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National Personal Protective Technology Laboratory
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DETERMINATION OF HYDROGEN SULFIDE SERVICE LIFE TEST, POWERED AIR-PURIFYING RESPIRATORS WITH CARTRIDGES STANDARD TESTING PROCEDURE (STP)

1. PURPOSE

This test establishes the procedure for ensuring that the level of protection provided by powered air-purifying respirators (PAPR) with cartridges submitted for Approval, Extension of Approval, or examined during Certified Product Audits meet the minimum hydrogen sulfide service life test requirements set forth in 42 CFR Part 84, Subpart G, Section 63 (a), (c), (d), and Subpart KK, Section 84.1157.

2. GENERAL

This STP describes the Determination of Hydrogen Sulfide Service Life Test, Powered Air-Purifying Respirators with cartridges 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 (250 Lpm) or equivalent. Air flow control accuracy is ± 2% F.S. Temperature control accuracy is ± 1° C. Humidity control accuracy is ± 3% R.H.

3.1.2. Edge Tech Dew Prime II Hygrometer, Model 2000 or equivalent. Accuracy is ± 0.2° C, ±0.5% RH.

3.1.3. Interscan Corporation Model RM-17-0 hydrogen sulfide detector or equivalent. Detector range: 0 - 1999 ppmv, resolution: 1 ppmv.

3.1.4. Interscan Corporation Model RM-17-2 hydrogen sulfide detector or equivalent. Detector range: 0 - 19.99 ppmv, resolution: 0.01 ppmv.

3.1.5. Mass Flow Controllers, Brooks Instruments, variable flow rate depending on use, model series 5850S and 5853S. Accuracy is 0.7% set point and 0.2% FS.

Approvals:			
First Level	Second Level	Third Level	Fourth Level

3.1.6. Read Out and Control Electronics, Brooks Instruments, Model 0154.

3.1.7. American Meter Co. Dry Test Meter Model DTM-325 and Diaphragm Meter Model AC-630 with DMP-2 Meter Pulser and R-2 Remote Totalizer.

3.1.8. Certified cylinders of approximately 5 ppmv and 1000 ppmv hydrogen sulfide in nitrogen.

3.1.9. Hydrogen sulfide cylinder, 99 % purity.

3.1.10. Electronic balance with accuracy of 0.01 grams (g).

3.2. Test fixture for mounting PAPR cartridges inside the test chamber. PAPR cartridges are tested on their blower units if possible, with the breathing tube attached to the outlet port, or on suitable substitutions, if the unit is too large for the test chamber. All adapters are checked for leak-tightness with soap solution.

3.3. The test chamber consisting of an air tight box, with clamp type locks on the door opening lined with gasket material, and appropriate inlet, outlet and sampling ports. This fixture is not commercially available.

3.4. Refer to the following Work Instructions for further information on performing this test:
TEB-RCT-APR-WI-1006- Laboratory Safety Procedures for Hydrogen Sulfide Tests
TEB-RCT-APR-WI-1106- Calibration Procedures for Hydrogen Sulfide Tests
TEB-RCT-APR-WI-1206- Start–Up and Shut–Down Procedures for Hydrogen Sulfide Tests
TEB-RCT-APR-WI-1306- Using the LabView System for Hydrogen Sulfide Tests
TEB-RCT-APR-WI-1406 – Reporting Results for Hydrogen Sulfide Tests

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 testing laboratory's calibration procedure and schedule. All measuring equipment utilized for this testing must have been calibrated using a method traceable to the National Institute of Standards and Technology (NIST) when available.

4.2. Any laboratory using this procedure to supply certification test data as a contractor to NIOSH will be subject to the provisions of the NIOSH Supplier Qualification Program (SQP). This program is based on the tenets of *ISO/IEC 17025, the NIOSH Manual of Analytical Methods* and other NIOSH guidelines. An initial complete quality system audit and follow on audits are requirements of the program. Additional details of the Program and its requirements can be obtained directly from the Institute.*
***Note** 4.2 does not apply to Pretest data from applicants as required under 42 CFR 84.64.

