Deadly Differences
Ionization vs Photoelectric Smoke Alarms

CREIA Fall Conference
Palo Alto, CA
September 23, 2012

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

An In-Depth Look at US Fire Death Rate Statistics and the Performance of Photoelectric and Ionization Smoke Alarms in Residential Fatal Fires

CREIA Fall Conference September 23, 2012

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Skip Walker

- *ACI, ASHI Certified Inspector*
- *MCI, CREIA Master Inspector*
- *ICC Certified Residential Combination Inspector*
- *F.I.R.E. Service Certified Inspector*
- *Published 19 Articles, 4 on Smoke Alarms and CO Issues*
- *Ion vs Photo Alarms & Prefab Fireplaces, ASHI GLC, March 2012*
- *Ion vs Photo Alarms, CREIA Spring Conference, April 2012*
- *Presented to California Association of Realtors (CAR), Risk Management/Consumer Safety Committee on Smoke Alarms*
- *Presented to National Association of Realtors (NAR), Risk Management/Consumer Safety Committee on Smoke Alarms*
- *Interviewed by SF Chronicle for Smoke Alarm Article*

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What If ….

Car Airbags Deployed When You Hit Pot-Holes?

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But Failed to Deploy in Serious Accidents.....

55% of the Time?

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There Are Very REAL Differences in How Different Smoke Alarms Types Perform in Real World Fatal Fires

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This is a Very REAL Problem.

This Issue Directly Contributes to at Least 1,000 Fire Deaths Per Year – Probably Many More

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This is an Old Problem.

We Have Known That These Alarms Were Not Providing Adequate Protection Since the Early 1980's and Even Earlier.

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As Professional Property Inspectors, We Are Uniquely Positioned to Have a Very Significant Impact on Public Awareness and Safety.

We Can Make a Difference!

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"This issue has more impact on the life safety of your clients than just about anything. Actually, make that just plain anything."

Douglas Hansen

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Please Welcome

Marc McGinn

Fire Chief (Retired)
Albany, CA

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There are *three* kinds of lies;
Lies, Damn Lies and ***Statistics***

- Benjamin Disraeli, British Prime Minister

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What We Will Talk About Today:

- *US Residential Fire Death and Injury Statistics 1960-2001*
- *Statistical Data, Trends and How to Interpret the Data*
- *A Brief History of Smoke Alarms*
- *The Types of Smoke Alarms Found In Residential Use*
- *Contrast the Performance of the Different Alarm Technologies in Residential Fatal Fires*

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Important:

All the Data Used Comes From Reputable Sources

<u>All Data Is Published & Verifiable</u>

- *NIST National Institute for Standards and Testing*
- *NFPA National Fire Protection Association*
- *CPSC Consumer Product Safety Commission*
- *FEMA Federal Emergency Management Agency*
- *UL Underwriters Laboratory*
- *Texas A&M University*
- *NFA National Fire Administration*
- *NCHS National Center for Health Statistics*
- *NIFRS National Fire Incident Reporting System*

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Now Let's Look At the Death/Injury Statistics and the Data Sources:

NFPA, Fire Loss Surveys and Various Studys
- *Survey of 3,000 Fire Departments Nationally – Mostly Larger*

NFIRS, National Fire Incident Reporting System
- Web Input System
- Voluntary Participation – Currently About 18,960 Fire Departments
- Participation Varies By State

NCHS, US Death Statistics Report
- *National Records of Death Certificates*
- *Cause of Death Classifications Limited*

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None of the Data is Perfect

They Are Estimates Only – Not Absolutes

- Numbers Vary Between Each Source
- Year to Year
- Sometimes Significantly

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NFPA and NFIRS Data:

Participation is Voluntary
Statistical Reports Include Extrapolated Data
Unknown Fire or Death Causes Are Reapportioned to Other Other Causes
Methods Used Are Sometimes Inconsistent Between Years/ Reports
Fire/Death/Injury Rates Are Estimates Only – Not Absolutes
Data Set Is Large Enough To Have A Degree Of Confidence In The Data

It Is Important to Understand the Limitations Of The Data

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NCHS, National Center for Health Statistics

US Death/Morbidity Statistics Report

The National Record of Death Certificates
Cause of Death Classifications Limited
i.e. Respiratory Failure from Smoke Inhalation
Can Be Used To Fill In Blanks From NFPA, NFIRS Data

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Caution must be used with statistical systems that allow voluntary/self-selection of participants. There is inherent bias in the statistical data. Only those that choose to participate do. Example: With NFIRS, since it is web based, only fire departments with web access can participate, etc.

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- From a fire perspective, the US is a Third World Country
- The NYC Fire Department responds to more calls per year than all fire departments in Japan
- US Fire Death Rate per Million Population = 12.3*
- Swiss Fire Death Rate per Million Population = 2.0*
- Singapore Fire Death Rate per Million Population = 2.3*

* *Source: FEMA International Death Rate Trends 1979-2007*

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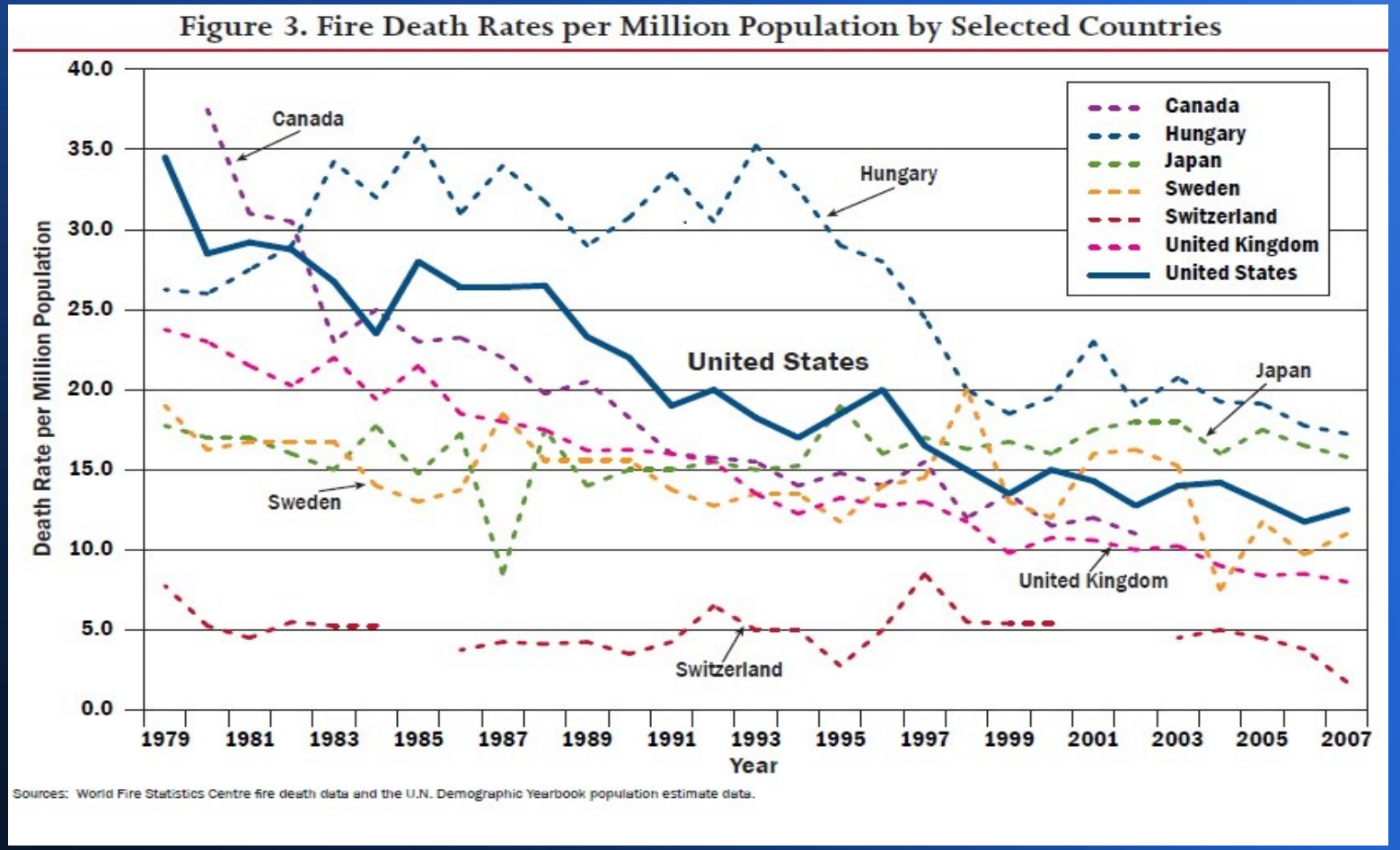

Source: FEMA Int Fire Trends 1979-2007

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Number of Households in The Us:

1960: 52 Million
1975: 72 Million
2007: 116 Million

Source: US Census Bureau, 2008

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Number of Households in The Us with Smoke Alarms:

1960: Almost Zero
1977: 18 Million/22%
2007: 111 Million/96%

Source: NFPA, Smoke Alarms in US Fires 2011

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Number of Households in The Us with Ionization Smoke Alarms:

Approximately 90%-95%
100-105 Million Homes

Source: Industry Sales Figures/Research Report Estimates

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*Thus the **home smoke alarm is credited as the greatest success story in fire safety in the last part of the 20th century**, because **it alone represented a highly effective fire safety technology** with leverage on most of the fire death problem that went from only token usage to nearly universal usage in a remarkably short time.*

Performance of Home Smoke Alarms
NIST Technical Note 1455-1
February 2008 Revision

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In 1980:

"We put 50 million smoke detectors in buildings in America in a two year period and our fire loss and death rate goes up. ***We're having a little trouble explaining these things****."*

Gordon Vickery, former head of the US. Fire Administration

Source: Fire engineering magazine, ***September 1980***

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"I estimate that at least 10,000-15,000 people have died unnecessarily in smoldering house fires since 1990 because they relied on ionization detectors."

Jay Fleming, Deputy Fire Chief , Boston, MA.

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Let's Look Closer at Residential Fires,
Where They Start
When They Start
How They Start
And The Consequences

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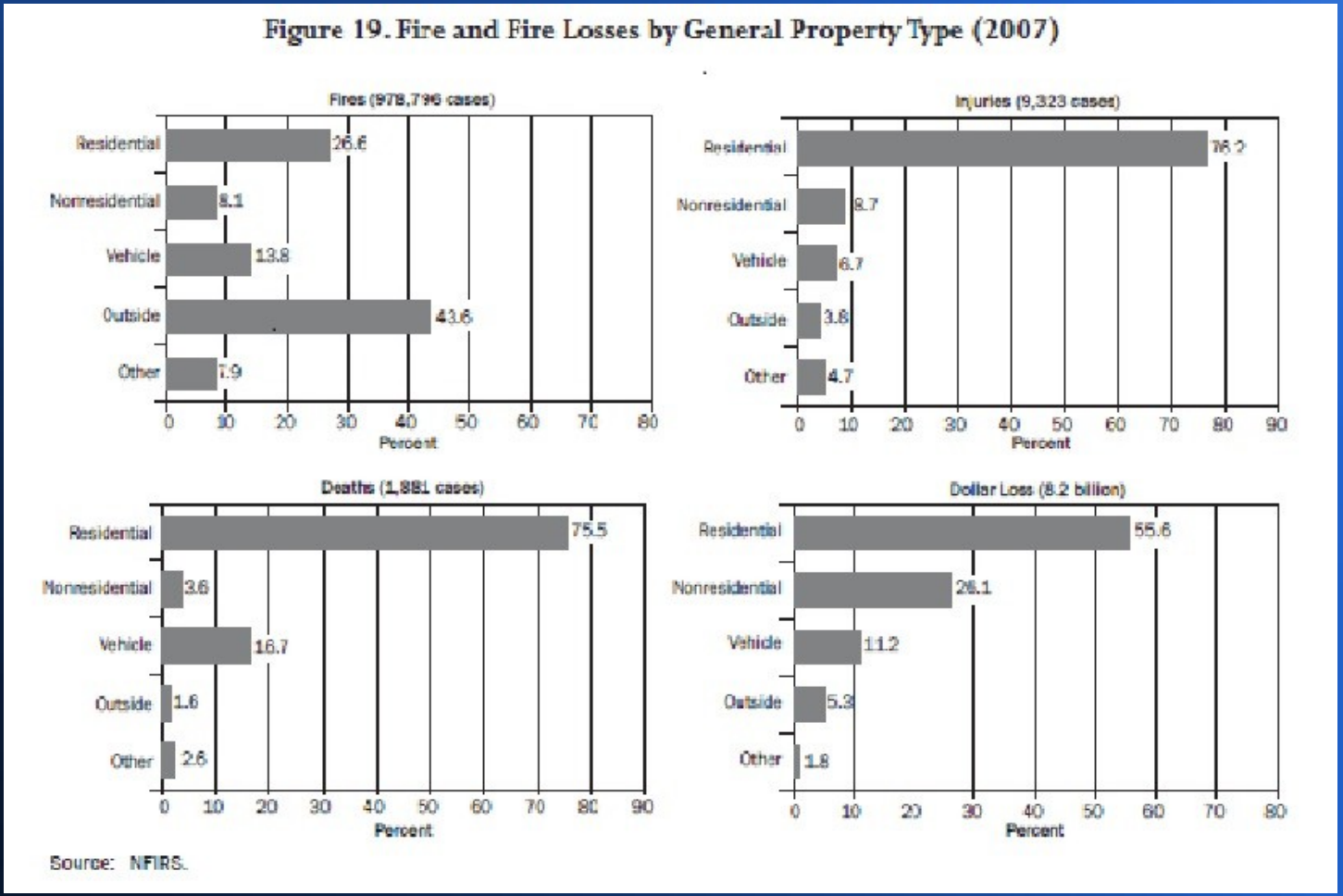

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- Most US Fire Deaths Occur at Home = 75.5%*
- Most US Fire Injuries Occur at Home = 76.2%*
- Most of Local Fire Prevention Budgets Are Spent on Commercial
  - Commercial = 99% (Estimate)
  - Residential = 1% (Estimate)

