



**TECHNICAL DATA BULLETIN #223
BATTERY MAINTENANCE FOR 3M™ VERSAFLO™ RESPIRATOR SYSTEMS**

Consult the TR-600 or TR-300 PAPR *User Instructions* for general system operation.

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Rev: 1 Replaces all previously published guides on this topic until superseded.

The following Technical Data Bulletin is for reference purposes only. **Before using the TR-300 or TR-600 PAPR, all users must read and understand the appropriate product's *User Instructions*.**

Battery should be charged immediately and fully upon receipt.
Battery should be fully recharged at least every 9-12 months.

General Recommendations

- Always read and follow the *User Instructions* that accompany the battery pack and charger.
- Use only 3M TR-600 chargers to charge TR-600 battery packs.
- Use only 3M TR-300 chargers to charge TR-300 battery packs.
- Battery pack capacity may be reduced if stored or used in high temperature environments or near radiant heat sources.
- 3M™ Versaflo™ PAPR battery packs can be charged any time during the discharge cycle. Battery memory (also known as voltage depression) is not a significant factor.
- Battery packs can be cleaned with a damp cloth and mild detergents. Solvents and strong detergents may damage the battery pack case.
- Do not charge battery packs in an enclosed cabinet without ventilation. Do not stack batteries together or on top of charger when charging. Heat naturally generated during charging must be allowed to dissipate or it may damage battery pack cells.
- 3M™ Versaflo™ battery pack capacity can be checked directly with the status indicator on the battery pack.
- Do not attempt to discharge the battery pack by short-circuiting the terminal pads.
- For long-term storage, disconnect battery pack from the motor/blower unit. See storage recommendations in this document.

PAPR	Battery Packs	Charger
TR-300	TR-330 Standard Capacity	TR-340 cradle
	TR-332 High Capacity	TR-341 - Single station, TR-344 - 4-station
TR-600	TR-630 Standard Capacity	TR-640 cradle
	TR-632 High Capacity	TR-641 - Single station, TR-644 - 4-station

Operational Recommendations

3M™ Versaflo™ lithium-ion (Li-ion) battery packs offer quick charging (100% typically in less than 3.5 hours), light weight and compact size. In addition to the general recommendations above, the following operational recommendations should be followed:

Charging

Initial Use: The 3M™ Versaflo™ battery packs do not require a learn cycle to calibrate or re-calibrate the battery pack charge indicator. However, it may take up to three complete charge/discharge cycles for the battery to reach its maximum capacity and claimed run times. Typically, the difference between the capacity of a new battery as received and the maximum capacity is only a few percent, and will likely be unnoticeable to the user. Other than charging the battery upon receipt, no special conditioning is required or recommended prior to initial use.

Operational Use

Operating temperature:

TR-300 battery packs have an operating temperature of 23° F (-5° C) to 129° F (54° C).

TR-600 battery packs have an operating temperature of 14° F (-10° C) to 129° F (54° C).

Do not expose battery pack to temperatures above 129° F (54° C). Run time will be reduced when used at temperature extremes. The 3M™ Versaflo™ PAPR battery alarm will activate if battery pack temperature reaches 130° F (55° C) while the motor blower is in use. If this happens immediately leave the contaminated area. The motor blower will immediately shut down when the internal battery temperature reaches 140° F (60° C).

Charging temperature: The internal battery pack temperature must be between 32° F (0° C) to 104° F (40° C) when charging – do not charge outside of this range. Optimal internal battery charging temperature is 68° F to 77° F (20° C to 25° C). Outside of the overall temperature range, the charger will indicate a temperature fault (slow flash amber LED error) and will not charge. Charging will start when battery pack temperature is within range. Repeated charging outside the optimal temperature range will reduce battery pack run time and cycle life. If a battery feels hot, let it cool for 1/2 hour before charging. If the charger senses the battery is too hot it will go into a standby mode until the battery has cooled.

Not intrinsically safe: The TR-300 and TR-600 PAPR respirator systems and battery pack chargers are not rated for intrinsic safety/hazardous location use. Use the PAPR system and charge battery packs only in non-hazardous locations.

