Contents

1.0 Purpose/Scope

The hood is a local exhaust ventilation system (LEV) used for safe work with hazardous vapors and gases. This procedure provides a standardized method for conducting periodic face velocity measurements of chemical hoods. This procedure is compatible with Radiological Control Division's FS-SOP-1200 *Face Velocity Measurements for Laboratory Fume Hood*. This SOP does not pertain to Biosafety Cabinets, Glove boxes, Clean Benches or hoods with a horizontal sash.

This procedure is limited to use in organizations providing direct funding for their Safety & Health Services Division personnel.

2.0 Responsibilities

2.1 **Demonstrated Competency:** This procedure is administered and implemented through the SHSD Industrial Hygiene Group. Only persons who have demonstrated competency in performing this procedure in accordance with Section 7 are authorized to use this procedure.

2.2 **Hazard Analysis of the Sampling Task:** It is the responsibility of the person using this

method and his/her supervisor to ensure that the appropriate personal protective equipment, as per section 5.2, is worn while performing this procedure. In addition, the person performing this procedure and his/her supervisor are responsible to ensure that all required training and qualification for hazards that may be present in areas where this procedure will be used have been met. The person performing this procedure and his/her line supervisor are responsible to comply with all work planning and work permit system requirements.

2.3 The person using this procedure is responsible to notify the system owner, the ESH Coordinator, and the Building Manger of any hood failing this surveillance test.

3.0 Definitions

Airfoil: Located along the bottom of the sash opening that streamlines airflow into the hood, preventing turbulent eddies that can carry vapors out of the hood. The space below the bottom airfoil provides a source of room air for the hood to exhaust when the sash is fully closed. Removing the airfoil can cause turbulence and loss of contaminant.

Area (A) - surface area of hood opening or duct of rectangular face opening: is measured as: A = length x width, in square feet (ft^2) or square meters (m^2).

Auxiliary By-pass Hood: This has a dedicated duct supply of *outside* air to the face of the hood. This results in energy savings but may create uncomfortable conditions for the user. Note: alteration of the air supply system such as sealing off the auxiliary air duct will adversely affect hood operation and may result in hazardous chemical exposures.

Average Face velocity: air speed necessary to overcome opposing air currents and contain a contaminant in the hood for exhaust to the outdoors. Unit typically expressed as feet per minute (fpm).

Acceptance Criteria:

- Average Face Velocity >/= 100 fpm
- All readings between +/- 20% of Average Face Velocity
- Average Face Velocity <= 180 fpm

Baffles: Moveable partitions used to create slotted openings along the back of the hood. Baffles keep the airflow uniform across the hood opening, thus eliminating dead spots and optimizing laminar flow.

Biosafety Cabinet: an engineering control, which provides protection for both the work product (biological specimen) and the user. A laminar flow of HEPA filtered air is passed across the work surface. The air is then re-filtered before being exhausted, usually back into the laboratory. Because all clean benches and some biological safety cabinets exhaust air back into the work area, they cannot be safely used with hazardous gases and vapors.

Bypass Hoods: These incorporate an additional source of room air above the sash for when the sash is closed. As the sash is lowered, the bypass area becomes exposed, effectively increasing the face opening while maintaining the face velocity. This reduces the chance for turbulence and loss of containment as the sash is lowered.

Chemical Hood: an engineering control designed to contain hazardous vapors and gases and exhaust them outside the building.

Clean Bench: an engineering control designed to protect biological specimens or other work products by bathing the work area with a laminar flow of air free of particulate contamination. These hoods use a HEPA filter and force the air across the work surface and toward the worker. Thus it protects the work and not the user.

Constant Volume Hood: A hood, which maintains a constant volume of airflow in the exhaust duct regardless of the sash position. Proper positioning of the sash is critical in this type of hood as the face velocity changes with the sash position to maintain a constant flow. Note: Face velocities in excess of 200 feet per minute cause excessive turbulence and loss of containment.

Conventional Hoods: the original and most simple design. A Constant Flow Hood.

Exhaust plenum: An important engineering feature connects the hood to the exhaust ductwork and helps to distribute airflow evenly across the hood face. Materials such as paper towels drawn into the plenum can create turbulence in this part of the hood resulting in areas of poor airflow and uneven performance.

Face: The imaginary plane running between the bottom of the sash to the airfoil. Hood face velocity is measured across this plane.

