EPA United States Environmental Protection Agency

EPA Tools and Resources Webinar: Preparing for Wildland Fire Smoke

Beth Hassett-Sipple & Amara Holder
US EPA Office of Research and Development

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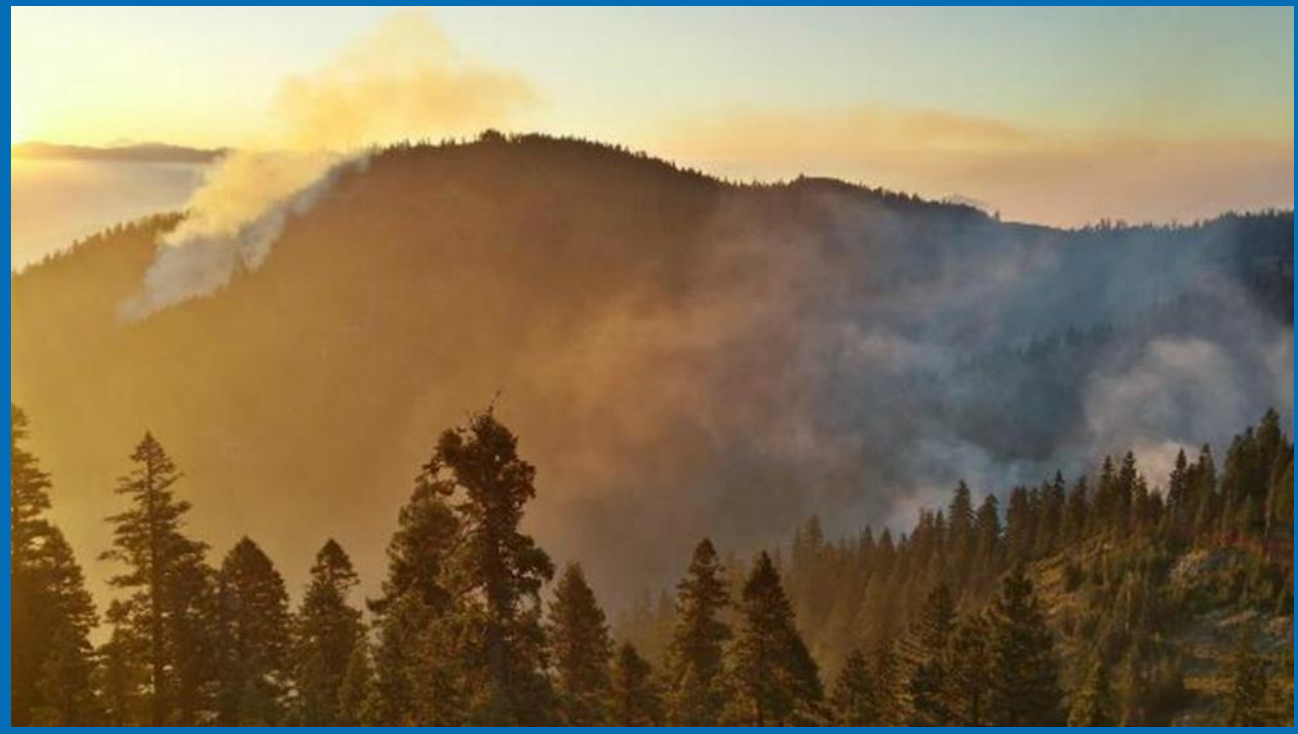


Red Salmon Complex Fire (CA) 2020 Credit: Tristean Kiehl
https://inciweb.nwcg.gov/incident/photograph/6891/47/100925

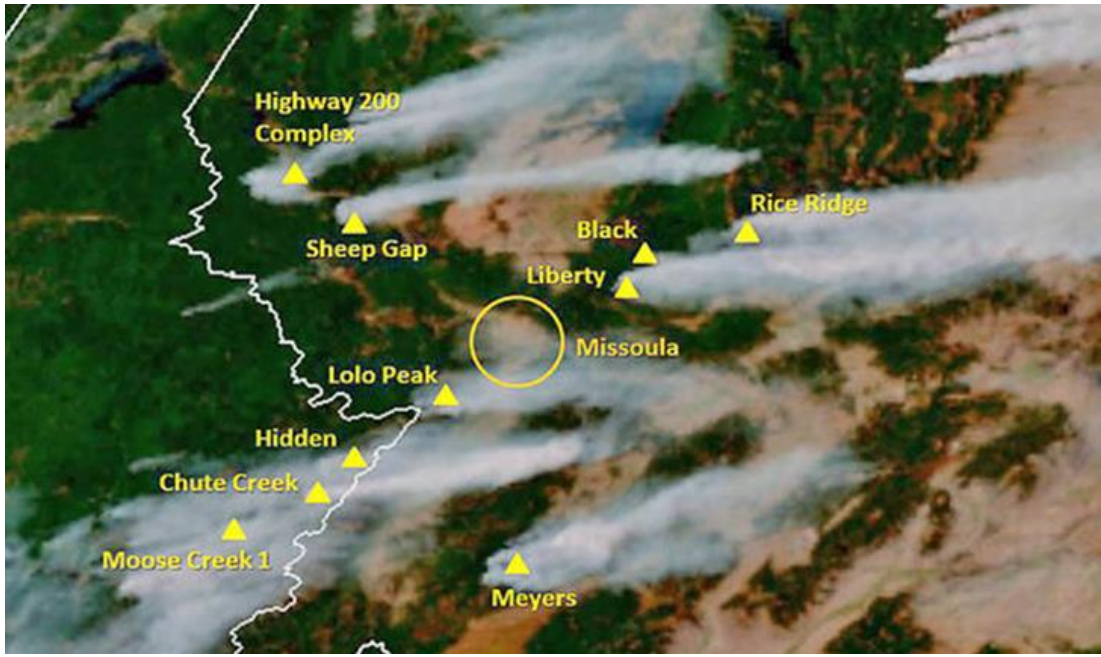
Overview of Today's Presentation

- Background
- Guidance for building managers - ASHRAE Interim Framework
- Ongoing EPA research - field studies of indoor air quality during smoke events
- Resources for more information

Red Salmon Complex fire (CA) 2020

Problem

- Frequency and magnitude of wildland fires is increasing
- Many U.S. communities are exposed to wildland fire smoke for days, weeks, or even months
- Smoke can infiltrate from ambient (outdoor) air to indoor environment
- Current public health guidance advises going indoors and closing windows and doors during smoke events to reduce smoke infiltration
- Often, people are not aware of the potential health impacts associated with wildland fire exposures…



Multiple fires (△) impacting Missoula, MT during 2017

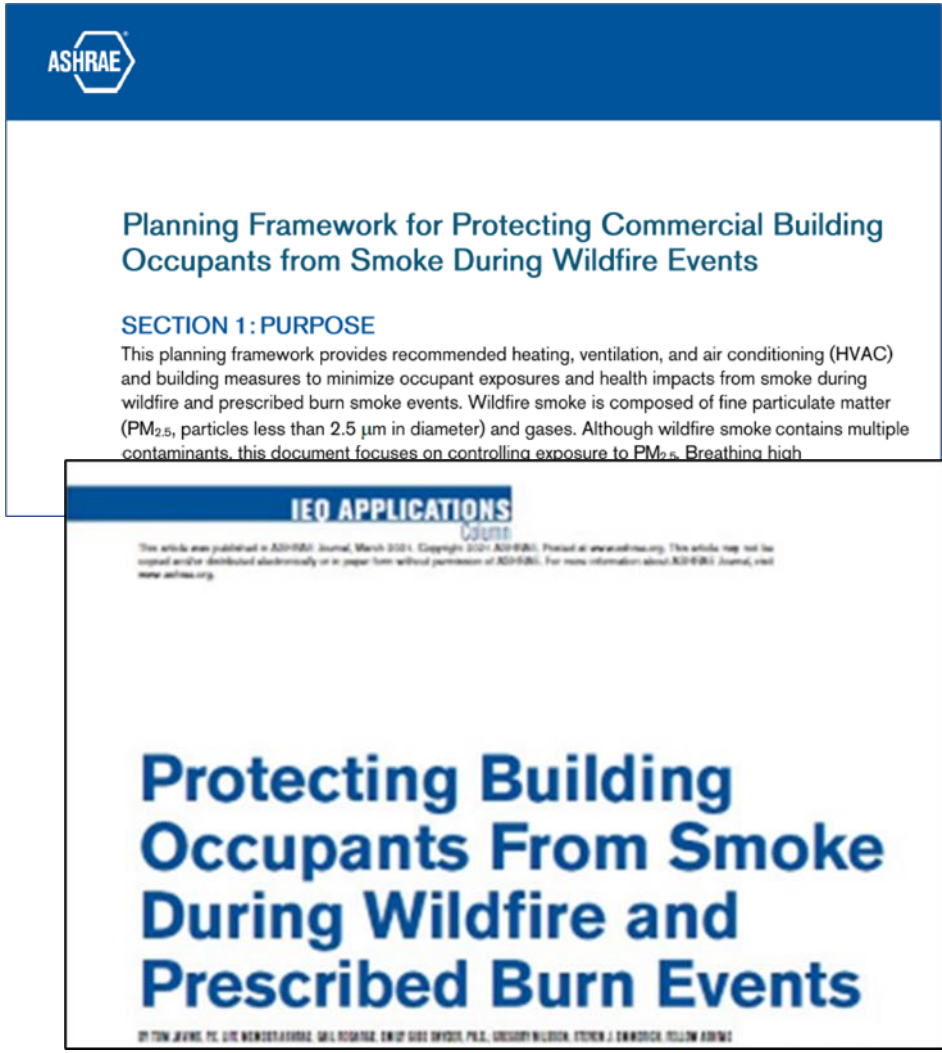
(Image courtesy of Sarah Coefield, MCCHD)

