

## Conducting Airflow Check on the 3M™ Versaflo™ PAPR

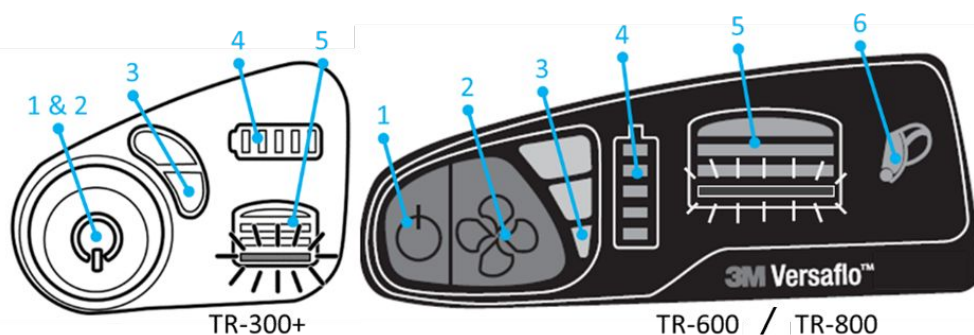
### Introduction

#### **i** IMPORTANT

The following Technical Data Bulletin is for reference purposes only. Before using TR-300+, TR-600, or TR-800 PAPR, all users must read and understand respective product's *User Instructions*. If you have questions, consult your supervisor, or call 3M Technical Service at 1-800-243-4630 (USA) or 1-800-267-4414 (Canada).

This document provides directions and examples of conducting airflow checks on the 3M™ Versaflo™ Powered Air Purifying Respirators. It expands on the directions in the *User Instructions*. It also provides insight on the behavior of the 3M™ Airflow Indicators, TR-971 (loose-fitting) and TR-973 (tight-fitting, TR-600 & TR-800 only), in more extreme environments. TR-300+, TR-600, and TR-800 are part of the 3M™ Versaflo™ family of respiratory protection products. The motor/blower unit draws ambient air through its filter/cartridge and supplies filtered air to the headgear via a breathing tube. Only TR-600 and TR-800 motor/blowers can connect to tight-fitting headgear and tight-fitting mode indicator would be illuminated (Fig. 1 #6). The blower provides user selectable airflow settings. It is equipped with automatic flow control; the motor airflow is regulated during operation to compensate for the charge state of the battery, the increasing level of airflow resistance caused by particle filter loading, and changes in air density due to changes in elevation and air temperature. Should the airflow fall below the minimum design flow rate, an audible alert will activate and the filter loading LED (Fig. 1 #5) on the blower unit will flash red to warn the user to immediately leave the contaminated environment. TR-600 also has a vibratory alert. Similar alerts for low battery alarm (Fig. 1 #4) will activate when the battery pack has approximately 10-15 minutes of charge remaining to warn the user to leave the contaminated area.

Figure 1: TR-300+ (left) and TR-600/800 (Right) Motor/Blower User Interface



1. On/Off button
2. low control button
3. Flow setting indicator
4. Battery charge status indicator/lower battery alarm
5. Filter loading indicator/low flow alarm
6. Tight-fitting mode indicator

The motor/blower unit is airflow controlled based on air volume. Even as the air density changes, the volume of air delivered by the PAPR is designed to remain consistent at the given user-selected airflow setting. This is similar to how your own lungs work. In other words, you should therefore be able to breathe roughly the same volume of air at sea level as you do atop a mountain, even though

at higher elevations that given volume of air weighs less because it is less dense. This same principle holds true for air temperature. A one cubic-foot volume of air at 100 °F (38 °C) weighs less (lower density) than a one cubic-foot volume of air at 32 °F (0 °C).

While the PAPR is pre-calibrated to help ensure required airflow, the 3M™ Airflow Indicator, TR-971 and TR-973 should be used to verify the minimum required airflow of 6 cfm (170 lpm) is attained prior to each day’s use.

