be useful for end-product evaluations to determine pre-selection of materials. UL would like to discuss the relevance of this data on the Recognition (yellow) cards. UL uses a different thickness for index testing (i.e., 0.75, 1.5, and 3.0 mm). UL would like to discuss with industry the thicknesses at which the materials should be tested and the manner in which the data should be reported.

### 15. DEVELOPMENT OF GENERIC BALL-PRESSURE TEMPERATURE INDICES

**DISCUSSION**

UL has received a request from industry to have standardized Ball-Pressure indices. This data could be useful for end-product testing for the pre-selection of materials. Having standardized data could eliminate the need to conduct this test for each product submittal as the pre-selection data could be used as a basis for waiving the test. UL would like to discuss the concept with industry to consider developing guidelines to implement the use of this pre-selection data.

### 16. HARMONIZATION OF LONG TERM HEAT AGING TESTS WITH ISO METHODS

**DISCUSSION**

A new protocol for UL 746B testing has been suggested by a manufacturer and will be presented for consideration at the meeting. The new method includes: (1) using standardized smaller-sized diagnostic property test specimens, (2) using yield energy during tensile tests to replace conventional impact tests, (3) using the Fixed Time Frame Method (FTFM) mentioned in Item 5 of this bulletin, and (4) the elimination of testing a "control" reference material.

### 17. GAS-ASSISTED INJECTION MOLDING

**DISCUSSION**

UL would like to discuss whether additional requirements are necessary to address a molding process called Gas-Assisted Injection Molding. This process uses low pressure, conventional molding methods to force a short shot of material into the mold cavity. Then, by using pressurized nitrogen gas, some of the material is displaced in pre-determined thick areas, forming hollow sections of the part.

It appears that this process is becoming more prevalent for molders. The suspected problem is that the hollow areas of parts that are molded using the gas assisted process may reduce the parts integrity, and the wall thickness may be reduced. One concern is the ability of the part to withstand the end-product impact test or dielectric strength test. The thinner wall sections could also affect the flammability rating of parts.

We are looking for input from the IAG on this process and the impact it has on molded parts. UL would like to establish further guidelines and requirements with respect to this process.

## 18. NEW PRODUCT CATEGORY "CONCENTRATES"

### DISCUSSION

UL has been approached to consider allowing the combination of a Recognized base resin with its corresponding additives at the molders location.

The "concentrate" is made by taking the various additives of the formulation and letting them down into a specified generic carrier. These pellets are to be packaged in containers marked with all of the pertinent information for use (i.e., let-down ratio, percentage of glass fiber, percentage of talc). This packaged product will then be dry blended in the proper ratio with the appropriate generic Recognized base resin at a Recognized molders facility. Dry blending by a Recognized molder is necessary to maintain traceability records. The dry blended mixture can then be used by that Recognized molder.

This particular arrangement does not appear to fit any existing Recognized component plastic category. If adopted, UL would establish the new category "Component-Concentrates".

## 19. EDITORIAL REVISION TO TABLE 10.1 OF UL 746B

### DISCUSSION

It has come to our attention that Table 10.1 in UL 746B needs to be revised to improve consistency. As presently written, note b does not include mention of the Flexural Strength test. Also, UL wants to clarify note b to state that, for the Charpy Impact test which uses 4.0 mm samples, note b would allow for a rating at 1.6 mm (and not 2.0 mm as some people would assume).

### RATIONALE

These clarifications are necessary to avoid misinterpretation of the standard.

### IMPACT

The proposed editorial revision will not result in a review or retesting of existing products; therefore, it will not have an appreciable affect on manufacturers.

**PROPOSAL**

**Table 10.1**
**List of properties and test methods**

Table 10.1 revised (date of publication)

| Property [a] | Test Method |
|---|---|
| Mechanical Properties | |
| Maximum Tensile Stress, and/or Flexural Strength[b] | UL 746A |
| Tensile[b], Izod[b], or Charpy Impact[b] | UL 746A |
| Electrical Properties | |
| Dielectric Strength | UL 746A |
| Flammability Properties | |
| Vertical Burning | UL 94 |

[a] The list of properties given in this table is not complete. Other properties that are critical in a particular end-use application are to be included in the program.

[b] ~~Tests conducted on the 3.2 mm thick specimens for Tensile and Izod impact and 4.0 mm for Charpy impact are considered representative of other thicknesses, down to 1.6 mm.~~ For Flexural-Strength and Tensile-, Izod-, and Charpy-Impact tests, tests conducted on the 3.2 or 4.0 mm samples would be considered representative of other thicknesses down to 1.6 mm.

## 20. RE-EVALUATION OF FOLLOW-UP SERVICE TESTING PROGRAM

**DISCUSSION**

A number of plastic manufacturers have expressed difficulty in supplying UL inspectors with the molded flame bars needed to send to the local UL offices for flammability tests. Manufacturers who don't have on-site molding capabilities must send tagged samples (pellets, granules, etc.) to either another "in-house" location or contract with an outside molder to do the work. This greatly increases the time necessary for the UL tests and introduces the possibility of lost samples. It was suggested that UL look into whether Follow-Up Service tests could be established that would utilize the plastic material in the "as-shipped" form rather than traditional molded flame bars.

UL has decided to form an Ad Hoc Committee to look into the feasibility of such a program. UL is asking for volunteers to serve on that Ad Hoc who may, through their industrial experience, be able to provide suggestions for evaluation and implementation.

PROPOSED REQUIREMENTS ARE OF A TENTATIVE AND EARLY NATURE AND ARE FOR REVIEW AND COMMENT ONLY. CURRENT REQUIREMENTS ARE TO BE USED TO JUDGE A PRODUCT UNTIL THESE REQUIREMENTS ARE PUBLISHED IN FINAL FORM.

# APPENDIX B

## IAG OF UL FOR PLASTIC MATERIALS

## ITEM 4. FLAMMABILITY AD HOC COMMITTEE REPORT; COPY OF MEETING REPORT

*UNDERWRITERS LABORATORIES INC.*

September 3, 1998
SU 2181

**MINUTES**
**UL Plastics Flammability Ad Hoc Meeting**
**June 16, 1998**

A meeting of the UL Plastics Flammability Ad Hoc was held on June 16, 1998 at the U.S. Consumer Product Safety Commission in Bethesda, Maryland. A list of meeting attendees is provided in Attachment A. The following is a report of the salient items of the discussions.

1. **Opening and Review of the Agenda:**

George Fechtmann welcomed the participants, both Ad Hoc members and observers, and opened the meeting with self introductions. George provided a brief background, indicating the Ad Hoc had been assembled to review the existing UL746C construction and performance requirements with respect to concerns regarding the potential fire hazard of plastics used in electrical products. This was the fifth meeting of the Ad Hoc group.

William King also welcomed the participants on behalf of the CPSC.

The agenda distributed with the memo dated April 27, 1998 was accepted.

2. **CPSC Test Program:**

William King provided background information on the CPSC proposal with regard to the enclosure flammability requirements of UL746C. The CPSC proposal has evolved into the following three objectives: 1) better definition of "attended" vs. "unattended" portable appliances, 2) clearly defined locations for application of the test flame during end-product tests, and 3) elimination of the exception for insulated component parts.

Hammad Malik provided an overview of the CPSC project on "Assessment of Thermoplastic Enclosure Flammability." Electrical products were selected based on incident reports that included plastic parts that may have ignited. These products were purchased, specimens cut from the molded finished plastic parts and small-scale flammability tests conducted. Hammad indicated that in many cases the test results were not as anticipated. Completion of the CPSC in-house review of the report is anticipated within the next few weeks. The CPSC intends to send the report to all Ad Hoc members.

One of the Ad-Hoc members requested clarification on whether the CPSC had issue with the potential ignition of plastic parts of electrical products from an external fire source. The CPSC confirmed that their concern is regarding the potential fire hazard relating to the likelihood of ignition of the product's plastic parts and propagation of fire from inside the product to its environment (inside to outside).

One of the Ad-Hoc members asked if the CPSC had a threshold incident rate to determine the critical level at which they would take action. The CPSC indicated there has been a decline in household fires in general; however, fires related to wiring and appliances have not declined. It was reported the CPSC has a goal to reduce the rate of fires in these areas and that it is addressing the use of polymeric materials in electrical appliances, the construction of countertop cooking appliances, and appliance design improvements. It was indicated that statistically these fire incidents are rare events, but collectively represent an important issue.

It was noted that an across-the-board increase in flammability requirements may subsequently require the use of flame retardants that, for some polymers, may contain halogens or bromine. It was reported that some groups are opposed to the use of these flame retardants due to environmental concerns. The CPSC indicated their primary responsibility is to consumers in this country and preventing fires in electrical products and that this outweighs environmental concerns with the use of flame retardants.

It was also noted that efforts are underway to harmonize U.S. and International standards. UL indicated that it intends to promote requirements that are technically appropriate for the specific application.

3. **Review of Recommendations for Revision of UL746C:**

The Chairman reviewed the actions recently taken by UL involving UL746 revisions covering polymeric parts. Requirements for creep have been moved from UL746A to UL746C. UL has issued a proposed first edition of UL 60335-1 for Household Appliances, based primarily on IEC 335-1, with minor national deviations.

In addition, work was started on an international guidance document based on UL746C. It has been planned to 1) more clearly define the end-product flame tests, including examples and reference to connections for application of the test flame; 2) better define "attended" vs. "unattended," wherein the definition of "attended" would only apply to products where there is a high level of confidence that an operator would be present, such as when the equipment is provided with a momentary contact switch; and 3) add requirements for electrical connections within products, wherein a polymeric part spaced 3 mm or less from connections may be subject to Glow Wire and Ball Pressure tests. The requirements in Tables 5.1 and 6.1 would be combined into one table describing specific end product tests and Table 8.1 will be revised to specify preselection tests and requirements for polymeric materials located near electrical connections.

Background information on "UL 60335-1 Resistance to Heat and Fire Concepts" and a draft of the proposed revisions to UL 746C were distributed, see Attachments B and C respectively. UL indicated that a formal proposal for revision of UL746C would be distributed in preparation for the 746 IAG meeting scheduled for October 14, 1998. The CPSC suggested the proposal also be distributed to the connector industry.

It was noted that it would be useful to compare (1) Glow Wire Ignition vs. Hot Wire Ignition test data and (2) Needle Flame vs. V-0, V-1, V-2 test results. UL indicated that a research project will be developed to cover this comparison work.

The CPSC applauded the initiative, especially with regard to electrical connections, and indicated they intend to further review the Glow Wire and Ball Pressure tests.