Nor what actions they can take to protect themselves

What guidance is available for building owners/managers?

ASHRAE Guideline Development

- Missoula, MT partners identified need for indoor air quality guidelines for building managers during wildfire smoke events
- EPA worked with National Institute of Standards and Technology (NIST) colleagues to propose ASHRAE develop wildfire smoke guidelines
  - ASHRAE is a global society advancing human well-being through sustainable technology for the built environment
  - Multidisciplinary team identified to develop:
    - Interim *Planning Framework for Protecting Commercial Building Occupants from Smoke During Wildfire Events* issued Feb 2021
    - Full guideline on *Protecting Commercial Building Occupants from Smoke During Wildfire and Prescribed Burn Events* under development (ASHRAE 44P)



Learn more at: https://www.epa.gov/indoor-air-quality-iaq/wildfires-and-indoor-air-quality-schools-and-commercial-buildings

ASHRAE Interim Framework

- Focuses on reducing fine particle ($PM_{2.5}$) exposures from smoke in commercial, school, healthcare facilities, multi-unit residential, and similar buildings
- Includes information for building managers on:
  - Developing a building-specific Smoke Readiness Plan,
  - Preparing for smoke events by having supplies on hand and testing procedures in advance,
  - Knowing when and how to implement measures in their plans, and
  - Monitoring effectiveness of the plan if a smoke event occurs, and making adjustments to the plan, if appropriate

ASHRAE Interim Framework Highlights

- Buy supplies early (filters, portable air cleaners)
- Evaluate your HVAC system, can it handle a higher efficiency filter?
- Conduct a full maintenance check on the HVAC system before fire season and make repairs, if needed
- During smoke events, limit outdoor air intake, while maintaining adequate air flows to maintain positive pressure
- Add supplemental filtration at intake air vent, if possible

Supplemental filtration with a MERV13 filter installed on an outdoor air intake

ASHRAE Interim Framework Highlights (cont.)

- Check filters and replace, if necessary
- Weatherize building to limit smoke intrusion, consider limiting allowable entrances to reduce smoke entry
- Monitor indoor $PM_{2.5}$ by using low-cost air sensors to ensure your actions are improving indoor air quality
- Consider creating temporary cleaner air spaces ***within*** the building
- Reduce sources of indoor $PM_{2.5}$, such as cooking, vacuum cleaning, use of printers or copiers, smoking
- Evaluate plan effectiveness and adjust, as appropriate

Note: Assistance from qualified HVAC professionals is generally needed

Clean HVAC filter

Heavily loaded HVAC filter

What can communities do to reduce their exposure to wildfire smoke indoors?

Hoopa, CA with good air quality (left) and impacted by smoke from the Red Salmon Fire in 2020 (right) (Photos by Brian McCaughey)

Wildfire ASPIRE Study

Advancing Science Partnerships for Indoor Reductions of Smoke Exposures

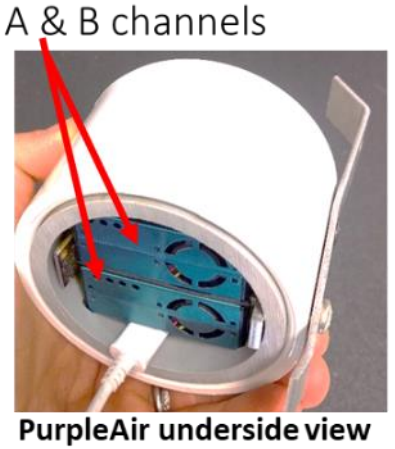
EPA partnered with Missoula, MT and Hoopa Valley Tribe in CA to develop research to meet their needs to protect public health from wildfire smoke

Partner discussions led to these research questions:

- What science is available to support recommendations for communities to develop cleaner air spaces in larger buildings (e.g., schools, community centers)?
- What interventions are effective for reducing wildland fire smoke exposures and risks?
- How effective are portable air cleaners (PACs) during smoke events?

Field Studies

- Goal: Improve understanding of indoor fine particulate matter ($PM_{2.5}$) concentrations during smoke events
- General Approach: Monitored indoor/outdoor $PM_{2.5}$ with PurpleAir sensors to understand real-world variation under typical ambient conditions and when smoke events occur
- Focus:
  - Measure $PM_{2.5}$ in public or commercial buildings
  - All facilities were measured with permission of building owners; monitoring equipment was placed to minimize disruption to building occupants
  - Conducted measurements in Missoula during 2 wildfire seasons
  - Conducted measurements in Hoopa Valley Tribal area for 2 full years, to capture extended wildfire season and wintertime woodsmoke