Since the airflow indicator is based on a ball rotameter-style flow meter, the height of the ball in the airflow indicator tube is subject to changes in the air density pushing on it. At a given volume of airflow, air at a higher density will push up on the ball with greater amount of force than air at a lower density. The greater amount of force results in the ball being pushed higher in the airflow indicator tube. Because of this difference in force, the airflow indicator is graduated into different ‘zones’ based on air density, which is based on altitude and ambient temperature.

Use *Chart 1* below or the reference card supplied with your TR-971 or TR-973 airflow indicator to determine your ‘Zone’. Follow the steps below for conducting an airflow check.

		°C						
		-10	0	10	20	30	40	50
m	°F	14	32	50	68	86	104	122
	ft							
-610	-2000	A	B	C	D	E	F	
-305	-1000	A	B	C	D	E	F	G
0	0	B	C	D	E	F	G	H
305	1000	C	D	E	F	G	H	I
610	2000	D	E	F	G	H	I	J
914	3000	E	F	G	H	I	J	K
1219	4000	F	G	H	I	J	K	L
1524	5000	G	H	I	J	K	L	M
1829	6000	H	I	J	K	L	M	N
2134	7000	I	J	K	L	M	N	O
2438	8000	J	K	L	M	N	O	P
2743	9000	K	L	M	N	O	P	Q
3048	10000	L	M	N	O	P	Q	R
3353	11000	M	N	O	P	Q	R	S
3658	12000	N	O	P	Q	R	S	T
3962	13000	O	P	Q	R	S	T	U
4267	14000	P	Q	R	S	T	U	V
4572	15000	Q	R	S	T	U	V	W
4877	16000	R	S	T	U	V	W	X
5182	17000	S	T	U	V	W	X	Y

Chart 1. Airflow Indicator Zone based on Elevation and Temperature for TR-971 and TR-973. Note: This chart comes attached on the Airflow Indicator.

## Determining Your ‘Zone’

To determine your ‘zone’, you must know the elevation and temperature for the environment where you are conducting the airflow check (not for where the system will be used). See your supervisor if you are not certain of these values. During use, the system will automatically compensate for changes in air temperature and pressure.

Example A: you are conducting an airflow check where the elevation is 2,700 feet (823 meters), and the temperature is 72 °F (22 °C).

- 2,700 ft falls between 2,000 and 3,000, rounding to the nearest value, round up to 3,000 ft.

- 72 °F falls between 68 °F and 86 °F, rounding to the nearest value, round down to 68 °F
- Locate the zone where 3,000 ft intersects with 68 °F
- Your 'zone' is 'H'.

Note: For TR-300+ the recommended operating altitude range is -2,000 ft (-610 m) to 14,107 ft (4,300 m). For TR-600 and TR-800, the recommended operating altitude range is -2,000 ft (-610 m) to 16,404 ft (5,000 m). For use outside this range, contact 3M Technical Service.

## Additional Examples

Example B: Temperature 99 °F (37 °C); Elevation 5 ft (1.5 m)

- 5 ft, rounding to the nearest value, rounds down to 0 ft
- 99 °F falls between 86 °F and 104 °F, rounding to the nearest value, round up to 104 °F
- Locate the zone where 0 ft intersects with 104 °F
- Your 'Zone' is 'G'

Example C: Temperature: 45 °F (7 °C); Elevation: 5,280 ft (1,609 m)

- 5,280 ft, rounding to the nearest value, rounds down to 5,000 ft
- 45 °F falls between 32 °F and 50 °F, rounding to the nearest value, round up to 50 °F
- Locate the zone where 5,000 feet intersects with 50 °F
- Your 'Zone' is 'I'

Additional guidance on determining your zone at different humidity and measured air pressure may be found in the 'Advanced Guidance' section of this bulletin.

## Airflow Check

Must be conducted before each day's use.

