Division of Technical Resources
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News to Use
Design Requirements Manual
The formulae $\frac{\partial \rho U_i}{\partial t}+\frac{\partial}{\partial x_j}(\rho U_i U_j)=-\frac{\partial p}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial U_i}{\partial x_j}\right)+g_i(\rho-\rho_0)$ for building $\frac{\partial}{\partial x_j}(\rho\overline{U_i}\overline{U_j})=-\frac{\partial \overline{p}}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial \overline{U_i}}{\partial x_j}-\rho\overline{u_i u_j}\right)+g_i(\rho-\rho_0)$ state of the art $\frac{\partial}{\partial x_j}(\rho\overline{U_i}\overline{H})=\frac{\partial}{\partial x_i}\left(\lambda\frac{\partial \overline{T}}{\partial x_i}-\rho\overline{u_i h}\right)$ biomedical research facilities.

'Design Requirements Manual (DRM) News to Use' is a monthly ORF publication featuring salient technical information that should be applied to the design of NIH biomedical research laboratories and animal facilities. NIH Project Officers, A/E's and other consultants to the NIH, who develop intramural, extramural and American Recovery and Reinvestment Act (ARRA) projects will benefit from 'News to Use'.
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NIH Fume Hood Testing Protocol

The National Institutes of Health (NIH) Fume Hood Testing Protocol is an enhanced testing procedure for testing fume hoods using ANSI/ASHRAE STD 110 as its baseline performance document.[1] ANSI/ASHRAE STD 110 does not make provision for related factors such as procedure being performed, internal obstructions and factors beyond basic performance of the hood itself. The standard does not provide 'pass/fail' criteria for the test—provides merely a method by which to conduct one. ANSI/ASHRAE STD 110 is meant as one tool in the evaluation of a fume hood, but not a final measure. The NIH Containment Fume Hood (CFH) Testing Protocol was created by Farhad Memarzadeh of the National Institutes of Health in 1997 and further revised by Memarzadeh and Brightbill in 1999 to address these and other deficiencies.[2] The protocol was developed using numerical and experimental testing methods for over 250 laboratory configurations. It features both static and dynamic test procedures that reflect actual exposure levels that workers may experience when using a CFH and it provides specific definitions, instrumentation requirements and pass/fail criteria for each test modification. Thousands of fume hoods have since been successfully tested using the NIH protocol.

Designers and engineers often assume that in complying with ANSI/ASHRAE 110 they are optimizing containment and accounting for the safety of the environment and the health of the workers. However, because a fume hood is a partial containment enclosure, it cannot provide absolute containment. Some level of leakage and exposure inevitably occurs during use. For a CFH acceptance to be based on achieving a minimum containment value by a standardized test protocol, a risk assessment to evaluate the fume hoods placement and working conditions when establishing the face velocity must be performed and tolerance limits defined in each set of circumstances. Once the CFH has been tested for containment, face velocity can be used as a presumptive measure of containment provided that no significant changes to the laboratory CFH supply air or exhaust air ventilation systems have occurred.

Unlike ANSI/ASHRAE STD 110, the NIH testing protocol has clear performance and prescriptive based pass/fail criteria for various parameters whose target values must meet prescribed acceptance levels for dynamic and static tests. The NIH "Static Testing" procedures account for a more cluttered hood, higher tracer gas (6 LPM) release rates and lower allowable measured leakage rates. The NIH "Dynamic Challenges" to the hood includes sash movements and subsequent Variable Air Volume (VAV) exhaust valve response, walk-byes and door movement. Additionally, it assesses turbulent intensity (TI), a much more proportional measurement than face velocity and a more representative parameter of containment effectiveness than those measured in the ANSI/ASHRAE 110 protocol. The NIH testing protocol assesses TI from face velocity for installed conditions. Contaminant leakage is observed from different positions within the hood, with a variety of sash opening settings, at different face velocities and with movement across the face of the hood with and without an operator. Further, it assesses quality of design, installation, and construction such as requiring mock-up testing prior to approval or Hood/Control system combination by an independent agency at the manufacturer's facility for "As Manufactured" (AM); performing most testing during final commissioning and assessing performance of at least 50% of units (100% of CFHs must be tested if the number of hoods is less than or equal to five) for "As Installed" (AI), and testing "As Used" (AU) conditions in which obstructions are present inside the hood and a simulated operator is present to measure the effects of disturbances during experimental setup. Other parameter performance requirements and measurements include:

a) Face Velocity Baseline (FVBL):.51 m/s ± .05m/s
b) Control Linearity (Cl expressed in %): < 2%
c) Time to Steady State$_{10}$ (TSS$_{10}$ expressed in seconds): < 2 sec.
d) Time to Steady State$_5$ (TSS$_5$ expressed in seconds): < 3 sec.
e) Face Velocity Overshoot/Maximum Deviation: < 15% which means at no point throughout the test shall a sample be recorded < 0.43 m/s or > 0.59 m/s
f) Response Time Constant (RTC expressed in seconds): < 0.5 Sec.
g) Steady State Deviation (SSD expressed in %): < 5% assessed using calculated face velocities
h) Controllability (expressed in mV/mm): > 12mV/25.4mm
i) Calculate the TI throughout each test
j) Correlate the TI to the "Box Leakage Factor"
k) For the VAV fume hoods, more details of Alternative Parameter Performance Requirements can be found in NIH Spec. 15992

All tests must be documented in a written report with graphics. On-site testing and off-site mock up to be performed per the NIH protocol are conducted independently of both the fume hood manufacturer and the fume hood control system manufacturer.

NIH Spec. 15991 & 15992 require that testing not start until testing, adjusting and balancing of the air and water systems, calibration and tuning of controls systems, off-site testing of fume hoods and commissioning are complete and the facility is ready for occupancy. Both testing protocols shall be conducted in accordance with ANSI/ASHRAE 110 - Method of Testing Performance of Laboratory Fume Hoods with modifications that constitute the NIH protocol requirements. Additional information regarding fume hood containment testing, room configuration, ventilation requirements etc. can be found in the NIH Design Requirements Manual.

References:

1. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE*): Method of Testing Performance of Laboratory fume hoods* (Standard 110). Atlanta, Ga.: ASHRAE (1995).

2. Memarzadeh, F**.** *Methodology for Optimization of Laboratory Hood Containment.* Vol I and Vol II National Institutes of Health Bethesda, Md.(1996).

Further details on this month's topic are available on the DRM website
http://orf.od.nih.gov/PoliciesAndGuidelines/BiomedicalandAnimalResearchFacilitiesDesignPoliciesandGuidelines/Pages/DesignRequirementsManualPDF.aspx
DRM Chapter 6, Section 1-00 D.7.d - Fume Hoods
National Institutes of Health Specifications -http://orf.od.nih.gov/PoliciesAndGuidelines/Bioenvironmental/Pages/default.aspx