4.3. Precision and accuracy (P&A) must be determined for each instrument in accordance

with laboratory procedures and NIOSH/NPPTL guidance. Sound practice requires, under *NIOSH Manual of Analytical Methods*, demonstrating a tolerance range of expected data performance of a plus or minus 25% of a 95% confidence interval of the stated standard requirement. NIOSH/NPPTL P&A tolerance can be higher but not lower.

4.4. The precision and accuracy of this method was determined by validation testing of a single lot of commercially available multi-gas type cartridges. The results of these tests are shown in the table below.

TEST TYPE	MEAN SERVICE LIFE (MINUTES)	STD. DEV.
AS RECEIVED	199.55	11.51
EQUIL. 25% RH	668.13	24.20
EQUIL. 85% RH	565.95	51.43

4.5. Normal laboratory safety practices must be observed. Please refer to Material Safety Data Sheets and the current NIOSH Pittsburgh Health and Safety Program for the proper protection and care in handling, storing, and disposing of the chemicals and gases used in this procedure.

4.6. The cylinder of 99% hydrogen sulfide, as well as the calibration gas cylinders, are typically used inside the laboratory fume hood. If there is a release of 99% hydrogen sulfide outside the hood, sound an alarm, and any personnel in the laboratory should immediately exit from the building. **THE LOWER EXPLOSIVE LIMIT OF H_2S IS 40,000 PPMV.**

4.7. HYDROGEN SULFIDE BENCH TEST FOR PAPR CARTRIDGES

4.7.1. Resistance to air flow of the complete respirator will be taken before and after each test (see 42 CFR 84.203). The standard testing procedures are described in TEB-APR-STP-003 and TEB-APR-STP-007.

4.7.2. Test conditions as required by 42 CFR 84.63 (a), (c), (d), and 84.1157.

SAMPLE	CONDITION	EQUILIBRATION CONDITIONS			TEST CONDITIONS			TEST CONCENTRATION	BREAKTHROUGH CONCENTRATION
		FOR 6 HOURS							
		TEMP. ° C	FLOWRATE[1] LPM	R.H. %	TEMP. ° C	FLOWRATE[1] LPM	R.H. %	PPMV H2S	PPMV H2S
1-3	AS RECEIVED	NA	NA	NA	25	115 / 170	50	1000	10
4-5	EQUIL. 25% R.H.	25	115 / 170	25	25	115 / 170	50	1000	10
6-7	EQUIL. 85% R.H.	25	115 / 170	85	25	115 / 170	50	1000	10

1 Flowrates are 115 lpm for tight-fitting facepieces and 170 lpm for loose-fitting facepieces.

Tolerances:

PARAMETER	TOLERANCE
25°C	± 2.5°C
115 LPM	± 1.0 LPM
170 LPM	± 1.0 LPM
25% R.H.	± 3% R.H.
50% R.H.	± 3% R.H.
85% R.H.	+0/-5% R.H.
1000 ppmv	± 10%

NOTES: R.H. levels greater than 85% are difficult to maintain and may cause rapid degradation of service life.
Tolerance on accuracy of air flow rates exceeds specification on Miller Nelson control unit because flow rates are calibrated for every test. This improves the precision of the measurement and allows for the tighter tolerance on short-term drift.

4.7.3. All equilibrated cartridges will be resealed, kept in a position such that the direction of airflow would be horizontal, at room temperature, and testing shall begin within 18 hours.

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. Set up the test equipment as shown in Figure 1.

5.2. Calibrate the breakthrough H_2S analyzer using the certified gas cylinder containing the 10 ppmv standard. Calibrate the challenge H_2S analyzer using the certified gas cylinder containing the 1000 ppmv standard.

5.3. Establish the correct humidity and temperature for the sample being tested as per the test requirements in paragraph 4.7.

5.4. Set the airflow to the required level for the sample being tested as per the test requirements in paragraph 4.7. Calibrate the total airflow, including any additional flow arising from challenge gas flow rates and / or hygrometer flow rates, from the test fixture using the dry test meter.

