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NEW UL SMOKE DETECTION REQUIREMENTS

SCOTT LANG
SENIOR INDUSTRY AFFAIRS MANAGER

AGENDA

Smoke detection standard history
- Motivation for new smoke detector requirements

The new requirements in detail
- New Fire Tests
  - How tests were developed; how thresholds were established
- New Nuisance Smoke Test
  - How nuisance test was developed
- Fire test suite and harmonization with ULC

Net effect of new limits on performance

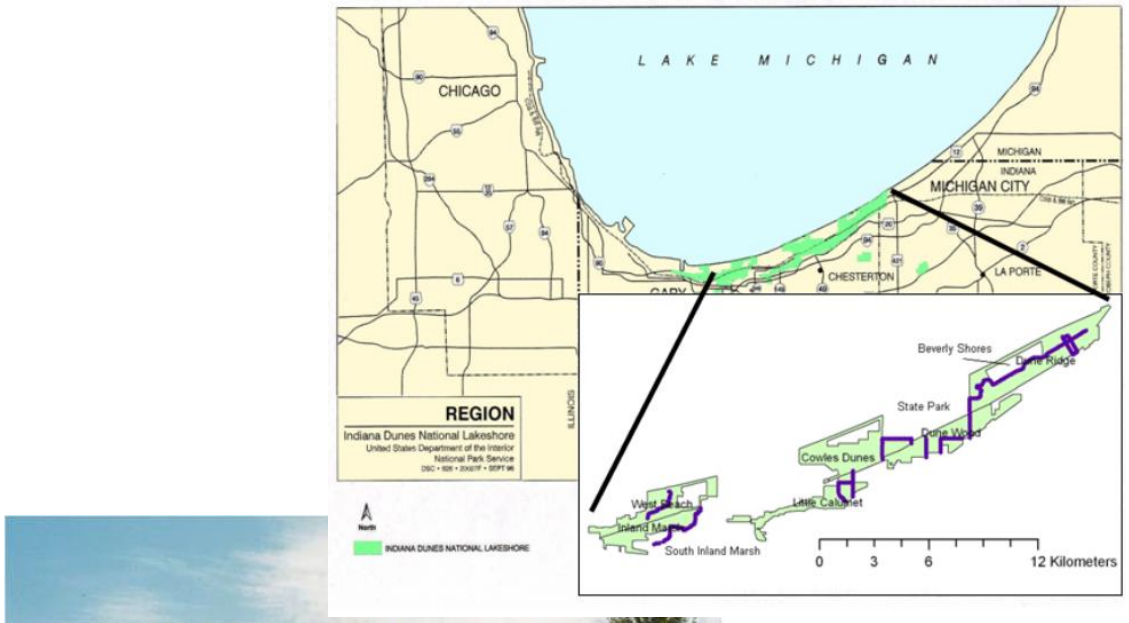
Honeywell approach for spot detection

Implications for ASD and High Sensitivity spot
- Residential vs. commercial needs
- Special application

50 YEARS OF FIRE DETECTION HISTORY

Dunes Studies (1975)

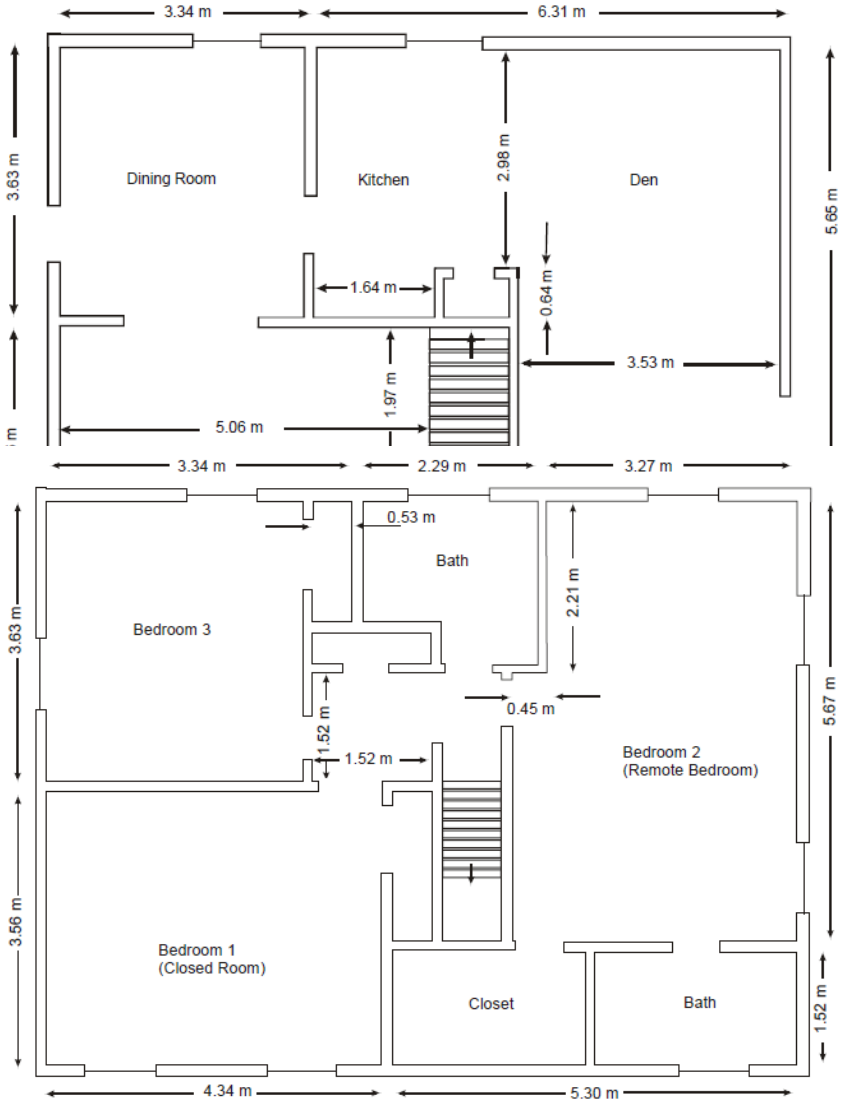
- NBS GCR 75-51 and NBS GCR 77-82 (Detector Sensitivity and Siting Requirements for Dwellings)
  - Work done by UL and IIT for the National Bureau of Standards – now NIST (National Institute of Standards and Technology)
- Investigated smoke detector sensitivity and location in homes with actual fires
- Conducted burns in actual homes on the Indiana Dunes lakeshore
- Formed the basis for requirements in UL and NFPA standards



50 YEARS OF FIRE HISTORY (CONTINUED)

“Dunes II” (2004) – not really Dunes related

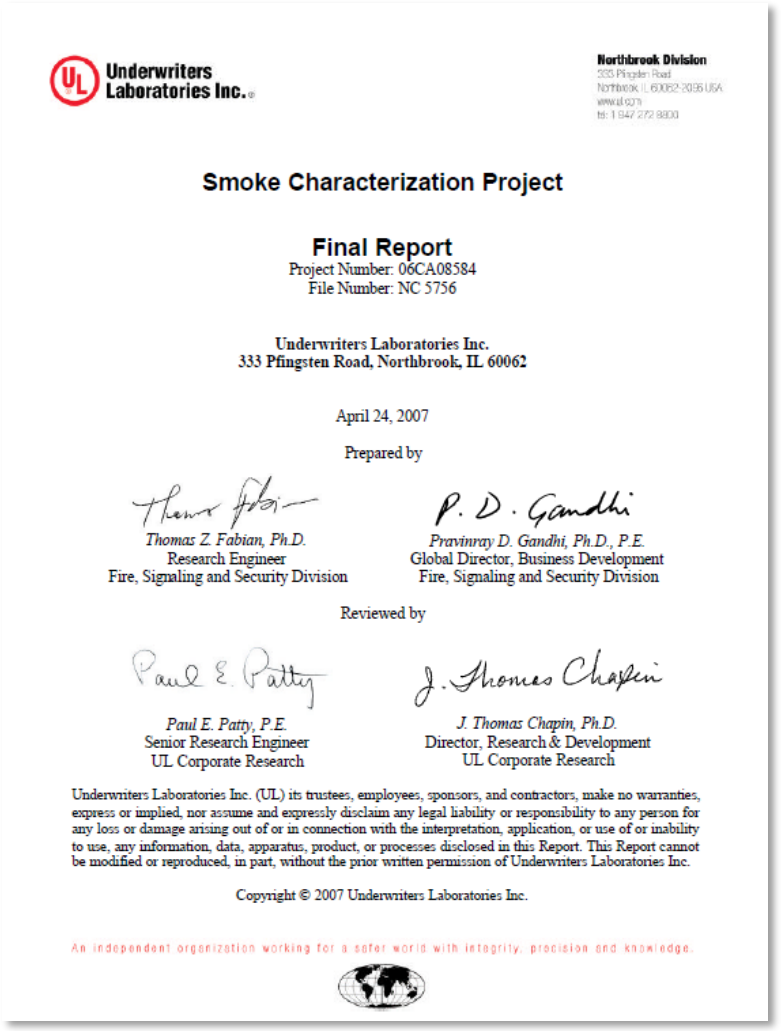
- Sought to update the research done in original Dunes tests
- NIST TN 1455 (Technical Note number 1455) – updated with corrections in 2008
- Performance of Home Smoke Alarms - Analysis of the Response of Several Available Technologies in Residential Fire Settings
  - Found that either photo or ion provide adequate escape time
  - The amount of escape had decreased since the 1970s due to the use of synthetic materials in furnishings (from 17 minutes to 3 minutes)