PurpleAir underside view

ASHRAE Framework Principle: Add ability to monitor $PM_{2.5}$

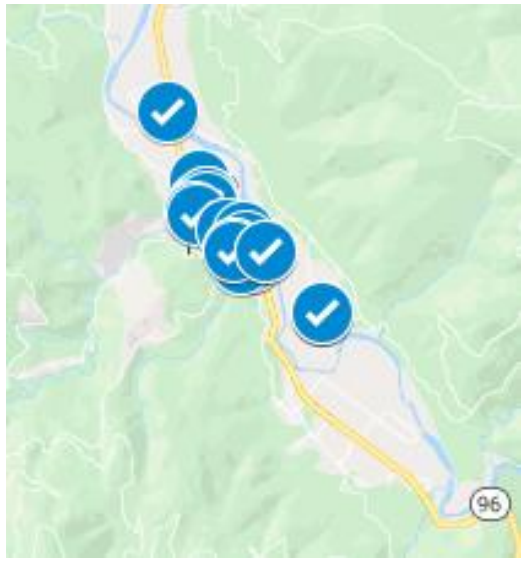
Study Sites

Missoula sites

Frenchtown site

Seeley Lake site

Hoopa Valley Tribe Sites

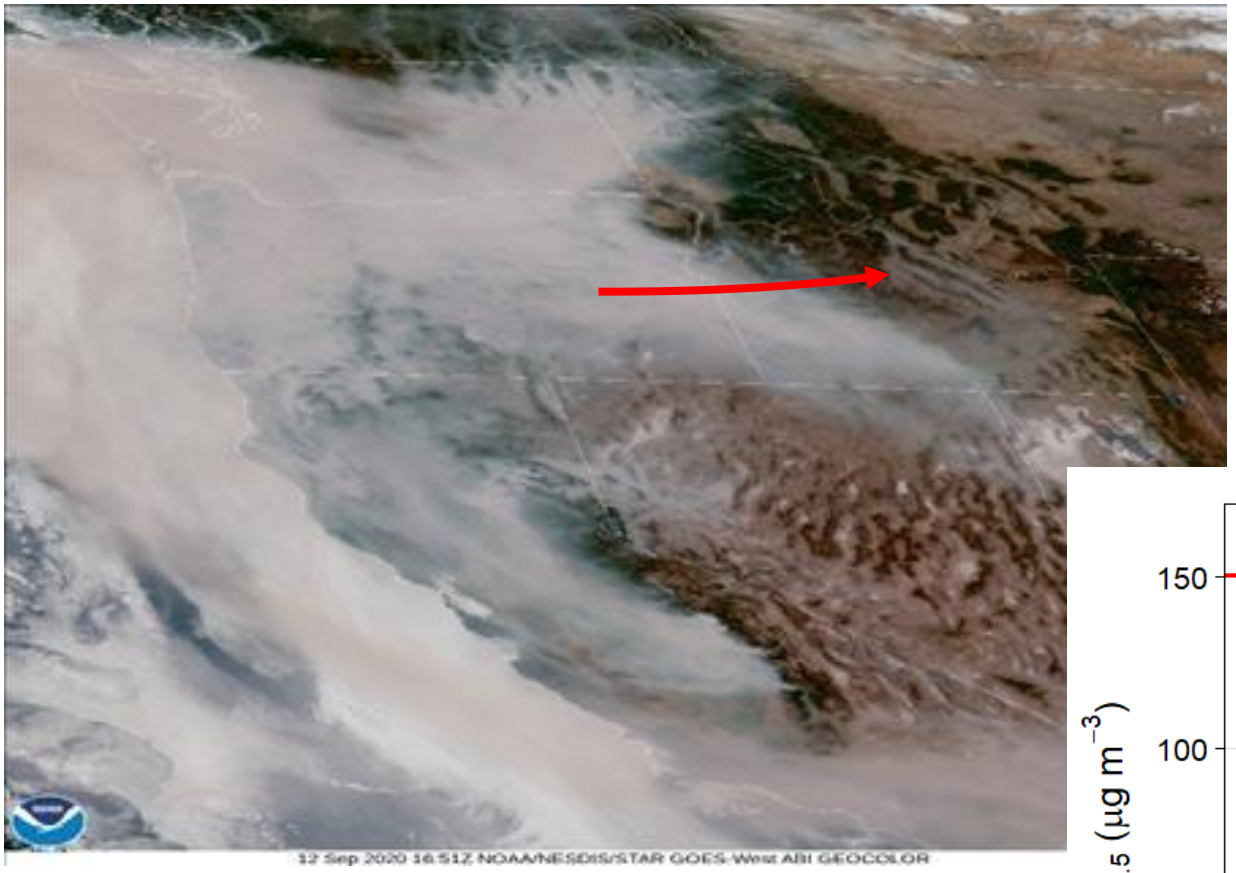


Targeted spaces where people may stay for extended durations or seek out cleaner air:

- Workplaces
- Schools/Daycares
- Community Centers
- Medical Center
- Fitness/Recreational Centers
- Places of worship

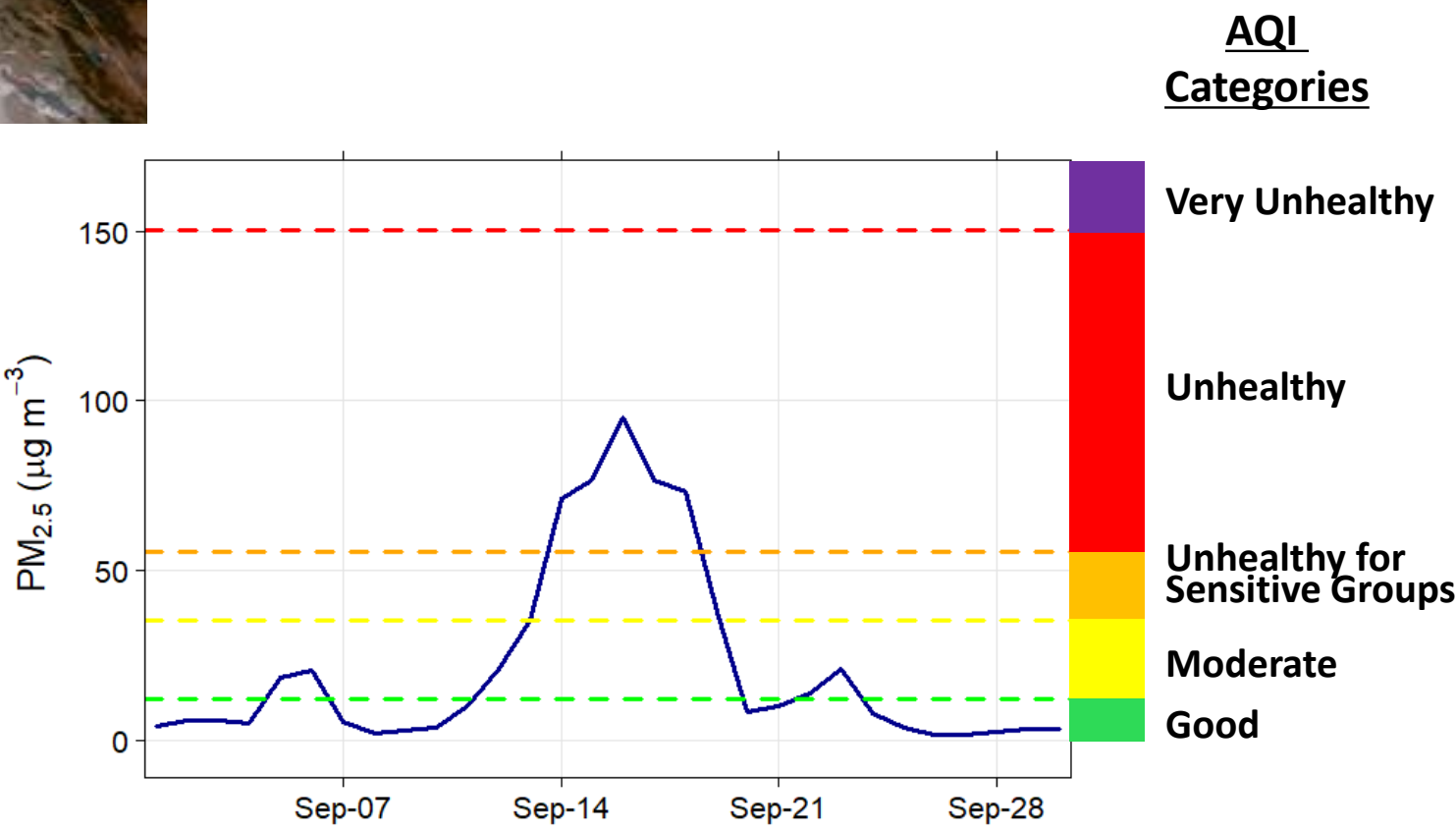
Data analysis for Hoopa sites still underway, focus here will be on Missoula

Results



Source: GOES Image Viewer via Montana DEQ

Smoke from wildfires in Idaho, Washington, and Oregon settled into Missoula for one week in 2020

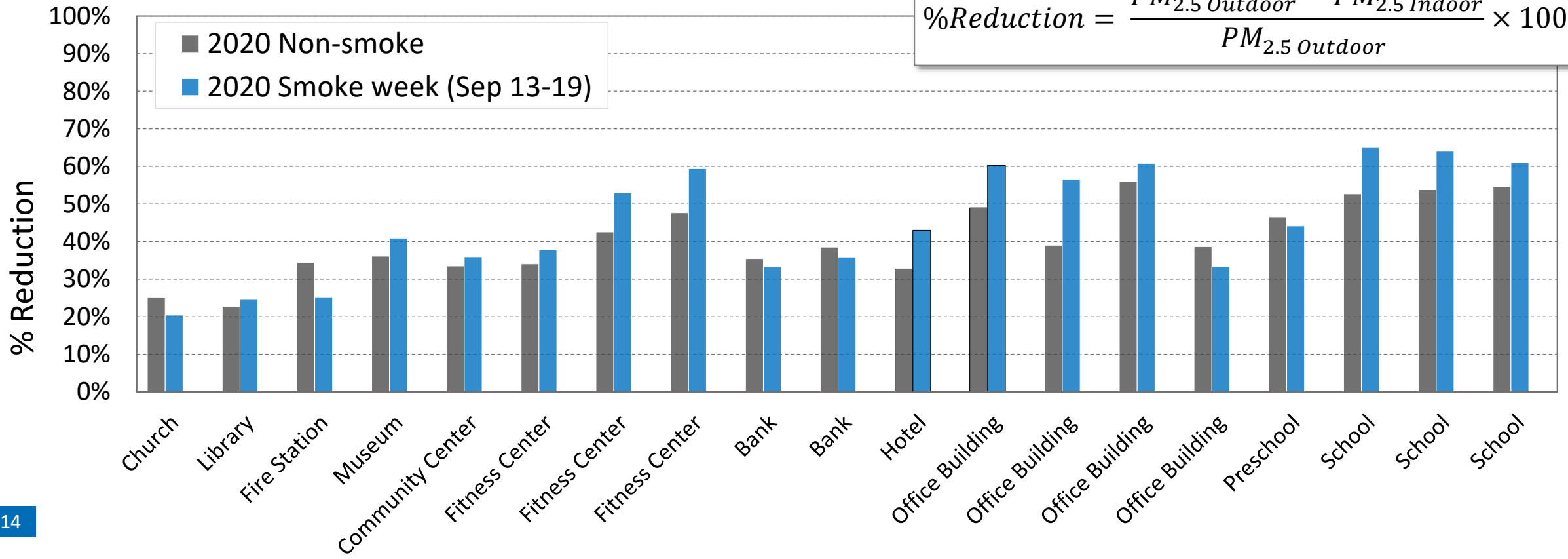


Results: Indoor PM Variability Missoula 2020

- Large differences in $PM_{2.5}$ reductions seen across and within buildings
- Filter MERV rating is <u>not</u> the most important factor
- HVAC system can improve indoor air quality
- Occupant behavior impacts smoke infiltration

