

Higher Reliability Household Smoke Detectors Result from SRC Root Cause Analysis Study

Problem: A large consumer advocate became aware of numerous smoke detectors that appear to be malfunctioning because of deterioration of separable contacts in the field. The consumer advocate wanted the smoke detectors that experienced field failures to be tested and evaluated. The effort's findings would then be used to propose change(s) to Underwriters Laboratories, Inc. (UL) 217 "Standard for Single and Multiple Station Smoke Detectors" to improve smoke detector field performance and to recommend design practices and procedures to manufacturers.

Approach: SRC proposed a four-step approach to identify the cause of the field failures and develop recommendations for revisions and/or additions to the voluntary standards to ensure smoke detector operability is not compromised. Examination of the failed smoke detectors would lead to the development of a detailed testing protocol for all failure samples. The test protocol would be conducted in the second step of the proposed approach with particular attention directed towards the contact surfaces of the separable contacts in the smoke detectors. The findings would be combined with the results of a comparison between naturally aged smoke detectors and UL 217 corrosion tested (aged) smoke detectors. The third step would review and evaluate UL 217 based on the previous results to identify weaknesses that would allow separable contacts prone to deterioration in service to meet the requirements of UL 217. The final step would then summarize recommendations for revisions and/or additions to UL 217 that would address the issue of separable contacts deterioration.

Solution: The SRC engineering evaluation confirmed that smoke detector horn separable contact deterioration can cause horn malfunction. The cause of failure was identified to be a function of contact materials, operating environment, and contact interface motion. Fretting corrosion was identified as the failure mechanism, which is an accelerated atmospheric oxidation that forms at metal contact interfaces. Although no life-limiting failure mechanisms were identified through component testing, the following changes were recommended to UL 217: addition of flowing mixed gas testing, evaluation of contact motion effects, and addition of horn reliability requirements.

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