CG2 Emergency Battery Replacement Postmortem
8/12/2013

1. Introduction to Report

This report is intended to assess the success of the work performed to mitigate failing batteries in the NETS CG2-MR Symmetra UPS on 8/12/13, identify current and new best practices, problem areas, and provide detailed suggestions for improvement on future efforts.

2. Report Goals

This Post Mortem Report aims to:

- Summarize the event.
- Review the deliverables and success of the effort
- Identify highlights and accomplishments for future efforts.
- Identify problem areas and how problems were mitigated/dealt with.
- Outline key lessons learned/key takeaways from the project to apply to future projects.

3. Event Summary

UPS Failure in CG2-MR

At 10:41am Aug 12, the UPS in CG2-MR auto-initiated a regular selftest. The unit then reported that it had failed the selftest stating, “a battery fault existed.” This was a recurring (third) similar battery failure on this unit resulting from two separate building events severely heating the batteries and near fully depleting their charge. Assessment after the second failed battery prompted NETS to order a full replacement set of 11 batteries for this critical UPS.

Having received and staged the new batteries in CG2 for installation, when the third battery fault occurred, the NETS-Infrastructure UPS team decided to schedule an Unplanned Service – No Outage Expected, and replace all the unit batteries, including the failed pack, thus clearing the alarm and restoring the unit to standard hold time and confidence. NI dispatched a crew to CG2 to perform the replacement. NETS has historically been successful with battery replacements, for this and similar UPS units, by putting the UPS into manual bypass which sustains power to service hardware.

At 11:46, while replacing the batteries, the UPS announced an input voltage or frequency problem occurred while in bypass and turned the UPS off. Generally, the UPS will still stay in bypass even when off, but since it was an input voltage problem, all outputs were turned off, bringing down some single [power] fed network and security equipment in the CG2 Machine Room.
The Notifier was updated to announce the incident, and identify a new POC (Fabian Guerrero) dedicating the onsite team to initiate problem identification and resolution.

The UPS then began reporting a number of problems that could be reset, but would reoccur including both Intelligent Modules faulting, all three Control Modules faulting, intermittent battery problems, and incorrect voltages on the PDU’s feeding the equipment racks. These problems would come and go as NETS tried resetting and removing the different modules. At times the UPS would act normally for a short period of time, and then fail again.

The one fault that was consistently reported was that a site wiring fault existed. NETS contacted Facilities and Tom Winterhalder was dispatched to assist. He confirmed that the power was good from the entrance of the building to the UPS.

Single fed equipment was at this point moved to utility (wall) power to restore service.

NETS contacted APC, the UPS manufacturer’s, support and was connected to a technician. NETS and APC conducted a number of tests on the unit with inconsistent results, except that the error codes were reporting an open neutral.

Facilities re-tested the input feed again eliminating the service feed as the fault. Facilities electrician and NETS decided to systematically disassemble the UPS working toward the inner working’s of the unit, and were eventually able to ascertain that the neutral was open inside the unit.

There is a removable module that an electrician uses when installing these units. This module has 3 sleeves that connect to pins inside the unit to connect the power, neutral and ground from the input power. The three sleeves have clips that snap into an assembly that holds them stable when placed back into the unit, enabling the pins inside the unit to make firm contact into the sleeves.

Under normal operation, It is not possible to see what happens when this assembly is placed back into the unit. In this instance, the neutral was not staying locked into position but still making physical connection - the pin did not slide into the sleeve, but pushed the sleeve back; leaving a connection that was not locked into place. The connection, however, was made and everything worked correctly until the team started to replace the batteries, thusly shaking the unit, and disrupting the neutral connection.

Upon the identification of this problem, Facilities electrician replaced the neutral back into the correct position and the UPS went back to normal operation. The condition reoccurred during reassembly of the unit, and again the team stopped, again removed the offending assembly, and readjusted the angle which the power feeds are led into the unit and were able to get the neutral to lock into position.

At 3:04PM this unit began normal operation, acknowledged the new battery packs, cleared all alarms and has continued to run fault free.
3. Project Performance

Key Accomplishments
- Available and knowledgably staff (both NETS and Facilities)
- Replacement batteries were on-hand and on-site
- All batteries are replaced and under warrantee
- Unknown fault has been mitigated
- Receipt of APC (manufactures) trouble shooting sequence and framework

Key Problem Areas
- UPS was single (power) point-of-failure for some single fed equipment
- An unidentified hardware condition existed within the main UPS

Risk Management

Risks that have been (are being) mitigated:
- Ordered: APC p/n AP7752 Rack-mount Transfer Switch for single power fed devices

Outstanding risks that need to be managed:
- Survey like environments for similar single[power] fed equipment and evaluate potential threat

4. Key Lessons Learned

Lessons Learned
- APC makes very robust well-built unit.
- With the awareness of this potential condition future installations will be specifically verified for appropriately locked power feeds prior to being put into production
- This event helped to bring attention to the vulnerability of single fed hardware in the network.
- When the UPS lost its neutral, and turned off all outputs, normally the UPS would have stayed in bypass, but without the neutral, all outputs went down.
Post Effort Tasks/Future Considerations

- Survey like environments for similar condition
- Supplemental order of transfer switches for critical single [power] fed devices
- Proactive inspection of FL2-3095 Symmetra for similar condition
- Update UPS service checklist
- Re-evaluate non-emergency UPS service during regular hours
- Consider building a UPS service kit: Extension cord, meter, power strips, etc
- Establish greater depth of knowledge in UPS and power within NI to maximize ability to mitigate UPS emergencies.