Research Supporting the Development of a Nuisance Resistance Standard Test

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NFPA Data on Unwanted Smoke Alarm Activations

According to Marty Ahrens in the NFPA report "Smoke Alarms in U.S. Home Fires" [1]:

> "When smoke alarms should have operated but did not do so, it was usually because batteries are missing, disconnected or dead. People are most likely to remove or disconnect batteries because of nuisance activations. Sometimes the chirping to warn of a low battery is interpreted as a nuisance alarm.
>
> Half of the households surveyed in a 2010 Harris Poll done for NFPA reported they had smoke alarms in their kitchen. Two out of every five (43%) households reported their smoke alarms had gone off at least once in the past year. Almost three-quarters (73%) said the activation was due to cooking. Eight percent mentioned low battery chirps."

Steps Taken by the NFPA 72 Technical Committee

During the revision cycle for the 2010 edition of NFPA 72, National Fire Alarm and Signaling Code, the Technical Committee on Single- and Multiple-Station Alarms and Household Fire Alarm Systems (SIG-HOU) added new smoke detection placement requirements. The new requirements intended to reduce nuisance alarms from smoke alarms and detectors installed close to stationary cooking appliances.

During the development of the 2013 edition of NFPA 72 the SIG-HOU Technical Committee added two new provisions to Chapter 29 to further reduce nuisance alarms.

- 29.8.3.4(5): Effective January 1, 2016, smoke alarms and smoke detectors used in household fire alarm systems installed between 6 ft (1.8 m) and 20 ft (6.1 m) along a horizontal flow path from a stationary or fixed cooking appliance shall be listed for resistance to common nuisance sources from cooking.
- 29.7.3: Effective January 1, 2019, smoke alarms and smoke detectors used in household fire alarm systems shall be listed for resistance to common nuisance sources.

Research Project Overview

The Foundation initiated a research project with the objective of characterizing common nuisance sources for the development of new performance test protocols in ANSI/UL 217/268 product standards in order to meet the NFPA 72-2013 requirements. A Phase 1 project included a literature review and test plan development. A Phase 2 project, which involves testing, is underway with completion expected this spring. At this point, the testing is complete and the data is being analyzed.

Based on currently available data, nuisance sources can be categorized by particle size into small, medium and large particle sources. The Phase 2 project will collect and analyze data that may be used to develop replicable UL 217/268 test protocols so that products can be listed to comply with resistance to cooking sources and other identifiable nuisance sources, specifically steam/water mist.

The tasks for Phase 2 are:

- Collect data to characterize nuisance sources.
- Verify that the chosen criteria correlate with past NIST results.

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[1] Ahrens, Marty. March 2014. "Smoke Alarms in U.S. Home Fires." NFPA Fire Analysis and Research Division, Quincy, MA. http://www.nfpa.org/research/reports-and-statistics/fire-safety-equipment/smoke-alarms-in-us-home-fires

- Compare results to existing fire test data.

The data collected will ultimately be used to develop a set of standardized test protocols and performance metrics, which will be completed in future work.

Phase 2 Technical Approach

As noted by Ahrens, cooking activities represent a large portion of nuisance alarms, so this is largely the focus of Phase 2. Previous testing conducted by CPSC[2] identified common cooking nuisance sources. Subsequent testing conducted by NIST[3] characterized the relative sizes of cooking nuisance particulate and binned potential sources into small, medium, and large particle types. The representative cooking nuisance tests selected include toasting bread (small particle), broiling frozen burgers (medium), and pan frying frozen burgers (large). These tests have been conducted using the general procedures outlined by NIST with the intent to produce comparable types and concentrations of cooking sources occurring in real homes and causing nuisance smoke alarm responses.

ANSI/UL 217 and 268 test fires have also been run using the same instrumentation as the nuisance sources. The test fires included the proposed flaming and smoldering foam sources as well as those already included in the standards: flaming paper, flaming wood crib, flaming liquid, and smoldering wood. The real fire sources were verified using the required beam/MIC profiles specified by the test standards. Test data is being analyzed to determine the relative smoke particle sizes and compare responses between the cooking sources and the real fire sources.

Tests were conducted in an instrumented test space similar in dimensions to the ANSI/UL 217 and 268 test room. The particulate and gas effluent character and concentration and response of smoke alarms and analog smoke detectors were measured and recorded. Measurements recorded included gas temperatures, smoke obscuration, smoke particulate measurements, number density of smoke particles, particulate mass concentrations, concentration of CO and CO_2 gases, and response of smoke alarms and analog smoke detectors. Two models of smoke alarms and smoke detectors were used and installed at four locations on the ceiling of the test space (6 ft, 10 ft, 17.7 ft, and 20 ft).

The Phase 2 testing also included some initial testing using a water mist source, which was a shower stall. Alarms and detectors were installed at 3 ft, 7 ft, 14 ft, and 17 ft and obscuration and temperature were measured at the alarm locations. Testing was conducted simulating a 2.5 minute and a 10 minute shower.

Initial Results

Data analysis is still underway, but some initial results are available:

- More ionization response (MIC) than obscuration response measured for all cooking types (toasting, frying, and broiling). This indicates that the particles are smaller than wavelengths of visible light. Measurements are below the standard fire curve obscuration values.
- It was also found that particle number densities are high during cooking, but mass measurements are low, which indicates a large number of small particles present during normal cooking.
- The testing has also confirmed the relative particle size estimates from the NIST testing.
- In terms of alarm response, it was found that ionization smoke alarms are most likely to respond to nuisance cooking.
- For the water mist testing, the highest obscuration was measured after approximately 2 to 3 minutes of showering. The obscuration levels peaked and decreased during prolonged showers.

[2] Lee, A. and Pineda, D. March 2010. “Smoke Alarms – Pilot Study of Nuisance Alarms Associated with Cooking.” CPSC, Bethesda, Maryland.

[3] Chernovsky, A. and Cleary, T. January 2013. “Smoke Alarm Performance in Kitchen Fires and Nuisance Alarm Scenarios." NIST TN-1784 Report.