4. **Fault Model Development and Plastics Data - Ignition Related Characteristics:**

Bob Davidson presented a Generic Enclosure Fire Fault Tree, see Attachment D. This fault tree addresses Scenario 6, presented at the February 11, 1998 Ad Hoc meeting, where a flaming enclosure part propagates fire to the surrounding environment. The arrows on the figure suggest methods to prevent such an occurrence. For example, the top right two boxes represent areas where operator intervention could prevent propagation of fire and could be applied to operator attended products. The letters in triangles are loop markers. For example, the bottom left section of the fault tree either loops back to the "Internal Flame Heat Source (B)" or the "Internal Electrical Heat Source (A)." Working through the fault tree, the ultimate root cause of fire would be an internal electrical heat source. It was noted that the fault tree would not be developed into a standard, but could be used as a tool to develop a new standard or evaluate an existing standard or to better understand underlying principles. It was agreed to continue development of the fault tree, with Bob Davidson and Rich Nute to develop the bottom half of the figure on electrical energy sources.

It was reported that plastics data on ignition related characteristics is indicating a temperature of at least 300°C is needed for ignition of plastics. Additional information is also needed to address the minimum energy level that constitutes a risk of fire. It was proposed this be handled under a Plastics Research Project.

5. **Computer Model to Study Energy Transfer:**

It was agreed that further work on a computer model for electrotechnical products would not be pursued at this time.

6. **Action Items:**

Move forward with proposals for UL746C.

Follow-up on status of proposal for courses to be developed on Hazard-Based Safety Engineering (HBSE).

Develop Plastics Research Project Proposals for the following:

1) Develop data for correlation of Glow Wire Ignition vs. Hot Wire Ignition and Needle Flame vs. V-0, V-1, V-2 - Richard Ross (UL)

2) Complete development of the Fault Model and prepare a guidance document - Bob Davidson (UL) and Richard Nute (Hewlett-Packard)

3) Develop test data needed to define the minimum energy level that constitutes a risk of fire - Bob Davidson (UL) and Richard Nute (Hewlett-Packard)

The next meeting was scheduled for October 15, 1998 at 8:30 a.m. at UL's Melville office.

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# APPENDIX C

## MEETING OF THE IAG FOR PLASTIC MATERIALS

## ITEM 4. FLAMMABILITY AD HOC COMMITTEE REPORT; PROPOSED REVISIONS FOR UL 746C

For your convenience in review, proposed additions to existing requirements are shown underlined and proposed deletions are shown ~~lined-out~~. Proposed new requirements are identified by (NEW). In the case of extensively revised paragraphs, the original text is identified by (CURRENT) and is ~~lined-out~~, followed by the proposed text identified by (PROPOSED). A paragraph that is proposed to be deleted is identified by (DELETED) and is shown ~~lined-out~~.

### PROPOSED EFFECTIVE DATE

All of the changes shown in this Appendix are proposed to become effective 5 years from the date revised pages of the standard are issued.

**3 Glossary**

3.3.1 (NEW) ATTENDED EQUIPMENT – Equipment intended for use where operator presence is required or where operator presence is essential for equipment function but not required for the equipment to operate. This equipment could possibly be left running, but the time of such unattended operation is effectively limited to a short duration due to one or more characteristics of the equipment, such as production of excessive noise or vibrations. Examples include hand-held drills, electric knives, hand-held hair dryers, blenders, and vacuum cleaners

3.6.1 (NEW) CONNECTION – The attachment of two or more component parts so that electrical conduction can take place between them. Examples of the manner in which connections are made are by solder, crimp, quick-connect terminal, screw, wire nut, and the like. For the purpose of applying this definition, metallurgical joints (welds) are not considered as connections.

3.13.1 (NEW) GLOW WIRE END-PRODUCT TEST (GWEPT) – A test performed by applying an electrically heated wire, at a predetermined temperature, to a part under investigation. This test is described in Section 73.

~~3.14 GLOW WIRE IGNITION TEST ON END PRODUCT (GWIT) – Glow wire resistance to ignition performance is expressed as the number of seconds required to ignite a specimen by an electrically heated bar operating at a specified temperature. This test is described in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.~~

<u>3.14 GLOW WIRE IGNITABILITY TEMPERATURE (GWIT) – The glow wire ignitability temperature is expressed as 25°C below the temperature of an electrically heated wire that causes ignition of standardized test specimens. This test is described in the Standard for Polymeric Materials - Short Term Property Evaluations, UL 746A.</u>

3.21.1 (NEW) INTERMITTENT OPERATION EQUIPMENT – Operation in a series of specified cycles each composed of a period of operation under NORMAL LOAD, followed by a rest period with the equipment switched off or running idle.

3.34.1 (NEW) UNATTENDED EQUIPMENT – Equipment intended for use where operator presence is not required or essential for the equipment to function. Operator absence is likely while this equipment is functioning. Examples include, flatirons, toasters, electric fry pans, and coffee makers.

## 4 General

~~4.1 The requirements for polymeric enclosures, or parts of enclosures of appliances and equipment are contained in Sections 5 – 7.~~

4.1 Equipment having an enclosure, or parts of the enclosure, comprised of polymeric material shall comply with the applicable requirements in Table 4.1.

4.2 (NEW) The requirements in this Section, do not cover the additional considerations that must be given to enclosure materials exposed to oils, acids, solvents, cleaning agents, and the like in use. The performance of the material shall not be adversely affected by such environments (if encountered in the end-use application) as determined by applicable tests as detailed in the Standard for Polymeric Materials – Short Term Property Evaluation, UL 746A.

4.3 (NEW) Polymeric material used to enclose a metal housing that encloses insulated or uninsulated live parts or as a decorative part, shall be classed either 5VA, 5VB, V-0, V-1, V-2, or HB by the burning tests described in the requirements for tests for flammability of plastic materials, UL 94, and comply with the Flame Spread requirements in Section 21 for large mass applications.

Exception No. 1: Decorative parts are not required to be made of a material classed 5VA, 5VB, V-0, V-1, V-2, or HB, providing the part: does not occupy a volume greater than 2 cubic centimeters (0.122 cubic inch), does not have any dimension greater than 3 cm (1.18 inch), and is located so it cannot propagate flame from one area to another or bridge between a possible source of ignition and other ignitable parts.

Exception No. 2: A material is to be considered equivalent if it complies with the requirements in 17.1, 51.1 – 51.5, 19.1, 53.1 – 53.5, when flame tested as used in the equipment. The use of a flame-retardant coating applied to the inside of a polymeric enclosure is not acceptable unless the coating/material interface is found to be acceptable by separate investigation (see Flame-Retardant Coatings, Section 22).

Table 4.1 (NEW)

**Table 4.1**
**Enclosure Requirements**

| Type of Equipment | Portable | Portable | Stationary And Fixed |
|---|---|---|---|
| Type of Use | Attended | Unattended | |
| Applicable requirements shown below | | | |
| **Minimum Flammability Rating** | HB[a,d] | V[b,d] | 5VA[c,d] |
| Material Properties per Table 8.1 | Yes | Yes | Yes |
| Impact Test per Section 24 | Yes | Yes | Yes |
| Crush Resistance per 23.1 | No | No | Yes |
| Abnormal Operations Test per 28.1 | Yes | Yes | Yes |
| Severe Conditions Test per 29.1 | Yes[e] | No[e] | Yes |
| Mold-Stress Relief Distortion per Section 30.1 | Yes[f] | Yes[f] | Yes[f] |
| Input after Mold-Stress Relief per 31.1 | Yes[e] | No[e] | Yes |
| Strain Relief Test per 32.1 | Yes[g] | Yes[g] | Yes[g] |
| UV Resistance per 26.1 | Yes[h] | Yes[h] | Yes[h] |
| Water Exposure and Immersion per Sec. 27 | Yes[i] | Yes[i] | Yes[i] |
| Dimensional Stability per 27.2 | Yes | Yes | Yes |
| Conduit Connections | No | No | Yes[j] |

[a] HB or the enclosure complies with the 12 mm or 20 mm end-product flame tests as described in section 17 and 18 respectively.

[b] V=V-0, V-1 or V-2 classed materials, or the enclosure complies with the 12 mm or 20 mm end-product flame tests as described in section 17 and 18 respectively. Exception: an HB enclosure material is acceptable if all internal polymeric materials comply with the requirements of Table 8.1.

[c] 5VA or the enclosure complies with the 127 mm end-product flame tests as described in section 19.

[d] May require flame spread per section 21.

[e] This test is only required for materials that are rated HB or did not comply with the 12mm or 20mm end-product flame tests per note b above.

[f] Mold-Stress Relief for HB enclosures use section 62.2. For V or 5VA enclosures use section 62.1.

[g] This test is only required if the means of strain relief is secured to the enclosure or is an integral part of the polymeric enclosure.

[h] This test is only required if the equipment is constructed such that exposure to outdoor weather conditions or UV radiation could increase the risk of fire, electric shock or injury to persons.

[i] This test is only required if the equipment is constructed such that exposure to water could increase the risk of fire, electric shock, or injury to persons.

[j] This test is only required if the equipment is permanently connected electrically in the wiring system. The continuity to the conduit system shall be a metal-to-metal contact. If the integrity of the polymeric enclosure is relied upon to provide for bonding between the parts of the conduit system at any location where conduit may be connected, the bonding shall be evaluated by the requirements contained in the Standard for Enclosures for Electrical Equipment, UL 50. If the polymeric enclosure is intended for connection to a rigid conduit system, it shall acceptably perform when tested using the pullout, torque and bending tests as described in the Standard for Industrial Control Equipment, UL 508.

**5 Portable Appliances** – Section Deleted (applicable requirements for Portable Appliances moved to Section 4)

~~5.1 Portable appliances having an enclosure of polymeric material shall comply with the applicable requirements in Figure 5.1. The use of Figure 5.1 is explained in 5.7 – 5.11.~~

~~5.2 The requirements in Portable Appliances, Section 5, do not cover the additional considerations that must be given to enclosures employing large masses of polymeric materials. Whether or not such enclosures reduce the risk of electric shock or fire, or both, consideration should be given to the probability of ignition of the material by sources within the equipment or by external sources.~~

~~5.3 A polymeric material which can contact electrically live parts, or is within 0.79 mm (1/32 inch) of uninsulated live parts, shall comply with the requirements indicated in Table 8.1.~~

~~5.4 The requirements in Portable Appliances, Section 5, do not cover the additional considerations that must be given to enclosure materials exposed to oils, acids, solvents, cleaning agents, and the like in use. The performance of the material shall not be adversely affected by such environments (if encountered in the end-use application) as determined by applicable tests as detailed in the Standard for Polymeric Materials – Short Term Property Evaluation, UL 746A.~~

~~5.5 The thermal endurance of a polymeric material shall be considered with respect to the requirements in Sections 33 – 38.~~

~~5.6 Polymeric material used to enclose a metal housing that encloses insulated or uninsulated live parts or as a decorative part, shall be classed either 5VA, 5VB, V-0, V-1, V-2, or HB by the burning tests described in the requirements for tests for flammability of plastic materials, UL 94.~~

*~~Exception No. 1: Decorative parts are not required to be made of a material classed 5VA, 5VB, V-0, V-1, V-2, or HB, providing the part: does not occupy a volume greater than 2 cubic centimeters (0.122 cubic inch), does not have any dimension greater than 3 cm (1.18 inch), and is located so it cannot propagate flame from one area to another or bridge between a possible source of ignition and other ignitable parts.~~*

