Batteries: The Achilles Heel in Wireless Communications

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Batteries: The Achilles Heel of Wireless Communications

For Joe Biese, Radio Technologist for Wisconsin Public Service Corp (WPS). Operation and Maintenance (O&M) considerations can be summed up in one word: Reliability. By basing all decisions on this measuring stick, he looks beyond equipment acquisition costs to the O&M requirements -- and the only real determinant of these costs.

“Reliability is paramount -- it is the absolute bottom line!!” he explains when discussing radio systems acquisition and management. “You can have brand new portable radios that costs $1000 or several thousand dollars. If the battery fails, the whole radio is inoperable. The weak link in the entire radio is the battery, and most portable failures are caused by the battery.

“In our power plant, the use of the radio is very critical to the operation of the plant -- a failed radio could actually cause a plant to be tripped off. A single trip could cost tens of thousands of dollars. The reliability of our generating systems and the entire plant management system is at stake. I support one of the tools that people use in maintaining the system -- and reliability allows them to do their job. It rules, more than cost, more than any other factor.”

Radio communications are used in the plant to prevent failures, but they are equally critical outside the plant when power connections and restorations are needed. The safety issues and economic implications of a power outage demand dependable equipment.

“We have a general maintenance philosophy -- we’re always looking for new strategies to increase reliability. The failure of Nickel Cadmium (NiCd) batteries was one of the remaining areas where I couldn’t get a satisfactory solution. I was willing to try to get a new charging technology to improve the failure rate,” he explains. “Using a better battery charger increases the reliability of the equipment.”

WPS is now using a new charging and conditioning system developed by Advanced Charger Technology, Inc. (***ACT***) incorporating patented enrev™ technology. The ***ACT***ivators charge NiCd 2-way radio batteries in about 30 minutes, eliminate memory effect, condition as they charge to assure a maximum capacity charge, and extend battery life three-to-six times – up to 2500 cycles for a single NiCd battery. A micro-processor-controlled algorithm reads the chemistry of the individual battery and responds with a precise, maximum capacity, self-terminating charge every time – without heating the battery.

“Heat is the enemy of a NiCd battery,” continues Biese. “***ACT*** technology not only addresses the temperature, it addresses the buildup of memory effect. The heat in the field is one factor in a rapid charger that’s always there. They charge the battery until it gets hot. The heat dries out the electrolyte. But after a couple of cycles on the ***ACT***ivator, it won’t get as warm. That impressed me. We’re charging batteries in well under an hour, and they’re barely above ambient, whereas with other technologies, I’ve had batteries so hot, you can’t touch it.”

When a battery is frequently charged before it is fully discharged, it begins to “remember” the level at which it was last charged, and it begins to think that that is the maximum level of capacity. Gradually, the usable time between charges is reduced, until a battery capable of lasting 12 hours can be reduced to only two or three hours. This is “memory effect,” which also reduces the life of the battery. Two-way radio NiCd batteries should last about 500-700 charge/discharge cycles, but that’s not the case in operations where no concern for battery chemistry is applied to daily usage. Memory effect is cumulative, so it builds up over time. Inconsistent battery care will usually result in a degree of memory effect which cannot be undone, even if methods are improved.

In spite of problems with reliability, Biese never considered switching battery types. “NiCd has at least twice the life expectancy of the other chemistries. When NiMh and Li Ion came along, the people who

make NiCds didn't roll over and play dead. They keep designing better, higher-capacity NiCds. Now we're getting almost twice the capacity from a short battery as we used to with a long battery. Now a radio can go almost twice as long on a smaller battery. The NiCd battery technology has greatly improved."

With proper battery maintenance practices, the dependability of NiCd batteries can be greatly improved. Battery life can be extended and memory effect, which shortens run time between charges, can be reduced. When properly maintained, NiCd batteries earn their title as the workhorse of batteries. Good battery maintenance techniques are not difficult, but they can be inconvenient (see sidebar). The majority of radio operations managers agree that instituting such a program amongst a fleet of radio users is the ideal, but it is not often effective. From technicians and line men to public safety officers and firefighters, the story is the same: No matter how important radios are to the job, managing the batteries seldom receives the attention it deserves. This results in increased battery failure, which translates to increased battery replacement budgets, which usually exceed initial estimates since frequency of replacement exceeds standard usage guidelines. Biese has been spending $5000-6000 per year for a fleet of ±350 portable radios.

For operations crews who spend their working hours on the road, portable radios are stored and charged almost exclusively in the vehicles. Unfortunately, maintaining a charging connection when a battery is already holding a full or partial charge deteriorates the battery and contributes to the memory effect problem -- shortening battery life. "Good or bad for the battery, it's important for the operation that they have an in-vehicle charger. Yes, they're cooking the battery, but that's the cost of doing business," says Biese.

Intelligent, in-vehicle chargers that will solve the problems of overcharging and memory effect will be available in ***ACT***'s next generation of ***ACT***ivators, premiering in 1999.