* *Source: NFIRS 2007*

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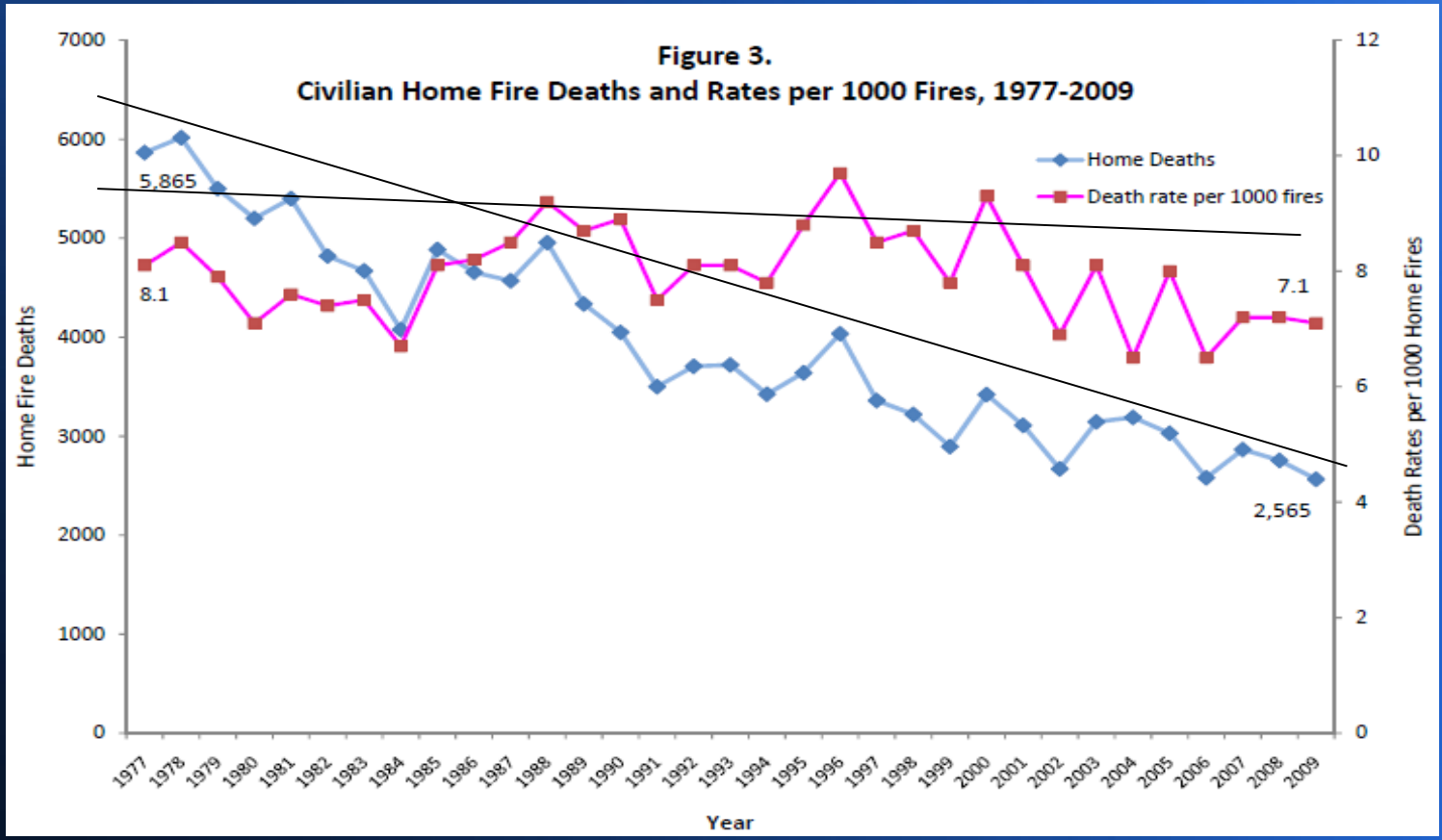
US Home Fire Deaths and Rate Per 1,000



Source: NFPA Fire Loss 2009

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Overall for the 1977-2009 period, the number of home fire deaths decreased from 5,865 in 1977 to 2,565 in 2009 for a decrease of 56%. The number of home fire incidents also declined steadily for an overall decrease of 50% for the same period. ***When the death rate per 1,000 home fire incidents is looked at (Figure 3), there is no steady decline, but rather the rate fluctuates considerably up and down. In fact, the death rate per 1,000 home fires was 8.1 in 1977 and 7.1 in 2009 for a decrease of 12%***. These results suggest that even though the number of home fires and home fire deaths declined similarly during the period, the death rate did not, and when there is a home fire, ***the fire death rate risk has not changed much for the period***.

Source: NFPA Fire Loss 2009 / Pg 7-8

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1977-2009 Fire deaths decreased from ***5,865*** to ***2,565*** a decrease of ***56%***

1977-2009 The number of home fire incidents decreased of ***50%***

There is a decline death rate per 1,000 home fire of 12% for same period from 8.1 to 7.1

"Even though the number of home fires and home fire deaths declined similarly during the period, the death rate did not"

Source: NFPA Fire Loss 2009

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When there is a home fire,
the fire death rate risk has not changed much for the period.

Source: NFPA Fire Loss 2009 / Pg 7-8

Yet *Between 1977 and 2009 Hundreds of Millions of Residential Smoke Alarms Were Installed in the US.*

In 1977, Around 22% of Homes Had At Least One Alarm
By 2009 Around 96% of Homes Have At Least One Alarm

Source: NFPA Fire Loss 2009/US Home Fires 2011

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- 1977: Fires: 5,865 / Deaths / 1,000: 8.1
- 2009: Fires: 2,565 / Deaths / 1,000: 7.1
- Variance in Deaths, Per 1,000 Over 1977-2009

High Approx 10
Low Approx 6.5

Source: NFPA Fire Loss 2009

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For Every One Residential Fire Death Approximately Five People Are Injured

- Many Injured Are Maimed/Scarred, Have Permanent Respiratory Damage, Etc
- Injuries In Apartment Fires Are Higher – Roughly Nine to Ten Injuries Per Death

Source: NFPA Fire Loss 2009

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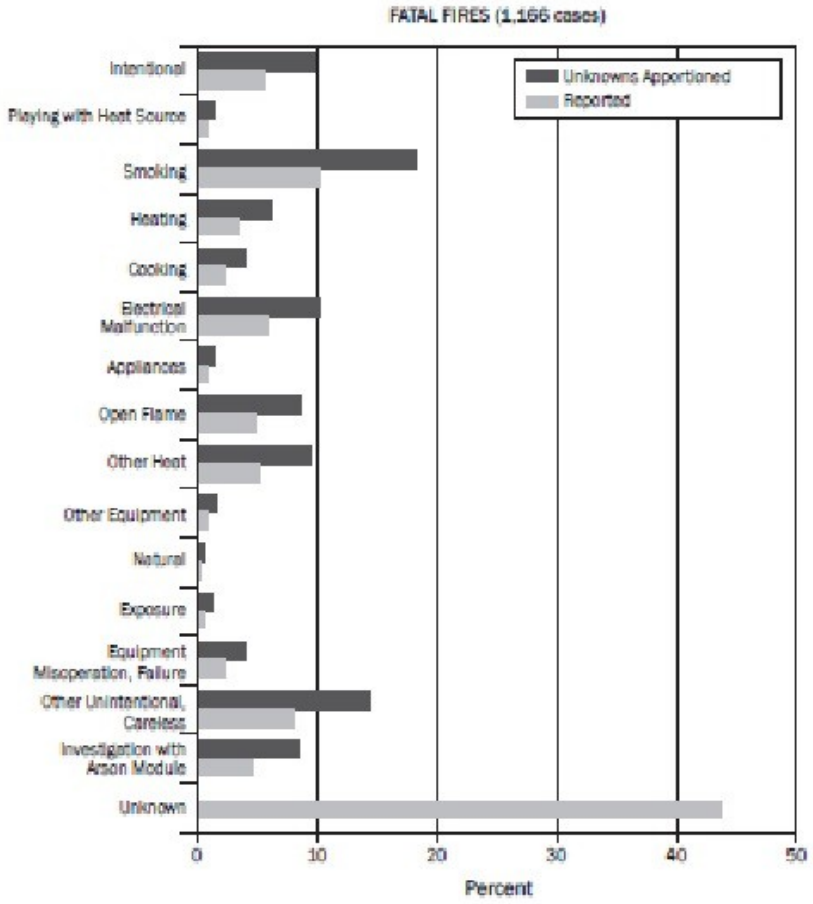
***Fatal** Fires By Source/Type from NFPA 2007 Fire Loss Study*



Cause	Reported	Unknowns Apportioned
Intentional	5.6	9.9
Playing with Heat Source	0.9	1.5
Smoking	10.3	18.2
Heating	3.5	6.2
Cooking	2.2	4.0
Electrical Malfunction	5.8	10.3
Appliances	0.8	1.4
Open Flame	4.9	8.7
Other Heat	5.3	9.4
Other Equipment	0.9	1.7
Natural	0.3	0.6
Exposure	0.7	1.2
Equipment Misoperation, Failure	2.3	4.1
Other Unintentional, Careless	8.1	14.4
Investigation with Arson Module	4.7	8.4
Unknown	43.6	0.0

Note: Dark Bar Is Unknown Fire Type - 43% Is Reapportioned to Know Types

Cooking/Open Flame Fires Estimated At 12.7%

Smoking Estimated at 18.2%

Heating & Other Heat includes Space Heaters At 15.6 %

Other Careless At 14.4%

Source: NFPA Fire Loss Study

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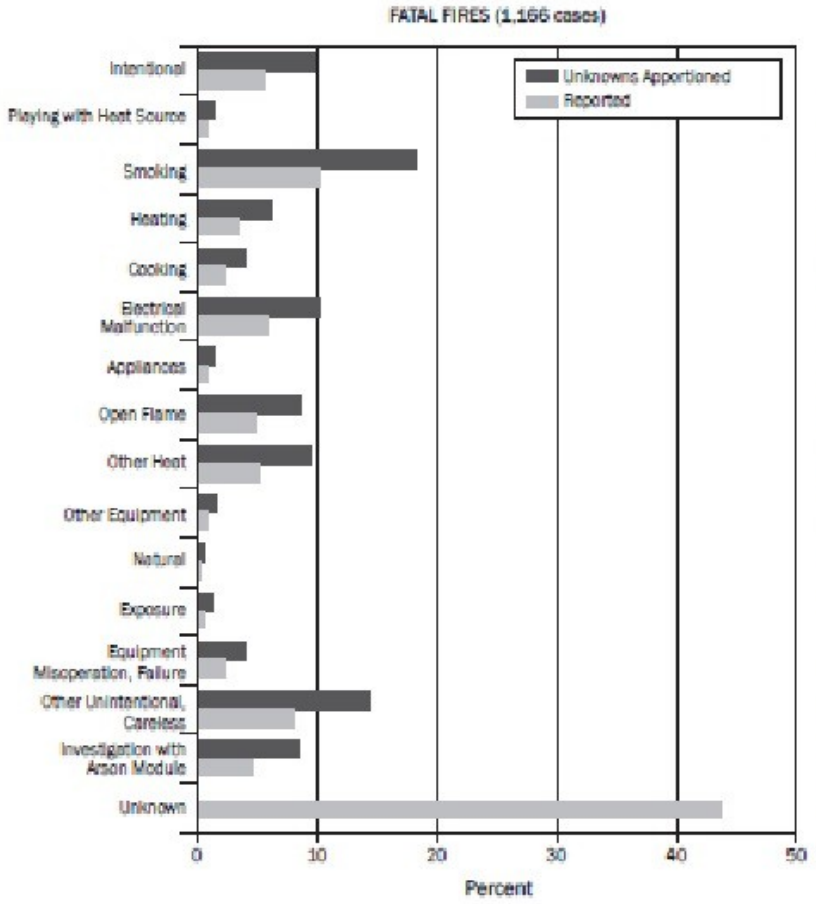
*Fire **Injuries** By Source/Type from NFPA 2007 Fire Loss Study*



Cause	Reported	Unknowns Apportioned
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Investigation with Arson Module	4.7	8.4
Unknown	43.6	0.0

Note: Dark Bar Is Unknown Fire Type 43% Is Reapportioned to Know Types

Cooking/Open Flame Fires Estimated At 36.5%

Smoking Estimated at 7%

Heating & Other Heat includes Space Heaters At 11.9 %

Other Careless At 11.3%

Source: NFPA Fire Loss Study

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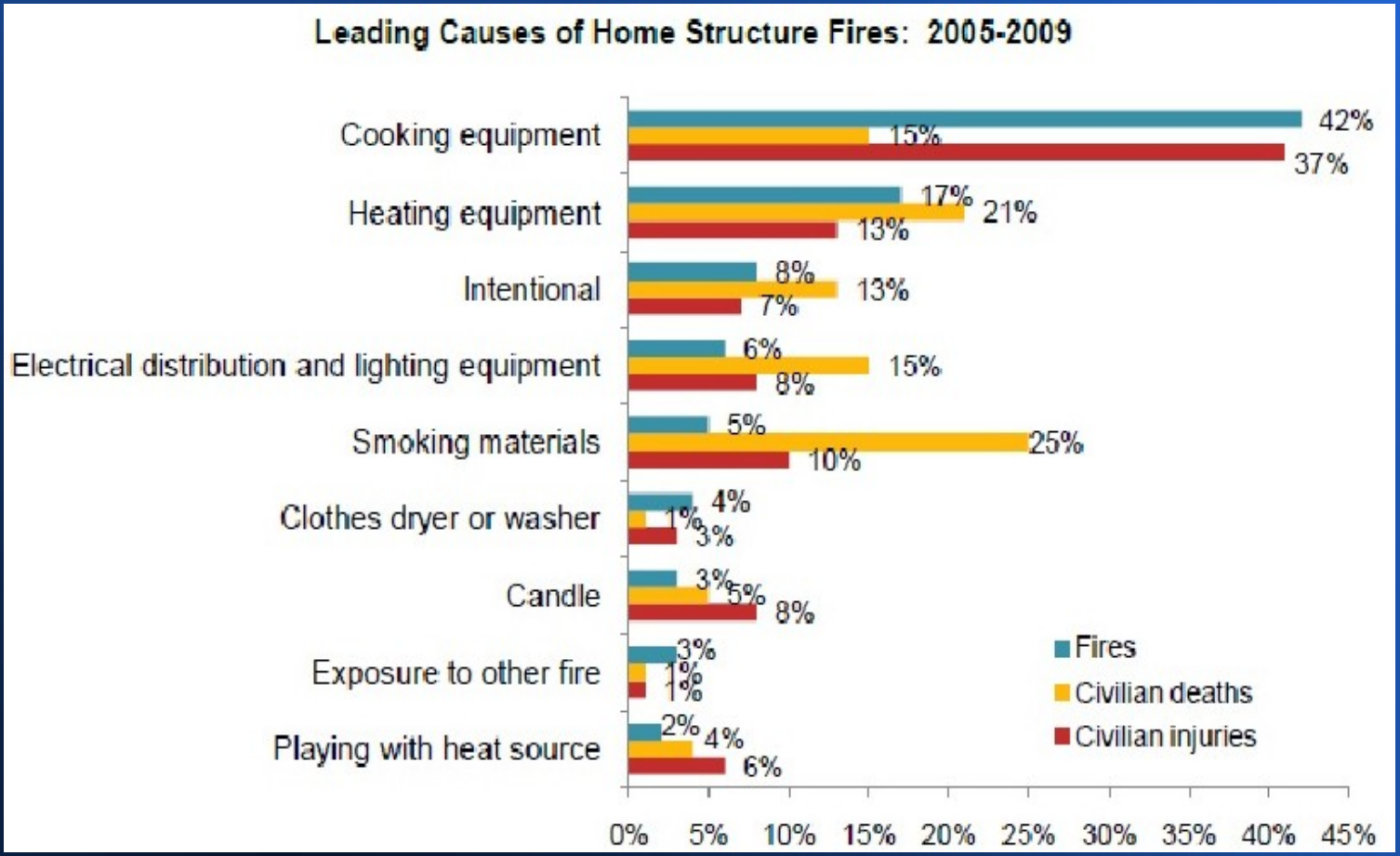

