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Subjects 486A (4, 44, 67, 83, 98,
 231, 310, 414, 486B, 486C, 486E, 489,
 493, 508, 508A, 512, 719, 854, 857,
 891, 1072, 1277, 1569, 1581, 1976)
 (In reply, refer to Subject 486A)

333 Pfingsten Road
 Northbrook, IL 60062
 December 11, 1995

TO: Electrical Council of Underwriters Laboratories Inc.,
 Subscribers to UL's Standards Services for the subjects shown in Appendix A
 Industry Representatives on the Industry Advisory Groups (IAG), Industry
 Advisory Conferences (IAC), and Technical Advisory Panels (TAB) of UL for
 the subjects shown in Appendix B

SUBJECT: Report of the Meeting of the Industry Advisory Groups of UL for Wire
 Connectors and Soldering Lugs, Splicing Wire Connectors, and Equipment Wiring
 Terminals; Request for Comments on Proposed Requirements for the Eighth
 Edition of the Standard for Wire Connectors and Soldering Lugs for Use With
 Copper Conductors, UL 486A; Third Edition of the Standard for Wire Connectors
 for Use With Aluminum Conductors, UL 486B; Second Edition of the Standard
 for Splicing Wire Connectors, UL 486C; Third Edition of the Standard for
 Equipment Wiring Terminals for Use With Aluminum and/or Copper Conductors,
 UL 486E; Sixth Edition of the Standard for Electrical Quick-Connect Terminals,
 UL 310; First Issue of the Outline of Investigation for Crimp Tools for Use with
 Wire Connectors, Subject 1976; PROPOSED EFFECTIVE DATES

SUMMARY OF TOPICS

The following topics were discussed at the meeting:

1. Corrections and Clarifications
2. Installation of Connectors at Low Temperatures
3. Marking Requirements for Insulated Connectors
4. Mathematical Formulas for Dielectric Voltage-Withstand Test Voltages

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SUMMARY OF TOPICS (Cont'd)

5. Revision of the Dielectric Voltage-Withstand Test
6. Withdrawal of Material ID Test Proposal
7. Moisture Absorption Test
8. Compact-Stranded Copper

Note: The attention of end-product equipment manufacturers, and connector manufacturers, is specifically requested on this topic.

9. Specific Crimp Tool Identification
10. High Voltage Connectors
11. 10-Day Moist Ammonia-Air Stress Cracking Test
12. Harmonization Activity
13. IEC Publications
14. Definition of Tubular and Non-Tubular
15. Non-Reusability of Connectors
16. Testing with THW Wire
17. Environmental Awareness in Standards
18. Consideration Of Revising Existing And Developing New UL Marking Requirements In Accordance With ANSI Z535.4-1991.
19. Future IAG Meeting
20. Single Input Wire

COMMENTS DUE: January 22, 1996

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976) -3-

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A meeting of the Industry Advisory Groups of UL for Wire Connectors and Soldering Lugs, Splicing Wire Connectors, and Equipment Wiring Terminals was held on October 19, 1995 at the Arlington/Rosslyn Courtyard by Marriott in Arlington, VA. The purpose of the meeting was to discuss issues regarding UL 486A, UL 486B, UL 486C, and UL 486E.

Attached as Appendix C are proposed requirements for UL 486A, UL 486B, UL 486C, UL 486E, UL 310, and Subject 1976. Attached as Appendix D is a list of those who attended the meeting. Questions regarding interpretation of requirements should be directed to the responsible UL Staff. Please see Appendix E of this bulletin regarding designated responsibility for the subject product categories.

Please note that 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.

PROPOSED EFFECTIVE DATES

If manufacturers of wire connectors want to add coverage for compact-stranded conductors to the rating of their presently Listed connectors, then the proposed new and revised requirements in paragraph 1.3, 3.1A, 7.10 and 20.7A in UL 486A; paragraphs 1.3B, 3.2, 7.12 and 19.8A in UL 486B; and paragraphs 1.4A, 4.1, 8.2.6 and 15.9A in UL 486E will necessitate a review and possible retest of currently Listed wire connectors. The preceding is optional as stated and therefore, UL proposes that the new and revised requirements in these paragraphs become effective upon publication.

Also, the proposed requirements in paragraphs 3.6 and 19.4A in UL 486B; paragraphs 1.5 and 24.6 in UL 486C; paragraphs 4.6 and 15.5.1 in UL 486E; and paragraph 4.2 in Subject 1976 will necessitate a review and possible retest of currently Listed and Recognized products. Therefore, UL proposes that the new requirements in these paragraphs become effective 24 months after publication. This is intended to provide manufacturers with sufficient time to submit modified products for investigation and to implement the necessary changes in production. Please note that this also includes the time that will be needed by UL to conduct a review of the modified product.

The remainder of the requirements will not necessitate a review or additional testing of currently Listed or Recognized products. Therefore, UL proposes that these requirements become effective upon publication.

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The following report is not intended to be a verbatim transcript of the discussions at the meeting, but is intended to record the significant features of those discussions.

1. CORRECTIONS AND CLARIFICATIONS

DISCUSSION

The August, 1995 revision pages for UL 486A, UL 486B, UL 486C, UL 486E and UL 310 were presented for discussion. UL pointed out corrections and clarifications that were needed to be proposed.

RATIONALE

In order to correct errors and clarify the requirements, UL proposes to add paragraphs 16.2 and 16.3 back into UL 486C and to revise paragraph 1.5 and Tables 7.6 and 11.2 in UL 486A; paragraphs 1.3, 1.4, 6.14A, 7.12, 8.6, 9.3, 9.13, 13.1 and Tables 5.2, 7.6, 9.3, 11.1, 13.1 and 14.1 in UL 486B; paragraphs 4.2, 5.5, 6.6 and 9.4 and Table 18.1 in UL 486C, paragraphs 1.5, 5.3, 6.1, 10.1.4 and Tables 6.1 and 8.6 in UL 486E; and paragraph 7.4 in UL 310.

IMPACT

If this proposal is adopted, no review, retest, or modification of presently Listed or Recognized products will be necessary.

PROPOSAL

See Appendix C, Item 1.

2. INSTALLATION OF CONNECTORS AT LOW TEMPERATURES

DISCUSSION

The UL 486 Series Bulletin dated September 26, 1994, which proposed revisions to include requirements for installation of connectors at low temperatures, was presented for discussion. The intent of this bulletin was to propose a requirement that was harmonized with the requirements currently contained in the CSA Standard for Wire Connectors, C22.2 No. 65. Based on comments that were received from industry, it became apparent that the proposal needed revision to clarify specific test parameters, such as the quantity of samples needed for the test, wire sizes, and other test parameters. In order to reduce or eliminate the need for retesting, UL previously indicated in the September 26, 1994 Bulletin, that results from tests previously performed for CSA certification would be reviewed. However, the limited data received to date has been incomplete.

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During further discussion of the proposal, representatives of industry indicated that they have not received any reports of field related problems concerning low temperature installation. Based on this discussion, the proposal will be put on hold until it can be discussed as part of any further harmonization of CSA C22.2 No. 65 and the UL 486 Standards.

3. MARKING REQUIREMENTS FOR INSULATED CONNECTORS

DISCUSSION

The requirements for the voltage rating of an insulated connector that were included in the August, 1995 revision pages for UL 486B, UL 486C, and UL 486E were presented for discussion. These revisions have an effective date of August 25, 1997. UL led a discussion about the requirements and the time table for the file review for compliance with the August 25, 1997 effective date. The representatives of industry had no additional comments.

Also, the August 1995 revision pages included additional requirements concerning the intermixing of conductor materials within a connector. The revisions included marking requirements that replaced the term "dry locations" with "intermixed." Since connectors that are intended to intermix certain conductor materials are for use only in dry locations, there is a concern that the concept of use in "only dry locations" may be lost. Accordingly, UL proposed that the requirements be further revised to clarify that connectors for use with intermixed conductor materials additionally be marked for use in dry locations. An example of an intermixed marking would be "AL-CU (intermixed - dry locations)" for an aluminum conductor connected with a copper conductor.

RATIONALE

To clarify the marking requirements for connectors that are intended for intermixed conductor materials, UL proposes to revise paragraphs 3.6 and 19.4A in UL 486B; paragraphs 1.5 and 24.6 in UL 486C; and paragraphs 4.6 and 15.5.1 in UL 486E.

IMPACT

If this proposal is adopted, a review and possible retest of presently Listed or Recognized wire connectors, soldering lugs, and equipment wiring terminals that have been previously investigated for use with intermixed conductor materials, will be necessary. Due to the limited number of manufacturers that may be affected if this proposal is adopted, UL intends to separately notify those manufacturers that a review and possible retest of those specific products, is necessary.

PROPOSAL

See Appendix C, Item 3.

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4. MATHEMATICAL FORMULAS FOR DIELECTRIC VOLTAGE-WITHSTAND TEST VOLTAGES

DISCUSSION

The July 24, 1995 Bulletin, which contains the proposal regarding the mathematical formulas used to determine the Dielectric Voltage-Withstand Test voltages, was presented for further discussion.

Representatives of industry asked that the equation in the proposal be revised from 10 times the rated voltage to 13 times the rated voltage to address the 1000 volt sign and lighting fixture rating. After a discussion on the advantages and disadvantages of this proposal, representatives of industry suggested that the present requirements be retained, but also expanded to include a 50 and 125 voltage rating in addition to the 300, 600, and 1000 volt ratings.

UL plans to develop a proposal to address these new ratings in the near future and welcomes input toward their development. Suggestions are requested on alternatives that accommodate harmonization with the IEC requirements and permit flexibility of different voltage ratings not presently available.

5. REVISION OF THE DIELECTRIC VOLTAGE-WITHSTAND TEST

DISCUSSION

UL discussed research that was conducted involving flexible skirted twist-on wire connectors and how they perform during the Dielectric Voltage-Withstand Test. Installation and representative type-testing issues were also discussed. UL asked for input from the representatives of industry concerning any field installation issues or reports.

Representatives of industry suggested that research tests should also be performed on hard shell connectors with the conductors exiting horizontally in order to obtain a better performance comparison. Per this request, UL will pursue further development of the proposed revisions to the Dielectric Voltage-Withstand Test.

6. WITHDRAWAL OF MATERIAL IDENTIFICATION TEST PROPOSAL

DISCUSSION

The June 22, 1995 IAG letter regarding the withdrawal of the proposed requirements for material identification tests was presented for further discussion. The representatives of industry had no comment.

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7. MOISTURE ABSORPTION TEST

DISCUSSION

The June 23, 1995 Bulletin, which contained the proposal regarding the Moisture Absorption Test, was presented for further discussion. Representatives of industry suggested modifications to the proposal. UL indicated that the proposal would be revised.

