HURRICANE RESTORATION:
TALES FROM THE FIELD

Michael P. O'Brien
Technical Services Manager
Nolan Power Group
Mandeville, LA 70471

INTRODUCTION

On August 29, 2005, Hurricane Katrina slammed into Louisiana, Mississippi, and Alabama causing damage on scale never before witnessed in the affected area. Three weeks later, Hurricane Rita slammed into southwest Louisiana and southeast Texas causing extensive damage. The vast majority of the damage caused by the hurricanes was evident to even the most casual observer; however, these powerful hurricanes also inflicted unseen damage. Stationary battery systems throughout the affected area were over-discharged, many to total exhaustion, by the extended power failures caused by these storms. Hundreds of stationary batteries that survived the winds and waves of these hurricanes were destroyed by over-discharge or the lack of timely recharge.

OVER-DISCHARGE

An over-discharge occurs when a battery is discharged beyond its designed end voltage, (expressed in volts per cell). The extended power failures caused by the hurricanes were generally between four and fourteen days in length. Most stationary battery systems, especially switchgear systems, have no automatic means of disconnecting the battery from the connected load when the battery discharges to its end voltage. (Note: There are many good reasons not to have automatic battery disconnect devices, but that discussion is beyond the scope of this paper.) During the hurricane-caused over-discharges, many stationary battery systems delivered far more energy then planned for in their design duty-cycle. The depth of these discharges coupled with the long time before recharging could be attempted, combined to cause severe degradation of the plates that in many cases was not readily visible. The ultimate cause of lead-acid battery failure, in properly maintained systems, is degradation of the positive plates. The deep extended over discharge essentially consumed the entire useful life of the affected batteries and the delayed recharge allowed accumulating lead sulfate deposits to weaken the internal support structure of the plates.

Some of the affected battery systems failed to recharge some recharged with a few obvious problems, while others appeared to recover will little to no ill effects. However, all the affected battery systems suffered severe to extensive plate degradation. The least damaged battery systems likely suffered a loss of several years of service life, while others have suffered much more severe loss, or consumption, of service life. The specifics of each individual battery system, (pre-storm condition, cell type and model, actual depth of discharge, and length of time before recharge); all combine to determine the ultimate fate of the battery system.

CAPACITY TESTING DIDN'T TELL THE WHOLE STORY

We began capacity testing recovered battery systems shortly after commercial power was restored. Most over-discharged batteries failed their capacity test outright while some passed with one or more failing cells and a very few seemed to suffer few ill effects. However, as time passed and recovery efforts progressed, a number of battery systems that had previously passed a capacity test experienced what appeared to be sudden failure. These failures appeared to result from plate degradation, (caused by the over discharge and delayed recharge), that had been getting progressively worse since recovery efforts began. Since capacity testing didn't tell the whole story for these hurricane damaged batteries we developed the following guidelines for determining replacement:

We recommended replacement for all hurricane affected battery systems that exhibit evidence of degradation as defined below:

a. Replace any battery, (complete battery replacement), that a capacity test shows one or more cells with less than 80% capacity, or any cell with an end of test voltage of 1.60VDC or less.

b. Replace any battery, (complete battery replacement), with one or more cells with a float voltage of 2.13 or less.

c. Replace any battery, (complete battery replacement), having one or more cells with electrolyte temperatures 5EF. above the ambient temperature, or if the average battery electrolyte temperature is 5EF. above ambient.

d. Replace any battery, (complete battery replacement), with excessive float charge current. A flooded lead-calcium battery will draw approximately 10 milliamps of current per 100 amp-hours of rated capacity at 77EF. at a float voltage of 2.25 volts per cell.

Note: Accurate low current measurements are not practical in a field environment. Therefore, on cells of 1000 amp-hour or less capacity, any repeatable float current measurement would be grounds for complete battery replacement.

LIFE IN THE FIELD

Working in a hurricane recovery area can present some unusual challenges. One of the biggest challenges is your own logistical support. Charging into a disaster area with personnel and equipment to repair things after a hurricane can be very rewarding, but if you aren't 100% self sufficient you're just adding to the problems. Hotel rooms and restaurants won't be available in the disaster area or anywhere close by. RV's work well, but remember that you're there to help, not cause more problems; be self sufficient.

Access to the Disaster Area
Contact your customers, local and state officials ahead of time to arrange access. Hurricanes don't drop out of the sky like tornados; we usually have several days advance notice. You will likely need access letters for each vehicle that needs to pass government check points. USDOT rules are usually relaxed or waived in large disasters, but each USDOT regulated driver will need a copy of any temporary waivers.

