

CANADIAN CENTRE FOR BUILDING EXCELLENCE

Engineering Health and Efficiency

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

Wildfire Smoke

A Guide for Public Health Officials

Revised May 2016



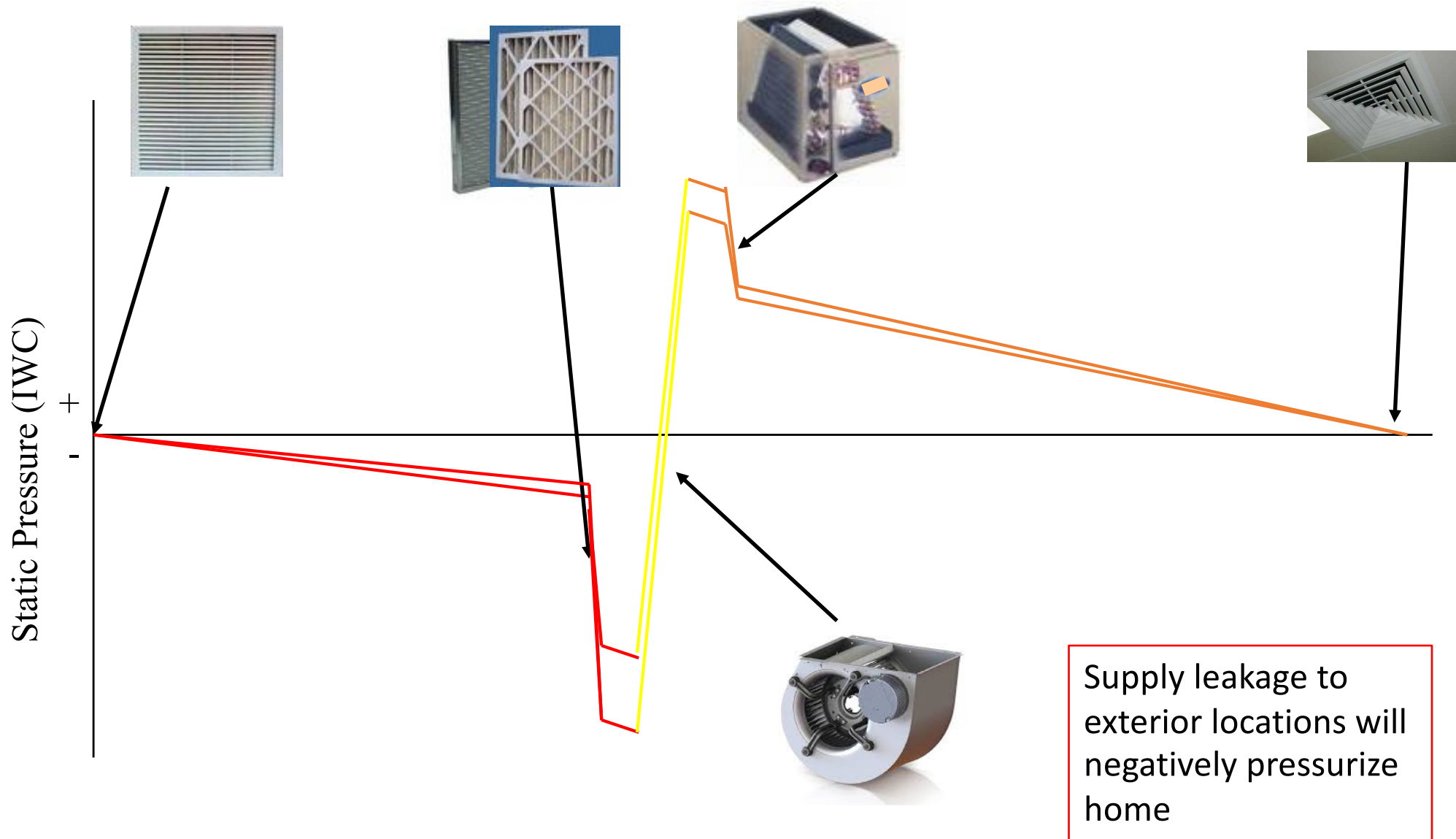