RATIONALE

In the interest of consistency, UL proposes that the wording for the Moisture Absorption Tests in UL 486A, UL 486B, and UL 486C be revised.

IMPACT

If adopted, these proposals will not require a review, retest, or modification in the manufacture of presently Listed or Recognized wire connectors or wire connector adaptors.

PROPOSAL

See Appendix C, Item 7.

8. COMPACT-STRANDED COPPER

DISCUSSION

The July 31, 1995 Bulletin, which contained a proposal to the Standard for Rubber-Insulated Wires and Cables, UL 44, regarding compact-stranded copper was presented for discussion. The bulletin also proposed the addition of requirements to the UL 486 series wire connector standards. UL pointed out that CSA has covered compact-stranded copper conductors for years and that there may be instances in which compact-stranded copper conductors are being used in the United States with connectors that have not been investigated for use with compact-stranded copper conductor. UL indicated that the proposal only affects connectors for use with 2 — 4/0 AWG conductors and that it would provide wire connector manufacturers the opportunity to List their products for compact-stranded copper conductors.

At the meeting, representatives of industry expressed concern that it would be difficult to identify whether a connector has been investigated for use with compact-stranded copper conductors versus concentric conductors. They also pointed out that the optional rating and marking could be misapplied. The discussion evolved into requiring all connectors in sizes 2 — 4/0 to be re-tested using compact copper wire.

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As a result of the discussion, UL indicated that the proposal would be modified so that the requirements would apply to all connectors for Nos. 2 — 4/0 AWG conductors. Representatives of industry suggested a proposed effective date of three years for single wire connectors and five years for parallel wire connectors. UL indicated that these effective dates would be included in the modified proposal.

Since the meeting, UL received reports of the implications that the new mandatory proposal would have on industry. Consequently, UL is in favor of returning to the original proposal from the July 31, 1995 proposal.

As this topic will affect the users of wire connectors, UL is additionally distributing this proposal to the IACs, IAGs and TAPS for the subject list in Appendix B.

RATIONALE

A manufacturer has requested that compact stranding be accepted as an alternative stranding for copper conductors in Listed No. 2 – 4/0 AWG wires and cables.

Copper conductors that are compact-stranded are somewhat stiffer than copper conductors having conventional or compressed stranding so insulated copper wires using the requested stranding were pulled through conduit using the NEC maximum number of conductors and also were installed in a service box that provided NEC 373-6 wire-bending space. The test results indicate that insulated No. 2 – 4/0 AWG compact-stranded copper conductors can be installed safely using the NEC guidelines.

The specifications for conduit fill and wire-bending space in Canada (ref. CSA C22.2 No. 0.12) are essentially the same as those in the NEC, and insulated compact-stranded copper conductors have been used in Canada without any difficulty related to the stranding.

UL proposes to accept compact stranding for copper conductors in Listed No. 2 – 4/0 AWG wires and cables but, because there is evidence that not all wire connectors Listed for stranded copper conductors are proper for connecting copper conductors that are compact-stranded, UL also proposes to require connector and wire markings:

- A. A surface marking on the wire, directly following the conductor size, identifying the conductor as being of compact-stranded copper. This marking may be "compact copper", "compact CU", or the like. The word "compact" is not to be abbreviated.
- B. A marking on the tag, reel, or carton for the wire specifying connectors identified for use with compact-stranded copper conductors.

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C. For connectors accepted for use with compact-stranded copper conductors, a marking indicating that the connectors are for connecting compact-stranded copper conductors. The marking would be on the connector itself, on the unit container, or on an information sheet in the unit container.

Based on the foregoing, UL proposes to revise its connector standards as shown in Appendix C.

IMPACT

Compact stranding is proposed for addition as an alternative in the wire and cable standards. Requirements for compact stranding already exist in UL 1072, so only a marking requirement is proposed for MV cable using these conductors. Manufacturers of other forms of stranded copper conductors need not take any action to maintain their current Listings, but wire and tag markings will be required for all wire manufacturers who use compact-stranded copper conductors.

Marking and testing will be required for manufacturers of wire connectors who want to add coverage for compact-stranded copper conductors to the ratings of their presently Listed connectors. Connector manufacturers not wanting the added rating need not take any action to maintain their current Listings.

PROPOSAL

See Appendix C, Item 8.

9. SPECIFIC CRIMP TOOL IDENTIFICATION

DISCUSSION

A manufacturer suggested that UL propose a revision to the Outline of Investigation for Crimp Tools for Use with Wire Connectors, Subject 1976 so that the crimp tool used to assemble a connector can be identified by the authority having jurisdiction. For example, a crimp tool could be constructed so that it leaves the manufacturer's company logo imprinted on a connector. UL requested input from the representatives of industry regarding this proposal.

During the discussion, it was pointed out that there are some designs of crimp tools that cannot leave such an imprint. This is especially true for some of the smaller hand-operated scissor type tools intended to be used with connectors for wire sizes smaller than 8 AWG. UL indicated that the proposal would only apply to tools intended to be used with connectors for wire sizes 8 AWG and larger.

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RATIONALE

Users and authorities having jurisdiction have expressed a need to be able to identify the tool/die used to make a connection. An imprint left on the connector after assembly identifying the tool/die used would be helpful. Accordingly, UL proposes to add paragraph 4.2 to the Subject 1976 Outline.

IMPACT

If this proposal is adopted, a review and possible retest of presently Listed or Recognized tool/die designs will be necessary. Due to the limited number of manufacturers that may be affected if this proposal is adopted, UL intends to separately notify those manufacturers that a review and possible retest of those specific products, is necessary.

PROPOSAL

See Appendix C, item 9.

10. HIGH VOLTAGE CONNECTORS

DISCUSSION

The requirements for high voltage connectors were included in the revision pages for UL 486A dated August 24, 1995 and for UL 486B dated August 25, 1995. These revisions were based on the September 26, 1994 Proposal Bulletin and pertain to uninsulated tool-applied, pressure-terminal connectors only. The recent discussions at the CSA C22.2 No. 65 Subcommittee Meeting expanded this coverage for C22.2 No. 65 to include other types of connectors as well as splicing connectors, insulated and non-insulated. UL requested comments from the representatives of industry concerning the pursuit of a similar course of action. The representatives of industry suggested splicing type connectors be included in the UL requirements, but not mechanical set screw type connectors. UL indicated that a revised proposal would be included in the meeting report and that the guide information would also be revised.

RATIONALE

UL proposes to revise the scopes in UL 486A and UL 486B to include splicing type connectors.

IMPACT

If adopted, these proposals will not require a review, retest, or modification in the manufacture of presently Listed or Recognized wire connectors.

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PROPOSAL

See Appendix C, item 10.

11. 10-DAY MOIST AMMONIA-AIR STRESS CRACKING TEST

DISCUSSION

UL's March 3, 1994 Subject 486A Bulletin, which proposed replacing the Mercurous Nitrate Test with a 10-Day Moist Ammonia-Air Stress Cracking Test, was presented for discussion. Based on review of comments to the bulletin and after further study, UL has determined that the aqueous ammonia used for the test should have a specific gravity of 0.94 rather than 0.90, as the 0.94 solution is more likely to produce test results consistent with the results obtained when testing with mercurous nitrate. UL indicated that the proposal would be modified accordingly.

RATIONALE

Parts made of brass alloys containing more than 20 percent zinc, are subject to applied residual stresses during forming that may result in cracking or delamination of the part in end-use applications. This cracking or delamination can occur at room temperature and in other common environments. To determine that such parts can be considered acceptable for end-use applications, they are subjected to a mercurous nitrate immersion test. During this test, parts are immersed in a solution containing mercury, water, and nitric acid for 30 minutes. The disposal of the mercurous nitrate waste material (coated parts and solution) in an environmentally-sound manner has become increasingly difficult. Also, there are potential health risks involved if the test is not conducted according to specific procedures.

After consideration of these difficulties, UL will discontinue use of the mercurous nitrate immersion test. In searching for an acceptable test, UL obtained information from the American Society for Testing and Materials (ASTM) and conducted evaluation tests to find a test that would provide results comparable to those obtained using the existing mercurous nitrate immersion test. As a result of these efforts, UL has determined that a 10-Day Moist Ammonia-Air Stress Cracking Test would be a suitable replacement. Accordingly, UL proposes to eliminate the Mercurous Nitrate Immersion Test and replace it with a 10-Day Moist Ammonia-Air Stress Cracking Test.

IMPACT

As all currently Listed and Recognized wire connectors, splicing wire connectors, and equipment wiring terminals already comply with the proposed requirements, there will not be a need for retesting or review if the proposed requirements are adopted.

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PROPOSAL

See Appendix C, item 11.

12. HARMONIZATION ACTIVITY

DISCUSSION

UL requested comments from the representatives of industry regarding harmonization with Canadian and Mexican requirements. Comments were also requested concerning the development of a binational or trinational standard in the IEC format.

A representative from the involved Canadian Standards Association (CSA) Subcommittee indicated that CSA will hold off complete adoption of IEC documents. This was decided in the interest of further development of harmonized Standards that are being developed by technical harmonization committees. The need for translating the harmonized documents into Spanish was also discussed since it may then be easier to get Mexico involvement. A suggestion was made that translation should occur directly after publication.

Based on the discussion, UL indicated that any harmonized standards would be written in IEC format.

13. IEC PUBLICATIONS

DISCUSSION

UL requested comments from the representatives of industry concerning testing to IEC Publications. Also discussed was the update for the category of Wire Connectors and Soldering Lugs, Classified in Accordance With IEC Publications. Recently published IEC 998-2-4 supersedes IEC Publication 685-2-4. This will require an update of guide card information and possible retesting of Classified products to the new publication. Representatives of industry had no comment. Due to the limited number of manufacturers that may be affected, UL intends to separately notify those manufacturers that currently have products that are Classified in accordance with IEC 998-2-4, that a review and possible retest of those specific products, may be necessary.

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14. DEFINITION OF TUBULAR AND NON-TUBULAR

DISCUSSION

UL pointed out that the Dielectric Voltage-Withstand Test contained in the UL 486 Series of Standards differentiates test programs based on whether a connector is considered tubular or non-tubular. In addition, the Flashover Test, Test B or C, is selected based on whether the connector is tubular or non-tubular. In the past, the word "tubular" has been used for such connectors as ring-type or spade-type. Twist-on connectors as well as other types have been considered non-tubular connectors.

UL requested that the representatives of industry supply any existing definitions of tubular and non-tubular connectors that they may have.

15. NON-REUSABILITY OF CONNECTORS

DISCUSSION

The UL 486 Series of Standards presently does not define connector reusability. UL 486C, in particular, includes a spring-action sequence that requires ten connections and disconnections of the wire from the connector. This anticipates that such a connector is reusable. Certain designs of connectors cannot be tested in this manner since they are not designed for reusable use. They must be (or are recommended to be) cut off from the wires. In other instances, manufacturers claim non-reusability although the design of the connector itself would allow for reuse.

