



Vision 20/20

National Strategies for Fire Loss Prevention



Model Performance in Community Risk Reduction

SYMPOSIUM 2020

Door Messaging Strategies & Smoke Alarm Waking Effectiveness

Victoria Hutchison,

Fire Protection Research Foundation

Project Basis

- To provide a scientific basis to some of EMAC's outstanding questions around door position messaging

impact educational messaging around this topic. Variables include:

- • Will a closed door delay early warning from a smoke alarm located outside the sleeping room?
- Will a single station smoke alarm, installed in the sleeping room with the door closed, provide early warning to a fire outside the sleeping area to allow for safe escape?
- Does a closed sleeping room door impact the use of that door as the primary escape route out of the room?
- • What is the impact of a closed door when the fire originates in the sleeping room and no smoke alarm is present in the room?
- • About one-quarter of home fire deaths occur from fires that originate in sleeping rooms. How will a closed sleeping room door impact the rates of fatalities?
- • Does closing the sleeping room door have the potential to increase risk of injury or death from fire?
- • Does a closed sleeping room door have different implications for special populations such as those who have mobility, sensory, or cognitive disabilities?
- • Will a closed sleeping room door reduce fatalities in homes if working smoke alarms are not present?

Based on these and other unanswered questions, the Committee recommends additional research to examine these and other variables.

Scope and Approach

- Goal: To assess and document the impact of a closed sleeping room door on smoke alarm early notification and home escape in the modern fire environment of residential dwellings.
- Tasks:
 - Document and analyze the problem and its impact on fire safety
 - Document current messaging on the issue
 - Assess the impact of a closed door with regard to fire dynamics
 - Assess the impact of a closed door on notification/audibility



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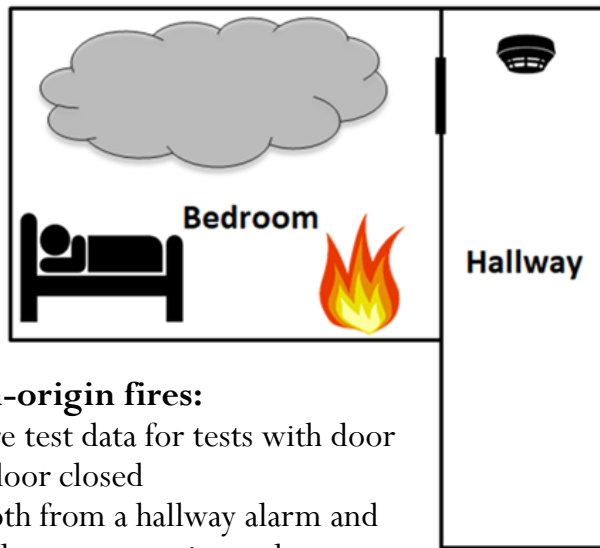
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Research Analysis of the Impact of Door Position on Home Escape

Approaches to Evaluate the Impact of Door Position on Home Escape

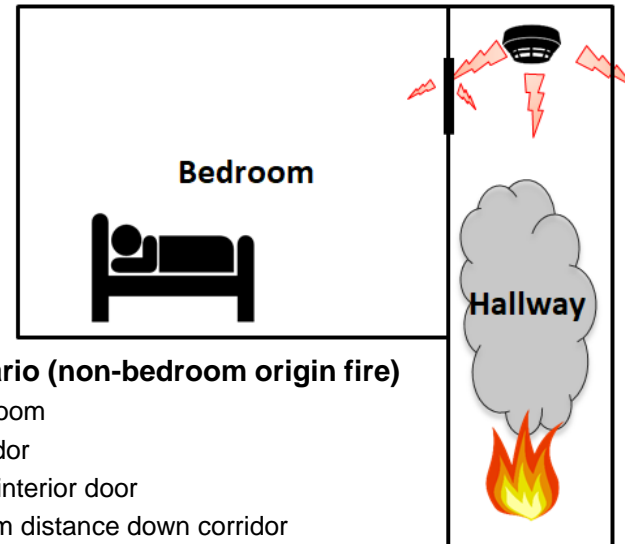
Fire Dynamics Assessment Bedroom Origin Fire



For bedroom-origin fires:

- Analyze fire test data for tests with door open and door closed
- Analyze both from a hallway alarm and bedroom alarm perspective and determine number of adverse outcomes

Notification/Audibility Assessment Outside Bedroom Fire



Audibility scenario (non-bedroom origin fire)

- 12'x11' bedroom
- 4' wide corridor
- Hollow core interior door
- Varying alarm distance down corridor (Between 0 and 21 ft)
- Varying sound pressure level of the alarm (85-90 dBA @ 10')

