PROCEDURAL STANDARDS FOR FUME HOOD PERFORMANCE TESTING

2007 – FIRST EDITION

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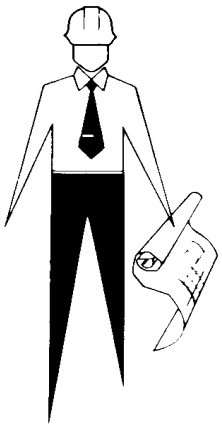

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PROCEDURAL STANDARD FOR FUME HOOD PERFORMANCE TESTING

FIRST EDITION – SEPTEMBER 2007, *PROCEDURAL STANDARDS FOR FUME HOOD PERFORMANCE TESTING*

These Procedural Standards were developed using reliable engineering principles and research plus consultation with, and information obtained from, manufacturers, users, testing laboratories and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable. Sound and vibration measurements and reporting, which complies with these Procedural Standards, will not necessarily be acceptable, if when examined and tested, it is found to have other features that impair the result intended by these standards. The National Environmental Balancing Bureau assumes no responsibility and has no liability for the application of the principles or techniques contained in these Procedural Standards. Authorities considering adoption of these Procedural Standards should review all Federal, State, local and contract regulations applicable to the specific installation.

FOREWORD

The purpose of the NEBB *Procedural Standards for Fume Hood Performance Testing* is to establish a uniform and systematic set of criteria for the performance testing of fume hoods.

This publication is the first edition of the Procedural Standard. Similar to the other NEBB disciplines, the Procedural Standard serves as the anchor for the program. Fume hoods and other safety control environments, such as bio-safety cabinets, offer a distinct set of challenges to the firms and individuals testing the field performance of these specialized, containment enclosures. The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) has developed a ANSI/ASHRAE Standard 110 *Method of Testing Performance of Laboratory Fume Hoods*. Another standard is ANSI/AIHA Standard Z9.5 *Laboratory Ventilation*. These publications define the testing procedures to be used when testing fume hoods and are well recognized and respected in this area of expertise. The NEBB discipline builds on these standards and complements them by providing a program that combines their testing requirements with a complete package for firm certification.

The NEBB Procedural Standard and the NEBB Fume Hood program define the requirements for firm certification, for supervisor qualification educational and experience requirements, for reporting consistencies, and for instrumentation requirements.

This Procedural Standard is similar to other NEBB Procedural Standards in that it is divided into two distinct Parts: S*tandards* and *Procedures*. These FHT procedural standards have been developed using language defined by **"*Shall, Should, and May*"** as it relates to the standards and procedures described in this manual. It is important to note these particular words throughout this manual and how they pertain to the NEBB standards and procedures.

These standards and procedures are intended as the minimum NEBB requirements that a NEBB Certified FHT Firm shall follow when performing fume hood testing and reporting the results. Contract documents may supercede the NEBB requirements. These FHT Procedural Standards have been carefully compiled and reviewed by the NEBB Technical Committees.

Part 1 STANDARDS

Part 1, STANDARDS, covers the requirements for Quality Control and Compliance, Instrumentation Requirements, and FHT Reports. The report requirements allow the NEBB Certified Firm more flexibility in designing their reports by prescribing sets of information that ***"Shall, Should*** and/or ***May"*** be required to complete an FHT Report.

Part 2 PROCEDURES

Part 2, PROCEDURES, covers required testing procedures to be followed when using ASHRAE 110 and ANSI Z9.5. Part 2 also addresses criteria and testing procedures other than those dictated by those referenced standards. This Procedural Standard allows that flexibility.

APPENDICES

The Appendices includes a suggested NEBB FHT specification, and sample report forms.

This Edition of the FHT Procedural Standards, when used by NEBB Certified FHT Firms, will assure the building owner of standard accurate reporting of fume hood performance.

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NEBB Technical Director

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PART 1 - STANDARDS

SECTION 1 DEFINITIONS

These procedural standards have been developed using language defined by "Shall, Should, and May" as it relates to the standards and procedures described in this publication. It is important to note these particular words throughout this publication and how they pertain to NEBB standards and procedures.

Accuracy: The *accuracy* of an instrument is the capability of that instrument to indicate the true value of a measured quantity.

AHJ: The local governing **A**uthority **H**aving **J**urisdiction over the installation.

Air Supply Fixtures: devices or openings through which air flows into the laboratory room. For the purpose of this standard all accessories, connecting duct adapters, or other mounting airways shall be considered part of the supply fixture and reported as a unit or an assembly. Some specific supply fixtures are defined as follows:

grille: a louvered or perforated face over an opening.
register: a combination grille and damper assembly.
diffuser: an outlet designed to mix supply air and room air and to distribute it in varying directions.
perforated ceiling: a ceiling with perforated panels used to distribute the air uniformly throughout the ceiling or a portion of the ceiling. Filter pads may be used to achieve a similar result.

Auxiliary Air: unconditioned or partially conditioned supply or supplemental air delivered to a laboratory at the laboratory fume hood to reduce room air consumption.

Calibrate: The act of comparing an instrument of unknown accuracy with a standard of known accuracy to detect, correlate, report, or eliminate by adjustment any variation in the accuracy of the tested instrument.

Contract Document Evaluation: A NEBB Certified FHT Firm evaluation of the contract plans and specifications is limited to determining the scope of responsibilities and reporting.

Control Level: the average measured concentration of tracer gas, in parts of tracer gas per million parts of air by volume (ppm), that is not exceeded at the hood face with a 4.0 Lpm release rate.

Deficiency: Any circumstance or operation that affects the measurement results as compared to the design criteria required by the contract documents.

Design Opening: the position of the sash at which the design team assumes that the hood will be operating. The design opening is critical for determining the volumetric flow through the laboratory hood.

Face Velocity: the average velocity of air moving perpendicular to the hood face, usually expressed in feet per minute (fpm) or meters per second (m/s).

Fume Hood System: an arrangement consisting of a fume hood, its adjacent room environment, and the air exhaust equipment, such as blowers and ductwork, required to make the hood operable.

Function: For the purposes of this NEBB Standard, *function* refers to the specific type of data measurement specified in Section 4, *Standards for Instrumentation and Calibration.*

Hood Face: the plane of minimum area at the front portion of a laboratory fume hood through which air enters when the sash(es) is (are) fully opened, usually in the same plane as the sash for a hood with a vertical sash. For a hood with horizontal sash(es) or a combination sash, the hood face is usually the plane passing through the midpoint between the inner and outer sashes.

Laboratory Hood (sometimes referred to as a fume hood): a box-like structure enclosing a source of potential air contamination, with one open or partially open side, into which air is moved for the purpose of containing and exhausting air contaminants. A laboratory hood is generally used for bench-scale laboratory operations but does not necessarily involve the use of a bench or table.

Lazy Airflow: airflow within the hood is described as lazy when smoke remains on the work surface without smoothly flowing to the back baffle.

LPM: Liters per minutes.

May: The word **may** is used to indicate a course of action that is permissible as determined by the NEBB Certified FHT Firm.

Maximum Opening: the position of the sash at which the hood has the largest opening.

N/A: *Not Available, Not Applicable, or Not Accessible.* The simple notation "N/A" without definition is not allowed.

NEBB Certified FHT Firm: A *NEBB Certified FHT Firm* is a firm that has met and maintains all the requirements of the National Environmental Balancing Bureau for firm certification in Fume Hood Performance Testing and is currently certified by NEBB. A NEBB Certified FHT Firm shall employ at least one NEBB Qualified FHT Supervisor in a full time management position.

NEBB Certified FHT Report: The data presented in a NEBB Certified FHT Report accurately represents system measurements obtained in accordance with the current edition of the NEBB *Procedural Standards for Fume Hood Performance Testing.* A NEBB Certified FHT Report does not necessarily guarantee that systems measured conform to the design requirements or stated guidelines. The report is an accurate representation of the measured results only.

NEBB Qualified FHT Supervisor: A *NEBB Qualified FHT Supervisor* is a full time employee of the firm in a management position who has successfully passed the supervisor level written and practical qualification examinations and maintains the Supervisor re-qualification requirements of NEBB.

Operating Opening: the position of the sash at which the hood user places the sash while working at the face of the hood. The operating opening should take into consideration all of the procedures to be conducted in the hood. There may be more than one operating opening.

PEL: Permissible Exposure Limit as defined by OSHA.

Performance Rating: a series of numbers and letters consisting of the letters AM, AI, or AU and a two- or three-digit number,

AM yyy
AI yyy
AU yyy

Where:

AM identifies an "as manufactured" test, that is, the laboratory hood is built and assembled by the manufacturer and testing is performed at the factory.
AI identifies an "as installed" test, that is, the laboratory hood is installed at the location of the customer. The hood is tested empty, but with the ventilation system in the installation balanced and the hood in its final location.
AU identifies an "as used" test, that is, the tests are conducted after the hood has been installed and used by the chemist. The typical equipment remains in the hood and other activities in the laboratory continue.
yyy is the control level of tracer gas established by the test in ppm.

A test rating of AU 0.5, for example, would indicate that the hood controls leakage into the laboratory to 0.5 ppm at the mannequin's sensing point with a tracer gas release rate of 4.0 Lpm (70 mL/s).

Positional Sash Movement Effect: the maximum 45-second rolling average of the tracer gas concentration observed during a series of sash movement tests at one ejector and mannequin position.

Positional Control Level: the average tracer gas concentration at a position during a test.

Precision: *Precision* is the ability of an instrument to produce repeatable readings of the same quantity under the same conditions. The precision of an instrument refers to its ability to produce a tightly grouped set of values around the mean value of the measured quantity.

PPM: Parts per million.

Procedure: A *Procedure* is defined as the approach to and execution of a sequence of work operations to yield a repeatable and defined result.

Range: *Range* is the upper and lower limits of an instrument's ability to measure the value of a quantity for which the instrument is calibrated.

Release rate: the rate of release, in actual litres per minute (Lpm), of tracer gas during a hood test.

Resolution: *Resolution* is the smallest change in a measured variable that an instrument can detect.

Reverse Flow: airflow within the hood when smoke released in the hood moves forward toward the front of the hood. Figure 3 shows an example of reverse flow. This term does not apply to the forward motion of the roll inside the hood that occurs in the upper cavity of the hood above the hood opening or to the cyclonic motion that occurs behind a closed horizontal sash.

Roll: the rotation of air in the upper cavity of the hood. The roll is induced by the momentum of the air entering the hood through the hood opening.

Sash Movement Effect: the maximum of the positional sash movement effects for all the positions tested on a particular hood.

Sash Movement Performance Rating: a series of letters and numbers consisting of the letters SME-AM, SME-AI, or SME-AU, and a two- or three-digit number:

SME-AU yyy
SME-AI yyy
SME-AM yyy

Where

SME means "sash movement effect," AM means "as manufactured," AI means "as installed," AU means "as used," and yyy equals the sash movement effect, in ppm. A test rating of SME-AM 10, for example, indicates that the maximum 45-second rolling average concentration of tracer gas measured during a sash movement test under the "as manufactured" test, with a tracer gas release rate of 4.0 Lpm (as required in Section 4.1), is 10 ppm.

Shall: The word **shall** is used to indicate mandatory requirements to be followed strictly in order to conform to the standards and procedures and from which no deviation is permitted. Note: In the event unique circumstances prevent a required action from being fulfilled, a notation shall be included in the FHT report explaining the exception. For example, such notation could be one of the following: *Not Available, Not Applicable, or Not Accessible.* The simple notation “N/A” without definition is not allowed.

Should: The word **should** is used to indicate that a certain course of action is preferred but not necessarily required.

Specified Rating: the hood performance rating as specified, proposed, or guaranteed either in the purchase of the hood or in the design and construction of the laboratory, or both.

Standard: A *Standard* is defined as a required qualification, action, or result for FHT work.