Quantify smoke infiltration by:

$$\%Reduction = \frac{PM_{2.5\ Outdoor} - PM_{2.5\ Indoor}}{PM_{2.5\ Outdoor}} \times 100\%$$



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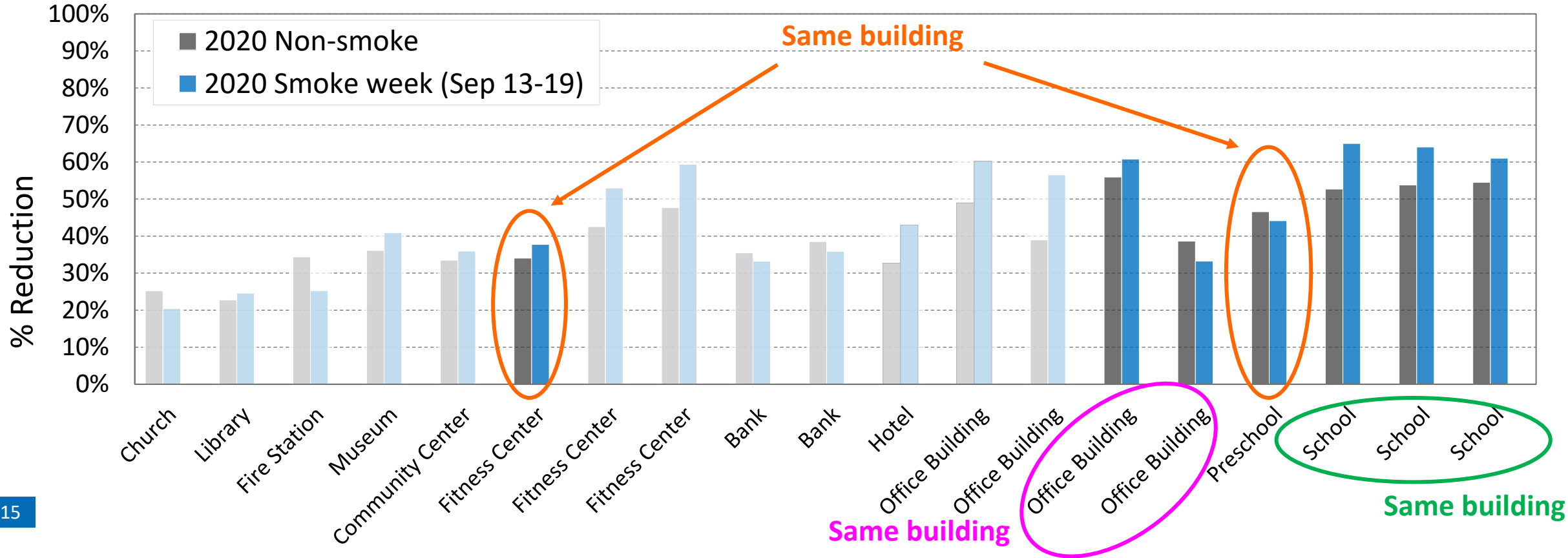

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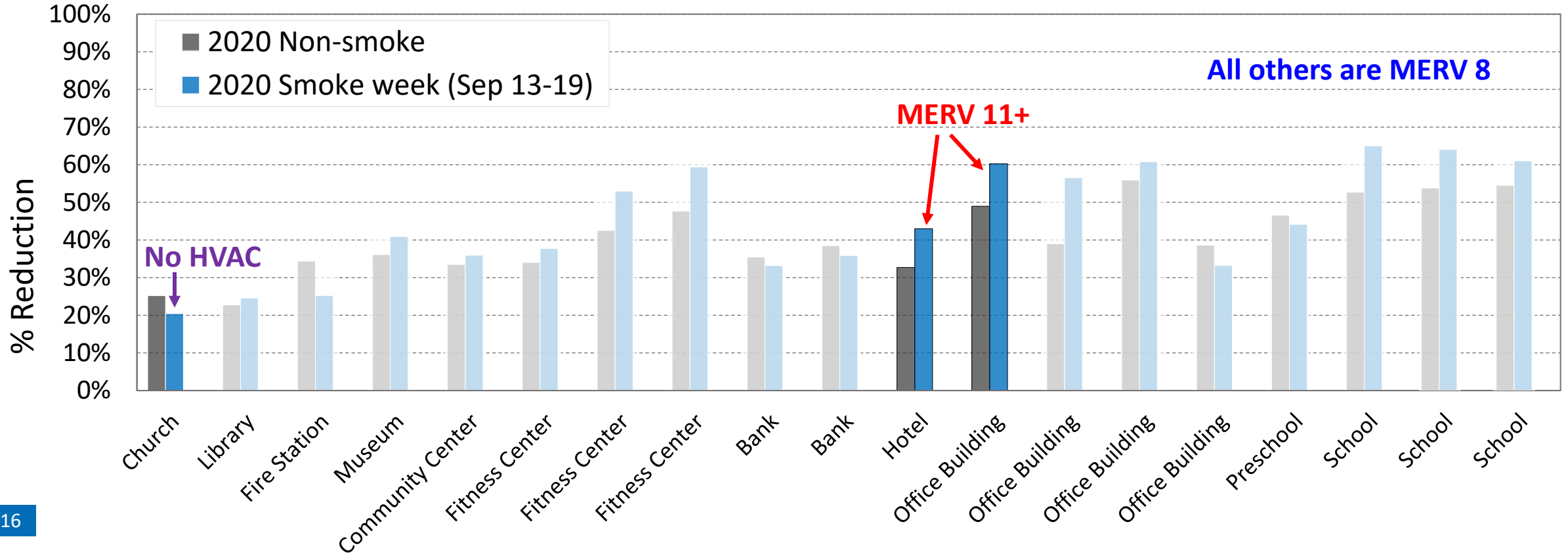

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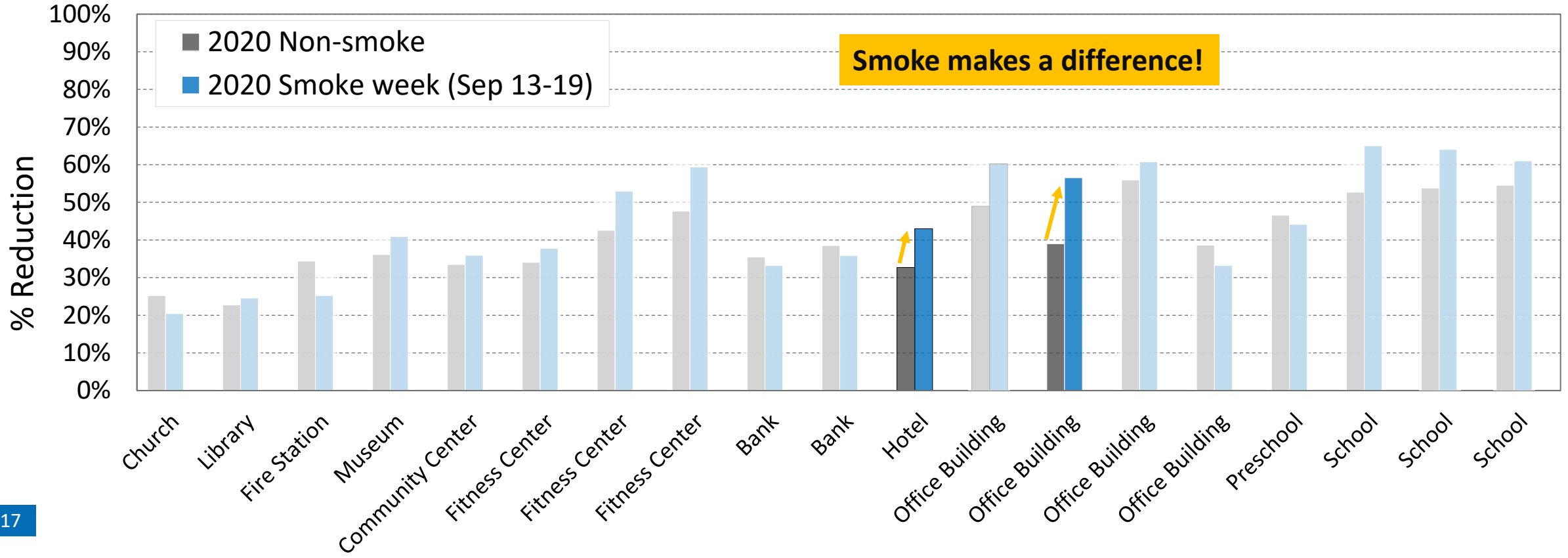

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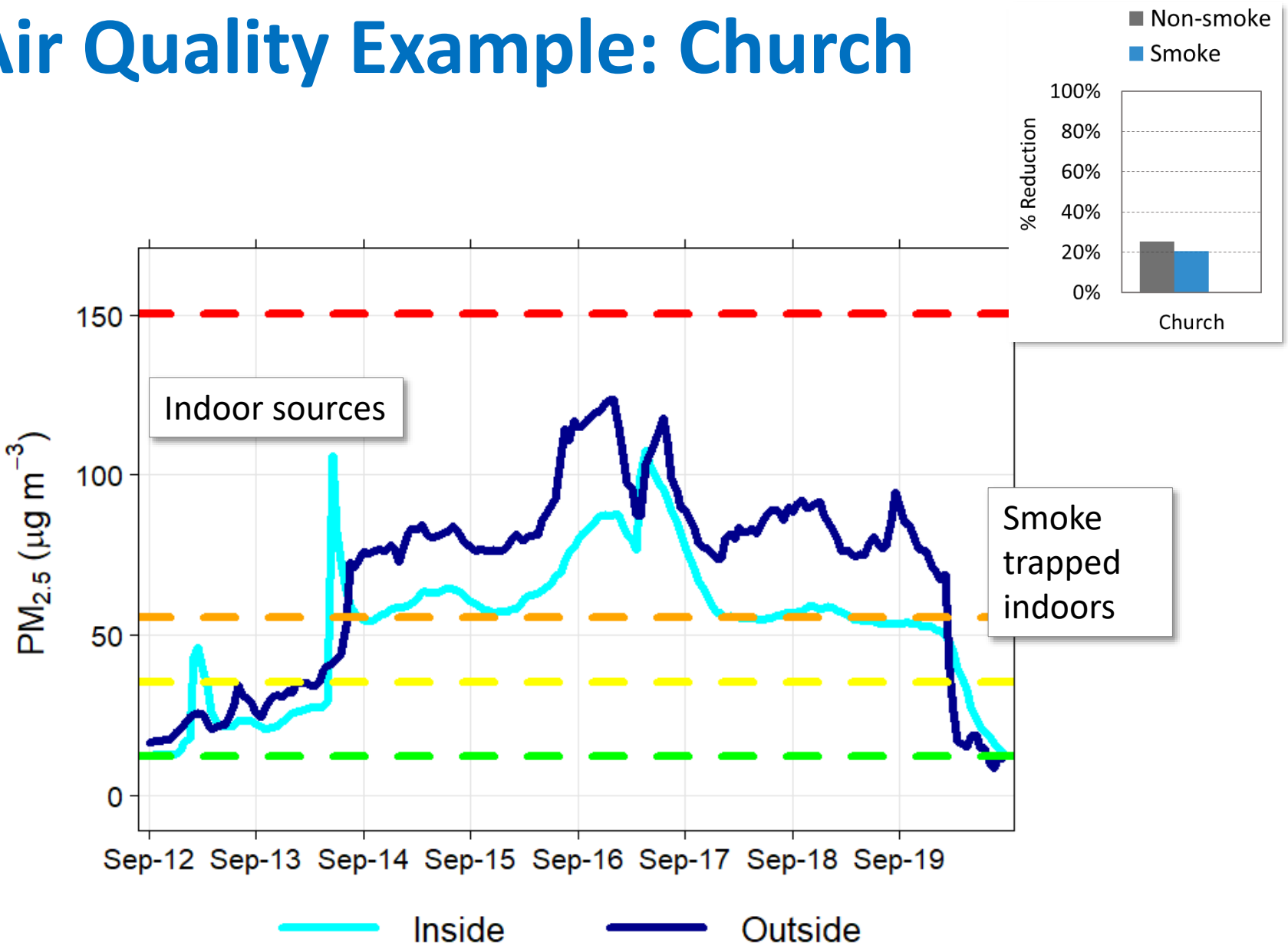
We can use these buildings to demonstrate the ASHRAE Framework principles

Indoor Air Quality Example: Church

- Older church with no HVAC system
- Several indoor sources of $PM_{2.5}$ (e.g., candles, incense)
- Indoor air pollution is frequently worse than outdoor
- After smoke clears outside, indoors is still polluted

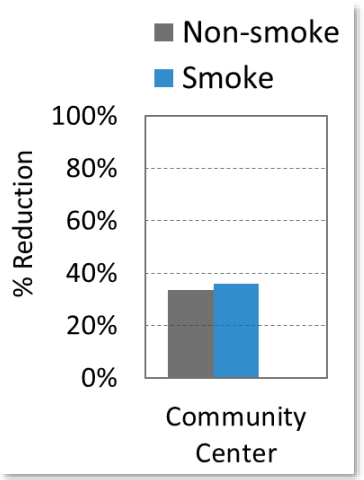


ASHRAE Framework Principle: Anticipate sources of indoor $PM_{2.5}$

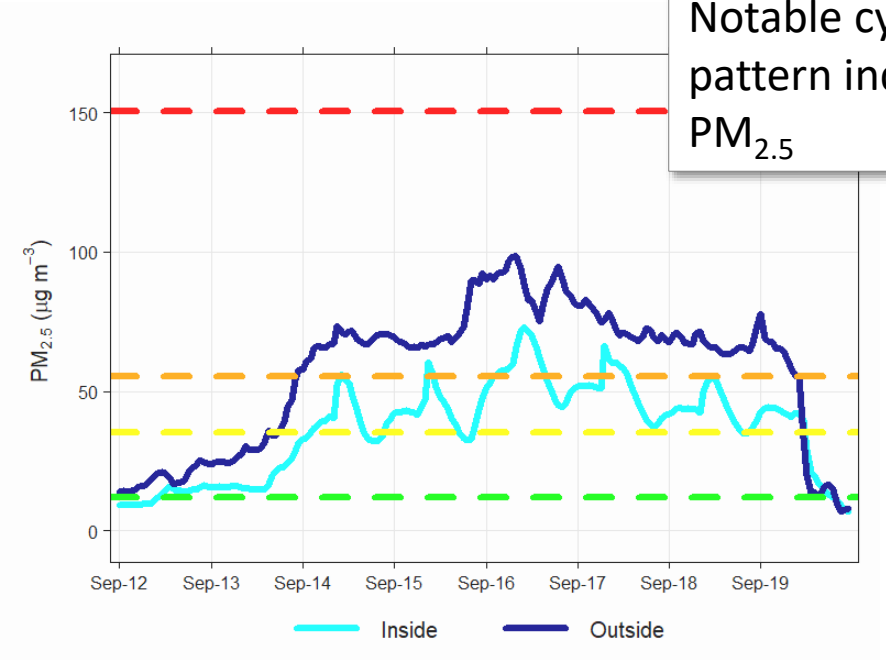
Indoor Air Quality Example: Community Center

- Masonry building constructed in 1955 in poor condition:
  - Gaps to ventilated attic
  - Gaps around doors
- Commercial kitchen with large exhaust hood
- Building pressure was variable with respect to outside

- 4 rooftop air handlers servicing different parts of building:
  - 1 unit equipped with MERV 5 filter
  - 3 units with MERV 8 filters
  - All units have loose fitting filters and loose access doors
  - Outdoor air dampers were broken (1-stuck closed, 1-stuck open)

