Summary of Events and Remediation Items observed at the UCSB North Hall Data Center during the scheduled Jan 3, 2015 0600-1200 Edison Campus Wide Power Outage
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Summary

Customer equipment hosted at NHDC did not experience interruptions, or adverse conditions, in our operational services as a consequence of the Jan 3, 2015 power outage. This is in contrast to the prior outage on Nov 29, 2014 when HVAC automation failed, resulting in our failsafe power shutdown at 90 degrees Fahrenheit impacting 16 of the 44 racks hosted at NHDC.

We committed to customers in our status update on the Nov 29, 2014 event that "We will do better." I am happy to report that we did so. Nonetheless, we did so with manual interventions and workarounds that need to be addressed.

This report is brief overview of the events on Jan 3, 2015 at NHDC, remedial steps to be taken, observations of temperature loads, power loads, and our recently deployed temperature alerting.

Major Events in Chronological Order

0551 – Utility Power Down, Generator Starts, UPS receives generator power
  • UPS2 transfers load to internal bypass and shuts down, Battery Cabinet Circuit Breakers and UPS input breakers opened. Same behavior as Nov 29 outage. Logs recorded. UPS2 successfully brought online by NHDC staff who were on standby for this event.

0633 – MetaSys Network Automation Engine (NAE) provided portable generator power just as it's reserve UPS dies resulting in NAE restart.
  • Upon restart NAE commanded max cooling, dropping IAT at R09R01 to 60F, gradually returned to normal setpoints.
  • CRAH-1 reporting alarm condition, appears to be humidity.

0740 – CRAH-2 still cooling to 62.5F, previously triggered LOW-TEMP-ALERTS for several racks seeing < 60F Intake Air Temperature.

0830 – Travis @ FM onsite again in response to our report of the CRAH-1 error. Turned out to be a setting to alarm on low humidity that was reset to active when the CRAH-1 logic board was replaced. Alarm reset to log but not alarm as MetaSys reports humidity, which drives the automation.

1011 – Kaz @FM onsite for some time, discusses operation, NHDC still being cooled by campus CHW loop "reserve." We probably have another hour before we hit the Critical Cooling temp setpoint. Kaz lowers setpoint to 48F so we transition to Critical Cooling while we still have some campus loop capacity. NHDC transitions to CC, Chiller 1 starts as expected.

1100 – KGG email to NHDC Customers - "all good, temp and power holding as expected"

1258 – Utility Power Restored.
1304 – Automatic Transfer Switch (ATS) transfers Utility Power to UPS, Generator enters cool down mode.

1310 – Per MetaSys – Generator Normal, i.e. powering down, NHDC still in Critical Cooling (CC) as campus Chilled Water (CHW) Loop not yet able to provide cooling.

1330 – KGG email to NHDC Customers – "all good, power restored, on CC until campus CHW avail"

1547 – Per MetaSys – Campus CHW Available, Over temp alarms clear, NHDC remains in CC pending operator disable of CC state – this is as planned so staff can be onsite to ensure no problems.

1552 – FM Staff reset CC state, NHDC returns to normal operations.

1800 – KGG email to NHDC Customers – "return to normal operation"

Significant Observations

- UPS1 Normal Load 23KW/13%, Utility Power Fail Load 34KW/18%, increase of 11KW/5%
- UPS2 Normal Load 26KW/14%, Utility Power Fail Load 35KW/21%, increase of 8KW/7%
- UPS reporting % per KW not uniform likely due to different generations of UPS model and relative age of battery. UPS1 battery is less than 1 year old, UPS2 3+ years old. Average battery life expectancy 5 years.
- UPS loads did not double on power failure as equipment in rows 1-4 do not have utility power options (yet) nor do all devices split power loads equally across available power supplies
- Emergency Lighting insufficient – batteries lasted < 4 hours, lack of coverage in all areas.

