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6/24/96  
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Products Identified  
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Fines/Assessments  
Comments/Assessments

LOG OF MEETING

**SUBJECT:** Wire Connectors for Aluminum Wiring, UL Technical Advisory Panel Meeting.

**DATE:** May 29-30, 1996

**PLACE:** Holiday Inn,  
Arlington, VA

**DATE OF LOG ENTRY:** June 18, 1996

**SOURCE OF LOG ENTRY:** William H. King, Jr., ESEE *W.H.K.*

**CPSC PARTICIPANT:** William H. King, Jr., ESEE

**NON-CPSC PARTICIPANTS:**

- Lee Hewitt, Underwriters Laboratories Inc. (UL)
- Jake Killinger, UL
- Christine Skinner, UL
- W. Blaha, Ideal Industries, Inc.
- R. Van Naarden, Ideal Industries, Inc.
- R. Ganatra, Alcan Cable
- B. Gentry, Southwire Co.
- P. Pollock, Aluminum Association
- Joan Sterling, Inchcape
- M. Bush, MMM
- C. Reed, AMP, Inc.
- M. Johnson, AMP, Inc.
- M. Oakes, Kleinhuis
- C. Korinek, GB Electrical, Inc.
- R. Lai, Burndy Electrical
- G. Nienaber, Connector Mfg Co.
- K. Rogers, Thomas & Betts
- M. Severson, 3M
- W. Fiske, ETL Inchcape

**SUMMARY:**

The meeting agenda centered around specific proposals submitted by the CPSC staff to UL in writing. See letter to UL dated April 18, 1996, copy included with UL agenda and copy attached to this log. UL plans to issue their report of the meeting.

The proposals were discussed at the meeting with the UL technical staff and with industry participants representing manufacturers of electrical connectors and manufacturers of aluminum electrical conductor material.

In general, industry members expressed concerns that changes to the UL standard might impact a wider variety of electrical connectors that just the manual, twist-on types intended for use with aluminum wiring which are of concern to the CPSC staff. The manufacturer of a twist-on connector who was present spoke in



opposition to the CPSC proposed changes.

UL staff indicated that, as is their standard practice, UL uses meetings such as this to gather information with regard to their standard (in this case, UL 486C), but reserves making decisions on what changes, if any, to propose for a later time.

UL staff indicated that it will issue a report summarizing the meeting from their perspective within several weeks of the meeting. The UL contact is Lee Hewitt, 1-847-272-8800. UL will likely propose some changes to their standard the will require additional testing of twist-on connectors for use with aluminum wiring.

Northbrook, Illinois • (847) 272-8800  
Melville, New York • (516) 271-6200  
Santa Clara, California • (408) 985-2400  
Research Triangle Park,  
North Carolina • (919) 549-1400  
Camas, Washington • (360) 817-5500



Subject 486C

333 Pfingsten Road  
Northbrook, IL 60062  
April 29, 1996

TO:           W. Blaha       )       M. Lane       )  
              J. Farrington )       H. W. Molto   )       Industry Representatives on the  
              M. Johnson   )       M. Oakes     )       Industry Advisory Group  
              C. Korinek    )       K. Rogers     )       of UL for Splicing Wire Connectors  
              R. Lai         )       M. Severson  )

**SUBJECT:** Industry Advisory Group Meeting Agenda

As announced in the Subject 486C letter to the IAG dated April 8, 1996, a meeting of the Industry Advisory Group of UL for Splicing Wire Connectors is scheduled for:

May 29 — 30, 1996  
Holiday Inn — Rosslyn Westpark  
1900 N. Fort Meyer Drive  
Arlington, VA 22209  
1:00 p.m. — 5:00 p.m., May 29, 1996  
8:00 a.m. — 3:00 p.m., May 30, 1996

*Peterson Room*

#### SUMMARY OF TOPICS

The following topics will be discussed at the meeting:

1. Heat Cycling Test Currents for Branch Circuit Sizes
2. Control Wire Type When Applying Paragraph 6.7 of UL 486C
3. Additional Wire Combinations For Copper To Multiple Aluminum Wire Combinations Where The Test Current Flows From Aluminum-To-Aluminum.
4. Test Sample Size
5. Environmental Testing
6. Short Time Current Test (Grounding Application)

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Post-It® Fax Note	7671	Date	5/8/96	# of pages	5
To	William King	From	Christine Skinner		
Co./Dept.	USCPSC	Co.	UL		
Phone #	301-504-0533	Phone #	847-272-8800		
Fax #	301-504-0508	Fax #	847-509-6217		