Standard Operating Procedure: An internal policy prepared by the each FHT firm and / or prepared by the Owner/Buyer. Procedures are written to provide guidance, direction, and step-by-step details relating to issues such as safety, testing protocols, acceptance criteria, etc. NEBB FHT Firm SOP’s shall be utilized in an absence of SOP’s prepared by the Owner.

System Effect: A phenomenon that can create undesired or unpredicted conditions that may cause a reduction in fan system performance capacities in all or part of a system and may increase sound and vibration levels.

Test Opening: the position or positions of the sash at which the hood is to be tested. Normally, the test opening is the design opening, the operating opening, or the maximum opening. Proper selection of the test position will depend on both the design opening and the operating opening. Because of the time involved in doing multiple equipment setups, the test position may also be the maximum opening. A good specification will limit the number of test positions. An example of a specification for a combination sash hood could include three positions with the vertical sash closed and the horizontal windows places in the left, center, and right. In addition, the hood may be tested with the vertical sash opened to a sash height determined by a sash stop.

Testing: *Testing* is the use of specialized and calibrated instruments to measure fluid quantities, temperatures, pressures, rotational speeds, electrical characteristics, velocities, and sound and vibration levels,

Testing, Adjusting, and Balancing (TAB): TAB is a systematic process or service applied to heating, ventilating and air-conditioning (HVAC) systems and other environmental systems to achieve and document air and hydronic flow rates. The standards and procedures for providing these services are addressed in the NEBB *"PROCEDURAL STANDARDS FOR THE TESTING, ADJUSTING AND BALANCING OF ENVIRONMENTAL SYSTEMS",* 7TH Edition, 2005.

Titanium Tetrachloride: a chemical, TiCl4, used to generate the white visible fumes required for preliminary testing in laboratory hoods.

VAV Speed of Response: is the time, measured from the first movement of the sash, for the VAV system to restore the slot velocity or airflow to 90 percent of the average steady-state value.

VAV Time to Steady State: is the time, measured from the first movement of the sash, for the VAV system restore and maintain the average slot velocity of airflow between 90 and 110 percent of the average steady-state value.

End of Section 1

SECTION 2 NEBB PROGRAM, QUALITY CONTROL AND COMPLIANCE

2.1 NEBB PROGRAMS

The National Environmental Balancing Bureau (NEBB) is a not-for-profit organization founded in 1971 to:

a) develop standards, procedures and programs for the performance of testing, balancing and commissioning of building systems,
b) promote advancement of the industry through technical training and development,
c) operate programs to certify firms and qualify individuals who meet and maintain NEBB standards with integrity.

Additional information on NEBB Programs is available at www.nebb.org.

2.1.1 NEBB DISCIPLINES

NEBB establishes and maintains standards, procedures, and specifications for work in its various disciplines, which include:

a) Testing-Adjusting-Balancing (TAB) -- Air and Hydronic Systems
b) Sound and Vibration (S&V) Measurement
c) Cleanroom Performance Testing (CPT)
d) Building Systems Commissioning (BSC)
e) Fume Hood Performance Testing (FHT)

Each discipline is anchored by a NEBB Procedural Standards manual that provides guidelines for work to be performed. NEBB also has created technical manuals, training materials and programs, and seminars to enhance and support each discipline.

2.1.2 FIRM CERTIFICATION

NEBB certifies firms that meet certain criteria, ensuring strict conformance to its high standards and procedures. Among other requirements, NEBB Certified FHT Firms must document a record of responsible performance, own a complete set of instruments and equipment required for the sophisticated techniques and procedures necessary to take and report fume hood testing measurements, and have a NEBB Qualified FHT Supervisor as a full-time employee.

2.1.3 SUPERVISOR QUALIFICATION

NEBB also establishes professional qualifications for the supervision and performance of work in its various disciplines. NEBB Qualified FHT Supervisors must have extensive experience, and they must pass appropriate, college-level written examinations and demonstrate certain practical working knowledge and proficiency in the use of instruments required for the various disciplines.

2.1.4 RECERTIFICATION REQUIREMENTS

Through the recertification procedures, the firm must verify that its NEBB Qualified FHT Supervisor is still on staff and that it continues to own a complete set of instruments that are in current calibration. In addition, the firm's NEBB Qualified FHT Supervisor renews his or her qualification. Among other requirements, Supervisors must keep abreast of developments in their discipline by successfully completing continuing education requirements annually.

2.2 QUALITY ASSURANCE PROGRAM - CONFORMANCE CERTIFICATION

The credibility of NEBB is built by maintaining integrity through high standards, quality programs, and demonstrated capabilities of its certified firms. As further assurance, NEBB offers a Quality Assurance Program to guarantee that the work will be accomplished in accordance with its standards. The NEBB Certificate of Conformance Certification is an integral element of the program. It assures that the NEBB Certified Firm will perform specified services in conformity with the current applicable NEBB Procedural Standards.

2.2.1 PROGRAM ADVANTAGES

The NEBB Quality Assurance Program affords building owners, architects, engineers and other agents a reliable basis for specifying work within the various disciplines of NEBB. The program promotes proper execution of projects by ensuring compliance with NEBB standards and procedures.

2.2.2 NEBB QUALITY ASSURANCE PROGRAM CERTIFICATE

The NEBB Certified FHT Firm shall make application to the NEBB Office for a Certificate of Conformance Certification if specified in the contract documents. The NEBB Quality Assurance Program Conformance Certification is also available for any project.

2.3 QUALITY CONTROL AND COMPLIANCE

Building owners are entitled to a professional service by every NEBB Certified Firm on every project, whether the job is NEBB-specified or not. It is the responsibility of the NEBB Certified Firm and its NEBB Qualified Supervisor to establish and maintain procedures and practices that will assure a consistent pattern of high quality work on all projects. This point cannot be overemphasized.

2.3.1 FHT WORK COMPLIANCE

The scope of work shall be performed as specified in the contract documents, Fume Hood Performance Testing specifications, the Test, Adjust, and Balance (TAB) specifications or as contractually amended. Each relevant or applicable item as identified in the contract documents by description, or by reference, shall be performed and recorded in the report. Data presented in the report shall provide an accurate quantitative and qualitative record of system measurements and information.

For projects where a design professional has been retained to prepare a set of contract documents, the design professional should adequately define the scope of the fume hood performance testing services. Many of today’s contract documents do not define the actual scope of services to be performed on the project. Contract documents may reference desired procedures and may include statements such as "…the work will be performed in accordance to NEBB Standards…" or, the contract documents may refer to NEBB and that fume hood performance testing work “…shall be done in accordance with the reference standard…” or, merely allude to the NEBB organization, ASHRAE, or ANSI and make reference to fume hood performance testing work.

When contract documents do not clearly identify the exact scope of fume hood performance testing services, the NEBB Qualified FHT Supervisor shall make every attempt to have the design professional dictate the actual scope through the addendum process.

If the design professional still does not adequately define the scope of fume hood performance testing, the scope requirements for fume hood performance testing services for that project and for all projects where a design professional is not retained by the owner, the scope of work shall be as agreed to between the Owner/Buyer and the NEBB Certified FHT Firm.

Regardless of what is specified, in all cases the process by which the data is acquired shall conform to the current edition of the NEBB *Procedural Standards for Fume Hood Performance Testing*.

2.4 FHT SUPERVISOR RESPONSIBILITIES

It is the responsibility of the NEBB Qualified FHT Supervisor to control the quality of the fume hood performance testing work. This means that the NEBB Certified FHT Firm, through its NEBB Qualified FHT Supervisor, shall satisfy the contract obligations set forth in the drawings and applicable specifications.

2.4.1 EXECUTION OF FUME HOOD TESTING PROCEDURES

The NEBB Qualified FHT Supervisor shall have project responsibility, which includes authority to represent the NEBB Certified FHT Firm. Examples of project responsibility may include labor decisions, negotiating change orders, committing to contract interpretations and implementing changes in job schedules.

The NEBB Qualified FHT Supervisor has the responsibility to assure that the measurements of the fume hood performance testing have been performed in accordance with these Procedural Standards and the contract documents to assure the accuracy of all data included in the final report. Factors such as instrument use, coordination / supervision, work instructions, and project communication play a critical role in achieving this requirement.

2.4.2 TECHNICIAN TRAINING

The NEBB Qualified FHT Supervisor has a responsibility to assure that technicians performing the work are properly trained and possess sufficient skills. Areas that should be stressed are fume hood performance testing procedures, instrument use and maintenance, safety procedures, coordination and supervision, and project communication.

2.4.3 FHT PROCEDURES TRAINING

NEBB Qualified FHT Supervisors must be prepared to completely measure and record data in the manner specified. It is mandatory that NEBB Qualified FHT Supervisors possess the ability to perform the specific tasks and procedures required for each project. An understanding of building system fundamentals and operating characteristics is important, and technicians should possess rudimentary knowledge of all related systems and procedural considerations. This may require periodic training to promote knowledge and skill development as well as to facilitate the transfer of knowledge and basic skills in the use of new technology.

2.4.4 INSTRUMENT USE and MAINTENANCE

NEBB Qualified FHT Supervisors shall possess knowledge and skill in the proper use and care of instruments required to perform the work. This shall include a thorough understanding of the

operating principles and use of fume hood equipment and instruments. Considerations for the delicate nature of many of the instruments typically used, as well as the adverse effects of dirt, shock, jarring movements and exceeding rated capacities, shall be addressed along with the proper methods for storing and transporting the instruments.

2.4.5 COORDINATION / SUPERVISION

The NEBB Qualified FHT Supervisor shall be responsible for directing technicians in performing the work. Instructions may delineate items such as the scope of work, location, type and quantity of measurements, etc. so that field personnel may know exactly what to do and what is required of them.

2.4.6 PROJECT COMMUNICATION

The NEBB Qualified FHT Supervisor shall report on progress made toward work completion, when required, as well as report and address problems if encountered. When a problem exists, the NEBB Qualified FHT Supervisor should notify the appropriate project personnel.

2.4.7 WORK COMPLETION

The NEBB Qualified FHT Supervisor shall determine when the fume hood performance testing work has been completed, and when to submit the report. Generally, the specified fume hood performance testing field work is complete when:

a) All specified fume hood performance testing is completed;

or

b) Reasonable efforts within the extent of testing for fume hoods have been performed in an effort to complete all required measurements. The NEBB Qualified FHT Supervisor shall notify the appropriate project personnel of any significant system deficiencies preventing fume hood performance testing from being performed before the final report is submitted.

2.4.8 COMPILATION AND SUBMISSION OF FINAL FHT REPORTS

Reports shall include information and data to provide an accurate quantitative and qualitative record of system measurements and information. Reports also shall include notes and comments, as appropriate, to provide the reviewer with additional details related to the test procedure, system operation and results. Reports shall meet the criteria listed in Sections 5.

The certification page shall bear the stamp of the NEBB Qualified FHT Supervisor. The stamp on the certification page shall be signed as evidence that the NEBB Qualified FHT Supervisor has personally reviewed and accepted the report. *Signature stamps are specifically prohibited.*

End of Section 2

SECTION 3 RESPONSIBILITIES

3.1 INTRODUCTION

Many approaches can be taken to deliver successful performance testing of fume hoods on a project. In order to maximize value and benefits from fume hood performance testing, it is important to understand that the design professionals and other construction team members have responsibilities that will affect the outcome of the fume hood testing process.

The following outline represents recommended practices that may take place on a conventional design/bid/buy/construct delivery project or on a direct procurement project between the Owner/Buyer and the NEBB Certified FHT Firm. While other delivery approaches will exist, the overall concept of the delineation of responsibilities remains. The Owner/Buyer shall be the responsible party that dictates the recommended following procedures.