*~~Exception No. 2: A material is to be considered equivalent if it complies with the requirements in 17.1, 51.1 – 51.5, 19.1, 53.1 – 53.5, when flame tested as used in the equipment. The use of a flame-retardant coating applied to the inside of a polymeric enclosure is not acceptable unless the coating/material interface is found to be acceptable by separate investigation (see Flame Retardant Coatings, Section 22).~~*

**Figure 5.1 – Deleted**
**Enclosure requirements for portable appliances**

~~5.7 The path shown on Part 1 of Figure 5.1 that matches the conditions of use for the polymeric material under consideration determines the requirements to be met.~~

~~5.8 Following the path in Part 1 of Figure 5.1 (selected using 5.7) leads to Part 2 and the applicable material requirements. It may be necessary to determine whether the equipment is of an attended, intermittent-duty, household-use type before the applicable material requirements can be selected.~~

~~5.9 Part 2 of Figure 5.1 indicates the required tests (marked with a "yes" and with a footnote reference if necessary) under the applicable path determined in Part 1 of Figure 5.1.~~

~~5.10 For example, a polymeric material used to enclose uninsulated live parts, such as a heating element, of an unattended household-use electric toaster, shall only be made from a V-rated material (second path from the left of Figure 5.1), specifically either V-0, V-1, V-2 or a material that complies with the requirements in 17.1, and 51.1 – 51.5.~~

~~5.11 Using this example, the material shall comply with the applicable requirements for:~~

~~a) Hot-wire ignition per Section 14,~~

~~b) Resistance to impact per 24.1 and 57.3,~~

~~c) Mold-stress-relief distortion per 62.1,~~

~~d) Creep per Section 24A,~~

~~e) Strain relief per 32.1,~~

~~f) Abnormal operation per 28.1,~~

~~g) Enclosure flammability per Section 17 or 18.~~

~~h) Mechanical/electrical properties per Table 8.1, and~~

~~i) Thermal endurance per Sections 33 – 39.~~

**6 Fixed or Stationary Equipment** – Section Deleted (applicable requirements for Fixed or Stationary Equipment moved to Section 4)

~~6.1 Electrical equipment that is fixed or stationary and not easily carried or conveyed by hand and that has an enclosure of polymeric material shall comply with the applicable requirements in Table 8.1 and Figure 6.1. The use of Figure 6.1 is explained in 6.7 – 6.11.~~

~~6.2 The requirements in Fixed or Stationary Equipment, Section 6, do not cover the additional considerations that must be given to enclosures employing large masses of polymeric materials. Whether or not such enclosures protect against electric shock and/or the likelihood of fire, consideration should be given to the probability of ignition of the material by sources within the equipment or by external sources. See 21.1 for large mass flammability considerations.~~

~~6.3 A polymeric material used for the support of electrically live parts, shall comply with the requirements indicated in Table 8.1.~~

~~6.4 The requirements in Fixed or Stationary Equipment, Section 6, do not cover the additional considerations that must be given to enclosure materials exposed to oils, acids, solvents, cleaning agents, and the like in production equipment. The performance of the material shall not be adversely affected by such environments (if encountered in the end-use application) as determined by applicable tests as detailed in the Standard for Polymeric Materials – Short Term Property Evaluation, UL 746A.~~

~~6.5 See Sections 33 – 39 for considerations of thermal endurance and Mechanical/Electrical Property Considerations, Section 8, for additional considerations of the mechanical/electrical properties of enclosure materials.~~

~~6.6 Polymeric material used to enclose a metal housing that encloses insulated or uninsulated live parts or as a decorative part, shall be classed either 5VA, 5VB, V-0, V-1, V-2, or HB by the burning tests described in the requirements for tests for flammability of plastic materials, UL 94.~~

~~*Exception No. 1: Decorative parts are not required to be made of a material classed 5VA, 5VB, V-0, V-1, V-2, or HB, providing the part: does not occupy a volume greater than 4000 cubic millimeters (0.24 cubic inch), does not have any dimension greater than 60 mm (2.4 inch) and is located so it cannot propagate flame from one area to another or bridge between a possible source of ignition and other ignitable parts.*~~

~~*Exception No. 2: A material is to be considered equivalent if it complies with the requirements in 17.1, 51.1 – 51.6 or 19.1, 53.1 – 53.5, when flame tested as used in the equipment. The use of a flame-retardant coating applied to the inside of a polymeric enclosure is not acceptable unless the coating/material interface is found to be acceptable by separate investigation (see Flame Retardant Coatings, Section 22).*~~

~~6.7 The path shown on Part 1 of Figure 6.1 that matches the conditions of use for the polymeric material under consideration determines the requirements to be met.~~

~~6.8 Following the path in Part 1 of Figure 6.1 (selected using 6.7) leads to the applicable requirements and the test considerations to be considered in Part 2 of Figure 6.1.~~

~~6.9 Part 2 of Figure 6.1 indicates the required tests (marked with a "yes" and with a footnote reference if necessary) under the applicable path determined in Part 1 of Figure 6.1.~~

**Figure 6.1 – Deleted**
**Enclosure requirements for fixed or stationary equipment**

~~6.10 For example, a polymeric material used to enclose uninsulated live parts (such as the motor windings) of a permanently wired, indoor-use ceiling fan shall be made from a 5VA classed material or a material that complies with the requirements in 19.1, 53.1 – 53.5.~~

~~6.11 Using the above example, the material shall also comply with the applicable requirements for:~~

~~a) Electrical/mechanical properties per Table 8.1,~~

~~b) Dielectric strength per 12.1,~~

~~c) Flammability testing per Flammability – 127 mm (5 inch) Flame, Section 19 and Enclosure Flammability – Large Mass Considerations, Section 21,~~

~~d) Crushing resistance per 23.1,~~

~~e) Resistance to impact per 24.1 and 24.3,~~

~~f) Dimensional change per 27.3,~~

~~g) Abnormal operation per 28.1,~~

~~h) Severe conditions per 29.1,~~

~~i) Mold stress-relief distortion per 62.1,~~

~~j) Input after mold stress-relief distortion per 31.1,~~

~~k) Creep per Section 24A.~~

~~l) Conduit connections per footnote h of Figure 6.1, and~~

~~m) Thermal endurance per Sections 33 – 39.~~

**7 Alternate Enclosure Material Considerations** – Section Deleted (applicable requirements moved to Appendix A)

~~7.1 From time-to-time, it may be necessary to select alternative or substitute materials for use as an enclosure. These considerations apply only to alternate materials for a given part. Changes in part dimensions and, in particular, reductions in material thickness, generally require an evaluation using all the end-product tests.~~

~~7.2 It may not be necessary that a complete series of end-product tests be required, provided that equivalent or better material properties can be demonstrated by standardized small scale tests on the candidate material when compared to the properties of a material having acceptable application performance.~~

*~~Exception: A candidate material that does not provide equivalent material properties to the properties of a material having acceptable application performance, may be acceptable providing that the candidate material possesses the minimum performance level required in Figure 5.1 or 6.1 for the application.~~*

~~7.3 Table 7.1 indicates general guidelines that can be used to evaluate alternate or substitute materials if small-scale test data is available. It should be noted that these guidelines apply to substitutions within the same class of materials (thermoplastic to thermoplastic and thermoset to thermoset).~~

~~7.4 Except as indicated in Table 7.1, if the originally tested material was considered acceptable based upon special tests (for example, determining the resistance of the material to ultraviolet light for an outdoor application or tests required by the end-product standard such as resistance to creep, endurance, and overload), these tests are to be conducted on the candidate material to determine acceptability.~~

~~7.5 In Table 7.1, the material property parameters are tabulated in column 1. Acceptance guidelines for those situations where the candidate material properties are equivalent to or better than the characteristics of the original material are tabulated in column 2.~~

~~7.6 Column 3 of Table 7.1 indicates the required end-product tests if the candidate material properties are not equivalent to the original material properties.~~

~~7.7 As an example, if the original enclosure material was a Type 66 nylon (PA66) and the candidate material is a polycarbonate (PC), then for each property parameter tabulated in column 1, the end-product test in column 3 would be required if the candidate material properties are not equivalent to the original material properties.~~

(Deleted)

**Table 7.1**
**Alternative enclosure material consideration**

| ~~Material property parameters (Column 1)~~ | ~~Candidate material characteristics, equivalent or better than characteristics of the original material considered acceptable for the application (Column 2)~~ | ~~Candidate material characteristics not equivalent to original material characteristics (Column 3)[a]~~ |
|---|---|---|
| ~~FLAMMABILITY~~<br><br>~~UL 94 flammability classification at use thickness and color~~ | ~~Candidate Material Considered Acceptable~~ | ~~Conduct flame test on part or enclosure (See Flammability – 12 mm Flame, Section 17, Flammability – 127 mm (5 inch) Flame, Section 19, Enclosure Flammability – Large Mass Considerations, Section 21)~~ |
| ~~ELECTRIC STRENGTH~~<br>~~(1) Volume resistivity,~~<br>~~and~~<br>~~(2) Dielectric Strength~~ | ~~Candidate Material Considered Acceptable~~ | ~~Conduct end-product:~~<br>~~(1) leakage current tests or insulation resistance~~<br>~~(2) See 12.1~~ |
| ~~TRACKING RESISTANCE~~<br>~~Comparative tracking resistance under moist conditions, or Inclined Plane Tracking~~ | ~~Candidate Material Considered Acceptable~~ | ~~Increase spacings~~ |
| ~~PERMANENCE~~<br>~~(outdoor equipment only)~~<br>~~Dimensional change after water exposure. Also see 7.4~~ | ~~Candidate Material Considered Acceptable~~ | ~~Conduct rain/humidity/immersion tests on end-product~~ |
| ~~RESISTANCE TO ELECTRICAL IGNITION~~<br>~~(1) Hot- wire ignition,~~<br>~~and~~<br>~~(2) High current arc resistance~~ | ~~Candidate Material Considered Acceptable~~ | ~~Conduct end-product:~~<br>~~Abnormal Overload Test (See Hot Wire Ignition (HWI) – Abnormal Overload Test, Section 14)~~<br>~~Arc Resistance Test (See 13.3 – 13.5)~~ |

(Continued)