Remediations Necessary

UPS and UPS Room Related

- UPS 2 Repair, including load bank testing under greater loading
- AHU1 – controller not on e-power
- MetaSys Panel not on e-power
- *goose environmental monitoring not on e-power

HVAC Related

- NAE – UPS 30m runtime, need great capacity, e-power and/or additional NAE at NHDC
- NAE - When NAE reenergizes, he commands max cooling before checking current status. On Jan 3, he set CRAH-2 to providing 60F IAT, on Nov 29 this resulted in 90F air being circulated and tripping PDU thermal failsafe. He needs to check status before engaging.
- CHW pump, need to reset status MetaSys status to AVAIL when the failure it solely due to utility power failure, otherwise unit is not available as backup even though it is functional. This should be the case for every redundant component.
- CHW - attach wrenches to CRAH supply valves to facilitate extreme "manual override"
- CHW - correct off / on labeling on CRAH supply valves
- OVERRIDE - Provide NHDC Staff Access to and training on MetaSys controls at NHDC to allow staff to restore / reset service.
Lighting and Other Areas

- ALARM – Bay Alarm not on e-power
- Lighting - 1201B RMV Office has no emergency or e-power lighting
- Lighting - 1242 Switch Room has no emergency or e-power lighting
- Lighting - 1240 UPS Room has no emergency or e-power lighting
- Lighting - emergency, battery backed lighting fails in 4 hours
- Lighting - removing lighting from Power Center A to e-power backed up panels at NHDC will address most or all of the lighting concerns.
Uninterruptible Power Supply (UPS) Loads

NHDC has two Liebert 600 Series 225KVA/180KW UPS units that are provided backup power by an onsite 400KW diesel generator. The generator also provides emergency power to NHDC’s HVAC and other systems in the event of a utility power outage. NHDC’s design calls for each UPS to be loaded to no more than 45% loading to facilitate increases in load due to utility power failure. The Nov 29, 2014 and Jan 2, 2015 outages have provided our only opportunity since NHDC opened in Spring 2012 to observe UPS operation in a utility power failure scenario.

<table>
<thead>
<tr>
<th>NHDC Liebert UPS Load Values Observed during Jan-3-2015 SCE Power Outage</th>
<th>UPS1</th>
<th>UPS2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal</td>
<td>Outage</td>
</tr>
<tr>
<td>Input Voltage L1</td>
<td>485</td>
<td>480</td>
</tr>
<tr>
<td>Input Voltage L2</td>
<td>482</td>
<td>478</td>
</tr>
<tr>
<td>Input Voltage L3</td>
<td>483</td>
<td>478</td>
</tr>
<tr>
<td>Input Current L1</td>
<td>54</td>
<td>64</td>
</tr>
<tr>
<td>Input Current L2</td>
<td>51</td>
<td>64</td>
</tr>
<tr>
<td>Input Current L3</td>
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<td>62</td>
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<tr>
<td>Output Frequency</td>
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</tr>
<tr>
<td>Output Current L1</td>
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<td>44</td>
</tr>
<tr>
<td>Output Current L2</td>
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<td>37</td>
</tr>
<tr>
<td>Output Current L3</td>
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<td>45</td>
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<tr>
<td>Output Voltage L1</td>
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<td>482</td>
</tr>
<tr>
<td>Output Voltage L2</td>
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<td>484</td>
</tr>
<tr>
<td>Output Voltage L3</td>
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<td>489</td>
</tr>
<tr>
<td>Load (Apparent Power)</td>
<td>24</td>
<td>35</td>
</tr>
<tr>
<td>Load (Real Power)</td>
<td>23</td>
<td>34</td>
</tr>
<tr>
<td>Load / Capacity</td>
<td>13</td>
<td>18</td>
</tr>
</tbody>
</table>

Notes:

1) UPS reporting % per KW not uniform may be due to different generations of UPS model and relative age of battery. UPS1 battery is less than 1 year old, UPS2 is 3+ years old. Average battery life expectancy 5 years.

2) UPS loads did not double on power failure as equipment in rows 1-4 do not have utility power options (yet) nor do all devices split power loads equally across available power supplies.