3.2 DESIGN AND CONSTRUCTION TEAM RESPONSIBILITIES

3.2.1 DESIGN PROFESSIONAL'S RESPONSIBILITIES

It is recommended that the contract documents shall:

a) Specify the equipment, systems and scope of testing services to be performed for the fume hoods on the project. NEBB standards and procedures define industry best practices to perform the measurements.

b) Define who retains the services of the NEBB Certified FHT Firm and require that the NEBB Certified FHT Firm be retained early in the construction process.

c) Clearly define on the contract documents all fume hood performance testing requirements and criteria.

d) Clearly identify on the contract documents all locations where fume hood performance testing is to be performed.

e) Specify that the building, mechanical, electrical and all associated work is to be completed prior to performing fume hood performance testing.

f) Specify that all building, mechanical, electrical, and other systems are completely operational, under control and performing according to the design intent prior to performing fume hood performance testing. This would include that all building automation / controls are installed, operational, calibrated and functioning properly and that the TAB work is completed. Fume hood performance testing performed prior to completion of these activities should be avoided. Actual final measurements may differ from measurements taken prior to the completion of the work.

g) Provide adequate access to all equipment and components required by the fume hood performance testing process.

3.2.2 CONSTRUCTION TEAM RESPONSIBILITIES

It is recommended that the construction team shall:

.

a) Provide the NEBB Certified FHT Firm with a conformed set of contract documents (drawings, specifications, and approved submittals), including all current approved change orders and contract modifications.

b) Develop a project schedule, with the input of the NEBB Certified FHT Firm that coordinates the work of other disciplines and provides *adequate* time in the construction process to allow successful completion of the fume hood performance testing work.

c) Notify the NEBB Certified FHT Firm of ***all*** schedule changes.

d) Ensure that the building enclosure is complete, including but not limited to, all structural components, windows and doors installed, door hardware complete, floor and ceilings complete. Ensure that the building enclosure and components are complete and operational such that the performance of the fume hoods would not be adversely affected.

e) Ensure that all necessary building systems are complete and are operating in a safe manner.

f) Complete the installation of permanent electrical power systems serving the building systems. Such electrical systems shall be properly installed in accordance with all applicable codes to ensure the safety of all construction personnel.

g) Perform start up of all building systems in accordance with manufacturers' recommendations.

h) Complete the installation, programming (including design parameters and graphics), calibration and startup of all building control systems. Verify that the building control system provider has commissioned and documented all building control work.

i) Complete all TAB related work. A copy of the completed TAB Report shall be furnished to the NEBB FHT Firm. If this is a recertification project, provide the NEBB FHT Firm with a copy of the most recent TAB Report or the most recent Fume Hood Performance Test Report.

3.2.3 NEBB CERTIFIED FHT FIRM RESPONSIBILITIES

The NEBB Certified FHT Firm shall:

a) Follow the current NEBB standards and procedures when performing the fume hood performance testing.

b) Communicate on a regular basis, through proper channels, items pertaining to design, installation or function that prevent the NEBB Certified FHT Firm from achieving completion of the FHT work in accordance with the current edition of the NEBB *Procedural Standards for Fume Hood Performance Testing.*

c) Perform the required fume hood performance tests.

d) Publish a NEBB Certified FHT Report of final conditions that accurately reflect the results of the fume hood performance testing.

End of Section 3

SECTION 4 STANDARDS FOR EQUIPMENT, INSTRUMENTATION AND CALIBRATION

4.1 MINIMUM INSTRUMENTATION

A NEBB Certified FHT Firm will use a variety of instrumentation to perform the specified fume hood performance tests on a project. It is the responsibility of the NEBB Certified FHT Firm to provide appropriate instrumentation that meets the minimum requirements for use on a project. Instrumentation used on a NEBB project shall be in proper operating condition and shall be applied in accordance with the manufacturer's recommendations. Table 4-1 lists the minimum instrumentation specifications that a NEBB Certified FHT firm shall utilize in all fume hood performance testing. The NEBB Certified FHT Firm shall own all of the required instrumentation and equipment as identified in Table 4-1.

4.2 RANGE AND ACCURACY

Calibration requirements for each function are specified and shall be met. Some instruments and accessories may not require calibration. However, if a "mechanical / electrical" device is substituted or employed in place of these types of instruments, the indicated calibration requirements noted shall apply. Multifunction instruments are allowed.

4.3 Calibration

Annual Calibration – ALL fume hood performance testing instrumentation shall be maintained with a current annual calibration certificate, traceable to the National Institute of Standards and Technology (NIST), or equivalent organizations in other countries, and to the ANSI specifications listed in Table 4-1, or manufacturers specifications, whichever is more stringent.

Firms with multiple sets of instrumentation shall comply with *either* of the following conditions as a minimum requirement for NEBB certification:

a) Calibrate all instrumentation used by the firm on FHT projects in accordance with Table 4-1.

TABLE 4-1 NEBB MINIMUM FHT INSTRUMENTATION REQUIREMENTS (U.S. UNITS)

Test	Instruments & Equipment	Description	Calibration Interval
Airflow Face Velocity Tests	Linear Measuring Device	Minimum 12' tape measure capable of reading 1/16" increments	Not Required
	Equipment Stand	Stationary stand (ring stand) that will allow the airflow face velocity measuring device to be secured.	
	Airflow Velocity Measuring Instrument	An airflow velocity measuring device Range: 25 to 2500 fpm Accuracy: ± 5% of reading (5 fpm @100 pm) Resolution: 1 fpm	12 Months
	Data Acquisition Device	Capable of taking readings every second	12 Months??
	Thermal Anemometer	Thermal anemometer with the following characteristics: Range: 20 fpm to 9999 fpm Accuracy: ±3 % or ± 3 fpm Resolution: 1 fpm Time Constant: Minimum 1 second TSI/Alnor VelociCalc 8345 -47A APN get specs	12 Months
Flow Visualization Tests – Local Challenge	puffer	Tom McK	Not Required
	Smoke Stick/Bottle	A smoke stick/bottle containing titanium-tetrachloride.	Not Required
	Other Smoke Source	Any device that may generate a small relatively neutrally buoyant smoke source.	Not Required
	Video Recorder (Optional)		
Flow Visualization Tests – Large Volume Challenge	Aerosol Generator	A device that can aerosolize artificial medium including Laskin nozzle type.	Not Required
	Smoke Generator	Theatrical smoke generator with a fluid approved by the owner, designer or AHJ.	Not Required
	Video Recorder (Optional)		

Tracer Gas Containment Tests	Detection Instrument (Spectrophotometer)	A digital, single beam, infrared spectrophotometer consisting of a portable gas analyzer and a separate ac/dc converter. The spectrophotometer shall be capable of measuring SF6 (or other approved gas) tracer gas and display in concentration measurement units (ppm). Accuracy: ±15% of reading between five times minimum detectable concentration and the upper value range. Noise: Maximum of 0.004 absorbance units (AU) with 20.25 m pathlengths at 12.0 μm wavelength and with AgBr lenses at 23° C (75°F) operating temperature. Drift: Maximum of 0.004 AU per 8 hours The internal diameter of the probe tip shall be less than 0.5 inches (12mm) The Detection Instrument shall be able to be field-calibrated using a calibration device.	When Required
	Detection Instrument (Leak Meter)	Leak Meter shall be configured to measure SF6 (or other approved gas) tracer gas and display in concentration measurement units (ppm) The minimum detection range shall be 0.01 ppm The minimum resolution shall be 0.01 ppm The minimum response time shall be 1 second (and capable of interfacing with a data logger to collect readings) The minimum accuracy shall be ±25% for readings between 0.05 ppm to 0.1 ppm and ± 10% for readings above 0.1 ppm The internal diameter of the probe tip shall be less than 0.5 inches (12mm) The Detection Instrument shall be able to be field-calibrated using a calibration device.	When Required
	Detection Calibrator	A "known leak" used to calibrate the leak detector instrument to manufacturers' specifications	
	Ejector System w/critical orifice	APN: copy direct from 110 std (ejector nozzle block Section 4.3 new 110.	
	Orifice Calibrator	Mechanical device Range: 0 – 15 Lpm Accuracy: ± 0.1 Lpm Resolution: ± 0.1 Lpm, Provide the mechanical device or the flow meter.	12 months
		Flow Meter Range: 0 – 15 Lpm Accuracy: ± 0.1 Lpm Resolution: ± 0.1 Lpm	Not Required
	Tracer Gas	Sulphur Hexaflouride (SF_6) Instrument grade	Not Required

		Other acceptable gas may be used and should be the approximately the same molecular weight, stability, and grade as SF_6. Other acceptable gas shall be approved by the owner, designer, or AHJ.	Not Required
	Mannequin	A three-dimensional mannequin (torso) shall be fully clothed that would replicate a normal operator complete with laboratory. The height shall adjustable to meet the height requirements of the various hood configurations (standard bench hood, ADA height, and walk in styles. Probe shall be placed in the normal breathing zone based on the various heights.	Not Required
	Data Acquisition Device	Capable of taking readings every second	12 Months??
	Video Recorder (Optional)		

End of Section 4

SECTION 5: STANDARDS FOR REPORTS AND FORMS

5.1 REPORTS

The NEBB *Procedural Standards for Fume Hood Performance Testing* establishes minimum requirements of a NEBB Certified FHT Report. The standards have been developed and written using **"Shall, Should, and May"** language. It is important to note these particular words throughout this document and how they pertain to NEBB Procedural Standards.

NEBB does not require the use of NEBB produced forms. Customized forms are acceptable based on the data acquisition requirements of this section. Where contract document data reporting requirements exceed the minimum requirements of NEBB, the NEBB Certified FHT Firm is responsible to meet the requirements of the contract documents. There are sample reporting forms included in the Appendix. These sample forms are available to NEBB Certified FHT Firms from the NEBB Website at www.nebb.org.

NEBB Fume Hood Performance Testing Reports shall include the following information:

A. REPORT TITLE

B. REPORT CERTIFICATION

C. TABLE OF CONTENTS

D. REPORT SUMMARY / REMARKS

E. APPROPRIATE FORMS

F. INSTRUMENT CALIBRATION

G. ABBREVIATIONS

5.2 REQUIRED FORMS

Listed below are the **requirements** for each NEBB Certified FHT Report in **Shall, Should, and May** language.

5.2.1 REPORT TITLE

Shall Data: The heading: "Certified Fume Hood Performance Testing Report"; Project Name, Address, NEBB Certified FHT Firm Name, Address, Contact Information and Certification Number.

May Data: Architect Name, Address and Contact Information; Engineer Name, Address, and Contact Information; HVAC Contractor Name, Address and Contact Information.

5.2.2 REPORT CERTIFICATION

The certification page SHALL bear the stamp of the NEBB Qualified FHT Supervisor. The stamp on the certification page SHALL be signed as evidence that the NEBB Supervisor has reviewed and accepted the report. ***Signature stamps are specifically prohibited.***

Shall Data: Project Name; Certifying NEBB Qualified FHT Supervisor's Name; Firm Name; Certification Number; Expiration Date; Certifying NEBB Qualified FHT Supervisor's NEBB Stamp (signed & dated); and either of the following exact certification verbiage.

Where fume hood performance testing was performed in complete accordance with the requirements of ASHRAE Standard 110, the following exact verbiage shall be used on the Report Certification page:

"THE DATA PRESENTED IN THIS REPORT IS A RECORD OF THE FUME HOOD PERFORMANCE TESTING OBTAINED IN ACCORDANCE WITH THE REQUIREMENTS OF THE CURRENT EDITION OF ASHRAE STANDARD 110 AND THE CURRENT EDITION OF THE NEBB *PROCEDURAL STANDARDS FOR FUME HOOD PERFORMANCE TESTING.* ANY VARIANCES FROM DESIGN / OR INDUSTRY STANDARDS WHICH EXCEED THE LIMITS SET BY THE CONTRACT DOCUMENTS, OR WHICH EXCEED THE LIMITS AGREED TO BETWEEN THE OWNER AND THE NEBB CERTIFIED FHT FIRM ARE NOTED THROUGHOUT THIS REPORT AND / OR IN THE REPORT PROJECT SUMMARY."