Subject 486C

333 Pfingsten Road  
 Northbrook, IL 60062  
 May 9, 1996

TO: W. Blaha ) M. Lane )  
 J. Farrington ) H. W. Molto ) Industry Representatives on the  
 M. Johnson ) M. Oakes ) Industry Advisory Group  
 C. Korinek ) K. Rogers ) of UL for Splicing Wire Connectors  
 R. Lai ) M. Severson )

SUBJECT: Technical Advisory Panel Meeting; Additional Agenda Item

UL's Subject 486C letter to the IAG dated April 8 and 29, 1996, announced a meeting of the Industry Advisory Group of UL for Splicing Wire Connectors for:

May 29 — 30, 1996  
 Holiday Inn — Rosslyn Westpark  
 1900 N. Fort Meyer Drive  
 Arlington, VA 22209  
 1:00 p.m. — 5:00 p.m., May 29, 1996  
 8:00 a.m. — 3:00 p.m., May 30, 1996

Please be advised that in order to accommodate participation by the United States Consumer Product Safety Commission (USCPSC) and others that wish to participate, the meeting format has been changed from an IAG meeting to a Technical Advisory Panel (TAP) meeting.

The attached copy of a letter from the USCPSC dated April 18, 1996 will be included as an additional agenda item at the May 29 and 30, 1996 TAP meeting in Arlington, Virginia. Please bring all comments regarding this issue to the meeting for discussion.

UNDERWRITERS LABORATORIES INC.

REVIEWED BY:

  
 CHRISTINE A. SKINNER (Ext. 43690)  
 Engineer  
 Standards Department

  
 JAKE KILLINGER (Ext. 42018)  
 Engineering Group Leader  
 Engineering Services 418D

SR:DES, L:AUL\_486C1ADD

A not-for-profit organization  
 dedicated to public safety and  
 committed to quality service

EXHIBIT A



U.S. CONSUMER PRODUCT SAFETY COMMISSION  
WASHINGTON, D.C. 20207  
April 18, 1996

Mr. Lee Hewitt  
Managing Engineer  
Underwriters Laboratories Inc.  
333 Pfingsten Road  
Northbrook, IL 60062-2096

Re: Standard for Safety, UL 486C, Splicing Wire Connectors

Dear Mr. Hewitt:

This letter presents proposals to UL regarding twist-on connectors for aluminum wire for inclusion in the UL safety standard.

The basis for recommending the changes to the standard is the engineering analyses of connectors for aluminum wire conducted and sponsored by the Consumer Product Safety Commission over the period when aluminum wire was used in the electrical branch circuits of residences. Although no longer used for this application, aluminum wire remains in place in over a million dwellings. These homes represent the only known application for the twist-on connector rated for aluminum wire.

The Commission staff continues to monitor developments in the technology of electrical contacts, field experiences with aluminum house wiring, and technical work conducted by outside parties testing aluminum wire connections. The Commission regularly receives requests from consumers for information on the repair of this wiring.

The specific proposals for UL 486C and the rationale for each proposal follows.

Section 4. Materials

4.5 (PROPOSED ADDITIONAL SENTENCE FOLLOWING THE EXISTING TEXT) The metal spring of a twist-on connector intended for aluminum conductor shall be considered a current-carrying part.

**Rationale:** As the wire-to-wire contact resistance increases within a twist-on connector while in service with aluminum conductor, the metal spring inside the connector becomes a more significant parallel path for the current. Because of the wire-to-spring contact resistance and the bulk resistance of steel which is typically used for the spring, a rapid rise in connector operating temperature takes place, resulting in degradation of the connector insulating material.

## EXHIBIT A

Mr. Lee Hewitt

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4.8 (NEW PARAGRAPH) For a twist-on connector intended for aluminum conductors, the insulating parts of the connector shall be acceptable for a minimum flammability classification of 94V-0 as determined by tests described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

4.9 (NEW PARAGRAPH) For a twist-on connector intended for aluminum conductors, the antioxidant paste (if used) shall be nonflammable.

**Rationale:** A failing twist-on connector involving aluminum conductor can generate extremely hot temperatures resulting in incandescent glowing of the metals. Flammable materials should not be in intimate contact with this potential ignition source in order to provide a margin of safety.

#### Section 5. General

5.9 (NEW PARAGRAPH) For a twist-on connector intended for aluminum conductors, when assembled in the intended manner using aluminum conductor, the resistance of the connection (total resistance minus the resistance of the wires) shall exhibit variations between like connections of less than one percent of the mean. Current is applied to the connection only for purposes of measuring voltage drop to calculate resistance using accepted laboratory measurement procedures. Measurements are made after reaching thermal equilibrium. The value of the current used for the measurement shall not exceed 80 percent of the ampacity of the smallest conductor in the test current path [ampacity determined by the *National Electrical Code (NEC)*, NFPA 70, for not more than three current-carrying conductors in a raceway]. The resistance of the connections (including connections intended for use in dry locations as defined in the *NEC*), shall not increase after exposure to temperature and humidity conditions likely to occur in service.

