



National Institute for Occupational Safety and Health
National Personal Protective Technology Laboratory
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Procedure No. RCT-APR-STP-0046	Revision: 1.1	Date: 23 August 2005
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DETERMINATION OF ORGANIC VAPOR SERVICE LIFE TEST,
AIR-PURIFYING RESPIRATORS
STANDARD TESTING PROCEDURE (STP)

1. PURPOSE

This test establishes the procedure for ensuring that the level of protection provided by the organic vapor service life requirements on chemical cartridges and gas masks air-purifying respirators submitted for Approval, Extension of Approval, or examined during Certified Product Audits meet the certification requirements set forth in 42 CFR Part 84, Subpart G, Section 84.63(a)(c)(d), Subpart I, Section 84.126, Subpart L, Section 84.207, and Subpart KK, Section 84.1157; Volume 60, Number 110, June 8, 1995.

2. GENERAL

This STP describes the Determination of Organic Vapor Service Life Test, Air-Purifying Respirators test in sufficient detail that a person knowledgeable in the appropriate technical field can select equipment with the necessary resolution, conduct the test, and determine whether or not the product passes the test.

3. EQUIPMENT/MATERIAL

3.1. The list of necessary test equipment and materials follows:

- 3.1.1. Miller Nelson Research Model 401 Flow-Temperature-Humidity Control System or equivalent.
- 3.1.2. Foxboro Miran Infrared Analyzer 1A with model 071-5707 closed loop system.
- 3.1.3. Sage syringe pump, Model 355 or equivalent.
- 3.1.4. Harvard Infusion syringe pump, Model 975 or equivalent.
- 3.1.5. Hamilton Gas Tight Syringes 25 μ l, 20ml-100ml with T-Valve assembly.
- 3.1.6. Hamilton Model Teflon Tubing Assembly 90630 or equivalent.
- 3.1.7. Three-necked round bottom flask (250ml) with glass beads.
- 3.1.8. Heating mantle with controller for 250ml flask.

Approvals:	<u>1st</u> Level	<u>2nd</u> Level	<u>3rd</u> Level
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- 3.1.9. Electronic Balance with an accuracy of 0.001 grams (g).
- 3.1.10. Houston Instruments, Model 451BE, strip chart recorder or equivalent.
- 3.1.11. Vaisala model HMI 31 humidity indicator.
- 3.2. Test fixture for mounting cartridges and canisters. The test fixture used is specific to each manufacturer depending on how the cartridge, canister, or powered air-purifying respirator (PAPR), mouth bit, etc. is mounted to the facepiece. The T-end has a 29/42 ground glass joint glued in place. Canisters are tested with their connections glued into the ground glass joint. In most cases the cartridge cups of the respirator are affixed by hot melt glue to a PVC pipe tee of appropriate size. PAPR cartridges and canisters are tested on their blower units if possible, or on suitable substitutions, if the unit is too large for the test chamber.
- 3.3. The test chamber consisting of a 12" x 11½" x 7" air tight box, made of ½" plexiglass with 2 hinge type locks on the door opening lined with gasket material. A ½" hole is located on the back of the test chamber for the introduction of the test concentration and a 1½" hole on the top for the exit of the test fixture and to detect the breakthrough concentration. This fixture is not commercially available.
- 3.4. Resistance tester consisting of a vacuum source capable of delivering 85 liters per minute (lpm), a 6-inch slant manometer, and a 29/42 female ground glass joint. The resistance testers currently being used are located on the silica dust chamber.

4. TESTING REQUIREMENTS AND CONDITIONS

- 4.1. Prior to beginning any testing, all measuring equipment to be used must have been calibrated in accordance with the manufacturer's calibration procedure and schedule. At a minimum, all measuring equipment utilized for this testing must have been calibrated within the preceding 12 months using a method traceable to the National Institute of Standards and Technology (NIST).
- 4.2. Normal laboratory safety practices must be observed. This includes safety precautions described in the current ALOSH Facility Laboratory Safety Manual.
 - 4.2.1. Safety glasses, lab coats, and hard-toe shoes must be worn at all times.
 - 4.2.2. Work benches must be maintained free of clutter and non-essential test equipment.
 - 4.2.3. When handling any glass laboratory equipment, lab technicians and personnel must wear special gloves which protect against lacerations or punctures.
- 4.3. **ORGANIC VAPOR TEST FOR CARTRIDGES**
 - 4.3.1. Resistance to air flow will be taken before and after each test (see 84.203).

