Portable Radio Batteries…

Battery Care and Maintenance Training

Cumberland County

December 2nd, 2010

INVITATION

Harris Portable Radio Battery Care & Maintenance Training with Dinner Buffet

Date: December 2nd, 2010

Location: New Kingstown Fire Company
277 North Locust Point Road
New Kingstown, PA 17072

Time: 6:00 PM - 8:00 PM

6:00 PM - Buffet Dinner will be served
6:45 PM - 8:00 PM - Training

RSVP Deadline: **November 18th, 2010, Thursday**
to Lori Miller lori.miller@harris.com (preferred)
or call at 717.930.1028

In addition to the battery training, Harris will displaying it's **next generation radios and accessories** as well as the **new Li-ion batteries for the P7200 portable radios.**

There will be drawings for **door prizes and give-aways.**

Harris representatives from Product Management, Customer Service, Sales and Field Services will be on hand for the event.

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Agenda

- Introduction
- Battery Characteristics
- New Battery Packs
- Charging Battery Packs
- Charging Guidelines
- Battery Pack Usage
- Usage Guidelines
- Servicing Battery Packs
- Battery Pack Usage Patterns
- Record Keeping Example
- Storing Battery Packs
- Discarding Batteries
- Lessons Learned
- Additional Info

Introduction

- This presentation provides information on the care and use of rechargeable battery packs for Harris portable land mobile radios. Typically, Harris portable radios use high capacity Nickel-Cadmium (NiCd) batteries, extra high-capacity Nickel Metal Hydride (NiMH) batteries or Lithium Ion (Li-Ion) batteries. These battery packs are constructed from top quality materials to ensure high performance and a long life. Their best performance and useful life can be improved through proper care and maintenance, as explained in this document.

Battery Characteristics

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Table 1 – Comparison of NiCd, NiMH, and Li-Ion Batteries

Approaching EOL

Parameter	NiCd	NiMH	Li-Ion
Relative Capacity	1	1.4	3 Lithium
Charge/Discharge Cycle Life	500+ cycles	300+ cycles	300+ cycles
Memory Effect	Noticeable effect. Can be eliminated by periodic conditioning	Little effect	No memory effect
Conditioning	Recommended periodically to eliminate memory	Recommended when new and after long storage periods	Not necessary
Operating Temperature	-22 to +140°F (-30 to +60°C)	+14 to +122°F (-10 to +50°C)	+14 to +122°F (-10 to +50°C)
Charging Temperature	+32 to 113°F (0 to +45°C)	+32 to +113°F (0 to +45°C)	+32 to +104°F (0 to +40°C)
Storage Temperature (>90 days)	+32 to +86°F (0 to +30°C)	+32 to +86°F (0 to +30°C)	+32 to +86°F (0 to +30°C)
High-Temperature Susceptibility	Some permanent loss of capacity above 140°F (60°C)	Greater permanent loss of capacity above 140°F (60°C)	Greater permanent loss of capacity above 140°F (>60°C)
Self-Discharge	20% loss of charge/month at 77°F (25°C)	30% loss of charge/month at 77°F (25°C)	Self-discharge is much lower than Nickel chemistries. 3% loss of charge/month at 77°F (25°C).
Recycling	Required by law in the U.S.	Not Required, but recommended	Not Required

Battery Characteristics

NiCd batteries provide more recharge cycles, operate over a wider temperature range, and are lower priced.

NiCd cell manufacturers are exiting the business in favor of greener chemistries.

NiMH batteries have middle relative capacity, limited induced memory effect, and are environmentally friendly.

Lithium chemistries have the highest capacity and volumetric efficiency. They have no memory effect. They self-discharge slower.

Current Lithium designs are limited to -10 to -20 degrees C operation. They are not yet available as <Intrinsically Safe>

Excessive heat degrades all batteries

Batteries are shipped uncharged. Nickel based batteries should be conditioned prior to their first use or after storage for longer than three months or they will deliver only a fraction of their rated capacity.

Critical communications fleets should have a battery maintenance program so users are assured of having fully compliant batteries

New Battery Packs

- Harris stores and ships NiMH & NiCd battery packs in an uncharged state, so packs must be conditioned before use. Conditioning enables a battery to reach its full performance capability. This process involves fully charging and fully discharging the battery using either a battery analyzer/conditioner (recommended) or through normal use (not recommended).