Run time: The run times for each 3M™ Versaflo™ PAPR system will vary for each configuration and is dependent on headgear, filter/cartridge, selected airflow, filter loading, battery selected, battery condition, and environmental conditions. For TR-600, refer to the TR-600 System Run Times Guide for additional information. For TR-300, refer to the TR-300 PAPR *User Instructions*.

Service life: 3M™ Versaflo™ battery packs provide approximately 250 full capacity charge/discharge cycles while maintaining 80% of the original charge capacity over the course of the first year of service when used under recommended conditions. See Figure 1. If the battery is used infrequently over an extended period of time, the approximate 250 full cycle equivalents may not be reached due to natural degradation of the battery's chemistry. Normal use of the battery and natural aging of battery cells will gradually decrease the battery's available capacity, which results in decrease in run time. Batteries may continue to be used as they age, as long

as battery run time is sufficient to power the PAPR for sufficient time to safely perform the given task and exit the contaminated area. Consider replacing the battery pack when maximum charging capacity drops below 80% as shown on the battery pack charge indicator.

1 cycle = discharge of 90% of battery pack capacity. Partial cycles are counted and added up until 90% is reached.

For example: User runs battery pack for 2 hours and depletes it 20% of capacity. User does this for 4 more days, recharging the battery pack at the end of each day (total of 5 days use). 1 cycle has occurred at the end of the 5th day. (20% discharge/day) X (5 days use) = greater than 90% discharge. The battery will register 1 charge/discharge cycle after 5 days.

The number of bars illuminated indicates approximate battery pack charge status remaining: 5 bars = 80-100%, 4 bars = 60-80%, 3 bars = 40-60%, 2 bars = 20-40%, 1 bar = < 20%, 1 bar flashing = < 10%. The charge status indicator is based on the original charge capacity. It does not recalibrate as the battery ages, and the number of bars illuminated with a fully charged battery will decrease as the battery naturally loses capacity. This is a safety feature so that throughout the life of the battery the number of charge status bars lit consistently indicates approximate run time remaining (with a given system setup and filter loading). When the low battery alarm sounds, users must immediately exit the hazardous area and replace the battery.

For example: An older battery pack or one that has been exposed to temperature extremes is showing less than 5 bars after the charger indicates the battery is fully charged (i.e. after a charge cycle, only 4 bars light indicating 60-80% of original capacity is available).

