Conducting Airflow Studies for Improved Air Quality Measurements

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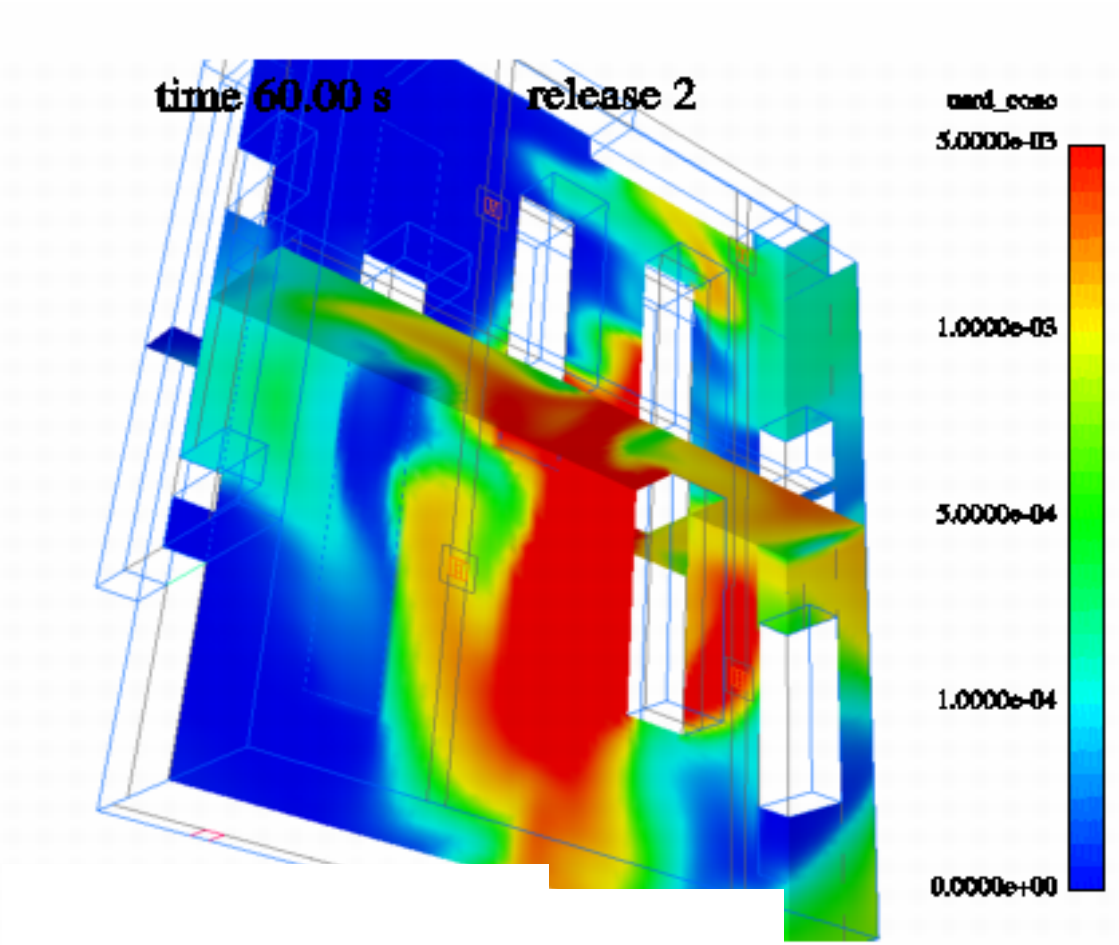
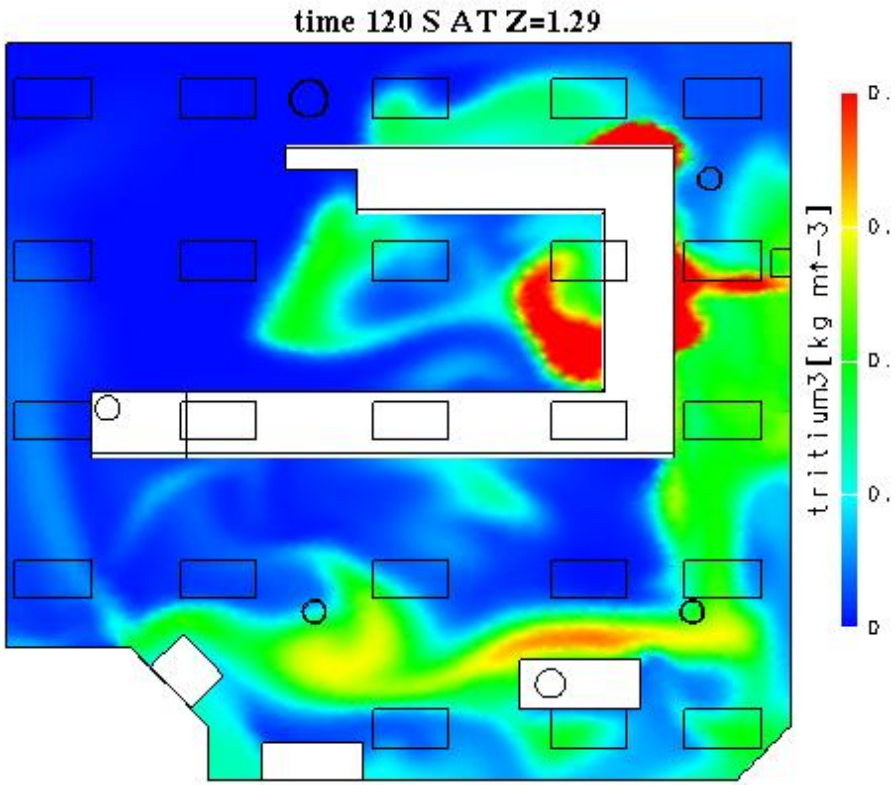
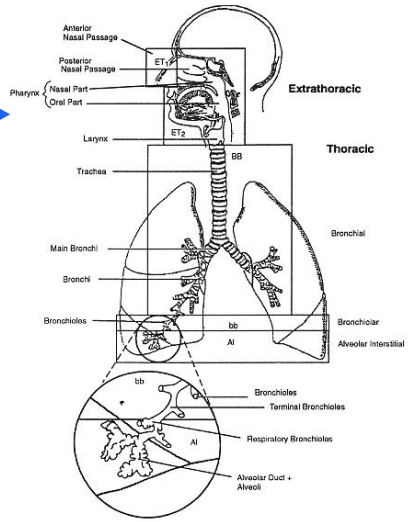
Aerosol and gas dispersion patterns are highly time dependent and spatially heterogeneous

