

# Improved Home Smoke Alarms Demonstrated



# A Perfect World:

- USER FRIENDLY SMOKE ALARMS:
  - Zero Nuisance alarms.
  - Earlier alarm to provide more escape time.
  - Better awakening performance.
  - Long life / minimal maintenance.

# Previously Reported

- Review of current and future sensor technology for smoke alarms.
- Linear Discriminant Analysis (LDA) technique was briefly described for optimal discrimination of hazardous and non-hazardous conditions.

# Demonstration

- Optimized LDA
- Fabricated prototype alarms.
- Complete battery of fire and nuisance tests at Underwriters Laboratories.
  - Current UL 217 fire tests.
  - Proposed smoldering and flaming polyurethane foam tests.
  - Proposed nuisance alarm tests.

# UL 217 Room Fire Tests



Flaming  
Wood



Flaming  
Newspaper

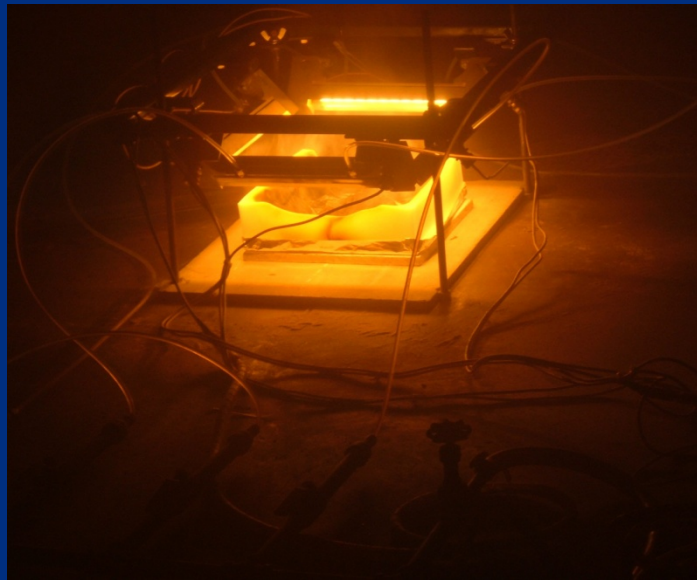


Smoldering  
Wood



Flammable  
Liquid  
Heptane /  
Toluene

# Proposed Polyurethane Foam Tests



Smoldering Foam



Flaming Foam

# Proposed Nuisance Tests

Oil in  
Small  
&  
Large  
Skillet



Toast



Steam



Bacon



# Results – Fire Tests

- **PASS.**
  - All prototypes responded well within the prescribed 4 minutes for the flaming tests.
  - All alarmed at obscuration readings between 0.5%/ft to 2%/ft, well below the required 10%/ft limit.

Test number:	9	10	11	12	13	14	15
Test:	Flaming Liquid	Flaming Wood	Flaming Paper	Smoldering Wood	Flaming Foam	Smoldering Foam	Smoldering Wood 2
5 (Ion, PE, CO, T)	0.57	2.53	1.53	46.00	1.67	35.10	30.32
7 (Ion, PE, CO, T)	0.77	2.82	1.98	39.57	2.33	32.42	38.27
8 (Ion, PE, CO, T)	0.78	2.98	1.93	38.05	2.52	33.45	41.10
9 (Ion, PE, CO, T)	1.27	3.45	1.95	35.83	2.62	31.70	35.45
10 (PE, CO, T)	1.60	3.03	1.87	39.68	3.17	30.32	43.35
12 (PE, CO, T)	2.37	3.90	1.88	48.05	3.28	34.37	56.10
13 (PE, CO, T)	2.42	3.23	1.95	41.92	3.20	32.45	41.30
14 (PE, CO, T)	2.72	2.88	1.90	41.27	3.28	29.67	44.28
15 (PE, CO, T)	1.52	3.27	1.83	29.75	3.00	32.80	30.00
Units 5-9 avg (with ion)	0.85	2.95	1.85	39.86	2.28	33.17	36.28
Units 10-15 avg (w/o ion)	2.12	3.26	1.89	40.13	3.20	31.92	43.01



# Results – Nuisance Tests

- **PASS.**
  - No unit sounded an alarm until either dangerous conditions or ignition was reached.
  - All units alarmed when alert was needed.

Test number:	16	17	18	19	20	21
Test:	Oil (small skillet)	Steam	Steam 2	Oil (large skillet)	Toast	Bacon
Time to ignition:	7.87	-	-	25.83	-	22.48
5 (Ion, PE, CO, T)	7.95	No alarm	No alarm	14.7	7.35	11.78
7 (Ion, PE, CO, T)	8.28	No alarm	No alarm	15.38	8.52	12.3
8 (Ion, PE, CO, T)	8.33	No alarm	No alarm	15.48	8.67	12.25
9 (Ion, PE, CO, T)	8.32	No alarm	No alarm	15.18	8.68	12.12
10 (PE, CO, T)	8.05	No alarm	No alarm	14.28	7.53	11.93
12 (PE, CO, T)	8.3	No alarm	No alarm	20.57	8.53	14.15
13 (PE, CO, T)	8.32	No alarm	No alarm	15.07	8.47	12.1
14 (PE, CO, T)	8.47	No alarm	No alarm	15.8	8.45	11.83
15 (PE, CO, T)	8.02	No alarm	No alarm	14.13	8.55	11.23
Units 5-9 avg (with ion)	8.22	-	-	15.19	8.3	12.11
Units 10-15 avg (w/o ion)	8.23	-	-	15.97	8.31	12.25

# Conclusions

- This project successfully demonstrated:
  - An affordable and reliable solution to the problem of common nuisance alarms.
  - Low-frequency alert tone can be included in home smoke alarms.
  - The proposed UL tests for burning polyurethane foam and common nuisance sources can be passed.

# Next Steps

- Final report will be available on USFA and CPSC websites in the near future.
- ORNL patent available for license.
- We have known for years:
  - The potential for improved alarms.
  - The principal sources of nuisance alarms
- We have enough information to move forward with regulatory changes that will improve both nuisance alarm rejection and awakening performance.

While we study and debate how to do this best, people continue to die!

**The maxim "Nothing but perfection"  
may be spelled "Paralysis."  
Winston Churchill**