Hood Face Velocity (V): Air velocity at the plane of and perpendicular to the opening of an exhaust hood.

Hood Air Flow Rate (Q): The total volume of air that moves across the hood opening per unit time. Where Q=VxA and A=area of hood opening and V=average face velocity. The measured hood airflow rate should be within 10% of the designed flow rate if it is known. A better measure of exhaust airflow is the duct airflow.

Horizontal hood: The sash of the hood moves sideways, i.e. the tracks of the sash travel in are horizontal.

Perchloric Acid Hoods: When heated above ambient temperature, perchloric acid will vaporize and may condense on hood, duct and fan components. In addition to being highly corrosive, condensed vapors can react with hood gaskets, greases and other collected materials to form explosive perchoric acid salts and esters. A perchloric acid hood is built with welded stainless steel hood surfaces, ductwork and fan to minimize the corrosive and reactive effects. They also have a wash-down system of water fog nozzles dispersed throughout the hood and exhaust system. Washing down the hood and ductwork removes and prevents the build up of hazardous perchlorates.

Sash: The sliding door to the hood. By using the sash to adjust the front opening, airflow across the hood can be adjusted to the point where capture of contaminants is optimized. Each hood is marked with the maximum sash opening. The sash should be held in this position or lower when working in the hood and closed completely

when the hood is not in use. The sash may be temporarily raised above this position to set up equipment, but must be returned prior to generating contaminants inside the hood.

Variable Air Volume Hoods: These hoods are sophisticated and maintain a constant face velocity as sash height changes. As the sash is moved the exhaust volume is adjusted so the average face velocity is maintained within acceptable parameters. It is best to use these hoods with the sash half open, as this provides more even air flow and a degree of face protection in case of an unexpected spill, fire or explosion in the hood. When not in use the sash should be closed to save energy.

Velocity (V): - speed of air passing a point in space. Units: English- feet per minute (fpm), Metric- meters per sec (m/s)

Vertical hood: The sash of the hood moves up and down, i.e. the tracks of the sash travel in are vertically mounted.

Walk-in Hood: A vertical or horizontal sash hood in which the sash opening goes to floor level. The sash opening allows temporary access of personnel and equipment for set-up of experimental apparatus. Occupancy during hazardous operations is not allowed.

4.0 Prerequisites

4.1 Prior to testing a local exhaust system, verify the calibration and operability of the test equipment.
4.2 Observe area postings and obtain approval to enter the test area, as required.
4.3 Make sure the typical experimental arrangement in the hood is in place at the time of the surveillance. The goal is to test the hood as it is routinely used, not an empty hood or a hood in which equipment is removed for the purpose of "passing the test", that will return to the hood for normal use.

5.0 Precautions

5.1 **Hazard Determination:**
5.1.1 This test may be done in areas where chemicals or radiological contamination is known or suspected to be present. These contaminants can have significant health effects and must receive a hazard evaluation by a cognizant ESH professional.
5.1.2 This operation may involve release of and exposure to hazardous chemicals (i.e. some type of air flow pattern detection smoke). The gases, vapors, or aerosols used to visualize effective airflow could cause exposure to the tester. The

sampler should take appropriate measures to review and understand the health effects and controls (e.g. MSDS) as well as minimize exposure to these contaminants.

5.1.3 Air testing meters used in this procedure do not generate Hazardous Wastes.

5.1.4 The smoke testing equipment may generate a very low airborne concentration that is not of environmental consequence under typical exposure levels.

5.1.5 The test equipment design does not cause significant ergonomic concerns in routine use.

5.2 **Personal Protective Equipment (PPE)**

The testing procedure will primarily be conducted in working laboratories.

5.2.1 **Eye:** Safety Glasses with side shields are required at a minimum.

5.2.2 **Hand**: Contact with work surfaces should be minimized as it could pose a health risk. Use of this operation in areas of known or suspected chemical contamination requires the use of disposable gloves. Exam-style, splash gloves are acceptable. Acceptable elastomers are: Nitrile, PVC, and Natural Rubber.