1. Ensure the filter you are planning to use is properly installed.
2. If the breathing tube is attached, remove it.
3. Insert appropriate air flow indicator into the outlet on the blower unit (Fig. 2). For loose-fitting configurations, use TR-971. For tight-fitting configurations, use TR-973. Make sure the float ball moves freely in the tube and the gasket at the bottom end of the tube is in place.
4. Turn the blower unit on (Fig. 1 #1) and run for 1 minute to allow the air flow to stabilize.
5. Ensure the airflow setting is set to standard / lowest (Fig. 1 #3). The unit will start-up in standard mode.
6. Tilt the blower unit so that the airflow indicator is vertical (Fig. 3).
7. The bottom of the floating ball must rest at, or above, the minimum flow mark for the 'letter' representing your 'Zone' as indicated on the reference card supplied with your airflow indicator, in the User Instructions, and on chart 1 below.
8. If the airflow indicator ball fails to rise above your 'zone' of the minimum flow level, do not use the unit.
9. Repeat the test with a fully charged battery and/or a new filter and cartridge (and pre-filter if used).

If issues persist, refer to the Troubleshooting guidance or contact 3M technical service at 1-800-243-4630 in the United States or 1-800-267-4414 in Canada.



Figure 2. Attaching Airflow Indicator

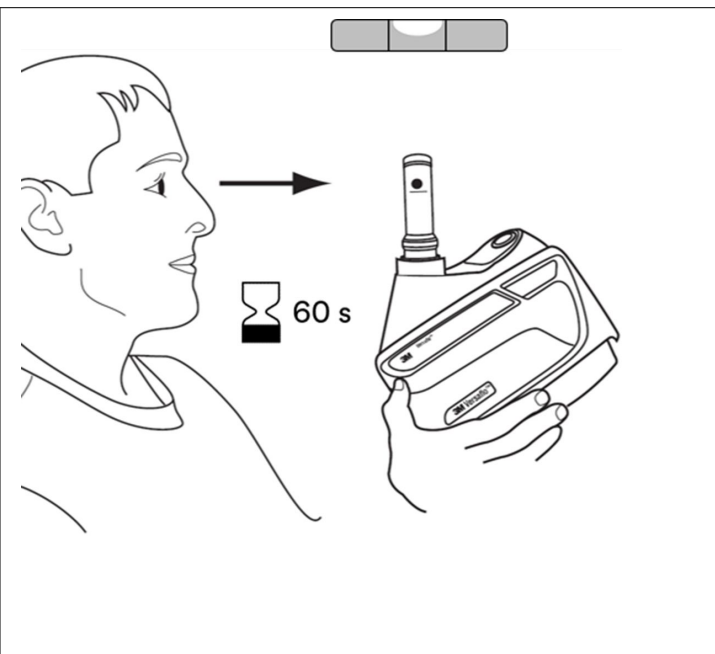


Figure 3. Reading Airflow Indicator at Level

If the airflow indicator ball fails to rise above the minimum flow level:

- Double check you selected the correct zone based on current environmental conditions.
- Do not use the unit.
- Refer to the guidance in this document, the troubleshooting guidance document, or contact 3M Technical Service.

## Low Flow Alarm Check

Check the low airflow alarm by simulating a low airflow condition.

With the motor/blower on:

- Remove the airflow indicator and tightly cover the outlet of the motor/blower with the palm of your hand (Fig. 4). The motor should automatically speed up, attempting to compensate for the low airflow condition. Continue to press your palm tightly against the end of the outlet, making a tight seal. In less than approx. 30 seconds, the unit will sound an audible and vibratory alarm, and the bottom bar on the filter loading/low flow indicator will flash red. (Fig 1, #5).
- Remove your hand from the end of the breathing tube. In less than approx. 30 seconds, the audible alarm and the flashing red LED should both stop when the motor returns to the selected speed.