**(Deleted)**

**Table 7.1 (Cont'd)**
**Alternative enclosure material consideration**

| | | |
|---|---|---|
| ~~**MECHANICAL**~~<br><br>~~Tensile or Flexural Strength and Tensile Strength and Tensile or Izod Impact~~ | ~~See note b below for candidate material of same basic composition as original material. For candidate material of different composition from original material, conduct end-product impact, strain relief, and loading tests such as crush resistance – see Crushing Resistance, Section 23.~~ | ~~Conduct end product impact, strain relief and loading tests such as crush resistance – see Crushing Resistance, Section 23.~~ |
| ~~**MOLD STRESS RELIEF**~~ | ~~All alternative or substitute materials are to be subjected to end-product mold stress-relief tests (see Mold Stress-Relief Distortion, Section 30), unless;~~<br>~~a) The candidate material is of the same basic composition,~~<br>~~b) The candidate material has equivalent or higher small scale heat deflection, vicat softening, or ball pressure temperature. Mold stress-relief tests are not required for thermosets.~~ | |
| ~~**CREEP**~~ | ~~All alternative or substitute materials are to be subjected to end product creep tests (see Section 24A) unless:~~<br>~~a) The candidate material is of the same basic composition~~<br>~~b) The candidate has equivalent or higher small scale heat deflection, vicat softening, or ball pressure temperature indexes.~~<br>~~c) The candidate has equivalent creepage characteristics based on tests and/or test data (Note – the test results being compared must have the same test parameters).~~<br>~~Creep evaluations are not required for rigid thermoset materials.~~ | |
| ~~**MAXIMUM USE TEMPERATURE**~~ | ~~Refer to Sections 33 – 39~~ | |
| ~~**SPECIAL END-USE CONSIDERATIONS**~~[e] | ~~If indicated by the applicable path in Figure 5.1 or 6.1, all alternative or substitute materials are to be subjected to the abnormal operation (28.1) and severe conditions tests (29.1), unless the candidate material is of the same basic composition.~~ | |

[a] ~~See the Exception to 7.2.~~

[b] ~~All alternative or substitute materials are to be subjected to end-product impact tests (see Resistance to Impact, Section 24) unless:~~

~~a) The candidate material is of the same basic composition as defined in 3.31, and~~

~~b) The candidate material has equivalent or higher small scale tensile impact or Izod impact strength.~~

[e] ~~See 7.4~~

**ELECTRICAL INSULATION**

**8. Material ~~Mechanical/Electrical~~ Property Considerations**

8.1 General

8.1.1 Mechanical and electrical properties of materials are to be judged with respect to the particular "end use" application. The requirements in this Section ~~Mechanical/Electrical Property Considerations, Section 8, are intended to~~ establish general minimum ~~acceptable~~ requirements for ~~those~~ applications where the polymeric material is relied upon to reduce the risks of fire and electric shock. ~~In the case where the material's characteristics do not meet the minimum performance levels specified, recommended engineering considerations will be made.~~

8.1.2 These requirements do not cover the additional considerations that must be given to applications employing large masses of polymeric materials. Whether or not such materials protect against electric shock or injury to persons, consideration is to be given to the likelihood of ignition of the material by sources inside the product or by sources outside the product. See Section 21 for Flame Spread requirements to be applied to large mass applications ~~for large mass flammability considerations~~.

~~8.1.3 These requirements alone do not cover enclosures that provide mechanical support of electrically live parts. For evaluation of such enclosures, Figure 5.1 or 6.1 is to be used in addition to the requirements in Mechanical/Electrical Property Considerations, Section 8~~

8.1.3 These requirements supplement the requirements for enclosures in Section 4.

~~8.1.4 Using Figure 8.1 as a guide, the figurative examples that match the application of the material under consideration determine the applicable properties tabulated in Table 8.1. A material shall provide acceptable levels of performance for each of these applicable properties tabulated in Table 8.1.~~

*~~Exception: End product tests may be used to determine if the material is acceptable in the application, as indicated in Table 8.2.~~*

8.1.4 Figure 6.1 is to be used as a guide to determine the applicable material-property requirements. First, the construction features found in the end product are to be matched to the Figurative examples given in Figure 8.1. By referring back to Table 8.1, it can be determined which minimum property vales are required for each of the typical constructions (Figurative examples).

Exception: End product tests may be used instead of preselection tests to determine if the material is acceptable in the application, as indicated in Table 8.2.

Note - As an example of using Table 8.1 and Figure 8.1, a polymeric material used in an application that most closely matches figurative example No. 7 of Figure 8.1, would be evaluated with respect to the distortion under load and mold-stress relief, creep, and maximum-use temperature properties indicated in Table 8.1.

~~8.1.5 For example, a polymeric material used in an application that most closely matches figurative example No. 6 of Figure 8.1, would be evaluated with respect to the distortion under load and mold-stress relief, creep, and maximum-use temperature properties indicated in Table 8.1.~~

8.1.6 To determine a polymeric material's performance profile, certain tests are to be performed according to the methods contained in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A and the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B. These tests, general engineering considerations, and minimum performance levels are tabulated in Table 8.1. Specific applications may require different limits than are shown in the general case. Refer to ~~8.2.1 and 8.2.2~~ 8.2 for considerations to be used in determining the acceptability of an insulating material that does not meet with the requirements tabulated in Table 8.1.

8.1.7 In establishing acceptable performance levels, consideration has been given to the service experience and to property values of presently available materials. Minimum performance characteristics have been grouped into four distinct levels based upon a material's flammability classification. The basis for the grouping is a relationship developed between resistance to ignition and persistence or rate of burning.

(no change – 8.1.7 shown for reference)

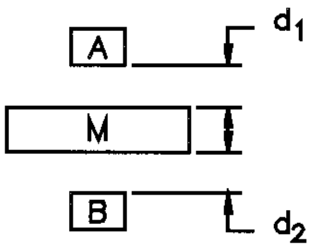
8.1.8 Nonrigid foamed materials – having a tensile or flexural modulus less than 0.69 gigapascals (100,000 $lbf/in^2$), and a density less than 0.5 gram per cubic centimeter (31.3 $lb/ft^3$) – are generally not considered acceptable for the direct or indirect support of live parts.

(no change – 8.1.8 shown for reference)

(OLD)

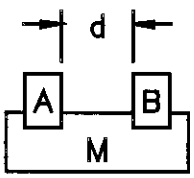
**Figure 8.1**
**Figurative examples for Table 8.1**

1.



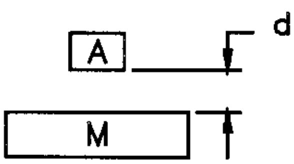

$d_1 + d_2 < S_a$
WHERE $d_1$ , $d_2$ = THROUGH AIR SPACING
$S_a$ = APPLICABLE THROUGH AIR SPACING REQUIREMENT

2.



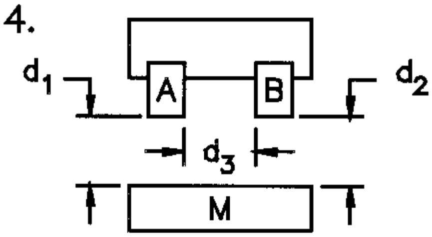

$d < 12.7mm$
WHERE d = OVER SURFACE SPACING

3.




$0 \leq d < 0.8mm$
WHERE d = THROUGH AIR SPACING

4.



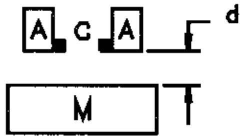

$d_1$ , $d_2 < 0.8mm$
$d_3 < 12.7mm$
WHERE $d_1$ , $d_2$ = THROUGH AIR SPACINGS
$d_3$ = OVER SURFACE SPACING

S3463B-1

(OLD)

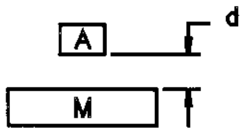
**Figure 8.1 (Cont'd)**
**Figurative examples for Table 8.1**

5.



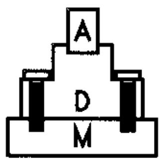

d < 12.7mm
WHERE d = THROUGH AIR SPACING
C = ELECTRICAL CONTACTS, e.g.
SWITCH CONTACTS,
RELAY CONTACTS,
BRUSH/COMMUTATOR CONTACTS

6.



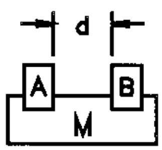

0.8mm ≤ d < 12.7mm
WHERE d = THROUGH AIR SPACING

7.




D = ACCEPTABLE INSULATING MATERIAL
IN CONTACT WITH "A" AND MOUNTED
ON "M" BY SCREWS

8.




d ≥ 12.7mm

A = UNINSULATED LIVE PART

B = (1) UNINSULATED LIVE PART HAVING DIFFERENCE IN POTENTIAL FROM A, OR
(2) DEAD METAL PART THAT MAY BE GROUNDED IN SERVICE OR IS EXPOSED TO CONTACT.

M = POLYMERIC MATERIAL UNDER CONSIDERATION

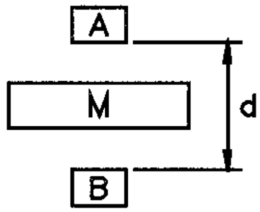
Note: (1) ALL SPACINGS ASSUMED TO BE RELIABLY MAINTAINED.
(2) UNLESS SHOWN IN CONTACT WITH "M", ALL LIVE PARTS ARE SUPPORTED BY STRUCTURES NOT DEPENDENT ON "M".

S3483B-2

**(NEW)**

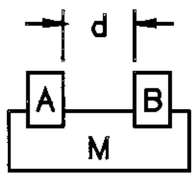
**Figure 8.1**
**Figurative examples for Table 8.1**

1.



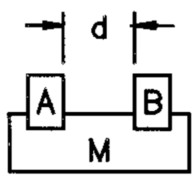

WHERE d = THROUGH AIR SPACING

2.



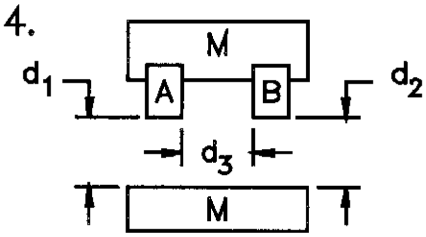

d < 12,7mm
WHERE d = OVER SURFACE SPACING

3.




d ≥ 12,7mm
WHERE d = OVER SURFACE SPACING

4.



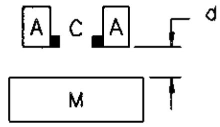

$d_1$ , $d_2$ < 0.8mm
$d_3$ < 12.7mm
WHERE $d_1$ , $d_2$ = THROUGH AIR SPACINGS
$d_3$ = OVER SURFACE SPACING

S3463C-1

**(NEW)**

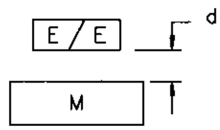
**Figure 8.1 (Cont'd)**
**Figurative examples for Table 8.1**

5.



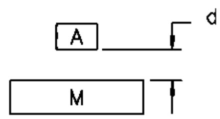

d < 12.7mm
WHERE d = THROUGH AIR SPACING

–OR–



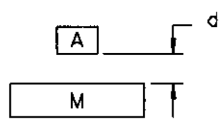

d < 12.7mm
WHERE d = THROUGH AIR SPACING

6.



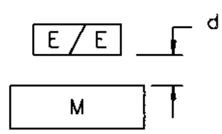

0 ≤ d < 0.8mm
WHERE d = THROUGH AIR SPACING

7.