5.2.3 **Body:**

- Appropriate lab apparel is required for all work under this SOP. Minimum laboratory wear includes: long pants, closed shoes and a lab coat.
- If contact of the body with contaminated surfaces is anticipated, a disposable suit should be used. Acceptable Chemical Protective Clothing (CPC) materials include: Tyvek®, KleenGuard®, and cotton. Disposable garments must be discarded as per Hazardous Waste Management Division instruction.
- If contact with potentially contaminated surfaces is not expected, disposable, protective clothing is optional. However, if personal clothing items become contaminated, they must be surrendered for BNL cleaning or disposal.

5.2.4 **Foot:**

- Open toed shoes are not allowed in laboratories.
- If contact of the footwear is anticipated with contaminated surface, disposable shoe coverings, boots or booties should be used. Acceptable CPC material include: Tyvek®, KleenGuard®, and rubber.
- If contact with potentially contaminated surfaces is not expected, shoe coverings are optional. However, if personal shoes become contaminated, they must be surrendered for BNL cleaning or disposal.

5.2.5 **Respiratory:** Under normal use, respiratory protection is not required. If chemical levels from contamination in the area cause the OSHA, ACGIH, or DOE standards to be exceeded, respirators are required.

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6.0 Procedure

6.1 **Equipment:** Follow the IH SOP on the operation of the meter:
- Air velocity meter
  - Alnor® swinging vane anemometer IH62640 or
  - TSI® thermal anemometer VelociCalc® IH62680.
- Measuring ruler.
- Labels/Signs for acceptable face velocity, sash height and failure notice (Attachments 9.1, 9.2, & 9.3).

6.2 **Pre-Testing Inspection of equipment**

6.2.1 Review the recommended practices for chemical hoods in Attachment 9.3.

6.2.2 Notify the hood user/owner that "smoke" will be used for visual verification. Verify the approval of the experimenter to use this material regarding its affect the experimental equipment.

6.2.3 Verify that the exhaust ventilation system is operating.

6.2.4 Observe any air flow warning device for proper operation. Test for proper operation if possible.

6.2.5 Visually observe the hood enclosure, visible ductwork in the room, and readily visible mechanical components for any obvious signs of damage (e.g., non-functioning sash, missing or damaged parts, breached ductwork, excessive rust, unusually loud motor noise, etc). Notify Plant Engineering, building manager and the system owner of these conditions. Do not test if the system is not operable or not of adequate integrity.

6.2.6 Ensure that multi-speed systems are functioning at all levels (as each level is to be tested independently.)

6.2.7 For HEPA filtered hoods:
- Review Differential Pressure gauge reading records. If the pressure readings exceeds 2 inches gauge water pressure (from its initial pressure), then the filter needs replacement. Report the status to the owner.
- Observe that a current HEPA surveillance test has been performed.

6.3 **Evaluate the existing use of the hood** for chemical container storage and experimental equipment problems such as: excessive chemical containers or equipment blocking

air intakes or outflows. Notify the lab owner if the system has conditions, which adversely affect air flow through the face. Do not test if the system with blocked airways.

6.4 **Evaluate and document unacceptable conditions surrounding the LEV system**. Using the "Comments" section of the survey form, document any of these condition:

- Doors and windows opened that impact the negative pressure with respect to adjoining spaces; verify airflow direction with a smoke test.
- HVAC system not functioning in supplying adequate air flow.
- Excess people and equipment traffic around the system.
- Unacceptable storage of equipment around the system.
- Unacceptable storage of equipment inside the unit.
- Multiple hoods or other equipment competing for airflow.

6.5 **Smoke Test**: Using a smoke generating device:

- Release smoke outside the hood at various points along the vertical face of the hood to ensure inward flow at all locations. If the airflow of smoke is not inward at all points across the face of the hood, try lowering the sash to a point where the airflow is inward at all points. If the flow of smoke is still not inward, stop the test, post a hood failure notice (Attachment 9.2). Notify the building manager and ESH coordinator of the problem.

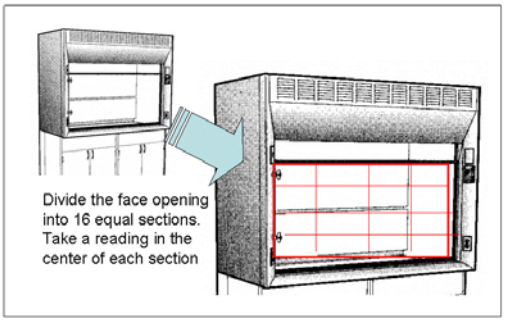
- Release smoke at various locations within the hood to determine there are no stagnant areas or eddy currents directing flow out of the hood. If the airflow of smoke is not retained within the hood or rolls back toward the hood sash, try lowering the sash to a point where the airflow is inward at all points. If the flow of smoke is still not retained, stop the test, post a hood failure notice (Attachment 9.2). Notify the building manager and ESH coordinator of the problem.