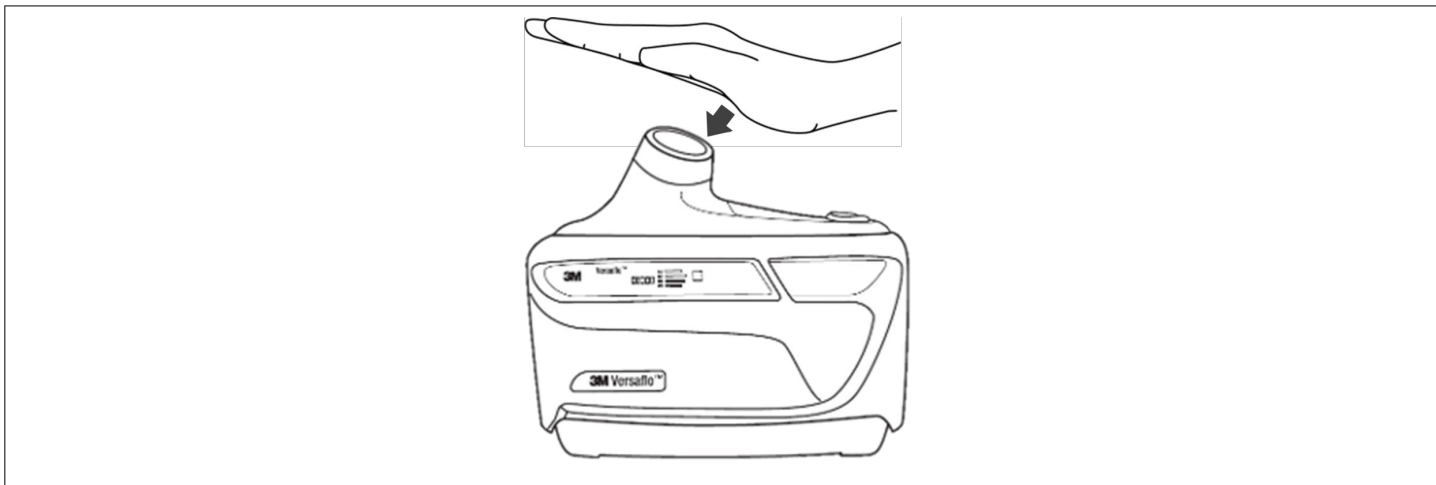


Figure 4. Placing Palm Over Blower Outlet

## Advanced Guidance

As discussed above, the height of the ball in the 3M™ Airflow Indicator TR-971 and TR-973 at a given airflow volume is based on the density of the air in the environment. Air density is mainly affected by air pressure and temperature, with minor effects based on relative humidity. Air pressure is primarily dependent on elevation. However, at a given elevation the air pressure can be affected by other variables, such as weather conditions, building ventilation, and artificially pressured environments (such as caissons, air locks, and positive or negative pressure rooms).


Since for most users it is easier to determine their elevation than ambient pressure, the table on the airflow indicator card uses elevation to determine the 'zone' (see Chart 1). It is also possible to determine the appropriate airflow indicator zone by knowing the ambient pressure in pascals (Pa). Chart 2 is similar to Chart 1, but with pressure values added in line with elevation.

~ 10% RH		°C								
		-10	0	10	20	30	40	50		
Pa	m	ft	°F	14	32	50	68	86	104	122
108866	-610	-2000		A	B	C	D	E	F	
105041	-305	-1000	A	B	C	D	E	F	G	
101325	0	0	B	C	D	E	F	G	H	
97717	305	1000	C	D	E	F	G	H	I	
94213	610	2000	D	E	F	G	H	I	J	
90812	914	3000	E	F	G	H	I	J	K	
87511	1219	4000	F	G	H	I	J	K	L	
84307	1524	5000	G	H	I	J	K	L	M	
81200	1829	6000	H	I	J	K	L	M	N	
78185	2134	7000	I	J	K	L	M	N	O	
75262	2438	8000	J	K	L	M	N	O	P	
72428	2743	9000	K	L	M	N	O	P	Q	
69682	3048	10000	L	M	N	O	P	Q	R	
67020	3353	11000	M	N	O	P	Q	R	S	
64441	3658	12000	N	O	P	Q	R	S	T	
61943	3962	13000	O	P	Q	R	S	T	U	
59524	4267	14000	P	Q	R	S	T	U	V	
57182	4572	15000	Q	R	S	T	U	V	W	
54915	4877	16000	R	S	T	U	V	W	X	
52722	5182	17000	S	T	U	V	W	X	Y	

Chart 2. Airflow Indicator Zone based on Elevation, Pressure, and Temperature for TR-971 and TR-973 at ~10% Relative Humidity.

