# Guide Specification
# for
# Laboratory Fume Hood Commissioning

3 February, 1997

**Application notes:**

This specification is intended to be used by qualified, experienced engineers and industrial hygienists as a guide for specifying the commissioning or testing of laboratory fume hoods.

Modifications to it will be required to customize it to your particular application, project or facility. Simply cutting and pasting it into another document is insufficient. If you are unfamiliar with the ASHRAE 110 method then you should retain a laboratory consultant for assistance. Consult the following WWW page for more information:

http://www.safelab.com/fact_sheets/fact7/fact7.htm.

Word processing files of this document may be downloaded in several different formats from the page above using most web browsers.

Comments embedded in this guide specification are enclosed in [brackets].

All references to the *ANSI/ASHRAE 110-1995 Method of Testing Performance of Laboratory Fume Hoods* shall be abbreviated as ASHRAE 110 herein.

Comments and questions about this specification should be addressed to:

Dale T. Hitchings, PE, CIH
Hitchings Associates, PC,
by e-mail at: dhitchings@safelab.com
or by calling: 317-872-6600.

1. Scope:

   1.1. The following fume hoods shall be commissioned using the method outlined herein:

   [Insert list of fume hoods to be commissioned here.]

2. Commissioning Contractor Qualifications.

   2.1. The fume hood commissioning contractor shall have a Certified Industrial Hygienist (CIH) on staff and the testing technician shall either be certified to perform the ASHRAE 110 test by the International Laboratory Safety Institute [see note below] or shall demonstrate competency in this are by proving that they perform at least 100 of these tests per year and can provide references acceptable to the owner.

> Note: At this time, a certification organization is being formed to train, test, certify, and maintain the certifications of consultants and contractors who do laboratory design and fume hood testing and commissioning. The organization is called the International Laboratory Safety Institute. As soon as they are operating their training and certification programs, a phone number and address will be added. Until then, we suggest the following three firms who are properly qualified to do ASHRAE 110 testing, interpret the results and make recommendations for improving fume hood performance. They are:
>
> Hitchings Associates, PC
> 5320 W. 79th St.
> Indianapolis, IN 46268
> Phone: 317-872-6600
> (Dale Hitchings is an expert in laboratory ventilation and has performed hundreds of ASHRAE tests and has performed significant research on applying and improving the method.)
>
> Exposure Control Technologies
> 120 Loch Haven Ln., Carey, NC 27511
> Phone: 919-859-6572
> (Tom Smith, President of ECT has performed more ASHRAE 110 tests than anyone on the planet and pioneered many of the automated data collection techniques outlined herein)
>
> Knutson Ventilation Consulting, Inc.
> 3404 W. 60th St.
> Minneapolis, MN 55410
> Phone: 612-928-0195
> (Dr. Knutson co-developed the ASHRAE 110 method as part of an ASHRAE research project back in the late 1970's and is imminently qualified.)]

3. Equipment and Supplies.

3.1. The commissioning contractor shall be properly equipped to perform this testing including, but not limited to: the equipment specified in section 4 of the ASHRAE 110 standard plus an automated data acquisition system capable of reading data from an analog velocity transducer and the tracer gas detector and producing graphical output.

3.2. All instruments used shall have been calibrated within the last year or within the time period specified by the instrument manufacturer.

3.3. The calibration gases used shall have certificates of analysis.

4. Test Conditions.

4.1. The test conditions outlined in section 5 of the ASHRAE standard shall be observed.

5. Test Procedures for All Fume Hoods

5.1. Exhaust System Stability Test.

5.1.1. This test shall be performed at least once on all manifolded exhaust systems to which fume hoods which are to be commissioned are connected.

5.1.2. Insert the velocity transducer into the exhaust duct (preferred) or insert it into the middle baffle slot of the hood normal to the back of the hood.

5.1.3. Orient the probe window parallel to the duct centerline if inserted into the duct or vertical if it is inserted into the baffle slot.

5.1.4. Take velocity readings to determine if the velocity is in the range of the transducer. If not, change the range of the transducer or relocate it to another location.

5.1.5. If excessive (high frequency) turbulence is experienced, relocate the transducer farther downstream from the nearest obstruction.