Comments were requested from the IAG concerning whether UL should waive the conditioning test of the spring-action sequence for non-reusable connectors. Representatives of industry explained that any connector that is reused is less likely to make a good connection. A good example of this is an insulation piercing type wire connector. Reuse of this type of connector could result in an inconsistent or less secure connection. Consequently, it was felt that all connectors are not intended to be reused.

Comments were also requested concerning the need for a marking requirement for connectors which indicate that the connectors are not intended to be reused. A specific concern was whether the marking should be located on the connector, the container, or on an accompanying information slip. Representatives of industry explained that a marking would not be an effective means for indicating to the installer that the connector is not intended for reuse.

UL indicated that requirements regarding reusability would not be proposed and that the guide information would be revised to clarify that connectors shall not be reused.

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16. TESTING WITH THW WIRE

DISCUSSION

Some manufacturers have commented on the availability of Type THW wire. This wire is used for the maximum fill testing to UL 486C and other tests to verify connectability with wire having a very thick insulation. Representatives of industry discussed their experiences in obtaining this wire and explained that there were no problems with availability. The subject of consistency of insulation thickness between reels, as well as on the same reel, was also discussed. It was stated that the thickness of the wire insulation may vary greatly from the minimum insulation thickness. In addition, single conductor Type UF wire can also be used and this insulation type is even thicker than Type THW wire. Based on the discussion, UL decided that the connectors intended for THW wire are designed to accommodate a range of insulation thicknesses so that consistency of insulation thickness is not a problem.

17. ENVIRONMENTAL AWARENESS IN STANDARDS

DISCUSSION

UL's involvement in environmental programs has been based primarily on the needs of industry and any applicable regulatory demands. Therefore, UL requested input from the representatives of industry on the industry's need to develop requirements that reflect the concepts of initially designing products that meet environmental needs and/or have a low environmental impact.

Representatives of industry expressed concerns with disposal of cyanide residues left over by tin plating and the advantages of wax coating. New practices used in other countries were discussed for recyclable packaging and environmentally responsible manufacturing.

18. CONSIDERATION OF REVISING EXISTING UL MARKINGS AND DEVELOPING NEW UL MARKING REQUIREMENTS IN ACCORDANCE WITH ANSI Z535.4-1991

DISCUSSION

UL requested manufacturer's views on the topic of evaluating the existing markings in UL 486A, B, C and E in order to determine how they correlate with the ANSI requirements. In addition, UL requested industry input regarding the possibility of revising the existing markings in accordance with the ANSI requirements and utilizing the ANSI requirements when developing new markings for the standard. Representatives of industry discussed the advantages and disadvantages of expanding and changing present markings. From the outcome of that discussion, UL decided not to propose any revisions at this time.

However, manufacturers are requested to supply input as the harmonization process moves forth. Attention should be paid to how existing colors and markings correlate with ANSI Z535.4.

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19. FUTURE IAG MEETINGS

DISCUSSION

A representative of industry suggested having a standing IAG meeting every two years. An advantage to this is that the IAG will be kept abreast of new developments and improvements to technology in the field. UL will attempt to hold meetings more frequently, such as on a biannual basis.

20. SINGLE INPUT WIRE

DISCUSSION

The availability of connectors for single input wire was discussed.

As a representative of industry explained, single input wire is wire made up of conductor strands of one uniform diameter or size. The size of the single input wire is determined by the number of conductor strands. The size of Class B and Class C wire is determined by changing the diameter of the individual strands as well as the number of strands. Consequently, a single input wire would not be considered Class B or C.

Therefore, UL pointed out that a connector rated for single input wire would need to be tested and marked for such use in accordance with the present UL 486 Standards.

REQUESTS FOR COMMENTS ON PROPOSALS

Please provide the following:

1. Your comments concerning the meeting report and the proposed requirements; and
2. Your comments concerning the proposed effective dates, should the proposals be adopted.

Written comments should be sent to the attention of Christine Skinner at UL's Northbrook office, 333 Pfingsten Road, Northbrook, IL 60062-2096. Please reference all correspondence to Subject 486A.

All comments should be sent by January 22, 1996.

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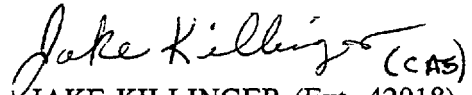
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Unless specifically requested to do so, UL will not acknowledge comments indicating concurrence with these proposals.

UNDERWRITERS LABORATORIES INC.

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SR:WRC

486AMTGR.C01

Subjects 486A (4, 44, 67, 83, 98, 231,
310, 414, 486B, 486C, 486E, 489,
493, 508, 508A, 512, 719, 854, 857,
891, 1072, 1277, 1569, 1581, 1976)

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December, 1995

A P P E N D I X A

UL'S STANDARDS SERVICES SUBSCRIBERS DISTRIBUTION

Wire Connectors and Soldering Lugs for Use with Copper Conductors
Electrical Quick-Connect Terminals
Wire Connectors for Use with Aluminum Conductors
Splicing Wire Connectors
Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
Crimp Tools for Use with Wire Connectors



Documents

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Subjects 486A (4, 44, 67, 83, 98, 231,
310, 414, 486B, 486C, 486E, 489,
493, 508, 508A, 512, 719, 854, 857,
891, 1072, 1277, 1569, 1581, 1976)

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December, 1995

A P P E N D I X B

UL'S INDUSTRY ADVISORY GROUPS, INDUSTRY ADVISORY CONFERENCE AND TECHNICAL ADVISORY PANELS DISTRIBUTION

(Attention is directed to Item 8: Compact-Stranded Copper)

Armored Cable
Rubber-Insulated Wires and Cables
Panelboards
Thermoplastic-Insulated Wires and Cables
Enclosed and Dead-Front Switches
Power Outlets
Meter Sockets
Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables
Industrial Control Equipment
Industrial Control Panels
Fuseholders
Nonmetallic-Sheathed Cables
Service-Entrance Cables
Busways and Associated Fittings
Dead-Front Switchboards
Medium-Voltage Power Cables
Electrical Power and Control Tray Cables with Optional Optical-Fiber Members
Metal-Clad Cables
Electrical Wires, Cables, and Flexible Cords



Documents

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Subjects 486A (4, 44, 67, 83, 98, 231,
310, 414, 486B, 486C, 486E, 489,
493, 508, 508A, 512, 719, 854, 857,
891, 1072, 1277, 1569, 1581, 1976)

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December, 1995

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 C

PROPOSED REQUIREMENTS AND PROPOSED EFFECTIVE DATE FOR THE
FOR THE EIGHTH EDITION OF THE STANDARD FOR WIRE CONNECTORS AND
SOLDERING LUGS FOR USE WITH COPPER CONDUCTORS, UL 486A; THIRD EDITION
OF THE STANDARD FOR WIRE CONNECTORS FOR USE WITH ALUMINUM
CONDUCTORS, UL 486B; SECOND EDITION OF THE STANDARD FOR SPLICING WIRE
CONNECTORS, UL 486C; THIRD EDITION OF THE STANDARD FOR EQUIPMENT
WIRING TERMINALS FOR USE WITH ALUMINUM AND/OR COPPER CONDUCTORS,
UL 486E; SIXTH EDITION OF THE STANDARD FOR ELECTRICAL QUICK-CONNECT
TERMINALS, UL 310; FIRST ISSUE OF THE OUTLINE OF INVESTIGATION FOR CRIMP
TOOLS FOR USE WITH WIRE CONNECTORS, SUBJECT 1976

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).

Numbered items correspond to the numbered items in the meeting report.

Subjects 486A (4, 44, 67, 83, 98, 231,
310, 414, 486B, 486C, 486E, 489,
493, 508, 508A, 512, 719, 854, 857,
891, 1072, 1277, 1569, 1581, 1976)

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1. CORRECTIONS AND CLARIFICATIONS

PROPOSALS

UL 486A

1.5 These requirements do not cover connectors intended for direct burial, insulated connectors intended for use at voltage levels in excess of 600 volts [1000 volts in a sign or lighting fixture (luminaire)], manually applied screw-on connectors, binding-screw terminals, built-in terminal connectors on devices rated under 30 A and intended for outlet-box mounting or having provision for strain relief, or built-in terminal connectors on devices having integral cable clamps.

Paragraph 1.5 revised (date of publication)

TABLE 7.6

~~TIGHTENING TORQUE FOR SOCKET~~ TIGHTENING TORQUE FOR RECESSED ALLEN

HEAD SCREWS

Socket Size		Tightening Torque,	
Across Flats, Inch (mm) ^a		Pound-Inches (N•m)	
1/8	(3.2)	45	(5.1)
5/32	(4.0)	100	(11.4)
3/16	(4.8)	120	(13.8)
7/32	(5.6)	150	(17.0)
1/4	(6.4)	200	(22.6)
5/16	(7.9)	275	(31.1)
3/8	(9.5)	375	(42.4)
1/2	(12.7)	500	(56.5)
9/16	(14.3)	600	(67.8)

^aSee note a to Table 7.4 for screws with multiple tightening means.

Table 7.6 revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231,
310, 414, 486B, 486C, 486E, 489,
493, 508, 508A, 512, 719, 854, 857,
891, 1072, 1277, 1569, 1581, 1976)

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December, 1995

TABLE 11.2
TEST CURRENTS FOR CONNECTORS INTENDED
FOR PARALLELING OF COPPER CONDUCTORS,
AMPERES^{a, b, c}

Conductor Size, AWG or kcmil (mm ²)	Number of Conductors		
	2	3	4
1/0 (53.49)	300	450	480
2/0 (67.43)	350	525	560
3/0 (85.01)	400	600	640
4/0 (107.2)	460	690	736
250 (127)	527	790	1053
300 (152)	579	868	1158
350 (177)	657	985	1314
400 (203)	709	1063	1418
500 (253)	806	1209	1612
600 (304)	1035	1554	2070
100 (355)	1133	1699	2266
150 (380)	1178	1767	2356
800 (405)	1223	1834	2446
900 (456)	1305	1958	2610
1000 (507)	1403	2104	2806
1250 (633)	1598	2397	3196
1500 (760)	1763	2644	3526
1750 (887)	1920	2880	3840
2000 (1016)	2078	3117	4156

^aThe current for conductor sizes 1/0 — 4/0 AWG are based on the National Electrical Code, NFPA 70-1993 (NEC), Table 310-16, 75°C column, multiplied by the number of conductors and de-rated by 80 percent.

^bThe current for conductor sizes 250 kcmil and larger are in accordance with the NEC, Sections ~~318-9(b)(1) and 318-9(b)(2)~~ 318-11(b)(1) and 318-11(b)(2) for Table 310-17 (free air ampacities), 75°C column, multiplied by the number of conductors and de-rated as follows:

250 — 500 kcmil — ~~de-rated by 75 percent~~ de-rated by 65 percent

600 kcmil and larger — ~~de-rated by 65 percent~~ de-rated by 75 percent

^cAny number of conductors other than tabulated are to be de-rated in accordance with the NEC, Table 310-16, footnote 8.