50 YEARS OF FIRE HISTORY (CONTINUED)

Smoke Characterization Project (2007)

- Work conducted by Underwriters Laboratories
- Burned an assortment of natural and synthetic materials and characterized the gas and particulate
- Conclusion: add other test fire materials



Underwriters Laboratories Inc.®

Northbrook Division
333 Pfingsten Road
Northbrook, IL 60062-2096 USA
www.ul.com
tel: 1 847 272 8800

Smoke Characterization Project

Final Report
Project Number: 06CA08584
File Number: NC 5756

Underwriters Laboratories Inc.
333 Pfingsten Road, Northbrook, IL 60062

April 24, 2007

Prepared by

Thomas Z. Fabian, Ph.D.
Research Engineer
Fire, Signaling and Security Division

Pravinray D. Gandhi, Ph.D., P.E.
Global Director, Business Development
Fire, Signaling and Security Division

Reviewed by

Paul E. Patty, P.E.
Senior Research Engineer
UL Corporate Research

J. Thomas Chapin, Ph.D.
Director, Research & Development
UL Corporate Research

50 YEARS OF FIRE HISTORY (CONTINUED)

Task Group formed in 2007 to consider changes to UL 217 and UL 268

- Many considered the standard inadequately addressed modern materials
  - TV news programs showing ionization alarms not responding to smoldering foam

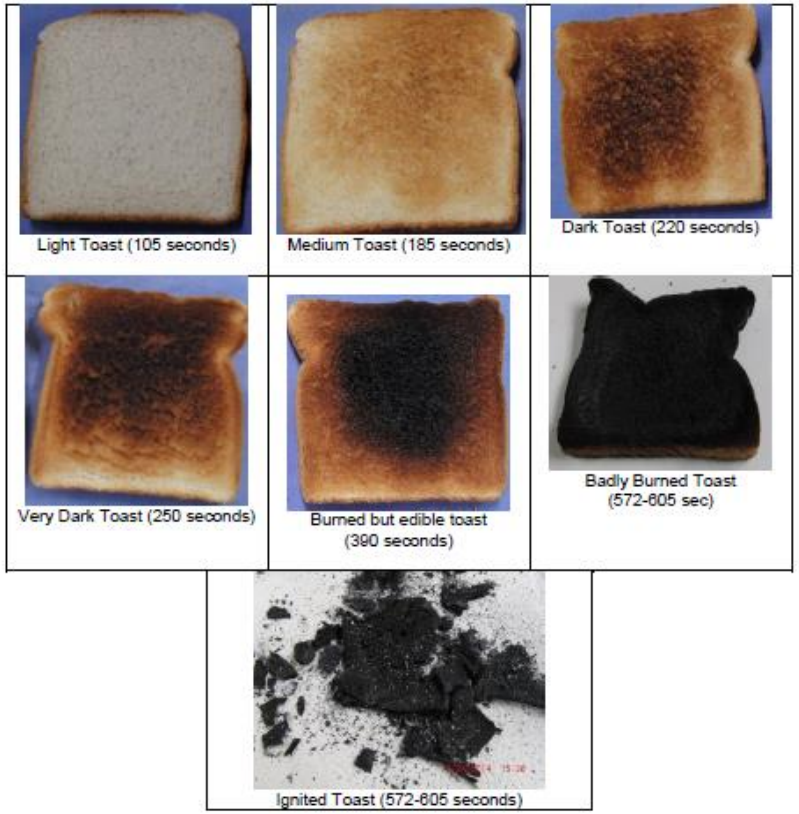
Massive research project…many years

- New smoldering polyurethane foam fire
- New flaming polyurethane foam fire
- Limits based on new NIST study TN 1837 (Improving Smoke Alarm Performance – Justification for New Smoldering and Flaming Test Performance Criteria); goal is to create adequate escape time
- Very aggressive activation criteria therefore very sensitive detectors

50 YEARS OF FIRE HISTORY (CONTINUED)

Nuisance Alarms

- Home smoke alarms (primarily ions) produce false alarms due to cooking
  - Homeowners disable alarms and then are without protection
- More studies
  - NIST TN 1784: Smoke Alarm Performance in Kitchen Fires and Nuisance Alarm Scenarios (2013)
  - NFPA/FPRF: Smoke Alarm Nuisance Source Characterization (Jensen-Hughes) 2015
  - UL: Characterization of Smoke Alarm Nuisance Sources from Cooking Scenarios (2015)



VISUAL REPRESENTATION OF THE NEED

Full video: https://youtu.be/87hAnxuh1g8

WHO DECIDES WHAT UL 268 REQUIREMENTS ARE?

UL.org is the Standards Developing Organization (SDO)

- Separate from UL LLC, the test lab

UL 268 is governed by a committee (approx. 40 members)

- Standards Technical Panel (STP)
- A variety of interest groups are represented
- UL LLC (the test lab) gets one vote

While the standard is called "UL" 268, they do not dictate the requirements

- Either Intertek/ETL or UL LLC can test products to UL 268

NEW FIRE TESTS

Goal of the new tests was to force a change in the performance of all smoke detectors and smoke alarms

- A new flaming test would challenge photoelectric smoke detectors
- And a new smoldering test would challenge ionization smoke detectors

Expand the range of smoke types that detectors are tested to

Existing/previous fire tests

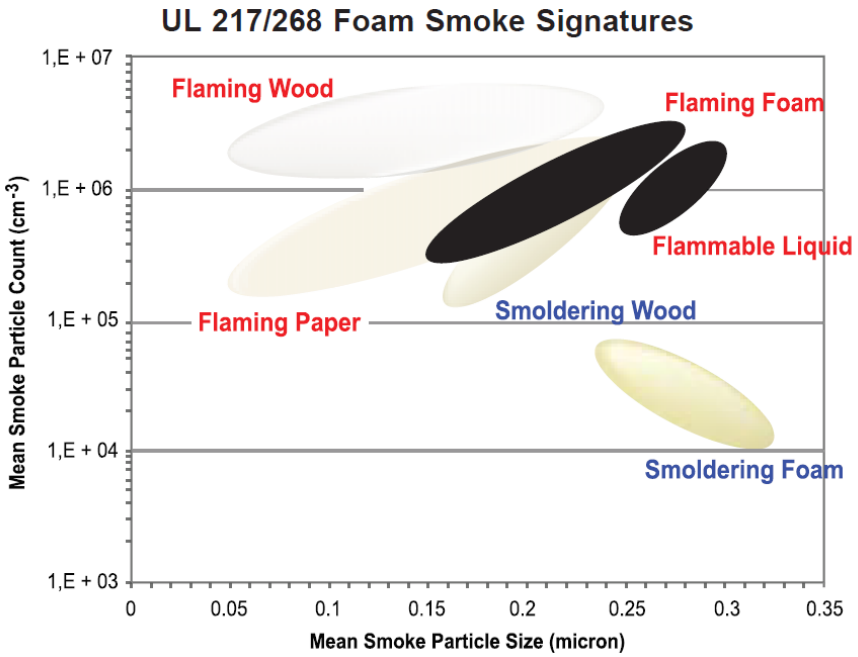
- Newspaper, wood crib, smoldering wood, flammable liquid (heptane)

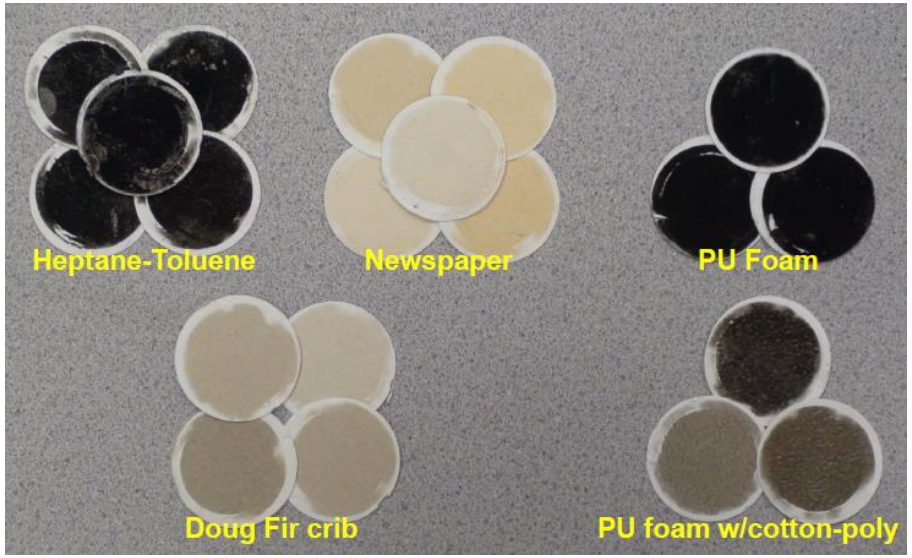
The new material is polyurethane foam – the stuff in your chair cushion

- 1.8 pounds per cubic foot density
- Size: 14.5 x 17 inches x 3-4 inches thick

The committee originally tried to use foam wrapped with synthetic fabric (nylon)

UL FIRE TESTS





Images courtesy of UL LLC

SMOLDERING POLYURETHANE FOAM TEST

First challenge is to create a test with a repeatable smoke build-up rate

- This step took years of research
- Foam “wants” to burst into flame when heated