Challenges Existing/Older Homes

- 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

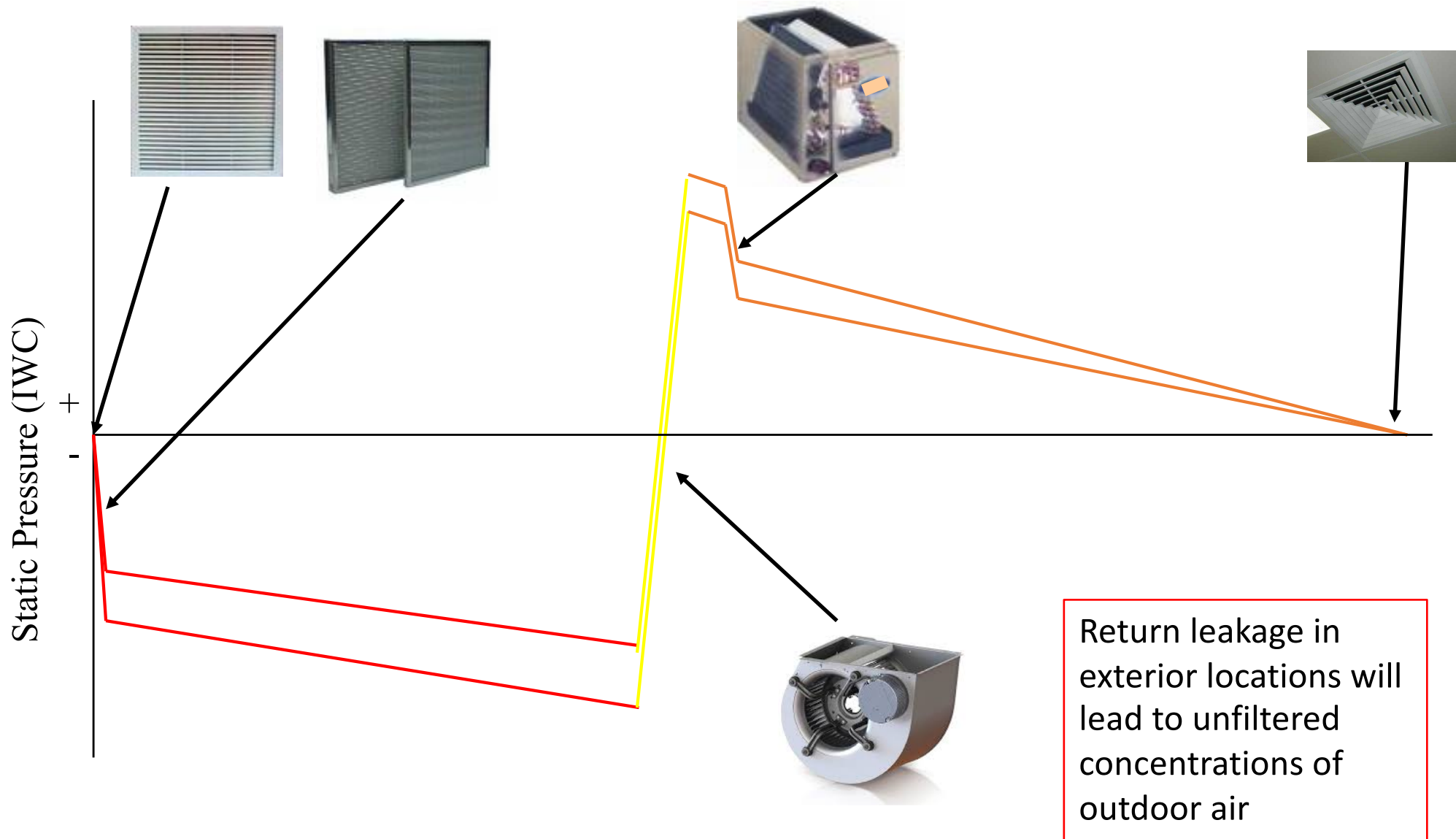
Leaky Enclosures

- 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

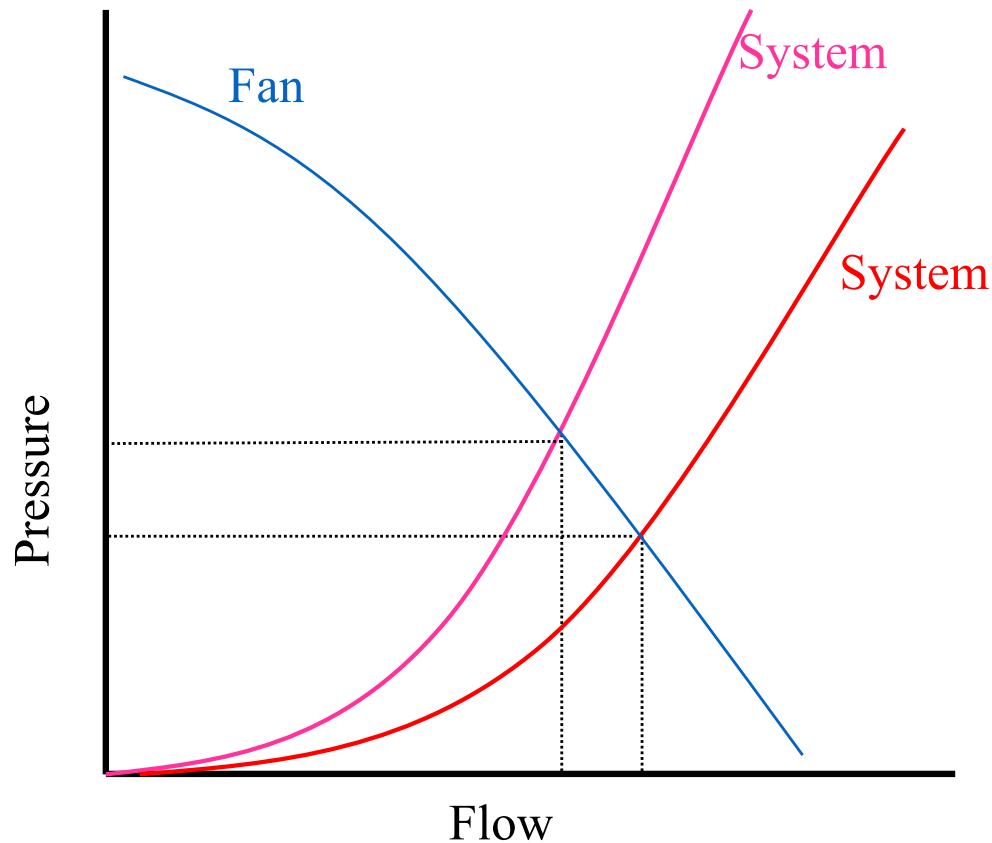
