National Institute for Occupational Safety and Health National Personal Protective Technology Laboratory 626 Cochrans Mill Road Pittsburgh, PA 15236		
Procedure No. CVB-APR-STP-0081	Revision: 0.0	Date: 23 March 2020

DETERMINATION OF PARTICULATE FILTER EFFICIENCY LEVEL AGAINST SOLID PARTICULATES FOR POWERED AIR-PURIFYING RESPIRATORS (PAPRs), SERIES PAPR100-N, STANDARD TESTING PROCEDURE (STP)

1. PURPOSE

This procedure establishes the means for ensuring that the particulate filtering efficiency of PAPR100-N series filters meet the requirements set forth in 42 CFR, Part 84, Subpart K, Section 84.180. These filters or filter cartridges may be integral to respirator construction; mounted individually, or in sets of up to three; used in conjunction with filters, cartridges and canisters for half-mask, full facepieces, hoods, and helmets.

2. GENERAL

This STP describes the test method to be used for the Determination of Particulate Filter Efficiency Level Against Solid Particulates for Powered, Air-purifying Respirators, Series PAPR100-N, test procedure in sufficient detail that a person knowledgeable in the appropriate technical field can conduct the test and determine whether, or not the product passes the test.

3. EQUIPMENT/MATERIALS

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

3.1.1. TSI Model 8130 Automated Filter Tester or equivalent instrument. Air flow control accuracy is 2% of full scale. Pressure measurement accuracy is 2% of full scale. Penetrations can be measured to 0.001%, efficiencies to 99.999%.

3.1.2. Microbalance accurate to 0.0001 grams (g).

3.1.3. Type A/E glass filters, 102 mm diameter, high efficiency filters with a 1 micrometer pore size.

3.1.4. Timer (accurate to 0.01 percent).

3.1.5. 2% sodium chloride solution in distilled water (NaCl).

3.1.6. Temperature and humidity chamber capable of maintaining 38 ±2.5 °C and 85 ± 5% relative humidity.

3.1.7. Respirator filter holder supplied for specific manufacturer type which is compatible with TSI filter tester. NIOSH will not be obligated to use these holders for actual certification testing. All manufacturer test fixtures must be correlated with the NIOSH test method.

3.1.8. Thermal printer (supplied with TSI 8130) or optional data acquisition system.

3.1.9. TSI, Green Line paper, part number 813010. Lot number must be included on each box. Each lot number must include the "Penetration vs. Resistance graph".

4. TESTING REQUIREMENTS AND CONDITIONS

4.1. Prior to beginning any testing, confirm that all measuring equipment employed has 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 recognized international standards when available.

4.1.1. Respirator filters and filter cartridges shall be tested as follows. Filters used in conjunction with PAPR100-Ns, and odd or unusually shaped filters may be tested on a test fixture provided by the applicant.

4.1.2. If a test fixture is supplied by the applicant, the test fixture shall have a serial number or other unique, easily referenced identifier permanently etched, engraved, or affixed.

5. PROCEDURE

5.1. Respirator filters will be challenged by a NaCl aerosol at 25 ±5 °C and a relative humidity of 30 ±10% that has been neutralized to the Boltzmann equilibrium state. The particle size distribution will be a count median diameter of 0.075 ± 0.020 micrometer and a geometric standard deviation not exceeding 1.86. Each respirator filter unit will be challenged with an aerosol concentration not exceeding 200 $mg/m^{3.}$

5.1.1. The NaCl aerosol concentration will be determined on the days that initial penetration testing is performed by the following gravimetric method and calculated as milligrams per cubic meter (mg/m^3).