Cooking/Open Flame Fires Estimated At 42% of Fires/15% of Deaths/37% of Injury

Smoking Estimated at 5% of Fires/25% of Deaths/10% of Injuries

Heating & Other Heat includes Space Heaters At 12% of Fires/21% of Deaths/13% of Injuries

Electrical 6% of Fires/15% of Deaths/6% of Injuries

Source: NFPA Home Structure Fires 2011

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- Cooking Fires Generally Open Flame/Fast Flame Fires
- Account For Largest Portion of Injuries but a Smaller Portion of Deaths
- Injured Person Is Generally “Intimate” With Fire
  - Intimate = Present
- Injuries Related to Suppressing Fire or Grease Etc
- Some Argue That Smoke Alarms Offer No Protection Since You Don't Need It To Tell You That Your Stove Is On Fire If You Are Cooking

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- Smoking/Heater/Electrical Related Fires = Smoldering Fires
- Accounts For Largest Portion of Deaths and Smaller Portion of Injuries
- Injured Person Is Generally Unaware of Fire
- Injuries Related to Slow Exit, Smoke Inhalation, Return/Heroics, Etc

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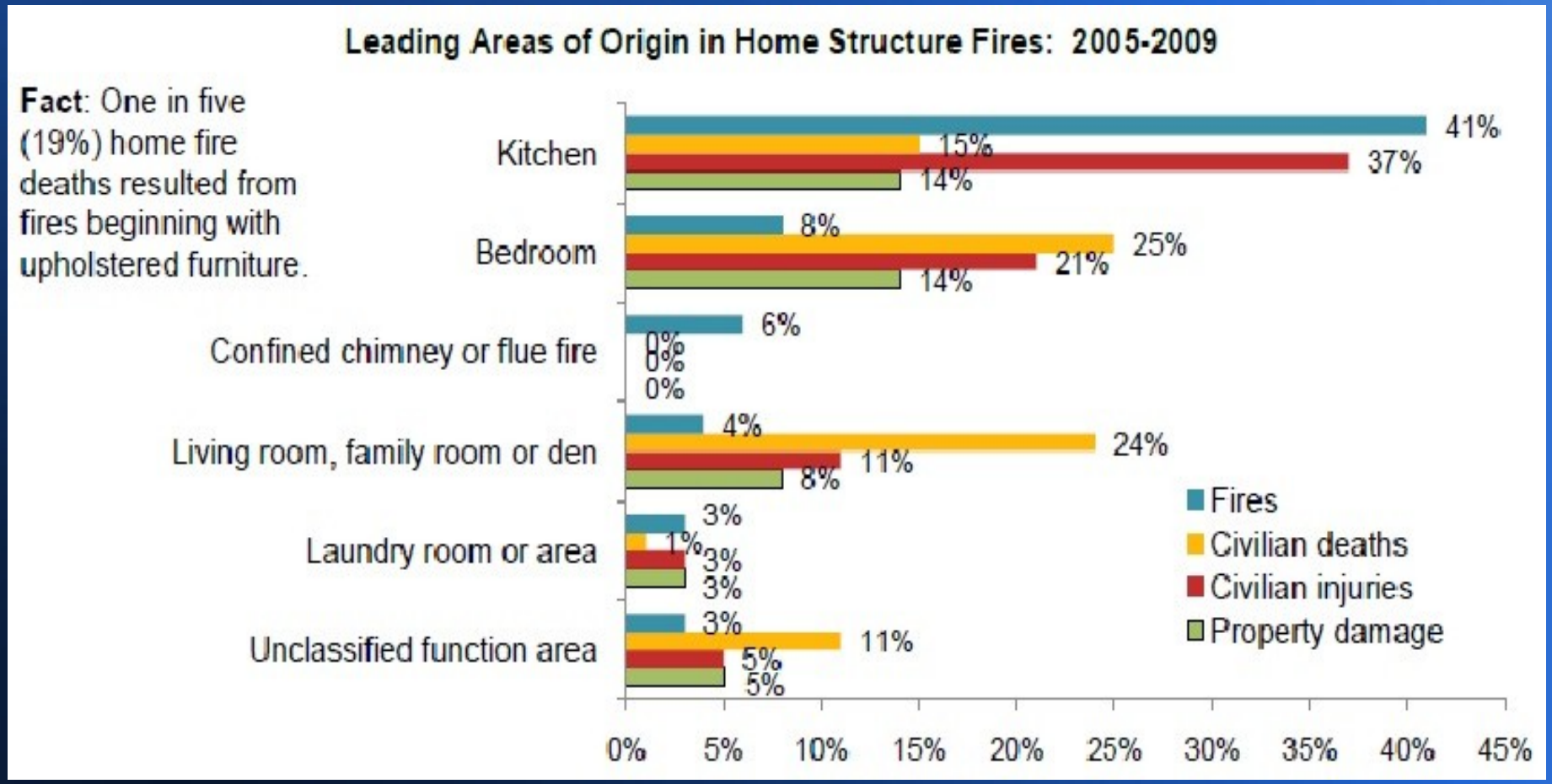

Source: NFPA Home Structure Fires 2011

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- Kitchen Fires Account For:
  - 41% of Fires
  - 15% of Deaths
  - 37% of Injuries

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- Living Room/Family Room/Den/Bedroom Fires Account For:
  - 12% of Fires
  - 49% of Deaths
  - 32% of Injuries

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Roughly 1 Out of Every 5 Deadly Fires Started in Upholstered Furniture

These Are Almost ALL Smoldering Fires

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Other Deadly Fire Criteria

- Smoking is Leading Fatal Fire Cause
- Time of Day Matters
- Age Plays a Strong Role
- Location – Death Rates Vary By State

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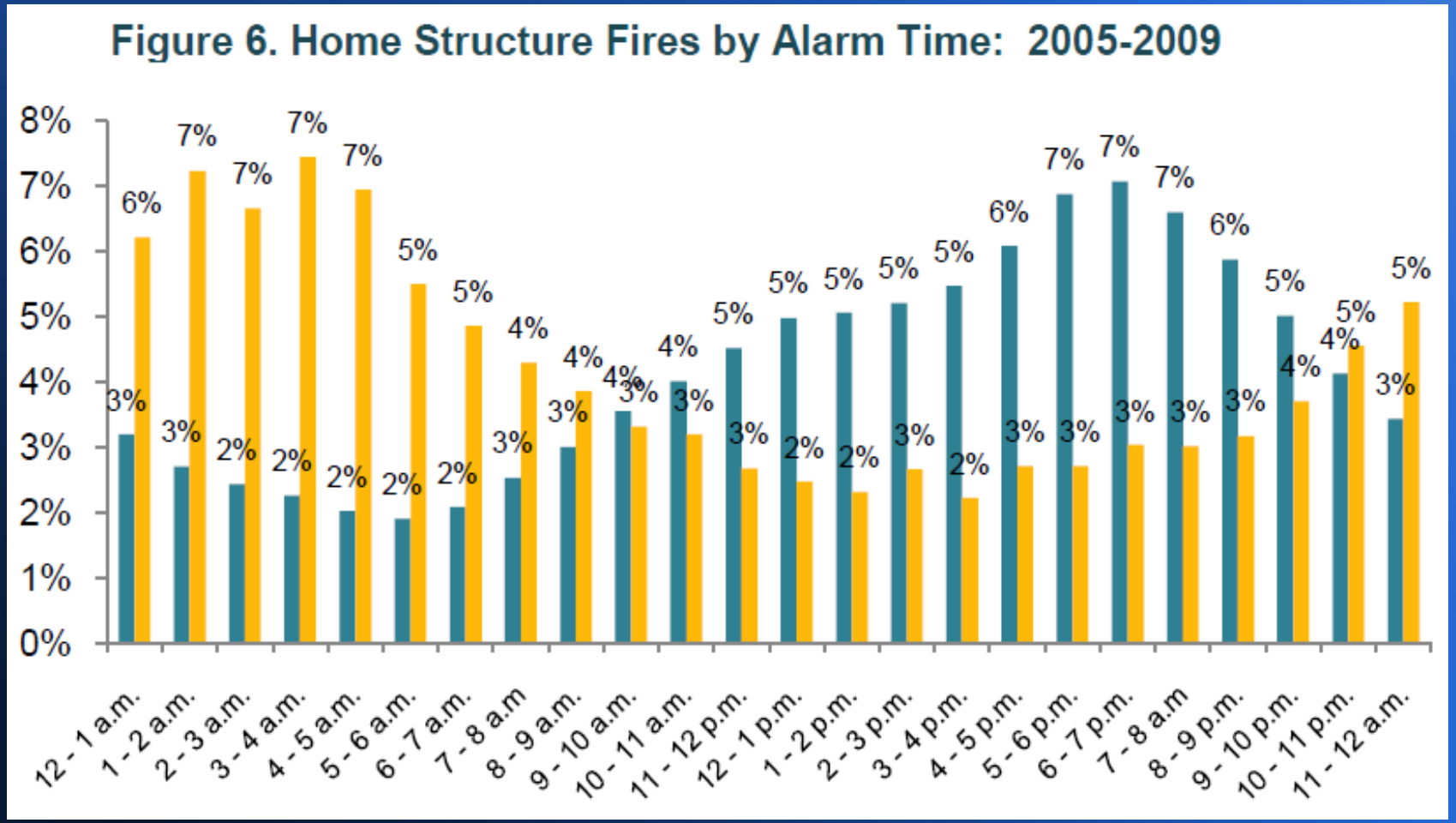

Source: NFPA Home Structure Fires 2011

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Time of Day Matters

- 37% of Fires Occur Between 8 PM & 8 AM
- 66% of Fire Deaths Occur Between 8 PM & 8 AM

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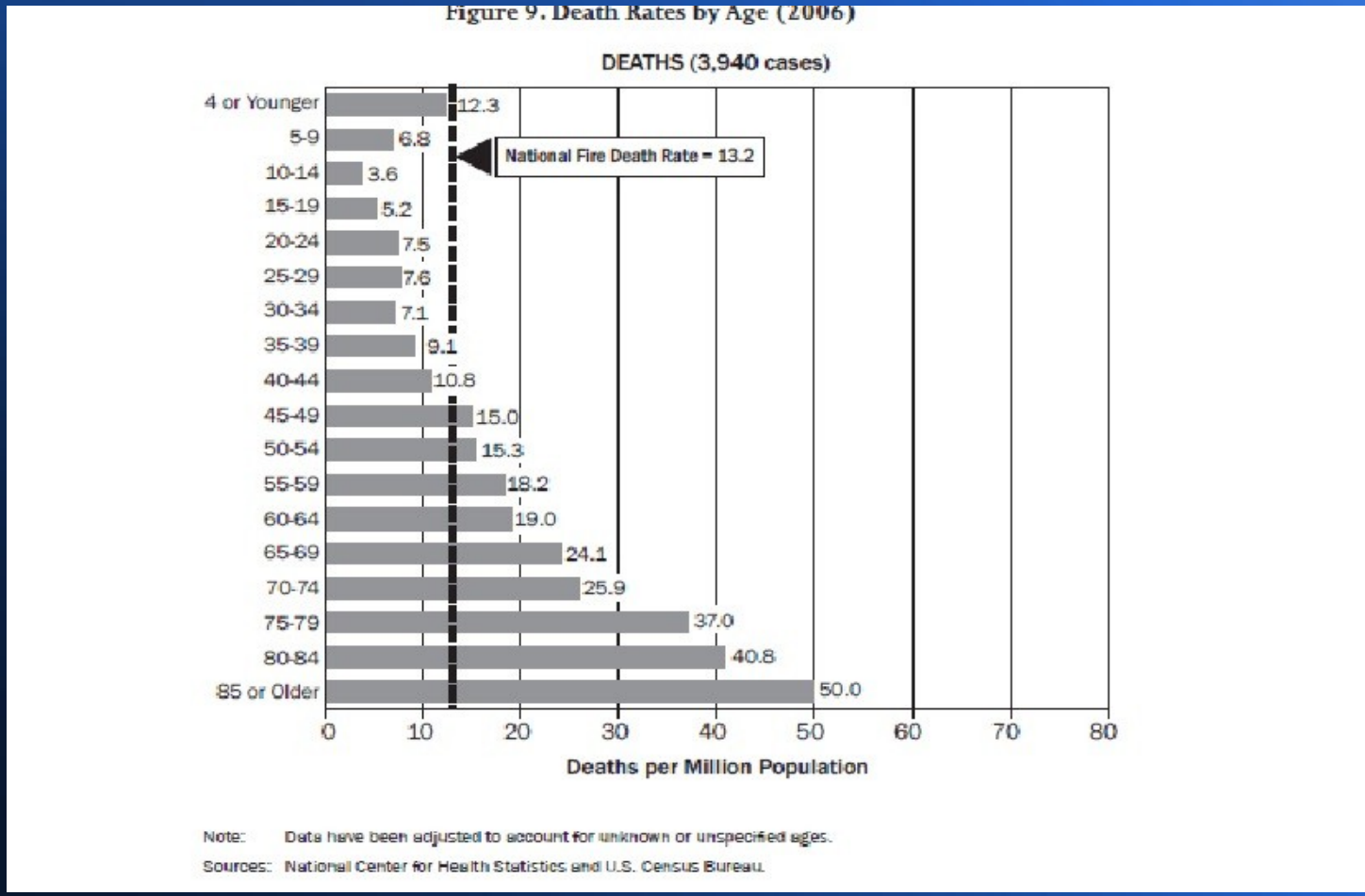

Source: NCHS/US Census Bureau

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Age Impacts Survival Rate

- National Average Death Rate = 13.2/Million
- Children 4 or Younger at Risk = 12.3/Million
  - That Is 2x-3x The Rate for 5-14 Years Old
- "Older" Folks = 65+ Highest Risk
  - 85+ Highest Risk = 50/Million

