



Technical Data Bulletin



#151, March 2002

PAPR Management and Planning for First Responders

First responders use Powered Air Purifying Respirators (PAPRs) differently than most industrial PAPR users. PAPR systems dedicated to first responder use are expected to stay in storage except for training and emergency use. The highest priority for first responders is that the system will be ready for use when the need arises. This bulletin outlines specific management practices that will help ensure that first responder PAPR systems are ready to perform as expected. This bulletin is not intended as a substitute for the User Instructions provided with each system. The User Instructions contain critical information about these respirators that must be understood before use.

Choosing the Appropriate Battery

First responder PAPR systems can be equipped with either a non-rechargeable lithium manganese dioxide battery (520-04-57) or a rechargeable nickel cadmium battery (520-01-15).

Lithium

The non-rechargeable lithium battery 520-04-57 is expected to provide 12 hours of service when new. During storage at room temperature, it will lose approximately 1% of its charge per year, as indicated by Figure 1. Therefore, a battery stored at 20° C (68° F) for 10 years will lose up to 10% of its charge. Because the lithium battery is non-rechargeable and has a long shelf-life, there is no need for periodic battery charging and testing. Note that the discharge rate increases significantly at higher storage temperature. The acceptable temperature range for storage of lithium batteries is -40° C (-40° F) to 70° C (158° F). Exceeding this temperature range may cause permanent damage to the battery.

Nickel Cadmium (NiCd)

Rechargeable NiCd batteries self-discharge at a higher rate than non-rechargeable lithium batteries, as indicated by Figure 2. For example, a battery stored at 25° C (77° F) for 30 days will lose up to 30% of its charge. Damaged cells may discharge faster. Therefore, the use of NiCd batteries for first responder applications requires strict adherence to a battery management plan that includes charging and testing at regular intervals. **Failure to follow a battery management plan can reduce the level of readiness for first responders.**

Figure 1. Lithium Battery Self-Discharge Rate vs. Storage Temp.

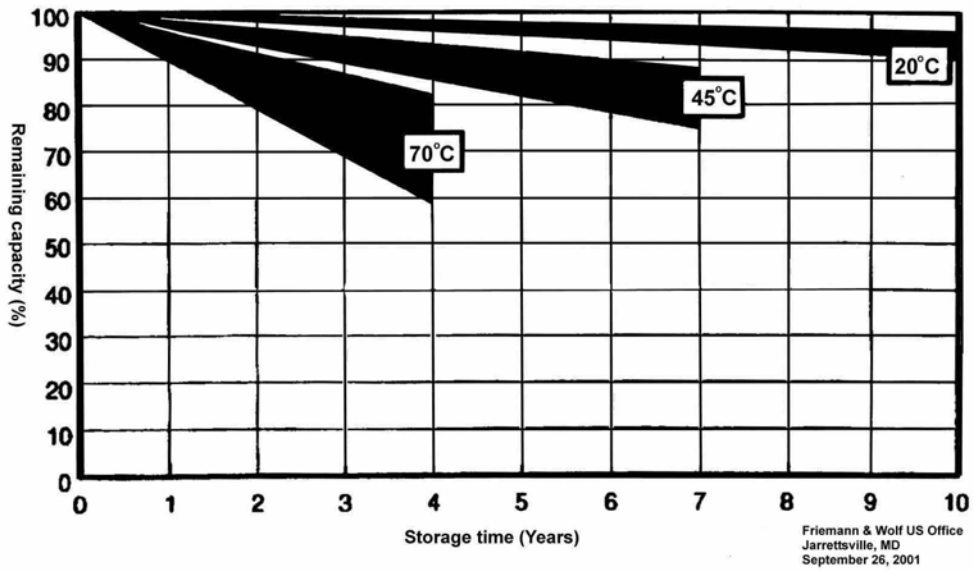
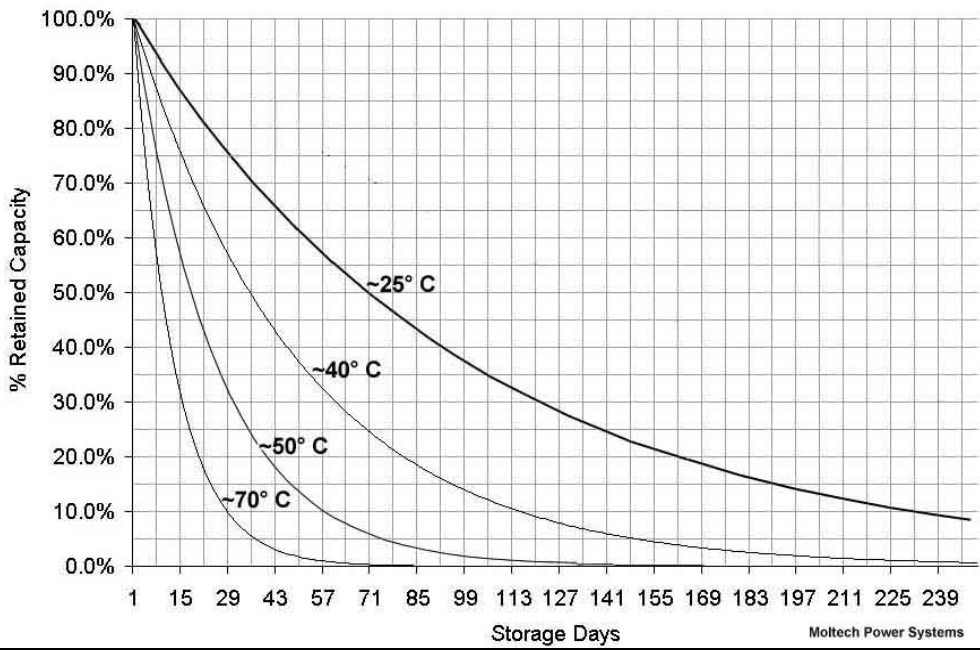