Ducts in Exterior Locations (1)



Ducts in Exterior Locations (2)

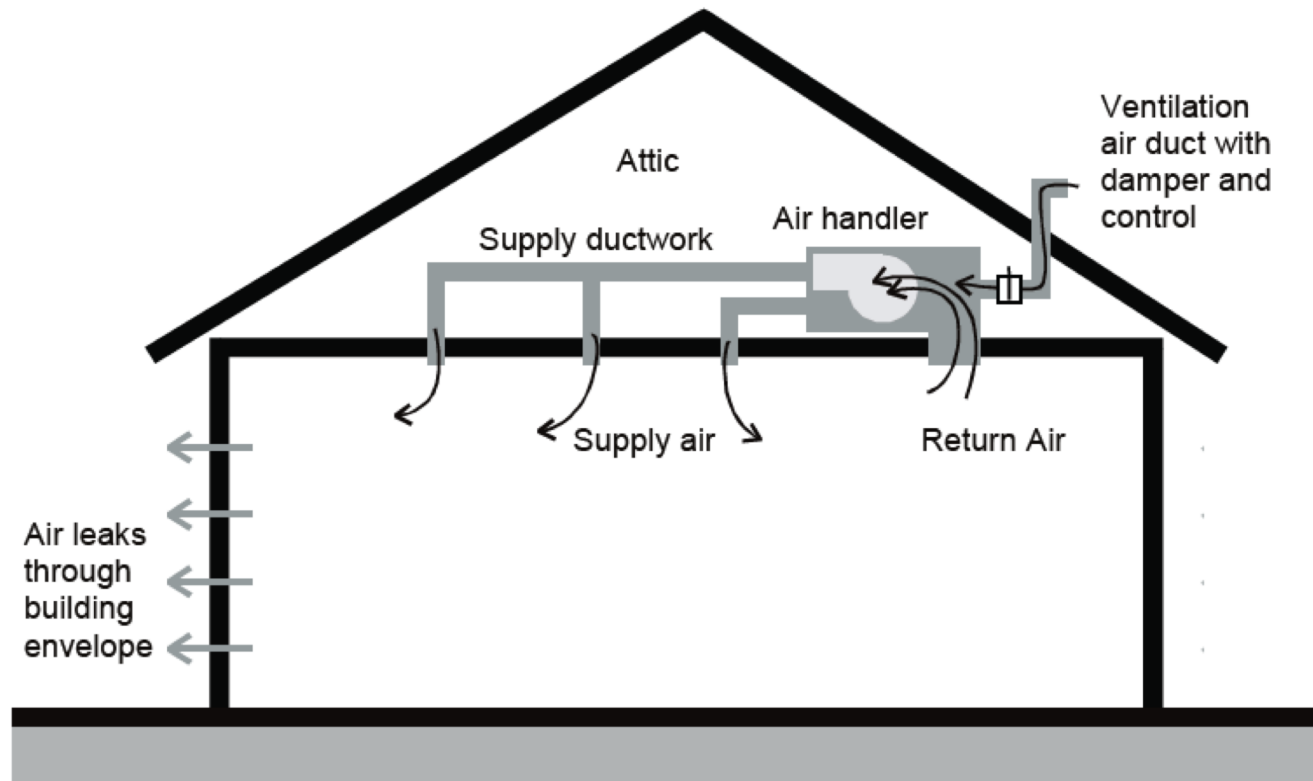


No Fan Speed Control



- Pressure drop goes up (higher pressure drop filter or dirty filter)
- Flow goes down
- Removal by filter goes down