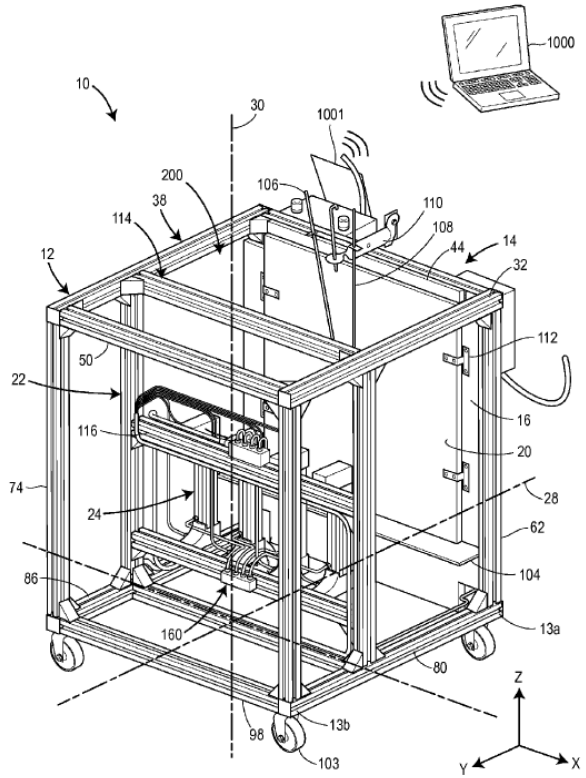
UL 268 does not specify how to smolder the foam – just the smoke profile

UL uses quartz radiant heaters (lamps)

- Foam is held vertically

Other methods might work

- Hot plate akin to smoldering wood test



ACTIVATION CRITERIA – WHEN DOES THE DETECTOR HAVE TO ALARM?

How was the 12%/ft test limit decided?

- Recall that smoldering wood test limit is 10%/ft

Tenability criteria was decided (based on tons of research)

- Must escape before visibility is less than 15 feet (0.25 OD/m)
- This is more conservative than temperature or carbon monoxide

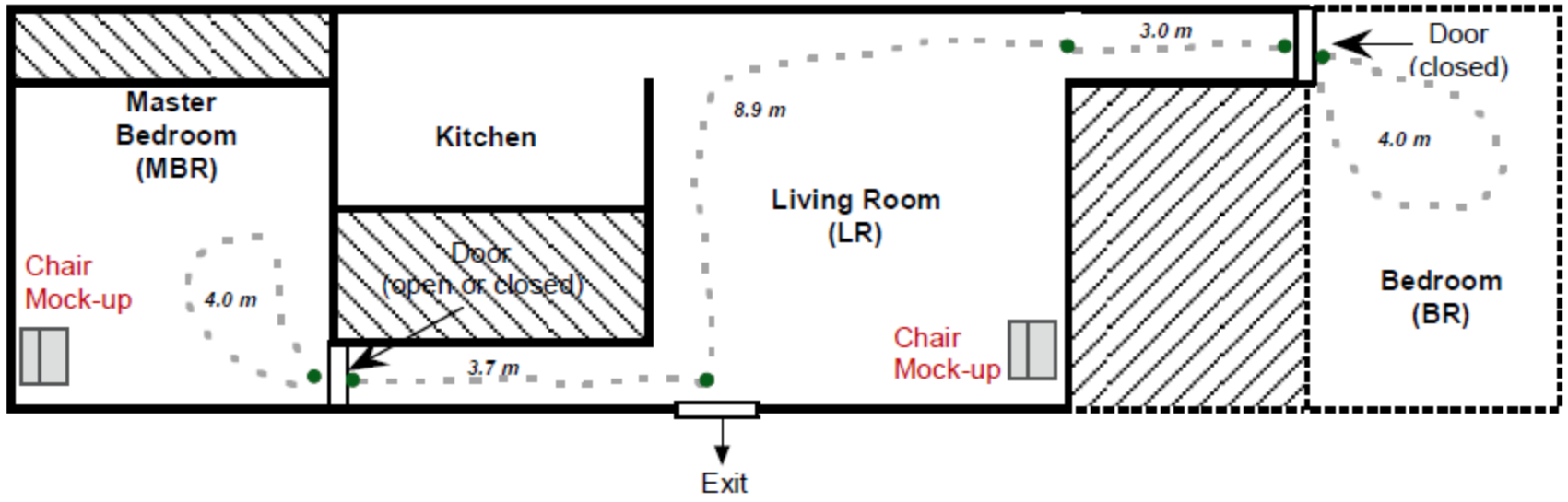
NIST performed fire tests in a full-scale house

- Estimated how long it takes to escape before tenability criteria is met
- Called RSET (required safe egress time)
- Assumes various walking speeds, times to awaken, not using a window, etc.

Analysis results in a distribution of probabilities

Ultimately, a metric of 85% success rate across all scenarios was chosen

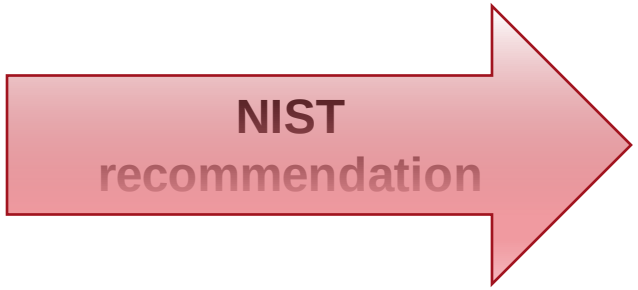
EXAMPLE OF FIRE LOCATIONS AND EXIT ROUTES



Source: NIST TN 1837

ESCAPE SUCCESS RATE VS. ALARM THRESHOLD

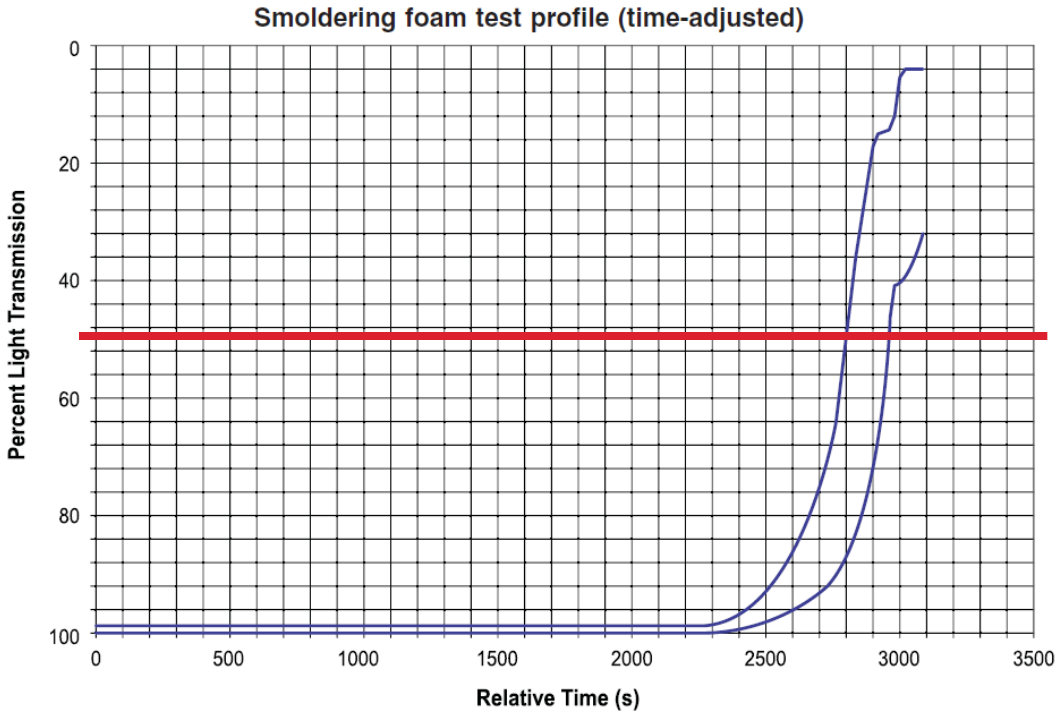
After weighing additional factors, UL recommended 12%/ft.