Figure 2. NiCd Battery Self-Discharge Rate vs. Storage Temp.



NiCd Battery Management for First Responders

Charging Schedule

At room temperature, NiCd batteries discharge approximately 1% per day. Note that the discharge rate increases significantly at higher storage temperature. Therefore, 3M recommends that NiCd batteries used for first responder applications receive an initial 16 hour charge before being placed into service. Batteries in storage should be charged for 8 hours every two weeks thereafter.

Storage of NiCd Batteries

Because long-term storage can lead to deactivation of the electrodes and reduced capacity, it is best to store batteries in areas where the temperature is kept between 10° C (50° F) and 30° C (86° F). Temporary fluctuations in storage temperature between -40° C (-40° F) and 60° C (140° F) will not damage NiCd batteries but capacity at these extremes may be reduced. Temperatures above 60° C (140° F) may cause permanent damage to the battery. Consider these limitations when storing batteries in vehicles.

When charging batteries for the first time after prolonged storage (longer than 1 year), deactivation of electrodes may lead to increased voltage and decreased capacity. The performance of such batteries may be restored after several normal cycles of charging and discharging.

Testing the Capacity of NiCd Batteries

Battery capacity determines the number of hours the battery can power the respirator at an acceptable airflow rate (run-time). Acceptable airflow is defined by NIOSH as 4 cubic feet per minute (CFM) for tight fitting facepieces such as the 6000-Series full facepiece, or 6 CFM for loose fitting headpieces such as the butyl rubber hood. Run-time depends not only on battery condition and charge status but also on the type of cartridge used, filter loading, ambient temperature and other variables. Battery capacity can be assessed by direct measurement of a particular system's run-time and/or by connecting the battery to a battery analyzer.

Checking PAPR System Run-Time

To determine the expected run-time for a PAPR system using a NiCd battery, conduct the following test:

1. Charge the battery for 12 hours or until the charger's green LED turns on indicating the battery is charged.
2. Connect the battery to a fully assembled PAPR system including cartridges, breathing tube and headpiece and turn the power switch on. Be sure that all three cartridges are uncapped and unobstructed during the test. Run the test in an area that is free of airborne contaminants such as vehicle exhaust fumes.
3. Check airflow as described in the User Instructions every hour. The PAPR unit should maintain adequate airflow for 8 hours. If not, there may be problems with the battery, cartridges or blower unit. Consult the User Instructions provided with the PAPR system for troubleshooting information.

4. If the test is successful, recharge battery, replace filter caps and return to storage.

Important: When charging batteries, plug the charging cord into the battery, set the battery down, wait a few seconds and then verify that the charger's green LED light is off - indicating a good connection to the battery. If the connection is poor, the LED will flicker or remain on. This may be mistaken as an indication that the battery is charged. Charge batteries at room temperature only. See the User Instructions for more information on charging.

NiCd Battery Analysis

Batteries can be connected to a battery analyzer/re-conditioner such as a Cadex C7400 with C700 Adapter (Cadex part numbers 07-740-0000 and 07-110-2960). Batteries should be tested starting 3 years from the date of manufacture and repeated every year thereafter. The month and year of manufacture is embossed into the case of each battery. In addition to determining capacity, these instruments may also be able to restore lost capacity due to prolonged storage. Battery analyzers can be purchased directly from Cadex, 22000 Fraserwood Way, Richmond, BC Canada V6W 1J6, Phone 604-231-7777.

Factory Analysis and Repair of NiCd Batteries

Batteries can be sent to 3M for diagnosis and repair, including cell replacement. Send batteries to: 3M PPR Repairs, 600 E. Meigs St., Valley, NE 68064 or call (800) 328-1667. In Canada, send to: 3M Service Center 1175, California Ave., Brockville, Ontario, K6V 5V8 or call (800) 267-4414.

General Tips on Extending the Life of NiCd Batteries

1. Voltage depression (AKA "memory") caused by repeated incomplete discharge cycles is not a significant issue in PAPR applications.
2. Running the batteries down completely (less than 1 volt output) or "deep discharging" will damage the battery cells and will not improve capacity.
3. Avoid charging batteries continuously for more than 1 week. Do not charge in clusters or in confined areas such as storage cabinets. These conditions increase cell temperature and reduce capacity.
4. Chargers must be kept in an open, ventilated area and must not be stacked on top of each other.

