Risk Assessment of Lab Bench Top Processes to Ensure Safety in Smart Labs

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Learning Objectives

1. Laboratory System – Primary/Secondary Controls
2. Centralized demand controlled ventilation (CDCV) overview
3. Lab bench top hazard screening process
4. Risk assessment criteria
5. Risk assessment-based air changes/hour (ACH) decision tree
Laboratory is a “System”

HVAC elements must work together as a system for contaminant control:

1. Primary control – Local exhaust ventilation (at source of contaminant generation)
2. Secondary control – Dilution of room air (ACH)

A key focus of the bench top risk assessment is to drive contaminants into primary controls whenever possible.
Primary (Source) Control – Fume Hood
Primary (Source) Control - Snorkel
Primary (Source) Control - Glove Box
Laboratory is a “System”

For contaminant control, critical to have:

- All HVAC elements in balance and maintained
- Fume hood commissioning & placement
- Good air mixing to avoid contaminant build-up & achieve effective dilution
Dilution – Secondary Control
Centralized Demand Controlled Ventilation (CDCV)

- Air quality monitor varies lab ventilation rates depending on contaminant levels sensed by sensor suite
- Monitors and/or controls ACH
- Variable air volume (VAV) labs
## CDCV - Sensors

<table>
<thead>
<tr>
<th>Type</th>
<th>Sensors</th>
<th>Activation Range</th>
<th>Units</th>
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<tr>
<td></td>
<td></td>
<td>Low</td>
<td>High</td>
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<tr>
<td>TVOC</td>
<td>PID (10.63V)</td>
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<td>Metal Oxide (MOS)</td>
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<td>NDIR</td>
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<td>Optical</td>
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<tr>
<td>CO</td>
<td>Electrochem</td>
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Implementing CDCV

- 6+ACH $\rightarrow$ 4/2 ACH setback with occupancy sensing
- Sensor failure must “fail safe” to 6 ACH
  - Sensor suite does not detect all chemicals
  - Calibration frequency at 6 months
- Visual signal to occupant of ACH
- Emergency exhaust red button
Smart Lab “Safety Net”

- Emergency General Ventilation Purge “Red Button”
  - Fully opens general exhaust ventilation valves
  - Response within minutes
  - Integrated alarm system
  - Deactivates when button is pulled out
Implementing CDCV

- Energy savings can be achieved without compromising safety
- Lab ACH determination requires:
  - Active EH&S involvement in bench top risk assessment of lab operations with lab staff
  - Contaminant source control
  - Reassessment when lab changes occur
  - Current/complete chemical inventories
Implementing CDCV

• ACH reduction not for:
  – Fume hood driven labs
  – Heat load driven labs
  – High risk labs
  – Chemical dispensing/storage areas
Step 1 - Lab Bench Top Screening Process

Conduct room-by-room hazard screening

– Industrial hygienist (IH) evaluates worker exposure
– Review chemicals inventory/operations
– Interview lab staff
– Review engineering controls
– Focus is outside of fume hood
Lab Bench Top Screening Process

• Compare screening data with risk assessment criteria

• Enter screening data in database and indicate if:
  – follow-up needed
  – No ACH reduction
Risk Assessment Criteria

High-risk labs – no ventilation reduction
- Biosafety Level 3 (airborne biohazard)
- Highly toxic gases
- Special ventilation requirements
- Chemicals/operations identified as high risk by bench top assessment or follow-up exposure monitoring
- Fire area control limits exceeded
Risk Assessment Criteria

• Chemicals of Concern
  – Acutely toxic by inhalation
  – Asphyxiants
  – Anesthetic gases
  – Carcinogens
  – Reproductive toxins
  – Air contaminants that have occupational exposure limits (PELs, TLVs)
  – Strong odor producers
Risk Assessment Criteria

Fire Concern

- Flammables/combustibles/toxics - amounts stored over fire control area limits
- 6 ACH at all times
- Reduce amounts!
Risk Assessment Criteria

Animal Allergen Concern

Airborne Allergens (proteins) from animal dander

– No exposure limits for allergens
– 6+ ACH at all times in 24/7 animal areas

The most allergenic animals are:

– Mice
– Rats
– Guinea pigs
Step 2 – Industrial Hygiene Follow-Up

Post Initial Risk Assessment

- Follow-up for chemicals of concern
  - Lab staff exposure monitoring studies
  - Work with lab staff to improve work practices
  - Training/Safety Operating Procedures
Industrial Hygiene Follow-up

• Follow-up for complaints or “other” issues of concern not previously identified (professional judgment)
Work Practice Improvements

- Use local exhaust ventilation for source control
- Substitute less hazardous chemical
- Obtain pre-packaged mixtures
- Reduce quantity/frequency
- Modify operation procedures
Step 2 – Industrial Hygiene Follow-Up

Post Initial Risk Assessment

• Follow-up for chemicals of concern
  – Ventilation reduction possible if exposures can be controlled (improved work practices)
  – ACH may be increased until work practices are improved
High or Low Hazard Lab?
High or Low Hazard Lab?
High or Low Hazard Lab?
High or Low Hazard Lab?
Overnight Set-Backs for “No Ventilation Reduction” Labs
Risk-based
ACH Decision Tree
(qualitative)

START
(6+ACH)

Was the initial reason to not reduce ventilation based on use of a flammable/combustible?

NO

Are there animals in the lab for at least 24 hrs at a time?

NO

Are quantities of flammable/combustibles in the lab over allowed storage limits?

YES

No Overnight Setbacks (6+ ACH)

End

YES

Vertebrate?

NO

Operation/Procedure performed overnight?

NO

NO

YES

Overnight Setbacks (4 ACH)

YES
Other Considerations

• **Good practice:**
  – Control contaminants at the “source”
  – Don’t rely only on general dilution for control
  – Review lab operations/chemicals
  – Communication with lab staff

• **ACH & exposure:**
  – Exposure limits are not based on ACH
  – No known correlation between ACH and exposure or disease
Challenges

- Lack of “universal” CDCV sensor for all chemicals
- Ongoing need for risk assessments of lab operations
- Changes in research operations and staff
- Incomplete chemical inventories
- Great variety of hazardous operations and chemicals
- Uncertainty of health effects of chemicals
Challenges

EH&S resource demand for

- **Ongoing** need for hazard assessments
- Exposure monitoring
- Work practice corrections
- Potential complaint investigations
- Training
Next Steps

• Develop system to identify changes in lab operations
• Re-assess bench top operations:
  – New researchers arrive
  – Lab moves (notification!)
  – Periodic re-assessments

• Promote current/complete chemical inventories

\textit{Lowered ACH is not “sustainable” without EH&S risk assessments and management of change!}
Lab ACH Reductions

Based on Risk Assessments Results to Date

- 13 lab buildings (~250 labs)
- 1540 lab rooms assessed
- 1346 lab rooms - reduced ACH (~87%)
- 194 lab rooms - not reduced ACH (~13%)
Conclusions

• Energy savings can be achieved without compromising safety

• Lab ACH determination requires:
  – Flexibility (evolving process)
  – Contaminant source control
  – Active EH&S involvement in risk assessment of lab operations with lab staff
  – Reassessment when lab changes occur
  – Current/complete chemical inventories