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MALTA TEST STATION · BALLSTON SPA, NEW YORK 12020

PHONE
(518) 899-2227

May 25, 1983

W. Hamp
Underwriters Laboratories Inc.
1285 Walt Whitman Road
Melville, L.I., NY 11747

Subject: UL 1567 (new)

Dear Mr. Hamp:

This comment on the proposed UL 1567 is based on testing of CO/ALR and other aluminum-wired connections, on review of some of the tests by UL and various manufacturers on aluminum-wired CO/ALR devices, and on field failure reports of aluminum-wired CO/ALR devices. The summation of experience indicates that while the performance of CO/ALR devices with aluminum wire may be improved compared with non-CO/ALR devices, there are still significant problems which should be addressed by a new standard.

We have on test 500 aluminum-wired CO/ALR receptacles, 100 of each of the five brands available. The tests are conducted in an environment representing that of a device box in the perimeter wall of a house. The current applied is 13.5A for receptacles wired with #12Al, and 18A for receptacles wired with #10 Al. The duty cycle is 13% (22 hours of "on" time each week), and the maximum "on" time is one hour. All connections were made according to UL and industry recommendations for aluminum-wired binding head screw connections (1/2 to 2/3 cw wrap, 12 in-lb tightening torque). After three years on test, two CO/ALR receptacles have exhibited wiring terminal failures. Additionally, two brands of CO/ALR receptacles show a definite weakness in the attachment plug connections.

Among each brand, the receptacles on test were divided into two groups. One group experienced insertion and withdrawal of attachment plugs, and the other did not. The two terminal connection

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failures involved one brand of CO/ALR receptacles. Both termination failures occurred on receptacles which had been subjected to the insertion and withdrawal of the attachment plugs. (A total of 97 insertion and withdrawal operations in each of the two plug positions.)

Considering the test specimens as divided into ten groups of 50 receptacles each (5 brands, each separated into 2 groups with respect to the attachment plug insertion/withdrawal operations), the probability that the only two failures would show up in the same group is only 1% if the failures were random. Therefore, it is most probable that the failures are not random, but rather are related to the design, materials, or properties of the particular brand of CO/ALR receptacle.

Two CO/ALR termination failures is in itself not a favorable result, considering the mild conditions of the test, the short time on test relative to the expected life in actual service, and the uniformity of installation. Even more significant, however, is the indication that the existing CO/ALR standard has passed, and allowed into the marketplace, a specific brand of CO/ALR receptacle which is failure-prone when used in the intended manner, with insertion and withdrawal of attachment plugs. Reviewing the CO/ALR standard, and the proposed UL 1567, there are no tests for sensitivity to the type of disturbance imposed on the wire terminals by the actions of inserting and withdrawing attachment plugs.

Further, it was determined that subjected to the 97 insertion and withdrawal operations, two of the brands of receptacles have demonstrated a definite weakness in the attachment plug connections. Again, neither the CO/ALR standard nor the proposed UL 1567 have effective tests with respect to this type of failure.

The CO/ALR receptacle testing that we have done was for the U.S. Consumer Product Safety Commission. Two reports have been issued regarding these tests, and copies might be obtained by request through the Freedom of Information administrator at CPSC.[1, 2]

CO/ALR device test data that I have reviewed from other sources confirms the view that the CO/ALR receptacles - and the qualification standard for them - should not be viewed as having solved the

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aluminum wire connection problem at wiring devices. CO/ALR receptacles are failing in tests involving alloy aluminum wire, at currents lower than the heat cycle test current. At UL, CO/ALR receptacles which were passed in tests using one sample of aluminum wire, failed tests using a different sample of wire.

Field failures of aluminum-wired CO/ALR devices are also known. Several have been noted in Ontario, Canada.[3,4] In the United States, several reported failures are being investigated. Considering the relatively few aluminum-wired CO/ALR receptacles in service, and the short time of service, these field failures are significant.

Receptacle failures involving connection overheating, whether at the wire terminations or the attachment plug connections, must be taken seriously as being hazardous.[5] A recent report from the National Bureau of Standards, with analysis of 110 electrical fire ignition reports, cited switches and receptacles as involved in the ignition of 18% of the fires, and 55% of these involved connections and terminations.[6] Aluminum wire connections are particularly hazardous when termination failures occur, as the aluminum wire connections are much more likely to develop "thermal runaway" (progressive failures leading to extremely high temperatures) than are their copper-wired equivalents.

The new standard, UL 1567 should not be issued until it is modified to deal effectively with the problems now known to exist in the older CO/ALR standard. If there is any serious intent to institute more stringent requirements in UL 1567, I would be glad to contribute specific recommendations. These recommendations would be based on our testing experience with CO/ALR and other types of aluminum-wired terminations and splices.

Please feel free to contact me should additional information be required, or to arrange for more detailed discussion and review of the tests and the data.

Yours truly,

Jesse Aronstein

Jesse Aronstein
Vice President,
Special Engineering Projects

JA/ec

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References:

1. Project Report, CPSC-C-79-0079, Task I, "Test of 'Old Technology' Aluminum Conductor at Binding Head Screw Terminals", February 12, 1981, Wright-Malta Corp.

2. Project Report, CPSC-C-81-1418, "Tests of 'Old Technology' Aluminum Wire", February 10, 1983, Wright-Malta Corp.

3. "Metallurgical Analysis of Failed CO/ALR Devices", M. Leger, Ontario Hydro Research Division Report 78-54-K.

4. "Report of the Commission of Inquiry on Aluminum Wiring" Part 2, J. Tuzo Wilson, Commissioner. Queen's Printer for Ontario, March 1979, Section 2.6.3 b 4, page 120.

5. "Fire Due to Overheating Aluminum-Wired Branch Circuit Connections", J. Aronstein, Wright-Malta Corp., Jan 12, 1981, (revised April 16, 1983), Electrical Fire Safety Conference, University of Wisconsin-Extension, April, 1981.

(copy enclosed)

6. "Analysis of Electrical Fire Investigations in Ten Cities", March, 1983, U.S. Dept. of Commerce, National Bureau of Standards, National Engineering Laboratory, Center for Fire Research, Washington DC 20234, NBSIR 83-2677, (see Tables 6 and 10).