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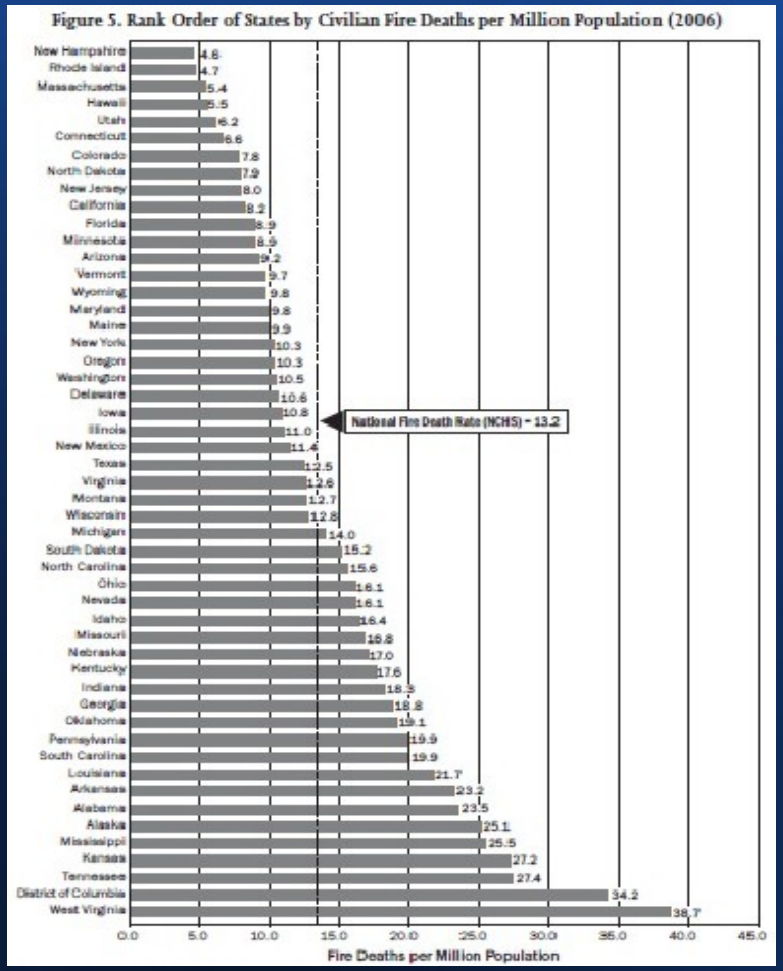

New Hampshire = 4.6 Fire Deaths Per Million
Rhode Island = 4.7 Fire Deaths Per Million

California = 8.2
Minnesota = 8.9

Illinois = 11.0

Wisconsin = 12.8

National Average = 13.2 Per NCHS

Beware:
District of Columbia = 34.2
West Virginia = 38.7

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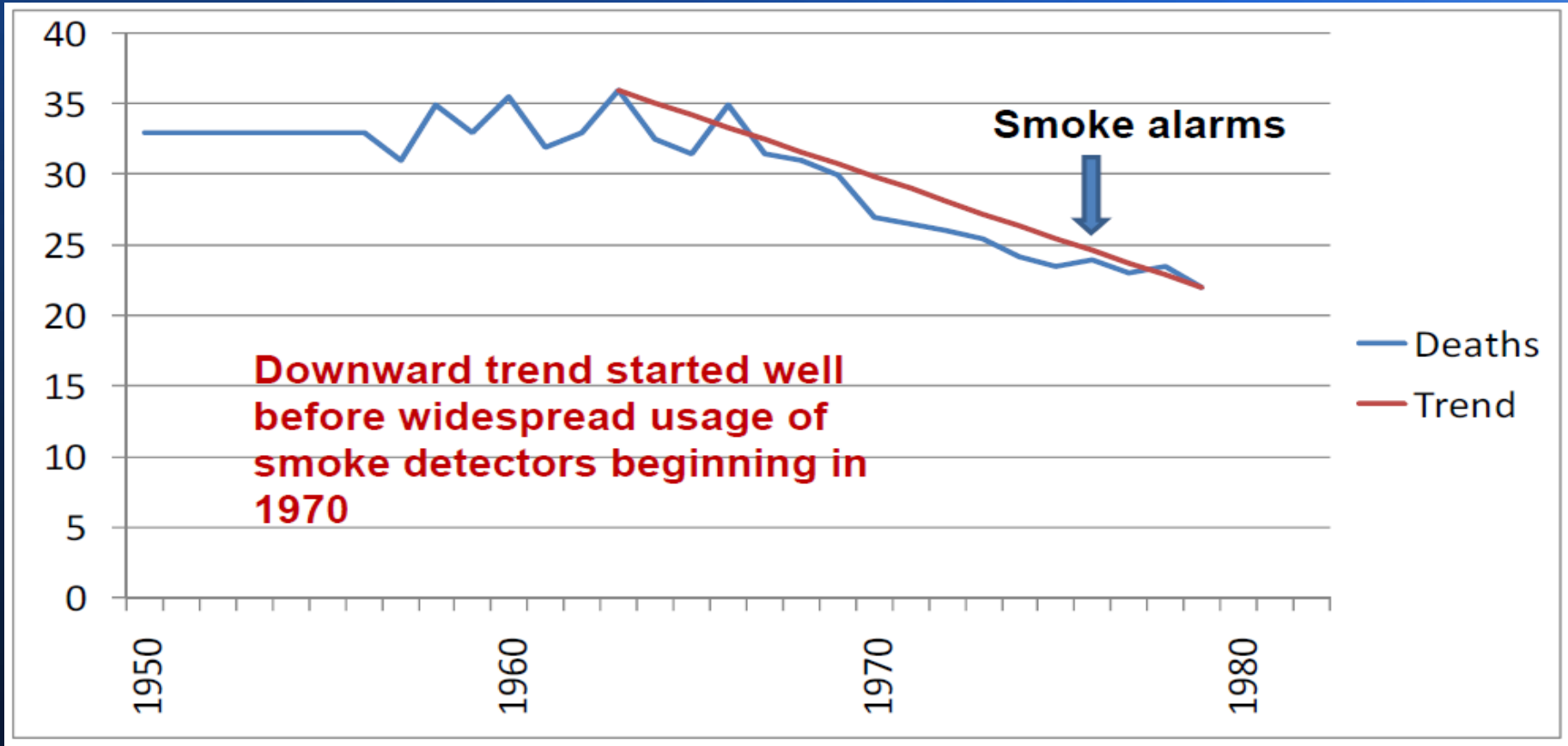
Fire Deaths Per Million Population 1950-1980



Source: National Safety Council

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The Bottom Line:

There Are Fewer Fire Deaths

Because There Are Fewer Fires.....

There Are *Many* Reasons For The Decline

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Factors Contributing to Reduction in Residential Fires:

- Significant reduction in people who smoke
- Fire retardants have been added to mattresses and furniture
- Building codes and inspections have improved
- Improvements in electrical wiring and fire related construction
- Home-heating deaths have decreased by over 70%
- Dramatic increase in full spectrum burn centers
- Firefighters Use of SCBA

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Significant Reduction in People That Smoke:

Smoking Population 1970 : 37.4%*

Versus

Smoking Population 2010: 19.3%*

Decrease of 48.4%

Sources: ** US Center for Disease Control* ***(CDC)***

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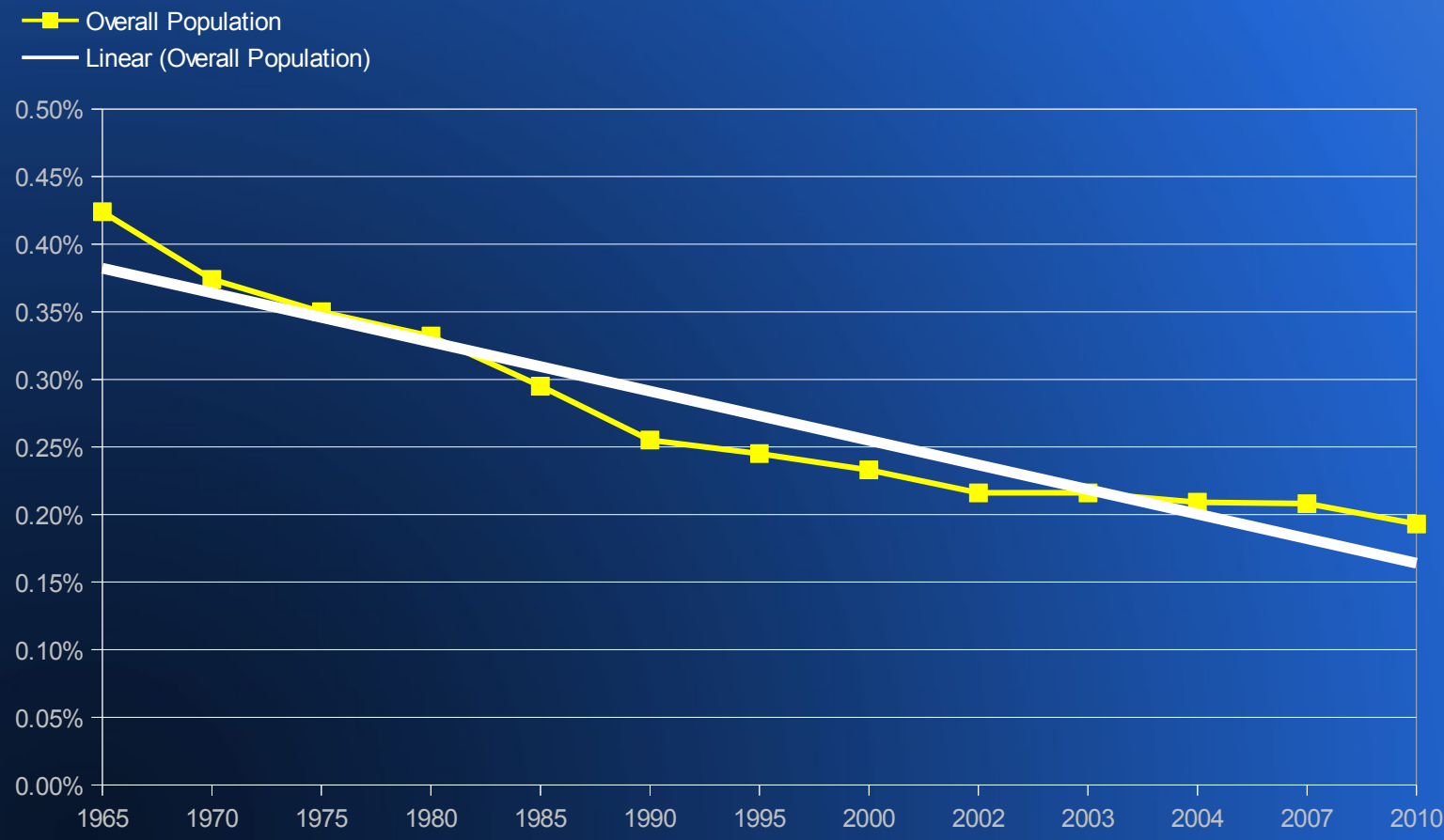
Estimated Smokers In US – Overall Population



Source: US Center for Disease Control

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Fires Involving People That Smoke:

Smoking Related Fire Victims Are 3x More Likely to Be Intimate with Fire

- Proximity to Fire Means Less Likely to Be Saved By Smoke Alarms, Etc
- Most Smoking Fires and 2/3's of Deaths Involve Trash, Mattresses, Bedding, Upholstered Furniture
- In Smoking Fires – 25% of Victims Were Not The Smoker
- 34% of Other Victims Were Children
- 25% Were Neighbors (From Adjacent Units) or Friends
- 14% Were Spouses

Sources: US Fire Administration "Behavioral Mitigation of Smoking Related Fires" FA-302 Feb 2006

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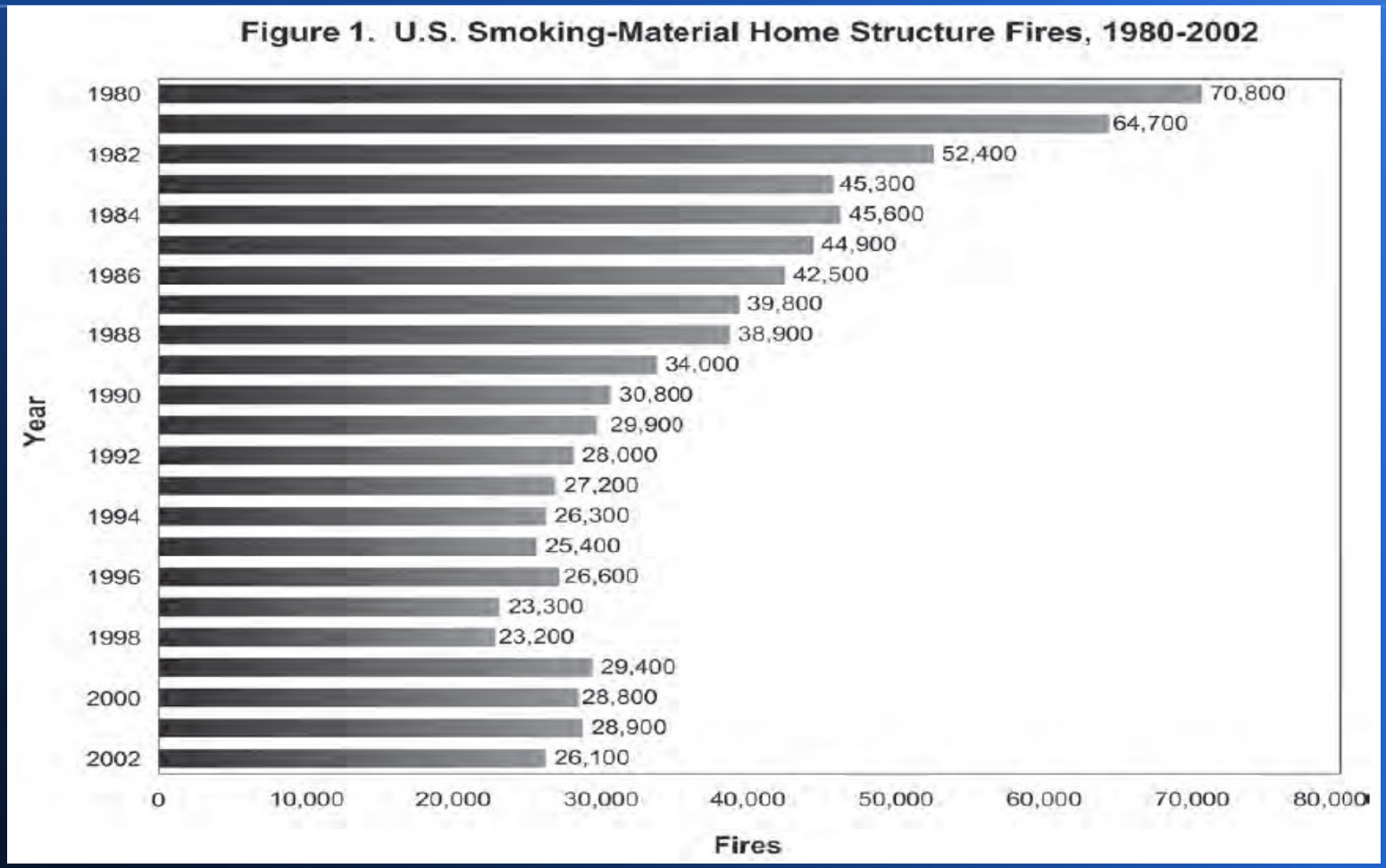

