U.S. CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Arthur Lee
Electrical Engineer
Division of Electrical Engineering
Directorate for Engineering Sciences

Tel: (301) 504-0508 Ext. 1393
Fax: (301) 504-0533
Email: alee@cpsc.gov

February 25, 2003

Mr. Paul Patty
Underwriters Laboratories Inc.
333 Pfingsten Road
Northbrook, IL 60062

Dear Mr. Patty:

This letter presents recommendations from the U.S. Consumer Product Safety Commission (CPSC) staff regarding revisions to UL 217, *Single and Multiple Station Smoke Alarms*, to address potential reliability and performance issues associated with interconnected smoke alarms. CPSC staff believes that failure of the interconnection circuitry may increase the risk of death and injury to consumers in the event of a fire.

The NFPA 101 Life Safety Code requires all smoke alarms in new construction to be interconnected. This requirement applies only to smoke alarms that are powered by 120 VAC, or house wiring. The interconnection of smoke alarms enables all the alarms to sound when any individual alarm detects smoke. This feature is intended to provide increased egress time for all occupants (e.g., notification to an occupant who may be at the furthest point in a home away from the alarm).

CPSC staff has received incident reports indicating that smoke alarm interconnection circuitry may be damaged by power transients. This damage may result in the failure of an alarm to send a signal to other, interconnected smoke alarms (see Attachment A – Incident Reports).

The current requirements of UL 217 include a test for transients, *Transient Tests (Section 53)*. However, this section only evaluates whether smoke alarm sensitivity has changed; there is no assessment of the interconnection circuitry/signal after transient testing. CPSC staff recommends that smoke alarms be tested for proper functioning of the interconnection circuitry following transient performance testing (see Attachment B – *Request for Proposal to UL Standard*).

Thank you for the opportunity to make these recommendations. We look forward to participating in further discussions on this matter at the upcoming meeting of the Standards Technical Panel for UL 217. The views expressed in this letter are those of the CPSC staff and have not been reviewed or considered by the Commission.

Sincerely,

Arthur Lee
Electrical Engineer
Directorate for Engineering Sciences

cc: James R. Beyreis, UL/Northbrook
Gordon Gillerman, UL/Washington
Colin Church, CPSC Voluntary Standards Coordinator

ATTACHMENT A

INCIDENT REPORTS

Consumer Incident 1 to CPSC

Dear Mr. XXXX (CPSC staff),

Attached is a copy of the document I sent to XXXX (Manufacturer of XXXX detectors). In the document I have outlined my experiences relating to damages sustained by the detectors, actions I have taken to correct the deficiency, and empirical observations that would seem to support my conclusions. Based on my observations of damages sustained to detectors that went unprotected, I believe it highly unlikely that the results were coincidence. To summarize my concerns addressed in the document,

1) The detectors exhibit a high degree of failure when subjected to spikes on the signal line caused by lightning.
2) The conditions causing failure of the detectors are not in my opinion extreme cases—no other equipment at my residence has sustained damage resulting from electrical activity.
3) Consumers relying on the capability of one detector to signal another may be at risk should a fire occur, and will likely be unaware of the failure until that feature is necessary, and
4) Based on my corrective actions and the degree of success I have had, I believe this problem could be corrected with a minor design change and very minor expense--hence my reason for pursuing this matter.

I have not actually examined the circuit boards on these detectors, but based on my experience, I believe the component responsible is a FET or MOSFET (essentially a specialized transistor). These FET devices use what is called a Gate to control current flow through the device. They are very effective and sensitive devices and work well in their intended application, however they have one drawback--the Gate is extremely sensitive to static discharges--the type that might be expected around a lightning strike. Second, the signal line used to connect the detectors and permit "communication" between them is what we refer to in electrical engineering as "floating" which means it is not tied to anything that would maintain a desired voltage. In practice, engineers will generally try to avoid conditions where signal lines "float" because one can never be certain what voltages may be present on it, particularly in the presence of lightning strikes.

Hopefully this information will be of some assistance in determining if the product has a legitimate flaw. I would also like to clarify that while I am an electrical engineer, I have

nothing to gain by reporting this (I work for an electric utility in topics unrelated to fire protection), nor have I asked for any compensation from the manufacturer on this matter, I simply have a concern about the safety of the product.