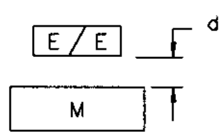

0.8mm ≤ d < 12.7mm
WHERE d = THROUGH AIR SPACING

8.



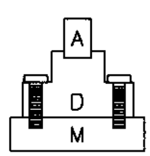

0 ≤ d ≤ 3mm

9.




d > 12.7mm

10.




D = ACCEPTABLE INSULATING MATERIAL IN CONTACT WITH "A" AND MOUNTED ON "M" BY SCREWS

S3463C-2

(NEW)

**Figure 8.1 (Cont'd)**
**Figurative examples for Table 8.1**

A = UNINSULATED LIVE PART

B = (1) UNINSULATED LIVE PART HAVING DIFFERENCE IN POTENTIAL FROM A, OR
(2) DEAD METAL PART THAT MAY BE GROUNDED IN SERVICE OR IS EXPOSED TO CONTACT.

C = ELECTRICAL CONTACTS (SUCH AS SWITCH, RELAY, OR BRUSH/COMMUTATOR CONTACTS

E = ELECTRICAL CONNECTIONS INVOLVING LIVE PARTS (OTHER THAN SOLDERED CONNECTIONS)

M = POLYMERIC MATERIAL UNDER CONSIDERATION

Note: (1) ALL SPACINGS ASSUMED TO BE RELIABLY MAINTAINED.
(2) UNLESS SHOWN IN CONTACT WITH "M", ALL LIVE PARTS ARE SUPPORTED BY STRUCTURES NOT DEPENDENT ON "M".

S3463C-3

**Table 8.1**
**~~Mechanical/electrical~~ Material property considerations**

| Property | Test | Method | Units or PLC | Recommended levels related to flammability classification[a] | | | | Appli |
|---|---|---|---|---|---|---|---|---|
| | | | | V-0 VTM-0 | V-1 VTM-1 | V-2 VTM-2 | HB | |
| **ELECTRIC STRENGTH** | Volume - resistivity (Sec. 16) | UL 746A | Min Ohm-cm (dry) | $50 \times 10^6$ | $50 \times 10^6$ | $50 \times 10^6$ | $50 \times 10^6$ | Material serves as in uninsulated live part or between uninsula dead metal parts tha service or (2) any su contact |
| | | | Min Ohm-cm (after 90% humidity) | $10 \times 10^6$ | $10 \times 10^6$ | $10 \times 10^6$ | $10 \times 10^6$ | |
| | Dielectric strength (Sec. 12) | UL 746A | Min V (rms) (both dry & after 90% humidity) | 5000 | 5000 | 5000 | 5000 | Same as above |
| **TRACKING RESISTANCE** | Comparative tracking index (CTI) (Sec. 11) | UL 746A | Max.[c] PLC | | | | | Material surface is in close proximity (less mm)) to (a) uninsula opposite polarity, or parts and either (1) may be grounded in surface exposed to |
| | | | | | | | | Higher CTI values ar greater degree of co involved, as follows: |
| | | | | 4 | 4 | 4 | 4 | Indoor equipment ex clean environment |
| | | | | 3 | 3 | 3 | 3 | Outdoor and indoor moderate contamina |

(Continued)

**Table 8.1 (Cont'd)**
**~~Mechanical/electrical~~ Material property considerations**

| Property | Test | Method | Units or PLC | Recommended levels related to flammability classification[a] V-0 VTM-0 | V-1 VTM-1 | V-2 VTM-2 | HB | Applications[b] |
|---|---|---|---|---|---|---|---|---|
| **TRACKING RESISTANCE (Cont'd)** | CTI | UL 746A | Max[c] PLC | 2 | 2 | 2 | 2 | Outdoor and indoor equip exposed to severe conta environments |
| | Inclined-plane tracking | UL 746A | Min time (min) to track 25.4 mm at 2.5 kV excitation | 60 | 60 | 60 | 60 | Same as above for CTI e that the application voltag range is 601 V-5 kV |
| | (See Sec. 15) | | | 300 | 300 | 300 | 300 | Same as above for CTI e that application voltage ra 5,001 V-35 kV |
| **PERMANENCE** | Dimensional change after water exposure (27.2.1) | UL 746A | Max percent change | 2 | 2 | 2 | 2 | ~~Same as Volume Resistiv above but also includes applications where the m maintains the relative pos of live parts and the parts be subjected to high humi moisture~~ Is required only the material serves to mai the relative positioning of parts and the parts could subjected to high humidit moisture |
| ~~**DISTORTION UNDER LOAD**~~ | ~~Heat deflection temperature under load or~~ | ~~UL 746A~~ | ~~Min °C at 66 psi~~ | ~~10°C (18°F) greater than the use temperature but not less than 90°C~~ | | | | ~~All applications except decorative parts~~ |
| | ~~Vicat softening point or~~ | | | ~~25°C greater than the use temperature but not less than 105°C (221°F)~~ | | | | |
| | ~~Ball pressure temperature~~ | | | ~~Greater than the use temperature by the difference between 40°C and the ambient, but not less than 95°C~~ | | | | |
| **THERMAL DISTORTION** | Ball Pressure Temperature (See 30a) | UL 746A | Min°C | At least 40°C greater than the maximum temperature rise as noted during the normal use temperature test, but not less than 125°C. | | | | Material is supporting live |

(Continued)

**Table 8.1 (Cont'd)**
**~~Mechanical/electrical~~ Material property considerations**

| Property | Test | Method | Units or PLC | Recommended levels related to flammability classification[a] V-0 VTM-0 | V-1 VTM-1 | V-2 VTM-2 | HB | Applications[b] |
|---|---|---|---|---|---|---|---|---|
| **DIMENSIONAL CHANGE DUE TO EXTERNAL STRESSES** | Resistance to Creep (Sec. 24A) | UL 746C | | Resistance to creep should be evaluated in the specific application | | | | All applications with mechanical stresses due to external sources |
| **RESISTANCE TO ELECTRICAL IGNITION SOURCES** | High current arc resistance to ignition (HAI) (Sec. 13) | UL 746A | Max PLC[d] | 3 | 2 | 2 | 1 | Material is in contact with or in close proximity to uninsulated live part 0.8 mm (1/32 inch) for nonarcing parts or 12.7 mm (1/2 inch) for arcing parts |
| | Hot wire ignition HWI (Sec. 14) | UL 746A | Max PLC[e] | 4 | 3 | 2 | 2 | Material is in contact with or close proximity to uninsulated live part [less than 0.8 mm (1/32 inch)] |
| | Glow Wire Ignitability Temperature (GWIT) (Sec. 14A.1) | UL 746A | Min °C | N/A | N/A | 750[f] | 750[f] | Material is spaced 3 mm or less from mechanical connections of live parts conducting more than 0.5 A. |
| ~~**MECHANICAL**~~ | ~~Tensile or flexural strength; tensile, Izod, or Charpy impact~~ | ~~UL 746A~~ | ~~MPa KJ/m² or J/m notch~~ | ~~Mechanical strength is judged in the application~~ | | | | ~~Material maintains the relative positioning of live parts or encloses live parts~~ |
| **MAXIMUM USE TEMPERATURE** | Relative thermal index (RTI) (Sec. 37 – 39) | UL 746A | Minimum °C | The maximum operating temperature of the part shall not exceed materials' temperature limit determined by the method, indicated in Table 33.1 (See Sections 33 – 39) | | | | All applications except decorative parts |

(Continued)

**Table 8.1 (Cont'd)**

[a] Materials classed as 5VA and 5VB only by the Vertical Burning Test described in the requirements for tests for flammability of plastic materials for 94, or a material when flame tested as used in the equipment, complies with the requirements in Flammability – 12 mm flame, Section 17, Flamma Flammability – 127 mm (5 inch) flame, Section 19, shall be considered with respect to the recommended performance levels of a material classed as

[b] Materials located in nonhazardous-energy circuitry, as defined in the appropriate end-product standard, shall only be considered with respect to th and mold stress relief, mechanical and maximum use temperature properties except the resistance to electrical ignition sources property may also b less than 12.7 (1/2 inch) from arcing parts or sources of ignition.

[c]

| CT1 Range – Tracking Index (Volts) | Assigned PLC |
|---|---|
| $600 \leq TI$ | 0 |
| $400 \leq TI < 600$ | 1 |
| $250 \leq TI < 400$ | 2 |
| $175 \leq TI < 250$ | 3 |
| $100 \leq TI < 175$ | 4 |
| $0 \leq TI < 100$ | 5 |

[d] During the HAI test, the electrodes are to be positioned as indicated in 13.2

| HAI Range – mean number of arcs to cause ignition | Assigned PLC |
|---|---|
| $120 \leq NA$ | 0 |
| $60 \leq NA < 120$ | 1 |
| $30 \leq NA < 60$ | 2 |
| $15 \leq NA < 30$ | 3 |
| $0 \leq NA < 15$ | 4 |

[e]

| HWI Range – mean ignition time | Assigned PLC |
|---|---|
| $120 \leq IT$ | 0 |
| $60 \leq IT < 120$ | 1 |
| $30 \leq IT < 60$ | 2 |
| $15 \leq IT < 30$ | 3 |
| $7 \leq IT < 15$ | 4 |
| $0 \leq IT < 7$ | 5 |

[f] Glow Wire Ignitability Temperature (GWIT) requirements apply only to unattended equipment per 3.34.1.