"In order to maintain reliability, I'm very generous in replacing batteries, and if we found a solution (to battery obsolecence), I might not do that as often," says Biese. "Reliability has been a goal of mine as long as I've been servicing mobile radios -- I've tried to determine what causes failure and to see how much can be anticipated and prevented before hand. It has absolutely paid off. We rarely have more than one or two pieces of equipment in the shop waiting for repair or parts, which reduces the number of spares required, the outage time and any inconvenience.

One area where Biese's department has effectively reduced costs is with in-vehicle radio mounts. Installations are not contracted out because Wisconsin Public Service standards are so high. Upgrades such as hermetically sealed fuse holders, carefully run cables and plywood-reinforced mounts have been adopted. A truck can be in service for up to 12 years, and a high-quality radio installation can prevent repeated trips to the service shop.

We take a proactive approach to preventative maintenance," he says. "We've refined radio reliability down to a science."

"Sometimes the cheaper thing is not the most cost-effective option. You can spend more in maintenance than you ever saved," echoes Mark Youngblood, Wireless Engineer for Duke Energy in North Carolina. "If you have to send someone out to repair it, then you haven't saved anything. People are a premium these days."

Youngblood establishes specs and recommends equipment for wireless communications for Duke Energy's operations, which include plants in the Carolinas, a pipeline from Texas to New York, and numerous international projects. The fleet numbers 5500 mobile radios, over 3000 portables, and 12,000 alpha-numeric pagers.

"We try to look beyond up-front costs" when considering equipment purchases, he explains. "I compare everything in the marketplace for that application, and I look at the maintenance and support from the

provider. My goal is to keep the meantime between failure down by choosing a good product and making sure it's properly installed and supported -- especially with mobile radios."

Youngblood's office out-sources in-vehicle radio installation. Duke Energy has established installation standards for each vehicle type, such as power point positioning and radio and antenna placement, and inspects all jobs for quality compliance. "The details may seem minor, but can become a big maintenance expense later," Youngblood says. "Standards save money."

"The biggest complaint we have in several plants is radio problems. A plant will call to say the portables aren't working very well. We'll send out a technician with a service manager to analyze the problems. They're right -- the portables don't work well. But it's not the radios -- it's the batteries. The voltage is dipping, but not enough to kill the whole radio -- just enough to make radios run poorly."

Youngblood and his engineers have researched the available solutions, including:

- **Comparing battery manufacturers:** most batteries are available from more than one manufacturer, which keeps pricing competitive. However, not all batteries are made the same, and results can vary with usage patterns;
- **The fit and seal of the battery to the radio:** Batteries for two-way radios are designed so each dimension fits snugly – down to 1/32nd of an inch. The slightest differentiation can affect the fit to the contact, and thus, the performance of the battery and the comfort of handling the radio;
- **Manufacturers' life cycle tests:** A life cycle test is a test process whereby batteries are repeatedly charged and discharged while measuring the capacity of the battery in each cycle. This is done to determine, in an accelerated manner, the useful life of a battery. The useful life is measured by the number of charge/discharge cycles accumulated at the time the battery's charge capacity has diminished to some percentage (typically 80%) of its original capacity when new; and
- **Battery analyzers:** this test instrument measures the capacity of a battery and are often used in a regimented battery maintenance program to periodically monitor the available capacity of a battery throughout its useful life.

After years of trial and error, Youngblood recommends an Original Equipment Manufacturer's batteries, which he purchases in large quantities at competitive prices.

Youngblood, like radio fleet managers across the country, remains frustrated with end-users who ignore battery management guidelines, which could extend cycle life and increase liability. With three shifts running, there is no time for batteries to trickle-charge for 14-16 hours, so some departments use the rapid chargers.

"People use the radios for one shift, and then put them into the rapid charger, where it will cook until the next shift. They go through batteries once every year to year-and-a-half," says Youngblood, whose own radio batteries last up to four years. He attributes his success with batteries to proper management -- discharging batteries fully before recharging them, and not overcharging them. Currently, he uses the ***ACT***ivator charger/conditioner from Advanced Charger Technology (***ACT***), which he has begun recommending that other utility departments purchase.

The ***ACT***ivator series of two-way radio battery chargers incorporate the company's patented ENREV technology, which triples battery life, charges a 1200 mAh NiCd battery in ~30 minutes, eliminates memory effect and provides a maximum capacity charge every time.

"I didn't believe the claims," says Youngblood. "But the ***ACT***ivators revived batteries the OEM chrager didn't even attempt to charge. I must say, I'm impressed -- I can't believe how well it works. You have to see it to believe it."

Like Biese, Youngblood insists it's not just the cost of batteries that the customers will save by investing in better charging technologies and battery maintenance. It's the savings in maintenance and dependability.

“About once every 1 to 2 years per battery, a person might be in a situation when a battery is inoperable,” says Biese. “If I can reduce the battery failure -- even by 1/2, I’ve improved the reliability of the radios and the reliability of the entire system. Using a better battery charger like the ACTivator increases the reliability of the equipment.”