Residential Forced Air Systems During Extreme Events: Help or Hindrance?

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Forced Air Systems As a Protective Measure

• **Context:** Most US homes have forced-air systems

• **History:** All forced air systems have filters, originally included to protect equipment

• **Opportunity:** During extreme event (like wildfire plume), people can shelter-in-place in their homes and filter will reduce exposure to particles

• **Challenges:** How can we maximize the benefit of such an approach?
Shelter-In-Place

1. Close outdoor air intakes (if possible)
2. Positively pressurize (if possible)
3. Install/use efficient* filter in system
4. Run fan continuously

*I’m conveniently not defining
Challenges Existing/Older Homes

- Enclosure is leaky
- No outdoor air intake (system only recirculates)
- Ducts located in exterior zones
- Return is undersized
- System fan does not have speed control
Leaky Enclosures

• Functionally, source is much larger
• Filter removal has to be correspondingly larger
• Positive pressurization is much harder to achieve
• Mixed evidence on whether shelter-in place is effective in leaky buildings
Ducts in Exterior Locations (1)

Static Pressure (IWC)

Supply leakage to exterior locations will negatively pressurize home
Return leakage in exterior locations will lead to unfiltered concentrations of outdoor air.
No Fan Speed Control

- Pressure drop goes up (higher pressure drop filter or dirty filter)
- Flow goes down
- Removal by filter goes down
Do Newer Homes Fare Better?

- Yes, but.....
  - Does outdoor air damper seal?
  - Is fan speed control/fan motor reliable?

Source: California Energy Commission
Filter-Specific Concerns

• Specificity
  • Particle removal + activated carbon
• Capacity
  • 90+% of mass on filters >10 µm
• Pressure drop as loading occurs
  • Bypass
  • Flow reduction
• Filtration efficiency declines
Capacity

• Manufacturers lifetimes can be wildly optimistic and are usually based on 20% runtime and typical indoor concentrations
  • When you run system continuously and at high concentrations, filter loads very quickly
  • Lifetime can be measured in days or weeks
• Absolutely essential to have a reasonable supply of new filters and homeowner knowledge to change them
What happens when a filter is heavily loaded (I)?
What happens when a filter is heavily loaded (II)?
What happens when a filter is heavily loaded (III)?
Summary

• Before using central system for shelter-in-place
  • Ensure home will benefit
    • Enclosure improvement
    • Duct sealing
    • Improve quality of filter installation (bypass including open filter slots)
  • Homeowner education
  • Replacement filters
Additional points

• Nature of wildfire (or other outdoor source) is important
  • Duration, pollutant concentrations, high peaks
• Portable air cleaners offer some advantages, but maintenance and homeowner educational issues are equally important
Questions?

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