Table 11.2 revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231,
310, 414, 486B, 486C, 486E, 489,
493, 508, 508A, 512, 719, 854, 857,
891, 1072, 1277, 1569, 1581, 1976)

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UL 486B

1.3A These requirements cover insulated connectors, insulating caps, and covers intended for use at 600 volts or less [1000 volts in a sign or lighting fixture (luminaire)] and ~~insulated~~ uninsulated connectors for use in general-use circuits rated 2000 volts nominal or less.

Exception: Uninsulated pressure terminal connectors that are compression tool applied may be used in circuits rated 35,000 volts or less. When connectors are used in such circuits, the stress-relief insulation prescribed by the manufacturers of shielded cables is to be provided when these connectors are installed.

Paragraph 1.3A revised (date of publication)

1.4 These requirements do not cover connectors intended for direct burial, insulated connectors intended for use at voltage levels in excess of 600 volts [1000 volts in a sign or lighting fixture (luminaire)], manually applied screw-on connectors, binding-screw terminals, built-in terminal connectors on devices rated under 30 amperes and intended for outlet-box mounting or having provision for strain relief, or built-in terminal connectors on devices having integral cable clamps.

1.4 revised (date of publication)

TABLE 5.2

TEST SEQUENCE FOR ALL CONNECTORS INTENDED
FOR A SINGLE CONDUCTOR

1	2 ^a	3 ^b
Heat Cycling	Static Heating Secureness ^c Static Heating —repeated Pullout	Secureness ^c Pullout
^a This series of tests is referred to as static-heating sequence.		
^b This series of tests is referred to as mechanical sequence.		
^c Conductor size Nos. 30 — 20 AWG (0.05 — 0.52 mm ²) are not subject to a secureness test.		

Table 5.2 revised (date of publication)

6.14A For the static-heating sequence where intermixing of conductor types is involved, the same selection of samples as indicated in paragraph 6.13A ~~is to~~ shall be tested.

Paragraph 6.14A revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976) -C5-

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7.12 The test and the control conductors are to be as follows. See also paragraphs 7.9, 7.10, and 7.11 and Table 7.1.

A. Aluminum:

1. Solid — No. 12 AWG (3.3 mm^2) and larger complying with the requirements for aluminum wire stock acceptable as an electrical conductor.
2. Stranded — Nos. 12 — 3 AWG ($3.3 — 26.7 \text{ mm}^2$), reverse lay concentric or compressed Class B, aluminum designation 1350H-19 (ASTM B230) or 1350H-16 or 1350H-26 (ASTM B609), and have an iron content of 0.4 percent maximum.
3. Stranded — No. 2 AWG — 1000 kcmil ($33.6 — 508 \text{ mm}^2$) (1) unidirectional lay, compact Class B, aluminum designation 1350H-19 (ASTM B230), and having an iron content of 0.25 percent maximum; or (2) reverse lay, compressed Class B, singly labeled Type USE, aluminum designation 1350H-19 (ASTM B230) or 1350H-16 or 1350H-26 (ASTM B609), and having an iron content of 0.25 percent maximum. Multilabeled Type USE, RHW, or RHHW using 8000 alloy is not to be used.
4. Stranded — larger than 1000 kcmil (508 mm^2) same as item 1 above.

B. Copper:

1. Solid and stranded — Nos. 30 — 16 AWG ($0.05 — 1.3 \text{ mm}^2$), soft annealed, tinned or untinned.
2. Solid — No. 14 AWG (2.1 mm^2) and larger, soft annealed, and untinned.
3. Stranded — Nos. 14 AWG — 2000 MCM kcmil ($2.1 — 1016 \text{ mm}^2$), soft annealed, and untinned. The stranding is to be concentric or compressed Class B or concentric Class C.

C. Copper-clad aluminum:

1. Solid — No. 12 AWG (3.3 mm^2) and larger, fully annealed, and untinned.
2. Stranded — No. 12 AWG — 2000 MCM kcmil ($3.3 — 1016 \text{ mm}^2$), fully annealed, and untinned. The stranding is to be concentric Class B.

Paragraph 7.12 revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231,
310, 414, 486B, 486C, 486E, 489,
493, 508, 508A, 512, 719, 854, 857,
891, 1072, 1277, 1569, 1581, 1976)

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December, 1995

TABLE 7.6
TIGHTENING TORQUE FOR SOCKET HEAD SCREWS
TIGHTENING TORQUE FOR RECESSED ALLEN HEAD
SCREWS

Socket Size Across Flats, Inch (mm) ^a	Tightening Torque Pound-Inches (N·m)			
	A		B	
1/8 (3.2)	35	(4.0)	45	(5.1)
5/32 (4.0)	80	(9.0)	100	(11.3)
3/16 (4.8)	100	(11.3)	120	(13.6)
7/32 (5.6)	120	(13.6)	150	(16.9)
1/4 (6.4)	150	(16.9)	200	(22.6)
5/16 (7.9)	225	(25.4)	275	(31.1)
3/8 (9.5)	300	(33.9)	375	(42.4)
1/2 (12.7)	400	(45.2)	500	(56.5)
9/16 (14.3)	500	(56.5)	600	(67.8)

^aSee note a to Table 7.4 for screws with multiple tightening means.

Table 7.6 revised (date of publication)

8.6 For temperature measurements on a copper control conductor, the following technique is to be employed:

A. A small flap is to be cut into the conductor insulation and rolled back to expose the conductor.

B. The thermocouple bead is to be positioned in the valley between conductor ~~stands~~ strands or on the surface of a solid conductor.

C. The flap of insulation is to be repositioned and secured by a tightly wrapped, double layer of black thermoplastic tape extending not more than 1/2 inch (12.7 mm) on each side of the flap, or by another acceptable means of holding the test conductor insulation in place.

Paragraph 8.6 revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231,
310, 414, 486B, 486C, 486E, 489,
493, 508, 508A, 512, 719, 854, 857,
891, 1072, 1277, 1569, 1581, 1976)

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December, 1995

TABLE 9.3
STATIC TEST CURRENTS FOR 75°C AND 90°C CONNECTORS
INTENDED FOR PARALLELING CONDUCTORS, AMPERES^{a, b, c}

Conductor Sizes, AWG or kcmil	Number and Material of Conductors					
	Two		Three		Four	
	Copper	Aluminum	Copper	Aluminum	Copper	Aluminum
1/0	300	240	450	360	480	384
2/0	350	270	525	405	560	432
3/0	400	310	600	465	640	496
4/0	460	360	690	540	736	576
250	527	410	790	615	1053	820
300	579	455	868	683	1158	910
350	657	514	985	770	1314	1028
400	709	553	1063	829	1418	1106
500	806	631	1209	946	1612	1262
600	1035	810	1554	1215	2070	1620
700	1133	893	1699	1339	2266	1786
750	1178	930	1767	1395	2356	1860
800	1223	968	1834	1452	2446	1936
900	1305	1050	1958	1575	2610	2100
1000	1403	1125	2104	1688	2806	2250
1250	1598	1383	2397	1924	3196	2566
1500	1763	1425	2644	2138	3526	2850
1750	1920	1575	2880	2363	3840	3150
2000	2078	1725	3117	2588	4156	3450

^a The currents for conductor sizes 1/0 — 4/0 AWG are based on the National Electrical Code, NFPA 70 - 1993 (NEC), Table 310-16, 75°C column, multiplied by the number of conductors and de-rated by 80 percent.

^b The currents for conductor sizes 250 kcmil and larger are in accordance with the NEC, Sections ~~318-9(b)(1) and 318-9(b)(2)~~ 318-11(b)(1) and 318-11(b)(2) for Table 310-17 (free air ampacities), 75°C column, multiplied by the number of conductors and de-rated as follows:

250 — 500 kcmil — de-rated by ~~75 percent~~ 65 percent

600 kcmil and larger — de-rated by ~~65 percent~~ 75 percent

^c Any number of conductors other than tabulated are to be de-rated in accordance with the NEC, Table 310-16, footnote 8.

Table 9.3 revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976)

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9.3 The stability factor "S" for each of the 11 temperature measurements mentioned in paragraph 9.1 is to be determined by subtracting algebraically the average temperature deviation "d" "D" from the value of the temperature deviation for that temperature measurement. The temperature deviation for the 11 individual temperature measurements is to be determined by subtracting the associated control-conductor temperature from the connector temperature. The value for "d" is a plus number when the connector temperature is more than that of the control conductor and a negative number when the connector temperature is less than that of the control conductor. The average of the 11 temperature deviations is then to be determined.

Example:

Cycle Number	Temperature °C		d	S
	Connector	Control Connector		
25	130	135	-5	-6.5
50	131	136	-5	-6.5
75	133	135	-2	-3.5
100	136	135	1	-0.5
125	136	135	1	-0.5
175	138	135	3	1.5
225	139	136	3	1.5
275	138	135	3	1.5
350	141	136	5	3.5
425	142	136	6	4.5
500	142	136	6	4.5
Sum			16	
Average			+ 1.5	

Paragraph 9.3 revised (date of publication)

9.13 The following hardware is to be used to make the connections mentioned in paragraph 9.6. Once the initial assembly is completed, there is to be no subsequent retightening.

A. A bolt is to be plated steel, SAE Grade 2, UNC thread having a maximum standard diameter compatible with the hole or holes in the connector tang and a minimum standard length allowing at least a 2-thread projection through the nut, and the projection is not to exceed 1/4 inch (6.4 mm) after assembly.

B. A single flat washer is to be used on each side of the tang-to-tang or tang-to-bus connection. These washers are to be plated steel having an SAE configuration compatible with the diameter of the bolt.

