Analysis of the Response of Smoke Detectors to Smoldering Fires and Nuisance Sources

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Nuisance alarms are an ongoing challenge for smoke alarm technology, particularly for ionization, which is installed in the bulk of residential applications. Repeated nuisance alarms can often cause consumers to disable the device, defeating the safety purpose. Numerous experimental programs have been conducted to assess the response of smoke detectors to smoldering fires and nuisance sources. Much of this work is been devoted to exploring nuisance alarm immunity or alternatively how can the signature of nuisance sources be distinguished from smoldering fires.

The response of a smoke detector is affected by the signature created by the source. Nuisance sources can transition to smoldering or even flaming fires in some cases, especially those related to kitchen activities. With the point of transition between nuisance and smoldering stages being vague in these cases, the ability of smoke detectors to distinguish between the sources may be challenged.

Several experimental programs have been conducted at the university over the last 20 years directed at assessing the performance of detection technologies to nuisance and smoldering fires. Two recent activities have included tests of several commercially available products and a second activity being to develop a conceptual prototype based on signals from several laboratory measurements and commercial detectors.

In the former, a project was conducted to assess the performance, capabilities and potential weaknesses of a new detector developed by Universal Security Instruments, Inc., including the response time of the IoPhic™ detector to smoldering fire sources and the frequency of alarms to nuisance sources. This project tested 10 commercially available smoke alarms representing all the technologies available to the American consumer. Nuisance sources used in this project were chosen for their likelihood to occur near residential bathrooms and kitchens. Based on the results of this test series, IoPhic-based smoke alarms were observed to have nominally equivalent nuisance alarm immunity to photoelectric smoke alarms in kitchen scenarios, and were more resistant to nuisance sources near bathrooms than photoelectric smoke alarms. They were more resistant to nuisance alarms than all other smoke alarms utilizing an ionization sensor.

In the latter project, experiments were conducted to simulate cooking scenarios in a residential kitchen. The response of the laboratory measurements and commercial detectors for smoldering sources (and even to precursors to flaming fires) was assessed. Light obscuration based measurements were shown to be particularly accurate in identifying fire precursors as were photoelectric and ionization smoke detectors.