5.1.2. Weigh a 102 mm filter to the nearest 0.1 mg., mount in the gravimetric filter holder, subject it to the generated aerosol at 30 Lpm for 40 minutes and reweigh the filter. Use a timer to monitor the duration of the test. Record the pre- and post-weights, time, and average flow rate on the data sheet and calculate the aerosol concentration in mg/m^3 by the following formula:

Concentration (C) in mg/m^3 = $\frac{(W2 - W1)}{(Q / 1000)(T)}$

Where:

W1 = Initial filter weight in mg
W2 = Final filter weight in mg
Q = Flowrate in liters per minute
T = Test time in minutes

With a flowrate of 30 Lpm for 40 minutes, the above formula simplifies to:

$$C = \frac{W2 - W1}{1.2}$$

5.1.3. Use the following formula to calculate the test duration:

T in minutes = $\frac{(\text{mg load})\ (1000\ L / m3)}{(C)\ \ (Q)}$

Where:

C = Concentration in mg/m3 from 5.1.2.
Q = Flow rate for test in Lpm

5.1.4. The upstream and downstream photometer readings are used for monitoring stability and for calculating a photometer correlation factor (CF). The correlation factor is determined with an empty filter holder and is calculated internally as shown below:

CF = $\frac{\text{Downstream Photometer Voltage} - \text{Downstream Background Voltage}}{\text{Upstream Photometer Voltage} - \text{Downstream Background Voltage}}$

The correlation factor is used by the software to express the upstream photometer signal in terms of the downstream photometer signal.

5.1.5. The NaCl particle size distribution shall be verified using "green line" filter discs supplied by TSI with a known penetration range. Graphs of penetration vs. resistance for two sheets and five sheets of stacked filter discs are supplied with each lot of the standard filters, with a central line and upper and lower lines representing the expected penetration range at a given resistance. The test data should fall within an acceptance zone having boundaries defined by the upper and lower curves on the graphs. The standard filter test using both 2 sheets and 5 sheets will be run at least once in each 8 hour test period to verify that the aerosol distribution is within the acceptance zone.

5.2. Respirator filters will be pre-conditioned at 85 ± 5% relative humidity and 38 ±2.5°C for

25 ±1 hours. After conditioning, the filters shall be sealed in a gas tight container and tested within 10 hours.

5.3. Filters will be mounted and sealed on holders to prevent leakage around the filter holder. Single air purifying respirator filters will be tested at a challenge flow rate of 85± 4 Lpm. Filters used as pairs on a respirator are tested using a single filter of the pair at 42.5 ± 2 Lpm challenge flow rate. Filters used in threes are tested using a single filter of the set at 28.3 ± 1 Lpm challenge flow rate.

5.3.1. The challenge flow rate must be checked for stability for at least 30 seconds prior to testing.

5.4. A sample of 20 filter units will be tested against the NaCl aerosol. Three filters will be loaded until the aerosol mass loading levels as shown in the table below are reached and evaluated to determine the method for the remaining 17 filters. This is the mass amount of NaCl aerosol that has contacted the filter.

Number of Filters In Respirator Configuration	Aerosol Mass Loading Level
Single	200 ± 5 mg.
Double	100 ± 5 mg.
Triple	66.7 ± 5 mg.

5.4.1. Type 1. If preliminary testing of all three initial test filters consistently results in a straight line (Figure 3), for the remaining 17 filters, record the initial penetration reading.

5.4.2. Type 2. If filter testing of all three initial test filters consistently results in a curve which indicates increased efficiency during the complete run (Figure 3), for the remaining 17 filters, record the initial penetration reading.

5.4.3. Type 3. If filter testing of all three initial test filters consistently results in decreased efficiency over time (Figure 3), load the remaining 17 filters with NaCl to the level specified in the table above and record the maximum penetration reading.

5.4.4. Type 4. If filter testing of all three initial test filters consistently results in increased efficiency, then a decrease in efficiency, and then flattens out during the remainder of the complete run (Figure 3), for the remaining 17 filters, record the maximum penetration reading after reaching and maintaining a flat line for a period of 20 minutes following the decreasing segment in efficiency.

5.4.5. For any other filter type, determine loading at which maximum penetration consistently occurs and test at that loading value for the remaining 17 filters.

5.4.6. If any one of the 20 filters have a penetration greater than 0.030%, further testing of that filter will be terminated. Any filter that exceeds the specified limit shall

be remounted and retested to ensure that leakage was not caused by a mounting leak If retesting eliminates the excessive leakage and testing has gone beyond the initial penetration, that sample will be considered an invalid sample, and another tested in its place.

5.5. The penetration of the first three filters will be measured, recorded, and printed at approximately 1-minute intervals during the test period. The highest penetration observed throughout the test of each filter will be recorded as the maximum penetration of that filter.