C. A nut is to be plated steel, and is to have a Class 2B, UNC thread and a hexagonal configuration.

D. Clean, dry, nonlubricated screws and bolts and nuts are to be used. The assembled hardware shall be torqued to the following values:

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976)

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Screw or Bolt Size	Tightening Torque	
	Pound-Feet (N·m)	
No. 8 or smaller	1.5	(2)
No. 10	2.0	(3)
1/4 inch	6	(8)
5/16 inch	11	(15)
3/8 inch	19	(26)
7/16 inch	30	(41)
1/2 inch	40	(54)
9/16, 5/8 inch, or larger	55	(75)

Exception No. 1: If the manufacturer's installation instructions — see paragraph 19.14 — specify that a dished washer is to be used, the hardware is to be as follows; (1) one plated or stainless steel dished washer per securing bolt is to be used; (2) bolts or nuts are to be tightened until the crown of the washer is no longer discernible; (3) a flat washer as mentioned in item B is to be used on the side of the tang-to-tang or tang-to-bus connection opposite the dished washer; and (4) the design of the dished washer is to be such that the force needed to flatten the washer is as specified for the corresponding bolt size in the following table:

Bolt Diameter,	Force, Minimum	
	Pounds	(N)
1/4	800	(3560)
5/16	1000	(4450)
3/8	1400	(6230)
7/16, 1/2	2700	(12015)
9/16, 5/8, or larger	3400	(15130)

~~Exception No. 2: Tests on a connector may be conducted using (1) hardware other than mentioned, (2) dished or other washers having different characteristics, or (3) part securement torque values if the manufacturer's installation instructions see paragraph 19.14 specify all necessary hardware.~~

Exception No. 2: Tests on a connector may be conducted using (1) hardware other than mentioned, (2) part securement torque values, or (3) dished or other washers having different characteristics if the manufacturer's installation instructions specify all necessary hardware. See paragraph 19.14.

Paragraph 9.13 revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976)

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TABLE 11.1
TEST VALUES

Size of Conductor		Diameter of Bushing Hole, Inches ^{a,c}	Height, Inches ^{b,c}	Weight, Pounds ^c	
AWG or kcmil	(mm ²)			Copper	Aluminum or Copper-Clad Aluminum
18	(0.82)	1/4	10-1/4	2	—
16	(1.3)	1/4	10-1/4	2	—
14	(2.1)	3/8	11	3	—
12	(3.3)	3/8	11	5	1.5
10	(5.3)	3/8	11	5	1.5
8	(8.4)	3/8	11	8	3
6	(13.3)	1/2	11-3/4	18	~~3~~ 10
4	(21.2)	1/2	11-3/4	30	15
3	(26.7)	9/16	12-1/2	30	15
2	(33.6)	9/16	12-1/2	30	15
1	(42.4)	5/8	13-1/2	50	25
1/0	(53.5)	5/8	13-1/2	50	25
2/0	(67.4)	3/4	14-1/2	50	25
3/0	(85.0)	3/4	14-1/2	60	30
4/0	(107)	3/4	14-1/2	60	30
250	(127)	7/8	16	60	30
300	(156)	7/8	16	80	40
350	(177)	1	17	80	40
400	(203)	1	17	80	40
500	(253)	1-1/8	18-1/4	100	~~40~~ 50
600	(304)	1-1/8	18-1/4	100	50
700	(354)	1-1/4	19-1/2	100	50
750	(380)	1-1/4	19-1/2	110	55
800	(406)	1-3/8	21-1/4	110	55
900	(456)	1-3/8	21-1/4	110	55
1000	(508)	1-1/2	22-1/4	110	55
1250	(635)	1-3/4	26	155	75
1500	(759)	2	28	180	90
1750	(886)	2-1/8	30	205	100
2000	(1010)	2-1/8	30	240	120

^aIf a hole with the diameter given is not adequate to accommodate the conductor without binding, a bushing having a hole of slightly larger diameter may be used.

^bFor Nos. 12 — 4 AWG aluminum conductor, use 12-1/2 inches.

^cFor SI units 1 inch = 25.4 mm and 1 pound = 454 grams.

Table 11.1 revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231,
310, 414, 486B, 486C, 486E, 489,
493, 508, 508A, 512, 719, 854, 857,
891, 1072, 1277, 1569, 1581, 1976)

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13.1 The connectors subjected to the repeated static-heating test or secureness test shall be subjected to a direct pull of the applicable value specified in Table 13.1 for 1 minute. For a connector intended to secure more than one conductor at a time by a single clamping means, only those conductors that have been subjected to the secureness test in accordance with paragraph 11.3 are to be subjected to the pullout test. In accordance with the Exception to paragraphs 5.1 and 11.1, Nos. 30 — 20 AWG (0.05 — 0.52 mm²) need not be subjected to the secureness test prior to the pullout test. The connector is not acceptable if it becomes separated from the conductor or conductors as a result of the test.

Paragraph 13.1 revised (date of publication)

~~TABLE 13.1~~

TABLE 13.1

TEST VALUES FOR CONNECTORS

Size of Conductor, AWG or kcmil (mm ²)		Pullout Force, Pounds (N)			
		Copper		Aluminum or Copper-Clad Aluminum	
30	(0.05)	1-1/2		—	
28	(0.08)	2		—	
26	(0.13)	3		—	
24	(0.20)	5		—	
22	(0.32)	8	(35.6)	—	
20	(0.52)	13	(57.9)	—	
18	(0.82)	20	(89.0)	—	
16	(1.3)	30	(133.5)	—	
14	(2.1)	50	(222.5)	—	
12	(3.3)	70	(311.5)	35	(155.8)
10	(5.3)	80	(356.0)	40	(178.0)
8	(8.4)	90	(400.5)	45	(200.3)
6	(13.3)	100	(445.0)	50	(222.5)
4	(21.2)	140	(623.0)	70	(311.5)
3	(26.7)	160	(712.0)	80	(356.0)
2	(33.6)	180	(801.0)	90	(400.5)
1	(42.4)	200	(890.0)	100	(445.0)
1/0	(53.5)	250	(1112.5)	125	(556.3)
2/0	(67.4)	300	(1235.0)	150	(667.5)
3/0	(85.0)	350	(1557.5)	175	(778.8)
4/0	(107)	450	(2002.5)	225	(1001.3)
250	(127)	500	(2225.0)	250	(1112.5)
300	(156)	550	(2447.5)	275	(1223.8)
350	(177)	600	(2670.0)	300	(1335.0)
400	(203)	650	(2892.5)	325	(1446.3)
500	(253)	800	(3560.0)	400	(1780.0)
600	(304)	900	(4005.0)	450	(2002.5)
700—2000	(354—1010)	1000	(4450.0)	500	(2225.0)

Table 13.1 revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976) -C12-

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TABLE 14.1
DIELECTRIC VOLTAGE-WITHSTAND TEST SEQUENCE

Connector Construction	Required Tests ^a
I. A connector having insulation in the form of a tubular sleeve and intended to accommodate only one conductor in each opening and intended for use with:	
(1) No. 10 AWG (5.3 mm ²) or smaller conductors	A, C
(2) Nos. 8–4/0 AWG (8.4–107 mm ²) (8.4–107.2 mm ²) conductors	A
II. Insulated connectors <u>not covered in Item I.</u>	A, B

^a A — Test A is described in paragraphs 14.5 — 14.7 and Tables 14.2 and 14.3.
B — Test B is described in paragraph 14.8 and Table 14.4.
C — Test C is described in paragraph 14.9.

Table 14.1 revised (date of publication)

UL 486C

4.2 The connector body of a copper, copper alloy, aluminum, or aluminum alloy connector intended for aluminum conductor shall be coated with an electrically conductive coating, such as tin, that will inhibit oxidation and corrosion.

Exception No. 1: A connector that is shipped prefilled with an oxide-inhibiting compound need not comply.

Exception No. 2: An aluminum-bodied connector intended for an aluminum conductor only, not copper-clad aluminum, need not comply.

~~Exception No. 3: The saw cut ends of a neutral bar need not be coated.~~

Exception No. ~~4~~ 3: The top cap of a lay-in lug or connector not in contact with the wire need not be plated.

~~Exception No. 5: A stamped mounting hole in a connector which is intended to be secured by a bolt, nut, and washer need not be plated.~~

Paragraph 4.2 revised (date of publication)

5.5 For the heat-cycling, ~~and static-heating,~~ and mechanical sequence tests if more than a single conductor is secured by a single securing means, tests on duplicate samples are to be conducted to represent the most severe conductor position conditions that could result when conductors are inserted into the connector.

Paragraph 5.5 revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976) -C13-

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6.6 If a connector is also intended for use with more than two conductors or two or more combinations of conductors differing in the number or sizes, or both, heat-cycling tests are to be conducted with the maximum size conductor in combination with the minimum size conductors where the sum of the test currents of the minimum size conductors is approximately equal to but not greater than the current of the maximum size conductor. The combination selected shall have the largest gap between the maximum and minimum conductor sizes.

Exception: For a connector that is intended for copper conductor in addition to aluminum or copper-clad aluminum conductor, heat-cycling tests with copper conductor need not be conducted if the copper conductor size that would be selected would result in a test current that is less than or equal to the test current used in the tests with aluminum or copper-clad aluminum conductor. With the concurrence of those concerned, the current used in the tests with aluminum or copper-clad aluminum conductor may be raised to the value normally used with copper conductor. See paragraphs 5.6 and 5.7.

~~Example: A connector intended for copper conductor only has combinations marked as follows (see Table 9.1 for test currents):~~

~~1 10 w/1 10 — 16,~~

~~1 12 w/1 12 — 16,~~

~~1 14 w/1 14 — 16,~~

~~1 16 w/1 16,~~

~~1 10 w/3 to 7 18, and~~

~~1 12 w/4 to 9 18.~~

Example: A connector intended for copper conductor only has combinations marked as follows (see Table 9.1 for test currents):

1 #10 with 1 #10 — 56A,

1 #12 with 1 #12 — 39A,

1 #14 with 1 #14 — 33A,

1 #16 with 1 #16 — 20A,

1 #10 with 3 to 7 #18 — 56A, and

1 #12 with 4 to 9 #18 — 39A.

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976)

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Samples selected for the heat-cycling test would be:

- A. Two No. 10 AWG, with a test current of 56 amperes — see paragraph 6.5;
- B. One No. 10 AWG with three No. 18 AWG, with a test current of 56 amperes — see above.

Paragraph 6.6 revised (date of publication)

9.4 The stability factor "S" for each of the 11 temperature measurements mentioned in paragraph 9.2 is determined by subtracting algebraically the average temperature deviation "~~d~~" "D" from the value of the temperature deviation for that temperature measurement. The temperature deviation for the 11 individual temperature measurements is to be determined by subtracting the associated control-conductor temperature from the connector temperature. "d" is a positive number when the connector temperature is higher than that of the control conductor and a negative number when the connector temperature is less than that of the control conductor. The average of the 11 temperature deviations is then to be determined.

Example:

Cycle Number	Temperature °C		d	S
	Connector	Control Conductor		
25	130	135	-5	-6.5
50	131	136	-5	-6.5
75	133	135	-2	-3.5
100	136	135	1	-0.5
125	136	135	1	-0.5
175	138	135	3	1.5
225	139	136	3	1.5
275	138	135	3	1.5
350	141	136	5	3.5
425	142	136	6	4.5
500	142	136	6	4.5
Sum			16	
Average			+ 1.5	

Paragraph 9.4 revised (date of publication)

(NEW)

16.2 The samples conditioned according to Section 15, Conditioning, are to be subjected to this test. The ambient temperature to be used for this test is 25°C (77°F).