New Battery Packs

- NiMH & NiCd conditioning is most easily accomplished by using a battery conditioner/analyzer/charger such as the Cadex® C7400 or the Intelligent Technologies iTECH® iQfive®. These units condition a battery pack by automatically charging and discharging (cycling) it 3 or more times. The units can also be used to test and charge battery packs. Refer to the manufacturer's technical data for instructions on using the conditioner/analyzer/charger and any required accessories.
- Li-Ion do not need conditioned

New Battery Packs

- NiMH & NiCd conditioning through normal use, that is charging the battery pack and using the radio until the battery pack is drained and then repeating the charge-discharge cycle, may require 25 to 50 full charge-discharge cycles to obtain optimal battery performance. This method, although optional for NiCd battery packs, is not recommended for NiMH battery packs. Failure to properly condition NiMH battery packs will result in initial short shift-life performance of the radio.

Charging Battery Packs

- Your Harris chargers are rapid chargers specifically designed for nickel-based battery packs. Rapid charging is a two-step process: rapid charge and trickle charge. During the rapid charge phase, the charger quickly replenishes about 90 to 92% of the battery's capacity. The charger then switches to the trickle charge mode to slowly fill the remaining capacity of the battery without causing excessive heat generation. This process enables the charger to recharge a NiCd battery pack in 1 to 2 hours and a NiMH battery pack in 1.5 to 2.5 hours.

Charging Battery Packs

- When a battery pack is first placed in the charger, the charger checks the condition of the battery pack (as indicated by the red LED flashing). During this period, the charger is checking the temperature and voltage of the battery. By monitoring these parameters, the charger ensures that the battery pack is ready for charging. Batteries that are too cold or too hot will not charge properly, therefore the charger will not enter the rapid charge mode until the battery temperature is within the acceptable limits, usually between 32 to 113℉ (0 to 45° C).

Charging Battery Packs

- Next, the charger measures the voltage of the battery pack. If the voltage is below the rechargeable level (about 6 Volts), a trickle charge is applied to the battery to raise its voltage to an acceptable level. This may take a while if the battery pack is severely drained. When the charger determines that the battery pack is ready, it begins the rapid charge. When the rapid charge phase is complete, about 90% of the capacity of the battery pack has been replenished, the charger switches to the trickle charge mode (green LED illuminates). The remaining 10% is restored using the trickle charge.

Charging Guidelines

- Observe the following guidelines when charging a battery pack:
  - Avoid high temperatures during charging, particularly when using vehicular chargers, where it is easy to exceed temperature limits due to the wide range of outdoor environments. Harris chargers prevent charging when temperatures exceed cell manufacturer's recommendations. This is indicated by a flashing LED (the actual LED that flashes depends on the charger model being used. Refer to the charger's user manual for specifics).
  - Battery packs normally become warm during charging. Harris chargers continually monitor battery temperature and discontinue charging if temperature limits are exceeded.

Charging Guidelines

- Only charge NiCd, NiMH, or Li-Ion battery packs using a rapid charger designed for this purpose. Harris desk and multi-chargers differentiate between NiCd, NiMH, or Li-Ion battery packs and automatically adjust charging parameters.
- **Do not leave batteries in the charger indefinitely.** For best results leave the battery in the charger for 2 to 6 hours after the ready light (green LED) comes on. Then, place the battery pack in service and fully discharge it (as indicated by the radio “Low Batt” warning) before recharging.
- If any faults are encountered while charging the battery pack, consult the manual for the charger to determine the cause and possible corrective action.

Battery Pack Usage

- The runtime available for NiCd, NiMH, or Li-Ion battery packs can be influenced by many factors, the most important of which are duty cycle and battery capacity. Most two-way radio battery shift life specifications assume a 5%-5%-90% duty cycle. This is further specified as transmitting for 3 seconds, receiving for 3 seconds, and sitting idle for 54 seconds. Adding extra receive time (actively receiving a signal) or transmit time changes the duty cycle and can reduce the runtime of the battery pack. Transmitting is especially taxing on the battery.