Where fume hood performance testing was performed for all non-ASHRAE related testing that may have been agreed to between the Owner and the NEBB Certified FHT Firm, the following exact verbiage shall be used on the Report Certification page:

"THE DATA PRESENTED IN THIS REPORT IS A RECORD OF THE FUME HOOD PERFORMANCE TESTING OBTAINED IN ACCORDANCE WITH THE REQUIREMENTS AND PROCEDURES AGREED TO BETWEEN THE OWNER AND NEBB CERTIFIED FHT FIRM AND THE CURRENT EDITION OF THE NEBB *PROCEDURAL STANDARDS FOR FUME HOOD PERFORMANCE TESTING.* ANY VARIANCES FROM DESIGN / OR INDUSTRY STANDARDS WHICH EXCEED THE LIMITS AGREED TO BETWEEN THE OWNER AND THE NEBB CERTIFIED FHT FIRM ARE NOTED THROUGHOUT THIS REPORT AND / OR IN THE REPORT PROJECT SUMMARY."

(This data may be included on the report title page or on a separate certification page.)

5.2.3 TABLE OF CONTENTS

The table of contents shall serve as a guide to the organization of the FHT report.

Shall Data: Page numbers of system and component information in the report.

5.2.4 REPORT SUMMARY / REMARKS

A NEBB Certified FHT Report includes a narrative description of test methods and system set-up conditions established prior to testing. The narrative should explain the rational for system parameters, such as to establish a the test state, and the steps taken to achieve the desired set-up.

This section also includes a listing of deficiencies in the summary and identifies the appropriate pages in the report. Deficiencies or other issues that are critical in nature relative to occupant health or facility safety shall be "red tagged" and brought to the immediate attention of the AHJ. The NEBB Certified FHT Firm ***SHALL NOT*** wait to identify these issues on a final FHT Report.

Shall Data: Summary of all items that exceed Contract Document tolerances or any other items that require discussion / explanation.

5.2.5 ALL REPORT PAGES

All tested items included in the NEBB FHT Report shall be clearly identified with its associated fume hood designation number or other unique descriptor.

The location of each tested item shall also be identified on each report page. The location identifier should be the room number, the space number or other unique descriptor to clearly identify the tested item.

The method of identification shall use schematic diagrams, mechanical plans where permissible, or a narrative description. Each data form supplied in a NEBB FHT Report shall include the name of the responsible technician / NEBB Qualified FHT Supervisor who reported the information, and the time period the data was collected.

Shall Data: Project name. All pages shall be numbered consecutively.

May Data: Remarks section to record any information pertinent to the data reported on the data sheet.

5.2.6 INSTRUMENT CALIBRATION

This is an overall listing of the instruments that will be used to verify the reported data.

Shall Data:

Instrument type
Instrument manufacturer
Instrument model number
Instrument serial number
Date of instrument calibration

5.2.7 ABBREVIATIONS

This is a list of definitions of the relevant abbreviations used in the report.

Shall Data: A listing of all abbreviations and their definition as used in the report.

5.2.8 AIRFLOW FACE VELOCITY TEST REPORT DATA – CONSTANT VOLUME SYSTEMS

Airflow face velocity tests shall be presented in graphical or tabular format for each measurement plane and location and the data shall be reported on the test reporting form(s).

Shall Data:

Technician Name	Average velocity (fpm)
Date of Test	Calculated Airflow (actual cfm) (@ conditions)
Test State	Specified Airflow (acfm)
Sash Configuration	Test Instrumentation
Sash Opening Height and Width	Acceptance Criteria
Individual Velocity Test Measurements (fpm)	

Should Data:

Other Sash Openings other than Design Conditions & associated results Temperature (°F) Altitude Room Layout Drawing

5.2.9 AIRFLOW FACE VELOCITY TEST REPORT DATA – VAV SYSTEMS

Airflow face velocity tests shall be presented in graphical or tabular format for each measurement plane and location and the data shall be reported on the test reporting form(s).

Shall Data:

Technician Name Date of Test Test State Sash Configuration Sash Opening Height and Width Individual Velocity Test Measurements (fpm) Average velocity (fpm)	Calculated Airflow (acfm) (@ conditions) Specified Airflow (acfm) Test Instrumentation Test results reported at 25%, 50% and 100% of specified conditions Speed of Response to Restore (in seconds) Time to Maintain (in seconds) Test Method (exhaust airflow volume method or fume hood plenum airflow velocity method) Acceptance Criteria

Should Data:

Other Sash Openings other than Design Conditions & associated results Temperature (°F) Altitude Room Layout Drawing

5.2.10 AIRFLOW VISUALIZATION TEST REPORT DATA – LOCAL CHALLENGE

Shall Data:

Technician Name Date of Test Test State Sash Configuration Sash Opening Height and Width	Challenge Medium Used Narrative description of actual visual test results including Statement of Pass/Fail Test Instrumentation Acceptance Criteria

Should Data:

Room Layout Drawing

May Data:

Video tape of actual test.

5.2.11 AIRFLOW VISUALIZATION TEST REPORT DATA – LARGE VOLUME CHALLENGE

Shall Data:

Technician Name Date of Test Test State Sash Configuration Sash Opening Height and Width	Challenge Medium Used Narrative description of actual visual test results including Statement of Pass/Fail Test Instrumentation Acceptance Criteria

Should Data:

Room Layout Drawing

May Data:

Video tape of actual test.

5.2.12 TRACER GAS CONTAINMENT TEST REPORT FORMS – STATIC MODE

Shall Data:

Technician Name Date of test Time of test Test State Sash Configuration Sash Opening Height and Width Room Layout Drawing	Report all individual readings including average and peaks Graphical display of each test Tracer Gas Release Rate Test Instrumentation Acceptance Criteria

Should Data:

5.2.13 TRACER GAS CONTAINMENT TEST REPORT FORMS – SASH MOVEMENT EFFECT

Shall Data:

Technician Name Date of test Time of test Test State Sash Configuration Sash Opening Height and Width Room Layout Drawing	Report all individual readings including average and peaks Graphical display of each test Tracer Gas Release Rate Test Instrumentation Acceptance Criteria

Should Data:

5.2.14 TRACER GAS CONTAINMENT TEST REPORT FORMS – PERIMETER SCAN

Shall Data:

Technician Name Date of test Time of test Test State Sash Configuration Sash Opening Height and Width Room Layout Drawing	Record any measurable leakage Report the location and magnitude of the leakage Tracer Gas Release Rate Test Instrumentation Acceptance Criteria

Should Data:

5.2.15 OTHER FUME HOOD PERFORMANCE TEST REPORT FORMS

Shall Data:

As agreed to between the Owner and the NEBB Certified FHT Firm

End of Section 5

PART 2 - PROCEDURES

SECTION 6 PRELIMINARY FUME HOOD TESTING PROCEDURES

6.1 INTRODUCTION

The purpose of this Section is to provide an overview of several procedural issues that shall be addressed by the NEBB Qualified FHT Supervisor in planning the fume hood testing work. Among these issues are:

a. Safety Procedures and Risk Management issues
b. Laboratory Protocol procedures
c. Preliminary Field Inspection Verifications

6.2 LABORATORY SAFETY PROCEDURES

Relative risks for work in research laboratories with infectious agents, radioactive materials, and toxic substances have been documented. Data from laboratory-associated infections that occurred in the United States and in foreign countries show that a high fatality rate can occur and points to the fact that risk assessment and safe laboratory operation can be a life and death matter. Currently, laboratory associated infections have decreased from the peak decade of 1945 through 1954. This trend may be due to increased awareness of the hazards of working with infectious agents, as well as the increased use of safety devices (fume hoods and biological safety cabinets) and other safety features included in recent laboratory designs. Table 6-1 is a compilation of laboratory safety guidelines.

Consequently, there are certain safety procedures that should be observed in performing the various fume hood performance tests. The NEBB FHT Supervisor shall determine these requirements prior to performing any work. Exact dictates may come from an owner, the contract documents or other source. The NEBB Certified FHT Firm is responsible to create their own safety program and develop it into a Standard Operating Procedure for their firm. The firm's SOP for Safety shall be followed when no other direction is given.

6.2.1 HEALTH HAZARDS

Fume hoods, bio-containment cabinetry and laboratories in general can be a health hazard source. The NEBB FHT Firm, the NEBB FHT Supervisors and the field technicians performing the fume hood testing work in these facilities shall be aware of the critical nature of the work.

Some fume hoods located in industrial or laboratory applications may have a minimum risk associated with performing the certification testing. Many others may possess a great risk to personnel health, life safety or facility protection issues. Chemical laboratory facilities may be a source of toxic chemicals,

solvents, flammable agents, radio-isotopes, and other hazardous materials. Medical research facilities can be a source of life threatening viruses, bacteria, and diseases. The electronics industry routinely deals with large and heavy equipment utilizing high voltage electricity, as well as custom and, sometimes, exotically designed laminar flow equipment, requiring balanced exhaust, as well as the HEPA filtered air supply. The medical/pharmaceutical manufacturers do require some unique precautions for safety which include the need for knowledge dealing with decontamination chemically or by the use of ultra violet lighting.

With these circumstances in mind, the necessity for a detailed safety program, responsible administration and records shall be required.

Table 6-1 represents a partial list of laboratory safety guideline publications. See Appendix C for additional references.

Table 6-1 Compilation of Laboratory Safety Guidelines

Description	Publication
Laboratory Safety	OSHA 29 CFR Part 1910-Occupantional Exposures to Hazardous Chemicals in Laboratories, Final Rules, 1990 *CRC Handbook of Laboratory Safety*, 3rd ed. (CRC Press) *Prudent Practices for Handling Hazardous Chemicals in Laboratories* (National Academy Press) *Guidelines for Laboratory Design* (John Wiley & Sons)
Microbiological and Biomedical Safety	*Bio-Safety in Microbiological and Biomedical Laboratories* (DHHS)
Hospital Laboratories	*Guidelines for Construction and Equipment of Hospital and Medical Facilities* (American Institute of Architects Press) *Medical Laboratory Planning and Design* (College of American Pathologists)
Chemical Carcinogens	OSHA Safety and Health Standards (Current Standards)
Fire Safety	Fire Protection for Laboratories Using *Chemicals—NFPA 45* (National Fire Protection Association 1991) *Health Care Facilities Handbook—NFPA 99* (National Fire Protection Association 1996)

6.2.2 SAFETY TRAINING

The NEBB FHT Qualified Supervisor is responsible for the firm's safety program and may act as the firm's safety officer. Training of personnel shall include, but not be limited to, a written handbook or

pamphlet which describes, in detail, the known common and specific hazards associated with this type of work in general. This handbook shall inform the reader of at least six specific facts as follow:

6.2.2.1 the existence of a known hazard,

6.2.2.2 the accepted method for prevention of exposure to, or the occurrence of each specific hazard,

6.2.2.3 the step-by-step procedure of what to do in the event of an exposure or occurrence,

6.2.2.4 the accepted method for determination of the existence of a potential hazard,

6.2.2.5 the preparation of hazardous material data sheets, and

6.2.2.6 the person(s) responsible for administration of the safety program..

6.2.3 PERFORMANCE

Each NEBB Certified FHT Firm shall have a designated safety officer who shall be responsible for:

6.3.3.1 establishment of a safety program,

6.3.3.2 training of personnel,

6.3.3.3 administration of the safety program, personnel compliance, updating, reporting, etc.

6.2.4 SPECIALIZED REQUIREMENTS

6.2.4.1 Each safety officer shall prepare a specialized data sheet which informs or directs personnel on jobs with unusual or unique hazards or safety requirements.

6.2.4.2 Within the procedures for the safety program shall be provisions for review and update on a minimum of six month intervals.

6.2.4.3 Each NEBB Certified FHT Firm shall maintain appropriate insurance to comply with project specifications and applicable laws.

6.2.4.4 Each NEBB Certified FHT Firm shall provide a written copy of its safety program to the owner / customer if requested.