Smoldering fire test alarm criterion	
Smoke Obscuration (%/ft obsc.)	Averaged success rate and standard deviation (%/%)
12*	93.0/4.4
14	86.0/11.6
16	80.8/16.5
20	69.0/19.7
22	58.8/20.0
24**	45.3/21.7

SMOLDERING FOAM SMOKE PROFILE

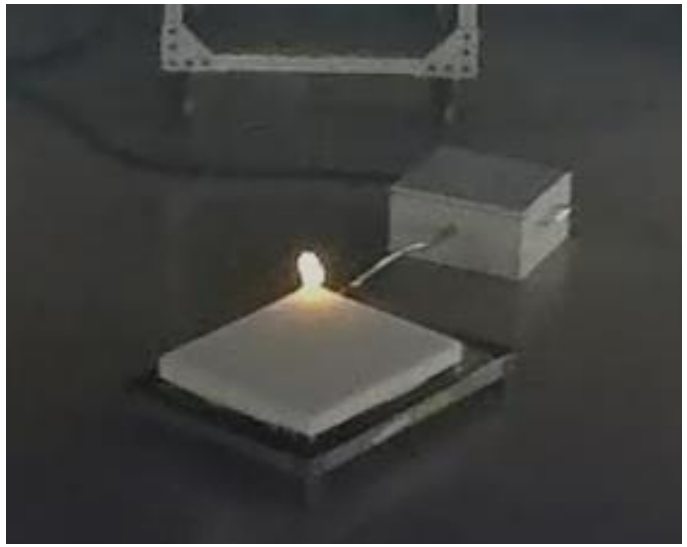
- Takes forever to start smoking, then test is over within 5-6 minutes
- Rapid smoldering rate
- Profile is the result of 50 trials with 3 sigma limits (at UL NBK)



FLAMING POLYURETHANE FOAM TEST

Easy fire test to develop compared to the smoldering version
Foam is laid horizontally in a pan and lit at the corner
This is an extremely repeatable fire test

- Similar smoke to the Flammable Liquid Fire, which was eliminated



FIRE PROGRESSION

10 seconds

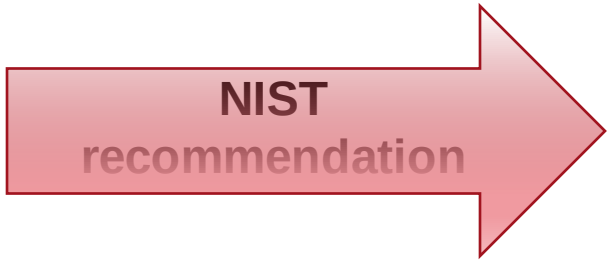
60 seconds

120 seconds

180 seconds

ACTIVATION CRITERIA FOR FLAMING PU FOAM FIRE

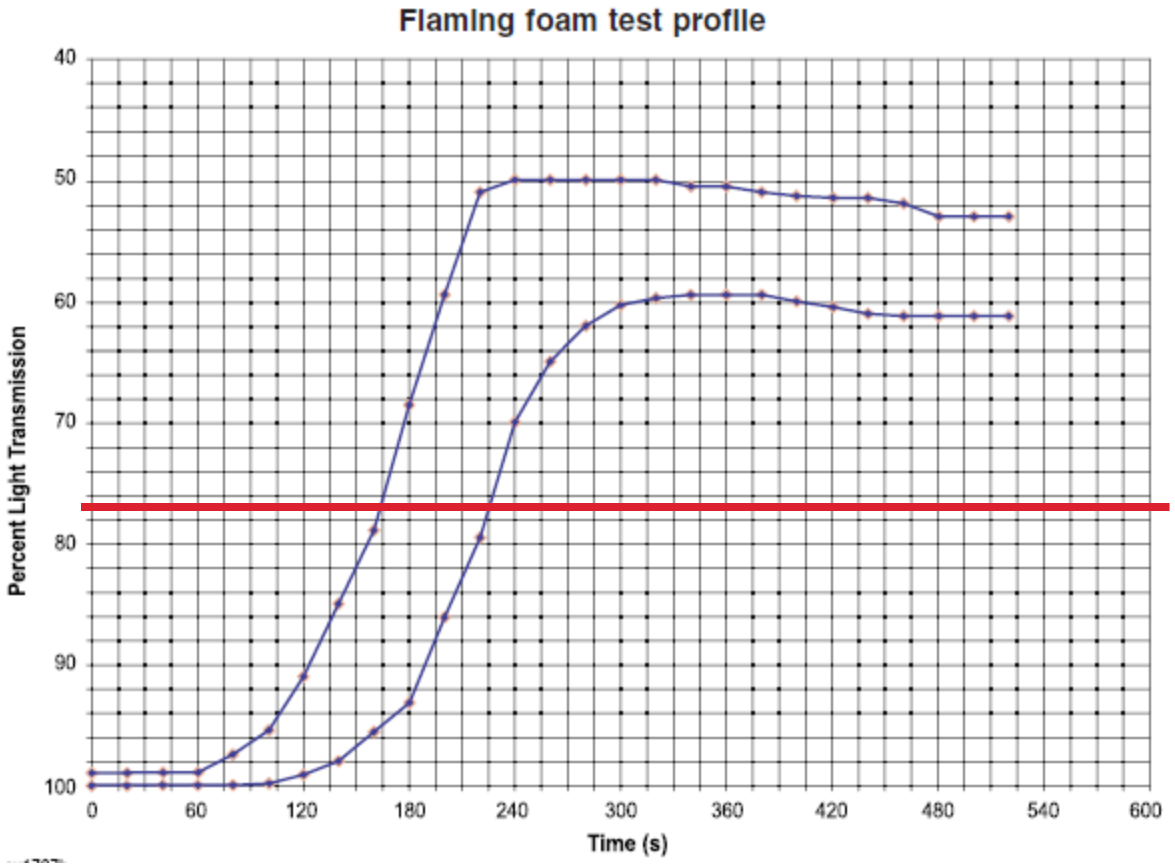
Same assumptions as for smoldering PU foam fire
After weighing various considerations, UL recommended 5%/ft



Flaming fire test alarm criterion	
Smoke Obscuration (%/ft obsc.)	Averaged success rate and standard deviation (%/%)
2*	94.3/5.7
4	86.0/11.4
5	79.0/14.1
6	71.8/17.0
8	59.8/19.1
10**	49.0/19.1

FLAMING PU FOAM SMOKE PROFILE

Fire starts slow, but is ultimately over in about 3 minutes
Profile is the result of 50 trials with 3 sigma limits



NOW WE HAVE SUPER SENSITIVE SMOKE DETECTORS…

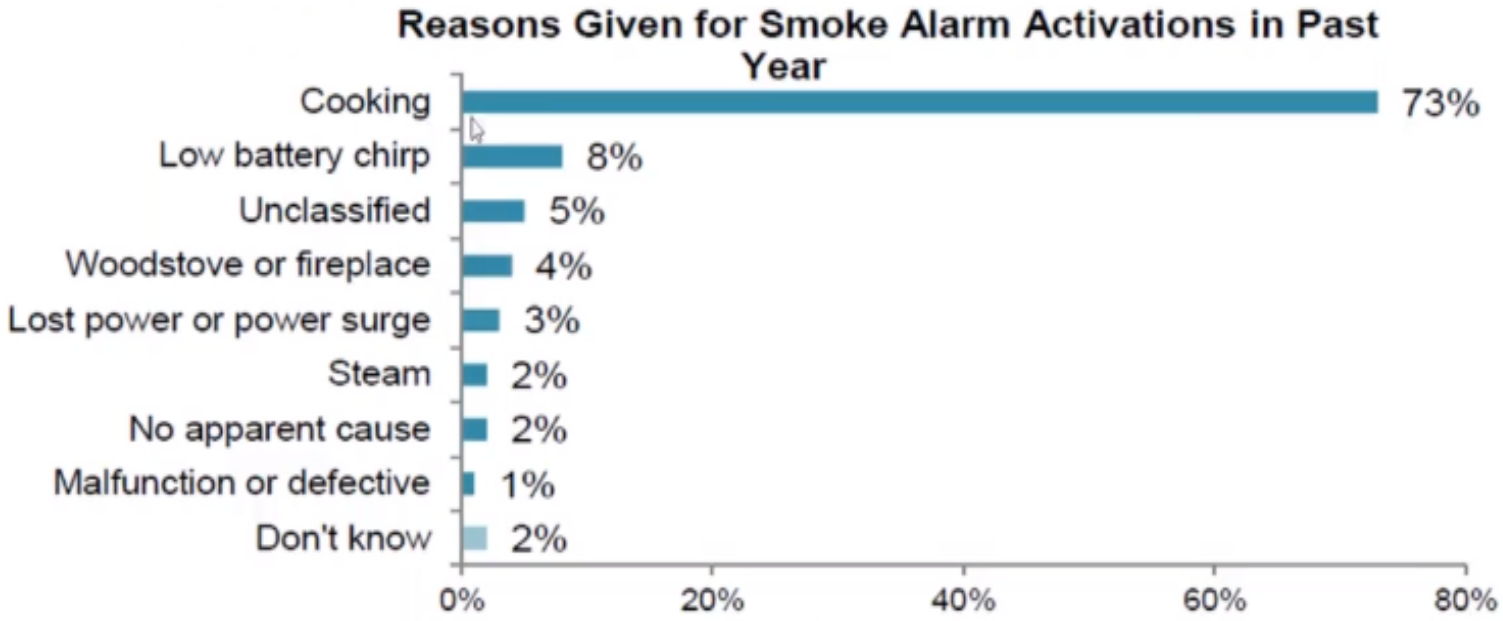
What could go wrong?
The UL committee realized that modifying UL 268 for new fires without a Nuisance Test would not be a good idea.
Research was commissioned and conducted by NIST and Jensen Hughes to characterize the nature of particles produced by normal cooking.

- Toast, frying vegetables, cooking hamburgers, heating frozen pizza

The committee expected a sophisticated test that mimicked the conditions produced during cooking.
Instead, the committee opted for a simpler solution.

Two frozen hamburgers under an electric broiler on high.

COOKING CAUSES THE MOST NUISANCE ALARMS.