5.5. Weigh the PAPR cartridge(s) and record the weight.

5.6. Measure initial inhalation and exhalation resistances of the PAPR cartridge(s) mounted on the respirator if the test sample is a tight-fitting PAPR. as described in TEB-APR-STP-003 and TEB-APR-STP-007. Measure airflows of PAPR cartridge mounted on blower assembly with the entire respirator as described in TEB-APR-STP-0012. Record values on the data sheet.

5.7. Make sure diverter valve in the system is diverting the challenge concentration airflow to discharge and not into the testing chamber.

5.8. Mount PAPR cartridge(s) and blower assembly onto test fixture, and place in testing chamber.

5.9. Divert 0.5 lpm airflow to the hydrogen sulfide challenge detector.

5.10. Open the 99% hydrogen sulfide cylinder.

5.11. Establish the test concentration of 1,000 ppmv ± 10% hydrogen sulfide by setting the theoretical flow rate of pure hydrogen sulfide to mix with the flow of air to produce the required concentration (see table below). Then, set the mass flowmeter to that level, and monitor the challenge concentration on the analyzer. Adjust the flowmeter setting as required. Once the hydrogen sulfide concentration has been established and is stable, testing may begin.

FLOW RATE FOR TEST	FLOW RATE OF PURE HYDROGEN SULFIDE TO ACHIEVE 1000 PPMV
lpm	sccm or mL/min.
115	115
170	170

5.12. Monitor and record challenge and breakthrough temperatures, challenge RH and breakthrough values and times throughout testing.

5.13. Run test until breakthrough of 10.0 ppmv is observed or minimum service life shown in section 6.2 is surpassed by 10%.

5.14. At end of test, system will automatically direct challenge concentration airflow through diverter valve to discharge.

5.15. Dismount PAPR cartridge(s), weigh and record final weight, and take final inhalation and exhalation resistances as described in TEB-APR-STP-003 and TEB-APR-STP-007 if the test sample is a tight-fitting PAPR. Measure final airflows of PAPR cartridge mounted on blower assembly with the entire respirator as described in TEB-APR-STP-0012. Record values on the data sheet.

5.16. If there is another sample to test, repeat steps 5.5 – 5.15.

5.17. After all tests are completed for the shift, set temperature and humidity to zero on the Miller Nelson system and allow clean air to pass through the system for 30 minutes. Purge the breakthrough and challenge detectors with clean air for 15 minutes.

6. PASS/FAIL CRITERIA

6.1. The legal basis for passing this test is set forth in 42 CFR Part 84, Subpart G, Section 84.63 (a), (c), (d), and SubpartKK, Section 84.1157.

6.2. Minimum service life requirements for cartridges are shown below.

Cartridge	Test condition	Test atmosphere		Flowrate (l.p.m.)[2]	Number of tests	Penetration [1] (p.p.m.v.)	Minimum life (min.)
		Gas or vapor	Concentration (p.p.m.v.)				
Hydrogen sulfide	As received	H_2S	1000	115 / 170	3	10	30
Hydrogen sulfide	Equilibrated	H_2S	1000	115 / 170	4	10	30

[1]Minimum life will be determined at the indicated penetration.
[2]Test flowrate shall be 115 lpm for tight fitting facepieces and 170 lpm for loose fitting facepieces.