5.6. Determine and record on the data sheet the maximum filter penetration for each of the 20 filters.

6. PASS/FAIL CRITERIA

6.1. The requirement for passing this test is set forth in 42 CFR, Part 84, Subpart K, Section 84.180.

6.2. The minimum efficiency for each of the 20 filters shall be determined and recorded and shall be equal to or greater than 99.97 %.

6.3. For the sample of 20 filters or filter cartridges to demonstrate acceptable performance, each filter shall meet or exceed the specified minimum efficiency level at the end point of the test.

7. RECORDS/TEST SHEETS

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

8. ATTACHMENTS

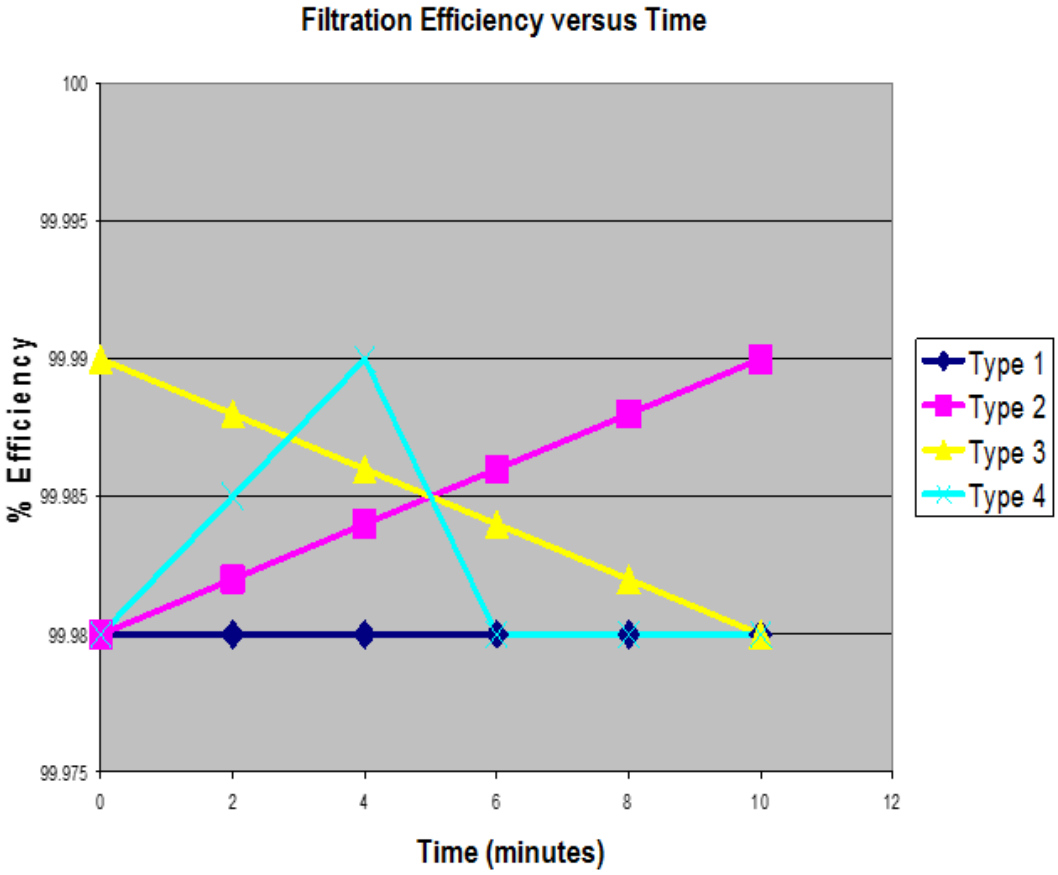
8.1. Filtration Efficiency versus Time Example Plots

8.2. Example Data Sheet

8.3. Photograph of TSI 8130 CertiTester with chuck open

8.4. Photograph of TSI 8130 CertiTester with the chuck closed

8.1. Filtration Efficiency versus Time Example Plots



8.2. Example Data Sheet

National Institute for Occupational Safety and Health
Respirator Branch
Test Data Sheet