Paragraph 16.2 added (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976) -C15-

December, 1995

(NEW)

16.3 The samples are to be connected in series and a current is to be passed through the circuit. The values of current used for this test are to be the applicable values specified in the static-heating columns of Table 9.1 for the conductor size and type. The test is to be run for 30 days without interruption. Temperatures are to be measured and recorded approximately every 24 hours.

Paragraph 16.3 added (date of publication)

TABLE 18.1
DIELECTRIC VOLTAGE-WITHSTAND TEST SEQUENCE

Connector Construction	Required Tests ^a
I. A connector having insulation in the form of a tubular sleeve and intended to accommodate only one conductor in each opening ^b and intended for use with:	
(1) No. 10 AWG (5.3 mm ²) ^b or smaller conductors	A, C
(2) Nos. 8–6 AWG (8.4–13.3 mm ²) conductors	A
II. ~~Connectors having insulation in other than a tubular form~~ ^c insulated connectors not covered in Item I.	A, B

^aA — Test A is described in paragraphs 18.6 — 18.8 and Tables 18.2 and 18.3.
B — Test B is described in paragraph 18.9 and Table 18.4.
C — Test C is described in paragraph 18.10.
^bThese types of connectors include insulation-piercing and push-in types.
^cThese types of connectors include twist-on types.

Table 18.1 revised (date of publication)

UL 486E

1.5 These requirements do not cover insulated connectors ~~intended for use at voltage levels in excess of 600 volts, 1000 volts in a sign or lighting fixture (luminaire), binding-screw terminals, built-in terminal connectors on devices rated under 30 amperes and intended for outlet-box mounting or having provision for strain relief, or built-in terminal connectors on devices having integral cable clamps.~~

1.5 revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, -C16-
310, 414, 486B, 486C, 486E, 489,
493, 508, 508A, 512, 719, 854, 857,
891, 1072, 1277, 1569, 1581, 1976)

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5.3 The body of a terminal intended for use with aluminum wire shall be coated with an electrically conductive coating that will inhibit oxidation and corrosion.

Exception No. 1: The wire securing (barrel) portion of a connector that is shipped prefilled with an oxide-inhibiting compound need not be coated.

~~*Exception No. 2: The saw cut ends of a neutral bar need not be coated.*~~

~~*Exception No. 3: The top cap of a lay-in lug or connector not in contact with the wire need not be plated.*~~

~~*Exception No. 4: A stamped mounting hole in a connector which is intended to be secured by a bolt, nut, and washer need not be plated.*~~

5.3 revised (date of publication)

6.1 An equipment wiring terminal shall perform acceptably when separate sets of samples are subjected to the tests specified in Table 6.1. As a result of the tests, there shall be no breakage of the conductor or any strand of a stranded wire, stripping of threads, shearing of parts, or other damage to the terminal.

Exception No. 1: A terminal of copper or copper alloy need not be subjected to the heat-cycling sequence with copper wire.

Exception No. 2: The initial state heating test need not be conducted in the static heating sequence using copper wire.

Exception No. 3: For other than a tool-applied crimp connector, the heat cycling test using copper wire need not be conducted provided the connector has been heat cycling tested with aluminum wire of a size not smaller than the size of copper wire that would otherwise be required for the heat cycling test.

Example No. 1: A setscrew connector is rated 4 AWG — 250 kcmil CU/AL. The conductor sizes required for heat cycling testing are 250 kcmil CU and 250 kcmil AL. In accordance with Exception No. 3 above, the heat cycling test using copper wire need not be conducted because the size of aluminum wire to be heat cycling tested is not smaller than the size of copper wire.

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976) -C17-

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Example No. 2: A setscrew connector is rated 4 AWG — 250 kcmil CU, 4 AWG — 1/0 kcmil AWG AL. The conductor sizes required for heat cycling testing are 250 kcmil CU and 1/0 kcmil AWG AL. As the size of aluminum wire to be tested is smaller than the size of copper wire, Exception No. 3 above would not apply and the heat cycling test would need to be conducted for both copper and aluminum wire.

Exception No. 4: Nos. 30 — 20 AWG (0.05 — 0.52 mm²) need not be subjected to the secureness test.

6.1 revised (date of publication)

(CURRENT)

Table 6.1
Test sequence for all wiring terminals

	Sequence		
	1	2	3
Terminals intended for a single conductor	Heat Cycling ^a	Static Heating ^b Secureness ^d Static Heating — Repeated Pullout	Secureness ^{c,d} Pullout
Terminals intended for paralleling conductors	Heat Cycling ^a	Static Heating ^b	Secureness ^{c,d} Pullout
^a Applicable to all terminals used with aluminum wire and aluminum bodied terminals used with copper wire.			
^b This series of tests is referred to as static heating sequence.			
^c This series of tests is referred to as mechanical sequence.			
^d Conductor size Nos. 30 — 20 AWG (0.05 — 0.52 mm ²) are not subject to a secureness test.			

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976)

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(PROPOSED)

Table 6.1
Test sequence for all wiring terminals

	Sequence		
	1	2 ^b	3 ^c
Terminals intended for a single conductor	Heat Cycling ^a	Static Heating ^e Secureness ^d Static Heating – Repeated ^e Pullout	Secureness ^d Pullout
Terminals intended for paralleling conductors	Heat Cycling ^a	Static Heating ^e	Secureness ^d Pullout

^a Applicable to all terminals used with aluminum wire and aluminum bodied terminals used with copper wire.
^b This series of tests is referred to as static-heating sequence.
^c This series of tests is referred to as mechanical sequence.
^d Conductor size Nos. 30 – 20 AWG (0.05 – 0.52 mm²) are not subject to a secureness test.
^e See 7.1.11 and 11.4.

Table 6.1 revised (date of publication)

Table 8.6
Tightening torque for recessed socket screws
Tightening torque for recessed allen head screws

Socket size across flats,		Tightening torque, pound-inches (N·m)	
Inch	(mm) ^a	A	B
1/8	(3.2)	35 (4.0)	45 (5.1)
5/32	(4.0)	80 (9.0)	100 (11.3)
3/16	(4.8)	100 (11.3)	120 (13.6)
7/32	(5.6)	120 (13.6)	150 (16.9)
1/4	(6.4)	150 (16.9)	200 (22.6)
5/16	(7.9)	225 (25.4)	275 (31.1)
3/8	(9.5)	300 (33.9)	375 (42.4)
1/2	(12.7)	400 (45.2)	500 (56.5)
9/16	(14.3)	500 (56.5)	600 (67.8)

^a A terminal having clamping screws with multiple tightening means; for example, a slotted, hexagonal head screw, is to be tested using both values of torque.

Table 8.6 revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976)

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10.1.4 The stability factor "S" for each of the 11 temperature measurements in 10.1.2 is to be determined by subtracting algebraically the average temperature deviation " $\bar{d}$ " "D" from the value of the temperature deviation for that temperature measurement. The temperature deviation for the 11 individual temperature measurements is to be determined by subtracting the associated control-conductor temperature from the terminal temperature. The value for "d" is a positive number when the terminal temperature is more than that of the control conductor and a negative number when the terminal temperature is less than that of the control conductor. The average of the 11 temperature deviations is then to be determined.

Example:

Cycle number	Temperature °C		d	S
	Connector	Control conductor		
25	130	135	-5	-6.5
50	131	136	-5	-6.5
75	133	135	-2	-3.5
100	136	135	1	-0.5
125	136	135	1	-0.5
175	138	135	3	1.5
225	139	136	3	1.5
275	138	135	3	1.5
350	141	136	5	3.5
425	142	136	6	4.5
500	142	136	6	4.5
Sum 16				
Average + 1.5				

10.1.4 revised (date of publication)

UL 310

7.4 Porcelain ~~and/or~~ cold-molded composition used as electrical insulation shall additionally comply with the Moisture Absorption Test, Section 17.

7.4 revised (date of publication)

3. MARKING REQUIREMENTS FOR INSULATED CONNECTORS

PROPOSALS

UL 486B

3.6 The construction of a connector intended to secure more than a single conductor shall be such that there will be no intermixing (direct contact) between the conductors of different materials unless the connector is investigated and marked for intermixing - dry locations only. See paragraphs 6.11A, 6.13A, 6.14A, and 19.4A.

Revised paragraph 3.6 effective (24 months after date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, -C20-
310, 414, 486B, 486C, 486E, 489,
493, 508, 508A, 512, 719, 854, 857,
891, 1072, 1277, 1569, 1581, 1976)

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19.4A A connector intended for intermixing between conductor types shall be additionally marked "(intermixed - dry locations)" immediately following the marking in paragraph 19.4, for example AL7CU (intermixed - dry locations). See paragraph 3.6.

Revised paragraph 19.4A effective (24 months after date of publication)

UL 486C

1.5 These requirements cover splicing connectors intended for copper-to-copper or aluminum-to-aluminum conductor combinations, or both. Also covered are copper-to-aluminum or to copper-clad aluminum conductor combinations intended for intermixing of conductors and dry locations only.

Revised paragraph 1.5 effective (24 months after date of publication)

24.6 The unit container or an information sheet packed in the unit container of a connector that accommodates two or more conductors in the same opening shall be marked with the following or equivalent wording:

- A. "CC" if for copper-clad aluminum conductor only.
- B. "CU" if for copper conductor only.
- C. "AL" if for aluminum or copper-clad aluminum conductor.
- D. "AL-CU" or "CU-AL" if for copper to copper, aluminum to aluminum, or copper-clad aluminum to copper-clad aluminum conductor but not intermixed.
- E. "CC-CU" or "CU-CC" if for either copper to copper or copper-clad aluminum to copper-clad aluminum conductor but not intermixed.
- F. "AL-CU (intermixed - dry locations)" or "CU-AL (intermixed)" if for copper to aluminum or copper-clad aluminum conductor.
- G. "CU-CC (intermixed - dry locations)" or "CC-CU (intermixed)" if for copper to copper-clad aluminum conductor.
- H. With the appropriate voltage rating — "300 volts maximum," "600 volts maximum," or "600 volts maximum building wire; 1000 volts maximum signs or lighting fixtures (luminaires)," or equivalent wording — for which the insulated connector has been found acceptable. The word "(luminaires)" is optional.
- I. With the operating temperature rating for which the insulated connector has been found acceptable. See also paragraph 24.16.

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976) -C21-

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J. With the complete or partial list of acceptable conductor combinations.

Revised paragraph 24.6 effective (24 months after date of publication)

UL 486E

4.6 A wiring terminal intended to secure more than a single wire shall be constructed such that there will be no intermixing (direct contact) between copper and aluminum wire, unless the connector is investigated and marked for intermixing - dry locations only. See 7.1.9, 7.2.1.1, 7.3.1.1, and 15.5.1.