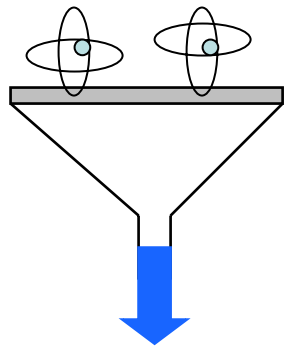


Whicker JJ, Rodgers JC, Fairchild CI, Scripsick RC, Lopez RC. 1997. Evaluation of continuous air monitor placement in a plutonium facility. Health Physics 72:734-743.

Airflow and aerosol dispersion indoors is highly complex and poorly understood, yet it drives human exposure and detection







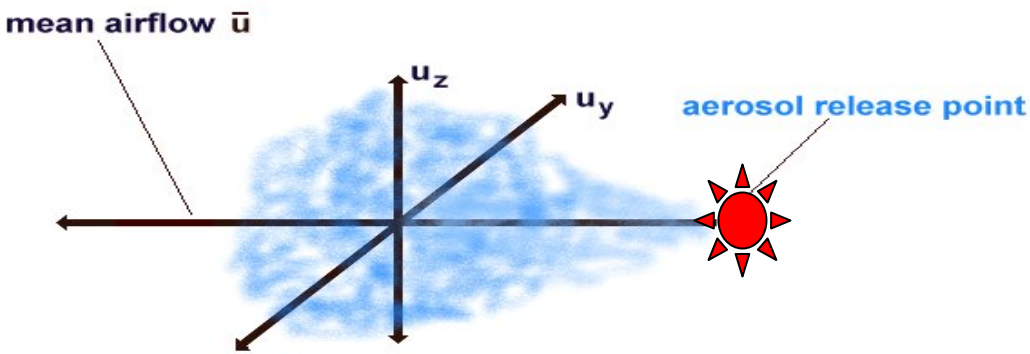
Placement of air samplers and monitors relative to airflow:10CFR835

- Identity potential exposures and verify effectiveness of engineering and other controls in containing radioactive material.
- Real-time air monitoring needed where individual likely to be exposed > 40 DAC-hrs in a year or where there is a need to detect and alert workers of increased concentrations….
  - Need sufficient sensitivity to alert workers to action
    - **Instrument**
    - **Placement**