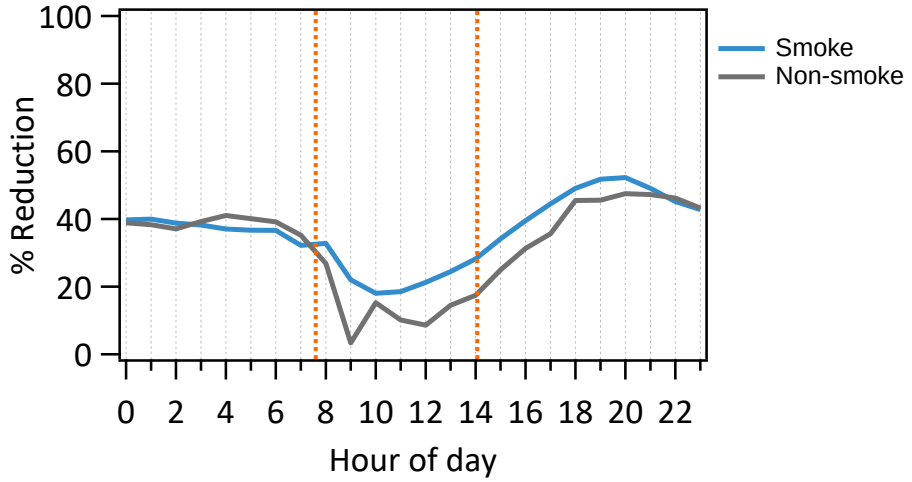


Notable cyclic pattern indoor $PM_{2.5}$



Calculate diurnal patterns to find cause of high $PM_{2.5}$

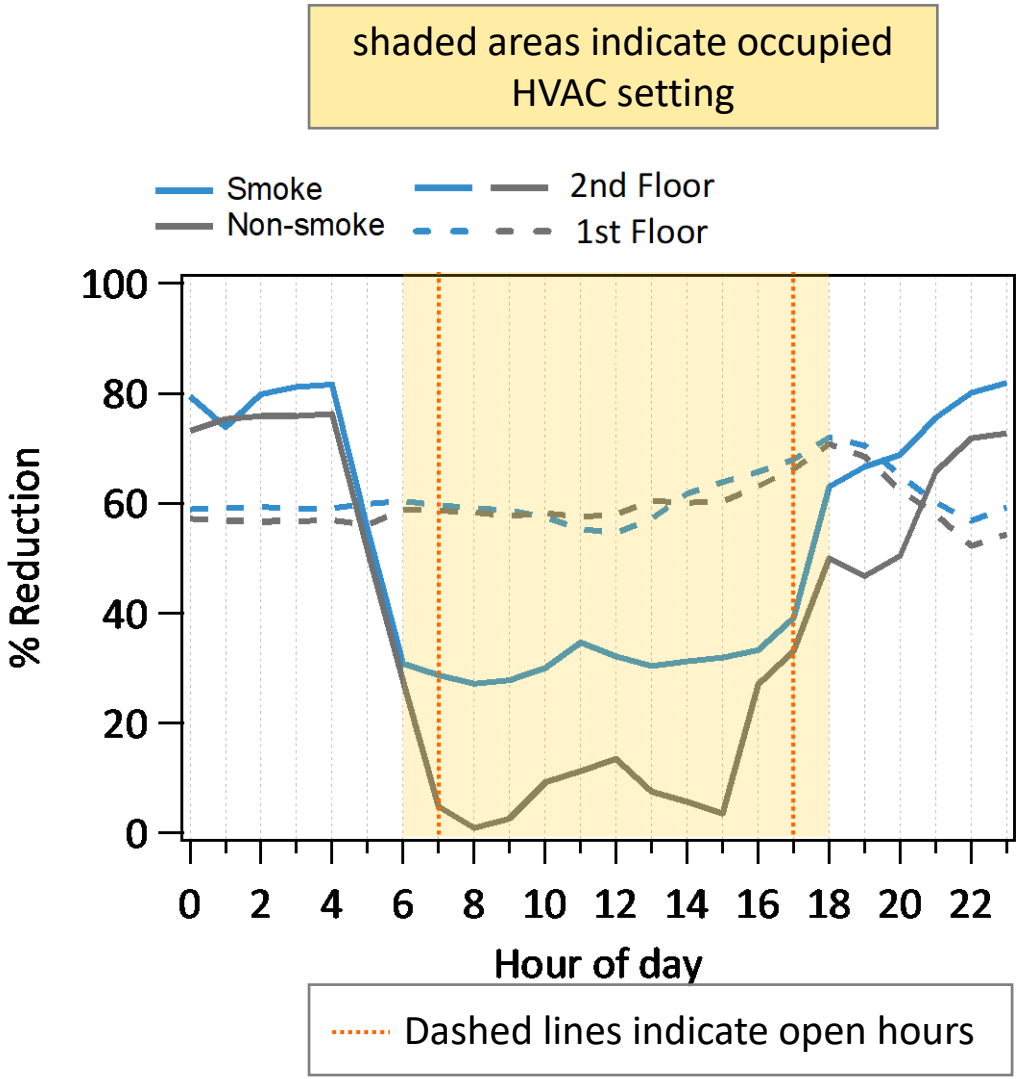
Dashed lines indicate open hours

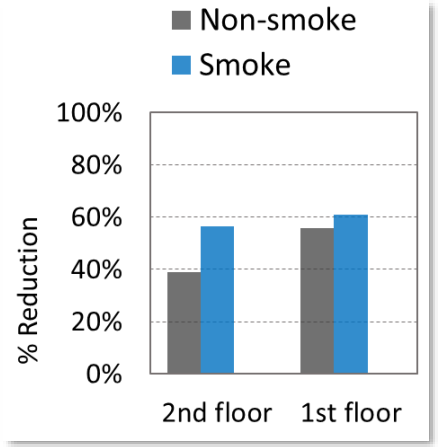


ASHRAE Framework Principle: Use higher efficiency filters, limit smoke intrusion

Indoor Air Quality Example: Office Building

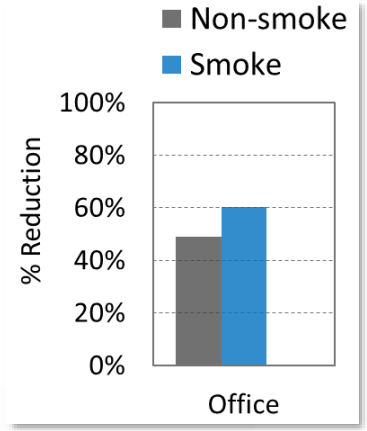
- 2-story office building constructed in 1975 with original HVAC system
- 1st floor HVAC in poor condition, outdoor air damper functions, filters fit tightly
- 2nd floor HVAC in very poor condition:
  - Filter access door has large gaps letting in unfiltered air
  - Outdoor air damper could not hold setpoint
- Occupants in both spaces used portable air cleaners