Do Newer Homes Fare Better?



Source: California Energy Commission

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

Filter-Specific Concerns

- Specificity
 - Particle removal + activated carbon
- Capacity
 - 90+% of mass on filters $>10\ \mu\text{m}$
- Pressure drop as loading occurs
 - Bypass
 - Flow reduction
- Filtration efficiency declines

Capacity

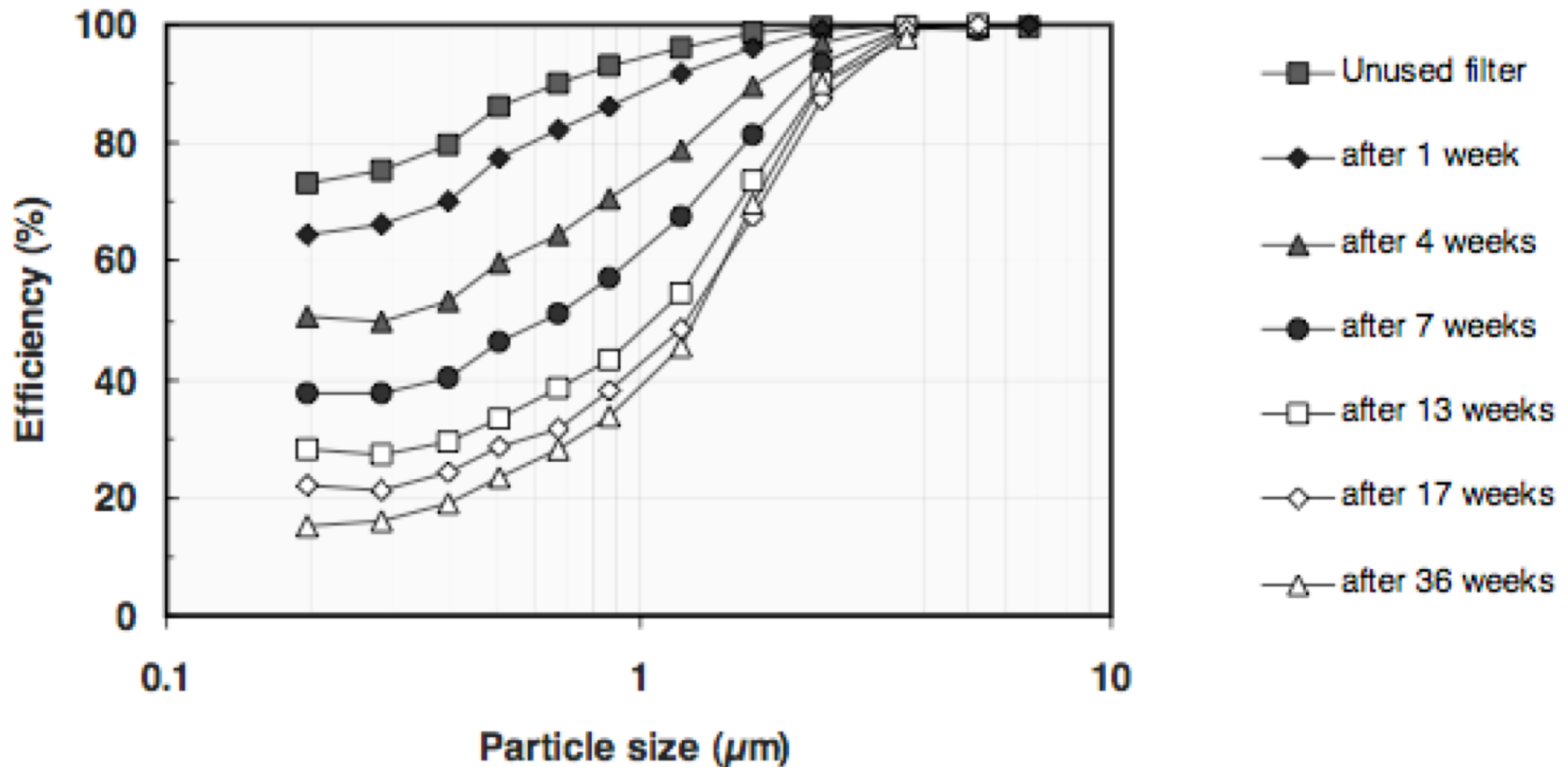
- Manufacturers lifetimes can be wildly optimistic and are usually based on 20% runtime and typical indoor concentrations
 - When you run system continuously and at high concentrations, filter loads very quickly
 - Lifetime can be measured in days or weeks
- Absolutely essential to have a reasonable supply of new filters and homeowner knowledge to change them