6.2.5 EXAMINATION

The contract drawings shall be examined for any information deemed necessary to perform the fume hood testing work in a safe manner.

6.3 LABORATORY/CLEANROOM PROTOCOL PROCEDURES

Prior to performing any fume hood testing work, the NEBB Qualified FHT Supervisor shall determine the exact protocol procedures that are required to be followed when performing the work. Exact dictates may come from an owner, the contract documents or other sources. The NEBB Certified FHT Firm is responsible to create their own laboratory/cleanroom protocol and develop it into a Standard Operating Procedure for their firm. The firm's SOP for laboratory/cleanroom protocol shall be followed when no other direction is given. **NOTE: Before entering any space to perform fume**

hood testing, no one or any tool or test instrument enters a laboratory/cleanroom space without permission of the owner or operator.

Fume hoods can be located in a variety of locations; from a single hood located in a non-descript commercial or industrial application to the most clean cleanroom application. The manner in which the work will be performed will also vary greatly within these two extremes.

A fume hood located in any cleanroom or clean space will require the personnel performing the testing to be gowned. Limitations on types of instruments, equipment and accessories may be required. As the cleanliness classes of cleanrooms become more clean, the more critical it becomes that special materials and instruments are used, and elaborate gowning and instrument cleaning procedures are required for everyone entering clean areas.

6.3.1 Gowning Procedures

If fume hoods are located within a cleanroom or clean space, a specific gowning protocol may be required. The requirements may be as specified in the contract documents or as agreed to between the owner/buyer and the NEBB Certified FHT Firm.

For a review of various gowning requirements, please review the material in the current edition of the NEBB *Procedural Standard for Certified Testing of Cleanrooms.*

6.3.2 LABORATORY/CLEANROOM CONDUCT

Some of the personnel rules used by many operators are:

a. Use proper eye protection
b. Use proper hearing protection if required
c. Smoking, eating and drinking is not permitted.
d. Cleanroom Specific Conduct/Protocol
    1. Clean hands and face before entering clean areas.
    2. Use lotions and soap containing lanolin to reduce skin flaking.
    3. Avoid skin contacts with solvents.
    4. Wearing cosmetics and skin medications is not permitted.
    5. Smoking, eating and drinking is not permitted.
    6. Required gowning, masks, gloves and shoe covers to be worn at all times.
    7. Equipment, instruments and materials are to be cleaned before entry.
    8. Non-shedding paper and pens are to be used. Pencils and erasers are not permitted.
    9. Work parts are to be handled only with gloved hands, tweezers, or other methods to avoid transfer of skin particles and oils.
    10. Use containers to transfer and/or store materials.

6.3.3. SUMMARY

These protocol procedures may or may not be required when performing fume hood testing. Again, it is the responsibility of the NEBB Qualified FHT Supervisor to determine the exact requirements to be followed and then instruct the NEBB Certified Firm's personnel of the expected requirements.

6.4 PRELIMINARY FIELD INSPECTION VERIFICATIONS

The purpose of the inspections is to become familiar with the actual project installation and to discover conditions in the system design or actual field installation that may preclude proper fume hood testing.

A second purpose of the field inspections is to verify that the installed applications match the designed parameters.

A third purpose of the field inspections is to verify that all equipment to be tested must be safely accessible. The NEBB Qualified FHT Supervisor can insure this fact by inspecting the equipment prior to testing

6.4.1 INSPECTION CHECKLIST

Prior to doing fume hood performance testing, the associated supply, return and exhaust air systems shall be completely operational, TAB work shall be complete, systems under automatic control and commissioned prior to testing. Electrical power and life safety systems shall be complete and commissioned. In addition to verifying the items of work stated before, the following items should be checked:

a) Fume hood manufacturer's recommendations
b) Owner/User requirements.

Report deficiencies as discovered to the appropriate parties.

6.4.2 CONSTRUCTION READINESS

As previously stated, most construction activities should be completed prior to fume hood testing. The building should be in a state of near occupancy conditions. Any item that will affect the performance of the fume hood operation and safety should be completed.

From a general construction standpoint, this means that the building exterior is complete, interior partitions complete, ceiling installed, carpeting installed, etc. Items such as painting, hard surfaces flooring, etc is not required.

From a building operating systems standpoint, this means all mechanical/electrical systems have been completed. This includes that the equipment and systems have been installed properly, startup is complete, and systems shall be under functional control. Testing, adjusting and balancing activities shall be completed. Building automation systems shall be completed, including installation, calibration, and functional performance testing. Commissioning of the following shall be completed prior to fume hood performance testing: building HVAC systems and equipment, automatic controls, electrical power and life safety systems, and TAB work.

6.4.3 CONSTRUCTION READINESS REPORT

Prepare a report identifying all issues that would preclude proper fume hood testing.

End of Section 6

SECTION 7 OVERVIEW OF TESTING REQUIREMENTS

7.1 INTRODUCTION

The purpose of this section is to provide an overview of the various tests associated with fume hood performance testing in accordance with the American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE) Standard 110, *Method of Testing Performance of Laboratory Fume Hoods*, and the American National Standards Institute (ANSI) Standard Z9.5, *Laboratory Ventilation*. An overview CANNOT provide all of the exacting requirements of these standards. **For this reason, the NEBB Certified FHT Firm SHALL possess copies of the current versions of both of these industry standards in addition to the NEBB Procedural Standard.** Another excellent reference material is the ASHRAE Handbook chapter on laboratory spaces. See Appendix C for additional references.

The methods and procedures to perform these tests and the results of the tests are a function of the hood types, fume hood sash configuration styles and test setup modes. Thus a brief overview of these parameters is also included in this section.

7.2 TEST SETUP PROCEDURES

7.2.1 FUME HOOD TYPES

Fume hoods are manufactured in two basic styles: bench type and walk-in. While most fume hoods are bench type hoods, walk-in hoods are still required where the physical size of the test apparatus can not be contained in a bench style enclosure.

Listed below are the most common types of fume hoods and their applications:

Standard: Basically a constant volume airflow hood. Airflow volume is relatively constant and airflow face velocity varies as a function of sash opening. May be furnished with all sash configurations. Common hood type found for almost all containment applications.

Bypass: Basically a constant volume airflow hood. Airflow volume and airflow face velocity are relatively constant for all sash openings. As opening size changes due to changes in sash position, openings at the top and the bottom of the hood allow the balance of the air to be drawn into the hood while the airflow face velocity remains constant. May be furnished with all sash configurations. Common hood type found in most containment applications.

Auxiliary Air: Basically a constant volume airflow hood. Airflow volume and airflow face velocity are relatively constant. A plenum is located above the face of the hood and a connection is provided to receive air from a secondary source other than environmentally controlled room air. This secondary source can be conditioned or unconditioned air. These hoods are utilized to achieve energy savings.

Variable Air Volume: This is basically a constant airflow face velocity hood. The airflow volume is a function of sash position. May be furnished with all sash configurations. Common hood type found for almost all containment applications.

While the above identify the most common fume hood types, fume hoods types also include: process, high-performance, radioisotope, perchloric acid, California, and distillation hoods. All of these fume hood types are simply variations of the four common types previously identified with some modifications. A process hood is basically a standard hood without a sash. ASHRAE also identifies a canopy hood as a type of fume hood. This is really a misnomer as a canopy hood is related to a kitchen style grease hood. Like a kitchen hood, the purpose of a canopy hood is to remove heat not fumes. Again, consult the ASHRAE Handbooks or various manufacturers' details and submittals data.

7.2.2 FUME HOOD SASH CONFIGURATIONS

Fume hood sashes are normally made from safety glass. The purpose of the fume hood sash is two-fold: observation and protection. Sash configurations are sometimes identified as sash opening types or sash styles. The wording sash configuration is the most appropriate. Fume hoods can be manufactured in three various sash configurations: horizontal, vertical, and combination. The number of sashes can vary and all sashes may not be operable.

Horizontal Sash: In these fume hoods the sash movement is horizontal. The arrangement can be where one or more of the sashes can be opened at any one time and the sashes can be located at any position in the horizontal tracks.

Vertical Sash. In these fume hoods the sash movement is vertical. In a vertical sash configuration, there may be one or more sashes and they can be moved completely down for full closed to completely up to full open or any position in between.

Combination Sash. As the name implies, the sashes are a combination of vertical and horizontal sashes that serve the fume hood.

7.2.3 TEST SETUPS

Test Setup is defined as the condition that the fume hood will be during the actual test. There are three test setups: As-Manufactured (AM), As-Installed (AI), and As-Used (AU). It is important to note the differences between the three test setups because the various test procedures, reporting and results are unique for each test setup.

As-Manufactured (AM): As the name implies, the fume hood is tested at the manufacturer's facility or under conditions that would replicate those conditions. The hood and work surface shall be void of all process equipment, apparatus and chemicals.

As-Installed (AI): With this test setup, the actual fume hood is installed in its operating condition. All supply, exhaust and return air systems are installed, operable and under control. The hood and work surface shall be void of all process equipment, apparatus and chemicals.

As-Used (AU): This test setup is the same as the As-Installed setup except the hood is being utilized for actual process work. Experiment equipment, chemicals and processes are being carried out inside the hood while the fume hood performance testing is being performed.

When doing fume hood performance testing in accordance with the ASHRAE standard, the test setup shall be defined prior to testing. Test setup can be as specified in the contract documents or as agreed to between the Owner/Buyer and the NEBB Certified FHT Firm.

7.3 ASHRAE STANDARD 110

The Forward of the ASHRAE 110 Standard states that: *"…The performance of a laboratory hood in providing protection for the worker at the face of the hood is strongly influenced by the aerodynamic design of the hood, the method of operation of the hood, the stability of the exhaust ventilation system, the supply ventilation of the laboratory room, the work practices of the user, and by other features of the laboratory in which it is installed. Therefore, there is a need for a performance test that can be used to evaluate the performance of a laboratory hood in the ideal environment and in the field to establish an "as used" performance rating, including the influences of the laboratory arrangement and its ventilation system.*

This standard defines a reproducible method of testing laboratory hoods. It does not define safe procedures. However, laboratory hoods are considered by many to be the primary safety devices in conducting laboratory operations.

There are many important factors in the safe operation of laboratory hoods that are not described in this standard."

There are several things about the ASHRAE standard that should be discussed. ASHRAE 110 DOES define a reproducible method of testing. It clearly defines the requirements for the three unique tests: Airflow Face Velocity Tests, Smoke Visualization Tests, and Tracer Gas Containment Tests. The ASHRAE standard DOES NOT define Pass/Fail criteria for the Airflow Face Velocity Tests. It DOES provide a Pass/Fail criteria that may, or may not, be subjective, for the Smoke Visualization Tests. And, while it DOES provide a quantitative rating of the Tracer Gas Containment Tests, the standard DOES NOT include an associated Pass/Fail criteria for this these tests.

Another feature of the ASHRAE tests is implied. The tests should be performed in order: Airflow Face Velocity Tests, Smoke Visualization Tests and finally the Tracer Gas Containment Tests.

As previously stated in Sections 2 and 3, the scope of testing services should be defined by the Design Professional. Where the scope is not defined, the scope shall be as agreed to between the Owner/Buyer and the NEBB Certified FHT Firm.

The NEBB Fume Hood Performance Testing program is flexible in that a fume hood can be tested and certified as conforming to the requirements of NEBB and still NOT be tested in complete accordance with the requirements of ASHRAE Standard 110. As an example, an owner may want to have a fume hood tested for Airflow Face Velocity Tests only and he dictates the acceptable criteria for the tests. The NEBB Certified FHT Firm can perform the tests in accordance with NEBB's requirements and can issue a certified report documenting the testing performed.

As previously stated in the Section 7.1, the NEBB Qualified FHT Supervisor shall become familiar with the requirements of ASHRAE Standard 110.