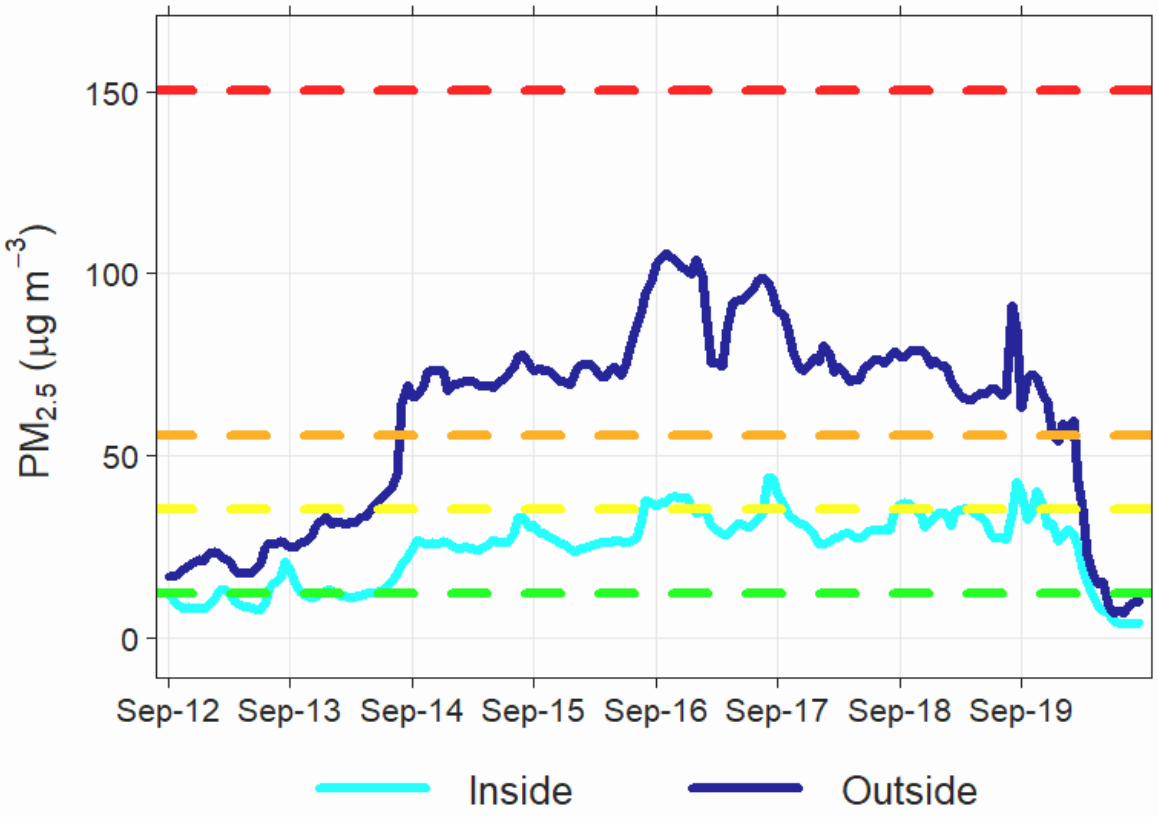


ASHRAE Framework Principle: Perform HVAC maintenance

Smoke Ready Mode Example



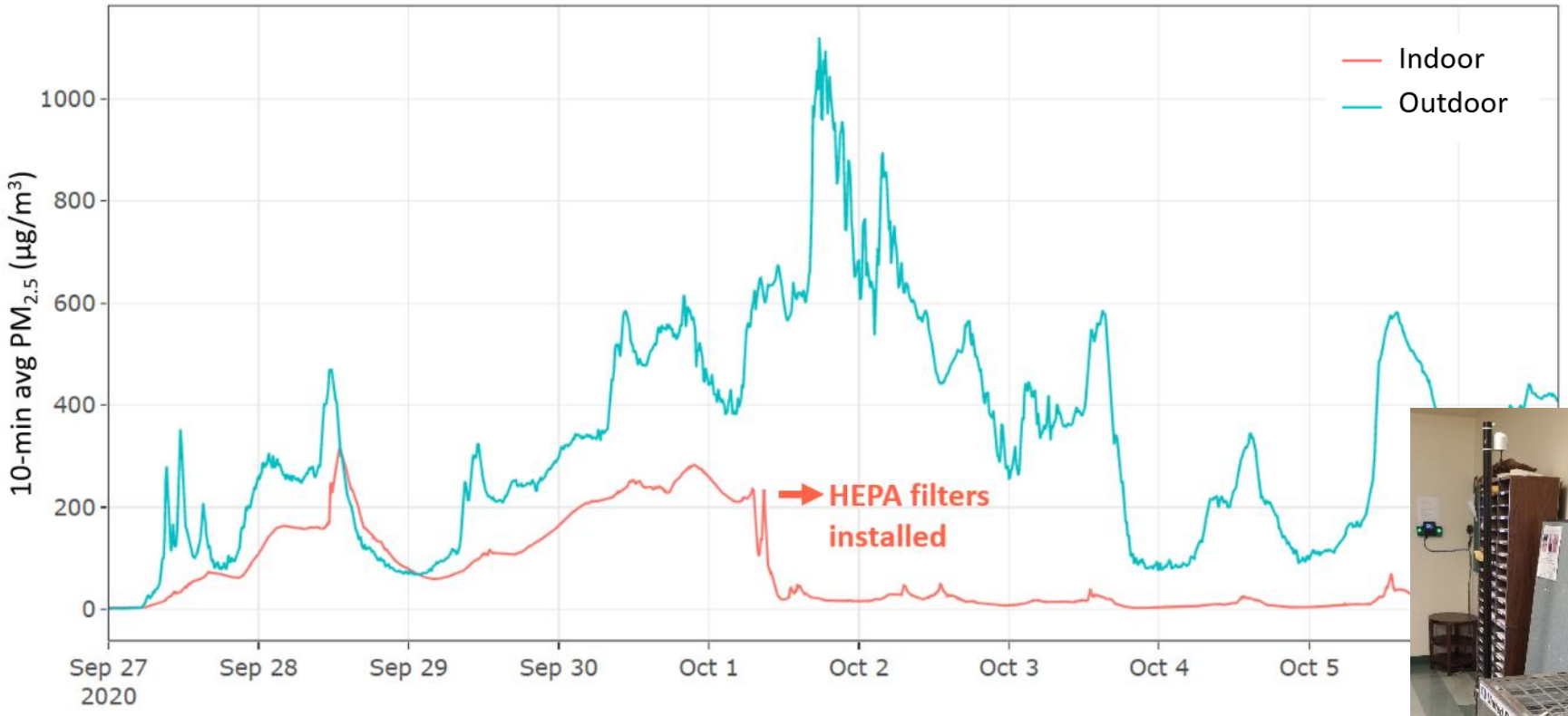
- ~75,000 ft^2 office building constructed in ~2005 with knowledgeable facility manager
- HVAC consists of 7 rooftop air handling units with economizers, modulating outdoor air dampers
  - 5 units have MERV 8 filters
  - 2 advanced filtration units have MERV 8 + MERV 6 with impregnated carbon + MERV14
- Wildfire smoke mode can 'switch on':
  1. Close outdoor air dampers on units with MERV 8 filters
  2. Advanced filtration unit 1 – no outdoor air, max fan speed, recirculate indoor air
  3. Advanced filtration unit 2 – 100% outdoor air, modulate fan speed to maintain positive building pressure



ASHRAE Framework Principle: Create a smoke ready mode

Preliminary Results from Hoopa, CA

- ~12,000 ft^2 Preschool/daycare constructed in 2010
- Building has central air conditioning system that was not optimized
- Building was mostly closed during this phase of the COVID shutdown, 1- 3 people occupy the building daily



During smoke episode, doors and windows were kept closed and an industrial rental air cleaner was used

ASHRAE Framework Principle: Create a temporary cleaner air space

Building/HVAC Inspection

- Inspections of building characteristics and ventilation systems were conducted to better understand factors affecting smoke infiltration and indoor air quality; key findings included:
  - Use ***clean*** filters rated for smoke (MERV 13 or greater) that fit in your HVAC system
  - Perform maintenance on HVAC system to ensure all components work properly
  - Seal gaps in the building envelope (around doors, windows, pipes, and conduits)
  - Close windows and limit door opening and closings

X Right Sized Filters

Crushed filter
(too large for filter rack)