5.10 (NEW PARAGRAPH) With reference to paragraph 5.9, a sample of not less than thirty connections shall be prepared for resistance measurements. Each measurement shall be repeated following exposure to one hundred cycles of temperature ranging from minus ten degrees Celsius (-10C) to thirty degrees Celsius (30C). The cycle time can be any convenient length as long as at least one half hour is at both the lower and the upper temperature levels in each cycle. Humidity conditions shall consist of exposure to 90 percent relative humidity for at least 100 hours.

**Rationale:** Experience has shown that connections for aluminum wire that do not exhibit initial low connection resistance, and connections that will not maintain low connection resistance over time, perform poorly under expected field service conditions. Measurements of connection resistances can be viewed as a screening device to determine if the connector should be further evaluated by performance tests specified in the Test Sequences (Table 5.1) of the standard. With modern digital instrumentation, these measurements can be made quickly, accurately and with repeatability.

Mr. Lee Hewitt  
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## Section 6. Selection of Samples, Heat Cycling

Table 6.1, Line 7

(ADDED NOTATION) For connectors intended to intermix copper with two or more aluminum conductors, see additional requirement at paragraph 6.7A.

6.7A (NEW PARAGRAPH AS DRAFTED BY UL) In addition to the tests in paragraph 6.7, if the connector is intended for the intermixing of two or more aluminum conductors in combination with one or more copper conductors, additional heat-cycling and static-heating sequences shall be conducted with the test current flowing from aluminum to aluminum. The copper conductor shall not be in the current path, but only used to facilitate making the wire combination. The test currents are based on the aluminum test current values in Table 9.1. The following combinations shall be tested:

- A. Maximum size aluminum (2-conductors) with maximum size copper (1-conductor.)
- B. Maximum size aluminum (2-conductors) with minimum size copper (1-conductor.)
- C. Minimum size aluminum (2-conductors) with maximum size copper (1-conductor.)
- D. Minimum size aluminum (2-conductors) with minimum size copper (1-conductor.)

**Rationale:** This testing represents a condition not presently covered by the existing requirements. Current flowing from aluminum to aluminum may represent a more severe condition but reflects current paths very likely to exist in the field.

## Section 7. Preparation of Samples

7.11, Subpart A. Aluminum

- 1. Solid - (ADDED ADDITIONAL SENTENCE) For twist-on connectors, No. 12-10 AWG (3.3-5.3 mm<sup>2</sup>) aluminum designation 1350 in 1/2 or 3/4 hard temper.

**Rationale:** The alloy currently specified in UL 486C does not represent the old technology conductors actually installed in most homes with aluminum branch circuits.

## Section 9. Heat-Cycling Test

9.1 (REVISED) The temperature rise of a connector shall not exceed 125C (225F) above the ambient temperature for any recorded cycle when subjected to the tests described in paragraphs 9.2 - 9.11. Exception: For a twist-on connector for aluminum conductor, the

May 9, 1996

Mr. Lee Hewitt

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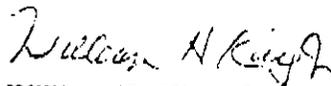
temperature rise shall not exceed the temperature rise of the control conductor.

9.1A (NEW PARAGRAPH) The stability factor "S" - see paragraph 9.4 - determined for each temperature measurement shall not exceed +/-10. Exception: For a twist-on connector for aluminum conductor, the stability factor "S" shall not exceed -5.

**Rationale:** Permitting a connector to operate progressively hotter than the control wire as more test cycles are completed can not be supported for the class of twist-on wire connectors that is destined for application in existing 20-30 year old residential installations. The need is for a connector that is exceptionally stable, reliable and above technical controversy. These are the criteria for the connector identified by the Commission in its recommendations to consumers residing in homes with aluminum wiring, and should be the standard for assessing alternatives.

Thank you for the opportunity to make these proposals. They represent the views of the technical staff of the Commission, and do not necessarily represent the official position of the Consumer Product Safety Commission.

Sincerely,



William H. King, Jr.

Director

Division of Electrical Engineering

- c: Colin Church, Voluntary Standards Coordinator, CPSC
- James Beyreis, Underwriters Laboratories Inc.
- William Blaha, Ideal Industries, Inc.
- Jesse Aronstein, Consulting Engineer