Battery Pack Usage

- Battery capacity is affected by battery chemistry, battery age, and charging. NiMH batteries have a larger capacity and will have a longer shift life than NiCd battery packs. However, a NiCd battery pack has a longer life cycle; that is, with proper charging and battery cycling, a NiCd battery pack will allow more charge/discharge cycles than a NiMH battery pack operating under the same conditions.

Usage Guidelines

- The following guidelines will increase the battery runtime or shift life:
  - Ensure that the battery pack is fully discharged (as indicated by the radio “Low Batt” warning) before recharging.
  - Condition battery packs in accordance with Table 1.
  - Do not leave batteries in a charger for more than a few days.
  - Avoid storing batteries in hot environments (above 86℉ (30℃)) – even for short periods.

Usage Guidelines

- Because of chemistry limitations, batteries removed from the charger immediately after the ready light (green LED) comes on will only perform to about 90% of capacity. To take advantage of its full potential, the battery must be allowed to trickle charge for 2 to 3 hours. Also, as a battery ages, its available capacity decreases. Older battery packs will not run as long as newer units. This is also true of battery packs that have been damaged by high temperature exposure.

Servicing Battery Packs

- To ensure that battery packs are readily available for radio operators (i.e., the user has a fully charged, long-running battery pack at the beginning of the work shift), Harris recommends setting up a battery service program. The type of service program depends on the number of battery packs available and the importance of maintaining full-shift life. Either of the following methods may be used to keep a fleet of batteries in good condition. However, Harris strongly recommends using the second method.

Servicing Battery Packs

– The first and simplest method is to ensure that all battery packs are fully discharged before starting the recharging cycle. Each day the battery pack should be discharged until the low battery warning occurs. The battery pack can then be placed in the charger and will be available for use after recharging (about 2 hours). This method ensures that the battery pack is kept in good running condition. Do not attempt to charge partially discharged battery packs; this will reduce the capacity of the battery pack.

Servicing Battery Packs

– The second method involves actively monitoring battery usage and periodically reconditioning the battery pack. The key to this method is maintaining accurate battery service records. Based on common usage patterns as described in Table 1, the service technician is able to monitor the performance of a battery pack and periodically recondition it. This practice alleviates some of the problems associated with reduced capacity resulting from partial discharge and enables the service technician to identify and dispose of any battery packs that are performing poorly. This method ensures that all battery packs available for use are healthy and capable.

Battery Pack Usage Patterns

- **Pattern, Description, Example, Need to Recondition**
  - A
    - Battery is taken out of the charger, used for 8 to 12 hours (low-battery warning), and then recharged.
    - A police officer that carries the radio all day.
    - Annually, to track capacity
  - B
    - Battery is charged, used for over 8 hours, recharged, and then immediately used for the next shift.
    - A manufacturing plant that has three shifts a day.
    - Semiannually

Battery Pack Usage Patterns

- **Pattern, Description, Example, Need to Recondition**
  - C*
    - Battery is fully charged, used for 4 hours or less, and returned to the charger.
    - An administrator. May also apply to a user that has two batteries.
    - Monthly
  - D*
    - Battery and radio reside in the desktop charger. Radio is turned ON waiting for a call.
    - Firefighter or EMS
    - Monthly

Battery Pack Usage Patterns

- **Pattern, Description, Example, Need to Recondition**
  - E
    - Battery and radio are used with a vehicular charger.
    - Vehicle patrol officer
    - Monthly
  - F
    - Batteries are stored for more than 2 weeks at room temperature.
    - After 1 month of storage
  - G
    - Batteries are stored for more than 2 weeks at elevated temperatures (Around 30℃)
    - After 2 weeks of storage

**These patterns are the most demanding on a battery pack and may require more frequent conditioning.*

Record Keeping Example

- The most comprehensive method for tracking a fleet of battery packs is to assign an identification number to each battery pack, periodically check the condition of the packs, and record the data for each battery using a card file system or an electronic database. This process enables the service technician to easily identify individual battery packs that do not meet performance expectations.

Record Keeping Example

- To begin, individually number and mark all battery packs in the fleet. Condition the battery pack using a conditioning charger and record the capacity of the battery. Next, based on the usage information in Table 1, determine when the battery pack will be due for reconditioning; this is the service due date. Mark the service due date on the battery pack using either an alphanumeric label or color-coded sticker. Finally, record the battery pack identification number, date conditioned, capacity, and service due date. The battery pack can now be placed in service.

Record Keeping Example

- When a battery pack reaches its service due date; remove the battery pack from service, recondition it, and record its capacity. If the capacity is unacceptable or the battery pack fails, properly dispose of the battery pack and replaced it with a new, conditioned battery pack. Battery packs that have an acceptable capacity can be relabeled and re-released into service. If a user complains about a battery pack loosing its capacity before its scheduled service due date, test and recondition the battery pack and either return it to service or replace it.

Example Battery Tracking Sheet

Battery Number: YearMMDD-XX

Battery Mfg	Model #	Battery Chemistry	MAh	Volts	Date Purchased	Date In Service	Battery Number	Battery Analysis #1 MAh/Volts		
								MAh	Volts	Date of Analysis
Harris	MAPT-PA9P	NiMH	2400	7.2 VDC	03/17/08	03/17/08	20080317-01	2459	7.2 VDC	03/08/08

Storing Battery Packs

- If a battery pack is expected to be idle for a month or more, it should be properly prepared. Battery packs should not be stored fully charged. Before storing the battery pack, discharge it to its end-of-life voltage (about 6 Volts). If the battery is not discharged prior to storage, its overall capacity may be reduced. Although all battery packs experience some capacity loss during storage, the shelf life for NiMH battery packs is about 3 years and for NiCd battery packs about 5 years. However, note that any capacity drop which occurs during storage is permanent and cannot be reversed.

Storage Guidelines

- While capacity loss cannot be totally prevented, the following guidelines will reduce the effect during storage:
  - Keep battery packs in a cool, dry storage area (32 to 86°F (0 to 30°C)). Refrigeration is recommended, but freezers should be avoided. When refrigerated, the battery pack should be placed in a plastic bag to protect against condensation.
  - Do not store charged battery packs. Ensure that the battery has been discharged.
  - Never leave a nickel-based battery sitting in a charger for more than a few days.
  - Recondition the battery pack before returning it to service.

Discarding Batteries

- All rechargeable batteries have a limited useful lifetime. After this, they must be properly disposed of. When a battery pack fails or is no longer able to retain an acceptable shift life, it should be replaced. For most users, the unacceptable level falls within 60 to 80% of the capacity provided by new batteries. The determination of the useful life of a battery should be based on the application.

Discarding Batteries

- NiCd batteries that fail to meet service requirements should be recycled. Disposal of NiCd batteries in the municipal waste system is prohibited by most state and municipality laws. Check with local solid waste officials for details concerning recycling options and proper disposal. In the United States, call toll free **1-800-8-BATTERY** for information and procedures for properly disposing of rechargeable batteries. Information regarding local NiCd drop-off locations may also be found on the Rechargeable Battery Recycling Corporation web site (http://www.rbrc.com).
- Currently there are no specific disposal requirements for NiMH batteries in the U.S. However, the Rechargeable Battery Recycling Corporation web site may be able to offer alternate disposal recommendations.

Conditioner Charger Analyzer

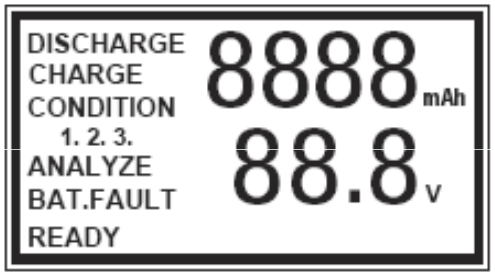
Overview of New Conditioner Charger Analyzer

- The Conditioner Charger Analyzer will work the same as your previous unit; it will look slightly different
- The unit can perform the following functions;
  - **Charge** – charges battery
  - **Condition** – three charge & discharge cycles with information readout
  - **Analyze** – one charge & discharge cycle with information readout
  - **Cycle Test** – continuous charge & discharge cycle
- Lessons Learned
  - Users may condition or analyze the battery each time when placing on unit to “charge”
    - This will result in a reduction of the life of the battery

New Conditioner Charger Analyzer

Displays for Charging Battery

Diagnostic Display

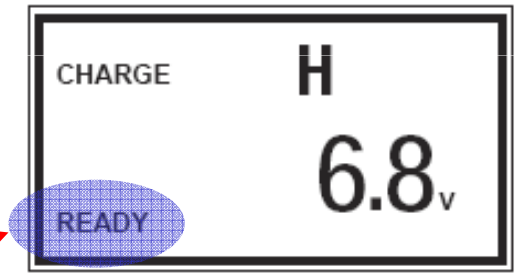


1 -Turning Unit On

CHARGE Mode; Beginning Charge

2 - Battery Beginning Charge

CHARGE Mode; Fully Charged Battery



Very Important

3 - Battery Charged

The Road Today & Tomorrow

Where are we - Power?

- 3 Current Battery Chemistries
  - NiCd (IS and non-IS)
  - NiMH (IS and non-IS)
  - Lithium-Ion (including Lithium-Ion Polymer) (non-IS only)

- 7 Desktop Chargers
  - P7100/5100 & P7200/5200 (2 versions of each)
    - Single Bay Multi-Chemistry (NiMH/NiCd or Li-Ion versions – sleeve req'd)
    - Multi-Bay Multi-Chemistry (NiMH/NiCd or Li-Ion versions – sleeve req'd)
  - P7300/P5300/5400
    - Single Bay Multi-Chemistry
    - Multi-Bay Multi-Chemistry
  - Unity - XG-100P
    - Single Bay Multi-Chemistry

- 3 Vehicle Chargers
  - VC4000 for P7100/5100 & P7200/5200
  - VC4000 for P7300/P5300/5400
  - Enhanced Vehicular Charger, Dual Contact - EOL

Where are we GOING - Power?

- 3 Current Battery Chemistries
  - NiCd (IS and non-IS)
    - NiCd for Legacy Platforms – already EOL
      - Latest versions discontinued as of 11/2010
      - Inability to procure cells to continue manufacturing
    - NiCd for Current Platforms – EOL will be September 2011
  - NiMH (IS and non-IS)
    - Will continue for 2011
  - Lithium-Ion (including Lithium-Ion Polymer) (non-IS only)
    - Working on enhancements to portfolio
      - IS versions
      - Li-Polymer for other existing radio platforms

User Requirements

- Battery shift life
  - Agree that expectations are growing from 8 to 12 to 16 hours with more demanding (realistic) duty cycles (10-10-80, 10-30-60)?
- Battery capacity life – how long before replacement?
  - Warranty expectations, charger requirements?
- Safety
  - Instrinsically Safe (does this vary with what Divs/Groups required?) Are there every day use specs?
- Ruggedness
  - Are there different acceptable levels? Utility versus Fire? Rugged versus cheap? Immersible?
- Operation in extreme temperatures
  - Minus 30 for cold climates; High temp for Fire?
- Chargers
  - Configurations, charge time, environmental, advanced capability, user interface, conditioning, multi-chemistry

Power – Shift to Li-Ion

- Benefits of a Li-ion (and Li-Ion Polymer) battery
  - Have a HIGHER energy density than most other types of rechargeables
    - Allows for smaller size, different shapes & sizes, and lighter weight
  - Lithium-ion batteries also have a LOWER self discharge rate than other types of rechargeable batteries
    - Will retain most of their charge even after months of storage
  - No Memory effect

- Disadvantages being addressed
  - Temperature range – not quite to the level of NiCd – working with vendors to expand operating temp range
  - IS versions – several projects underway to achieve IS certs
  - Long-term storage capacity loss – training users

Take-a-ways

- Understand differences between battery chemistries
- Educate your agency users
- Constant charging and heat are very detrimental to batteries
- Short cycling (recharging before needed) is will “hard” on the batteries
  - Recharge the battery when the radio indicates recharge is needed
- “Today” the best battery chemistry for public safety is Li-Ion

Take-a-ways

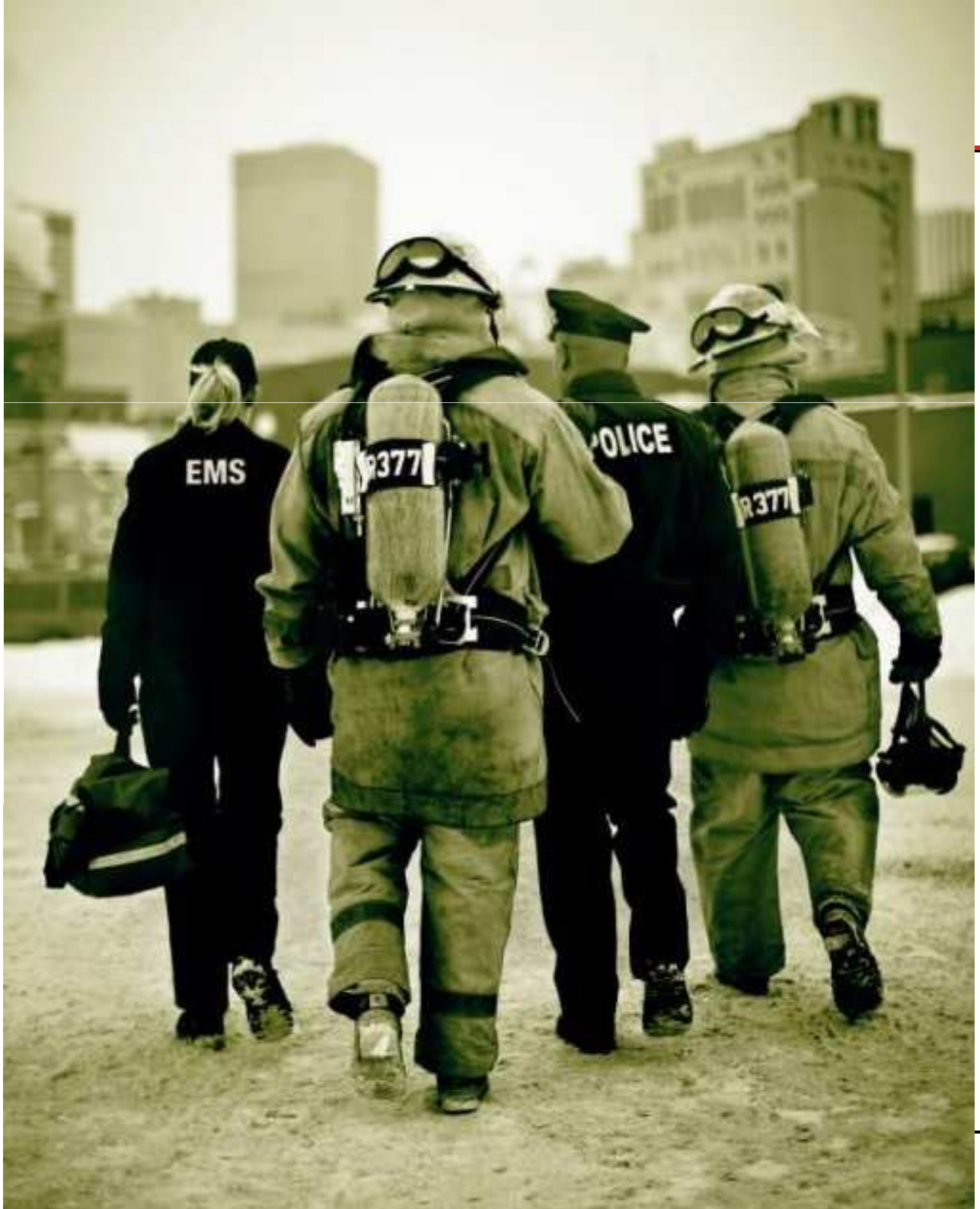
- Consider purchasing multi-bay charger for general use

Take-a-ways

- Maintain batteries quarterly
  - Based upon your agency use
    - Analyze or condition
  - Follow suggested testing schedule per battery whitepaper and document results on spreadsheet
  - Label each battery with in-service date and number
    - Suggest using a **silver** “Sharpie”
    - Actual labels can cause issues
- Example of “label”
- Document your findings of your maintenance

Additional Info

- Additional Questions contact Field Services
  - 717.930.1010
- Customer Service
  - Lori Miller
  - lori.miller@harris.com
  - 717.930.1028
- Sales
  - Roger A. Kohr
  - roger.kohr@harris.com
  - 717.930.1037



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Thank You