Sources: US Fire Administration "Behavioral Mitigation of Smoking Related Fires" FA-302 Feb 2006

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Fire Retardants Added to Mattresses, Furniture. Etc:

Long-Term Impact Fire Retardants Seen in Rising Number of Fires Beginning with Ignition Other than Upholstered Furniture, Mattresses, or Bedding

Fatal Smoking Fires NOT Starting in Upholstered Furniture, Mattresses, or Bedding:

- 15% of Total in 1980
- 20% of Total in 1990
- 29% of Total in 2000

Sources: US Fire Administration "Behavioral Mitigation of Smoking Related Fires" FA-302 Feb 2006

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Improved Building Codes and Inspections:

- Additional Requirements for Fire-Blocking, Draft-Stopping
- Separation Requirements Between Heavy Fire Load Areas and Living Spaces
- Generally More Sophisticated Inspectors

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Improvements in Electrical Wiring & Fire Related Construction:

- 90% of Electrical Fires Occur in Homes That Are 10 Years Old or Older (NFPA 73)
- Better Understanding of Fire Progression

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Home-heating deaths have decreased by over 70%:

- Safer Gas and Electric Heat Appliances
- Safety Devices on Portable Electric Heaters, etc

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Dramatic Increase in Full Spectrum Burn Centers:

1975: 12 Full Spectrum Burn Care Units in US

1999: 100 Burn Care Units with 25 Full Spectrum Burn Care Units

"On a yearly basis, deaths, once the victim has been placed into the burn care system, have decreased from around 4,000 to 1,000"

Source: FEMA: America Burning: Recommissioned, May 2000

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Firefighters Use of SCBA:

"It has been my personal experience that Fire Fighters SCBA has made a significant contribution to victims survival rate."

**SCBA = Self Contained Breathing Apparatus*

Source: Photoelectric & Ionization Smoke Alarms Re-Visited
Jay Fleming, Deputy Fire Chief, Boston MA, Dec 2010

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Let's Look At Smoke Alarms

Skip Walker, MCI, ACI

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Brief History of Smoke Alarms:*

1929: Walter Kidde Obtains First UL Listing for Shipboard Smoke Detector

1955: First Fire Alarms – Uses Heat Cue

1960's-1970's: Studies Determine That Smoke Sensors More Effective Than Heat

1965: First Single-Station Smoke Alarm – 120 VAC Photoelectric

1967: NFPA Founded

1970: First 9 Volt Powered Single Station Alarm Invented – Ionization Type

Mid-1970's: Smoke Alarm Sales Accelerate

1976: NFPA 101 – Life Safety Code Requires Smoke Alarms in Single Family Homes

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Brief History of Smoke Alarms:*

1973-1979: Model Codes Require Smoke Alarms in 1 & 2 Unit Dwellings

Mid-1970's: FHA/VA Require Smoke Alarms to Qualify for Funding

1976: UL 217 Smoke Alarm Test Developed

1977: Indiana Dunes Smoke Alarm Tests Conducted

1978: NFPA 74 Requires Every Level Coverage

1980: Half of US Homes Have at Least One Smoke Alarm

1982: Two-Thirds of US Homes Have at Least One Smoke Alarm

1984: Three-Quarters of US Homes Have at Least One Smoke Alarm

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Brief History of Smoke Alarms:*

1984: Model Codes Require One Alarm Per Level

1985: UL 217 Sensitivity Level Lowered to Reduce Nuisance Tripping

1988: Model Codes Begin Requiring Smoke Alarms in Bedrooms and Interconnected in New Construction

1989: NFPA 74 Requires Smoke Alarms to Be Interconnected in New Construction

1993: NFPA 72 Requires Smoke Alarms in Bedrooms in New Construction

1995: 10 Year Lithium Battery Smoke Alarm Introduced

1999: NFPA 72 Requires Replacement of Smoke Alarms After 10 Years

2009: Homes with at Least One Smoke Alarm - Approximately 95%

**Primary Source: White Paper, Private/Public Fire Safety Council, April 2006*

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Smoke Alarms/Detectors in Residential Construction

Smoke Detector:

Sensor Only, Connected to a Central System with Separate Annunciator/Horn

Smoke Alarm:

Single Station, Sensor and Annunciator/Horn in Single Package

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Smoke Alarms/Detectors in Residential Construction

In Residential Construction, The Two Smoke Alarm Sensor Technology Types Most Commonly Found Are:

Ionization

Photoelectric

Skip Walker, MCI, ACI

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Ionization Alarms:

Most Prevalent Alarm Sensor Type in US Market

Approximately 95% of Single Station Alarm Installations

Uses a Small Amount of Radioactive Material to Charge Air, Particles in Air Disrupt Current Flow and Set Off Alarm

Detects Small Particle Sizes Well, .3 Micron and Less

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Ionization Alarms:

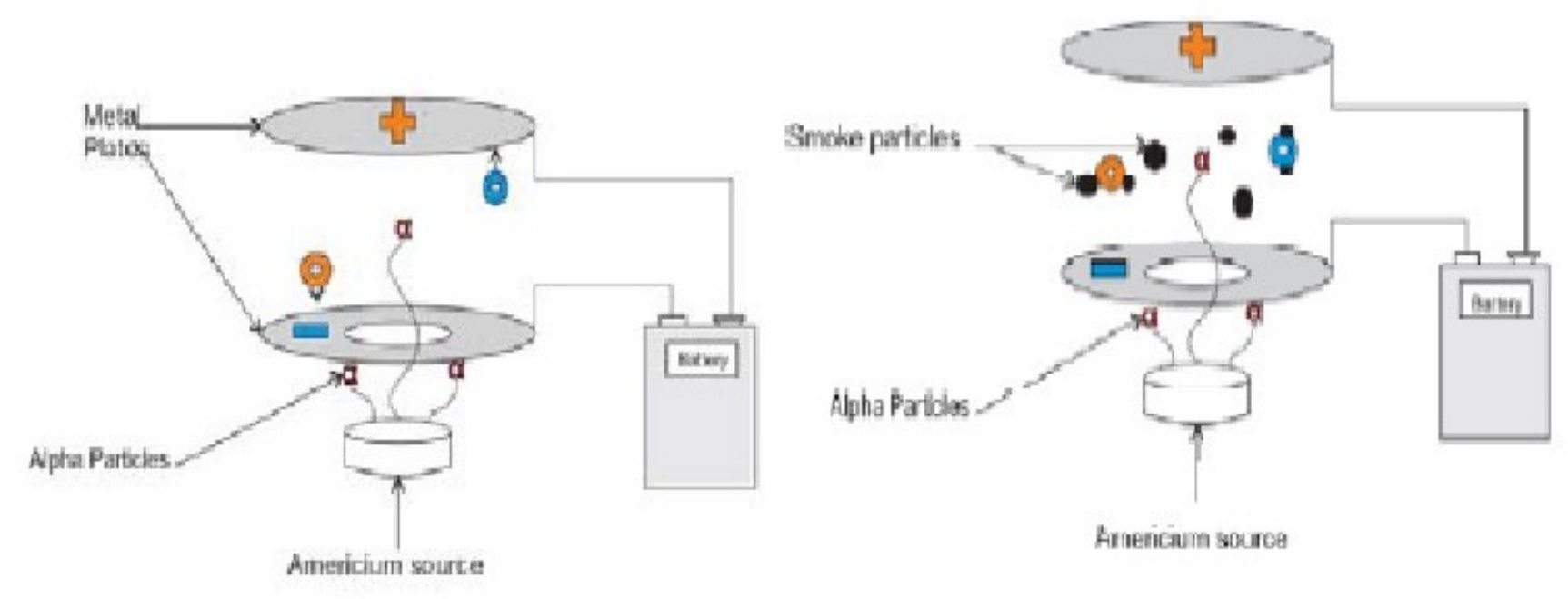


Figure 1. Ionization Chamber

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Photoelectric Smoke Alarms:

In US Market, Low Market Share

Approximately 5% (Estimate) of Single Station Alarms

Uses an LED Light Source and Sensor

Smoke Particles in Air Scatter Light onto Sensor and Set Off Alarm

Detects Larger Particles Best, .5 Micron and Up

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Photoelectric Smoke Alarms:

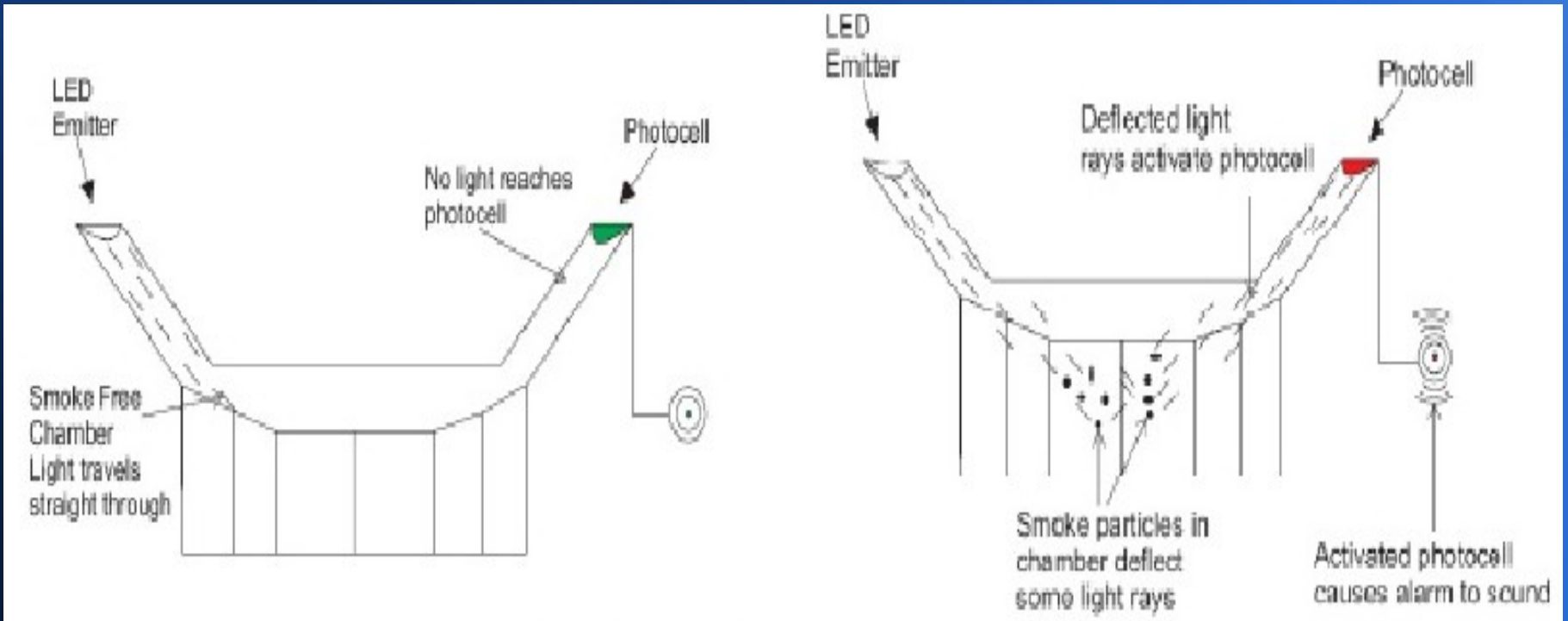


Figure 2. Photoelectric Chamber

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Differences Between Alarm Sensor Types:

Ionization:

Detects Small, Fast Moving Particles Best

Poor at Detecting Large, Slow Moving Particles

Color and Density – Relatively Insensitive

Nuisance Tripping: High

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Differences Between Alarm Sensor Types:

Photoelectric:

Detects Medium/Large Particles Best

Less Sensitive to Small Fast Moving Particles

Color and Density – Insensitive to Colorless, Low Sensitivity to Black Particles, Detects Smoke Density Well

Nuisance Tripping: Low

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Fire Types:

Fast Flame Fires:

Flames Visible, Short Duration

Found in Cooking Fires, Accelerant Based Fires, Last Stage Smoldering Fires

Generates Small Fast Moving Particles

Alarm Test Used: UL 217

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Fire Types:

Smoldering Fires:

No Flames Visible, Long Duration

Found in Smoking Fires, Electrical Fires, Heating Fires, Upholstered Furniture

Generates Medium/Large Slow Moving Particles

Alarm Test Used: UL 268

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Tenability Criteria:

Tenability, An Estimate of When the Environment Becomes Too Hazardous to Safely Allow Egress

NIST Smoke Alarm Tests Used the Following Criteria for Tenability:

Temperature: Greater Than 88° C/190° F

CO Gas Concentration: Range: .02%-.03%

Smoke Obscuration: O.D.* Less Than/Equal to .25/M

**O.D. = Optical Density*

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Some Terms/Acronyms Used in Test Results:

ASET = Available Safe Egress Time

RSET = Required Safe Egress Time

Untenable = Condition Will Not Support Life Without Special Equipment

Flashover = Simultaneous Ignition of Combustible Materials In an Enclosed Area

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Now Let's Take Look at A Number of NIST/NFPA/UL/University/Canadian/UK/Norwegian Tests and Results Comparing the Performance of Ionization and Photoelectric Alarms Under Various Fire Conditions

<u>This is Where the Rubber Hits the Road.....</u>

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

20+ Studies/Tests/Articles over a 30 year period

All Published and Available for Review

Reputable Sources

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Important Facts to Keep in Mind:

Cooking/Fast Flame Fires Account for:

42% of Fires, **37%** of Injuries and **15% of Deaths**

Smoldering Fires Account for:

23% of Fires, 29% of Injuries and **61% of Deaths**

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Important Facts to Keep in Mind:

Nearly Two-Thirds of All Residential Fatalities Occur In Homes With Either No Alarm or Non-Functional Alarms

US Homes with No Smoke Alarm Installed – About 4%

That Means That 96% of No Functional Alarm Fire Deaths Occur in Homes with Smoke Alarms That Are Not Functional

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

<u>Important Facts to Keep in Mind:</u>

<u>UL 217 Flaming Test:</u>

Alarm Must Trigger at .5%-4.0%/ft O.D.