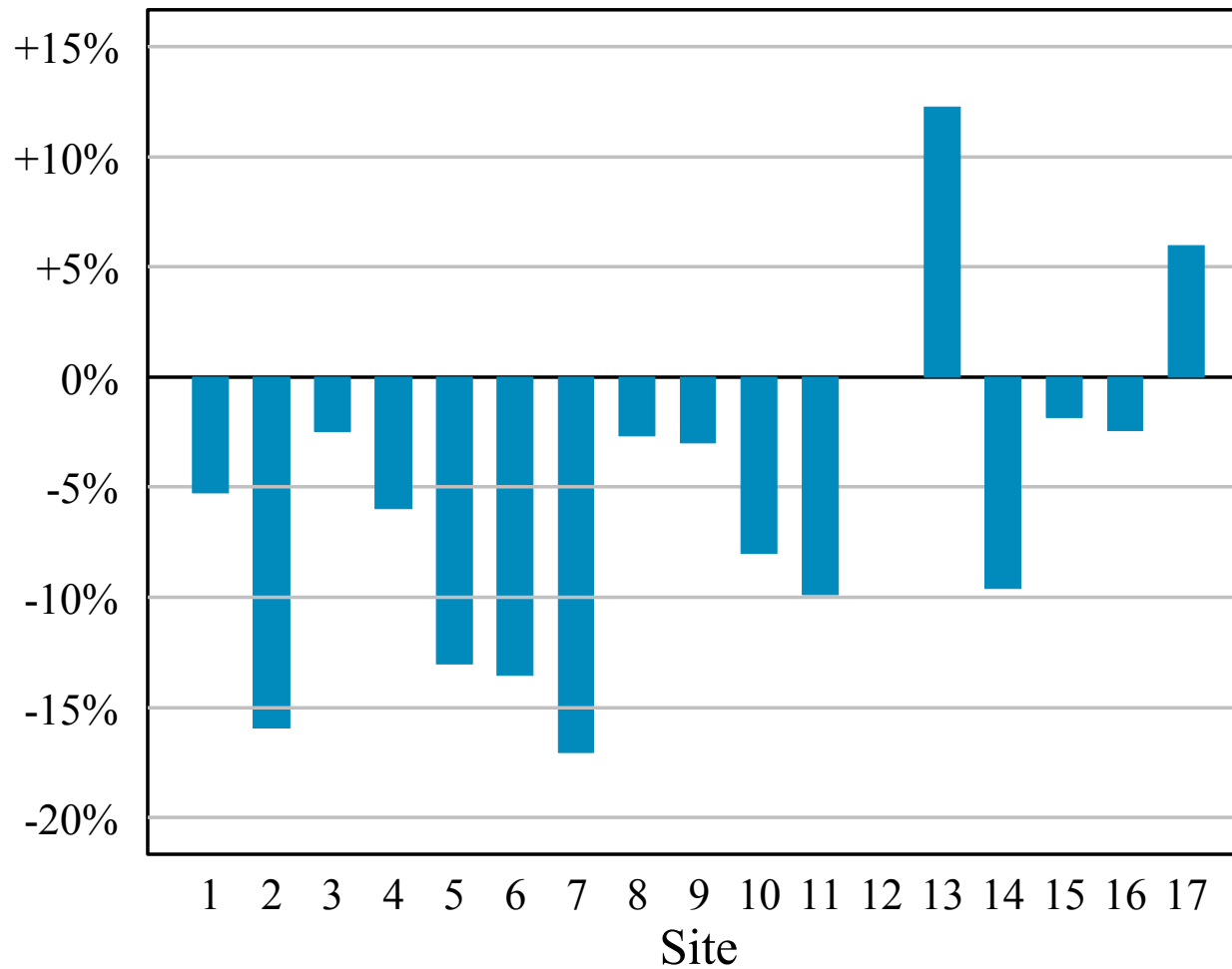
What happens when a filter is heavily loaded (I)?



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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