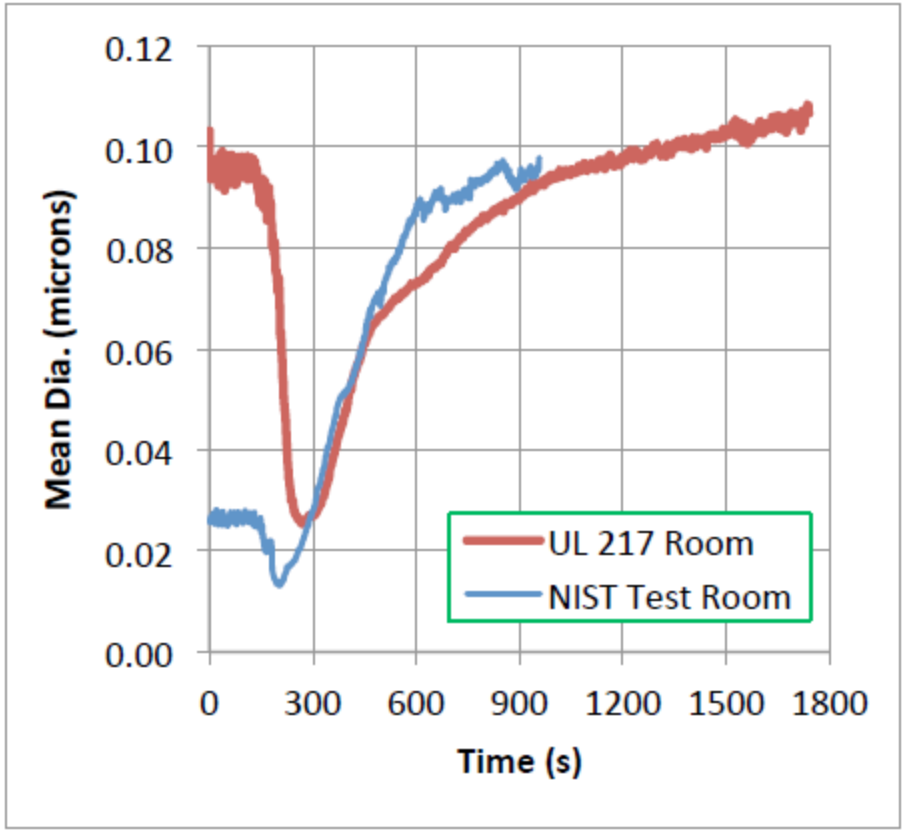
Source: Harris Poll National Quorum. National Fire Protection Association -- Smoke Alarms. 2010.

WHY BROILING HAMBURGERS?

Wide range of particle sizes are generated

- 30 nm to 0.11 micron

Particles evolve to a larger size during the test



UL COOKING NUISANCE SMOKE TEST

Smoke detectors mounted 10 feet from the range

- Rather than 18 feet for fire tests
- Set to highest sensitivity
- 8 ft effective ceiling height

Detectors must ignore smoke to 1.5%/ft level

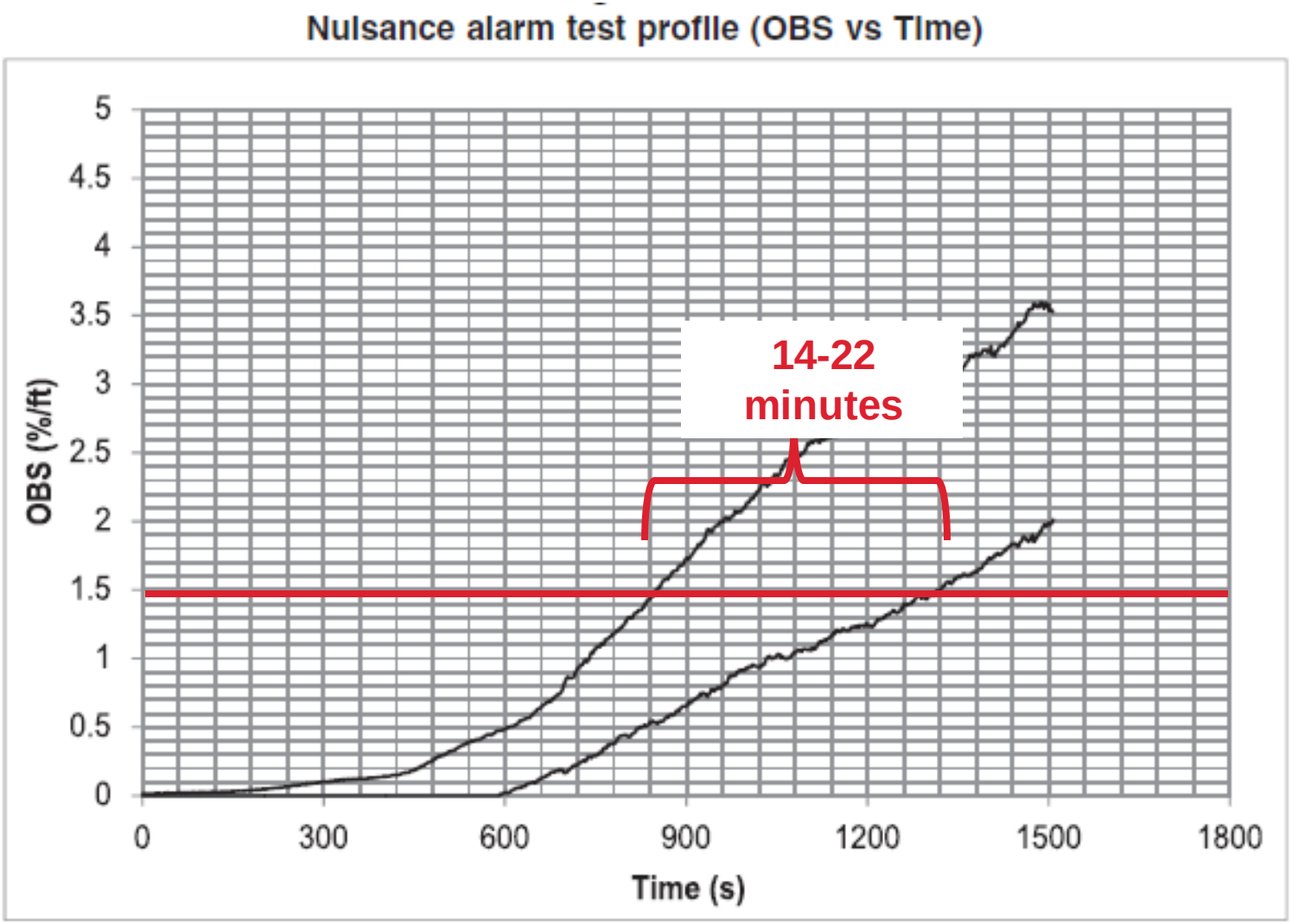
- And then alarm to flaming PU foam fire

1.5%/ft is a lot of smoke…

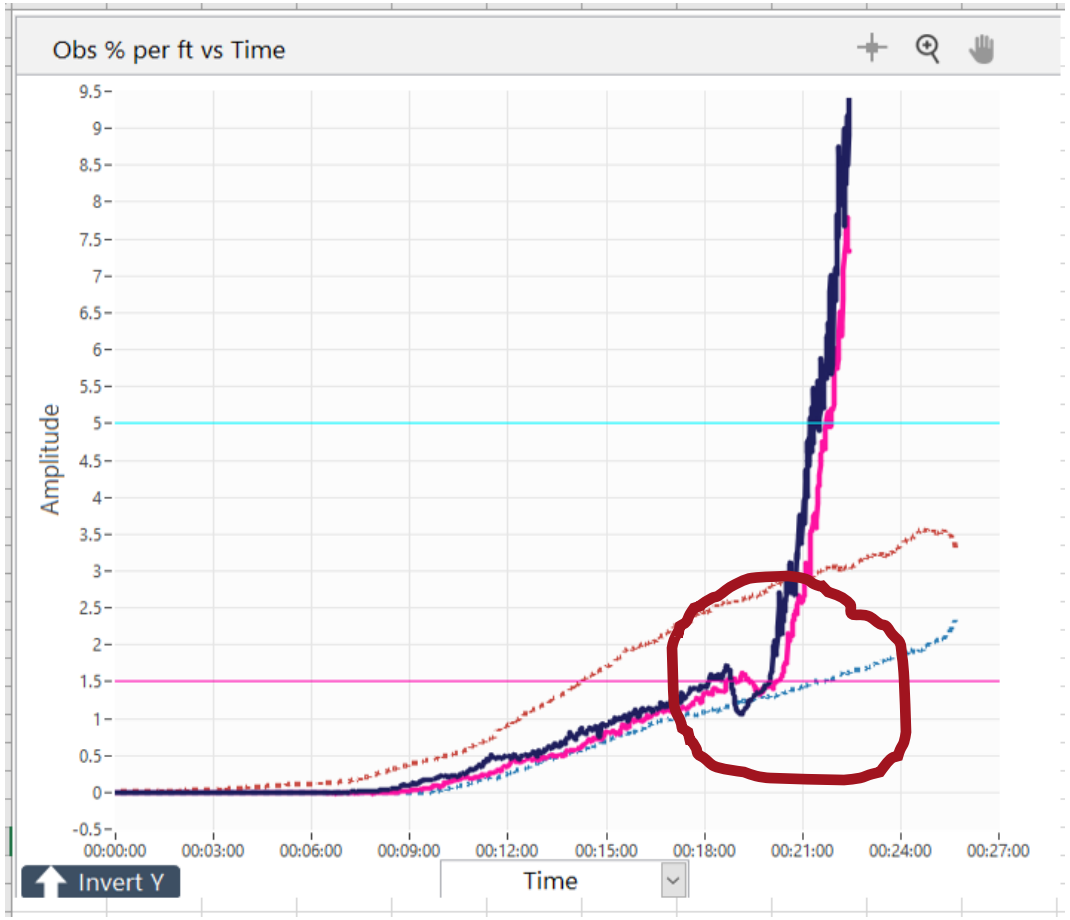
- Smoke detectors have a 0.5%/ft threshold under previous requirements!