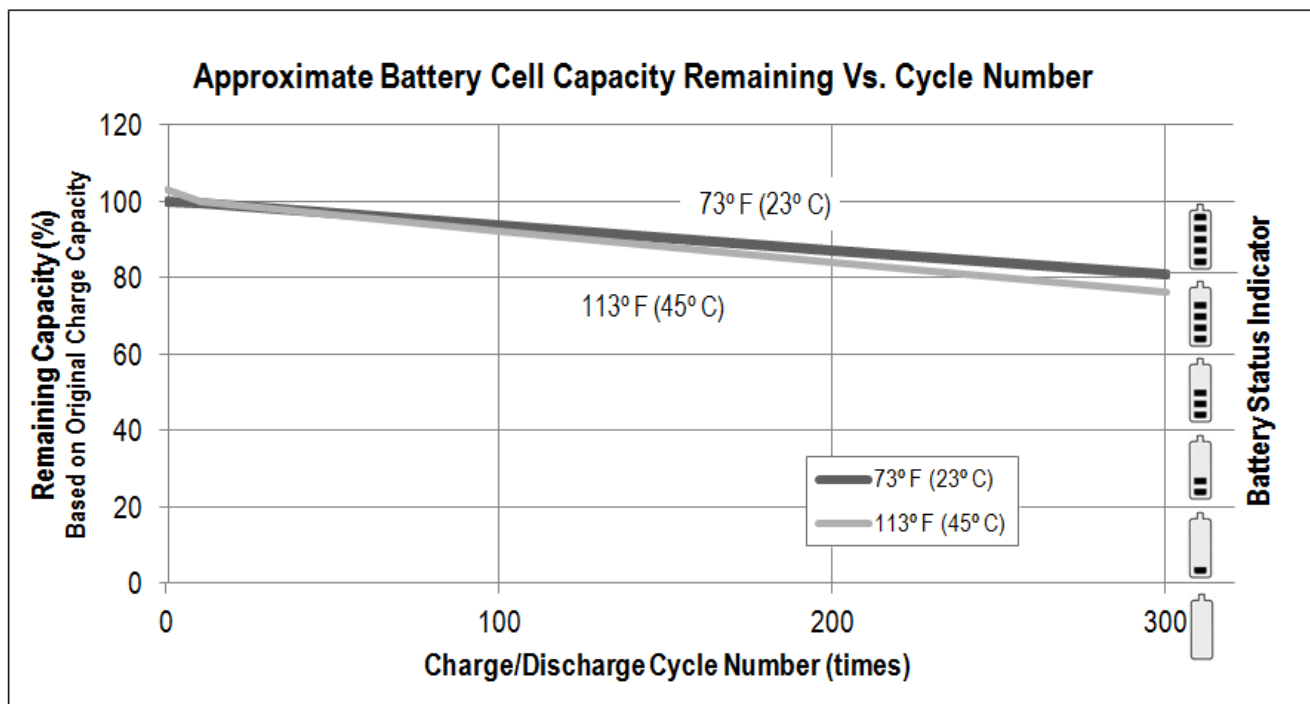


Figure 1 – Remaining battery cell capacity decreases with cycle number.

No serviceable parts: There are no user serviceable parts inside either the battery pack case or the chargers. Do not attempt to open; doing so may expose you to hazardous voltage.

Transportation: Consult a transportation specialist for any requirements or limitations prior to transporting lithium-ion battery packs. 3M™ Versaflo™ battery packs are shipped compliant with UN 38.3.

Cleaning

Follow the hygiene practices established by your employer for cleaning the specific contaminants to which the system has been exposed. **Solvents should not be used to clean the battery pack or battery charger. Liquid solvents may chemically weaken the plastic.** Many water based cleaners have been tested on the battery pack housing using a wipe test and found to not degrade the plastic. More information on the cleaners tested, the test procedure, and the results can be found in 3M Technical Data Bulletin #222 – Cleaning and Maintenance of the TR-600. The TR-300 and TR-600 batteries use similar blends of plastic for the housing.

The smooth finish on the TR-300 and TR-600 batteries make them conducive to being effectively cleaned by simply wiping them down with a damp cloth. Wipe the housing of the battery pack with a soft cloth dipped in mild cleaning solution or a pre-wetted cleaning wipe, such as the 3M™ 504 Respirator Cleaning Wipes. Liquid should not be allowed to remain on the batteries gold plated terminals, and the terminals should be dried after cleaning. If the terminals are dirty or corroded and wiping with a cleaning cloth is not working, using a pencil eraser to gently clean the terminals may be effective.

TR-300 Batteries: Do not submerge TR-300 batteries and do not attempt to clean TR-300 batteries in a respirator washer.

TR-600 Batteries: The TR-600 batteries are sealed and designed for temporary immersion for cleaning. The TR-600 batteries are rated to IP67 under the Ingress Protection standard (IEC 60529). With the cleaning and storage plug installed (Figure 2) from the TR-653 cleaning and storage kit, the TR-600 batteries may be immersed for cleaning. There are two locking loops on the battery cleaning cover. The smaller loop position is for use with the Versaflo TR-630 standard capacity battery, the large loop position is for use with the Versaflo TR-632 high capacity battery. Do not immerse the battery in greater than 2 feet (0.6 meters) of water, or for longer than 2 minutes. Dry the battery after cleaning, paying particular attention to drying battery terminals. If water is found between the battery and the cleaning cover after immersion, inspect the cleaning cover for damage. If the cover is damaged or is no longer sealing correctly, discard the cleaning cover and replace. **Do not attempt to clean battery in respirator washer. Do not submerge TR-300 batteries.**