- 4.3.2. Three "as received" cartridges (or pairs of cartridges) will be tested at 64 lpm, continuous air flow, 50 ± 5 percent relative humidity (RH), approximately 25 degrees Celsius ($^{\circ}\text{C}$), and 1000 ppm CCl_4 .
- 4.3.3. Two cartridges or pairs of cartridges will be equilibrated at room temperature by passing 25 percent RH air through them at 25 lpm for 6 hours and then testing them at 50 percent RH, approximately 25°C , and 32 lpm continuous air flow rate containing 1000 ppm CCl_4 .
- 4.3.4. Two cartridges or pairs of cartridges will be equilibrated at room temperature by passing 85 percent RH air through them at 25 lpm for 6 hours and then testing them at 50 percent RH, approximately 25°C , and 32 lpm continuous air flow rate containing 1000 ppm CCl_4 .

4.4. ORGANIC VAPOR BENCH TEST FOR CANISTERS

- 4.4.1. Three "as received" canisters will be tested at 64 lpm, continuous air flow, 50 ± 5 percent RH, approximately 25°C , containing 5000 ppm CCl_4 for chin style and escape gas mask canisters, or 20,000 ppm CCl_4 for front and back mounted canisters.
- 4.4.2. Two canisters will be equilibrated at room temperature by passing 25 percent RH air through them at 64 lpm for 6 hours and then testing them at 50 percent RH, approximately 25°C , and 32 lpm continuous air flow rate containing 5000 ppm CCl_4 for chin style and escape gas mask canisters, or 20,000 ppm CCl_4 for front and back mounted canisters.
- 4.4.3. Two canisters will be equilibrated at room temperature by passing 85 percent RH air through them at 64 lpm for 6 hours and then testing them at 50 percent RH, approximately 25°C , and 32 lpm continuous air flow rate containing 5000 ppm CCl_4 for chin style and escape gas mask canisters, or 20,000 ppm CCl_4 for front and back mounted canisters.

4.5. ORGANIC VAPOR BENCH TESTS FOR PAPR CARTRIDGES/CANISTERS

- 4.5.1. Resistances and airflows for tight fitting PAPR will be taken before and after each test. Airflows only for loose fitting PAPR will be taken before and after each test.
- 4.5.2. Three cartridges (or pairs of cartridges) will be tested at 115 lpm for tight fitting PAPR or 170 lpm for loose fitting PAPR hood or helmet continuous air flow, approximately 25°C , and 50 ± 5 percent RH with 1000 ppm CCl_4 . Tight fitting only PAPR gas mask canisters will be tested at 115 lpm at 5000 ppm CCl_4 .
- 4.5.3. Two cartridges (or pairs of cartridges) will be equilibrated by passing 115 lpm for tight fitting PAPR or 170 lpm for loose fitting PAPR hood or helmet, continuous air flow through them at approximately 25°C , and 25 percent RH for 6 hours. They will then be tested at 115 or 170 lpm continuous air flow,

approximately 25°C, 50 ± 5 percent RH, 1000 ppm CCl₄. Tight fitting only PAPR gas mask canisters will be tested at 115 lpm at 5000 ppm CCl₄.

- 4.5.4. Two cartridges (or pairs of cartridges) will be equilibrated by passing 115 lpm for tight fitting PAPR or 170 lpm for PAPR loose fitting hood or helmet, continuous air flow through them at 25°C, and 85 percent RH for 6 hours. They will then be tested at 115 or 170 lpm continuous air flow, 25°C, 50 ± 5 percent RH, 1000 ppm CCl₄. Tight fitting only PAPR gas mask canisters will be tested at 115 lpm at 5000 ppm CCl₄.

- 4.6 **Please refer to Material Safety Data Sheets and the NIOSH Health and Safety Manual for the proper protection and care in handling, storing, and disposing of the chemicals and gases used in this procedure.**

5. PROCEDURE

Note: Reference Section 3 for equipment, model numbers and manufacturers. For calibration purposes use those described in the manufacturer's operation and maintenance manuals.

- 5.1. Follow individual instruction manuals for set up and maintenance of equipment used in this procedure prior to beginning testing. Malfunctioning equipment must be repaired or replaced and properly set up and calibrated before starting all tests.
- 5.2. Prepare solutions:
- 5.2.1. 5 ppm breakthrough standard: add 1 ml CCl₄, to a 100 ml volumetric and dilute to mark with benzene.
- 5.3. Calibrate Infrared Analyzer: Inject 11 μl sample of 5 ppm breakthrough standard into closed loop system of the IR as described in the IR manual (see attachment). Let stabilize and mark point on recorder. Disconnect inlet tubing from vacuum pump, and allow IR to return to zero reading.
- 5.4. Cover the bottom of 250 ml round bottom flask with glass beads and place onto heating mantle.
- 5.5. Determine rate of advance of the syringe pump for the appropriate syringe volume and the desired concentration. (See Tables 1 and 2).
- 5.6. Set up test equipment as shown in Figure 1. In addition to the humidity reading controlled by the Miller Nelson system, the Vaisala HMI 31 humidity indicator sensor is inserted into the challenge test concentration via a tee set-up directly prior to entering the test chamber. The humidity reading obtained at this point takes into account tubing length and outside hood air temperature.
- 5.7. Turn on:
- 5.5.1. Miller Nelson Unit.