What is required by regulations: DOE Implementation Guide for Air Monitoring

- "Proper strategy for the placement of real-time air monitors is critical to the effectiveness of the air monitoring program."
- "The number and placement of real-time monitors should be optimized."
  - Balance worker protection against cost
- Reevaluation needed (3 yrs or when there is a significant change in the room)

Gas and aerosol dispersion dynamics



Transport Mechanisms*

1) Molecular Diffusion (0.0008 cm/s)
2) Gravitational Settling (0.003 cm/s)
3) Turbulent Diffusion (> 0.2 cm/s)
4) Room Airflow (> 1 cm/s)

*Rates based on 1 μm diameter particles at STP

Conclusion: Gas and aerosol dispersion dynamics are driven primarily by room ventilation and associated airflow

NUREG-1400 guidance

- Qualitative studies-
  - visual observations, e.g. smoke, balloons
  - record by drawing or video
- Quantitative studies-
  - release tracer and measure concentrations over time and space
  - air velocity measurements (thermal or sonic anemometers)

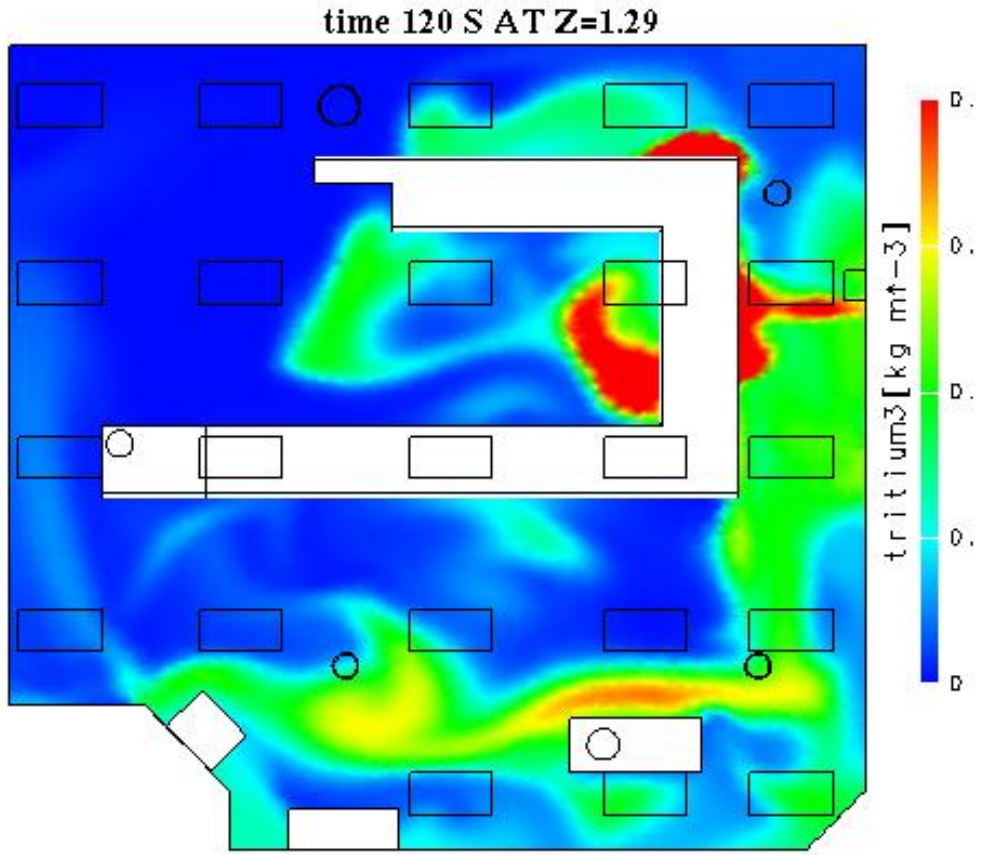
Criteria for ventilation-induced airflow

- Negative differential between ventilation zones of different potential for airborne releases
- Local exhaust ventilation (e.g., hoods)
- Rapidly remove released material from breathing zones of workers and exhaust from room