Revised 4.6 effective (24 months after date of publication)

15.5.1 A connector intended for intermixing between conductor types shall be additionally marked "(intermixed - dry locations)" immediately following the marking in 15.18, for example AL7CU (intermixed). See 4.6.

Revised 15.5.1 effective (24 months after date of publication)

7. MOISTURE ABSORPTION TEST

PROPOSALS

UL 486A

4.10 Porcelain or cold-molded composition used as insulation shall additionally comply with the Moisture Absorption Test, Section 19.

Paragraph 4.10 revised (date of publication)

19. Moisture Absorption Test

Section 19 title revised (date of publication)

19.1 ~~To determine the acceptability of a Porcelain or a cold-molded composition used as insulation on connectors parts as mentioned in paragraph 4.10, a sample of the material shall not absorb more than 3 percent of its weight when broken and submerged for 24 hours in distilled water at room temperature tested as described in paragraph 19.2.~~

Paragraph 19.1 revised (date of publication)

19.2 A Samples used for the Moisture Absorption Test is are to be clean and dry. ~~The sample~~ The insulation on the connector is to be broken, weighed, and then submerged ~~for 24 hours~~ in distilled water at room temperature for 24 hours. After removal from the water ~~it the broken insulation~~ is to be dried with a soft cloth to remove all surface water ~~before being and immediately~~ immediately reweighed.

Paragraph 19.2 revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231,
310, 414, 486B, 486C, 486E, 489,
493, 508, 508A, 512, 719, 854, 857,
891, 1072, 1277, 1569, 1581, 1976)

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UL 486B

4.10 Porcelain ~~and or~~ cold-molded composition used as insulation shall ~~not absorb more than 3 percent of its weight when broken and submerged for 24 hours in distilled water at room temperature~~ additionally comply with the Moisture Absorption Test, Section 18A.

Paragraph 4.10 revised (date of publication)

(CURRENT)

4.11 ~~Samples for the absorption test are to be clean and dry. Each sample is to be broken, weighed, and then submerged in distilled water at room temperature for 24 hours. After removal from the water it is to be dried with a soft cloth to remove all surface water before being reweighed.~~

(PROPOSED)

4.11 *Paragraph 4.11 revised and relocated as paragraph 18A.2 (date of publication)*

(NEW)

18A. Moisture Absorption Test

Section 18 added (date of publication)

18A.1 Porcelain or cold-molded composition used as insulation on connectors shall not absorb more than 3 percent of its weight when tested as described in paragraph 18A.2.

Paragraph 18A.1 added (date of publication)

18A.2 Samples used for the moisture absorption test are to be clean and dry. ~~Each~~ The insulation on the connector is to be broken, weighed, and then submerged in distilled water at room temperature for 24 hours. After removal from the water the broken ~~connector~~ insulation is to be dried with a soft cloth to remove all surface water and immediately reweighed.

Paragraph 4.11 revised and relocated as paragraph 18A.2 (date of publication)

UL 486C

4.7 Porcelain ~~and or~~ cold-molded composition used as insulation shall additionally comply with the Moisture Absorption Test, Section 22.

Paragraph 4.7 revised (date of publication)

22.2 Samples used for the moisture absorption test are to be clean and dry. ~~Each~~ The insulation on the connector is to be broken, weighed, and then submerged in distilled water at room temperature for 24 hours. After removal from the water the broken ~~connector~~ insulation is to be dried with a soft cloth to remove all surface water and immediately reweighed.

Paragraph 22.2 revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976)

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8. COMPACT-STRANDED COPPER

PROPOSALS

UL 486A

(NEW)

1.3A These requirements also cover connectors additionally rated for Nos. 2 — 4/0 AWG compact-stranded copper conductors. These connectors are identified in accordance with paragraph 20.7A. See also paragraphs 3.1A and 7.10C exception.

Added paragraph 1.3A effective (date of publication)

(NEW)

3.1A A connector rated and tested with compact-stranded copper conductors according to these requirements shall also accept all strands of a Class B concentric-stranded conductor of the same size. See also paragraphs 1.3A and 7.10C exception.

Added paragraph 3.1A effective (date of publication)

7.10 The test conductors are to be as follows. See also paragraphs 7.8, 7.9, and Table 7.1:

- A. Solid and Stranded — Nos. 30 — 16 AWG (0.05 — 1.3 mm²), soft annealed, tinned or untinned.
- B. Solid — No. 14 AWG (2.1 mm²) and larger, soft annealed, and untinned.
- C. Stranded — No. 14 AWG — 2000 kcmil (2.1 — 1016 mm²), soft annealed, and untinned. The stranding is to be concentric or compressed Class B or concentric Class C.

Exception: Connectors additionally rated for Nos. 2 — 4/0 AWG compact-stranded copper conductors shall be tested with compact-stranded Class B copper conductors. See also 3.1A and 20.7A.

Revised paragraph 7.10 effective (date of publication)

(NEW)

20.7A Connectors additionally rated for Nos. 2 — 4/0 AWG compact-stranded copper conductors shall have the connector, the unit container, or an information sheet packed in the unit container marked "For compact-stranded copper conductors" or the equivalent.

Added paragraph 20.7A effective (date of publication)

UL 486B

1.3B These requirements also cover connectors additionally rated for Nos. 2 — 4/0 AWG compact-stranded copper conductors. These connectors are identified in accordance with paragraph 19.A. See also paragraphs 3.2 and 7.12B.3 exception.

Added paragraph 1.3B effective (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976)

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3.2 A connector tested with ~~unidirectional lay~~ a compact stranded aluminum and/or copper conductor according to these requirements shall also accept all strands of a Class B concentric stranded conductor of the same size and type.

Revised paragraph 3.2 effective (date of publication)

7.12 The test and the control conductors are to be as follows. See also paragraphs 7.9, 7.10, and 7.11 and Table 7.1.

A. Aluminum:

1. Solid — No. 12 AWG (3.3 mm²) and larger complying with the requirements for aluminum wire stock acceptable as an electrical conductor.
2. Stranded — Nos. 12 — 3 AWG (3.3 — 26.7 mm²), reverse lay concentric or compressed Class B, aluminum designation 1350-H19 (ASTM B230) or 1350-H16 or 1350-H26 (ASTM B609), and have an iron content of 0.4 percent maximum.
3. Stranded — No. 2 AWG — 1000 kcmil (33.6 — 508 mm²) (1) ~~unidirectional lay~~, compact-stranded Class B, aluminum designation 1350-H19 (ASTM B230), and having an iron content of 0.25 percent maximum; or (2) reverse lay, compressed Class B, ~~singly-labeled~~ single-rated Type USE, aluminum designation 1350-H19 (ASTM B230) or 1350-H16 or 1350-H26 (ASTM B609), and having an iron content of 0.25 percent maximum. ~~Multilabeled~~ Type USE, RHW, or RHHW using an AA-8000 alloy is not to be used.
4. Stranded — larger than 1000 kcmil (508 mm²) same as item 1 above.

B. Copper:

1. Solid and stranded — Nos. 30 — 16 AWG (0.05 — 1.3 mm²), soft annealed, tinned or untinned.
2. Solid — No. 14 AWG (2.1 mm²) and larger, soft annealed, and untinned.
3. Stranded — Nos. 14 AWG — 2000 MCM (2.1 — 1016 mm²), soft annealed, and untinned. The stranding is to be concentric or compressed Class B or concentric Class C.

Exception: Connectors additionally rated for Nos. 2 — 4/0 AWG compact-stranded copper conductors shall be tested with compact-stranded Class B copper conductors. See also 3.2 and 19.8A.

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976)

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C. Copper-clad aluminum:

1. Solid — No. 12 AWG (3.3 mm²) and larger, fully annealed, and untinned.
2. Stranded — No. 12 AWG — 2000 MCM (3.3 — 1016 mm²), fully annealed, and untinned. The stranding is to be concentric Class B.

Revised paragraph 7.12 effective (date of publication)

(NEW)

19.8A Connectors additionally rated for compact-stranded copper shall have the connector, the unit container, or an information sheet packed in the unit container marked "For compact-stranded copper conductors" or the equivalent.

Added paragraph 19.8A effective (date of publication)

UL 486E

(NEW)

1.4A These requirements also cover connectors additionally rated for Nos. 2 — 4/0 AWG compact-stranded copper conductors. These connectors are identified in accordance with 15.9A. See also 4.1 and 8.2.6(b)(3) exception.

Added 1.4A effective (date of publication)

4.1 An equipment wiring terminal intended for use with stranded wire shall be constructed such that all strands of the conductor will be contained within the terminal. A terminal tested with a unidirectional lay compact stranded aluminum and/or copper wire conductor in accordance with these requirements shall also accept all strands of a Class B concentric stranded wire conductor of the same size and type.

Revised 4.1 effective (date of publication)

8.2.6 The configuration of both the test and the control conductors selected in accordance with 7.1.9 shall be as follows. See also 8.2.3, 8.2.4, and 8.2.5 and Table 8.1.

a) Aluminum:

- 1) Solid — No. 12 AWG (3.3 mm²) and larger complying with the requirements for aluminum wire stock acceptable as an electrical conductor.
- 2) Stranded — Nos. 12 — 3 AWG (3.3 — 26.7 mm²), reverse lay concentric or compressed Class B, aluminum designation 1350-H19 (ASTM B230) or 1350-H16 or 1350-H26 (ASTM B609) having an iron content of 0.4 percent maximum.

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976)

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3) Stranded — No. 2 AWG — 1000 kcmil (33.6 — 508 mm²) unidirectional lay, compact Class B, aluminum designation 1350-H19 (ASTM B230) having an iron content of 0.25 percent maximum; or reverse lay, compressed Class B, ~~singly labeled~~ single-rated Type USE, aluminum designation 1350-H19 (ASTM B230) or 1350-H16 or 1350-H26 (ASTM B609) having an iron content of 0.25 percent maximum. ~~Multilabeled~~ Type USE, RHW, or RHHW using an AA-8000 alloy shall not be used.

4) Stranded — larger than 1000 kcmil (508 mm²) same as (1) above.

b) Copper:

1) Solid and stranded — Nos. 30 — 16 AWG (0.05 — 1.3 mm²) soft annealed, tinned or untinned.

2) Solid — No. 14 AWG (2.1 mm²) and larger, soft annealed, and untinned.

3) Stranded — Nos. 14 AWG — 2000 MCM (2.1 — 1016 mm²); concentric or compressed Class B, or concentric Class C; soft annealed, and untinned.

Exception: Connectors rated for Nos. 2 — 4/0 AWG copper conductors shall be tested with a compact-stranded Class B copper conductors in that range. See also 4.1 and 15.9A.

c) Copper-Clad aluminum:

1) Solid — No. 12 AWG (3.3 mm²) and larger, fully annealed, and untinned.

2) Stranded — No. 12 AWG — 2000 MCM (3.3 — 1016 mm²), concentric Class B, fully annealed, and untinned.