8.2 **~~Performance weaknesses~~ Evaluation of Materials Not Meeting Preselection Test Performance Levels in Table 8.1**

~~8.2.1 Some materials may have performance characteristics that are less than those tabulated in Table 8.1. In such cases, the application must be considered or special tests conducted to determine if the reduced value can be accepted without increasing the likelihood of risk for the particular end product.~~

<u>8.2.1 Some materials may have performance characteristics less than the minimum required for the construction type (Figurative example) in Table 8.1. In such cases, the application can be considered in the context of the complete end product construction and special tests conducted to determine if the lower value can be accepted without increasing the likelihood of risk for the particular end-product.</u>

~~8.2.2 Table 8.2 is intended to be used as a guide in determining the acceptability of a material where performance is less than the anticipated level.~~

<u>8.2.2 Table 8.2 indicates which end-product tests, or other considerations such as increased thicknesses or spacings, may be used as alternatives to the requirements in Table 8.1.</u>

**Table 8.2**
**Additional considerations for ~~performance weaknesses~~**
**materials not meeting pre-selection test performance levels**

| Test | | Additional end product considerations |
|---|---|---|
| 1. | Volume resistivity | Conduct end product leakage current test – see 16.1 |
| 2. | Dielectric strength | Use thicker material section – see 12.1 |
| 3. | Comparative tracking index (CTI) | Increase spacings |
| 4. | Inclined Plane tracking | Increase spacings |
| 5. | Permanence | Conduct end product conditioning test – see 27.3 |
| 6. | Distortion under load | Conduct end product mold stress-relief distortion test where stress is internal (i.e, results from molding or fabrication process) – see 30.1<br><br>Conduct end-product creep test where stress is due to externally applied forces – see Section 24A |
| 7. | High current arc ignition (HAI) | Conduct end product arc resistance test – see 13.3 and 13.4 |
| 8. | Hot wire ignition (HWI) | Conduct end product abnormal overload test, or end-product Glow-Wire Test – see Hot-Wire Ignition (HWI)) – Abnormal Overload Test, Section 14 |
| 9. | Maximum Use Temperature | Conduct end product thermal aging test – see Relative Thermal Index, Section 36, Relative Thermal Capability, Section 37, and Temperature Excursions Beyond the Maximum Use Temperature, Section 39 |

9 Internal Barriers (OLD)

~~9.1 A vulcanized fiber barrier or liner having a minimum 0.71 mm (0.028 inch) thickness may be an acceptable alternative to maintaining electrical spacing between live parts of opposite polarity or between uninsulated live parts and accessible metal parts where the maximum temperature does not exceed 90°C (194°F).~~

~~Exception No. 1: 0.33 mm (0.013 inch) thick vulcanized fiber is acceptable if used in conjunction with an air space of at least one-half of the required spacing.~~

~~9.2 A barrier or liner of other than vulcanized fiber, employed where spacings are unacceptable between uninsulated live parts of opposite polarity or between uninsulated live parts and accessible metal parts, shall comply with all of the following:~~

~~a) The barrier or liner shall be of insulating material that complies with Table 9.1.~~

~~b) The minimum thickness of the barrier or liner shall be at least 0.71 mm (0.028 inch), except that 0.33 mm (0.013 inch) is acceptable where used in conjunction with an air space of at least one-half of the required spacing.~~

~~*Exception: The thickness of the barrier may be less than that specified in 9.1 providing that the results of a separate investigation indicate acceptable performance. For example, 0.18 mm (0.007 inch) thick polyethylene terephthalate (PETP) film is considered equivalent to 0.71 mm (0.028 inch) thick vulcanized fiber. Resin-bonded mica 0.15 mm (0.006 inch) thick is considered electrically equivalent to 0.71 mm (0.028 inch) thick vulcanized fiber; however, its use is limited to applications where it is protected from mechanical abuse or movement.*~~

~~c) The barrier or liner shall be equivalent to vulcanized fiber in mechanical strength (tensile strength, tear resistance, puncture strength, creep, and the like) if likely to be subject to mechanical damage. See Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials used in Printed Wiring Boards, UL 746E, Vulcanized Fibre, Section 9, for specific performance indexing data on vulcanized fiber.~~

~~d) The maximum use temperature shall not exceed either the Functional Use Temperature Indices, Section 34, Generic Thermal Indices, Section 35, or the Relative Thermal Index, Section 36, of the barrier material, unless an end-product relative thermal capability evaluation is conducted using the requirements of Relative Thermal Capability, Section 37.~~

~~9.3 A material, that is used as a physical barrier against contact with parts that can cause injury to persons during intended use, cleaning, servicing, or to restrict access to circuitry where there is an increased risk of electric shock, shall comply with the requirements in 9.2.~~

**(Deleted)**

**Table 9.1**
**Material requirements for internal barriers**

| ~~Application~~ | ~~Properties~~ | | | | |
|---|---|---|---|---|---|
| | ~~Resistance to ignition from~~ | | | | |
| | ~~Hot wire (HWI) max. PLC~~[b] | ~~High-current arc (HAI) max. PLC~~[c] | ~~Flammability classification~~[d] | ~~Comparative tracking index (CTI) max. PLC~~[e] | ~~Other criteria~~[f] |
| ~~Used instead of spacings~~ | ~~4 or g~~ | ~~3~~ | ~~V-0 or VTM-0~~ | ~~e, o~~ | ~~i, j, k, l, m, n~~ |
| ~~in contact with live parts~~ | ~~3 or g~~ | ~~2~~ | ~~V-1 or VTM-1~~ | ~~e, o~~ | ~~i, j, k, l, m, n~~ |
| | ~~2 or g~~ | ~~2~~ | ~~V-2 or VTM-2~~ | ~~e, o~~ | ~~i, j, k, l, m, n~~ |
| ~~Used instead of spacings~~ | ~~4 or g~~ | ~~3~~[h] | ~~V-0 or VTM-0~~ | 4 | ~~i, k~~ |
| ~~in conjunction with an~~ | ~~3 or g~~ | ~~2~~[h] | ~~V-1 or VTM-1~~ | 4 | ~~i, k~~ |
| ~~air space~~ | ~~2 or g~~ | ~~2~~[h] | ~~V-2 or VTM-2~~ | 4 | ~~i, k~~ |
| | ~~2 or g~~ | ~~1~~[h] | ~~HB~~ | 4 | ~~i, k~~ |
| ~~Used as a physical barrier only~~ | – | – | ~~V-0 or VTM-0 or V-1 or VTM-1 or V-2 or VTM-2 or~~ | – | ~~k~~ |
| | ~~2 or g~~ | ~~1~~[h] | ~~HB~~ | – | ~~k~~ |

[a] ~~Deleted.~~

[b] ~~Hot Wire Resistance to Ignition – See 3.18.~~

[c] ~~High-Current Arc Resistance to Ignition – See 3.17.~~

[d] ~~Flammability Classification – See 3.13.~~

[e] ~~Comparative Tracking Index – See 3.5 and Comparative Tracking Index (CTI), Section 11.~~

[f] ~~Other criteria; mechanical strength is to be judged in the application. Special consideration is to be given to cold flow or creep characteristics if the barrier material is subjected to any type of long time mechanical loading (for example, bending, compressive, or tensile loading). See section 24A.~~

[g] ~~Abnormal Overload Test or End Product Glow-wire Test described in Section 14.~~

(Continued)

**Table 9.1 (Cont'd)**

[h] ~~Material evaluated with test electrodes positioned as indicated in 13.2. Test is not required if:~~

~~a) An arcing part is located 12.7 mm (1/2 inch) or more from the material, or~~

~~b) A nonarcing live part (bus bar, terminal, and the like) is located 0.8 mm (1/32 inch) or more from the material.~~

[i] ~~Dielectric Breakdown Strength – The barrier material shall comply with the dielectric strength criteria specified in 12.1.~~

[j] ~~Volume Resistivity – The barrier material shall comply with the volume resistivity criteria specified in Section 16.~~

[k] ~~Mold Stress Relief – The barrier material shall comply with the mold stress relief distortion criteria specified in Sections 30 and 62 upon completion of the test described in 62.1.~~

~~This test is not required for rigid thermosetting material.~~

[l] ~~Creep – Parts subject to mechanical stresses from internal or external sources (such as bending, compressive or tensile loading) are required to withstand the test described in Section 24A. There is to be no warpage or distortion that:~~

~~a) Interferes with normal operation or servicing,~~

~~b) Results in accessibility of live parts, or~~

~~c) Reduces electrical spacings below the level necessary to comply with the applicable requirements pertaining to dielectric strength and leakage current~~

~~This test is not required for rigid thermosets.~~

[m] ~~UV Resistance – The barrier material shall comply with the applicable UV and water immersion requirements in Section 26.~~

[n] ~~Water Exposure and Immersion (For Equipment Intended for Outdoor Use) – The barrier material shall comply with the applicable water immersion and dimensional change criteria specified in Section 27.~~

[o] ~~For a barrier in contact with electrically live parts, a maximum CTI PLC of 4 is required for indoor equipment in a relatively clean environment. Higher CTI values would be required where a greater degree of contamination and/or potentials are involved, as indicated in Table 8.1 and Comparative Tracking Index (CTI), Section 11.~~

9 Internal Barriers (NEW)

9.1 A barrier or liner employed where spacings are unacceptable between uninsulated live parts of opposite polarity or between uninsulated live parts and metal accessible parts, shall comply with all of the following:

a) The barrier or liner shall be of insulating material that complies with Table 8.1

b) The minimum thickness of the barrier or liner shall be at least 0.71 mm, except that 0.33 mm is acceptable where used in conjunction with an air space of at least on-half of the required clearance.

*Exception No. 1: The thickness of the barrier may be less than that specified in 9.1(b) providing that the results of a separate investigation indicate acceptable performance. Resin bonded mica 0.15 mm thick is considered to meet this thickness requirement when its use is limited to applications where it is protected from mechanical abuse or movement. Polyethylene terephthalate (PETE) film 0.18 mm thick, or greater, is considered to meet the thickness requirement.*

c) The barrier or liner shall be equivalent to vulcanized fiber in mechanical strength (tensile strength, tear resistance, puncture strength, Cold Flow, and the like) if likely to be subject to mechanical damage. See Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials used in Printed Wiring Boards, UL 746E, Vulcanized Fibre, Section 9, for specific performance indexing data on vulcanized fiber.

9.2 A material, that is used as a physical barrier against contact with parts that can cause injury to persons during intended operation and user servicing, or to restrict access to circuitry where there is an increased risk of electric shock, shall comply with the requirements in Table 8.1.

**14.3 Glow-wire end-product test (GWEPT)**

14.3.1 A polymeric material shall be capable of withstanding the effects of an electrically heated wire as described in 73.1.1 – 73.6.2. The specimen is considered to have satisfactorily withstood the glow-wire end-product test if either:

a) There is no ignition, or

b) All flaming and glowing of the specimen, the parts surrounding the specimen, and (if a material was used other than the tissue paper/pinewood board) the flaming particle indicator, ceases within 30 ±1 s after removal of the glow-wire. The results are not acceptable if the specimen, the parts surrounding the specimen, or the flaming particle indicator are completely consumed.

**14A (NEW) Glow Wire Ignitibility Temperature Test (GWIT)**

14A.1 Materials that do not comply with the minimum glow wire ignition temperature shown in Table 8.1 or are not comprised of materials with a flammability rating of at least V-0, V-1, may be evaluated by conducting the glow wire end product test at 750°C as described in 73.1.1 – 73.6.2. The material is considered acceptable if:

a) There is no ignition, or

b) All flaming and glowing of the specimen ceases within 30 ±1 s after removal of the glow wire and all surrounding polymeric materials within a 10-mm radius from the material under investigation and the height of the observed flame height are classed V-0 or V-1 or comply with the 12-mm or 20-mm end-product flame tests as described in Sections 17 and 18, respectively, or

*Exception: A material that does not comply with 14A.1 (a) or 14A.1 (b) is acceptable if all surrounding polymeric materials within a 50-mm radius of the material under investigation are classed V-0 or V-1 or comply with the 12-mm or 20-mm end-product flame tests as described in Sections 17 and 18, respectively.*

14A.2 With regard to paragraph 14A.1, the V-0 or V-1 flammability rating requirement is considered to be met if it has one of the following alternate ratings:

a) VTM-0 or VTM-1 in accordance with UL 94, the Standard for Tests for Flammability of Plastic Materials in Devices and Appliances,

b) SC-0, SC-1, SC-TC 0, or SC-TC 1 in accordance with UL 1694, the Standard for Tests for Flammability of Small Polymeric Component Materials, or

c) VW-1 for wiring evaluated in accordance with UL 1581, the Standard for Electrical Wires, Cables, and Flexible Cords.