Vehicle Signs & Lights
Look official. All vehicles used in the disaster area, (including RV's), should have signs designating them as "Emergency Response" or "Disaster Recovery" vehicles. These signs should also include your company name and the signs should be semi-permanently or permanently affixed. Magnetic signs are not a good idea as they are easily stolen and applied to vehicles that shouldn't have access to the area. We've been down this road and the last thing you want is to have one of your company signs on a looter's vehicle.

In addition to the signs, all vehicles used in the disaster area should have amber strobe lights. These will help identify your vehicles as official or required vehicles. The more official your personnel and vehicles look, the more official they are and the less time your personnel will spend stuck in traffic or explaining to some official why they need to enter an area. I was never stopped at any checkpoint because the signs and lights on my truck made it obvious that I was part of the recovery team.

Security
Plan on providing your own security during the first few days. It may take local, state, and federal officials several days to a week or more to reestablish a law enforcement presence. Act accordingly and lock everything that isn't being directly observed by your personnel. Thieves and looters are a lot like cockroaches. They don't like the light, so lighting your work and living areas is a good idea, just lock down the light stands. All your personnel should have bright flashlights with them at all times. They'll likely need the flashlights for work in poorly lit buildings and a good flashlight is valuable tool for personal protection. Remember to bring a good supply of batteries.

Firearms: I've worked a number of hurricane recoveries and other disaster zones and the Katrina-Rita recovery was the only time I needed a firearm. In fact, the law enforcement personnel we supported strongly recommended our personnel be armed and several of our customers requested that we be armed. The presence of armed workers appeared to keep those with nefarious intent at bay.

Safety
Urgency and long work hours can cause workers to be less cautious. Remember, you're there to help, and you can't help if you or your equipment is damaged. One of our more urgent jobs after Katrina was installing a replacement UPS in the data center of the only functioning hospital on the Mississippi Gulf Coast. Today's hospitals rely on electronic medical records and don't function well without an operating data center. In our haste, we cut into a conduit that contained energized cables! Fortunately no one was injured, but we shut down a third of the data center. The conduit was misidentified by hospital personnel. We relied on them and didn't take the time to verify that we were working on the correct conduit. Our mistake. Constantly remind your personnel all circuits are energized until proven otherwise.

Sanitation: The residue, (goo), left by the storm surge flood waters can be a toxic soup of chemicals, bacteria, and mold. Ideally, these areas should be decontaminated before recovery efforts proceed, but that's not always possible. Remind your personnel to use the appropriate PPE, (Personal Protective Equipment), and to wash their hands at every opportunity. Simply wiping the sweat from your eyes with an unwashed hand can lead to serious eye infections. "Baby Wipes" and hand sanitizer work well when potable water is in short supply. Disease can spread rapidly in this environment and hand washing is one of the best methods all personnel can employ to curb the spread of dangerous bacteria. All cuts and scrapes, no matter how minor, need to be disinfected and bandaged as soon as possible.

Driving: Driving in a hurricane damaged area will be a challenge. Debris of every type and description will be on the roads, and some of the roads may not even exist anymore. Trees that stood through the storm may fall across the road with no warning. Bridges in the storm surge area may be missing or damaged. It's a wise idea not to cross any bridges in the storm surge area until they've been inspected. The state DOT will usually make short work of inspecting Interstate and State Highway bridges; however, it may take several weeks before bridges on county or Parish roads are inspected. Traffic control devices will be missing or not functioning. Treat every intersection as a four-way stop. Be patient and prepared to deal with irate drivers. Many people will be trying to get back to their property and traffic will be anything but pleasant. Also, the stress of a major disaster pushes some people to the breaking point and you may see or become a victim of their behavior. We had a woman start screaming at and beating on one of our trucks for no apparent reason as the truck was stuck in traffic. Why? We have no idea, but she eventually calmed down and was led away by her husband and son. Some people just snap under the stress and you're likely to encounter this behavior when stuck in traffic.

Navigation
All or most of the landmarks and street signs will be gone. Normal routes may be blocked by debris or completely gone and alternate routes must be found. Massive destruction and damage can disorient even longtime residents. These are just a few reasons that make a good GPS with a real time navigation map invaluable for navigating in a major disaster area. It would have been nearly impossible to locate and get to the many cell sites along the Mississippi Gulf Coast without a good GPS and site coordinates.

Be Prepared

Be prepared. It's the Boy Scout motto and it should be the motto of anyone in hurricane prone areas. Stationary battery users can prepare by maintaining their batteries in accordance with the applicable IEEE/ANSI standards. When possible, stationary batteries should be isolated from the connected loads when securing a facility before an approaching hurricane. Make arrangements for emergency power for charging of battery systems that must remain in service. Restore power to charging systems as soon as possible after a hurricane. Remember that over-discharging is what kills most stationary batteries that survive the battering wind and waves of a hurricane.