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5.5.2. Air and water supplies.

- 5.8. Fill syringe with 99 percent CCl₄ and weigh and record weight of the syringe with T valve assembly.
- 5.9. Mount syringe onto the syringe pump and set the dial to calculated setting.
- 5.10. Weigh the cartridge or canister and record the weight.
- 5.11. Take inhalation and exhalation resistances of the cartridge or canister mounted on the facepiece at 85 lpm. See Sections 84.122, 84.203, 84.1157 Title 42, Code of Federal Regulations, Part 84 for breathing resistance requirements. Take airflows of PAPR cartridge or canister mounted on blower assembly.
- 5.12. Mount cartridge or canister onto test fixture and place in testing chamber.
- 5.13. Turn on syringe pump, and start timer and recorder when CCl₄ is delivered into the flask.
- 5.14. Direct challenge concentration airflow into test chamber. Start timer. Mount small piece of tygon tubing onto the outlet of the test fixture. Insert intake tubing of analyzer into a slit cut into the side wall of the tubing to allow the analyzer to sample at the flow rate of the analyzer without interference from airflow back pressure. Monitor and record upstream and downstream temperatures throughout testing. Record breakthrough values and times.
- 5.15. Run test until breakthrough of 5.0 ppm is observed or minimum service life is surpassed depending on type of cartridge or canister tested.
- 5.16. Turn off syringe pump, remove the syringe along with T-valve assembly. Weigh and record the final weight.
- 5.17. Dismount cartridge or canister, weigh and record final weight, and take final inhalation and exhalation resistances and PAPR airflows.
- 5.18. Calculate the concentration of CCl₄ in air using the concentration calculation formula for liquids in Table 1.
- 5.19. Allow clean air to purge through system for 10-15 minutes.
- 5.20. Turn off air and water supply to Miller Nelson system.
- 5.21. Turn off Miller Nelson system and infrared analyzer.

6. PASS/FAIL CRITERIA

- 6.1. The criterion for passing this test is set forth in 42 CFR Part 84, Subpart G, Section 84.63(a)(c)(d), Subpart I, Section 84.126, Subpart L, Section 84.207, and Subpart KK, Section 84.1157; Volume 60, Number 110, June 8, 1995.

6.2. This test establishes the standard procedure for ensuring that:

84.63 Test requirements; general.

(a) Each respirator and respirator component shall when tested by the applicant and by the Institute, meet the applicable requirements set forth in subparts H through L of this part.

(c) In addition to the minimum requirements set forth in subparts H through L of this part, the Institute reserves the right to require, as a further condition of approval, any additional requirements deemed necessary to establish the quality, effectiveness, and safety of any respirator used as protection against hazardous atmospheres.

(d) Where it is determined after receipt of an application that additional requirements will be required for approval, the Institute will notify the applicant in writing of these additional requirements, and necessary examinations, inspections, or tests, stating generally the reasons for such requirements, examinations, inspections, or tests.

84.126 Canister bench tests; minimum requirements.

(a)(1) Bench tests, except for carbon monoxide tests, will be made on an apparatus that allows the test atmosphere at 50 ± 5 percent relative humidity and room temperature (25 ± 2.5 °C.) to enter the canister continuously at concentrations and rates of flow specified in Tables 5, 6, and 7 of this subpart.

(2) Three canisters will be removed from containers and tested as received from the applicant.

(3) Two canisters, other than those described in paragraph (a)(2) of this section, will be equilibrated at room temperature by passing 25 percent relative humidity air through them at 64 liters per minute for 6 hours.

(4) Two canisters, other than those described in paragraphs (a) (2) and (3) of this section, will be equilibrated at room temperature by passing 85 percent relative humidity air through them at 64 liters per minute for 6 hours.

(5) The equilibrated canisters will be resealed, kept in an upright position at room temperature, and tested within 18 hours.

(b) Front-mounted and back-mounted gas mask canisters will be tested and shall meet the minimum requirements set forth in Table 5 of this subpart.

(c)(1) Front-mounted, and back-mounted, and chin-style canisters designated as providing respiratory protection against gases, ammonia, organic vapors, carbon monoxide and particulate contaminants shall have a window or other indicator to warn the gas mask wearer when the canister will no longer satisfactorily remove carbon monoxide from the inhaled air.

- (2) Other types of front- and back-mounted canisters may also be equipped with a window or other indicator to warn of imminent leakage of other gases or vapors.
- (3) The window indicator canisters will be tested as regular canisters, but shall show a satisfactory indicator change or other warning before the allowable canister penetration has occurred.
- (d) Chin-style gas mask canisters shall meet the minimum requirements set forth in Table 6 of this subpart.
- (e) Escape gas mask canisters shall meet the minimum requirements set forth in Table 7 of this subpart.

Tables to Subpart I of Part 84

Table 5-Canister Bench Tests and Requirements for Front-Mounted and Back-Mounted Gas Mask Canisters

[42 CFR part 84, subpart I]

Canister type	Test condition	Test atmosphere			Number of tests	Maximum allowable penetration (parts per million)	Minimum service life (minutes) ¹
		Gas or vapor	Concentration (parts per million)	Flow rate (liters per minute)			
Acid gas	As received Equilibrated	SO ₂	20,000	64	3	5	12
		Cl ₂	20,000	64	3	5	12
		SO ₂	20,000	32	4	5	12
		Cl ₂	20,000	32	4	5	12
Organic vapor	As received Equilibrated	CCl ₄	20,000	64	3	5	12
		CCl ₄	20,000	32	4	5	12
Ammonia	As received Equilibrated	NH ₃	30,000	64	3	50	12
		NH ₃	30,000	32	4	50	12
Carbon monoxide	As received	CO	20,000	² 64	2	(³)	60
		CO	5,000	⁴ 32	3	(³)	60
		CO	3,000	² 32	3	(³)	60
Combination of 2 or 3 of above types ⁵							
Combination of all of above types ⁶							

¹Minimum life will be determined at the indicated penetration.

²Relative humidity of test atmosphere will be 95 ± 3pct; temperature of test atmosphere will be 25 ± 2.5° C.

³Maximum allowable CO penetration will be 385 cm³ during the minimum life. The penetration shall not exceed 500 p/m during this time.

⁴Relative humidity of test atmosphere will be 95 ± 3pct; temperature of test atmosphere entering the test fixture will be 0 + 2.5° C - 0° C.

⁵Test conditions and requirements will be applicable as shown in this table.

⁶Test conditions and requirements will be applicable as shown in this table, except the minimum service

lives for acid gas, organic vapor, and ammonia will be 6 min instead of 12 min.

Table 6-Canister Bench Tests and Requirements for Chin-Style Gas Mask Canisters
[42 CFR part 84, subpart I]

Canister type	Test condition	Test atmosphere			Number of tests	Maximum allowable penetration (parts per million)	Minimum service life (minutes) ¹
		Gas or vapor	Concentration (parts per million)	Flow rate (liters per minute)			
Acid gas	As received Equilibrated	SO ₂	5,000	64	3	5	12
		Cl ₂	5,000	64	3	5	12
		SO ₂	5,000	32	4	5	12
		Cl ₂	5,000	32	4	5	12
Organic vapor	As received Equilibrated	CCl ₄	5,000	64	3	5	12
		CCl ₄	5,000	32	4	5	12
Ammonia	As received Equilibrated	NH ₃	5,000	64	3	50	12
		NH ₃	5,000	32	4	50	12
Carbon monoxide	As received	CO	20,000	² 64	2	(³)	60
		CO	5,000	⁴ 32	3	(³)	60
		CO	3,000	² 32	3	(³)	60
Combination of 2 or 3 of above types ⁵							
Combination of all of above types ⁶							

¹Minimum life will be determined at the indicated penetration.

²Relative humidity of test atmosphere will be 95 ± 3pct; temperature of test atmosphere will be 25 ± 2.5° C.

³Maximum allowable CO penetration will be 385 cm³ during the minimum life. The penetration shall not exceed 500 p/m during this time.

⁴Relative humidity of test atmosphere will be 95 ± 3pct; temperature of test atmosphere entering the test fixture will be 0 + 2.5° C - 0° C.

⁵Test conditions and requirements will be applicable as shown in this table.

⁶Test conditions and requirements will be applicable as shown in this table, except the minimum service lives for acid gas, organic vapor, and ammonia will be 6 min instead of 12 min.

Table 7-Canister Bench Tests and Requirements for Escape Gas Mask Canisters
[42 CFR part 84, subpart I]

Canister type	Test condition	Test atmosphere			Number of tests	Maximum allowable penetration (parts per million)	Minimum service life (minutes) ¹
		Gas or vapor	Concentration (parts per million)	Flow rate (liters per minute)			
Acid gas	As received Equilibrated	SO ₂	5,000	64	3	5	12
		Cl ₂	5,000	64	3	5	12
		SO ₂	5,000	32	4	5	12
		Cl ₂	5,000	32	4	5	12
Organic vapor	As received Equilibrated	CCl ₄	5,000	64	3	5	12
		CCl ₄	5,000	32	4	5	12
Ammonia	As received Equilibrated	NH ₃	5,000	64	3	50	12
		NH ₃	5,000	32	4	50	12
Carbon monoxide	As received	CO	10,000	² 32	2	(³)	⁴ 60
		CO	5,000	⁵ 32	3	(³)	60
		CO	3,000	² 32	3	(³)	60

¹Minimum life will be determined at the indicated penetration.

²Relative humidity of test atmosphere will be 95 ± 3 pct; temperature of test atmosphere will be $25 \pm 2.5^\circ$ C.

³Maximum allowable CO penetration will be 385 cm³ during the minimum life. The penetration shall not exceed 500 p/m during this time.

⁴If effluent temperature exceeds 100° C during this test, the escape gas mask shall be equipped with an effective heat exchanger.

⁵Relative humidity of test atmosphere will be 95 ± 3 pct; temperature of test atmosphere entering the test fixture will be $0 + 2.5^\circ$ C - 0° C.

84.207 Bench tests; gas and vapor tests; minimum requirements; general.

(a) Bench tests will be made on an apparatus that allows the test atmosphere at 50 ± 5 percent relative humidity and room temperature, approximately 25 °C, to enter the cartridges continuously at predetermined concentrations and rates of flow, and that has means for determining the test life of the cartridges.

(b) Where two cartridges are used in parallel on a chemical cartridge respirator, the bench test will be performed with the cartridges arranged in parallel, and the test requirements will apply to the combination rather than to the individual cartridges.

(c) Three cartridges or pairs of cartridges will be removed from containers and tested as received from the applicant.

(d) Two air purifying cartridges or pairs of cartridges will be equilibrated at room temperature by passing 25 percent relative humidity air through them at the flow rate of 25 liters per minute (l.p.m.) for 6 hours.

(e) Two air purifying cartridges or pairs of cartridges will be equilibrated by passing 85 percent relative humidity air through them at the flow rate of 25 l.p.m.

(f) All cartridges will be resealed, kept in an upright position, at room temperatures, and tested within 18 hours.

(g) Cartridges will be tested and shall meet the minimum requirements set forth in Table 11 of this subpart.

Tables to Subpart L of Part 84

Tables 9 and 10 [Reserved]

Table 11-Cartridge Bench Tests and Requirements

[42 CFR part 84, subpart L]

Cartridge	Test condition	Test atmosphere		Flowrate (l.p.m.)	Number of tests	Penetration ¹ (p.p.m.)	Minimum life ² (min.)
		Gas or vapor	Concentration (p.p.m.)				
Ammonia	As received	NH ₃	1000	64	3	50	50
Ammonia	Equilibrated	NH ₃	1000	32	4	50	50
Chlorine	As received	Cl ₂	500	64	3	5	35
Chlorine	Equilibrated	Cl ₂	500	32	4	5	35
Hydrogen chloride	As received	HCl	500	64	3	5	50
Hydrogen chloride	Equilibrated	HCl	500	32	4	5	50
Methylamine	As received	CH ₃ NH ₂	1000	64	3	10	25
Methylamine	Equilibrated	CH ₃ NH ₂	1000	32	4	10	25
Organic vapors	As received	CCl ₄	1000	64	3	5	50
Organic vapors	Equilibrated	CCl ₄	1000	32	4	5	50
Sulfur dioxide	As received	SO ₂	500	64	3	5	30
Sulfur dioxide	Equilibrated	SO ₂	500	32	4	5	30

¹Minimum life will be determined at the indicated penetration.

²Where a respirator is designed for respiratory protection against more than one type of gas or vapor, as for use in ammonia and in chlorine, the minimum life shall be one-half that shown for each type of gas or vapor. Where a respirator is designed for respiratory protection against more than one gas of a type, as for use in chlorine and sulfur dioxide, the stated minimal life shall apply.

