SECTION 15991
ON SITE TESTING CONSTANT
VOLUME FUME HOODS

PART I. GENERAL

Tests identified below, other than the ANSI/ASRAE 110 test, were created by Farhad Memarzadeh of the National Institutes of Health in 1997 and further revised by Memarzadeh and Brightbill in 1999.

On site testing shall 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.

1.1 DESCRIPTION OF WORK

1. The work of this section consists of on site testing the performance of constant volume chemical fume hoods.
2. This section specifies procedures that are common to the scope of Division 11 Section – Laboratory Hoods With Vertical Sash

1.2 SUBMITTALS

1.2.1 TESTING EQUIPMENT AND FACILITIES

1. Specification sheets on all equipment proposed for on site testing specified in Part III of this section.
2. Sample test reports for approval. Contractor shall demonstrate the ability to perform necessary calculations on site the day of the test for the on site testing requirements.

1.2.2 LIST OF HOODS

Submit list of hoods to project officer a minimum of two weeks prior to start of testing. Project officer will check which hoods are to be tested and return submittal. Fifty percent of hoods will be tested.

1.2.3 CERTIFICATIONS

Submit test data attesting that each type of hood to be provided has been tested as installed in accordance with the Modified ANSI/ASHRAE 110-2003 and meets the requirements of this specification. Values of all required measurements and calculations shall be included.

1.2.4 TESTING AGENCY STATEMENT OF QUALIFICATIONS

On Site Testing
Constant Volume Fume Hoods
15991-2

Submit documentation of company experience and registration of the individuals supervising test.

1.3 QUALITY ASSURANCE

1. Testing agency for on site testing shall be independent of both the fume hood control system manufacturer and the fume hood manufacturer.
2. Independent testing agency shall be approved by the NIH project officer. Testing agency shall submit Statement of Qualifications demonstrating experience relating to fume hood testing. As a minimum testing agency shall:
    1. Have a registered Professional Engineer or Industrial Hygienist supervising the testing
    2. Demonstrate prior experience with indicated tests.

1.4 REFERENCE DOCUMENTS

1. ANSI/ASHRAE 110-1999 *Standard for Testing Performance of Fume Hoods*
2. National Fire Protection Association NFPA 45 - *Fire Protecting for Laboratories Using Chemicals*
3. ANSI/AIHA Z9.5 *Laboratory Ventilation Standard*
4. Memarzadeh, F.: *Methodology for Optimization of Laboratory Hood Containment, Volumes I and II*. Bethesda, MD: National Institutes of Health, 1996.

PART II. PRODUCTS

2.1 TEST AND MEASUREMENT EQUIPMENT

1. Anemometers:
1. Anemometers:
    1. Accuracy: ±5% of reading
    2. Internal Time Constant: <=100 ms

    Definition

    a. The Internal Time Constant (ITC) is the amount of time it takes the sensor to respond 63% of the way to a step change.
    b. The Response Time is the length of time to get to within the stated accuracy of the sensor.
    c. Response time = ITC * 3 or 5 depending on what accuracy. Example: If the Response Time is

200ms, the ITC + 40 – ms.

2. Tracer Gas Ejector in accordance with ANSI/ASHRAE 110

3. Tracer Gas (SF6) Sensor:
    1. Sensitivity: 0.01 to 100 ppm
    2. Accuracy:
        a) Above 0.1 ppm: ±10% of reading
        b) Below 0.1 ppm: ±25% of reading
4. Data Acquisition System: minimum 6 channel system capable of simultaneous sampling at 10 Hz or greater

PART III. EXECUTION

3.1 FUME HOOD CONTAINMENT TESTING (ON SITE)

1. General: Constant volume fume hoods shall be tested as installed to assess the level of containment. Testing shall be conducted as outlined below for 50% of the hoods provided in the project. The project officer shall select which hoods are to be tested.

2. Testing shall be conducted in accordance with ANSI/ASHRAE 110 - Method of Testing Performance of Laboratory Fume Hoods with the following modifications. This is primarily a test of the hood and laboratory configuration.

1. Hoods shall be tested with simulated apparatus. This apparatus shall consist of: two each 3.8 L round paint cans, one 300mm by 300mm by 300mm cardboard box, three each 150mm by 150mm by 300mm cardboard boxes. These items shall be provided by the contractor and be positioned from 150mm to 250mm behind the sash, randomly distributed, and supported off the work surface by 50mm by 50mm blocks.