51.2 Three samples of the part are to be subjected to the flame test described in 51.5. In the performance of the test, the equipment is to be supported in its intended operating position in a draft-free location. Consideration is to be given to leaving in place components and other parts that might influence the performance. The flame shall be applied to an inside surface of the sample at a location judged to be likely to become ignited because of its proximity to a source of ignition. For example, motor or transformer windings, brush holders, switch contacts, terminals, connections, and so forth are considered possible sources of ignition. If more than one part is near a source of ignition, each sample shall be tested with the flame applied to a different location.

*Exception: The flame may be applied to the outside surface of an enclosure, if the equipment is of the encapsulated type or of such size that the flame cannot be applied inside.*

52.2 Three samples of the part are to be subjected to the flame test described in 52.4. In the performance of the test, the equipment is to be supported in its normal operating position in a draft-free location. Nonpolymeric portions of the part in contact with or fastened to the polymeric portions are not to be removed and, insofar as possible, the internal mechanism of the equipment is to be in place. The flame shall be applied to an inside surface of the sample at a location judged to be likely to become ignited because of its proximity to a source of ignition. For example, motor or transformer windings, brush holders, switch contacts, terminals, connections, and so forth are considered possible sources of ignition. If more than one part is near a source of ignition, each sample shall be tested with the flame applied to a different location.

*Exception: The flame may be applied to the outside surface of an enclosure if the equipment is of the encapsulated type or of such size that the flame cannot be applied inside.*

## ANNEX A

### Guidelines for Evaluation of Substitute Polymeric Materials (relocated from Section 7)

A.1 From time-to-time, it may be necessary to select alternative or substitute materials for use as an enclosure. These considerations apply only to alternate materials for a given part. Changes in part dimensions and, in particular, reductions in material thickness, generally require an evaluation using all the end-product tests.

A.2 It may not be necessary that a complete series of end-product tests be required, provided that equivalent or better material properties can be demonstrated by standardized small-scale tests on the candidate material when compared to the properties of a material having acceptable application performance.

Exception: A candidate material that does not provide equivalent material properties to the properties of a material having acceptable application performance, may be acceptable providing that the candidate material possesses the minimum performance level required in Table 4.1 for the application.

A.3 Table A.1 indicates general guidelines that can be used to evaluate alternate or substitute materials if small-scale test data is available. It should be noted that these guidelines apply to substitutions within the same class of materials (thermoplastic to thermoplastic and thermoset to thermoset).

A.4 Except as indicated in Table A.1, if the originally tested material was considered acceptable based upon special tests (for example, determining the resistance of the material to ultraviolet light for an outdoor application or tests required by the end-product standard such as resistance to creep, endurance, and overload), these tests are to be conducted on the candidate material to determine acceptability.

A.5 In Table A.1, the material property parameters are tabulated in column 1. Acceptance guidelines for those situations where the candidate material properties are equivalent to or better than the characteristics of the original material are tabulated in column 2.

A.6 Column 3 of Table A.1 indicates the required end-product tests if the candidate material properties are not equivalent to the original material properties.

A.7 As an example, if the original enclosure material was a Type 66 nylon (PA66) and the candidate material is a polycarbonate (PC), then for each property parameter tabulated in column 1, the end-product test in column 3 would be required if the candidate material properties are not equivalent to the original material properties.

**Table A.1**
**Alternative enclosure material consideration**

| Material property parameters (Column 1) | Candidate material characteristics, equivalent or better than characteristics of the original material considered acceptable for the application (Column 2) | Candidate material characteristics not equivalent to original material characteristics (Column 3)[a] |
|---|---|---|
| **FLAMMABILITY**<br><br>UL 94 flammability classification at use thickness and color | Candidate Material Considered Acceptable | Conduct flame test on part or enclosure (See Flammability – 12 mm Flame, Section 17, Flammability – 127 mm (5 inch) Flame, Section 19, Enclosure Flammability – Large Mass Considerations, Section 21) |
| **ELECTRIC STRENGTH**<br><br>(1) Volume resistivity, and<br>(2) Dielectric Strength | Candidate Material Considered Acceptable | Conduct end-product:<br><br>(1) leakage current tests or insulation resistance<br>(2) See 12.1 |
| **TRACKING RESISTANCE**<br><br>Comparative tracking resistance under moist conditions, or Inclined Plane Tracking | Candidate Material Considered Acceptable | Increase spacings |
| **PERMANENCE** (outdoor equipment only)<br><br>Dimensional change after water exposure. Also see A.4 | Candidate Material Considered Acceptable | Conduct rain/humidity/immersion tests on end-product |
| **RESISTANCE TO ELECTRICAL IGNITION**<br><br>(1) Hot- wire ignition, and<br>(2) High current arc resistance | Candidate Material Considered Acceptable | Conduct end-product:<br><br>Abnormal Overload Test (See Hot-Wire Ignition (HWI) – Abnormal Overload Test, Section 14)<br><br>Arc-Resistance Test (See 13.3 – 13.5) |

(Continued)

**Table A.1 (Cont'd)**
**Alternative enclosure material consideration**

| | | |
|---|---|---|
| **MECHANICAL**<br><br>Tensile or Flexural Strength and Tensile Strength and Tensile or Izod Impact | See note b below for candidate material of same basic composition as original material. For candidate material of different composition from original material, conduct end-product impact, strain relief, and loading tests such as crush resistance – see Crushing Resistance, Section 23. | Conduct end-product impact, strain-relief and loading tests such as crush resistance – see Crushing Resistance, Section 23. |
| **MOLD STRESS-RELIEF** | All alternative or substitute materials are to be subjected to end-product mold stress-relief tests (see Mold Stress-Relief Distortion, Section 30), unless;<br>a) The candidate material is of the same basic composition,<br>b) The candidate material has equivalent or higher small scale heat-deflection, vicat softening, or ball pressure temperature. Mold stress-relief tests are not required for thermosets. | |
| **CREEP** | All alternative or substitute materials are to be subjected to end product creep tests (see Section 24A) unless:<br>a) The candidate material is of the same basic composition<br>b) The candidate has equivalent or higher small scale heat deflection, vicat softening, or ball pressure temperature indexes.<br>c) The candidate has equivalent creepage characteristics based on tests and/or test data (Note – the test results being compared must have the same test parameters).<br>Creep evaluations are not required for rigid thermoset materials. | |
| **MAXIMUM-USE TEMPERATURE** | Refer to Sections 33 – 39 | |
| **SPECIAL END-USE CONSIDERATIONS**[c] | If indicated by the applicable path in Table 4.1, Enclosure Requirements, all alternative or substitute materials are to be subjected to the abnormal operation (28.1) and severe conditions tests (29.1), unless the candidate material is of the same basic composition. | |

[a] See the Exception to A.2.

[b] All alternative or substitute materials are to be subjected to end-product impact tests (see Resistance to Impact, Section 24) unless:

a) The candidate material is of the same basic composition as defined in 3.31, and

b) The candidate material has equivalent or higher small-scale tensile-impact or Izod-impact strength.

[c] See A.4

PROPOSED REQUIREMENTS ARE OF A TENTATIVE AND EARLY NATURE AND ARE FOR REVIEW AND COMMENT ONLY. CURRENT REQUIREMENTS ARE TO BE USED TO JUDGE A PRODUCT UNTIL THESE REQUIREMENTS ARE PUBLISHED IN FINAL FORM.

# APPENDIX D

## MEETING OF THE IAG FOR PLASTIC MATERIALS

## ITEM 10. PROPOSED REVISIONS FOR METALLIZED PARTS IN UL 746C

**METALLIZED PARTS**

**45 General**

45.1 ~~Method A –~~ Ductile Coatings, Section 46, ~~Method B –~~ Brittle Coatings, Section 47, and ~~Metallized Parts – Performance Considerations~~ Tape Adhesion Test, Section 71A describe requirements to evaluate metallized processes such as those for use in the fabrication of decorative parts or enclosures treated with a conductive surface coating intended for electromagnetic interference (EMI) suppression.

45.1 revised (date of publication)

45.2 The purpose of these requirements is to evaluate the integrity of the bond between the substrate material and the metallized coating by means of bond strength testing (ductile coatings) ~~– Method A)~~ or by tape adhesion tests (brittle coatings) ~~– Method B)~~. The results of these adhesion tests can then be used to judge the acceptability of metallized processes in the end-product where loss of the bond strength might result in electric shock, fire, or both.

45.2 revised (date of publication)

45.4 ~~Method A –~~ Ductile Coatings, Section 46 and ~~Method B –~~ Brittle Coatings, Section 47 describe the performance requirements for metallized ~~metallizing~~ parts. ~~Method A~~ Section 46 describes the performance requirements for ductile coatings, such as those found on metallized parts using electroplated ductile copper. ~~Method B~~ Sections 47 and 71A describe~~s~~ the performance requirements for brittle coatings, such as those found on electromagnetic interference (EMI) shields using vacuum-applied foil, arc- or flame-spray coatings, conductive paints, cathode sputtering, and the like.

45.4 revised (date of publication)

### 46 ~~Method A –~~ Ductile Coatings

46.1 The process shall produce metallized parts that are free of wrinkles, pits, blisters, corrosion, and the like that could result in electric shock, fire, or injury to persons, and have a minimum average unconditioned bond strength between the metal surface and the plastic of 36 g/mm (2 lb/inch) of width. The bond strength is to be determined by tests on copper-plated plaques in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. Results obtained on 0.05 mm (0.002 inch) ductile copper can be considered representative of lesser thicknesses.

46.1 shown for reference

46.2 The process shall produce metallized parts that are capable of withstanding accelerated aging and environmental cycling conditions without a reduction in average bond strength less than 18 g/mm (1 lb/inch) of width. See items ~~71.1~~ 71A.5 (b), (c) and (d) for conditioning requirements.

46.2 revised (date of publication)

### 47 ~~Method B –~~ Brittle Coatings

47.1 The metallic coating process shall produce metallized parts that are free of wrinkles, pits, blisters, corrosion, and the like that can result in electric shock, fire, or injury to persons; and have ~~an~~ acceptable cohesion and adhesion between the metallized coating and between the metallized coating and the substrate as received and after conditioning. The adhesion strength is to be determined by tests on the flat sections of the test specimens. The tape adhesion test shall be conducted in accordance with the Standard Methods for Measuring Adhesion by Tape Test, ANSI/ASTM D 3359-95a ~~78~~, Method A or B and Section 71A . ~~All surface incisions shall be brushed lightly prior to conditioning.~~

47.1 revised (date of publication)

47.2 ~~The metallic coating process shall produce finished metallized parts that are capable of withstanding accelerated aging and environmental cycling conditions without adverse effects as determined by the following criteria. Trace peeling or removal of the coating along incisions shall not exceed 79 mm (0.031 inch) for ANSI/ASTM D 3359, Method A testing. For ANSI/ASTM D 3359, Method B testing, not more than 5 percent of the metallic coating shall be removed within the grid area.~~

47.2 deleted (date of publication)

47.3 If the contemplated end use of metallic coated parts is such that the temperatures to which these parts are to be subjected exceeds the lowest assigned RTI for the applicable critical material properties, the metallized plastic shall be investigated in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B. The primary property for evaluating the thermal degradation shall be adhesion by means of the tape adhesion test. After aging, the coatings shall comply with the requirements in 47.1 ~~2~~.