Alarm Must Trigger Within 240 sec

Induced Air Flow Across Alarm at 32/fpm – 1.6M/s

<u>UL 268 Non-Flaming Test:</u>

Alarm Must Trigger at .5%-10.0%/ft O.D.

Note: O.D. = Optical Density

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency:	***LA Fire Department***
Year:	*1960*
Used Synthetic Material:	*No*
Duration of Smoldering Test:	*N/A*

Comments: Test comparing Heat Detectors to Older Photoelectric Technology

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency: ***National Research Council of Canada***

Year: *1963*

Used Synthetic Material: *N/A*

Duration of Smoldering Test: *N/A*

Comments: Study with no testing. Used judgment to estimate potential effectiveness of detectors

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency:	***Bloomington Mn Fire Depart***
Year:	*1969*
Used Synthetic Material:	*No*
Duration of Smoldering Test:	*N/A*

Comments: Remote Smoke Detectors Better than Heat Detectors. Used Older Technology

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency:	***Japan Housing Corp***
Year:	*1974*
Used Synthetic Material:	*Unknown*
Duration of Smoldering Test:	*Unknown*

Comments: Smoke Detectors Better than Heat Detectors. Used New Photo Technology

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency:	***Factory Mutual Study (Heskestad)***
Year:	*1974*
Used Synthetic Material:	*Yes*
Duration of Smoldering Test:	*> 30 Mins*
Comments:	*Ion Good for Flaming/Bad for Smoldering* *Photo Good for Smoldering/Bad for Flaming*

Ion Flaws Inherent/Not Fixable

Photo Flaw Fixable by Correcting Smoke Entry Issues – Was Fixed in Early 80's

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency: ***Indiana Dunes Test***

Year: *1976*

Used Synthetic Material: *No*

Duration of Smoldering Test: *> 30 Mins*

Comments: *Smoke Detectors Better Than Heat Detectors, One Per Level Desirable*

Note: Dunes Test Was Actually Three Separate Tests

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency: *Massachusetts **Analysis of Dunes Test***

Year: *1976*

Used Synthetic Material: *N/A*

Duration of Smoldering Test: *N/A*

Comments: *Analysis of Dunes Data Only - A Detector Per Level Will Provide 3 Min Escape Time 89% of Time*

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency:	***Edmonton Fire Dept Test***
Year:	*1976*
Used Synthetic Material:	*Unknown*
Duration of Smoldering Test:	*> 60 Mins*

Comments: Both Ion and Photo improve life safety/survival rates

In smoldering fires, Ion's may go off too late

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency:	***Minneapolis Fire Dept Test***
Year:	*1978*
Used Synthetic Material:	*Yes*
Duration of Smoldering Test:	*< 10 Mins*

Comments: Both Ion and Photo's gave good early warning if smoke could reach detector

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency:	***Cal Chiefs/LA Fire Dept Test***
Year:	*1978*
Used Synthetic Material:	*Yes – Modern Furniture Used*
Duration of Smoldering Test:	*> 30 Mins*

Comments: Smoke Detectors More Reliable than Heat Detectors. NIST Concluded Both Adequate. LAFD & IAFC Favored Photo's Based on Results

Note: IAFC = International Association of Fire Chiefs

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency:	***UK Fire Res Station Test***
Year:	*1978*
Used Synthetic Material:	*Yes*
Duration of Smoldering Test:	*> 30 Mins*

Comments: Both Ion & Photo Smoke Detectors Respond Rapidly to Flaming Fires. Ion's Were Not Adequate in Smoldering Fires

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency: ***Australian Dept of Housing & Construction Test***

Year: *1979*

Used Synthetic Material: *Unknown*

Duration of Smoldering Test: *Flaming Fire*

Comments: *All Smoke Detectors Better than Heat Detectors in Flaming Fires*

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency: ***Australian Smoldering Test – Pub in Fire Tech Mag***

Year: *1986*

Used Synthetic Material: *Yes*

Duration of Smoldering Test: *< 10 Mins*

Comments: *Photo's Provide Adequate Escape Times in Most Fires. Ion's Generally Inadequate Escape Times*

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency:	***Norwegian Fire Research Lab Study***
Year:	*1993*
Used Synthetic Material:	*Yes*
Duration of Smoldering Test:	*> 30 Mins*

Comments: Reasons to Inadequate Ion's Are Inadequate for Smoldering Fires. Ion's Only 15-20 Sec Better Than Photo's in Flaming Fires. Advantage Only Beneficial in Extraordinary Circumstances

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency: ***Texas A&M Risk Analysis of Res Fire Detector Performance***

Year: *1995*

Used Synthetic Material: *N/A – Analysis of Prior Data*

Comments: Took Previous Major Studies plus Texas A&M 2 1/2 Year Fire Simulation Study. Built a Risk Model to Estimate Failure to Alarm Rates Based on Fire Incident Reports/Types and Smoke Alarm Types

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Texas A&M Risk Analysis of
Residential Fire Detector Performance

Final Texas A&M Report Conclusions:

Ionization Alarm Smoldering Failure Rates: 55.80%

Photoelectric Alarm Smoldering Failure Rates: 4.06%

Meaning Ionization Alarms Work About 45% of Time

While Photoelectric Alarms Work 96% of Time

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Texas A&M Risk Analysis of
Residential Fire Detector Performance

Final Texas A&M Report Conclusions:

Ionization Alarm Flaming Failure Rates: 19.80%

Photoelectric Alarm Flaming Failure Rates: 3.99%

Meaning Ionization Alarms Work About 80.2% of Time

While Photoelectric Alarms Work About 96% of Time

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency: ***UK Smoke Alarms in Typ Dwelling – Part I***

Year: *1997*

Used Synthetic Material: *Yes*

Duration of Smoldering Test: *> 30 Mins*

Comments: Ion's Cannot Be Guaranteed to Detect Smoldering Fires. Ion's Better Than Photo's in Flaming Fires. Advantage Could be Critical

Note: Fires Smoldered > 30 Mins

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency: ***UK Practical Comparison of Smoke Alarms – Part II***

Year: *1997*

Used Synthetic Material: *Yes*

Duration of Smoldering Test: *< 15 Mins*

Comments: Both Ion's and Photo' Adequate.

Note: Fires Smoldered < 15 Mins. There Was an Unexplained Change in Way Researchers Ignited Fires

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency:	***Simplex Study***
Year:	*2001*
Used Synthetic Material:	*UL 268 Test*
Duration of Smoldering Test:	*UL 268 Test*

Comments: Ion's Slightly Better in Flaming Fires. Photo's Provide Clear Advantage in Smoldering Fires.

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency:	***Kermano Fire Study***
Year:	*2003*
Used Synthetic Material:	*Yes*
Duration of Smoldering Test:	*< 15 Mins*

Comments: Combination Alarms Worked Best. Ion's Best for Flaming Fires. Photo's Best for Smoldering Fires. All Gave Adequate Evacuation Times.

Note: Alarms Used Were UL-Canada – ULC Standard Is Different than US Standard i.e. More Sensitive

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency:	***NIST Fire Study***
Year:	*2003*
Used Synthetic Material:	*Yes*
Duration of Smoldering Test:	*N/A – Variety of Scenarios*

Comments: "Both common residential smoke alarm technologies (ionization and photoelectric) provided positive escape times in most fire scenarios".

Note: Ion Alarms Provided a -43 sec and a +16 Escape Time in Two of the Deadliest Fire Scenarios. Positive Escape Time Does Not Equal Enough Time to Escape

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

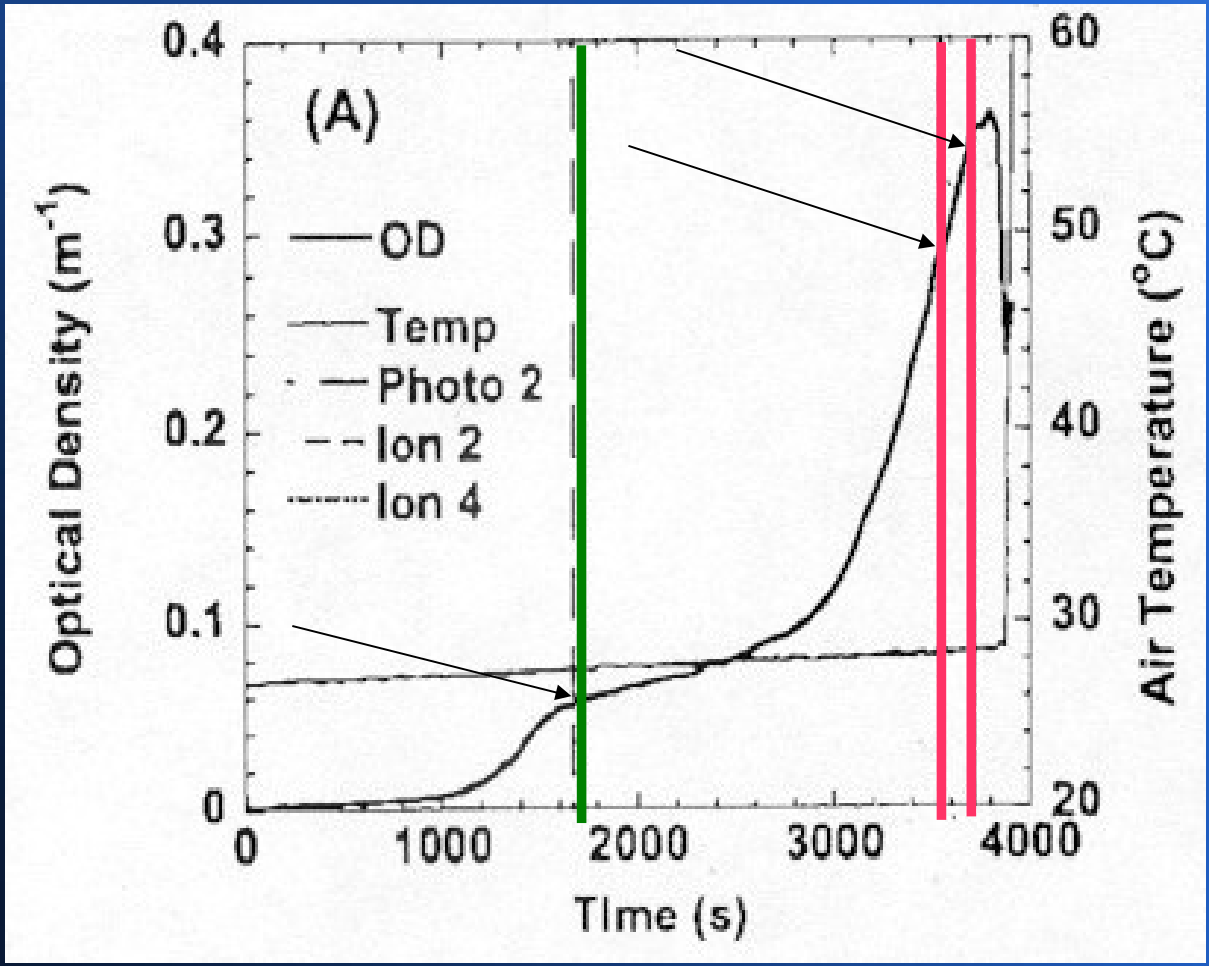
NIST 2003:

Fig 1: Test 34

Smoldering Fire

In Living Room

Note: This is one of the deadliest fire scenarios



Deadly Differences
Ionization vs Photoelectric Smoke Alarms

NIST 2003:

Data for Previous Slide – Note Ion Response Far Exceeds UL Required Upper Response Threshold of 10% O.D

TABLE 3 – RESPONSE CHARACTERISTICS (TEST 34)

DETECTOR TYPE	RESPONSE TIME	%OBSCURATION AT RESPONSE
Photoelectric	1600 secs	3-4% obsc/ft
Ionization	3550 secs	17-19% obsc/ft
Ionization	3700 secs	20-22% obsc/ft

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

NIST 2003:

TABLE 1 - AVAILABLE SAFE EGRESS TIME (PAGE 242)
(Manufactured Home)

	Photoelectric	Ionization
Flaming		
Living Room	85	142
Bedroom	58	93
Bedroom (Door Closed)	451	898
Smoldering		
Living Room	172	-43
Bedroom	1091	82
Cooking		
Kitchen	575	821

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

NIST 2003:

TABLE 2 - AVAILABLE SAFE EGRESS TIME (PAGE 243)
(Two-Story Home)

	Photoelectric	Ionization
Flaming		
Living Room	108	152
Living Room(Replicate)	134	172
Living Room(Fully Furnished)	144	172
Bedroom	---	374
Bedroom (Door Closed)	3416	3438
Smoldering		
Living Room	3298	16 ⟸
Living Room (Air Conditioned)	2772	-54 ⟸
Bedroom	135	135
Cooking		
Kitchen	952	278

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency: ***NIST Fire Study***

Year: *2008*

Used Synthetic Material: *Variety of Materials Flame/Smoldering*

Comments: All Alarms Responded in Flame Tests within Stds.

Wood Smolder Test: Photoelectric alarms reached thresholds earlier and at more locations than ionization alarms

Polyurethane Foam Smolder Test: The propensity was for photoelectric alarms to reach threshold values during smoldering, and all alarms to reach thresholds after transition to flaming.