2. The test gas for the tracer gas performance rating and sash movement performance tests shall have a 6 LPM flow rate.

3. The tracer gas and rapid walk-by test will be conducted only at the center position for the manikin.

4. Tracer gas test duration for performance rating test shall be 5 minutes.

5. At the conclusion of each 5-minute test there will be three sash movement performance tests (also called rapid walk-by) at 300mm behind the manikin. Each test shall be spaced 30 seconds apart.

6. There will be a minimum of three and a maximum of five people in the test room during the test procedure.

7. Representatives of the NIH will witness the tests.

8. Test of Alarm: Shut off the fume hood exhaust and verify that the

individual fume hood alarm activates.

9. Test individual controls: Test any controls that are provided at the fume hood such as unoccupied cycle override, alarm override, etc.

3. The following measurements shall be taken, recorded in the certification submittal and must meet the listed criteria:

1. Sash design position or positions: 457 mm
2. Face velocities at each grid point with sash in operating position; Velocity points shall be labeled FVm1, FVm2, FVm3, FVm4, FVm5, FVm6, FVm7, FVm8, FVm9, FVm10, FVm11 and FVm12. (8 points for 1200 mm hoods and 12 points for 1800 mm hoods.) FV shall be sampled at 10 Hz for 5 seconds. No velocity reading shall be below 0.41 mps or above 0.61 mps. This maximum and minimum is to be worst case actual not as measured. Measured are to be adjusted for accuracy of test instrument to get worst case actual. Average shall be recorded for each point. Extremes shall also be recorded for use in calculating Turbulence Intensity.
4. Face velocity for sash at 50% (test and label points and take averages similar to test at operating position): 0.41 to 0.76 mps
5. Face velocity for sash at 25% (test and label points and take averages similar to test at operating position): 0.41 to 1.52 mps
6. Tracer gas performance rating: 0.05 ppm
7. Sash Movement Performance Rating (Also called walk-by test): 0.10 ppm returning to 0.05 ppm within 15 seconds. (Separate readings for each walk-by.)
8. Percentage of auxiliary air supply: 0%. (Auxiliary air hoods are not allowed.)
9. Static Pressure Loss (hood static pressure): Not more than 124 Pa at 0.51 mps face velocity.
10. Volumetric flow rate: Criteria for volumetric flow rate shall be in l/s calculated based on 0.51 mps with the sash in the operating position. Typically it will be around 220 l/s for a 1200 mm hood.

4. The following values shall be calculated, recorded in the certification submittal and must meet the listed criteria

1. Steady State Face Velocity Actual (SSFVa): 0.51 mps (plus or minus 10%). Average of all grid points with each point averaged over 5 seconds. This shall be done at operating, 50% and 25% sash positions.
2. Steady State Face Velocity Measured (SSFVm): 0.51 mps (plus or minus 10%). Volumetric flow rate measured in exhaust duct at two diameters downstream of hood connection divided by face opening area.

3. Turbulence Intensity: (no pass/fail requirement) Root mean square of fluctuation in face velocity measurements. (See 5.1.c for equation.)
4. Box Leakage Factor/Sash Leakage Factor: (no pass/fail requirement)

Value taken from graph. See 5.1.c.