7.4 ANSI STANDARD Z9.5

The Forward of the ANSI Z9.5 Standard states that: *"… This standard describes required and recommended practices for the design and operation of laboratory ventilation systems used for control of exposure to airborne contaminants. It is intended for use by employers, architects, industrial hygienists, safety engineers, Chemical Hygiene Officers,*

Environmental Health and Safety Professionals, ventilation system designers, facilities engineers, maintenance personnel, and testing and balance personnel. It is compatible with the ACGIH Industrial Ventilation: A Manual of Recommended Practices, ASHRAE ventilation standards, and other recognized standards of good practice."

The ANSI standard is presented in two-column format. The left column states the requirements of the standard as expressed by the use of "shall." In the right column is a commentary and/or descriptive explanation of the requirements and suggested good practices. The right column contains examples that are expressed by the word "should".

This is same as the language of the NEBB Procedural Standard.

Where the ASHRAE standard is very task oriented, the ANSI standard is more results oriented. The ANSI standard has an excellent section on airflow face velocities with suggested criteria. The Forward of the ANSI standard clearly states that "…*Requirements should be considered minimum criteria and can be adapted to the needs of the User establishment. It is the intent of the standard to allow and encourage innovation provided the main objective of the standard, "control of exposure to airborne contaminants," is met. Demonstrably equal or better approaches are acceptable. When standard provisions are in conflict, the more stringent applies."*

The ANSI standard DOES contain suggested criteria for airflow face velocity, but DOES NOT contain any exacting acceptance requirements for airflow face velocity. It also DOES NOT contain any acceptance criteria related to the Airflow Visualization Tests. It DOES contain acceptance criteria for the Tracer Gas Containment Tests.

The ANSI standard is another excellent reference source for information regarding fume hoods, bio-safety cabinets and laboratory ventilation system design.

End of Section 7

SECTION 8 AIRFLOW FACE VELOCITY TESTS PROCEDURES

8.1 INTRODUCTION

The purpose of this test is to validate that the average airflow face velocity meets the specified requirements at the required sash configuration. The required sash configuration condition may be dictated by the Owner, the Specifier, local code requirements, or the AHJ. Prior to conducting the Airflow Face Velocity Tests, all mechanical ventilation systems serving the space shall be functional and operating in the normal mode. This includes, but is not limited to, the supply, return and exhaust duct systems, air terminal boxes, air outlets, air inlets, etc. serving the space. The automatic control equipment and building automation systems shall be operational, calibrated, and commissioned. The TAB work shall be completed.

Additionally, the operation of the space shall replicate the normal mode of operation during the tests. This would include that all SOP's are followed relating to safety, hood operation, quantity of equipment in operation during the tests, etc.

Finally, the Airflow Face Velocity Tests should be conducted prior to performing the Airflow Visualization Tests and the Smoke Containment Tests.

8.2 AIRFLOW FACE VELOCITY TESTS – CONSTANT AIR VOLUME FUME HOOD

8.2.1 INSTRUMENTS AND EQUIPMENT

8.2.1.1 Provide airflow velocity measuring instruments that conform to the requirements of Table 4-1.

8.2.1.2 Provide a linear measuring device.

8.2.1.3 Provide an equipment stand.

8.2.2 TEST PROCEDURES

8.2.2.1 Set hood to full open sash position and measure the area of the opening. The area shall be determined as follows:

Height: Height shall be based on the dimension from the bottom of the sash position to the work surface.
Width: Width shall be based on the interior wall-to-wall dimension.

8.2.2.2 Determine a grid pattern for the opening comprised of one square foot grid locations.

8.2.2.3 Measure and record velocities within each one square foot grid locations. Each grid location shall have a total of 20 samples per location. Average the 20 samples at each location

to determine the average airflow face velocity at each location and record the value. Determine the average airflow face velocity by averaging the average airflow face velocity from each location.

8.2.2.4 Calculate the total air volume.

8.2.2.5 Set the sash position to achieve the required specified airflow face velocity. Record the sash position.

8.2.2.6 Measure and record airflow face velocity readings within each one square foot grid of this new sash position. Each grid location shall have a total of 20 samples per location. Average the 20 samples at each location to determine the average airflow face velocity at each location and record the average, minimum and maximum value at each location.

8.2.2.7 Document the sash position.

8.2.3 ACCEPTANCE

The acceptance criteria shall be as specified in the contract documents or as agreed to between the Owner and the NEBB Certified FHT Firm.

8.2.4 REPORTING

See Section 5.2.8 for reporting requirements.

8.3 AIRFLOW FACE VELOCITY TESTS – VARIABLE AIR VOLUME (VAV) FUME HOOD

Variable air volume hoods are tested in a similar manner to constant air volume hoods for determining airflow face velocity. Additionally, VAV hoods are also tested to determine response time to return to a near steady-state condition after a change in sash position.

8.3.1 INSTRUMENTS AND EQUIPMENT

8.3.1.1 Provide airflow velocity measuring instruments that conform to the requirements of Table 4-1.

8.3.1.2 Provide a linear measuring device.

8.3.1.3 Provide an equipment stand.

8.3.1.4 Provide an electronic data logger that conforms to the requirements of Table 4-1.

8.3.1.5 Provide a flow sensor or pressure sensor that conforms to the requirements of Table 4-1.

8.3.2 TEST PROCEDURES (Average Airflow Face Velocity)

8.3.2.1 Set hood to specified sash position and measure the area of the opening. The area shall be determined as follows:

Height: Height shall be based on the dimension from the bottom of the sash position to the work surface.

Width: Width shall be based on the interior wall-to-wall dimension.

8.3.2.2 Determine a grid pattern for the opening comprised of one square foot grid locations.

8.3.2.3 Measure and record airflow face velocities within each one square foot grid locations. Each grid location shall have a total of 20 samples per location. Average the 20 samples at each location to determine the average airflow velocity at each location and record the value. Determine the average airflow face velocity by averaging the average airflow face velocity from each location.

8.3.2.4 Calculate the total air volume.

8.3.2.5 Reduce the sash position to 50% of the specified height and repeat airflow face velocity measurements as described above. Record the average at the 50% height.

8.3.2.6 Reduce the sash position to 25% of the specified height and repeat airflow face velocity measurements as described above. Record the average at the 25% height.

8.3.3 TEST PROCEDURES (Response Time)

There are two acceptable methods to perform and measure response time: exhaust airflow volume or hood plenum airflow velocity. Determine the baseline and response conditions by either of the following methods:

a. Exhaust airflow volume method: Place a flow sensor or pressure sensor in the fume hood exhaust duct, or
b. Fume hood plenum airflow velocity method: Place a flow sensor in the fume hood plenum behind the baffle panel.

8.3.5.1 Measure the velocity/pressure at the full sash opening to establish a baseline condition.

8.3.5.2 The Response Time Test involves 3 cycles of opening and closing the sash position from full opened to full closed. When changing the sash position, use a smooth continuous motion.

8.3.5.3 Close the sash completely and leave closed for 30 seconds. Open the sash to full opening for 60 seconds. Close the sash for 30 seconds. Open the sash to full opening for 60 seconds. Close the sash for 30 seconds. Open the sash to full opening for 60 seconds. Close the sash for 30 seconds.

8.3.5.4 Measure and record readings of velocity/pressure at one second intervals.

8.3.5.5 Measure and record speed of response to restore velocity/pressure to 90% of baseline condition.

8.3.5.6 Measure and record time to maintain velocity/pressure to within ±10% of baseline condition.

8.3.5.7 Perform measurements for all 3 cycles. The procedure stated above applies to either vertical or horizontal sash configurations. For fume hoods with combination sash

configurations, the procedure shall be performed both in the vertical and in the horizontal sash opening positions.

8.3.4 ACCEPTANCE

The acceptance criteria shall be as specified in the contract documents or as agreed to between the Owner and the NEBB Certified FHT Firm.

8.3.5 REPORTING

See Section 5.2.9 for reporting requirements.

End of Section 8

SECTION 9 AIRFLOW VISUALIZATION TESTS

9.1 INTRODUCTION

The purpose of this test is to visually verify the fume hood airflow patterns. As with the Airflow Face Velocity Tests described in Section 8, all mechanical ventilation systems serving the space shall be functional and operating in the normal mode. This includes, but is not limited to, the supply, return and exhaust duct systems, air terminal boxes, air outlets, air inlets, etc. serving the space. The automatic control equipment and building automation systems shall be operational, calibrated, and commissioned. The TAB work shall be completed.

Additionally, the operation of the space shall replicate the normal mode of operation during the tests. This would include that all SOP's are followed relating to safety, hood operation, quantity of equipment in operation during the tests, etc.

Finally, the Airflow Face Velocity Tests should be completed prior to performing the Airflow Visualization Tests and the Airflow Visualization Tests should be completed prior to performing the Tracer Gas Containment Tests.

9.2 AIRFLOW VISUALIZATION TESTS – LOCAL CHALLENGE

The purpose of the test is to provide a preliminary visual indication of the fume hood's capture performance with a small smoke challenge without that challenge producing the flow quantity, volume or momentum that the visual observations might be affected by the challenge. The Local Challenge Test should be performed prior to performing the Large Volume Challenge Test.

The smoke source shall be as specified in the contract documents or as agreed to between the Owner and the NEBB Certified FHT Firm. In all cases, the NEBB FHT Firm shall have written approval from the Owner, Designer, or AHJ before using a particular smoke source.

9.2.1 INSTRUMENTS AND EQUIPMENT

9.2.1.1 Provide a small smoke source such as a puffer, titanium-tetrachloride, or other sources that are neutrally buoyant that provides the same visualization. Small smoke sources shall meet the requirements of Table 4-1.

9.2.2 TEST PROCEDURES

9.2.2.1 Set the sash position to operating condition as determined by the Airflow Face Velocity Test.

9.2.2.2 Place the smoke source outside the fume hood and under the airfoil. Verify that the smoke is drawn into the hood and properly exhausted.

9.2.2.3 Position the smoke source along the sides and bottom of the hood in the sash plane opening. For combination, or horizontal sash fume hoods, pass smoke source along the inside edge of all openings. Verify that the smoke is drawn into the hood and exhausted properly.

9.2.2.4 Place the smoke source 6" inside the hood along the bottom of, and parallel to, the sash. Verify that the smoke is contained within the hood and properly exhausted.

9.2.2.5 Move the smoke source so that it traverses the entire work surface and around internal equipment when applicable. Verify that the smoke is drawn into the hood and properly exhausted.

9.2.2.6 Place the smoke source outside the fume hood and determine effects of room and HVAC system conditions by observing the smoke patterns.

9.2.2.7 Place smoke source in cavity above the hood opening and observe the smoke roll inside the hood.

9.2.3 ACCEPTANCE
Smoke shall be contained within the fume hood under all test procedures.

9.2.4 REPORT
See Section 5.2.10 for reporting requirements.

9.3 AIRFLOW VISUALIZATION TEST – LARGE VOLUME CHALLENGE

The purpose of the Large Volume Challenge Test is to provide a visual indication of the fume hood's capture performance when a large scale challenge is introduced. The test procedures for the Large Volume Challenge Test are similar to the Local Challenge Test. ***Care should be taken to compensate for smoke discharge velocity and exposure outside of the fume hood.***

The smoke source shall be as specified in the contract documents or as agreed to between the Owner and the NEBB Certified FHT Firm. In all cases, the NEBB FHT Firm shall have written approval from the Owner, Designer, or AHJ before using a particular smoke source.

9.3.1 INSTRUMENTS AND EQUIPMENT
9.3.1.1 Provide a large smoke source such as an aerosol generator, fog machine, or other sources that are neutrally buoyant that provides the same visualization. Large smoke source shall meet the requirements of Table 4-1.

9.3.2 TEST PROCEDURES
9.3.2.1 Set the sash position to operating condition as determined by the Airflow Face Velocity Test.

9.3.2.2 Place the smoke source outside the fume hood and under the airfoil. Verify that the smoke is drawn into the hood and properly exhausted.