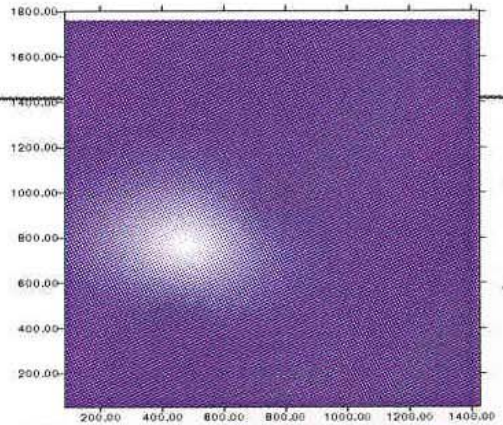
Placement of samplers has to integrated with airflow patterns

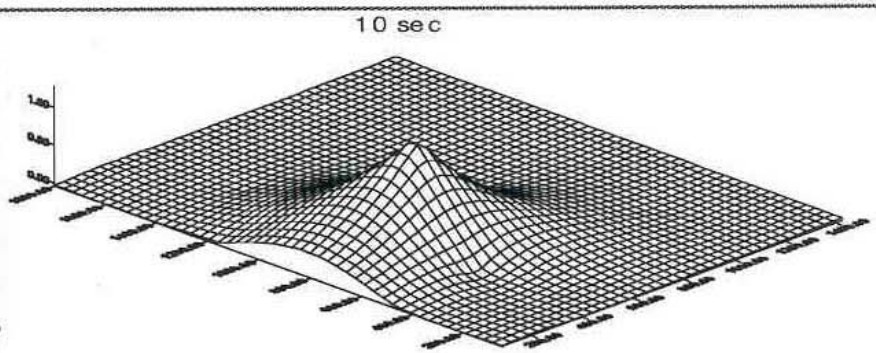
How much of the released material gets to the sampler/monitor?

How quickly does the released material get to the monitor?



Particle cloud transport





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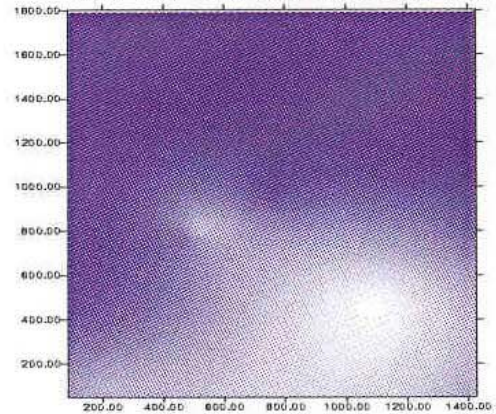

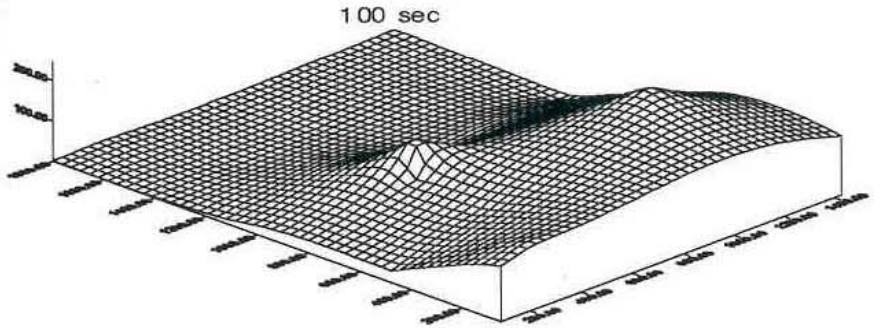

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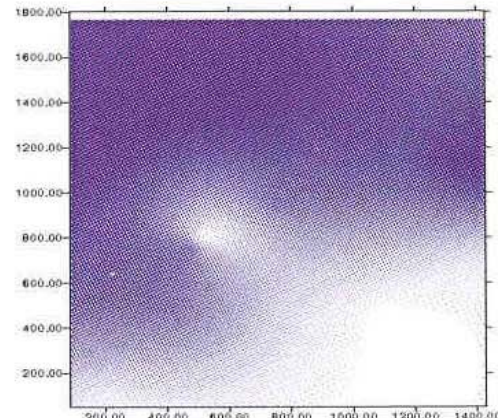