Revised 8.2.6 effective (date of publication)

(NEW)

15.9A Connectors rated for Nos. 2 — 4/0 AWG conductors shall have the connector, unit container, or an information sheet packed in the unit container marked "for compact-stranded copper conductors" or the equivalent.

Added 15.9A effective (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976)

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9. SPECIFIC CRIMP TOOL IDENTIFICATION

SUBJECT 1976

PROPOSAL

(NEW)

4.2 A tool intended to be used with connectors for wire sizes 8 AWG and larger shall leave a unique tool identification or a unique designation of a removable tool part, such as a pressing die, on the connector after assembly. This marking shall be a permanent part of the tool/die such as an engraving.

Added 4.2 (24 months after date of publication)

10. HIGH VOLTAGE CONNECTORS

UL 486A

PROPOSAL

1.4A These requirements cover insulated connectors, insulating caps, and covers intended for use at 600 volts or less [1000 volts in a sign or lighting fixture (luminaire)] and uninsulated connectors for use in general use circuits rated 2000 volts nominal or less.

Exception: Uninsulated pressure ~~terminal~~ wire connectors (both terminal and splicing type) that are compression tool applied may be used in circuits rated 35,000 volts or less. When connectors are used in such circuits, the stress-relief insulation prescribed by the manufacturers of shielded cables is to be provided when these connectors are installed.

Paragraph 1.4A revised (date of publication)

UL 486B

1.3A These requirements cover insulated connectors, insulating caps, and covers intended for use at 600 volts or less [1000 volts in a sign or lighting fixture (luminaire)] and uninsulated connectors for use in general use circuits rated 2000 volts nominal or less.

Exception: Uninsulated pressure ~~terminal~~ wire connectors (both terminal and splicing type) that are compression tool applied may be used in circuits rated 35,000 volts or less. When connectors are used in such circuits, the stress-relief insulation prescribed by the manufacturers of shielded cables is to be provided when these connectors are installed.

Paragraph 1.3A revised (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976) -C28-

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11. 10-DAY MOIST AMMONIA-AIR STRESS CRACKING TEST

PROPOSAL

UL 486A

4.4 A brass part of a connector shall be resistant to stress corrosion cracking.

Paragraph 4.4 revised (date of publication)

4.5 A brass part containing ~~not less than 80 percent copper~~ not more than 15 percent zinc is considered to be resistant to stress corrosion cracking.

Paragraph 4.5 revised (date of publication)

4.6 A brass part containing ~~less than 80 percent copper~~ is acceptable if it withstands the Immersion Test more than 15 percent zinc shall comply with the 10-day Moist Ammonia-Air Stress Cracking Test, Section 18.

Paragraph 4.6 revised (date of publication)

(CURRENT)

~~18. Immersion Test~~

~~18.1 A brass part containing less than 80 percent copper as mentioned in paragraph 4.6 shall not crack when subjected to the Mercurous Nitrate Test for Copper and Copper Alloys, ASTM B154-89. The test is to be conducted on samples previously unused, and not attached to a conductor or otherwise subjected to external stress.~~

(PROPOSED)

18. 10-Day Moist Ammonia-Air Stress Cracking Test

Section 18 title revised (date of publication)

18.1 After being subjected to the conditions described in 18.2-18.4, a brass part containing more than 15 percent zinc shall show no evidence of cracking when examined using 25X magnification.

Paragraph 18.1 revised (date of publication)

18.2 Each test sample is to be subjected to the physical stresses normally imposed on or within a part as the result of assembly. Such stresses are to be applied to the sample prior to and maintained during the test. Samples shall be assembled to a 6 inch length of the maximum rated size conductor and torqued to the value specified in 7.19.

Paragraph 18.2 added (date of publication)

18.3 Three samples are to be degreased and then continuously exposed in a set position for ten days to a moist ammonia-air mixture maintained in a glass chamber approximately 12 by 12 by 12 inches (305 by 305 by 305 mm) having a glass cover.

Paragraph 18.3 added (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976) -C29-

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(NEW)

18.4 Approximately 600 ml of aqueous ammonia having a specific gravity of 0.94 is to be maintained at the bottom of the glass chamber below the samples. The samples are to be positioned 1-1/2 inches (38.1 mm) above the aqueous ammonia solution and supported by an inert tray. The moist ammonia-air mixture in the chamber is to be maintained at atmospheric pressure and a temperature of $93 \pm 4^{\circ}\text{F}$ ($34 \pm 2^{\circ}\text{C}$).

Paragraph 18.4 added (date of publication)

UL 486B

4.4 A brass parts of a connector shall be resistant to stress corrosion cracking.

Paragraph 4.4 revise (date of publication)

4.5 A brass part containing not less than 80 percent copper not more than 15 percent zinc is considered to be sufficiently resistant to stress corrosion cracking.

Paragraph 4.5 revised (date of publication)

4.6 A brass part containing less than 80 percent copper is acceptable if it withstands, without cracking, the Mercurous Nitrate Test for Copper and Copper Alloys, ASTM B154-82, more than 15 percent zinc shall comply with the 10-Day Moist Ammonia-Air Stress Cracking Test, Section 18A. The test is to be conducted on samples previously unused, and not attached to conductors or otherwise subjected to external stress.

Paragraph 4.6 revised (date of publication)

(NEW)

18A. 10-Day Moist Ammonia-Air Stress Cracking Test

Section 18A added (date of publication)

18A.1 After being subjected to the conditions described in 18A.2 — 18A.4, a brass part containing more than 15 percent zinc shall show no evidence of cracking when examined using 25X magnification.

Paragraph 18A.1 added (date of publication)

18A.2 Each test sample is to be subjected to the physical stresses normally imposed on or within a part as the result of assembly. Such stresses are to be applied to the sample prior to and maintained during the test. Samples shall be assembled to a 6 inch length of the maximum rated size conductor and torqued to the value specified in 7.23.

Paragraph 18A.2 added (date of publication)

18A.3 Three samples are to be degreased and then continuously exposed in a set position for ten days to a moist ammonia-air mixture maintained in a glass chamber approximately 12 by 12 by 12 inches (305 by 305 by 305 mm) having a glass cover.

Paragraph 18A.3 added (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231,
310, 414, 486B, 486C, 486E, 489,
493, 508, 508A, 512, 719, 854, 857,
891, 1072, 1277, 1569, 1581, 1976)

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18A.4 Approximately 600 ml of aqueous ammonia having a specific gravity of 0.94 is to be maintained at the bottom of the glass chamber below the samples. The samples are to be positioned 1-1/2 inches (38.1 mm) above the aqueous ammonia solution and supported by an inert tray. The moist ammonia-air mixture in the chamber is to be maintained at atmospheric pressure and a temperature of $93 \pm 4^{\circ}\text{F}$ ($34 \pm 2^{\circ}\text{C}$).

Paragraph 18A.4 added (date of publication)

UL 486C

4.3 A brass parts of a connector shall be resistant to stress corrosion cracking. A brass part containing not less than 80 percent copper not more than 15 percent zinc is considered to be resistant to stress corrosion cracking.

Paragraph 4.3 revised (date of publication)

4.4 A brass parts of a connector, containing less than 80 percent copper more than 15 percent zinc, shall be subjected to the corrosion test outlined in Corrosion Cracking Test comply with the 10-Day Moist Ammonia-Air Stress Cracking Test, Section 23.

Paragraph 4.4 revised (date of publication)

(CURRENT)

~~23. Corrosion Cracking Test~~

~~23.1 A brass part of a connector containing less than 80 percent copper shall withstand, without cracking, the Mercurous Nitrate Test for Copper and Copper Alloys, ASTM B154 82.~~

(PROPOSED)

23. 10-Day Moist Ammonia-Air Stress Cracking Test

Section 23 title revised (date of publication)

23.1 After being subjected to the conditions described in 23.2 — 23.4, a brass part containing more than 15 percent zinc shall show no evidence of cracking when examined using 25X magnification.

Paragraph 23.1 revised (date of publication)

23.2 Each test sample is to be subjected to the physical stresses normally imposed on or within a part as the result of assembly. Such stresses are to be applied to the sample prior to and maintained during the test. Samples shall be assembled to a 6 inch length of the maximum rated size conductor and torqued to the value specified in 7.21.

Paragraph 23.2 added (date of publication)

23.3 Three samples are to be degreased and then continuously exposed in a set position for ten days to a moist ammonia-air mixture maintained in a glass chamber approximately 12 by 12 by 12 inches (305 by 305 by 305 mm) having a glass cover.

Paragraph 23.3 added (date of publication)

Subjects 486A (4, 44, 67, 83, 98, 231, 310, 414, 486B, 486C, 486E, 489, 493, 508, 508A, 512, 719, 854, 857, 891, 1072, 1277, 1569, 1581, 1976) -C31-

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23.4 Approximately 600 ml of aqueous ammonia having a specific gravity of 0.94 is to be maintained at the bottom of the glass chamber below the samples. The samples are to be positioned 1-1/2 inches (38.1 mm) above the aqueous ammonia solution and supported by an inert tray. The moist ammonia-air mixture in the chamber is to be maintained at atmospheric pressure and a temperature of $93 \pm 4^{\circ}\text{F}$ ($34 \pm 2^{\circ}\text{C}$).

Paragraph 23.4 added (date of publication)

UL 486E

5.5 A brass parts of a connector shall be resistant to stress corrosion cracking. A brass part containing not less than 80 percent copper not more than 15 percent zinc is considered to be resistant to stress corrosion cracking.

5.5 revised (date of publication)

5.6 A brass part containing ~~less than 80 percent copper is acceptable if it withstands, without cracking, the Mercurous Nitrate Test for Copper and Copper Alloys, ASTM B154-82. more than 15 percent zinc shall comply with the 10-Day Moist Ammonia-air Stress Cracking Test, Section 14A. The test is to be conducted on samples previously unused, and not attached to wire or otherwise subjected to external stress.~~

5.6 revised (date of publication)

(NEW)

14A. 10-Day Moist Ammonia-Air Stress Cracking Test

Section 14A added (date of publication)

14A.1 After being subjected to the conditions described in 14A.2 — 14A.4, a brass part containing more than 15 percent zinc shall show no evidence of cracking when examined using 25X magnification.

14A.1 added (date of publication)

14A.2 Each test sample is to be subjected to the physical stresses normally imposed on or within a part as the result of assembly. Such stresses are to be applied to the sample prior to and maintained during the test. Samples shall be assembled to a 6 inch length of the maximum rated size conductor and torqued to the value specified in 8.4.4.

14A.2 added (date of publication)

14A.3 Three samples are to be degreased and then continuously exposed in a set position for ten days to a moist ammonia-air mixture maintained in a glass chamber approximately 12 by 12 by 12 inches (305 by 305 by 305 mm) having a glass cover.

14A.3 added (date of publication)