9.3.2.3 Position the smoke source along the sides and bottom of the hood in the sash plane opening. For combination, or horizontal sash fume hoods, pass smoke source along the inside edge of all openings. Verify that the smoke is drawn into the hood and exhausted properly.

9.3.2.4 Place the smoke source 6" inside the hood along the bottom of, and parallel to, the sash. Verify that the smoke is contained within the hood and properly exhausted.

9.3.2.5 Move the smoke source so that it traverses the entire work surface and around internal

equipment when applicable. Verify that the smoke is drawn into the hood and properly exhausted.

9.3.2.6 Place the smoke source outside the fume hood and determine effects of room and HVAC system conditions by observing the smoke patterns.

9.3.2.7 Place smoke source in cavity above the hood opening and observe the smoke roll inside the hood.

9.3.3 ACCEPTANCE
Smoke shall be contained within the fume hood under all test procedures.

9.3.4 REPORT
See Section 5.2.11 for reporting requirements.

End of Section 9

SECTION 10 TRACER GAS CONTAINMENT TESTS

10.1 INTRODUCTION

The purpose of this test is to verify the fume hood's containment performance. As with the Airflow Face Velocity Tests described in Section 8 and the Airflow Visualization Tests described in Section 9, all mechanical ventilation systems serving the space shall be functional and operating in the normal mode. This includes, but is not limited to, the supply, return and exhaust duct systems, air terminal boxes, air outlets, air inlets, etc. serving the space. The automatic control equipment and building automation systems shall be operational, calibrated, and commissioned. The TAB work shall be completed.

Additionally, the operation of the space shall replicate the normal mode of operation during the tests. This would include that all SOP's are followed relating to safety, hood operation, quantity of equipment in operation during the tests, etc.

A Room Layout Drawing shall be prepared for each tested item. The drawing shall identify, but not limited to, the following:

Walls and doors
Fume hood(s),
Other environmental enclosures such as s bio-safety cabinets, laminar flow hoods, canopy hoods, etc.
Location of all air supply, return and exhaust grilles, registers and diffusers.

Finally, Tracer Gas Containment Tests should only be performed after the Airflow Face Velocity Tests and the Airflow Visualization Tests are completed and successfully passed.

10.2 TRACER GAS CONTAINMENT TESTS

When performing the Tracer Gas Containment Tests, the NEBB Certified FHT Firm must establish the test setup (AM, AI, AU). See Section 7 for descriptions. Fume hood size and sash configuration will also affect the number of sample locations for these tests.

The most widely utilized tracer gas is sulfur hexaflouride (SF_6). This chemical may react with surfaces, equipment and other chemicals inside of the hood. Other gases may be utilized as the tracer gas, but they should be of the same approximate molecular weight and stability as that of sulfur hexaflouride.

The tracer gas shall be as specified in the contract documents or as agreed to between the Owner and the NEBB Certified FHT Firm. In all cases, the NEBB FHT Firm shall have written approval from the Owner, Designer, or AHJ before using a particular tracer gas.

Perform a field calibration of the detection instrument prior to performing each tracer gas test session. Perform a verification of the calibration at the end of the test session using a known concentration of tracer gas. If verification test fails, re-calibrate detection systems and perform the tracer gas test session again.

While the test procedures identified below are somewhat germane to the type of gas utilized, there will be slight variances based on the actual tracer gas.

10.2.1 INSTRUMENTS AND EQUIPMENT

10.2.1.1 Provide a detection instrument w/calibrator that meets the requirements of Table 4-1.

10.2.1.2 Provide an ejector system w/calibrator or bubble gauge that meets the requirements of Table 4-1.

10.2.1.3 Provide a tracer gas that meets the requirements of Table 4-1 and Section 10.1

10.2.1.4 Provide a mannequin that meets the requirements of Table 4-1.

10.2.1.5 Provide a data logger that meets the requirements of Table 4-1.

10.2.1.6 Provide a video tape camera that meets the requirements of Table 4-1. (Optional)

10.2.2 **TEST PROCEDURES (Static Mode)**

10.2.2.1 Sash Position

The sash position should be reflective of actual operating conditions. If this setup is unknown, perform the test with sash at full open. If the test is performed at conditions other than full open, it is suggested that this test should also be performed at full open sash position to determine the effect of misuse or condition during equipment setup or loading.

10.2.2.2 Perform a background measurement test at a representative location. Perform frequent background measurements for the duration of the test.

10.2.2.3 Ejector System Locations

All test locations shall be 6" behind the sash. Use the following method to identify the ejector system locations:

a. Vertical Sash: 3 locations are required for fume hood 8' or less: 12" from the left wall, 12" from the right wall and in the center. 4 locations are required for fume hoods greater than 8': 12" from the left wall, 12" left of center line, 12" right of center line and 12" from the right wall.
b. Horizontal Sash: centerline of each maximum opening space such that the minimum airflow face velocity is maintained.
c. Combination Sash: locations shall be determined by both the vertical and horizontal sash configurations described above.

10.2.2.4 Place the ejector system inside the fume hood at the first location.

10.2.2.5 Mannequin Test Location

The mannequin test location shall be directly in front of the ejector system at each test location. The sensor shall be located at a distance of 3" from the face of the sash and 22" above the work surface.

10.2.2.6 System Activation

Release the gas at the rate as specified in the contract documents or as agreed to between the Owner and the NEBB Certified FHT Firm. If a release rate has not been specified, then the release rate shall be 4 l/m. Wait 30 seconds before taking samples.

10.2.2.7 Sample Recording Duration and Rate
Record gas concentration for a minimum of 5 minutes. Record samples every second.

10.2.2.8 Proceed to the next test location and repeat procedure.

10.2.2.9 Results:
Report the average concentration for each test location. Report the maximum of the averages and the concentration of the peaks of the average peak RMS at each sample location.

10.2.2.11 Acceptance:
Acceptance ratings for the Static Mode Tests shall be based on the criteria listed below:

Average concentration shall be no greater than:

0.05 ppm for AM at a generation rate of 4l/m
0.10 ppm for AI at a generation rate of 4l/m
0.10 ppm for AU at a generation rate of 4l/m

10.2.2.12 Reporting
See Section 5.2.12 for reporting requirements.

10.2.3 TEST PROCEDURES (Sash Movement Effect)
10.2.3.1 Ejector System Location
The test location shall be the center of the fume hood.

10.2.3.2 Mannequin Test Location
The mannequin test location shall be directly in front of the ejector system. The sensor shall be located at a distance of 3" from the face of the sash and 22" above the work surface.

10.2.3.3 System Activation
Release the gas at the rate as specified in the contract documents or as agreed to between the Owner and the NEBB Certified FHT Firm. If a release rate has not been specified, then the release rate shall be 4 l/m.

10.2.3.4 Sash Movement
10.2.3.4.1 Start with the sash in the closed position for 60 seconds. Open the sash to the same operating position utilized when performing the Static Test as described above. The sash shall remain open for 60 seconds. Close the sash for 60 seconds. Repeat the process for two additional cycles.

10.2.3.4.2 The sash should be opened and closed with a smooth motion at a rate of 1.0 to 1.5 feet per second.

10.2.3.4.3 For combination hoods, testing shall be performed in both the vertical and in the horizontal positions.

10.2.3.5 Recording and Duration Rate
Record the concentration levels continuously for all three cycles. Record measurements every second.

10.2.3.5 Results:
Calculate the average concentration using the 45 second rolling average of the 3 opening cycles. Maximum average of the three cycles is the Sash Movement Effect (SME) performance rating.

10.2.3.6 Acceptance:
Acceptance ratings for the Sash Movement Effect (SME) shall be as follows: Report results as indicated above. Results should be evaluated by properly trained personnel for SEL.

10.2.3.7 Reporting
See Section 5.2.12 for reporting requirements.

10.2.4 TEST PROCEDURES (Perimeter Scan)
10.2.4.1 Sash Position
Open the sash to the same operating position utilized when performing the Static Test as described above.

10.2.4.2 Ejector System Location
The test location shall be the center of the fume hood.

10.2.4.3 Sensor Test Location
Remove the mannequin from the fume hood. Remove the sensor from the mannequin.

10.2.4.4 System Activation
Release the gas at the rate as specified in the contract documents or as agreed to between the Owner and the NEBB Certified FHT Firm. If a release rate has not been specified, then the release rate shall be 4 l/m. Release the gas for 30 seconds prior to scanning.

10.2.4.5 Sample Recording
Continuously scan the perimeter of the sash opening and below the airfoil at a rate of not more than 3"/sec. Sensor shall be passed 1" from the fume hood test surface.

10.2.4.6 Results
Record any measurable leakage and report the location and magnitude.

10.2.4.7 Acceptance
Acceptance ratings for the Perimeter Scan Tests shall be as follows: Report results as indicated above. Results should be evaluated by properly trained personnel for SEL.

10.2.4.8 Reporting
See Section 5.2.12 for reporting requirements.

End of Section 10

SECTION 11 OTHER TESTS AND PROCEDURES

11.1 INTRODUCTION

As previously stated in Section 7.3, the NEBB Fume Hood Performance Testing program is flexible. The required scope of work in the contract documents or as agreed to between the Owner/Buyer and the NEBB Certified FHT Firm may differ from the testing requirements of ASHRAE Standard 110.

The NEBB Certified FHT Firm shall be capable of performing any of the fume hood performance tests identified in the NEBB *Procedural Standards for Fume Hood Performance Testing*. The NEBB Certified FHT Firm shall also be capable of performing a variation of these tests. This may include, but is not limited to, portions of these tests, or tests that may stipulate different procedures and/or reporting requirements.

The NEBB Certified FHT Firm is still capable of providing a certified report that identifies the measured data and the results of the tests.

11.2 OTHER TESTS AND PROCEDURES

When reporting the results of non-standard tests, the NEBB Certified FHT Firm shall clearly indicate in the report the unique procedures followed for the test.

11.3 SUPPLEMENTARY TESTS AND PROCEDURES

In addition to variations of standard tests, a stated scope of work may also require the NEBB Certified FHT Firm to perform other supplementary tests such as:

a) airflow face velocity uniformity tests
b) temperature/humidity uniformity tests
c) sound and vibration level tests
d) other tests

11.3.1 Airflow Face Velocity Uniformity Tests

Airflow face velocity uniformity tests may be performed to determine the overall average velocity of the air being supplied, returned or exhausted from a space. This test may utilized as a diagnostic tools when trouble shooting a project where containment enclosures such as fume hoods are not performing adequately due to poor air distribution layout.

When performing this test, the NEBB Certified FHT Firm should follow the procedures and requirements as identified the current edition of the NEBB *Procedural Standards for Certified Testing of Cleanrooms.*

11.3.2 Temperature/Humidity Uniformity Tests

Temperature and/or humidity uniformity tests may be performed to determine the temperature and /or humidity gradient that may exist in space. This test may utilized as a diagnostic tools when trouble

shooting a project where excessive temperature and/or humidity differentials may exist and could effect the results of the process being conducted in a containment enclosure.

When performing this test, the NEBB Certified FHT Firm should follow the procedures and requirements as identified the current edition of the NEBB *Procedural Standards for Certified Testing of Cleanrooms.*

11.3.3 Sound and Vibration Level Tests

Sound level tests may be performed to determine the overall sound pressure levels in an operating space. Vibration level tests may be performed to determine vibration magnitude levels of rotating equipment that may be in, or adjacent to an operating space. These tests may be performed as an adjunct test to normal fume hood performance testing or may be used as a diagnostic tools when trouble shooting a project where sound and/or vibration levels may be excessive.

When performing these tests, the NEBB Certified FHT Firm should follow the procedures and requirements as identified the current edition of the NEBB *Procedural Standards for Measurement of Sound and Vibration.*

End of Section 11

APPENDIX A SAMPLE FHT SPECIFICATION

(This recommended Fume Hood Testing specification is available from www.nebb.org)

SECTION 15xxx (23xxx) – FUME HOOD TESTING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

This Section includes tests, measurements, and reporting of fume hood testing.