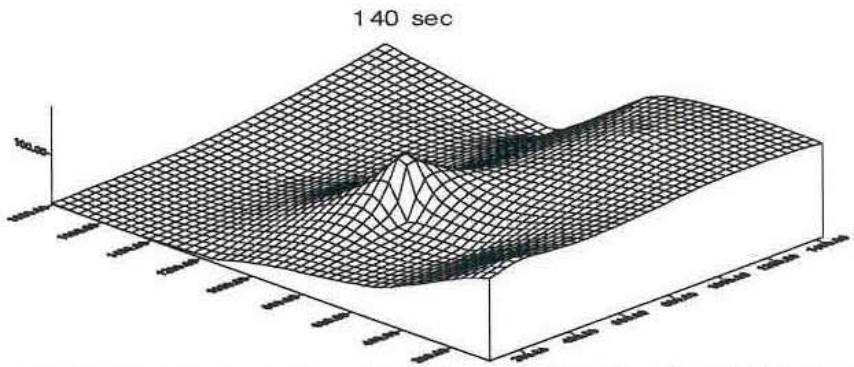

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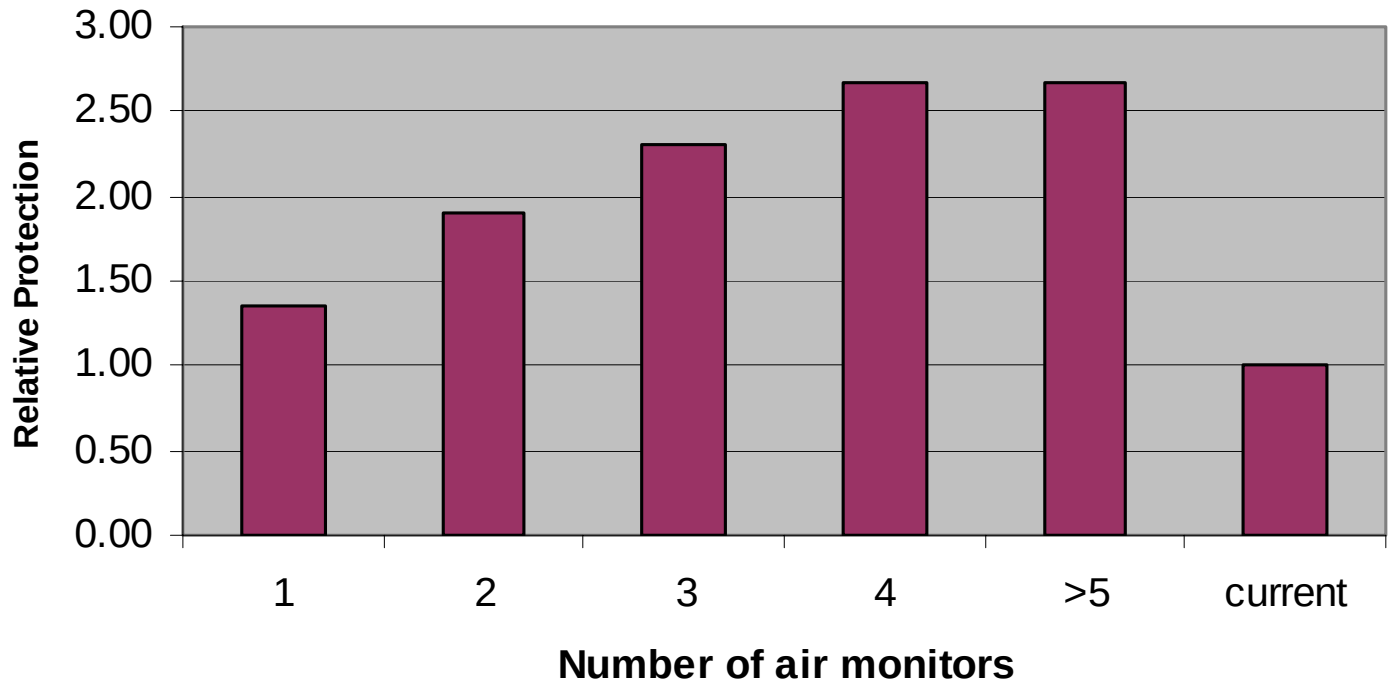
Airflow studies reveal optimal placement strategies to balance safety with cost



Whicker JJ, Rodgers JC, Moxley JS. 2003. A quantitative method for optimized placement of continuous air monitors. Health Physics 85:599-609.

General considerations for airflow studies

- Selection of aerosol generator
  - Particle size
  - Thermal gradients
  - Energy of release
  - Puff verses continuous release
- Room conditions
  - People in room
  - Temperature
  - Ventilation rate
  - Equipment layout
  - Representative of other rooms?

Conclusion: Good Progress

- First draft of the chapter is almost complete
- Goal is to make this chapter useful for practitioners, not just a review of the literature
- Needs better organization
- Balance of detail/generalities needs review