Summary Findings: Fire Dynamics Perspective

	Bedroom Alarm Present?	Hallway Alarm Present?	Probability of Escape with Door Open	Probability of Escape with Door Closed
Occupant INSIDE room of origin (e.g. bedroom origin fire)	√	X	Good Probability of Escape (96.6% likelihood)	Moderate Probability of Escape (66% likelihood)
Occupant INSIDE room of origin (e.g. bedroom origin fire)	X	√	Good Probability of Escape (96.6% likelihood)	Low Probability of Escape (0% likelihood)
Occupant INSIDE room of origin (e.g. bedroom origin fire)	X	X	Low Probability of Escape (0% likelihood)	Low Probability of Escape (0% likelihood)
Occupant OUTSIDE room of origin (e.g. living room origin fire)	√	X	Moderate Probability of Escape	Good Probability of Escape
Occupant OUTSIDE room of origin (e.g. living room origin fire)	X	√	Moderate Probability of Escape	Good Probability of Escape

This data assumes occupants are not intimate with ignition and are capable of self-rescue; Also assumes occupants are asleep INSIDE the bedroom

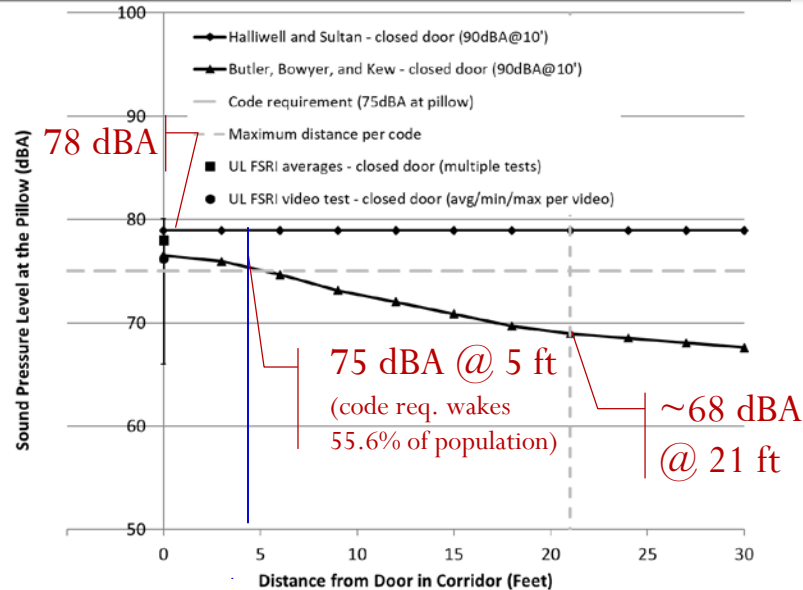
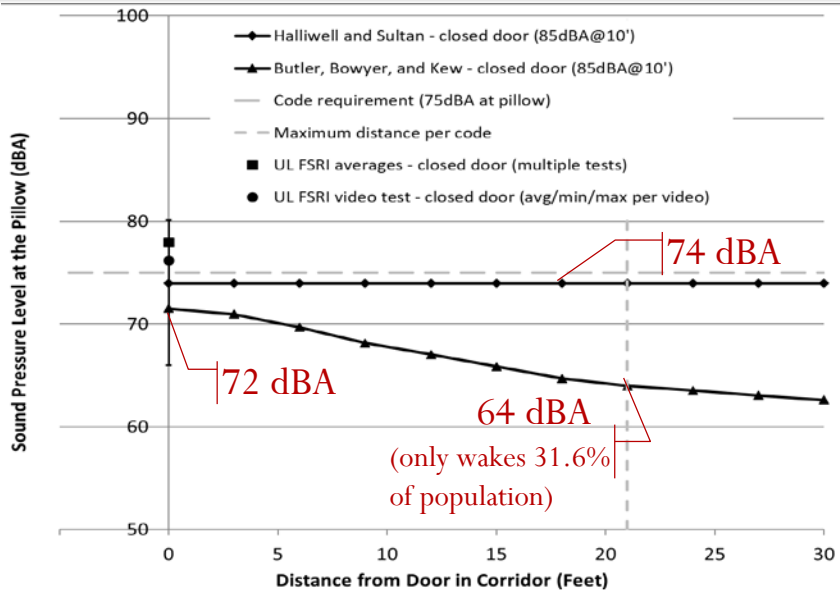
After incorporating the fatal fire statistics and the presence of bedroom and hallway alarms in homes, the summary findings are:

- **Additional 2.2 – 3.2%** of residential **fires** may have an adverse outcome from closing the door (based solely on the fire dynamics analysis).

Notification/Audibility Analysis with Closed Doors

85 dBA Alarm at 10 ft

90 dBA Alarm at 10 ft



Closed door attenuates sound by approximately **14-17 dBA**; Average mean awakening threshold = **72.5 dBA**

A Closed Door is Acceptable, under certain conditions, from an audibility perspective

Findings

- A closed door can provide additional tenability time for occupants behind a closed door, not in the room of origin.
 - Non-bedroom origin fires are 93% of residential fires and 77% of fatalities
 - In ~50% of residential fire fatalities, the victim was not in the room of origin
 - 20% of these fires occur at night (11pm – 7am) and 51% of fatalities occurred during these hours
 - Therefore, 39.3% of fatalities may benefit from a closed bedroom door at night.
- Additional risk posed by a closed door is relatively low.
- The benefit or hindrance of a closed door is still unclear for at-risk populations (e.g. elderly, impaired, disabled, etc.).