1.3 DEFINITIONS

(To be added as per Section 1 of the FHT PS)

1.5 FUME HOOD (FHT) TESTING FIRM QUALIFICATIONS

The Fume Hood Testing firm shall be NEBB Certified in Performance Testing of Fume Hoods (FHT).

1.6 FHT FIRM SUBMITTALS

1.6.1 Qualification Data: When requested, submit 2 copies of evidence that FHT firm and this Project's TAB team members meet the qualifications specified in Sub-section 1.3 *Fume Hood Firm Qualifications.*

1.6.2 FHT Agenda: When requested, submit 2 copies of the FHT Agenda. Include a complete set of report forms intended for use on this Project.

1.6.3 Certified FHT Reports: Submit a final FHT report in accordance with the current edition of the NEBB *Procedural Standards for Performance Testing of Fume Hoods.*

1.7 QUALITY ASSURANCE

1.7.1 The NEBB Certified FHT Firm shall submit 2 copies of the firm's NEBB FHT Certification.

1.7.2 When requested, the NEBB Certified FHT Firm shall apply for the NEBB Certificate of Conformance Certification.

1.7.3 FHT Report Forms: Prepare report forms in accordance with the requirements from the current edition of the NEBB *Procedural Standards for Performance Testing of Fume Hoods.*

1.7.4 Instrumentation Calibration: Calibration of instruments shall be in accordance with the current edition of the NEBB *Procedural Standards for Performance Testing of Fume Hoods.*

1.8 CONSTRUCTION TEAM RESPONSIBILITY TO FHT FIRM

1.8.1 Provide the NEBB Certified FHT Firm with a conformed set of contract documents (drawings, specifications, and approved submittals), including all current approved change orders / contract modifications.

1.8.2 Develop a project schedule with the input of the NEBB Certified FHT Firm that coordinates the work of other disciplines and provides adequate time in the construction process to allow successful completion of the fume hood testing work.

1.8.3 Notify the NEBB Certified FHT Firm of schedule changes.

1.8.4 Ensure that the building enclosure is complete, including but not limited to, all structural components, windows and doors installed, door hardware complete, ceilings complete, stair, elevator and mechanical shafts complete, roof systems complete, all plenums sealed, etc.

1.8.5 Ensure that all necessary mechanical work is complete. This includes, but is not limited to, duct leakage testing and hydrostatic testing. The piping systems should be flushed, filled, vented, and chemically treated. The duct systems and equipment have been cleaned.

1.8.6 Complete the installation of permanent electrical power systems serving the HVAC equipment and systems. Such systems shall be properly installed in accordance with all applicable codes to ensure the safety of all construction personnel.

1.8.7 Complete the installation of all HVAC equipment and systems to ensure safe operation.

1.8.8 Perform the start up of all HVAC equipment and systems in accordance with the manufacturer's recommendations.

1.8.9 Complete installation, programming (including design parameters and graphics), calibration, and startup of all building control systems.

1.8.10 Verify that the building control system provider has commissioned and documented their work before the fume hood testing work begins.

1.8.11 Require that the building control system firm provide access to hardware and software, or onsite technical support required to assist the fume hood testing effort. The hardware and software or the onsite technical support shall be provided at no cost to the NEBB Certified FHT Firm.

1.8.12 Complete the TAB work prior to fume hood testing.

PART 2 - PRODUCTS (Not Applicable)

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper fume hood testing of systems and equipment. *Contract Documents* are defined in the General and Supplementary Conditions of Contract.

B. Examine approved submittal data of final installed HVAC systems and equipment, provided by the mechanical/general contractor, or building owner's representative.

C. Examine appropriate system and equipment test reports, for systems and equipment requiring factory start-up.

D. Verify that all system and equipment installations are complete and that testing, adjusting, and balancing specified in the contract documents have been performed.

E. Verify that the Building Automation Systems have been installed, calibrated and functionally tested and that the complete control system has been commissioned.

F. Report deficiencies as discovered to the appropriate parties.

3.2 PROCEDURES FOR FUME HOOD TESTING

A. Perform the following fume hood performance tests:
1. Airflow Face Velocity Tests
2. Airflow Visualization Tests
3. Tracer Gas Containment Tests
4. Other Tests

B. Perform all fume hood performance tests in accordance with the requirements of the current edition of the NEBB *Procedural Standards for Fume Hood Performance Testing.*

3.3 REPORTING

Provide appropriate deficiency information to the construction team as FHT work progresses. Deficiency information shall be sufficient to facilitate contractor's dispatch of appropriate personnel to resolve items noted prior to final FHT work.

3.4 FINAL REPORT

The final report shall be in accordance with the requirements of the current edition of the NEBB *Procedural Standards for Fume Hood Performance Testing.*

End of Appendix A

APPENDIX B SAMPLE FHT REPORT FORMS

FORM TITLE	FORM NO.	PAGE NO.
Report Title		
Certification Form		
Instrument Calibration Report		

FUME HOOD PERFORMANCE TESTING REPORT

REPORT DATE: _____

PROJECT:

NAME: _____

ADDRESS: _____

_____

DESIGN ENGINEERING FIRM:

NAME: _____

ADDRESS: _____

_____

HVAC CONTRACTOR:

NAME: _____

ADDRESS: _____

_____

NEBB FHT FIRM:

NAME: _____

ADDRESS: _____

_____

FHT CERTIFICATION NUMBER: _____

CERTIFICATION

PROJECT: _____

_____

"THE DATA PRESENTED IN THIS REPORT IS A RECORD OF THE FUME HOOD PERFORMANCE TESTING OBTAINED IN ACCORDANCE WITH THE REQUIREMENTS OF THE CURRENT EDITION OF ASHRAE STANDARD 110 AND THE CURRENT EDITION OF THE NEBB *PROCEDURAL STANDARDS FOR FUME HOOD PERFORMANCE TESTING.* ANY VARIANCES FROM DESIGN / OR INDUSTRY STANDARDS WHICH EXCEED THE LIMITS SET BY THE CONTRACT DOCUMENTS, OR WHICH EXCEED THE LIMITS AGREED TO BETWEEN THE OWNER AND THE NEBB CERTIFIED FHT FIRM ARE NOTED THROUGHOUT THIS REPORT AND / OR IN THE REPORT PROJECT SUMMARY."

SUBMITTED & CERTIFIED BY

NEBB CERTIFIED SUPERVISOR (Print Name): _____

NEBB CERTIFIED SUPERVISOR (Signature): _____

NEBB CERTIFIED FHT FIRM NAME: _____

CERTIFICATION NO: _____ CERTIFICATION EXPIRATION DATE: _____

REPORT DATE: _____

SEAL

INSTRUMENT CALIBRATION REPORT

PROJECT:_____

INSTRUMENT TYPE	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	CALIBRATION DATE	DATES OF USE

MEASUREMENT SCHEMATIC, DESCRIPTION AND OTHER CONDITIONS

PROJECT: _____ SYSTEM: _____

LOCATION: _____

LOCATION DESCRIPTION: _____

Page _____ of _____

APPENDIX C REFERENCES, AND REFERENCED PUBLICATIONS

A. Air Movement Control Association International, Inc. AMCA)

30 West University Drive, Arlington Heights, IL 60004
AMCA Publication 201-2002 , *Fan Application Manual*
AMCA Publication 203-1990, *Field Performance Measurement of Fan Systems*
Both publications contain engineering fundamentals of fan application, design and performance ratings and field measurements.

B. American Industrial Hygiene Association (AIHA)

2700 Prosperity Avenue, Suite 250, Fairfax, VA 22031
ANSI/AIHA Standard Z9.5-2003, *Laboratory Ventilation*
Contains information on the recommendations, design, installation, and maintenance of laboratory ventilation systems.

C. American Conference of Governmental industrial Hygienists (ACGIH)

Kemper Meadow Drive, Cincinnati, Ohio 45240
ACGIH Publication: *Industrial Ventilation, A Manual of Recommended Practice*
Contains information on the design and installation of industrial ventilation systems and exhaust systems and hoods.

D. American Society of Heating, Air Conditioning and Refrigerating Engineers (ASHRAE)

1791 Tullie Circle Northeast, Atlanta, Georgia 30329
ASHRAE Handbook—*HVAC Applications (2003)* Chapter 7—*Health Care Facilities*
Chapter 14—*Laboratory Systems*
Chapter 16—*Clean Spaces*
ANSI/ASHRAE Standard 110-2006, *Method of Testing Performance of Laboratory Fume Hoods*

E. National Environmental Balancing Bureau (NEBB)

8575 Grovemont Circle, Gaithersburg, Maryland 20877-4121
E.1 *Environmental Systems Technology*
A full length, hard-back "collectors type" textbook in a distinctive Victorian style incorporating HVAC system history and fundamentals, engineering principles, system design, equipment components and installation, testing and balancing, controls, acoustics, and an extensive glossary and set of engineering tables and charts.
E.2 *Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems—2005*
A "how-to" set of procedural standards that provide systematic methods for testing, adjusting, and balancing (TAB) of HVAC systems includes sections on TAB instruments and calibration, report forms, and sample specification.
E.3 *Testing, Adjusting, Balancing Manual for Technicians—1997*

A practical field-use manual for balancing technicians designed to be used for reference and job site application as well as for training balancing crews. This edition includes a section on mathematics and equations for field use.

E.4 *Procedural Standards for Certified Testing of Cleanrooms—2006*

This manual provides an extensive array of information on cleanroom testing, technology and test procedures. It includes: cleanroom design; cleanroom systems; laboratory and health facilities; test instruments and test procedures; HEPA filter leak testing; and particle counts.

E.5 *Study Course for Certified Testing of Cleanrooms*

A self-study course in cleanrooms and systems including cleanroom testing equipment, control systems, cleanroom test procedures, system and unit test procedures, and cleanroom equipment and accessories. The package includes 10 lessons plus a study course examination, reference material and two reference texts.

E.6 *Procedural Standards for the Measurement of Sound and Vibration—2006*

This publication provides background information and step-by-step comprehensive guidance for obtaining and recording sound and vibration data on HVAC systems. Topics include: instrumentation, inspection of building construction and conditions, interior and exterior sound measurement, and vibration measurement procedures. Also covered are sample specifications and report forms.

E.7 *Sound and Vibration Design and Analysis—1994*

A concise coverage of sound and vibration as it relates to HVAC systems. Basic concepts of the science of sound and vibration are covered, plus the most current information on equipment sound levels, duct element regenerated and sound power and attenuation, duct breakout and breakin, sound transmission in indoor and outdoor spaces, and vibration analysis. Includes references and glossary.

E.8 *Study Course for Measuring Sound and Vibration—1995*

A home study course on measuring sound and vibration, it guides the student in an orderly sequence, with diagrams, charts and problems to recognize principles and procedures. The package includes 15 lessons and final examination, two reference texts and binder.

E.9 *Procedural Standards for Building Systems Commissioning—1999*

A manual providing comprehensive guidance for commissioning building HVAC systems. The text describes organization, planning, procedures and methods for verifying and documenting the performance of building systems. Included are a sample specification, model reporting forms, check sheets and functional test checklists, as well as a schematic depicting the commissioning process.

F. National Sanitation Foundation (NSF)

789 N. Dixboro Road, Ann Arbor, Michigan 48106

NSF 49-2005, *Class II (Laminar Flow) Biohazard Cabinetry*

This document applies to cabinetry designed to minimize hazards inherent in work with low and moderate risk biological agents and defines tests which must be passed.

G. National Fire Prevention Association (NFPA)

1 Batterymarch Park, Quincy, Massachusetts 02169

H. Scientific Equipment and Furniture Association (SEFA)

I. United States of America, Agencies and Departments

US Department of Labor - Occupational Safety & Health Administration

200 Constitution Avenue, NW, Washington, DC 20210

End of Appendix C