5.1.6. Start velocity acquisition and accumulate velocity data for 5-10 minutes.

5.1.7. Calculate the standard deviation of the velocity data and normalize by the mean to get the coefficient of variation (COV).

5.1.8. Analyze the velocity plot graphically and determine if system instability exists. Instability is normally manifested by large velocity variations (>10% above and below the mean) with a relatively low frequency (>10 seconds). The variations may be random or periodic.

5.1.9. If instability exists, investigate and correct the problem and repeat the stability test before proceeding with further testing.

5.1.10. Record the final COV data and the plot of the velocity on the test report.

5.2. Local Visualization Challenge (Low-Volume Smoke Test)

5.2.1. This test is to be performed per section 6.1.1. of the ASHRAE 110 standard.

5.2.2. The observations shall be classified using the following criteria and recorded on the test report.

5.2.2.1. **Fail:** Smoke observed escaping from the hood.

5.2.2.2. **Poor:** Reverse flow of smoke near opening. Lazy flow into opening along boundary. Observed potential for escape.

5.2.2.3. **Fair:** Some reverse flow, not necessarily at the opening. No visible escape.

5.2.2.4. **Good:** No reverse flows. Active flowstreams into hood around boundary.

5.2.3. If smoke escapes from the hood during this test it indicates a gross leak and testing shall be terminated until the cause of the leakage is determined and corrected.

5.3. Large-Volume Smoke Visualization Challenge (High-Volume Smoke Test)

5.3.1. This test is to be performed per section 6.1.2. of the ASHRAE 110 standard.

5.3.2. The observations shall be classified using the following criteria and recorded on the test report.

5.3.2.1. **Fail:** Smoke observed escaping from the hood.

5.3.2.2. **Poor:** Reverse flow of smoke near opening. Slow capture and clearance. Observed potential for escape.

5.3.2.3. **Fair:** Some reverse flow, not necessarily at the opening. Limited turbulent vortex in hood. All smoke captured and cleared readily. No visible escape.

5.3.2.4. **Good:** Good capture and quick clearance. Limited hood roll vortex. No reverse flows. No visible escape.

5.3.3. If smoke escapes from the hood during this test it indicates a gross leak and testing shall be terminated until the cause of the leakage is determined and corrected.

5.4. Face Velocity Measurements

5.4.1. Face velocity testing shall be performed per section 6.2 of the ASHRAE 110 standard with the following exceptions:

5.4.1.1. The instrument shall be a velocity transducer with a continuous analog output interfaced to a data acquisition system and a computer with software capable of reading, storing and displaying graphically the velocity data.

5.4.1.2. Velocity data shall be taken at a frequency not less than the response time of the instrument and not greater than once per second.

5.4.1.3. Velocity data shall be taken for a minimum of 30 seconds at each traverse point.

5.4.1.4. The average, minimum, maximum, standard deviation, and grid coordinates for each traverse point shall be calculated and recorded on the test report.

5.4.1.5. The average face velocity shall be calculated from the data above and recorded on the test report.

5.4.1.6. The *Turbulence* shall be calculated by averaging the standard deviations of each traverse point and normalizing by the mean face velocity. Record this data on the test report.

5.4.1.7. The *Profile* shall be calculated by determining the standard deviation of the traverse point means and normalizing by the average face velocity. Record this data on the test report.

5.5. Tracer Gas Containment Test.

5.5.1. This test shall be performed per section 7 of the ASHRAE 110 standard with the following exception.

5.5.2. If the tracer gas detector has a detection limit below 0.01 ppm, a lower supply concentration of tracer gas may be substituted for pure gas. The concentration of the tracer gas in percent shall not be lower than:

Tracer Gas Supply Concentration >= (Detection Limit / 0.01) x 100

5.5.3. If the tracer gas detector *cannot* be programmed for the tracer gas supply concentration, the instrument output needs to be scaled. The scale factor is calculated as follows:

Scale Factor = 100 / Tracer Gas Supply Concentration

The actual control level is calculated as follows:

Actual Control Level = Instrument Control Level x Scale Factor

5.5.4. If the tracer gas detector *can* be programmed for the tracer gas concentration, it will automatically perform the calculations in 5.5.3 above and the instrument readings *should not* be adjusted.

6. Test Procedures for All Variable-Air-Volume (VAV) Fume Hoods.

6.1. The tests in section 5 above shall also apply to VAV hoods.

6.2. VAV Linearity Test.

6.2.1. This test shall be performed per section 6.3 of the ASHRAE 110 standard except that the velocity measurements shall conform to section 5.4 above.

6.2.2. The average velocities at the three sash positions shall be calculated and recorded on the test report. A graph of average velocity vs. Sash position is recommended.

6.2.3. If any of the readings vary more than 10% from the mean of the three face velocity averages corrective action is indicated. Calibration of the VAV control is recommended. If this does not correct the problem, reconfiguring the VAV control sensor location or replacement of the control may be required.

6.3. Combination VAV Dynamic Tests.

Note: the VAV speed-of-response and VAV Sash Movement Effect tests are described separately below but may be performed simultaneously.

6.3.1. VAV Speed-of-Response Test

6.3.1.1. This test is performed per section 6.4 of the ASHRAE 110 standard with the following exceptions and modifications:

6.3.1.1.1. The velocity transducer is positioned per sections 5.1.2-5.1.5 above.

6.3.1.1.2. The sash movement procedure is performed while accumulating real-time velocity data.

6.3.1.1.3. The speed of response is determined by analyzing the duct/slot velocity graph with time on the horizontal axis and velocity on the vertical axis. A vertical line on the graph is located at the time the sash movement is initiated. A horizontal "recovery" line is added to the graph at a velocity equal to 90% of the final duct/slot velocity at the design sash opening. Another vertical line is placed at the intersection of the velocity trace and the "recovery" line. The distance between the two vertical lines (in seconds) is the speed of response for that single iteration. The average of three iterations is the speed of response for the aggregate test.

6.3.1.1.4. The individual iteration response times and the average shall be calculated and recorded on the test report. It is recommended that the actual velocity vs. Time graphs be included on the report as well.

6.3.1.1.5. This test may be performed simultaneously with the Sash Movement Effect test below and both the velocity and tracer gas concentration data may be represented on the same chart.

6.3.2. VAV Sash Movement Effect Test.

6.3.2.1. The tracer gas test is set up per section 7-7.11 of the ASHRAE 110 standard with the following exceptions:

6.3.2.1.1. The tracer gas data is accumulated in real-time by a data acquisition system.

6.3.2.1.2. The maximum and average spike magnitudes (if any) shall be calculated and recorded on the test report. It is recommended that the concentration vs. Time plots be included on the report as well.

6.3.2.1.3. This test may be performed simultaneously with the Speed-of-Response test above and both the velocity and tracer gas concentration data may be represented on the same chart.

7. Acceptable Test Criteria.

7.1 Exhaust System Stability Test

7.1.1. The COV of the duct/slot velocity shall not exceed 10% as described in section 5.1 above.

7.2 Low-Volume Smoke Test

7.2.1. The minimum acceptable test result is [Good/Fair/**Poor** - user choses] as described in section 5.2. above.

7.3 High-Volume Smoke Test

7.3.1. The minimum acceptable test result is [Good/Fair/**Poor** - user choses] as described in section 5.3. above.

7.4 Face Velocity Test

7.4.1. The acceptable face velocity range is [80-120 fpm - user choses] as described in section 5.2. above.

7.4.2. The maximum acceptable Turbulence is [10%] as described in section 5.4.1.6. above.

7.4.3. The maximum acceptable Profile is [15%] as described in section 5.4.1.7. above.

7.5 Tracer Gas Containment Test

7.5.1. The maximum acceptable Control Level is [AM/AU/AI 0.10 (0.1 ppm)] as described in section 5.5. above.

7.6 VAV Dynamic Tests

7.6.1. The maximum acceptable speed of response is [3.0 sec or the response time required to meet the Sash Movement Effect criteria listed in 7.6.2. below, whichever is smaller] as described in section 6.3.1. above.

7.6.2. The maximum acceptable average tracer gas spike magnitude is [1.0 ppm] as described in section 6.3.2. above.

End of Specification