If you have any further questions, please don't hesitate to contact me.

Regards,
XXXXX
XXXXX

Excerpt from Consumer Letter to Manufacturer

September 1, 2002

XXXXX
XXXXX
XXXXX

Dear Sir or Madam:

This letter is in regard to the XXXX Smoke Alarm Model XXXX with the identification "Item XXXX" sold in multi-pack units at XXXX and possibly other stores. I have been using this brand and model detector since December 1999 and have recently confirmed what appears to be a serious vulnerability with the interconnectivity of these units as a result of voltage surges and/or spikes on the signal line interconnecting the detectors.

In late 1999, eight XXXX Model XXXX detectors were installed and tested. As part of the testing, I confirmed that each detector was capable of remote activating every other detector. This particular detector was purchased to comply with Winchester building codes, which require AC powered detectors with battery backup and interconnect capability. The interconnection between detectors is achieved via the use of a third conductor in electrical cabling "daisy-chained" between detectors as specified in the installation instructions and shown in figure 1.

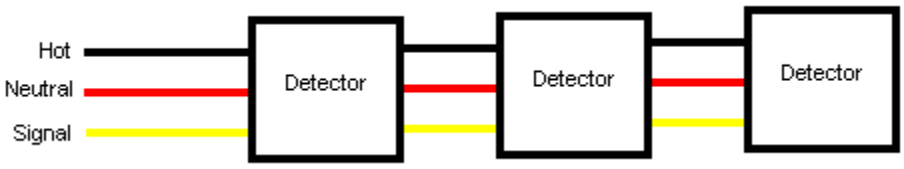

Figure 1

In late summer 2001, during a thunderstorm, multiple lightning strikes occurred within the vicinity of my residence. On one particular strike, I recall hearing one of the detectors emit a single short beep. Later that year, during routine battery replacement and testing, I discovered that while the test button could cause the alarm to activate, it would not activate any other alarms. Similarly, individual testing of every other alarm revealed that, while each would activate locally, not one could cause the other alarms to remote activate. It was necessary to purchase eight replacements, one of which was used to determine the method by which the detectors "communicate". The signal line on the detector sensing smoke is pulled to a "high" state, or roughly 9 volts. Every other detector senses this voltage and in turn activates such that all detectors tied to the common signal line activate. After determining the method by which the signaling works, the old detectors were tested (along with the newly purchased detectors), and it was confirmed that none of the old detectors were capable of pulling the signal line to the approximately 9 volts necessary to operate remote detectors. Similarly, none of the old detectors were capable of detecting 9 volts applied to

the signal pin. Identical testing on the new units confirmed that they were operating normally—that is, they did respond to 9V on the signal pin, and they could pull the signal pin to 9V. I would like to reiterate as I stated in the beginning that every original detector was tested for interoperability immediately after installation and all worked correctly. This confirmed that the detectors were not faulty from manufacturing, but instead failed some time after installation.

While testing, I recalled the incident during which I had heard one detector emit a short beep during an electrical storm. I surmised that a nearby lightning strike had induced a voltage on the signal line (which is essentially operating at a "floating" potential) sufficient to damage the remote signaling circuitry on the detectors, but not sufficient to damage the smoke detection or alarming capability of the individual detector. On this premise, I inserted two back-to-back 9.1Volt zener diodes as shown in figure 2 across the signal pin and neutral pin of detectors on outside rooms of the residence. I believed that if a future strike caused the same effect, these were sufficient to protect the entire system.

The function of a zener diode is that it normally conducts in one direction—from anode to cathode. However, if a reverse voltage is applied which exceeds the voltage rating of the diode, it temporarily breaks down and becomes conductive from cathode to anode. By putting two of these diodes back-to-back, i.e. anode to anode, and then connecting the cathodes to the signal line and neutral respectively, I was effectively isolating those lines from each other as they normally would be unless the voltage between the two exceeded 9.1V. At that voltage, the diode would become conductive and allow current to flow from the signal line to neutral and shunt damaging spikes to ground. Since their operational voltage is slightly above that present during normal operation of the alarms, i.e. 9V (actually slightly less due to line resistances), the zener diodes would not interfere with normal operation of the alarms. Simultaneously, the sense and signaling circuitry in the alarms would now no longer be subjected to voltages much above 9.1 V, which should be well within the tolerable range of the components in the detector.