Event Duration

The following table lists several event duration scenarios that may be encountered and the equipment needed to respond to each.

Maximum Event Duration	Batteries per PAPR Unit	Chargers per PAPR unit	Typical Emergency Usage	Advantages	Disadvantages
8 hours	1 NiCd	1 (single output type)	Use for 8 hours then recharge for 8 to 12 hours before reuse.	<ul style="list-style-type: none"> When used frequently, more cost effective than lithium 	Dependence on NiCd requires strict adherence to maintenance schedule
12 hours	1 Lithium	0	Use for 12 hours, then replace with a new battery	<ul style="list-style-type: none"> No battery maintenance Highest level of reliability No charger required 	Non-rechargeable – single use only. Expensive for training use.
20 hours then one 8-hour shift per day thereafter	1 Lithium 1 NiCd	1 (single output type)	Use lithium while charging NiCd, switch after 12 hours	<ul style="list-style-type: none"> 12 hours assured run-time regardless of battery maintenance. Conduct training with NiCd 	Dependence on NiCd requires strict adherence to maintenance schedule
28 hours then two 8-hour shifts per day thereafter	1 Lithium 2 NiCd	1 (single output type)	Use lithium while charging NiCds, switch after 12 hours. Continue cycling NiCds.	<ul style="list-style-type: none"> 12 hours assured run-time regardless of battery maintenance. Conduct training with NiCd 	Dependence on NiCd requires strict adherence to maintenance schedule
Continuous	1 Lithium 3 NiCd	2 (single output type)	Use lithium while charging NiCds, switch after 12 hours. Continue cycling NiCds for continuous 8-hour shifts.	<ul style="list-style-type: none"> Maximum flexibility on event duration 12 hours assured run-time regardless of battery maintenance. Conduct training with NiCd 	Dependence on NiCd requires strict adherence to maintenance schedule

Cartridge Service Life

Cartridge service life is the period of time before breakthrough of a gas or vapor contaminant for a specific chemical cartridge under specified conditions. Service life must be determined based on worksite conditions such as contaminant concentration, relative humidity, temperature, work activities and other factors. In the absence of such data, 3M is unable to make recommendations regarding expected cartridge service life. Service life data for various military and industrial chemical agents are presented in 3M Technical Data Bulletins 154 (for FR-40 canisters) and 155 (for FR-57 cartridges).

For non-infectious contaminants requiring particulate filtration, change cartridges when sufficient airflow cannot be obtained (see User Instructions). If exposed to chemical or biological warfare agents, cartridges should be disposed of appropriately after use.

Cartridge Shelf Life

FR-Series cartridges and canisters have a 5-year maximum shelf life. The expiration date is stamped on the back face of every cartridge. Removal of the outer foil wrapping from FR-Series cartridges and canisters will not reduce shelf life, provided the front and rear caps are not removed. For storage, FR-Series cartridges and canisters should be removed from the PAPR unit and stored inside the bag/vest with both front and rear caps installed. Customers with FR PAPR systems sold with the cartridges attached to the PAPR unit should contact 3M Technical Service at the number below for further information about cartridge shelf life.

Cartridge Care

Never attempt to clean the filters by knocking or blowing out accumulated material. Such actions may rupture the filter media. Particles may then bypass the filter resulting in exposure to the user and possible damage to the motor.

Cleaning and Sanitizing

After each use, 3M PAPR systems should be appropriately cleaned and sanitized. Cleaning procedures must be site-specific and based on known or suspected contaminants. PAPR components (motor/blower, battery, breathing tube) and hoods should not be submersed in liquids. Tight fitting PAPR facepieces may be submersed for cleaning and sanitizing. PAPR components may be wiped down with a damp towel or sponge. Aqueous cleaning solutions containing up to 20% household/laundry bleach (e.g., 1 part bleach to 4 parts water) will not damage PAPR, breathing tube or headpiece materials. Cleaning solutions containing petroleum-based solvents or lanolin may damage plastic components. The RRPAS bag/vest 361-35-00R01 can be machine washed.

3M PAPR respirator systems are not designed for sterilization by irradiation, ethylene oxide or steam autoclaving and may be permanently damaged by these methods.

Inspection

OSHA's respiratory protection standard 29 CFR 1910.134 requires that an inspection and user performance check be conducted at least monthly and before and after each use when respirators are maintained for emergency use. To maintain the shelf life of cartridges stored with the PAPR system, airflow checks should be conducted with a set of substitute cartridges (same model) which are dedicated for testing only. Procedures for inspection and user performance (airflow) checks are included in the User Instructions provided with the PAPR system.

Contacting 3M

For more information about 3M respirator systems, visit the 3M Occupational Health and Environmental Safety Division web site at: www.3MRespirators.com or contact a Technical Service Representative at 1-800-243-4630 (United States) or 1-800-267-4414 (Canada).