47.3 revised (date of publication)

## ~~71 Metallized Parts – Performance Considerations~~

Section 71 deleted (date of publication)

71.1 ~~The test specimens indicated in 47.1 are to be conditioned as follows:~~

~~a) As-Received Tests – Three specimens are to be conditioned for at least 40 hours at a temperature of 23.0 ±2.0°C (73.0 ±3.6°F) and a relative humidity of 50 ±5 percent prior to testing.~~

~~b) Thermal Cycling Evaluation~~

~~1) Three specimens are to be conditioned for 1 hour at 10.0 plus 0.0, minus 1.0°C (18.0 plus 0.0, minus 1.8°F) higher than the normal use temperature of the plastic, but not less than 70°C (158°F) in any case, followed by~~

~~2) One hour at 23.0 ±2°C (73.0 ±3.6°F) and a relative humidity of 50 ±5 percent, followed by~~

~~3) One hour at minus 29.0 ±2.0°C (minus 20.2 ±3.6°F) followed by~~

~~4) One hour at 23.0 ±2.0°C (73.0 ±3.6°F) and a relative humidity of 50 ±5 percent prior to testing, followed by~~

~~5) Steps 1 – 4 repeated two more times.~~

~~c) For Short Term Aging Considerations –~~

~~1) Three specimens are to be conditioned for 14 days at 10.0 plus 0.0, minus 1.0°C (18.0 plus 0.0, minus 1.8°F) higher than the normal use temperature of the plastic (minimum 70°C), with testing at the end of 14 days;~~

~~2) A second set of three specimens is to be conditioned for 14 days at 35.0 ±0°C (95.0 ±3.6°F) and 90 ±5 percent relative humidity with testing at the end of 14 days.~~

~~d) For long term aging considerations refer to 46.3 for Ductile Coating, or 47.3 for Brittle Coatings.~~

## 71A Tape Adhesion Test (NEW)

Section 71A added (date of publication)

### 71A.1 General

71A.1.1 The test method for conducting the Tape Adhesion Test shall be in accordance with ASTM D3359-95a. This test method is applicable to the brittle coatings of metallized parts that are described in Section 47.

71A.1.2 Test panels shall be selected as shown in Table 71A.1.1 for a full and short program of test. A full program is performed when the combination of the coating and substrate have not been previously tested by the coating or substrate supplier. A short program is performed when the coating and substrate have been previously tested by the coating or substrate supplier.

*Exception: No testing is required for a substrate which is generically equivalent and which is similar to a substrate from the same manufacturer which has been tested with the same coating of that manufacturer.*

**Table 71A.1.1**

| Program | Number of Panels | Conditioning |
|---|---|---|
| Full | 12 | 71A.5 (a), (b), (c) and (d) |
| Short | 6 | 71A.5 (a) and (b) |

71A.1.3 The tape used to measure adhesion by ASTM D3359-95a shall have a Tape Adhesion Strength as determined per ASTM D1000 of 36 ±2.5 oz/in.

### 71A.2 Samples

71A.2.1 Test panels shall be approximately 3 by 5 inches, rigid, flat and with no obstructions (e.g. ridges, bosses, and ventilation openings).

71A.2.2 Each test panel shall be coated with the minimum thickness of coating being investigated.

### 71A.3 Coating Thickness Measurement

71A.3.1 Prior to environmental conditioning, the coating thickness for each panel is to be measured. The thickness shall be determined by a mechanical device such as a micrometer, an optical device, or a radioactive device which shall render an actual coating thickness at any given point.

### 71A.4 Sample Preparation

71A.4.1 For coating thicknesses up to 2 mils, an 11 cross-cut is to be made. For coating thicknesses between 2 to 5 mils, a 6 cross-cut is to be made. For coatings of greater than 5 mils an X cut is to be made. The cuts are to be made in a accordance with ASTM D3359-95a, Test Method A or B.

71A.4.2 Cuts are to be made to all panels prior to conditioning. They are to be made on a flat surface by using a sharp blade to cut through the coating to the substrate in one steady motion. If the blades are not sharp, excess coating and substrate will be removed by the rough cut. Blades should be examined for sharpness after 50 cuts or if rough cuts are observed.

71A.4.3 After cutting, brush lightly over the surface to remove excess flakes and ribbons.

**71A.5 Conditioning**

a) As-Received – Three specimens are to be conditioned for at least 40 hours at a temperature of 23.0 ±2.0°C (73.0 ±3.6°F) and a relative humidity of 50 ±5 percent prior to testing.

b) Thermal Cycling Evaluation

1) Three specimens are to be conditioned for 1 hour at 10.0 plus 0.0, minus 1.0°C (18.0 plus 0.0, minus 1.8°F) higher than the normal-use temperature of the plastic, but not less than 70°C (158°F) in any case, followed by

2) One hour at 23.0 ±2°C ( 73.0 ±3.6°F) and a relative humidity of 50 ±5 percent, followed by

3) One hour at minus 29.0 ±2.0°C (minus 20.2 ±3.6°F) followed by

4) One hour at 23.0 ±2°C (73.0 ±3.6°F) and a relative humidity of 50 ±5 percent, followed by

5) Steps 1 – 4 repeated two more times.

c) Oven – Three specimens are to be conditioned for 14 days at 10.0 plus 0.0, minus 1.0°C (18.0 plus 0.0, minus 1.8°F) higher than the normal-use temperature of the plastic (minimum 70°C), with testing at the end of 14 days.

d) Humidity – A second set of three specimens is to be conditioned for 14 days at 35.0 ±0°C (95.0 ±3.6°F) and 90 ±5 percent relative humidity with testing at the end of 14 days.

**71A.6 Results**

71A.6.1 The test specimens shall be examined, both as received and after conditioning, as follows:

a) Examine the grid area and the tape for removal of coating from the substrate (for adhesion failure) or separation of the coating from itself (cohesion failure).

b) Record the percentage of coating removal from the substrate for each specimen. If the removal is cohesive, record the percentage of coating removal, using the tape as a reference.

Note: Removal due to cutting is not counted as part of the adhesive and cohesive bond removal. Removal due to cutting is evident as a pattern of traces that follow the edges of the cross hatch lattice typically seen on the tape. These are micro fractures caused by blades pressing through the coated substrate. These fractures are strong enough to resist the brushing-off of flakes and ribbons yet weak enough to be pulled up by the Tape Test.

Note: Unlike adhesive removal where the substrate becomes exposed cohesive removal is indicated by the tape containing a layer or a dusting of coating.

71A.6.2 If 5% or more of the coating is removed in Method B of ASTM D-3359-95a and if more than 0.8 mm (1/32 inch) of the coating is removed along the incision of the "X" cut in Method A of ASTM D-3359-95a, the results are not acceptable.

CPSA 6 (b)(1) Cleared
No Mfrs/PrvtLblrs or Products Identified
Excepted by
Firms Notified,
Comments Processed.

# LOG OF MEETING
# DIRECTORATE FOR ENGINEERING SCIENCES

1999 JUN 2 P CPSC/OFFICE OF THE SECRETARY

**SUBJECT:** Underwriters Laboratories Plastics Flammability Ad-Hoc Committee Meeting

**DATE(S) OF MEETING:** June 16, 1999

**PLACE:** Underwriters Laboratories Office, Research Triangle Park, NC

**LOG ENTRY SOURCE:** Hammad A. Malik, PE HAM

**DATE OF ENTRY:** June 23, 1999

**COMMISSION ATTENDEES:**

William H. King, Jr., ESEE
Hammad A. Malik, PE, ESEE

**NON-COMMISSION ATTENDEES:**

Wayne Morris, Association of Home Appliance Manufacturers.
Inder Wadehra, IBM
Steve Watson, DuPont
Chip Pudims, Bryant
Aaron Chase, Leviton
Ric Erdheim, NEMA
Richard Nute, Hewlett-Packard, San Diego
Dan Yee, Toro
Fredric Clarke, Benjamin Clarke
Gordon Gillerman, Underwriters Laboratories, Washington, DC
Rich Pescatore, Hewlett Packard (ITI)
Al Brazauski, Underwriters Laboratories, Santa Clara

Joe Lesniewski, Albermarle
Paul B. Brown, GE-Plastics
Doug Wetzig, GEON
Robert Davidson, Underwriters Laboratories, Melville, NY
George Fechtmann, Underwriters Laboratories, Melville, NY
John Stimitz, Underwriters Laboratories, Melville, NY

## SUMMARY OF MEETING:

Mr. John Stimitz, UL, started by having all attendees introduce themselves. The meeting minutes for the October 15, 1998 meeting were reviewed.

Mr. Stimitz then provided an update on the proposed revisions to UL 746C that were made in October of 1998. It was indicated that UL received numerous comments and as a result is revamping the structure of the proposal. Mr. Stimitz went over the revamped structure and demonstrated that the contents of the original proposal were not changed. It was shown that the new requirements will take the form of a supplement that will be included in UL 746C rather than being directly incorporated into the existing text. This was done mostly for clarity and ease of use. Mr. Stimitz stated that this new format will be sent out for comment in early August of this year and comments will have a deadline of October with subsequent adoption. It was stated that upon adoption all new products will be tested to the new requirements, however, the standard itself will retain the originally proposed five year effective date.

Mr. Bob Davidson, UL, indicated that there has been no progress in developing a Hazard Based Safety Engineering (HBSE) approach towards the flammability of plastics used in electrical appliances.

Mr. Stimitz then provided an update on UL's comparison of Hot-Wire Ignition Test data with Glow-Wire Ignition Test data for various plastic materials. He indicated that no direct correlation could be found.

Mr. Richard Nute, Hewlett-Packard, provided some general heat transfer information in relation to his formulation of a guidance document to reduce the ignition potential of plastics.

Mr. Davidson went over some work that he had been doing relating to the minimum amount of energy required to ignite plastic.

Mr. John Stimitz, UL, updated the committee on the task force on external flame sources work. Mr. Stimitz indicated that a report was currently being formulized.

Mr. George Fechtmann, UL, then updated the committee on IEC TC89 activities.

Mr. Bill King recapped the information provided by UL on the UL 746C revisions.

Mr. Fechtmann then announced that the next IAG meeting will be at the UL Research Triangle Park location on October 5, 1999. He also stated that there will be no Ad-Hoc Committee Meeting until next year, if needed. The meeting was then adjourned.