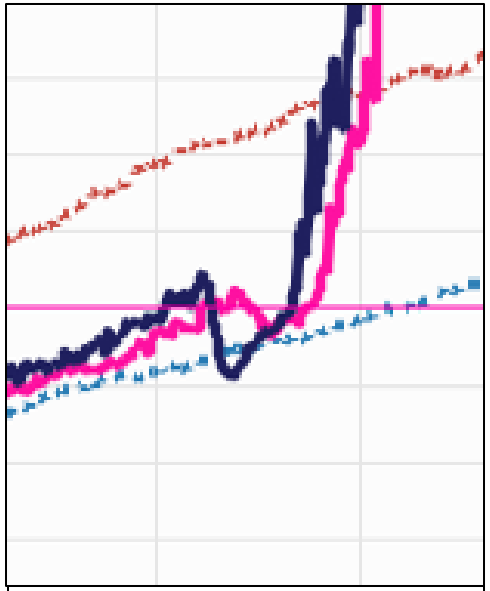
Credit: ABC News

NUISANCE SMOKE TEST PROFILE



FIRE TEST ROOM
NUISANCE SMOKE + FLAMING PU FOAM





Smoke level dips after fire starts!

CAN I PUT SMOKE DETECTORS IN COOKING AREAS?

No, it's a fine line between over-cooked food and a fire.

- Dirt/grease build up will lead to false alarms over time
- Detectors are only being tested against one, very specific, nuisance scenario with a specific build up rate and detectors mounted at a location 10 feet from the source

Be Sure to Review the New Certification

WHY DO ALL DETECTORS NEED TO PASS THIS TEST?

When detectors are sold, manufacturers do not know where they will wind up. The cooking nuisance is representative or any number of other nuisance conditions.

US VS CANADIAN FIRE TEST REQUIREMENTS

Canada uses the smoldering wood test, newspaper fire, flammable liquid fire
US uses smoldering wood test, flaming wood test, newspaper fire, flaming PU foam fire, smoldering PU foam

- Flammable liquid was eliminated due to similarity of particulate to flaming PU foam

Canada has agreed to use the US Fire Tests, plus the Nuisance Smoke Test

- Standard will likely be updated in 2022

BREAK FOR QUESTIONS

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WHAT IS THE *EFFECT* OF THE NEW REQUIREMENTS?

Initially, it was thought that multi-criteria detectors would be needed to pass the requirements

- UL envisioned combo photo-ion units in the Smoke Characterization Report

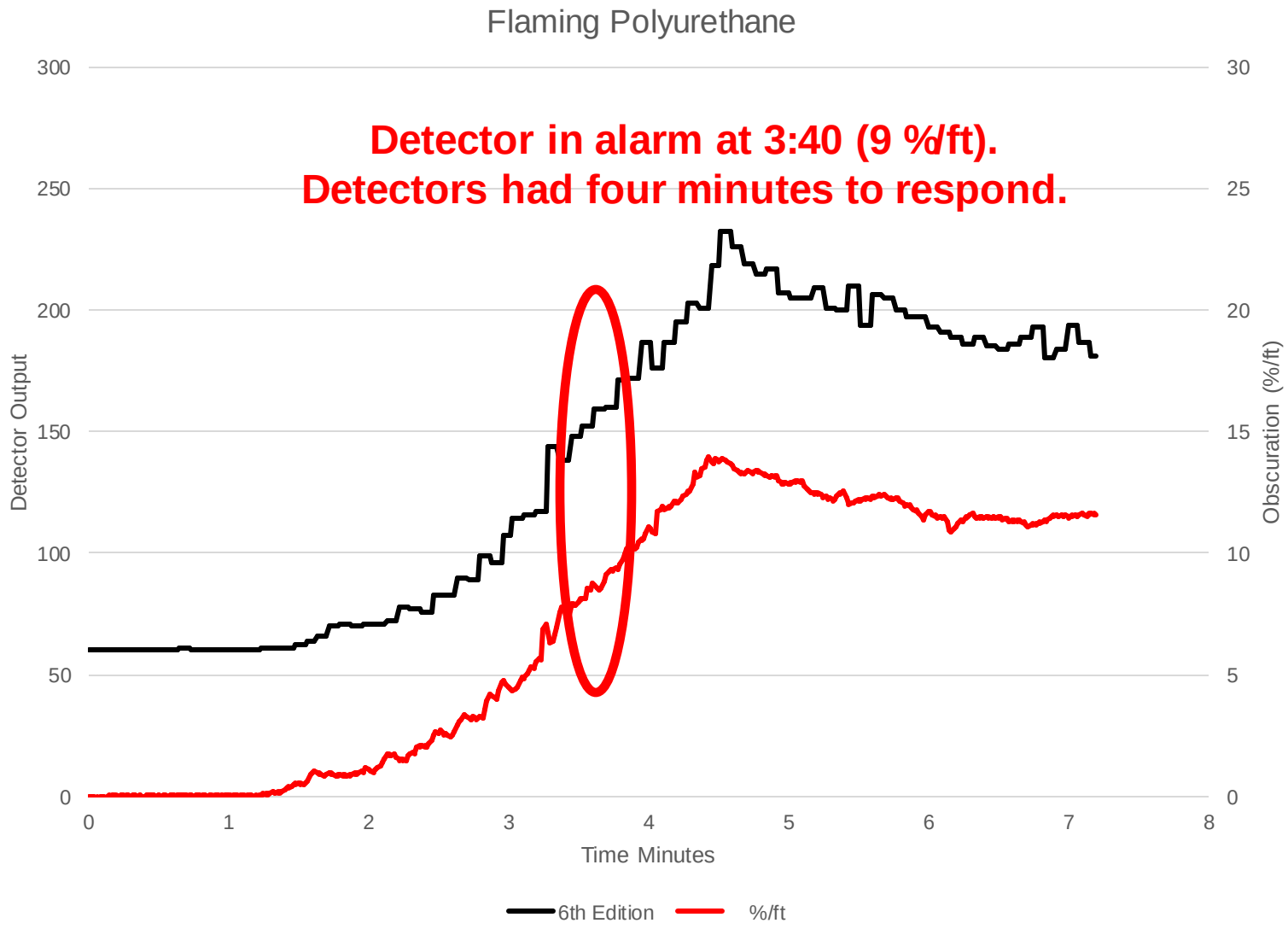
Simple detector alarm thresholds don't work

- Overlap between flaming PU foam fire and cooking nuisance
  - At 1.5%/ft cooking smoke, a 2%/ft photo will respond
  - To alarm in time for 5%/ft of black smoke, sensitivity needs to be 1.5%/ft

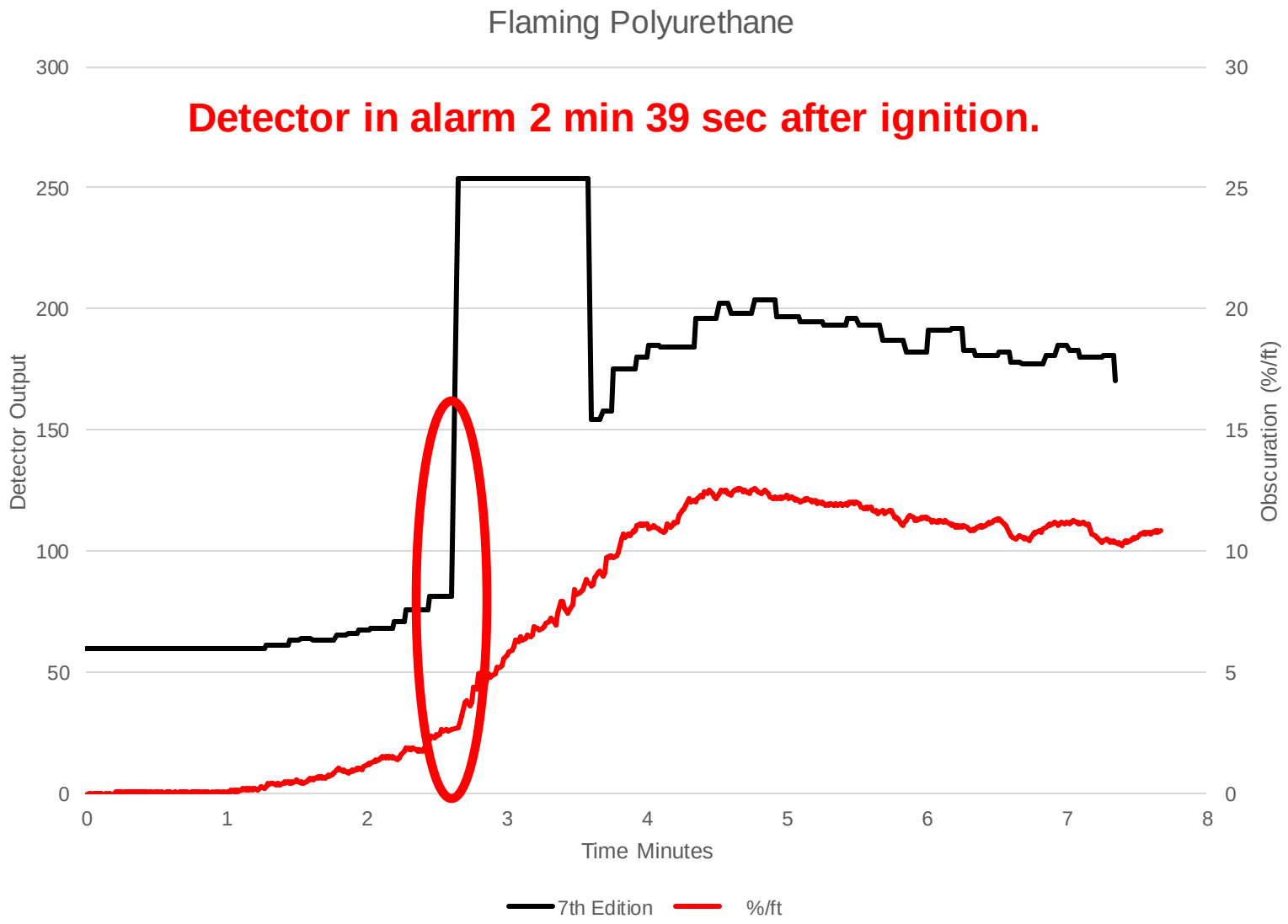
Microprocessors running new algorithms have allowed single-criteria photoelectric detectors to pass the new tests