5. The following further defines the above requirements.

1. Face Velocity Parameters shall include:

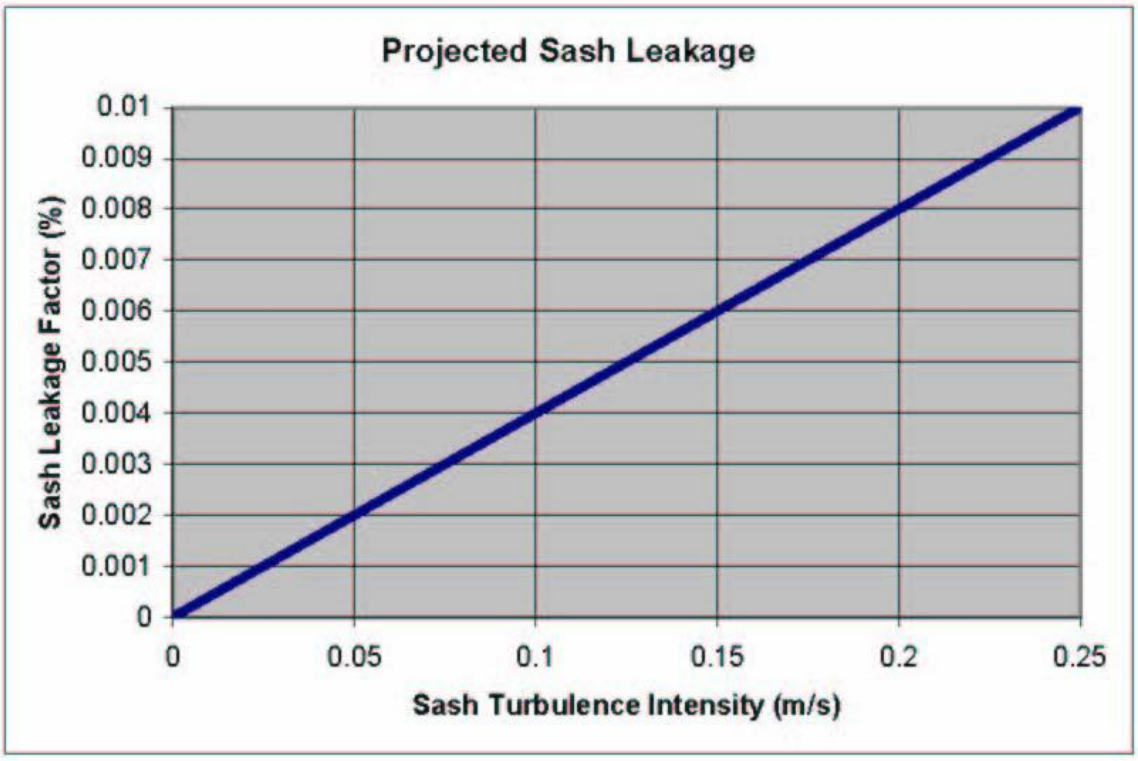
a) Measured Face Velocity (FVm expressed in m/s): Face velocity shall be measured in the plane of the sash at each grid point. Three sensors shall be used simultaneously at each point. Samples for each sensor shall be recorded simultaneously at no less than 10 Hz for 5 seconds. The sensors shall be point sensors located in a grid. Grid points shall be evenly spaced with no more than 300 mm between points. Rotate sensors so that each grid point has three readings; i.e. eight sets of three readings are taken in 1200 mm hoods and 12 sets of three readings are taken in 1800 mm hoods. Averages shall be calculated to assess overall measured face velocity, however individual sensor samples shall be used in calculating Turbulence Intensity (TI).

b) Steady State Face Velocity (SSFV): The average of all sampled face velocities for a 5 second period. SSFVs will be determined for both measured face velocity and calculated face velocity.

c) Turbulence Intensity (TI expressed in m/s): Calculated root mean square of the fluctuating face velocity determined using FVm, calculated as follows:

$$TI = [SUM_{1 \text{ to } n}((FV_{m1}-SSFV)^2+\ldots+(FV_{mn}-SSFV)^2)]^{1/2}$$

The most extreme values of FV taken during the sample period shall be used. This value shall be calculated for each of the steady state conditions preceding and following each sash movement performance test. This shall be correlated to a "Sash Leakage Factor" using the following graph of the installation using the Methodology for Optimization of Laboratory Fume Hood Containment" (MOLHC) by NIH Office of the Director, Farhad Memarzadeh principal investigator. While this value does not have a pass/fail requirement, it is the fundamental indicator of containment and therefore shall be clearly reported.



d) Hood Static Pressure: Take traverse readings to measure exhaust rate and measure the hood static pressure two straight-line duct diameters downstream from the point of connection between the hood and the exhaust line. The readings shall be taken with a face velocity of .51 m/s ±.05 m/s at the full open sash position. (Open sash typically is 18" to 22").

e) Test Execution: Testing agency shall be equipped to execute the testing and assess all performance parameters on site the day of the test.

f) Test Documentation: All testing, calculated, and recorded parameters shall be presented in a report that shows the recorded parameters graphically and tabulates and summarizes all the results. Performance of the hood, the hood controls, and the laboratory in general shall be described and summarized.