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency: ***FEMA Smoke Alarm White Paper***

Year: *2006*

Used Synthetic Material: *N/A – Limited Field Test Only*

- *Comments: 24% of US Households Surveyed Had Either No Alarm or Non-Functional Alarm – Accounts for 2/3's of Fire Deaths*

  50% of Households with Non-Functional Alarms Cited Nuisance Trips as Reason for Disabling
  Also Looked at Age, Race, Income Levels vs Risk

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

UL Smoke Characterization Project:

Fire Protection Research Foundation/UL, April 2007

To Download a Copy:

http://ul.com/global/documents/corporate/newsroom/storyideas/smokecharacterizationstudy/SmokeStudyTechnicalReport.pdf

It is important to refer to Page 109, Table 25

This UL Study examines smoke characteristics for the materials used in the UL 217/268 tests plus various synthetic materials

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

UL Smoke Characterization Project:

The Study Collected Data on Smoke Characteristics such as:

Particle Size, Particle Color, Heat Generation, Gas Generation
Under UL Test Conditions

Table 25 Summarizes the Results of Residential Ionization and Photoelectric Alarm Response Times to the Materials Tested in Non-Flaming/Smoldering Conditions (UL 268)

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

UL Smoke Characterization Project:

Other Smoldering Fire Results:

Smoldering Ponderosa Pine, a UL 217 Test Material:

Photoelectric Alarms - 2.3% Faster (Basically the Same)

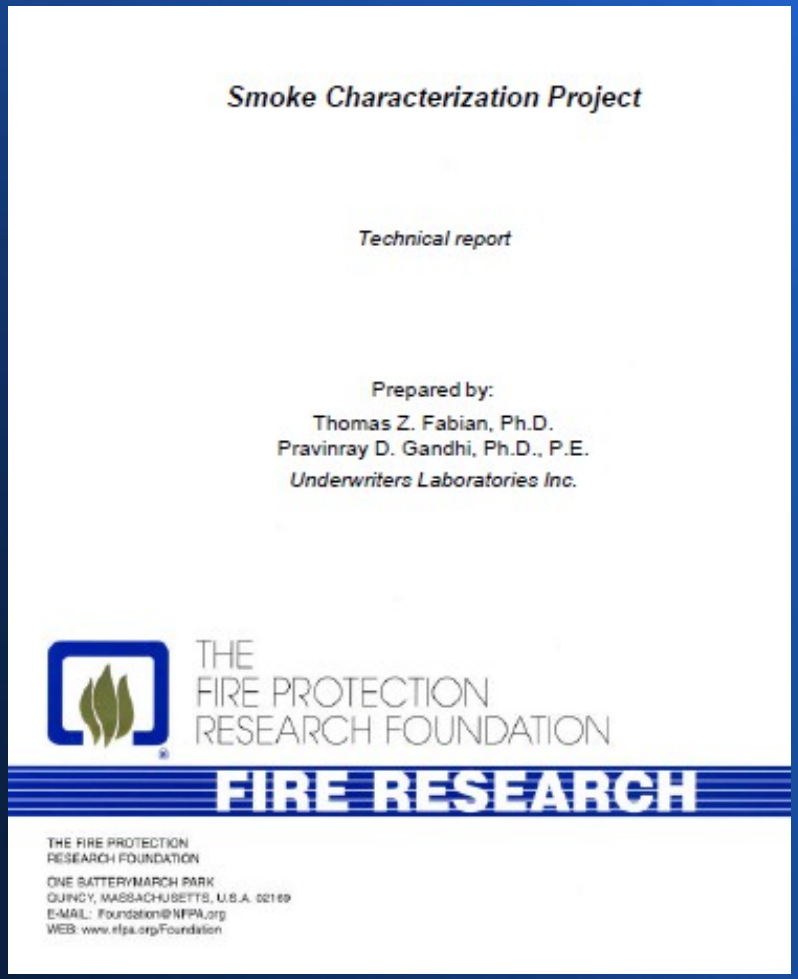
Ionization Alarms Did Not Respond in 1 of 4 UL Test Materials
A 25% No Alarm Rate

Bread/Toaster: Ionization Alarms 22% Faster Response

In ALL Other Smoldering Test Synthetic Material Scenarios:

NONE of the Ionization Alarms Triggered Within Test Parameters

Deadly Differences
Ionization vs Photoelectric Smoke Alarms



Smoke Characterization Project

Technical report

Prepared by:

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Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Smoke Alarm Response to Flaming Fires

In all but one flaming test the ionization alarm activated first. Both alarm types activated within the 4 minute time limit specified in UL 217 for the three UL 217 flaming test targets (Douglas fir, heptane/toluene mixture, and newspaper). ***In one of two flaming tests involving PU foam with cotton/poly fabric the photoelectric smoke alarm did not activate, however the ionization alarm did activate in both tests. In a flaming PU foam with cotton/poly fabric test using a smaller sample size neither alarm type activated.*** It should be noted that the maximum obscuration in these PU foam tests was less than for Douglas fir, heptane/toluene mixture, and newspaper test samples.

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Smoke Alarm Response to Non-Flaming Fires

The photoelectric alarm activated first in the non-flaming tests with the exception of the higher energy bread/toaster test in which the ion alarm activated first. The UL 217 smoldering Ponderosa pine test triggered both the ionization and photoelectric smoke alarms. ***For many of the other materials, the ionization smoke alarm did not trigger***. In each of these cases, the obscuration value was less than the 10 %/ft limit specified in UL 217. It was also found that there was settling of the smoke particles in the test room over time. Measurements from several non-flaming tests showed that the obscuration values at the ceiling dropped over time, and the maximum obscuration values were observed at the 2 feet measurement location below the **ceiling.**

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Table 25 – Non-flaming mode alarm response times

Target Sample Description	Test No.	Ion Alarm Trigger Time (s)	Analog Signal Value		Photo Alarm Trigger Time (s)	Analog Signal Value	
			MIC (pA)	Photo (mV)		MIC (pA)	Photo (mV)
UL 217 Ponderosa pine	12126	3244	63.9	71.1	3226	63.9	72.0
	12132	DNT	--	--	3318	73.4	76.4
	12143	3826	66.0	74.3	3805	68.2	75.0
	12184	3547	66.0	70.1	3451	71.6	75.9
	12185	2894	64.6	73.6	2722	72.3	79.1
Bread – 4 slices	12133	319	66.1	98.0	364	45.9	55.5
	12155	306	71.5	99.4	371	41.5	45.8
	01244	343	75.8	98.5	448	28.4	19.4
Polyisocyanurate insulation – 150 × 150 × 200 mm pieces	12271	DNT	--	--	DNT	--	--
Mattress PU foam – 150 × 150 × 50 mm foam	12192	DNT	--	--	DNT	--	--
	12193	DNT	--	--	DNT	--	--
Mattress PU foam – 100 × 125 × 100 mm foam with a 25 × 150 × 150 mm piece on two opposing sides	12202	DNT	--	--	3149	85.3	77.2
	12261	5610	63.2	58.5	3032	81.4	68.8
Mattress PU foam wrapped in CA TB 117 cotton sheet – 100 × 150 × 200 mm foam	01232	DNT	--	--	3530	83.2	77.5
Mattress PU foam wrapped in CA TB 117 cotton sheet – 125 × 125 × 300 mm foam	01241	DNT	--	--	4207	88.5	80.5
Mattress PU foam wrapped in polyester microfiber sheet – 125 × 125 × 300 mm foam	01233	DNT	--	--	5353	83.5	79.8
	01245	DNT	--	--	4128	90.2	73.6
Nylon carpet – 150 × 150 mm sample	12262	DNT	--	--	5727	84.4	84.3
Polystyrene pellets – 69.8 g	12272	DNT	--	--	5546	82.6	74.5

Note to Table 25:
DNT = Did not trigger

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

UL 217 Ponderosa pine	12126	3244	63.9	71.1	3226	63.9	72.0
	12132	DNT	--	--	3318	73.4	76.4
	12143	3826	66.0	74.3	3805	68.2	75.0
	12184	3547	66.0	70.1	3451	71.6	75.9
	12185	2894	64.6	73.6	2722	72.3	79.1
Bread – 4 slices	12133	319	66.1	98.0	364	45.9	55.5
	12155	306	71.5	99.4	371	41.5	45.8
	01244	343	75.8	98.5	448	28.4	19.4

Ion Did Not Respond In 1 Out Of 5 UL 217 Tests – 20% Failure Rate

<u>This Is The Test and Material They Are Required to Pass to Be Sold</u>

Ion Responded Average of 22% Faster to Burnt Toast

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Polyisocyanurate insulation – 150 × 150 × 200 mm pieces	12271	DNT	--	--	DNT	--	--
Mattress PU foam – 150 × 150 × 50 mm foam	12192	DNT	--	--	DNT	--	--
	12193	DNT	--	--	DNT	--	--

Neither Alarm Responded

Sample Size Too Small to Generate Enough Smoke

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Mattress PU foam – 100 × 125 × 100 mm foam with a 25 × 150 × 150 mm piece on two opposing sides	12202	DNT	--	--	3149	85.3	77.2
	12261	5610	63.2	58.5	3032	81.4	68.8
Mattress PU foam wrapped in CA TB 117 cotton sheet – 100 × 150 × 200 mm foam	01232	DNT	--	--	3530	83.2	77.5
Mattress PU foam wrapped in CA TB 117 cotton sheet – 125 × 125 × 300 mm foam	01241	DNT	--	--	4207	88.5	80.5
Mattress PU foam wrapped in polyester microfiber sheet – 125 × 125 × 300 mm foam	01233	DNT	--	--	5353	83.5	79.8
	01245	DNT	--	--	4128	90.2	73.6
Nylon carpet – 150 × 150 mm sample	12262	DNT	--	--	5727	84.4	84.3
Polystyrene pellets – 69.8 g	12272	DNT	--	--	5546	82.6	74.5

DNT = Did NOT Trigger **Ion's Did Not Trigger in 7 of 8 Tests**

Test 12261: Time = 5610 at 10% Obs / Tripped 43 Mins After Photo

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Mattress PU foam – 100 × 125 × 100 mm foam with a 25 × 150 × 150 mm piece on two opposing sides	12202	DNT	--	--	3149	85.3	77.2
	12261	5610	63.2	58.5	3032	81.4	68.8
Mattress PU foam wrapped in CA TB 117 cotton sheet – 100 × 150 × 200 mm foam	01232	DNT	--	--	3530	83.2	77.5
Mattress PU foam wrapped in CA TB 117 cotton sheet – 125 × 125 × 300 mm foam	01241	DNT	--	--	4207	88.5	80.5
Mattress PU foam wrapped in polyester microfiber sheet – 125 × 125 × 300 mm foam	01233	DNT	--	--	5353	83.5	79.8
	01245	DNT	--	--	4128	90.2	73.6
Nylon carpet – 150 × 150 mm sample	12262	DNT	--	--	5727	84.4	84.3
Polystyrene pellets – 69.8 g	12272	DNT	--	--	5546	82.6	74.5

DNT = Did NOT Trigger **Ion's Did Not Trigger in 7 of 8 Tests**

Test 12261: Time = 5610 at 10% Obs / Tripped 43 Mins After Photo

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Test/Study:

Agency:	***CPSC Nuisance Trip Study***
Year:	*2010*
Used Synthetic Material:	*N/A - Cooking in Real Homes*
Duration of Smoldering Test:	*N/A*

Comments: Limited Test – 9 Home Test
8 Homes for 30 Days
1 Home for 60 Days
Combination Ion/Photo Twice as Likely to Nuisance Trip at 5 Feet Than Either Ion/Photo Only

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Other Issues Impacting Safe Egress Times

Skip Walker, MCI, ACI

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

The Use of Modern Engineered Wood and Synthetic Materials Have Reduced Escape Times:

Engineered Wood Framing Burns to Structural Failure Significantly Faster

Than Dimensional Lumber

Source: Fire Engineering Magazine, Toomey, May 2008

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Figure 1. Collapse Time for Assemblies

Structural Element – Ceiling Finish	Type of Construction	Ceiling Materials	Floor/Roof Subfloor/Finish	Collapse Time (min:sec)
2 x 10 Joist Floor – Without Ceiling	Legacy	None	1 x 6 and Hardwood	18:45
2 x 10 Joist Floor – With Ceiling	Legacy	Gypsum Board	OSB and Carpet	44:45
2 x 10 Joist Floor – With Ceiling	Legacy	Lath and Plaster	1 x 6 and Hardwood	79:45
12-inch Wood I-Joist Floor – Without Ceiling	Modern Lightweight	None	OSB and Carpet	6:03
12-inch Wood I-Joist Floor – With Ceiling	Modern Lightweight	Gypsum Board	OSB and Carpet	26:45
14-inch Finger Joint Truss Floor – Without Ceiling	Modern Lightweight	None	OSB and Carpet	13:06
14-inch Finger Joint Truss Floor – With Ceiling	Modern Lightweight	Gypsum Board	OSB and Carpet	26:45
14-inch Metal Gusset Truss Floor w/ Cord Splices and Framed Stair Opening – Without Ceiling	Modern Lightweight	None	OSB and Carpet	13:20
14-inch Metal Gusset Truss Floor – With Ceiling	Modern Lightweight	Gypsum Board	OSB and Carpet	29:15
14-inch Metal Gusset Truss Floor w/ Cord Splices, Recessed Lights and Ducts With Ceiling	Modern Lightweight	Gypsum Board	OSB and Carpet	30:08
Metal Gusset Truss Roof – With Ceiling	Modern Lightweight	Gypsum Board	OSB and Shingles	13:06
2 x 6 Joist and Rafter Roof – With Ceiling	Legacy	Gypsum Board	1 x 6 and Shingles	40:00

Floor Collapse In as Little as 6 Minutes.

Engineered wood floor assemblies have the potential to collapse very quickly under well-ventilated fire conditions. When it comes to lightweight construction, there is no margin of safety. There is less wood to burn and, therefore, potentially less time to collapse.

Source: Structural Collapse: The Hidden Dangers of Residential Fires, Fire Engineering, May 2008

Dalton, Backstrom, and Kerber , UL & City of Chicago

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Floor Collapse In as Little as 6 Minutes.

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

The Use of Modern Engineered Wood and Synthetic Materials Have Reduced Escape Times:

The Time From Ignition to Flashover Has Fallen Significantly Due Primarily to Modern Synthetic and Composite Wood Materials

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

"Both rooms were ignited by placing a lit stick candle on the right side of the sofa. The fires were allowed to grow until flashover. The legacy room transitioned to flashover in 29 minutes and 30 seconds whereas the modern room transitioned in just 3 minutes and 30 seconds."

Source: Smoke Alarms and the Modern Residence Fire – UP May 2011

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

"The National Institute of Standards and Technology (NIST) compared escape times from house fires before and after the increase of synthetic materials in home furnishings. The study found that escape time in 1975 averaged 17 minutes. By 2003, that average had dropped to just three minutes."

Source: ICC Residential Fire Sprinkler Systems book

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Examples of Real Word Fires:

Hilton Hotel Fire, Houston 1982

Room Fire, Room Had Ion Alarm

First Alarm to Operate was a Photoelectric Alarm 4 Floors Above in a Corridor

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Examples of Real Word Fires:

Prudential Building Fire, Boston 1986

Fire on Floor 14 of 52

Alarms Were Ion's at Each Elevator Lobby

Most Alarms on Upper Floors Never Activated During 2 1/2 Hour Event – Even Though Smoke Reached Them Within 4 Minutes

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Examples of Real Word Fires:

Andrea Dennis, Kyle Raulin, Al Schlessman, Erin DeMarco, and Christine Wilson These five students died at Ohio State University on April 13, 2003

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Examples of Real Word Fires:

Julie Turnbull, Kate Welling & Steve Smith died in this house on April 10th, 2005 at Miami University

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Examples of Real Word Fires:

Between the Dennis, Ohio State and Turnbull Miami University there were an estimated 22 Smoke Alarms.

All Were Ionization Alarms. Most Were Believed Functional. Some Had Been Disabled.