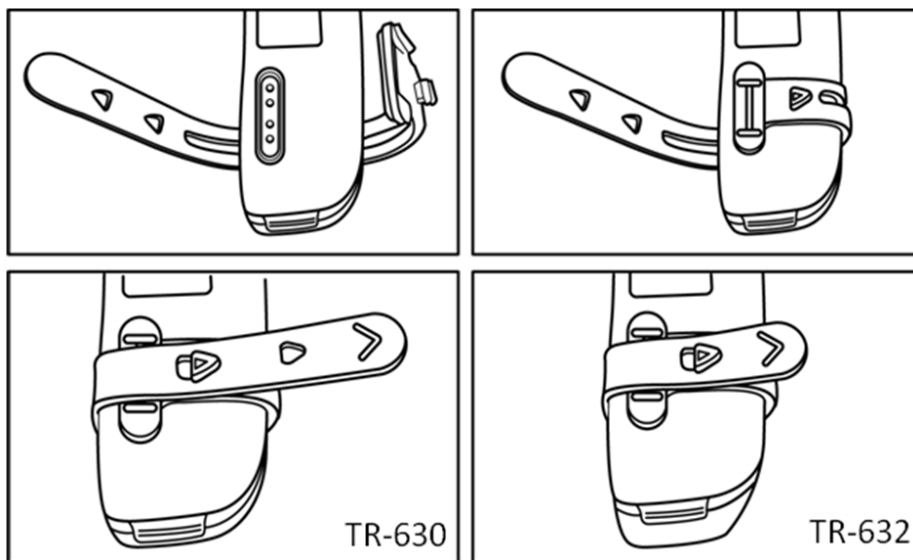


Figure 2 – Installation of battery cleaning cover.

Storage

Battery packs should be charged immediately and fully upon receipt. The battery should be fully recharged after each use and at least every 9-12 months.

Recommended storage conditions: -22° F (-30° C) to 122° F (50° C); Optimal: 59° F (15° C). Dry conditions, relative humidity < 85%.

The battery pack may remain connected to the charger for an extended period of time. However, for long-term storage, to maximize battery pack life, 3M recommends storing the battery pack off the charger at approximately 40% charge as shown by the battery pack charge indicator. The battery pack should be disconnected from the motor/blower during storage.

Shelf life: The battery packs have a one (1) year suggested shelf life from the date of manufacture when stored in original packaging and recommended storage conditions. The LOT code is embossed on each battery pack, and can be used to determine the date of manufacture. See Figure 3 for locating the LOT code. The LOT code is formatted as (YYWWX); YY = year of manufacture; WW = week of year.

For Example: Your battery has a LOT code of 14231. This means that your battery was manufactured on 23rd week of 2014, or the week of June 8th, 2014.

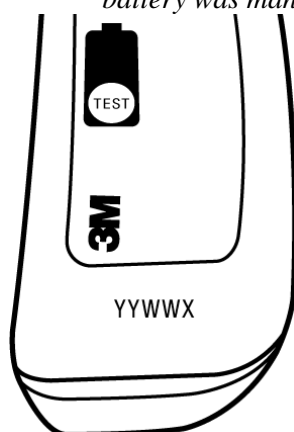


Figure 3 – Location of lot code.

Self-discharge: During storage (anytime not in use or being charged) batteries will naturally lose a percentage of their charge (remaining capacity), known as self-discharge. The self-discharge rate is mainly governed by the battery chemistry itself and storage conditions, but may also be affected by on-board circuitry. The 3M™ Versaflo™ battery packs have a self-discharge rate between approximately 2.5% and 4% per month depending on the size of the battery pack. Smaller battery packs have a higher self-discharge rate than larger packs. Batteries stored at higher temperatures have a higher self-discharge rate than batteries stored at lower temperatures.

Hibernation: The TR-300 and TR-600 battery packs are controlled and monitored by onboard electronics. This circuit board uses a small amount of power to continuously monitor the battery and keeps it ready to communicate with the PAPR or the battery charger. This small amount of power draw contributes to the self-discharge rate of the battery. When the battery is low on charge, the circuit board will automatically shut itself down to conserve power. This is referred to as hibernation. While hibernating, the charge status indicator on the battery pack will not light, the battery will not power the PAPR, and the battery will not communicate with the battery charger to initiate a charge cycle. The TR-600 battery chargers and certain TR-300 chargers are equipped with a 'wake-up' feature that will provide a small voltage into the battery when it is first placed on the charger. This wake-up pulse may be enough to bring a battery out of hibernation, thus allowing the charge cycle to continue as normal. TR-300 battery chargers labeled 'Rev. C' and later and all TR-600 battery chargers include the wake-up feature.