6.6 Remove the "Maximum Opening" sticker from the hood if it has been previously tested.

6.7 **Face Velocity Measurements:** The equipment and containers for normal operations should be in place within the hood at the time the face velocity test is performed.

6.7.1 Set the sash to a height of 12-24 inches to start testing. If necessary, conduct measurements for a higher sash height if required by the experimenter. A sash height of less than 19 inches provides eye protection for most hoods and should be the maximum setting when possible.

6.7.2 Divide the open face of the hood into an imaginary grid of 16 rectangles of equal area. The entire face of the hood must be tested.



6.7.3 Stand to the side of the hood face, away from the opening. The probe should be perpendicular to the hood face and in vertical alignment with the sash. Place the velocity-measuring meter's probe at the center of each of the **16** imaginary rectangles.

6.7.4 Record the readings in each of the 16 sections on the ***Laboratory Hood Face Velocity Periodic Validation*** form (Attachment 9.1). If the velocity is below 80 fpm in any section, lower the sash height and repeat the test.

6.7.5 When all reading in each section are at least 80 fpm, calculate the average of all 16 points. IUf the average is <100 fpm, lower the sash and repeat.

6.7.6 The hood **PASSES** the surveillance test , when all of the following criteria are acceptable:

- Smoke tests from outside the hood indicate all airflow is inward (over the entire face of the hood).
- Smoke tests from within the hood indicate no airflow leaves the hood (over the entire face of the hood).
- Sash height provides at least 12 inches opening (at the 100 fpm average setting).
- **Average Face Velocity >/= 100 fpm** and **<= 180 fpm.**
- **No single face velocity measurement is less than 80 fpm.**
- **All results are +/- 20% of the average flow rate.**

6.8 For hoods which pass all tests:

- Post a label or tag on the hood (at the passing sash height) noting the test date and name of tester (see Attachment 9.3 for the label).

- Take a photo of the hood showing test conditions with all equipment/chemicals/gas cylinders and new position of the sash. This photo is to be imported to the printed periodic evaluation form and posted on the hood to be visible for users. Post this photo and the Attachment 9.1 *Lab Hood Periodic Face Velocity Validation* form near the hood.

6.9 If the average is below 100 fpm: Observe the readings and lower the sash while observing the velocity until the readings are acceptable. Do not lower the sash less than a height of 12 inches. If the hood will not pass at 12 inch sash height it fails the standard testing. Post the *Laboratory Hood Testing Failure Notic*e sign (Attachment 9.2) on the hood.

6.10 Record-keeping: The original test report (*Lab Hood Periodic Face Velocity Validation* form) is transferred to the IH lab manager in accordance with the BNL record keeping requirements. Send a copy of the record to the ESH Coordinator for the organization.

7.0 Implementation and Training

7.1 Tests shall be performed by persons who have demonstrated the competence to satisfactorily perform the tests as evidenced by experience and training as documented in Attachment 9.5 *Job Performance Measure.*

7.1.1 Qualification to use this procedure, testing of applicants, and documentation of qualification shall be set by the IH Group Leader, or designee.

7.1.2 Official qualification records are maintained by the IH manager.

8.0 References

8.1 American Conference of Governmental Industrial Hygienists (ACGIH). *Guidelines for Testing Ventilation Systems*; 1991.

8.2 American National Standards Institute (ANSI). *Laboratory Ventilation* ANSI/AIHA Z9.5 2003.

8.3 American Conference of Governmental Industrial Hygienists (ACGIH) *Industrial Ventilation – A Manual of Recommended Practice* 25th Edition.