Photoelectric detectors are more responsive to flaming fire conditions…additional seconds to escape a flaming fire condition

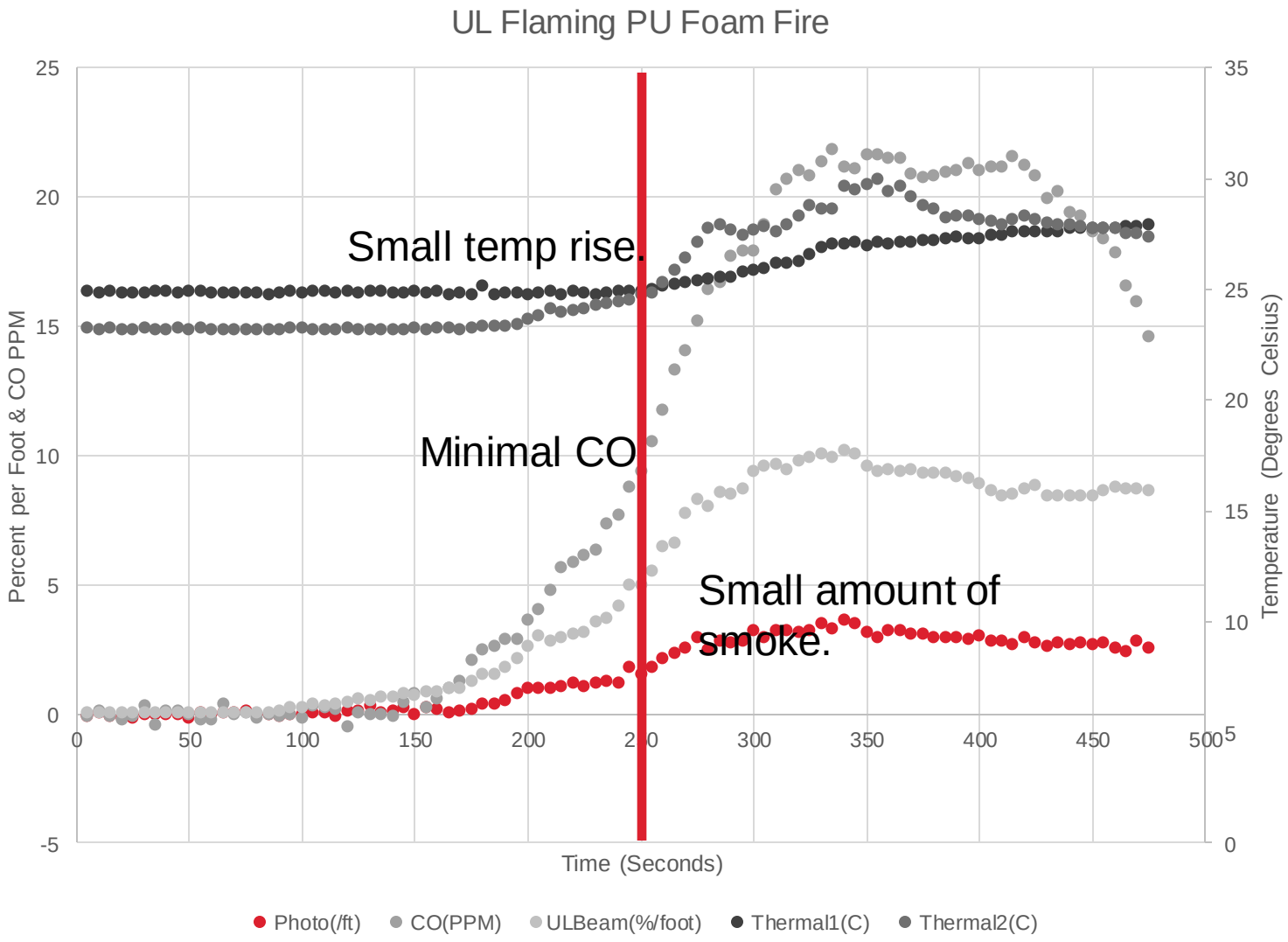
6TH EDITION PERFORMANCE – SPOT DETECTOR



7TH EDITION PERFORMANCE – SPOT DETECTOR



MULTI-CRITERIA SPOT DETECTORS



WHAT ABOUT DUAL ANGLE OR DUAL WAVELENGTH?

Another approach to detection and nuisance identification is to use:

- 2 different color LEDs in the smoke chamber
- Or 2 different photosensors (at different angles)
- Or both

Attempts to measure the size of the particulate (smoke or nuisance)

Can be challenging because:

- Sometimes a fire starts during a nuisance condition
- Not all nuisances are large particles

WHAT IS SPECIAL APPLICATION MODE?

Early on, committee members felt strongly that the new fire tests and nuisance tests should apply to smoke alarms and smoke detectors.
UL 268 Smoke detectors are used on both UL 864 and UL 985 control panels

- Smoke detectors wind up in residential occupancies
- Even aspirated smoke detectors are used in residences

The committee recognized that some smoke detectors needed to be more sensitive than the standard allowed

- Some applications are unlikely to have cooking nuisances.
- Think VESDA or VIEW

Special Application Mode listing is an option available to detector manufacturers

SPECIAL APPLICATION MODE

First, <u>all smoke detectors must be capable of meeting all of the requirements of UL 268</u>

- Beam detectors are the only exception (no Nuisance Test)

But, they can have a mode which is more sensitive

- This means that the detector does not pass the nuisance test

Why do it this way?

- The committee did not want to create a loophole that would allow detectors to avoid the nuisance test
- Manufacturers could claim <u>all</u> their detectors were special application

In UL 268 6th edition, Special Application was just a detector with sensitivity greater than 0.5%/ft.

REQUIREMENTS FOR SPECIAL APPLICATION

- **Detector needs to default to a mode or configuration where it passes all the Fire and Nuisance Test**
- **The detector can be put in a mode where it does not pass the Nuisance Test – that is, higher sensitivity**
- **It must be a deliberate action to enable Special Application setting.**
- **It must indicate that it is in Special Application mode…somehow**
- **The installation instructions must provide guidance on where to and <u>not</u> to install**

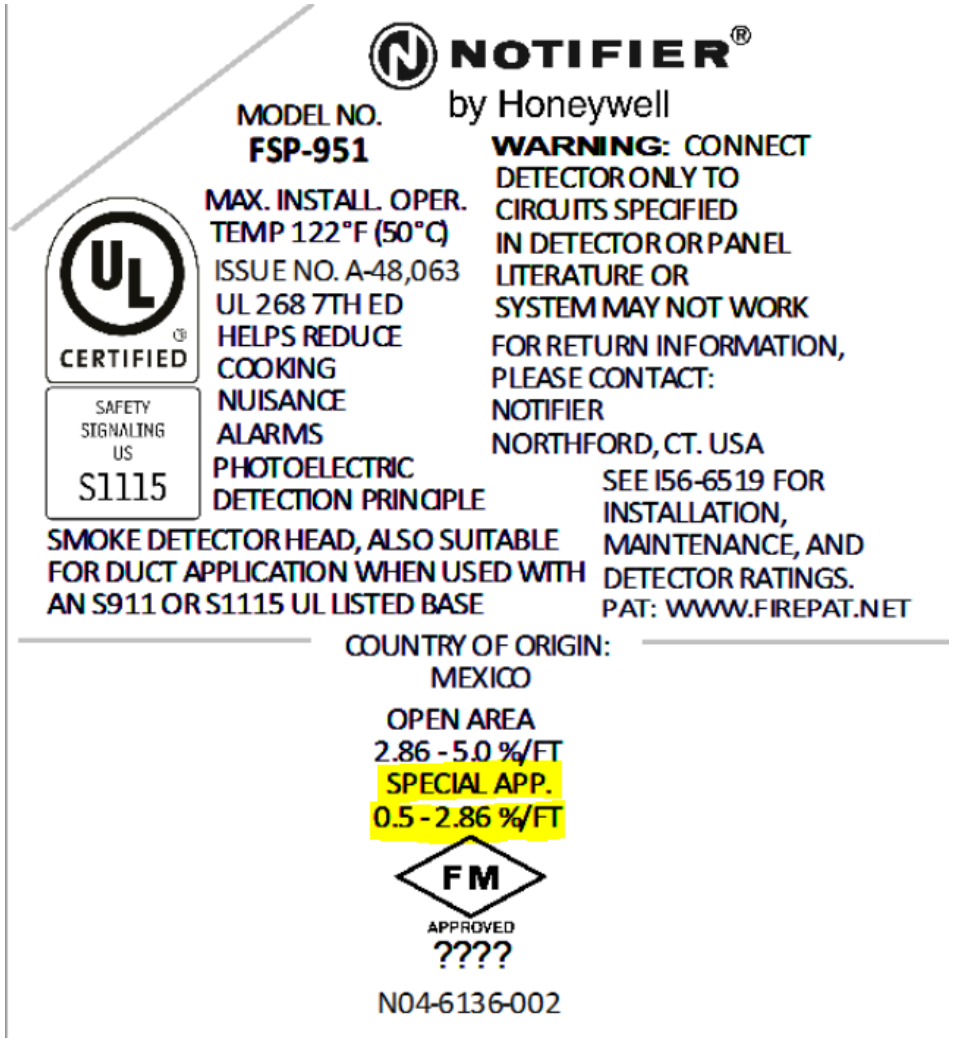
STANDARD SPOT DETECTORS ARE SPECIAL APPLICATION LISTED