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Research Findings in Response to EMAC Questions

Will a closed door delay early warning from a smoke alarm located outside the sleeping room?

Simple Answer: Yes, it can delay early warning, in some situations

Change in Awakening Percentage

A closed door can reduce the probability of waking to an alarm outside the bedroom by **24%**.

(in a worse case scenario where the alarm is 21 ft outside the bedroom door)

Required Sound Level

In most cases, the sound level required at the pillow (75 dBA) **can be met with a 90 dBA alarm located within 5 ft from the closed bedroom door** (for sober adults).

The required sound pressure level **cannot** always be met with a 85 dBA alarm.

What is the impact of a closed door when the fire originates in the sleeping room and no smoke alarm is present in the room?

Adverse outcome is expected for the occupant in the room of origin.

- This is a key fire dynamics scenario. With a closed door, heat, smoke, and fire will build up more quickly in the room of origin, making an adverse outcome likely for the occupant in the room of origin.
- However, the closed door will delay the spread of the fire, smoke, and heat to other parts of the home, potentially giving other occupants more time to escape.

Nearly 25% of home fire deaths occur from fire that originate in sleeping rooms.

How will a closed sleeping room door impact the rates of fatalities?

Potential benefit of closing the bedroom door:

Potential to prevent ~39% of fatalities by closing the door (for occupants **outside** the room of origin)

Potential for adverse outcome by closing the door:

~5 – 7 % potential for increased risk of fatalities by closing the door

- 1.9 to 3.1% of all residential fires could have an adverse effect due to shutting the bedroom door due to notification issues when they would not otherwise.
- 2.2 – 3.2% of all residential fires could have an adverse effect due to shutting the bedroom door due to fire dynamics issues when they would not otherwise.

Does closing the sleeping room door have the potential to increase risk of injury or deaths from fire?

Simple Answer: Yes, there is a small increased risk for the occupants in the room of origin

For occupants **INSIDE** the room of origin:

Generally, the potential for increased risk of injury or death by closing the door is **low (~ less than 5%)**

If no alarm is present and the bedroom door is closed, the risk of injury or death is high.

For occupants **OUTSIDE** the room of origin:

Potential to reduce the risk of injury/death from fire.

Will a closed sleeping room door reduce fatalities in homes if working smoke alarms are not present?

If no working alarms are present, a ***closed door could result in a drop in successful escapes*** for occupants in the room of origin.

Note:

- Life Safety Code (NFPA 101) scope excludes occupants involved in ignition (i.e. cannot prevent injury incurred by an individual due to that individual's failure to use reasonable care).
- NFPA 72 excludes occupants intimate with ignition.
 - 46% of bedroom fire fatalities
 - 39% of living room fire fatalities were involved in ignition



Summary Observations

- Smoke alarms are essential to reducing risk.
 - When no smoke alarms are present, the probability of escape in various fire scenarios is low *regardless of door position*.
- If appropriate alarm coverage is provided, a closed door can provide a benefit to the occupants. However, messaging regarding door position makes it more important to have working smoke alarms and a practiced home escape plan.
- Door position messaging should be considered as part of a holistic community risk assessment, informed by:
 - Local fire incident data
 - The priorities and needs of that community
 - The community demographics (at-risk populations)



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Review of Audible Alarm Waking Effectiveness: Low Frequency Alarm Sound Pressure Levels

Can we justify a reduction in the sound pressure level (SPL) to remove the impediment and get more productive and effective alarms in homes?

Project Overview

- Sound Pressure Level (SPL) requirements for low frequency alarms have been questioned
- Low frequency notification devices currently required for:
 - Sleeping areas
 - Mild to Severe hearing loss
- Improved performance of low frequency over high frequency alarms has been proven in numerous studies
 - Required SPL for devices remained unchanged
 - Achieving required SPL at low frequency requires additional power – battery limitations
 - Research needed to justify a reduction in SPL for low frequency alarms

Audible Alarm Waking Effectiveness: Low Frequency Alarm Sound Pressure Levels

How much can the Sound Pressure Level be Reduced with Assured Improved Performance?

- At a minimum reduced Sound Pressure Level (SPL) alarms must be equal to existing alarms
- Equal for the normal population and superior for at-risk groups is still a huge win
- Low frequency tone is only attenuated ~ 7 dBA through barriers (compared to 14-17dBA with high freq)
- Based on analyses:
 - Low frequency tone transmits better through the home, and is more efficient at waking occupants
 - Assuming equal waking performance could justify 4-8 dBA reduction in SPL for low frequency tones due to reduced attenuation in non-compliant installations
 - The SPL could be reduced more for code-compliant installations
 - A 10-20 dBA SPL reduction for at-risk groups would provide improvement over existing alarms

Contact Information

Victoria Hutchison

Research Project Manager

Fire Protection Research Foundation

Email: vhutchison@nfpa.org

Phone: 1-617-984-7741

Website: www.nfpa.org/foundation

Door Messaging Strategies Report and Workshop Proceedings are available at: www.nfpa.org/news-and-research/Data-research-and-tools/Detection-and-Signaling

Smoke Alarm Waking Effectiveness Report is Coming Soon!