Deep-discharge: When a battery is discharged past a certain point, it can go into a 'deep-discharge' state. During deep-discharge the battery cell can physically break down and become permanently and progressively

damaged. The deeper the discharge and the longer allowed to remain discharged, the more damaged the battery will become. One phenomenon that can occur during deep-discharge is the tendency of the Li-ion electrolyte to crystallize and adhere on the battery cell's anode (negative terminal side), which reduces the amount of free electrolyte capable to do work. Cycling the battery three or more times may help break-up the crystallized electrolyte, thereby restoring capacity to the battery. However, this procedure is only occasionally and partially effective.

Causes of Deep-discharge:

- Prolonged storage – The TR-300 and TR-600 battery packs have a one (1) year suggested shelf life from the date of manufacture when stored in original packaging and recommended storage conditions. While in storage, the battery will continuously lose charge through self-discharge. If stored off the charger for an excessive amount of time, the battery may self-discharge into a deep-discharge state. Batteries should be charged immediately and fully upon receipt, and at least every 9-12 months.
- Storage after use without charging – Batteries that have been fully or partially discharged will go into a deep-discharge state due to self-discharge faster than a fully charged battery. Depending on how much capacity is remaining on the battery, it may start going into a deep-discharge state in only a few days. Because of this, batteries should be charged soon after each use.
- Forced overuse – Forced overuse is caused by turning the PAPR back on (without charging or changing the battery) after the PAPR has automatically shut down due to low battery charge. The automatic shut down due to low battery level occurs approximately 10-15 minutes after the PAPR's low battery alarm sounds. The automatic shut down point is set to preserve a small amount of charge capacity to prevent the battery from going into a deep-discharge state. Forcing the PAPR to turn back on after automatic shut down may cause the battery to go into a deep-discharge state in a very quickly.

TROUBLESHOOTING

Use the table below to help identify possible causes and corrective actions for problems you may experience. Consult the TR-600 trouble shooting guide or contact 3M Technical Service to help identify possible causes and corrective actions for any other problems you may experience.

<i>Problem</i>	<i>Probable Cause</i>	<i>Corrective Action</i>
Charger Power on indicator not lit	AC power cord not connected to wall outlet Power cord not connected to charger Power supply not functioning Cradle not seated properly in multi-base Battery has gone into hibernation	Check all power supply connections Check all power supply connections Switch to alternate power source Remove and reseal cradle TR-300 batteries – place on TR-340 charging cradle Rev. C or later. TR-600 batteries – place on any TR-640 charging cradle.
Battery will not go into charge mode	Battery is fully charged Battery not seated properly in cradle Battery or charger contacts are	No action necessary Remove battery and reseal in cradle Clean and dry electrical contacts

	dirty Defective battery Defective charger Battery too hot or too cold Battery/charger electrical contacts are dirty Battery has been exposed to water beyond acceptable limits	Replace battery Replace charger Allow battery to return to room temperature Clean contacts and reseat in cradle Cease using; replace battery and remove from further service.
Battery becomes hot during charging (>113°F, 45°C)	Defective battery	Remove battery from charger immediately. Replace battery and remove from further service.
Error message (amber and green light flashing)	Fault condition identified Defective battery	Remove battery from cradle and reinsert. Reseat cradle in docking station if used. Contact 3M Warranty and Repair. Replace battery and remove from further service.
Charger indicates complete charge, but battery pack on-board charge status gauge shows less than 5 bars.	Battery pack has reduced capacity due to age, damage, or use outside of recommendation in these <i>User Instructions</i> .	Remove battery pack from service and replace with new pack.
Battery pack does not fully charge within the stated charge times.	Charging location or battery excessively hot or cold.	Charge battery in room temperature location. Allow battery to cool to room temperature prior to charging.
TR-644N charger does not power up when plugged in.	Blown fuse in charger	Replace fuse 250V; 15A
Battery pack does not power motor blower.	Battery contact on battery pack or blower is damaged Contaminant on battery or blower contacts Battery is completely discharged (no charge) Battery internal safety circuit tripped during cleaning Battery internal safety circuit tripped during charging	Check that the battery contact is not bent or broken Ensure battery contacts are clean Fully charge the battery pack / contact 3M Warranty and Repair Replace battery. Do not exceed battery cleaning guidelines. Segregate battery and charger. Contact 3M Warrant and Repair.