Only A Few Sounded, But Went Off Too Late

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

June 12, 2008
Chairman Nancy Nord
US Consumer Product Safety Commission
4330 East-West Highway
Room 419
Bethesda, MD 20814

Dear Chairman Nord:

I am writing as a follow-up to a letter sent to the Consumer Product Safety Commission (CPSC) by Deputy Fire Chief Joseph Fleming of the Boston Fire Department on March 12, 2008 regarding the safety of smoke alarms. It is my understanding that there are multiple unresolved issues concerning ionization detectors' inability to detect smoke or sound an alarm. In fact, it is my understanding that the CPSC expressed serious concerns regarding ionization detectors as early as 1995. These concerns mirror those put forward by Chief Fleming, an outspoken advocate for removing ionization detectors from the marketplace. Yet, the CPSC still has not acted to remove the alarms from the market, nor has the CPSC warned consumers as to the potential drawbacks of ionized detectors.

The issues that appear to be the most prescient and that were addressed by Mr. Fleming in his letter to you, still remain unsettled. I ask that you address, the questions in Chief Fleming's letter in detail, and respond to the following concerns:

1. The National Institute for Standards and Technology (NIST) has found that, on average, a photoelectric detector is 30 minutes faster in detecting a smoldering fire than an ionized detector. The highest percentage of deaths caused by smoldering fires occurs while people are sleeping, when the operation of a smoke detector is critical. In fact, this percentage may be as high as 100 percent. Four years ago NIST reached the conclusion that ionization detectors sometimes fail to alarm in smoldering fires, even when visibility is significantly degraded by smoke.

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

2. While ionized detectors alarm sooner in "ultra-fast" flaming fires by an average of 50 seconds, those seconds appear to be negligible considering that most people are awake when flaming fires occur. In addition, in what appears to be the most common type of flaming fires (i.e. cooking fires) the photoelectric detector was providing more than enough time for an occupant to escape.

3. Several studies show that the ionization smoke detector is many times more likely to be disabled than photoelectric detectors.

4. The ionization smoke detector is being used by the vast majority of Americans. The ionization smoke alarms susceptibility to nuisance alarms (leading to disablement) and inadequate response to smoldering fires could be responsible for hundreds of needless deaths each year.

Recently, due to the efforts of Chief Fleming of the Boston Fire Department to educate the authorities to these facts, the states of Massachusetts and Vermont have taken steps to restrict the use of ionization smoke detectors in residential occupancies. In response to the available evidence that suggests the inherent danger of ionization detectors, I ask that you promptly investigate the issues raised by Chief Fleming, and that you respond to his letter of March 12, 2008.

Fire safety and the use of working fire alarms are vital to the protection of our children, seniors, adults and families around the United States. I strongly urge you to provide a timely response to the above concerns and to consider the potential loss of life should it become clear that a large percentage of Americans are using inadequate smoke detectors.

I appreciate your attention to this matter. Please feel free to contact me if you have any questions.

Sincerely,

John F. Kerry

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Adrian Butler is a Former Fire Fighter
He Started a Smoke Alarm Manufacturing Company
Adrian Noticed That He Was Receiving a Number of Complaints About His Alarms Not Going Off in Fires...
So He Started Digging

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Adrian Butler is a Former Fire Fighter
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Deadly Differences
Ionization vs Photoelectric Smoke Alarms

What He Found Made Him Get Out of the Smoke Alarm Business

and

Co-Found the World Fire Safety Foundation

Skip Walker, MCI, ACI

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Now... Live Via Skype Welcome

Adrian Butler

Chairman, World Fire Safety Foundation

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Canadian Television – Channel 5 Report Excerpts Including

Texas A& M Video

Note: Canadian UL (ULC) Standards Are More Strict Than US Standards
Canada = Max OB Level 6% / US = Max OB Level 10%

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Skip Walker, MCI, ACI

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

What Is Being Done?

Skip Walker, MCI, ACI

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

In the US, Photoelectric Technology Laws In Place In:

Massachusetts

Vermont

Maine

Rhode Island

Iowa

New York (Averyana's Law)

Under Review In Several Other States

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Averyana's Law, New York

Currently there are two types of smoke detectors available in the market place, Ionization and Photoelectric. **Ionization detectors are present in about 95% of homes. Unfortunately these types of detectors have a high rate of failure** when detecting smoldering fires. **Photoelectric detectors on the other hand, are extremely successful** at detecting smoldering fires.

Averyana Dale most likely lost her life because the ionization smoke detector that was present in the home she was in did not alert her to the fire until it was too late. If a photoelectric detector had been in the home, it is considerably more likely she would have been alerted to the smoke sooner and would have made it out safely.

This legislation is meant to provide an incentive for homeowners to purchase photoelectric detectors. These detectors will save lives by adding an extra layer of protection for anyone who may experience a fire.

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

In the CA, Photoelectric Technology Ordinances Are In Place In:

Palo Alto
City of Albany
Sebastopol
City of Orange

Skip Walker, MCI, ACI

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

International Association of Fire Fighters:

Official Position Calling for Photoelectric Only Technology
Specifically States, No Combination Detectors

Union Represents Over 290,000 US & Canadian Fire Fighters

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

California Real Estate Inspection Association

Official Position Calling for Photoelectric Only Technology
Specifically States, No Combination Detectors

Mirrors IAFF Position, First HI Organization in The World to Take a Stand

Skip Walker, MCI, ACI

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

California Real Estate Inspection Association
Standards of Practice
Modified to State:

Inspector is Not Required to Determine Type of Alarm
CREIA Legal Counsel Feels No Additional Liability with Position

Skip Walker, MCI, ACI

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

<u>What Can We Do as Inspectors?</u>

Tell Your Agents...Your Clients...

Your Family...Neighbors...Friends, Etc!

<u>What Can CREIA Do?</u>

As a group, make public awareness a Priority

We Have Attention of Local State Assemblyman

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

<u>What Do I Say on Inspections?</u>

- Any Alarms Installed Meet Legal Requirement

- 95% of Homes Have Ion's

-Type NOT Verified

- Change All Alarms to Photo/Doubles Survival Rate

- Not A Cost Issue

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

RECOMMENDED SAFETY UPGRADE: I recommended that ALL ionization alarms - regardless of age - be replaced with photoelectric smoke alarms. Extensive research clearly shows that photoelectric smoke alarms are far more reliable in most real-world fire scenarios. Nearly 95% of the smoke alarms installed in US residences are IONIZATION alarms. Ionization alarms are approved smoke alarms and DO comply with the legal requirements for transfer in MOST jurisdictions. However, significant research shows that ionization alarms RESPOND TOO SLOWLY to the smoldering/smoke fires responsible for most residential fire deaths. Ionization alarms are also notorious for nuisance tripping from cooking, shower steam, etc. Ionization alarms will fail to adequately warn occupants about 55% of the time. With photoelectric alarms the occupants will receive sufficient warning about 96% of the time. Ionization technology alarms pose a significant life-safety risk. Combination alarms are not recommended. The type of alarm installed was not verified as part of this inspection. Interested parties should consult with a qualified trade specialist for service.

Carbon Monoxide

Skip Walker, MCI, ACI

Carbon Monoxide Alarms

Carbon Monoxide is One of the Leading Causes of Poisoning Deaths in the US

Carbon Monoxide Alarms

A Product of Incomplete Combustion

- Too Little Combustion Air
- Too Much Combustion Air
- Flame Impingement

CO Molecules Bond with Hemoglobin 200 Times More Easily Than Oxygen

CO Poisoning Is Asphyxiation from the Inside Out

Carbon Monoxide Alarms

Table 1: CO Symptoms

Concentration (ppm CO)	Symptoms
50	No adverse effects with 8 hours of exposure
200	Mild headache after 2-3 hours of exposure
400	Headache and nausea after 1-2 hours of exposure
800	Headache, nausea and dizziness after 45 minutes of exposure; collapse and unconsciousness after 2 hours of exposure
1,000	Loss of consciousness after 1 hour of exposure
1,600	Headache, nausea and dizziness after 20 minutes of exposure
3,200	Headache, nausea and dizziness after 5-10 minutes of exposure; collapse and unconsciousness after 30 minutes of exposure
6,400	Headache and dizziness after 1-2 minutes of exposure; unconsciousness and danger of death after 10-15 minutes of exposure
12,800 (1.28% by volume)	Immediate physiological effects; unconsciousness and danger of death after 1-3 minutes of exposure

*ppm = parts per million

Carbon Monoxide Alarms

Effects of CO Poisoning Vary by Age, Sex, Weight and Overall Health

Children, Elderly, Women, Those with Respiratory Issues Most at Risk

Note: Women Almost Twice At Risk

Carbon Monoxide Alarms

CO Poisoning Often Misdiagnosed

In One Study
Only 1 of 77 Cases Diagnosed on Symptoms Alone

In Another, 200 Doctors Sent Symptoms of Hypothetical Patient – None Correctly Diagnosed CO Poisoning

Carbon Monoxide Alarms

Symptoms:

Memory Loss

Severe Muscular Pain

Headaches

Tiredness

Dizziness

Flu-Like Symptoms without the Fever

Improves When They Leave Home

Carbon Monoxide Alarms

CO Poisoning

Children, Elderly, Women, Those with Respiratory Issues Most at Risk

Based on Gender, Women Are At Twice Risk

Carbon Monoxide Alarms

Myth: Only Students, Low Income at Risk
Fact: Everyone is at risk. CO exposure usually occurs at home

Myth: Chronic CO poisoning rare
Fact: Grossly under diagnosed

Myth: CO poisoning either kills or it doesn't, few long-term effects
Fact: CO poisoning causes many permanent and debilitating effects

Carbon Monoxide Alarms

Myth: Everyone in the household will be affected, including pets

Fact: Some may not be affected, depending on rooms, proximity to source, body weight, exposure duration, etc

Carbon Monoxide Alarms

Primary Sources of CO Alarm Trips in the Home:

Often assumed to be cracked heat exchangers

They account for less than 1% of CO alarm triggers

Carbon Monoxide Alarms

Primary Sources of CO Alarm Trips in the Home:

Autos – Idling in Garage, drawn into living by pressure differentials 60%

Improperly Maintained, Installed or Vented Gas/Oil
- Appliances 20%

Gas Appliance Back drafting 19%

Carbon Monoxide Alarms

Nearly 60% of the Time, CO Poisoning is Detected Only When Someone Collapses

HVAC Equipment Repair Calls will Detect CO Issues Only 30-40% of Time

Routine Cleaning or Service by Gas Utility or HVAC Detect CO Issues Less Than 10% of Time

Carbon Monoxide Alarms

CO Poisoning is Dependent on Both Time and Concentration

Small Amount for a Long Time

High Concentration For Short Period

Detection is Far More Complicated Than Smoke Alarms

Carbon Monoxide Alarms

CO Gas Behavior:

Weight Neutral/Slightly Lighter Than Air

- **CO = 28 vs Air = 29 Approx 3% Difference**

Generally Introduced in Warm Air Stream

Homogenizes/Mixes Rapidly in Living Space

Carbon Monoxide Alarms

CO Alarms:

US CO Alarms Tested to UL 2034

Most Residential Are Electrochemical Sensors

Alarm Life Usually 5-7 Years, Some as Little as 2-3

Sensor Response and Recovery Rates Vary Significantly

Carbon Monoxide Alarms

UL 2034 CO Alarm Criteria:

At 30 ppm:	**Unit must sound alarm within 30 days**
At 70 ppm:	**Unit must sound alarm within 60-240 minutes**
At 150 ppm:	**Unit must sound alarm within 10-50 minutes**
At 400 ppm:	**Unit must sound alarm within 4-15 minutes**

Carbon Monoxide Alarms

UL 2034 CO Alarm Test:

A Design Standard, NOT A Manufacturing Specification

Does Not Address Manufacturing Variances

Does Not Address Loss Of Sensitivity Over Time

Does Not Require Concentration Changes to Be Integrated Over Time

Studies Show No Improvement Over Pre-1998 Specification

Carbon Monoxide Alarms

CO Alarms:

Number of Studies Show Performance Issues:

4% Will False Alarm to Fresh Air Out of Box

In 7 of 10 Brands Tested, 37% Failed UL Test

In 6 of Worst Performing Brands, 80% Failed to Respond in Low Humidity Conditions

Digital Displays Very Inaccurate - +/- 30%, One Read Zero at 100 ppm

Carbon Monoxide Alarms

California CO Poisoning Act of 2010

Impacts ALL Single Family Dwelling Units

Skip Walker, MCI, ACI

Carbon Monoxide Alarms

California CO Poisoning Act of 2010:

Defines a Single Family Dwelling Unit As:

HSC 13261 4(b) **" Dwelling unit intended for human occupancy " means a single-family dwelling, factory-built home as defined in Section 19971, duplex, lodging house, dormitory, hotel, motel, condominium, stock cooperative, time-share project, or dwelling unit in a multiple-unit dwelling unit building or buildings. "Dwelling unit intended for human occupancy" does not mean a property owned or leased by the state, the Regents of the University of California, or a local governmental agency.**

Carbon Monoxide Alarms

California CO Poisoning Act of 2010:

Required When:

January 1, 2011: New construction and Remodels requiring permits with a construction value of $1,000 or more.

July 1, 2011: ALL single family dwelling units that have any one of the following ; A fossil fuel burning appliance (gas, oil, LP, etc.), fireplace, or an attached garage.

January 1, 2013: ALL other single family dwelling units.

Carbon Monoxide Alarms

California CO Poisoning Act of 2010:

CRC 2010:

R315.1 Carbon monoxide alarms. For new construction, an approved carbon monoxide alarm shall be installed in *dwelling units and in sleeping units* within which *fuel-burning appliances* are installed and in dwelling units that have *attached garages*.

R315.3 Alarm requirements: *Carbon monoxide alarms required by Sections R315.1 and R315.2 shall* be installed in the following locations:

1. Outside of each separate dwelling unit sleeping area in the immediate vicinity of the bedroom(s).

2. On every level of a dwelling unit including basements.

Carbon Monoxide Alarms

California CO Poisoning Act of 2010:

CRC 2010:

R315.3 Alarm requirements. Single- and multiple-station **carbon monoxide alarms shall be listed as complying with** ***the requirements of UL*** **2034.** ***Carbon monoxide detectors shall be listed as complying with the requirements of UL 2075. Carbon monoxide alarms and carbon monoxide detectors*** **shall be installed in accordance with this code,** ***the current edition of NFPA 720 "Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment"*** **and the manufacturer's installation instructions.**
Revised

Carbon Monoxide Alarms

Combination Alarms:

Meet The Legal Requirements

CO/Ion's – Bad Due to Ion Technology

CO/Photo – Single Point of Failure

CO & Smoke Have Different Life Spans – 5-7 vs 10

Deadly Differences
Ionization vs Photoelectric Smoke Alarms

Questions

And

Comments!