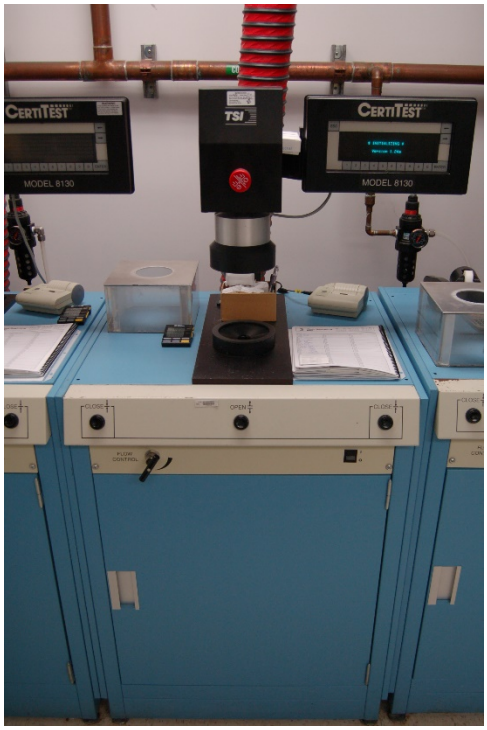
Task Number: TN-XXXXX **Reference No.:** CFR 84.180
Test: Sodium Chloride (NaCl) PAPR100-N **STP No.:**
Manufacturer: Company Name
Item Tested:

Filter	Flow Rate	Initial Filter Resistance	Maximum Allowable Percent Leakage	Initial Percent Leakage	Maximum Percent Leakage	Result
1	85	7.9	0.03	.002	.002	PASS
2	85	8.2	0.03	.002	.002	PASS
3	85	8.1	0.03	.001	.003	PASS
4	85	7.8	0.03	.003	.004	PASS
5	85	7.8	0.03	.001	.003	PASS
6	85	8.3	0.03	.002	.002	PASS
7	85	8.2	0.03	.001	.002	PASS
8	85	8.1	0.03	.002	.003	PASS
9	85	8.2	0.03	.001	.002	PASS
10	85	8.2	0.03	.001	.002	PASS
11	85	8.3	0.03	.002	.003	PASS
12	85	7.8	0.03	.001	.001	PASS
13	85	7.9	0.03	.001	.001	PASS
14	85	8.3	0.03	.002	.002	PASS
15	85	8.2	0.03	.001	.002	PASS
16	85	7.9	0.03	.002	.002	PASS
17	85	8.2	0.03	.002	.003	PASS
18	85	7.9	0.03	.001	.002	PASS
19	85	8.2	0.03	.000	.002	PASS
20	85	7.8	0.03	.002	.003	PASS

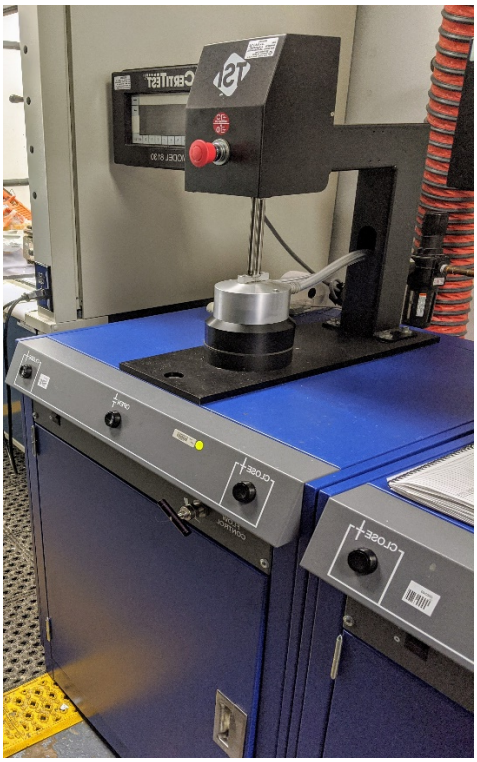
Overall Result: PASS

Signature: _____ **Date:**_____
Engineering Technician

8.3. Photograph of TSI 8130 with chuck open



8.4. Photograph of TSI 8130 with chuck closed



Revision History

Revision	Date	Reason for Revision
0.0	23 March2020	Original release