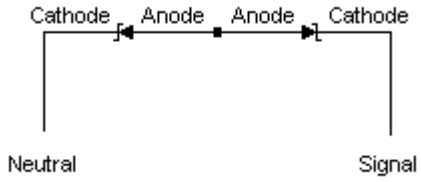

Figure 2

Once again, during routine testing and battery replacement, I discovered that three detectors had again failed in the manner I had observed in 2001, likely the result of one of two recent severe electrical storms. Interestingly, and very supportive of my theory, not one single detector I protected with the diodes sustained any observable damage—they all operated normally during testing. Every detector but one that was NOT protected required replacement. I again surmise that the one undamaged detector was probably protected indirectly by zener diodes on a nearby detector.

Consumer Incident 2 to CPSC

Excerpt from CPSC Incident Field Report (IDI 021028CCN0057)

SUMMARY
A four-year-old smoke detector multi-station system failed to activate upon testing. The system, consisting of four smoke detectors, was wired into a single family home and detectors were located on three floors. The consumer conducted the first test of the system since moving into the home by activating a canister of smoke near one of the detectors. The immediate detector sounded, but the others in the home did not. The consumer removed the smoke detectors and replaced them. No injuries were reported.

PRE-INCIDENT
The complainant stated that he and his wife and their four-year-old son moved into a single family home in May 2002. The home had been built in 1998 and during its construction, the builder installed a XXXX smoke detector multi-station system, which was wired into the home. Following and attached as Exhibit "A" are photographs of the smoke detector component of this system (Photo not included).

The complainant related that there were four smoke detectors that comprised this system and they were located in the basement, first floor and second floor. He added that when he purchased the home, he did not receive a manual for the smoke detector system. From May 2002 to October 2002, the complainant did not experience an activation of the system.

INCIDENT
On October 25, 2002, the complainant decided to test the smoke detector system, as it was their custom in past residences to check the smoke detectors in the Fall and Spring when they changed their clocks. He purchased a canister of smoke and activated it near the smoke detector on their first floor. The complainant noted that the smoke detector on the first floor sounded but the detectors on the other two floors did not. He then activated the smoke canister near the basement detector and later near the detector on the second floor. Each of the individual smoke detectors sounded when the smoke was activated near it, but the other smoke detectors on the other floors did not.

The complainant explained that with a multi-station system, all of the detectors are supposed to alarm when any unit detects smoke. Each unit is supposed to generate a signal when it detects smoke so that the other units will alarm. This feature gives the members in the household extra time to escape if a fire occurred in the basement and they were sleeping on the second floor. As the system was currently operating, each smoke detector was functioning as a single station and as a result, the complainant could not hear the basement unit if it activated when he was on the second floor. The complainant immediately removed the smoke detectors from his home and replaced them.

ATTACHMENT B

REQUEST FOR PROPOSAL TO A UL STANDARD

APPENDIX B

REQUEST FOR PROPOSAL TO A UL STANDARD

(Instructions: Please use a separate form for each proposal. Proposal should be in legislative format and in mandatory language. Incomplete proposals will be returned to the submitter.)

UL STANDARD NUMBER_ 217_____

Title _SINGLE AND MULTIPLE STATION SMOKE ALARMS_____

Proposal recommends: (check one) ☑ new text __revised text __deleted text

Rationale: (a brief explanation of the changes needed and why the changes are needed).

The transient test does not evaluate the reliability of interconnection wiring and circuitry for a smoke alarm.

Proposal: (indicate clause number. For new text, indicate in general where it should be placed and show it as "NEW").

53.1.4 The operation for alarm of one station shall result in the alarm signal of all connected stations as specified in 34.1.5

UL reserves the right to edit the information in this form to comply with UL's Procedures for Submittal of Draft UL Standards manual found at "http://ulstandardsinfonet.ul.com/generalinformation/styleman.html"

I hereby grant Underwriters Laboratories Inc. (UL) the non-exclusive royalty rights, including non-exclusive royalty rights in copyright, in my proposals and I understand that I acquire no rights in publication of this standard in which my proposals in this or other similar analogous form is used. I hereby attest that I have the authority and am empowered to grant this copyright release.