84.1157 Chemical cartridge respirators with particulate filters; performance requirements; general. Chemical cartridge respirators with particulate filters and the individual components of each such device shall, as appropriate, meet the following minimum requirements for performance and protection:

(a) Breathing resistance test. (1) Resistance to airflow will be measured in the facepiece, mouthpiece, hood, or helmet of a chemical cartridge respirator mounted on a test fixture

with air flowing at a continuous rate of 85 liters per minute, both before and after each test conducted in accordance with paragraphs (d) through (f) of this section

(2) The maximum allowable resistance requirements for chemical cartridge respirators are as follows:

Maximum Resistance
[mm. water-column height]

Type of chemical cartridge respirator	Inhalation		Exhalation
		Final ¹	
For gases, vapors, or gases and vapors, and dusts, fumes, and mists	50	70	20
For gases, vapors, or gases and vapors, and mists of paints, lacquers, and enamels	50	70	20

¹Measured at end of service life specified in Table 11 in subpart L of this part.

(b) Facepiece test. The facepiece test will be conducted as specified in 84.205.

(f) Bench tests; gas and vapor tests. (1) Bench tests will be made in accordance with 84.207 and tested cartridges shall meet the minimum requirements set forth in Table 11 of Subpart L of this part. Cartridges will be equilibrated in accordance with paragraph (f)(2) of this section.

(2)(i) Two powered air-purifying cartridges or pairs of cartridges will be equilibrated at room temperature by passing 25 percent relative humidity air through them at the following flow rates (expressed in liters per minute (l.p.m.) for 6 hours:

<u>Type of cartridge</u>	<u>Airflow rate, l.p.m.</u>
Powered air purifying with tight-fitting facepiece	115
Powered air purifying with loose-fitting hood or helmet	170

(ii) Two powered air-purifying cartridges or pairs of cartridges will be equilibrated by passing 85 percent relative humidity air through them at the flow rates stated in paragraph (f)(2)(i) of this section.

(iii) All cartridges will be resealed, kept in an upright position, at room temperatures, and tested within 18 hours.

7. RECORDS/TEST SHEETS

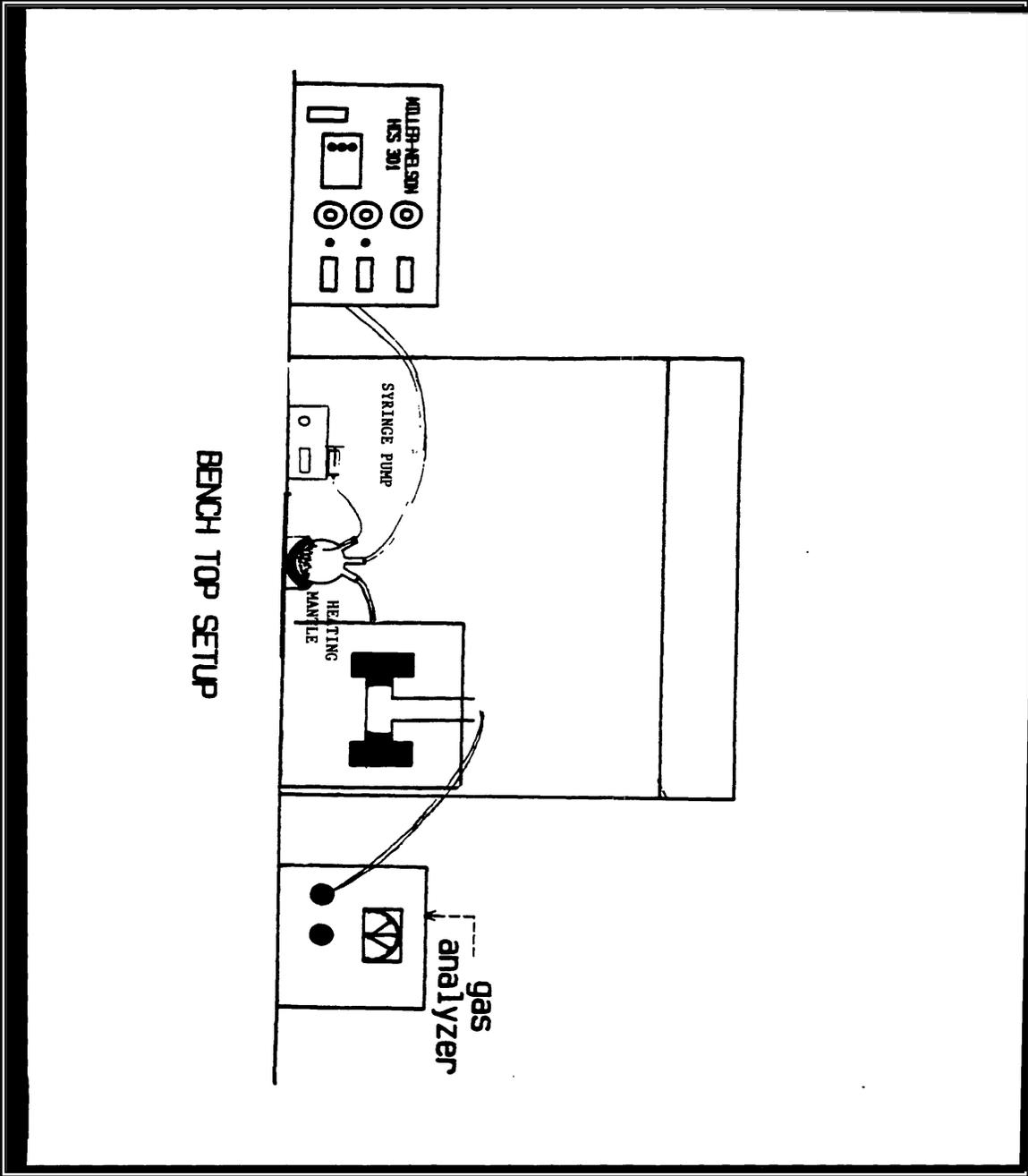
7.1. All test data will be recorded on the ORGANIC VAPOR SERVICE LIFE test data sheet.