9.0 Attachments

9.1 Sample BNL Laboratory Hood Periodic Evaluation form.
9.2 Sample of the BNL Laboratory Hood Testing Failure Notice.
9.3 Sample of the BNL Label for Passing Hoods.
9.4 Work Practices for Laboratory Hoods: *ACGIH Industrial Ventilation 25th Edition.*
9.5 *JPM Qualification Form.*

10.0 Documentation

Document Development and Revision Control Tracking		
Prepared By: *(signature/date on file)* J. Peters 09/05/07 Certified Industrial Hygienist	Reviewed By / Date: *(signature/date on file)* R. Selvey 09/07/07 Certified Industrial Hygienist	Approved By / Date: *(signature/date on file)* R. Selvey 09/17/07 Industrial Hygienist Group Leader
ESH Coordinator/ Date: *none*	Work Coordinator/ Date: *none*	SHSD Manager / Date *none*
QA Representative / Date: *none*	Training Coordinator / Date: *none*	Filing Code: **IH52**
Facility Support Rep. / Date: *None*	Environ. Compliance Rep. / Date: *none*	Effective Date: **09/17/07**
ISM Review - Hazard Categorization ☐ High ☒ Moderate ☐ Low/Skill of the craft	Validation: ☐ Formal Walkthrough ☒ Desk Top Review ☐ SME Review Name / Date:	Implementation: Training Completed: Tracked in BTMS Procedure posted on Web: 09/17/07 Hard Copy files updated: 09/17/07 Document Control: 09/17/07

Revision Log		
Purpose: ☐ Temporary Change ☐ Change in Scope ☐ Periodic review ☐ Clarify/enhance procedural controls Changed resulting from: ☐ Environmental impacts ☐ Federal, State and/or Local requirements ☐ Corrective/preventive actions to non-conformances ☐ none of the above Section/page and Description of change:		
(signature/date on file) SME Reviewer/Date:	*(signature/date on file)* Reviewer/Date:	Reviewer/Date:

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Attachment 9.1

BROOKHAVEN NATIONAL LABORATORY

IH62420 ATTACHMENT 9.1

Laboratory Hood Face Velocity Periodic Validation

Safety & Health Services Division

System Identification

DIVISION	BUILDING	ROOM/AREA
BLDG MANAGER	ESH COORDINATOR	OTHER CONTACT (owner)

System Description

HOOD TYPE: ☐ Bypass ☐ Aux Bypass ☐ Variable Air Volume ☐ Vertical ☐ Horizontal ☐ Walk In ☐ Perchloric Acid ☐ Other		AIRFOIL PRESENT ☐ Y ☐ N
MANUFACTURER	MODEL	EQUIPMENT ID# or SERIAL#
HEPA Filtered ☐ Y ☐ N Magnehelic Gauge ☐ Y ☐ N	CONTINUOUS FLOW METER/ALARM ☐ Y ☐ N TYPE ALARM CALIBRATION DATE ☐ Pass ☐ Fail	
Gauge Reading Current: Previous:	Last SHSD/RCD Surveillance Test Date	

SMOKE TEST TYPE: ☐ matches ☐ tube ☐ generator ☐ other		Smoke Test ☐ Pass ☐ Fail
METER:	METER SN:	METER CALIB. DATE:

Photograph – As Used

SAMPLE
See the SHSD SOP web page for the most recent version of this controlled document form.

Velocity Measurements

			D
			H
			L
M	N	O	P

Average Face Velocity = _____ fpm

Surface Area of Hood at 100 fpm setting: _____

Overall: ☐ Pass ☐ Fail

Maximum Sash Height:

COMMENTS:

REVIEW and AUTHORIZATION

EVALUATOR(S) NAME	SIGNATURE	TEST DATE

IH62420 ATTACHMENT 9.1 Form Revision 09/17/07

ATTACHMENT 9.2

Sample of the
Laboratory Hood Testing Failure Notice

CAUTION

THIS HOOD FAILED
FACE VELOCITY TESTING
REQUIREMENTS SPECIFIED BY IH62420

DO NOT USE THIS HOOD
FOR ON
REQUI OOD.

SAMPLE
See the SHSD SOP web page for the most recent version of this controlled document form.

Posted by: (Print) _____ Signature _____ Date _____

SHSD IH62420 Attachment 9.2

ATTACHMENT 9.3

Sample of
Label for Passing Hoods

MAXIMUM OPENING

FOR REQUIRED FACE VELOCITY

TESTED BY:

_____
Printed Name:

_____
Signature

_____
Date

TESTING DUE ONE YEAR
FROM THE ABOVE DATE

SAMPLE
See the SHSD SOP web page for the most recent version of this controlled document form.

