Effect of Ceiling Fans on Smoke Alarm Performance

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Background

- Smoke alarms and smoke detectors shall not be installed within a 36 in. (910 mm) horizontal path from the tip of the blade of a ceiling-suspended (paddle) fan. [NFPA 72 – 29.8.3.4 (8)]
- Not always possible
Example of Potential Problem
Background - Safety Questions?

• Will a ceiling fan prevent smoke from getting to the alarm? Does the fan direction matter?

• Will a fan dilute the smoke and prevent or delay the smoke alarm from sounding?

• Will different alarm locations be better than the three foot requirement?
Objective

• To determine the effect of a ceiling fan on the performance of smoke alarms.

• To determine if the 3 ft requirement is valid or if closer distances can be used.
Approach

- Ran fire experiments in a 17 x 17 x 8 ft high room.
- 2 paper fire locations
- 8 ionization smoke alarms
- Fan conditions:
  - Fan off
  - Slow and Fast
  - CW and CCW
Experimental Setup
Experimental Setup
Fires

- 100 grams of shredded paper in a 9x9 inch steel pan
Procedure

1. Set the fan on the predetermined speed and direction (ex. Fast, counter clockwise)
2. Turn the data acquisition system on for 60 seconds before igniting the fire
3. Light the fire, leave the room and shut the door
4. Wait for all the smoke alarms to alarm and then extinguish the fire

Ran each test condition 3 times (except no fan condition run once for each fire location)
Results - All Tests with Fire in Corner

Alarm Times (s): Fire in Corner

- CW Slow
- CCW Slow
- No Fan
Results - All Tests with Fire in Corner

Alarm Times (s): Fire in Corner

- CW Fast
- CW Slow
- CCW Fast
- CCW Slow
- No Fan
Results - All Tests with Fire near Center

![Graph showing alarm times for different conditions with fire near center](image-url)

**Alarm Times (s): Fire near Center**

- **S Above**: Red dots and line
- **C Above**: Red circles and line
- **S 1 ft**: Red dots and line
- **C 1 ft**: Red circles and line
- **S 3 ft**: Red dots and line
- **C 3 ft**: Red circles and line
- **S 6 ft**: Red dots and line
- **C 8 ft**: Red circles and line

Legend:
- **CW Slow**
- **CCW Slow**
- **No Fan**
Results - All Tests with Fire near Center

Alarm Times (s): Fire near Center

- CW Fast
- CW Slow
- CCW Fast
- CCW Slow
- No Fan
Safety Questions?

- Will a ceiling fan prevent smoke from getting to the alarm? NO

- Does the fan direction matter? Generally NO, particularly for 3 ft and longer
Results - Fan Direction

Alarm Times (s): Fire in Corner with Slow Fan
Safety Questions?

- Will a fan dilute the smoke and prevent or delay the smoke alarm from sounding?
  - Fan operation delays detection (typ~34 s with a range of 15-65 s).
  - Fast speed ~25 s longer to alarm than slow speed.
Safety Questions?

- Will different alarm locations be better than the three foot requirement?
  - For fires near the center, no significant difference in alarm locations.
  - For fires in the corner, little difference for most, except a CW fast fan where 3 ft or larger had faster alarm times.
Results - Smoke Alarm Location

Alarm Times (s): Fire near Center with Fast Fan

Alarm Times (s): Fire in Corner with Fast Fan
Conclusion

• Ceiling fans negatively affect smoke alarm performance. The faster the fan, the slower the response.
  ▫ Fan operation delays detection (typ~34 s with a range of 15-65 s).
  ▫ Fast speed ~25 s longer to alarm than slow speed.
• The direction of the fan does not typically matter.
Conclusion

- The location of smoke alarms only matters in a few scenarios.
  - For fires near the center, no significant difference in alarm locations.
  - For fires in the corner, little difference for most, except a CW fast fan where 3 ft or larger had faster alarm times.
- Tests should be done with smaller rooms
- The code requirement should allow for closer spacing when 3 ft is not physically possible.
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