7.2. All videotapes and photographs of the actual test being performed, or of the tested equipment shall be maintained in the task file as part of the permanent record.

- 7.3. All equipment failing any portion of this test will be handled as follows:
- 7.3.1. If the failure occurs on a new certification application, or extension of approval application, send a test report to the RCT Leader and prepare the hardware for return to the manufacturer.
 - 7.3.2. If the failure occurs on hardware examined under an Off-the-Shelf Audit the hardware will be examined by a technician and the RCT Leader for cause. All equipment failing any portion of this test may be sent to the manufacturer for examination and then returned to NIOSH. However, the hardware tested shall be held at the testing laboratory until authorized for release by the RCT Leader, or his designee, following the standard operating procedures outlined in Procedure for Scheduling, and Processing Post-Certification Product Audits, RB-SOP-0005-00.

8. ATTACHMENTS.

- 8.1. Bench Top Set-Up.
- 8.2. Data Sheet.
- 8.3. Table 1- Concentration Calculation for Syringe Pump Injection Rates.
- 8.4. Table 2- Nominal Injection Rates for Sage Model 355 Syringe Pump.
- 8.5. Schematic Diagram of Closed Loop Calibration System.



 RB - RESPIRATOR CERTIFICATION TEAM GAS & VAPOR RESPIRATOR TEST DATA SHEET (Ref.33-48,50,62)		STP No.: [_____]
Task Number: TN- _____	Gas Name: _____	
Manufacturer: _____	Item Tested: _____	

RESISTANCE	Maximum Allowable Resistance (mm of H ₂ O)				Actual Resistance (mm of H ₂ O)				Result
	Inhalation		Exhalation		Inhalation		Exhalation		
			Initial		Initial	Final	Initial	Final	
1									
2									
3									
4									
5									
6									
7									

Overall Results: Pass _____ Fail _____ Comment: _____

WEIGHTS AND AIRFLOWS	WEIGHTS (gm)				Conc. (ppm)	AIRFLOW (Lpm)			
		Con'd				Test Rate		(PAPR Only)	
						RH%	Lpm	Initial	Final
1									
2									
3									
4									
5									
6									
7									

Overall Results: Pass _____ Fail _____ Comment: _____

DATA TABLE	Test Cond.	Final Time (min)	Leakage (ppm)	Temperature (°C)				Corrected Time (min)
				Downstream		Upstream		
				stream	Dns	eam	Upstr	
1								
2								
3								
4								
5								
6								
7								

Overall Results: Pass _____ Fail _____ Comment: _____
 Was all testing equipment in calibration throughout all testing: Yes _____ No _____
 Signature: _____ Date: _____

RB - RESPIRATOR CERTIFICATION TEAM

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GAS & VAPOR RESPIRATOR TEST DATA SHEET (Ref:33-48,50,62) STP No.: [_____]

Task Number: TN- _____ Gas Name:
Manufacturer: _____ Item Tested:

Additional Comments:

Signature: _____ Date:

TABLE 1

CONCENTRATION CALCULATIONS FOR SYRINGE PUMP INJECTION RATES

At 25°C and 1 atm.