3) UPS units are Liebert 600T and 610T 225KVA / 180KW units designed to be loaded to 45% each in present deployment, and powered at that level (+/- 160KW) while on generator power.
Increase in Rack Power Loads on UPS

NHDC PDU (power distribution units) track and report the power loads of equipment in the rack. With utility power out the loads of the equipment are aggregated onto the UPS PDU. This represents the total power draw of the equipment in the rack, which is distributed across UPS and utility power in normal operations. The power load graphs of selected "higher density" racks are presented below for the period Jan 2 – Jan 8, 2015. The outage window is bracketed in red.

Row 6, Rack 7 - PDU Load

Row 9, Rack 2 - PDU Load

Row 9, Rack 11 - PDU Load
Rack Intake Air Temperature

Each rack at NHDC has temperature sensing to measure intake air temperature (IAT). IAT is the cold isle air temperature seen by the customer equipment in the rack. The following graphs are of typical hot or cold spots (rack 3) and the NHDC network aggregation point (rack 8) in each row. NHDC was able to maintain IAT at levels within our range of temperatures expected in normal operations. This held true both while on campus chilled water loop reserve and on transition to Critical Cooling and NHDC’s pad mounted electrical chillers. The Jan 3 outage Window bracketed in red.

Row 6, Rack 3 - Intake Air Temperature - Jan 2 to Jan 8, 2015

Row 6, Rack 8 - Intake Air Temperature - Jan 2 to Jan 8, 2015

Row 9, Rack 3 - Intake Air Temperature - Jan 2 to Jan 8, 2015
Row 9, Rack 8 - Intake Air Temperature - Jan 2 to Jan 8, 2015

Row 10, Rack 3 - Intake Air Temperature - Jan 2 to Jan 8, 2015

Row 10, Rack 8 - Intake Air Temperature - Jan 2 to Jan 8, 2015
Intake Air Temperature Alerts issued during the Jan 3, 2015 power outage

The alerts issued were limited to low temp alerts 1-3.5 degrees below the 60F threshold we alert at. These occurred when the MetaSys NAE was transitioned to emergency power at 0630. The NAE momentarily lost power, restarted, commanded cooling and overcooled for a short time at CRAH-2 between 0640 and 0810 hours before stabilizing. These temperatures are safe for IT equipment, were not a risk for condensation at the time, but are energy wasteful given modern equipment operating temperature ranges. There were no high temperature alerts.

This information is from NHDC status reporting at:

http://nhdcstatus.ets.ucsb.edu/

pdutemps.20150103-0810.txt:R09R02U0P1:59.0:TEMP-LOW-ALERT
pdutemps.20150103-0755.txt:R09R02U0P1:59.0:TEMP-LOW-ALERT
pdutemps.20150103-0720.txt:R09R02U0P1:59.0:TEMP-LOW-ALERT
pdutemps.20150103-0715.txt:R09R02U0P1:59.0:TEMP-LOW-ALERT
pdutemps.20150103-0705.txt:R09R02U0P1:58.0:TEMP-LOW-ALERT
pdutemps.20150103-0700.txt:R09R07U0P1:58.0:TEMP-LOW-ALERT
pdutemps.20150103-0700.txt:R09R06U0P1:58.0:TEMP-LOW-ALERT
pdutemps.20150103-0700.txt:R09R03U0P1:59.0:TEMP-LOW-ALERT
pdutemps.20150103-0700.txt:R09R02U0P1:58.0:TEMP-LOW-ALERT
pdutemps.20150103-0655.txt:R09R02U0P1:56.5:TEMP-LOW-ALERT
pdutemps.20150103-0655.txt:R09R07U0P1:59.0:TEMP-LOW-ALERT
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pdutemps.20150103-0640.txt:R09R03U0P1:59.0:TEMP-LOW-ALERT
pdutemps.20150103-0640.txt:R09R02U0P1:58.0:TEMP-LOW-ALERT