To provide additional flexibility to installers and system designers Honeywell lists all standard spot detectors for special application.

- Normal range is 2.86 to 5%/ft

This means they can be set as low as 0.5%/ft

Use caution



HIGH SENSITIVITY SPOT DETECTOR*

Replaces Laser-based detectors
Opto-electronic and analog electronics has improved since Laser was introduced in the 1990s
High Sensitivity detectors are listed as Special Applications

- Backwards compatible to Laser based detectors

Sensitivity ranges

- 0.02%/ft to 2.86%/ft (Special Application)
- 2.86%/ft to 2.0%/ft (Normal Open Area)

*7th edition coming soon

Commonly used in NFPA 76 applications.

EFFECTS OF 7TH EDITION ON ASPIRATED SMOKE DETECTORS

As of today, ASD is not adequately addressed in UL 268

- Changes are coming

Certification issues

- Each sampling point is now considered equivalent to a spot detector and its sensitivity must be in range (“Port Sensitivity”)
- Fire test performance determines transport time
- Configuration software (ASPIRE) is certified with the hardware – prediction must be within 10% of measured values

Alarm thresholds

- Fire1 Alarm threshold, used to signal the alarm condition, each sampling port must be configured to be above the nuisance smoke level & below the smoke alarm level.
- Alert and Action configuration is not subject to the UL 268 Ed7 standard requirement and remain available for signaling at a higher sensitivities.
- Fire 2 configuration is not subject to the UL 268 Ed7 standard requirement and remains available for signaling lower sensitivities

ASPIRE

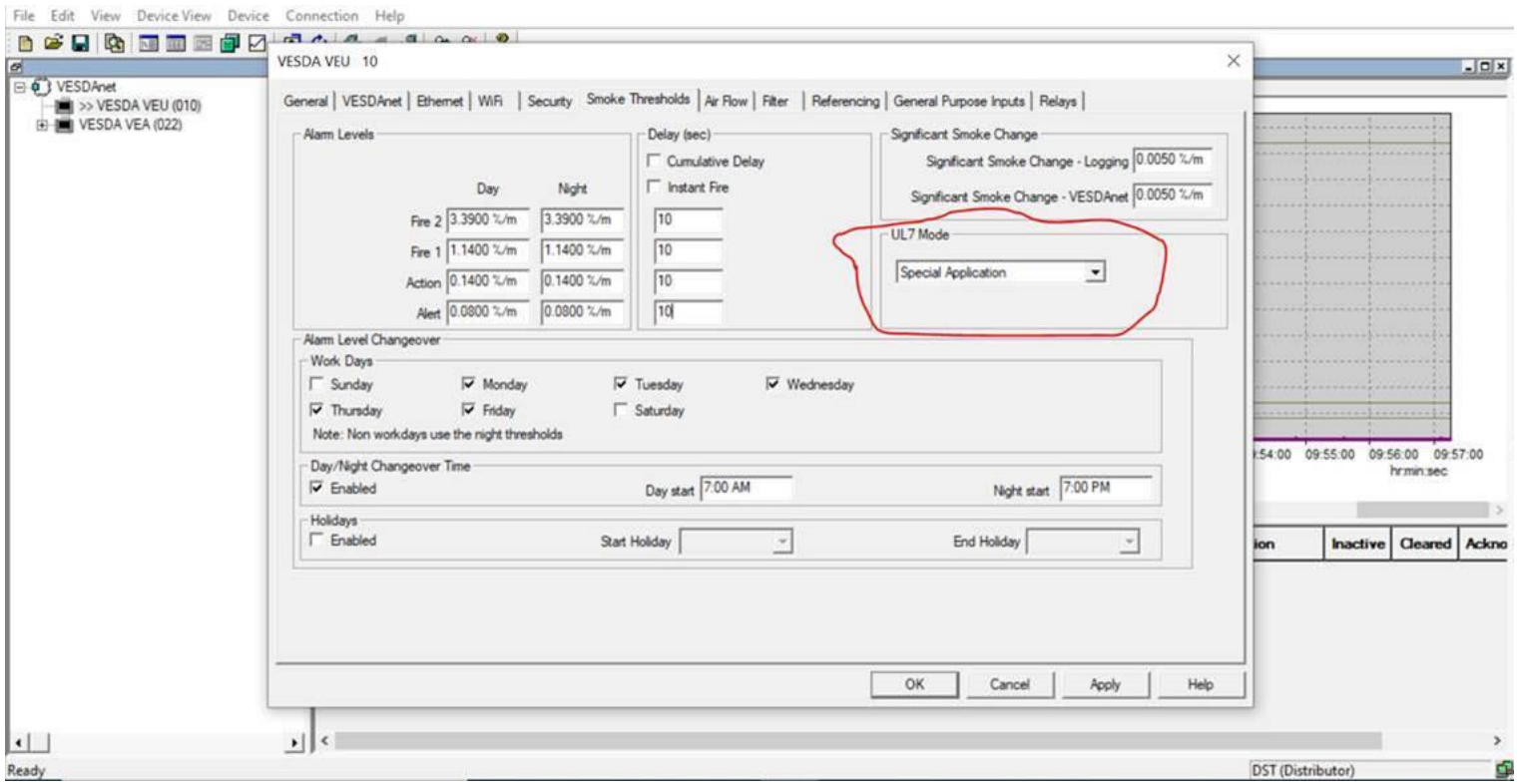
Modeling tool configured to meet UL 268 7th edition
Each sampling port is reported with a transport time and sensitivity
Assures that the pipe network

- Transport time is less than the max determined during certification
- Each sampling port sensitivity is within the listed range

Max pipe length is the result of meeting sensitivity and transport time
Alarm thresholds generated by ASPIRE must be applied to the detector configuration in order to meet UL 7th edition
A balanced pipe network is recommended

- Ratio between min and max port sensitivity is not more than 1:2

ASPIRE



You will pick the operating mode: Special Application or Normal/Open Area

ACCEPTABLE SENSITIVITIES (EXAMPLE)

VEU application	Hole Sensitivity				Transport Time (s)	
	Obscuration					
	%/m		%/ft			
	Max	Min	Max	Min	Max	Min
Open Area 0 to 300 cfm	5.00	10.00	1.524	3.049	50	6
Open Area High Velocity 300 to 4000 cfm	5.00	10.00	1.524	3.049	50	6
Special Application High Sensitivity 0 to 300 cfm	0.01	1.50	0.003	0.457	85	6
Special Application Low Sensitivity 0 to 300 cfm	0.01	10.00	0.003	3.049	50	6
Special Application High Sensitivity 300 to 4000 cfm	0.01	1.50	0.003	0.457	79	6
Special Application Low Sensitivity 300 to 4000 cfm	0.01	10.00	0.003	3.049	50	6
DUCT Applications (Single Pipe) 0 to 4000 cfm	1.65	10.00	0.503	3.049	50	6

“Open Area” means that the configuration passes all the Fires and Nuisance Test.

WHEN DOES THIS CHANGE HAPPEN?

UL has changed their effective date several times

- COVID
- New UL Fire Test Room
- Resources

The date in NFPA 72 will be January 1, 2025??
The UL certification date is June 30, 2024
The ETL certification date is June 30, 2024
In some cases, product is available now (depends on model).

Each Test Lab sets their own effective date for new requirements.

WHAT ABOUT OLDER DETECTORS ALREADY INSTALLED?

UL 268 detectors listed to the older test fires have saved thousands of lives
Older detectors can remain in place as long as they pass annual tests

What about retrofits?

- New detectors are backward compatible
- Old and new detectors can be mixed

SUMMARY & CONCLUSIONS

- Smoke detector standards needed to evolve along with changing materials in homes and buildings.
- This is the biggest detector change in 50 years!
- The industry developed test methods and alarm thresholds that are forcing detectors' performance to improve.
- Be aware of the differences in performance that will come with the new detectors – both spot type and aspirating

ANY QUESTIONS?

PRESENTER: SCOTT LANG
SCOTT.LANG@HONEYWELL.COM

THANK YOU

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