For liquids:

For gases:

$$C = \frac{(24.6 \times 10^6) KRp}{QM}$$

$$C = \frac{RK 10^3}{Q}$$

$$R = \frac{CQM}{(24.6 \times 10^6) Kp}$$

$$R = \frac{CQ}{K 10^3}$$

where:

R= rate of advance (mm/min)*

C= concentration (ppm)

K= syringe constant (ml/mm)

p= solvent density (g/ml)

Q= airflow rate (lpm)

M= molecular weight (g/mol)

Syringe capacity (ml)	Length (mm)	Syringe constant (K=ml/mm)
0.05	59.5	0.000840
0.10	59.5	0.00168
0.25	59.5	0.00420
0.50	59.5	0.00840
1.0	59.5	0.0168
2.5	59.5	0.0420
5.0	59.5	0.0840
10.0	59.5	0.168
20.0	66.5	0.301
30.0	74.1	0.405
50.0	80.6	0.620

For a syringe constant not listed, divide the volume of the syringe in ml by the length of the syringe in mm. For ml/min, multiply the syringe rate in mm/min. by the syringe constant.

Sample calculation: Find the rate of advance and % of flow setting required to produce a concentration of 1000 ppm CCl₄ in 64 lpm of air, using a 20 ml syringe.

$$R = \frac{(1000 \text{ ppm}) (64 \text{ Lpm}) (153.82 \text{ g/mol})}{(24.6 \times 10^6) (0.301 \text{ mL/mm}) (1.588 \text{ g/mL})}$$

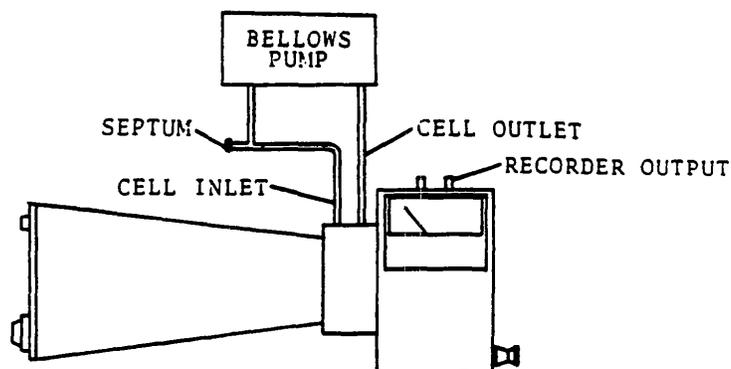
$$R = 0.837 \text{ mm/min.}$$

*From Table 2, the flow setting would be 576.8 at a range setting of 1/100.

For syringe pumps delivering in volumes of milliliters/minute, multiply rate of advance R by syringe constant.

TABLE 2
 NOMINAL INJECTION RATES FOR SAGE SYRINGE PUMP MODEL 355

% Flow dial setting	Rate of advance (R) (mm/min.)			
	<u>1</u>	Range setting		
		<u>1/10</u>	<u>1/100</u>	<u>1/1000</u>
100	14.5	1.45	0.145	0.0145
150	21.8	2.18	0.218	0.0218
200	29.0	2.90	0.0290	0.0290
250	36.3	3.63	0.0363	0.0363
300	43.5	4.35	0.0435	0.0435
350	50.8	5.08	0.508	0.0508
400	58.0	5.80	0.580	0.0580
450	65.3	6.53	0.653	0.0653
500	72.5	7.25	0.725	0.0725
550	79.8	7.98	0.798	0.0798
600	87.0	8.70	0.870	0.0870
650	94.3	9.43	0.943	0.0943
700	102	10.2	1.02	0.102
750	109	10.9	1.09	0.109
800	116	11.6	1.16	0.116
850	123	12.3	1.23	0.123
900	131	13.1	1.31	0.131
950	138	13.8	1.38	0.138
1000	145	14.5	1.45	0.145



SCHEMATIC DIAGRAM OF CLOSED LOOP CALIBRATION SYSTEM

This system is based upon the use of the kit consisting of a stainless steel bellows pump, septum, stainless steel fittings and teflon connecting tubes. Calibrated samples are introduced through a septum by a gas or liquid syringe and circulated through the cell by means of the pump. Liquid samples are vaporized in the process of circulation, their concentrations, in parts per million, being determined by the following formula, where Ideal Gas Laws and the total volume of the system may be assumed.

$$\text{For liquids: } C \text{ (ppm)} = \frac{\rho V}{M} \times \frac{(RT)}{P} \times \frac{10^3}{5.64}$$

Where: V = Sample volume in microliters. (Total volume of cell and calibration system = 5.64 liters).

ρ = liquid density (g/cm^3)

M = Molecular weight of sample.

$\frac{(RT)}{P}$ = Molar volume of gas (24.4 at 25°C)

Revision History

Revision	Date	Reason for Revision
1.0	22 March 2002	Historic document
1.1	23 August 2005	Update header and format to reflect lab move from Morgantown, WV No changes to method