

# ASSESSMENT OF CONTAINMENT PERFORMANCE OF CHEMICAL FUME HOODS UNDER OPERATIONAL LABORATORY CONDITIONS

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# Study Objective

- ❑ To investigate the results of field performance testing of 440 laboratory chemical fume hoods in the As-Installed (AI) and As-Used (AU) condition
- ❑ Testing performed during past two years at variety of medical research facilities for both commissioning of new hoods (AI) and performance monitoring existing hoods (AU)



# Overview of Chemical Fume Hoods Tested

- ❑ Variety of hood types from various manufacturers (walk-ins excluded from data set)
- ❑ Sash types: vertical, horizontal, combination
- ❑ 196 tested in as-installed condition (empty)
- ❑ 244 tested in as-used condition (empty and w/material)
- ❑ Mean hood width 6.8 ft
- ❑ Mean test sash height 20.5"
- ❑ Mean face velocity 109 fpm
- ❑ Mean cross draft velocity 30 fpm

# Testing Performed per ASHRAE 110-1995 *“Method of Testing Performance of Laboratory Fume Hoods”*

- ❑ Face velocity airflow and cross draft airflow testing (fixed thermal anemometer w/10 second averaging)
- ❑ Flow visualization testing—small and large volume smoke
- ❑ Static tracer gas testing—SF<sub>6</sub> gas release 4 l/min for 5 minutes in 3 positions ( iTi Qualitek 200 Ultra High Sensitivity Trace Gas Leak Detector)
- ❑ Testing performed at design sash height

# ASHRAE 110 Testing-Tracer Gas Testing



# Gas Release Pass/Fail Criteria

- ❑ At discretion of buyer, must have tracer gas release level for 5-minute average tests at each location of no greater than 0.10 ppm for "as installed" or "as used" testing and 0.05 ppm for "as-manufactured" per ANSI/AIHA Z9.5 *"American National Standard for Laboratory Ventilation"*

# Overall Pass/Fail Results—Gas Release (.10 ppm Criteria)

440 Hoods Tested Overall: All Pass Face  
Velocity and Airflow Visualization Testing

- ❑ 411 had avg. tracer gas release of  $\leq .10$  ppm--PASS
- ❑ 29 had avg. tracer gas release of  $> .10$  ppm—FAIL
- ❑ Pass Rate 93.4%
- ❑ Fail Rate 6.6%

# Overall Pass/Fail Results—Gas Release (.05 ppm Criteria)

440 Hoods Tested Overall: All Pass Face  
Velocity and Airflow Visualization Testing

- ❑ 387 had avg. tracer gas release of  $\leq$  .05 ppm--PASS
- ❑ 53 had avg. tracer gas release of  $>$  .05 ppm—FAIL
- ❑ Pass Rate 88 %
- ❑ Fail Rate 12 %



# Variables Investigated vs. Gas Release (Outcome Variable)

- ❑ Hood width
- ❑ Sash type (vertical/horizontal/combination)
- ❑ Test condition: AU vs. AI
- ❑ Material in hood—uncluttered, moderately cluttered, cluttered
- ❑ Sash height
- ❑ Area of face opening
- ❑ Face velocity
- ❑ Cross drafts in front of hood

# Open Area as Predictive Factors Gas Release

- ❑ Open Area R Square .15
- ❑ Mean open area of all hoods tested: 9.3 ft<sup>2</sup>
- ❑ Mean hoods passing per .10 ppm criteria: 9.2 ft<sup>2</sup>
- ❑ Mean hoods failing per .10 ppm criteria: 11.5ft<sup>2</sup>
- ❑ Of 213 hoods with openings > mean 9.3 ft<sup>2</sup>
  - 19 had avg. tracer gas > .10 ppm
  - Failure Rate of 9% vs. 7% overall population

# Sash Height as Predictive Factor on Gas Release

- ❑ Sash Height R Square .10
- ❑ Mean sash height of all hoods tested: 20.5"
- ❑ Mean sash height hoods passing per .10 ppm criteria: 20"
- ❑ Mean sash height hoods failing per .10 ppm criteria: 25"
- ❑ Of 99 hoods with sash heights > mean 20.5"
  - 15 had avg. tracer gas > .10 ppm
  - Failure Rate of 15 % vs. 7% overall population

# A Closer Look at Cross Drafts and Sash Heights

- ❑ Mean cross drafts all hoods 30 fpm
- ❑ Mean cross drafts hoods passing 30 fpm/failing 36 fpm
- ❑ Of 341 hoods with sash heights < mean 20.5"
  - Mean cross drafts of 14 failures 52 fpm
  - Mean cross drafts of 327 passes 27 fpm
- ❑ Of 99 hoods with sash heights > mean 20.5"
  - Mean cross drafts of 15 failures 22 fpm
  - Mean cross drafts of 327 passes 28 fpm

## A Closer Look at Cross Drafts and Open Area

- ❑ Mean cross drafts all hoods 30 fpm
- ❑ Mean cross drafts hoods passing 30 fpm/failing 36 fpm
- ❑ Of 215 hoods with open area < mean 9.3ft<sup>2</sup>
  - Mean cross drafts of 15 failures 54 fpm
  - Mean cross drafts of 200 passes 27 fpm
- ❑ Of 225 hoods with sash heights > mean 9.3ft<sup>2</sup>
  - Mean cross drafts of 14 failures 26 fpm
  - Mean cross drafts of 211 passes 31 fpm

# Summary of Key Results:

- ❑ Face velocity testing in combination with smoke testing does not assure containment
- ❑ Sash height and open area are strong predictive factors on containment.
- ❑ In combination with sash height and size of open area, low cross drafts may impact containment. Further multivariate analysis is needed.