7. RECORDS/TEST SHEETS

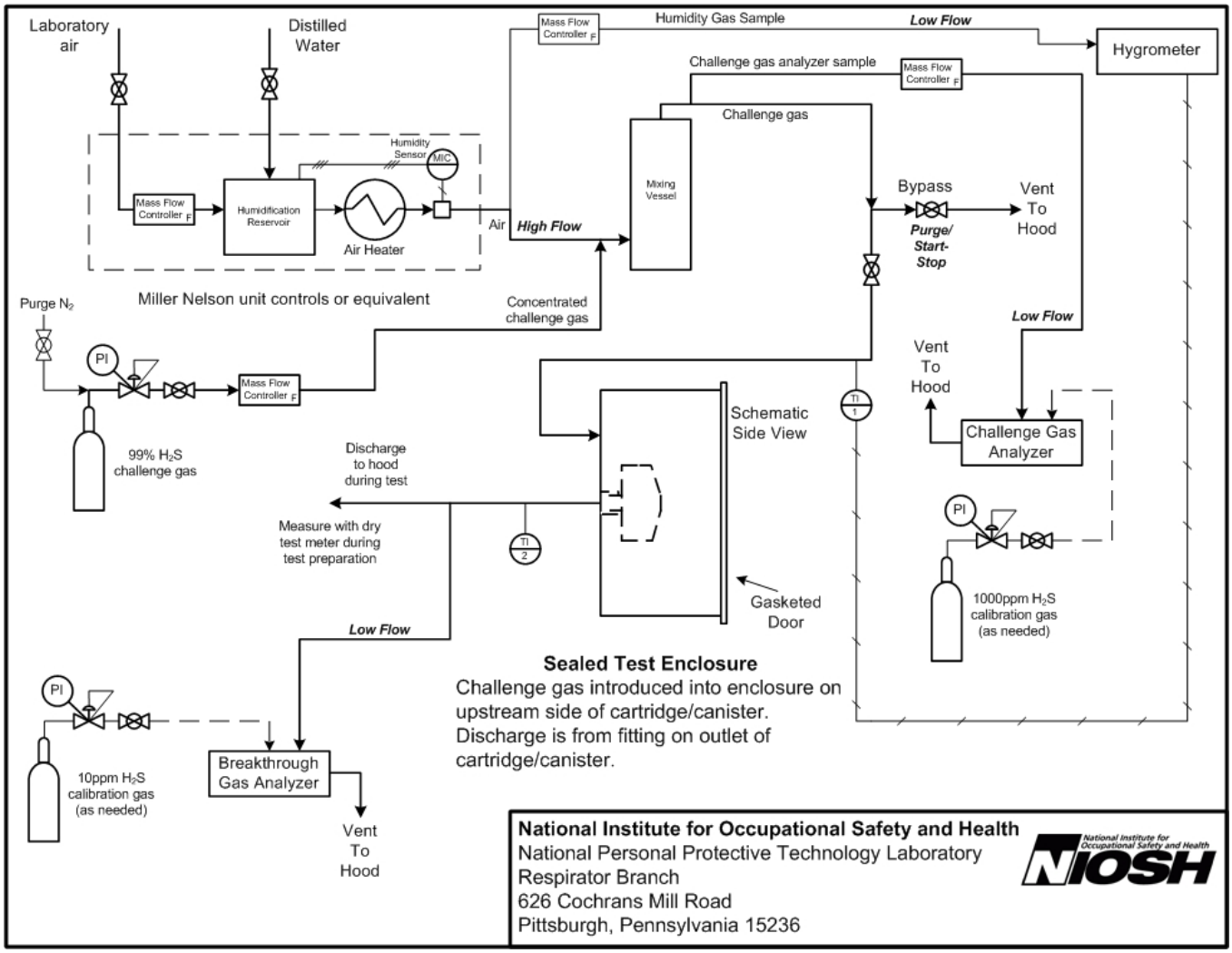
7.1. Record the test data in a format that shall be stored and retrievable.

8. ATTACHMENTS

8.1. Bench Top Set-Up

8.2. Data Sheet

8.1 Test Set-Up



8.2 Data Sheet

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_2O)				Actual Resistance (mm of H_2O)				Result
Test	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)**					**AIRFLOW (lpm)**			
		Con'd			**Conc.**	**Test Rate**		**(PAPR Only)**	
Test					**(ppmv)**	RH%	lpm	Initial	Final
1									
2									
3									
4									
5									
6									
7									

Overall Results: Pass _____ Fail _____ Comment:

DATA TABLE Test	Test Cond.	Final Time (min)	Leakage (ppmv)	Temperature (°C) Dnstream	Temperature (°C) Upstream	Corrected Time (min)
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:

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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:

Revision History

Revision	Date	Reason for Revision
1.0	14 March 2002	Historic document
1.1	30 June 2005	Update header and format to reflect lab move from Morgantown, WV No changes to method
2.0	14 March 2008	Significant rewrite of form and clarification of technical content.