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

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ABSA Biosafety Conference, October, 2002
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 a 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

- 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—SF6 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 ≤ .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 ft²
- Mean hoods passing per .10 ppm criteria: 9.2 ft²
- Mean hoods failing per .10 ppm criteria: 11.5 ft²
- Of 213 hoods with openings > mean 9.3 ft²
  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 9.3ft²
  Mean cross drafts of 15 failures 54 fpm
  Mean cross drafts of 200 passes 27 fpm
- Of 225 hoods with sash heights > mean 9.3ft²
  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.