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ATTACHMENT 9.4

ACGIH Industrial Ventilation A Manual of Recommended Practice 25th edition

WORK PRACTICES FOR LABORATORY HOODS

No large, open-face hood with a low face velocity can provide complete safety for a worker standing at the face against all events that may occur in the hood. The hood may not adequately protect the worker from volatile or otherwise airborne contaminants with a TLV® in the low part-per-billion range. For more ordinary exposures, a properly designed hood in a properly ventilated room can provide adequate protection. However, certain work practices are necessary in order for the hood to perform capably. The following work practices are generally required; more stringent practices may be necessary in some circumstances.

1. Conduct all operations that may generate air contaminants at or above the appropriate TLV® inside a hood.
2. Keep all apparatus at least 6 inches back from the face of the hood. A stripe on the bench surface is a good reminder.
3. Do not put your head in the hood when contaminants are being generated.
4. Do not use the hood as a waste disposal mechanism except for very small quantities of volatile materials.
5. Do not store chemicals or apparatus in the hood. Store hazardous chemicals in an approved safety cabinet.
6. Keep the hood sash closed as much as possible.
7. Keep the slots in the hood baffle free of obstruction by apparatus or containers.
8. Minimize foot traffic past the face of the hood.
9. Keep laboratory doors closed (exception: some laboratory designs require lab doors to be open).
10. Do not remove hood sash or panels except when necessary for apparatus set-up; replace sash or panels before operating.
11. Do not place electrical receptacles or other spark sources inside the hood when flammable liquids or gases are present. No permanent electrical receptacles are permitted in the hood.
12. Use an appropriate barricade if there is a chance of explosion or eruption.
13. Provide adequate maintenance for the hood exhaust system and the building supply system. Use static pressure gauges on the hood throat, across any filters in the exhaust system, or other appropriate indicators to ensure flow is appropriate.
14. If hood sash is supposed to be partially closed for the operation, the hood should be so labeled and the appropriate closure point clearly indicated.

ACGIH® WORLDWIDE	TITLE WORK PRACTICES FOR LABORATORY HOODS	FIGURE VS-35-04
		DATE 2-91

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

Laboratory Hood Performance Surveillance- Face Velocity Testing Job Performance Measure (JPM) Completion Certificate

Candidate's Name	Life Number:	Qualification Number: **HP-IHP- 62420**

Knowledge of the Principles of Exhaust Ventilation Investigations

Criteria	Qualifying Standard	Unsatis-factory	Recov-ered	Satisf-actory
Hazard Analysis	Understands the need to perform a hazard analysis of the sampling area and potential exposure to the sampler.			
Personal Protective Equipment	Understands the need to be aware of potential exposures to the sampler and how to determine appropriate PPE.			
Sampling Protocol	Understands the ventilation system design parameters and logic necessary to appropriately select sampling locations for accurate measurements.			
Analysis of data	Understands the need to perform analysis on the sampling data to assess the effectiveness of the ventilation system and potential exposure to the sampler, worker, public and environment. Also, to recommend corrective actions as necessary.			

Practical Skill Evaluation: Demonstration of Sampling Methodology

Criteria	Qualifying Performance Standard	Unsatis-factory	Recov-ered	Satisf-actory
Sampling Equipment	Knows where equipment needed for the procedure is located and how to properly sign it out.			
Selecting the proper parameters to measure	Can describe which design specification are appropriate for be measured and what an acceptable variation in measured versus design value would be.			
Meter Operation	Demonstrates the proper meters that would be used to determine if design specifications are met.			
Smoke test	Demonstrates the proper testing technique for verifying airflow patters with a smoke generating device. Describes acceptable conditions internal and external to the hood.			
Face Velocity Measure	Demonstrates the proper testing technique for measuring the average velocity at the designated sampling points. Describes how to calculate average velocity. Describes the acceptable criteria.			
Record forms	Shows how to correctly and completely fill all forms associated with this SOP.			
Data Analysis	Knows the correct criteria and operating ranges. Shows how to correctly analyze data and compare to acceptable criteria.			
Report preparation and distribution	Knows how to document the assessment and the correct distribution.			

I accept the responsibility for performing this task as demonstrated within this JPM and the corresponding SOP.

Candidate Signature:	Date:

I certify the candidate has satisfactorily performed each of the above listed steps and is capable of performing the task unsupervised.

Evaluator Signature:	Date: