Summary

On August 21, 22, and 23, 2012 we performed load bank testing on the two Liebert 225 KVA (180KW) UPS units that provide UPS power to IT hosts in the North Hall Data Center. Our goals were:

1. take the UPS systems to their maximum design load of 45% loading on each unit (80KW each, 160KW total) to ascertain that the as-built HVAC could control the temperature in the UPS room.

2. to determine how much run time we had in the event of complete HVAC failure, as would occur in a generator non-start during a Utility Power outage, at the 45% UPS load level.

3. determine the signalling the UPS’s embedded management, MetaSys Building Management System (BMS) and our Mini-Goose temperature probes would provide as event thresholds were reached.

Our testing determined that:

1. the UPS room HVAC can maintain all temperature probe locations at or below the 78 degree Fahrenheit threshold desired, except UPS2 Battery Cabinet 1 which rose to 81F in normal testing. This area is a known hot spot. Physical Facilities has some thoughts on how to address airflow to mitigate the hot spot.

2. in the event of complete HVAC failure we have no more than 15 minutes before the UPS systems must be shutdown to avoid 85F or higher temperatures in the UPS battery cabinets. Battery temperatures above 78F are detrimental to battery lifespan. After 27 minutes without HVAC battery cabinet temperatures reach or approach 90F as does room ambient temperature.

In practical terms this means that at 10 minutes of HVAC failure we need to either transfer UPS IT loads to UPS internal bypass, if utility power is available, or signal the IT loads that UPS power loss is imminent so that they may shutdown before the the UPS systems are shutdown.

We are investigating how UPS shutdown may be accomplished with automation, as well as signalling IT loads in the Data Center that this condition has occurred.

3. the MetaSys BMS provides both UPS state transitions and room temperature state that are useful for event detection. The UPS embedded management can be polled via SNMP for state, but unfortunately does not send useful proactive “traps” on critical events. The Mini-Goose temperature system performed well, tracking the temperature at the (6) monitored battery cabinets and the room ambient at (1) minute intervals. We are determining how to best use this signalling to control UPS room automation, and IT equipment load shedding in the NHDC Data Center itself.
**Selected Testing Highlights and Data Points**

Battery Cabinet (BattCab) 1 is adjacent to the UPS module in both UPS systems. The UPS module is the key heat producing component in the UPS system, so Battery Cabinet 1 tends to be the hottest location(s) in the room.

1) Present UPS load is 27KW (UPS1 15KW, UPS2 12KW) which results in typical UPS room temperatures of 67F ambient, 72F in UPS1 BattCab1, 77F in UPS2 BattCab 1.

2) At 45% UPS loading, 160KW, temperatures were 70F ambient, 74F in UPS1 BattCab1, 80F in UPS2 BattCab1.

3) On UPS1 we calculate the runtime on battery at 45% load to be in the range of 35 to 45 minutes, well beyond the time we can run without functional HVAC.

4) The table below displays the observed rise in temperature with simulated HVAC failure. Outside air temperature was 66F on a cloudy morning. The UPS room experiences thermal solar heat gain so these are best case numbers. The test was aborted when any temperature sensor hit 90F.

<table>
<thead>
<tr>
<th>Location</th>
<th>Start</th>
<th>+5M</th>
<th>+10M</th>
<th>+15M</th>
<th>+20M</th>
<th>+27M Abort</th>
<th>TTL Rise</th>
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<tbody>
<tr>
<td>Room</td>
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<td>78.38</td>
<td>83.25</td>
<td>83.44</td>
<td>84.81</td>
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<td>80.13</td>
<td>82.38</td>
<td>83.97</td>
<td>9.22</td>
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</table>

**MetaSys Building Management System Signalling Summary**

The MetaSys system has the ability to send alerts via email in response to events detected. These emails in turn can be forwarded to SMS for humans, or perhaps received by programs for action decisions. The specific alerts observed from MetaSys that are likely to be useful for us in this context follow:

- Alarm! Bldg 535 North Hall Data Center AHU-1 UPS Room Zone Temperature Alarm!
- Alarm! Bldg 535 North Hall Data Center AHU-2 UPS Room Zone Temperature Alarm!
- Alarm! Bldg 535 North Hall Data Center UPS-1 Load Alarm!
- Alarm! Bldg 535 North Hall Data Center UPS-1 Load On Bypass Alarm!
- Alarm! Bldg 535 North Hall Data Center UPS-1 Battery Discharging Alarm!
UPS Trap Signalling Technical Summary

The input breaker on UPS1 was flipped off/open while it was in maintenance bypass to see what kind of signals we could get when it cut over to battery power. The SNMP traps sent were not terribly useful. They were too specific. The specific traps we saw were "utility fail", "input bad", and "input disconnect open". None of these are all-inclusive enough to be used as a general "on battery" signal, which is a trap defined in the MIB, but we never received it.

As far as SNMP variables we could poll for determining whether we are running on battery, there was really only one reliable one: SecondsOnBattery. The value here is not truly the number of seconds the UPS has been running on battery, but rather, the number of seconds since the OnBattery Alarm came on. That can take up to 50 seconds to occur, which is a design decision by Liebert to avoid false alarms for brief power flickers. The reason this value is useful is because if it is greater than 0, it means we are running on battery and are likely to stay that way. BatteryVoltage is a value we can poll and trust to be accurate, but it’s probably not going to change at a rate fast enough for us to make a determination based on it. There is a minimum voltage the batteries have to be before the UPS shuts itself down. With our projected run time on battery, we are not likely to hit the low voltage UPS shutdown threshold before the UPS room gets too hot.

Logging Graphs

Start of load bank testing, initially with 75KW per UPS. Increased to 80KW per UPS prior to HVAC failure simulation.
Simulated HVAC failure.

Testing Completed.