Relative humidity (RH) can also affect the density of air, and thus the height of the ball in the airflow indicator. Dry air has a higher density than humid air. As such, at a given temperature, pressure, and airflow dry air will push the ball higher in the airflow indicator tube than humid air will. The chart provided with the 3M™ Airflow Indicator TR-971 and TR-973 is based on dry air (~10% RH), which is a conservative approach. Charts 3 & 4 show airflow zones based on 50% RH and 90% RH respectively.

Note: If the airflow check passes using the standard chart supplied with the 3M™ Airflow Indicator (TR-971) – based on 10% RH - it will also pass using on Charts 3 & 4 – based on higher RH values.



~50%RH

Pa	m	°C		°F											
		-10	0	14	32	50	68	86	104	122					
108866	-6.10	-2000	A	B	C	D	E	F	G						
105041	-3.05	-1000	B	C	D	E	F	G	H						
101325	0	0	C	D	E	F	G	H	I						
97717	305	1000	D	E	F	G	H	I	J						
94213	610	2000	E	F	G	H	I	J	K						
90812	914	3000	F	G	H	I	J	K	L						
87511	1219	4000	G	H	I	J	K	L	M						
84307	1524	5000	H	I	J	K	L	M	N						
81200	1829	6000	I	J	K	L	M	N	O						
78185	2134	7000	J	K	L	M	N	O	P						
75262	2438	8000	K	L	M	N	O	P	Q						
72428	2743	9000	L	M	N	O	P	Q	R						
69682	3048	10000	M	N	O	P	Q	R	S						
67020	3353	11000	N	O	P	Q	R	S	T						
64441	3658	12000	O	P	Q	R	S	T	U						
61943	3962	13000	P	Q	R	S	T	U	V						
59524	4267	14000	Q	R	S	T	U	V	W						
57182	4572	15000	R	S	T	U	V	W	X						
54915	4877	16000	S	T	U	V	W	X	Y						
52722	5182	17000	T	U	V	W	X	Y							





Chart 3. Airflow Indicator Zone based on Elevation, Pressure, and Temperature for TR-971 and TR-973 at ~50% Relative Humidity.



~90%RH

Pa	m	°C		°F											
		-10	0	14	32	50	68	86	104	122					
108866	-6.10	-2000	B	C	D	E	F	G	H						
105041	-3.05	-1000	C	D	E	F	G	H	I						
101325	0	0	D	E	F	G	H	I	J						
97717	305	1000	E	F	G	H	I	J	K						
94213	610	2000	F	G	H	I	J	K	L						
90812	914	3000	G	H	I	J	K	L	M						
87511	1219	4000	H	I	J	K	L	M	N						
84307	1524	5000	I	J	K	L	M	N	O						
81200	1829	6000	J	K	L	M	N	O	P						
78185	2134	7000	K	L	M	N	O	P	Q						
75262	2438	8000	L	M	N	O	P	Q	R						
72428	2743	9000	M	N	O	P	Q	R	S						
69682	3048	10000	N	O	P	Q	R	S	T						
67020	3353	11000	O	P	Q	R	S	T	U						
64441	3658	12000	P	Q	R	S	T	U	V						
61943	3962	13000	Q	R	S	T	U	V	W						
59524	4267	14000	R	S	T	U	V	W	X						
57182	4572	15000	S	T	U	V	W	X	Y						
54915	4877	16000	T	U	V	W	X	Y							
52722	5182	17000	U	V	W	X	Y								




Chart 4. Airflow Indicator Zone based on Elevation, Pressure, and Temperature for TR-971 and TR-973 at ~90% Relative Humidity.



**Personal Safety Division**

3M Center, Building 235-2W-70  
St. Paul, MN 55144-1000

3M PSD products are occupational use only.

**3M Canada**  
P.O. Box 5757  
London, Ontario  
N6A 4T1

**In United States of America**  
Technical Service 1-800-243-4630  
Customer Service 1-800-328-1667  
3M.com/workersafety

**In Canada**  
Technical Service 1-800-267-4414  
Customer Service 1-800-364-3577  
3M.ca/Safety

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