X Unobstructed Air inlets

Obstructed air inlets

X Clean Filters

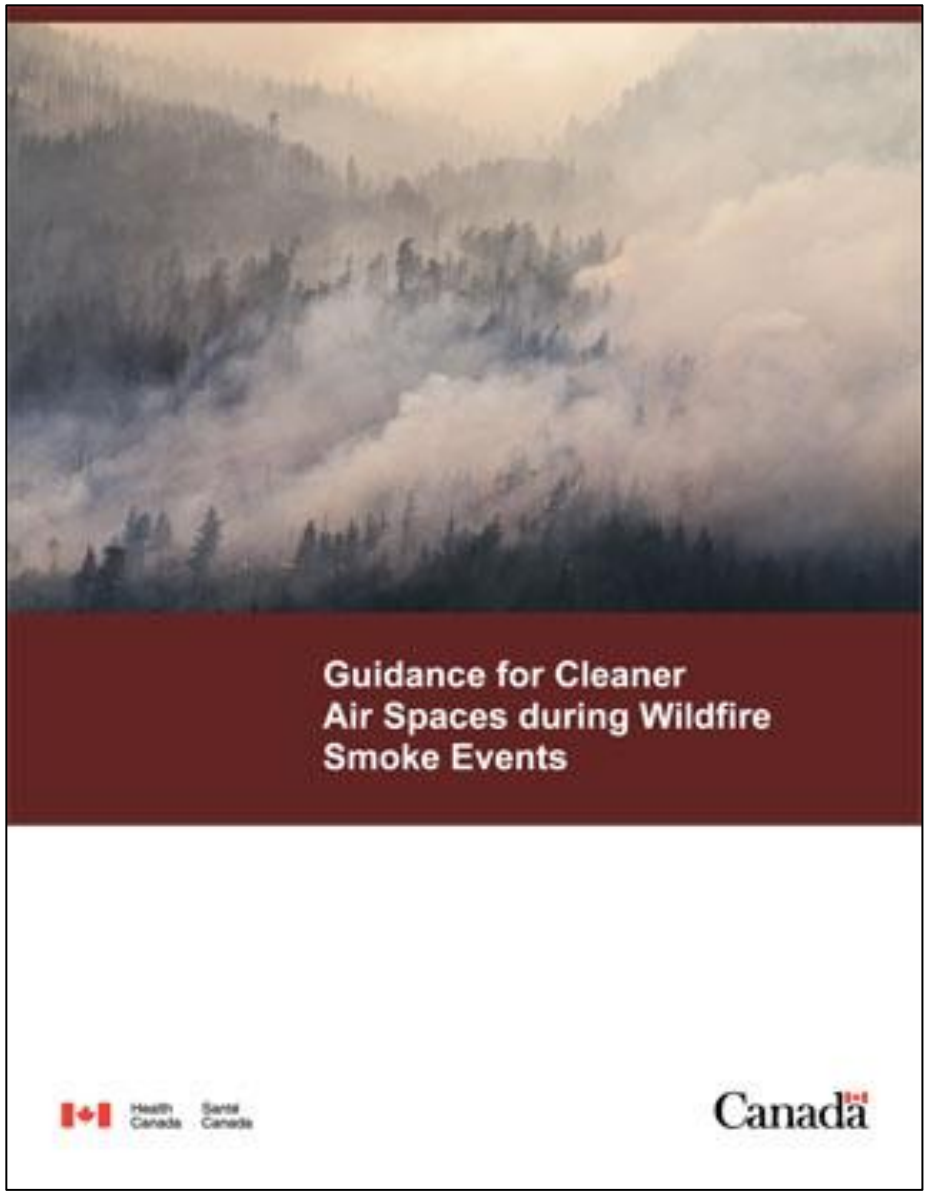
Heavily loaded HVAC filter

X Leaky Doors/Windows

Gap at bottom of exterior door

Cleaner Indoor Air Shelters

- Not everyone has access to clean air at home or work
- Limiting smoke infiltration (e.g., closing doors and windows) results in a trade-off between heat and air quality – both can adversely impact health
- A community cleaner air shelter can be an effective approach to provide clean and cool air to people who made need it most
- May be most effective to target buildings where vulnerable populations spend the most time to turn into cleaner air shelters



Guidance for Cleaner Air Spaces during Wildfire Smoke Events

Take Home Messages: Factors Affecting $PM_{2.5}$ Indoors

Many structural and operational factors of the HVAC system can affect indoor air quality; key points to keep in mind during wildfire smoke events:

- Type, condition, and fit of filters
  - Filters rated lower than MERV 13 do not significantly reduce $PM_{2.5}$
- HVAC system operating hours/settings
  - No filtration occurs when the HVAC system is off since indoor air is not recirculating (same for thermostat settings that reduce use of A/C during nights or weekends)
  - Economizers may bring in large amounts of outdoor air increasing indoor pollution when operating
    - Adjust to a minimum outdoor air setting during smoke events to maintain positive pressure
- Nonfunctioning HVAC components
  - Dampers that regulate the amount of outdoor air coming into the building may be damaged or not operating correctly

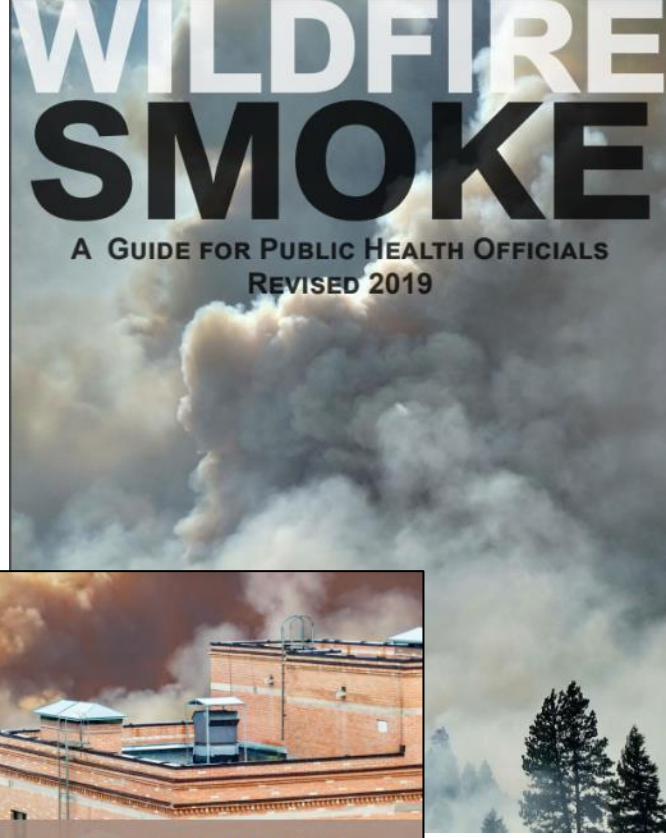
Take Home Messages: Factors Affecting $PM_{2.5}$ Indoors (cont.)

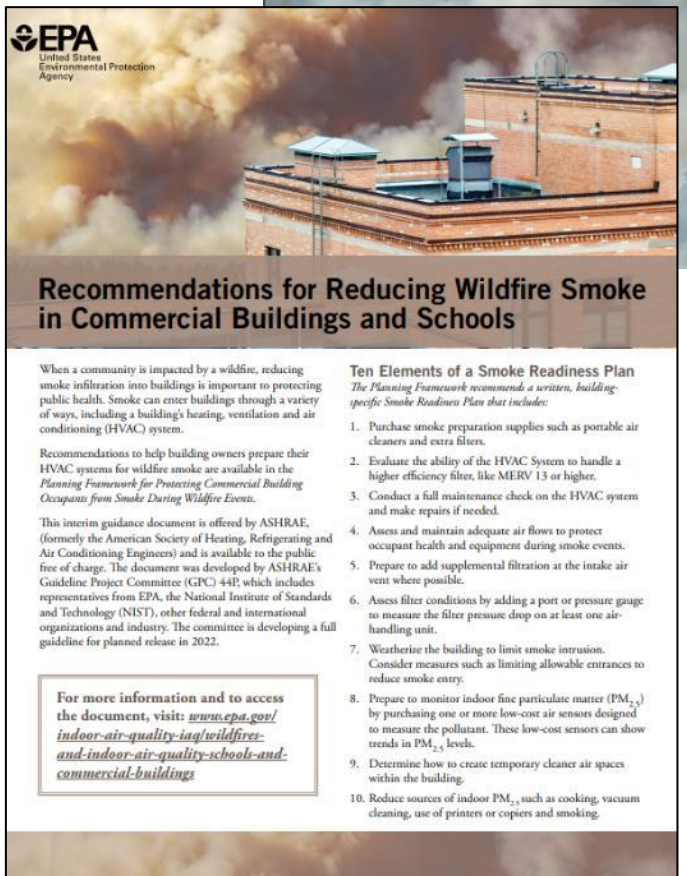
- Older buildings with cracks and gaps around doors and windows may be letting in more smoke
- Positive building pressure can reduce smoke from coming in through cracks and gaps around doors and windows and door openings
- Large air cleaners can be very effective in improving indoor air quality, when practical

Develop a Smoke Readiness Plan before smoke arrives!

Resources for More Information

- ASHRAE committee (including EPA and NIST) interim planning framework – *Protecting Commercial Building Occupants from Smoke During Wildfire Events*
- EPA websites:
  - *Wildfires and Indoor Air Quality in Schools and Commercial Buildings*
  - *Wildfire Smoke: A Guide for Public Health Officials*, *Appendix B Identification and Preparation of Clean Air Shelters for Protection of the Public from Wildfire Smoke, US Interagency*
  - *EPA Wildfire ASPIRE Study*
- Useful guides on filtration and wildfire smoke:
  - *Wildfire Smoke Guide*; Chapter 3, Appendix B, Appendix D
  - *Air Cleaners and Air Filters in the Home*
  - *Create a Clean Room to Protect Indoor Air Quality During a Wildfire*
  - *Guidance for Cleaner Air Spaces during Wildfire Smoke Events*





Contacts

Beth Hassett-Sipple, MSPH
Biologist
Center for Public Health and Environmental Assessment (CPHEA)
US EPA Office of Research and Development
hassett-sipple.beth@epa.gov

Amara Holder, PhD
Mechanical Engineer
Center for Environmental Measurement and Modeling (CEMM)
US EPA Office of Research and Development
holder.amara@epa.gov