SVLG Panel on Data Center Cooling
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Lower humidity limit

- Electrostatic discharge (ESD)
  - IT equipment is tested for ESD resilience
  - The problem is handling the components
  - Recommended mitigation procedures
    - Personnel grounding
    - Cable grounding prior to plug in
  - Recommended equipment
    - Grounding wrist straps on racks
    - Grounded plate for cables
    - Grounded flooring
    - Servers rated for ESD resistance
  - Industry practices
    - Telecom industry has no lower limit
    - The Electrostatic Discharge Association has removed humidity control as a primary ESD control measure in their ESD/ANSI S20.20 standard
Upper humidity limit

- This is generally not an issue, the cooling systems operate at a dew point lower than the humidity levels of concern.
- It can be an issue of concern with liquid cooling technologies that are located in the rack (e.g. rear door coils).
  - This can be addressed with either dehumidification or using higher cooling temperatures for close coupled systems.
Issues with the ASHRAE/TIA envelope

- Limits the effectiveness of air-economizers

<table>
<thead>
<tr>
<th></th>
<th>Washington, D.C. 4A</th>
<th>Salt Lake City 5B</th>
<th>Houston 2A</th>
<th>San Jose, Calif. 3C</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Upper or Lower</td>
<td>76%</td>
<td>91%</td>
<td>79%</td>
<td>89%</td>
</tr>
<tr>
<td>Humidity Limits</td>
<td></td>
<td></td>
<td>47%</td>
<td>76%</td>
</tr>
<tr>
<td>Lower Humidity Limit:</td>
<td>30%</td>
<td>45%</td>
<td>13%</td>
<td>20%</td>
</tr>
<tr>
<td>$T_{dp} \geq 42^\circ F$</td>
<td>21%</td>
<td>25%</td>
<td>13%</td>
<td>20%</td>
</tr>
<tr>
<td>Both Upper and Lower</td>
<td>3%</td>
<td>6%</td>
<td>7%</td>
<td>13%</td>
</tr>
<tr>
<td>Limits: $T_{dp} \geq 42^\circ F$ and $T_{dp} \leq 59^\circ F$</td>
<td>21%</td>
<td>25%</td>
<td>13%</td>
<td>20%</td>
</tr>
<tr>
<td>Both Upper and Lower</td>
<td>3%</td>
<td>6%</td>
<td>7%</td>
<td>13%</td>
</tr>
<tr>
<td>Limits: $T_{dp} \geq 42^\circ F$, $T_{dp} \leq 59^\circ F$, and RH $\leq 60%$</td>
<td>3%</td>
<td>6%</td>
<td>7%</td>
<td>13%</td>
</tr>
</tbody>
</table>
### Issues with humidity control

<table>
<thead>
<tr>
<th>Vaisala Probe</th>
<th>CRAC Unit Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temp</td>
</tr>
<tr>
<td>AC 005</td>
<td>84.0</td>
</tr>
<tr>
<td>AC 006</td>
<td>81.8</td>
</tr>
<tr>
<td>AC 007</td>
<td>72.8</td>
</tr>
<tr>
<td>AC 008</td>
<td>80.0</td>
</tr>
<tr>
<td>AC 010</td>
<td>77.5</td>
</tr>
<tr>
<td>AC 011</td>
<td>78.9</td>
</tr>
<tr>
<td>Min</td>
<td>72.8</td>
</tr>
<tr>
<td>Max</td>
<td>84.0</td>
</tr>
<tr>
<td>Avg</td>
<td>79.2</td>
</tr>
</tbody>
</table>

- **Tdp (calculated) should be the same at all locations**
- **RH sensors located in the return, high Tdp but low RH**
- **RH sensor is located in the return, low Tdp but high RH**

**Notes:**
- RH sensor is located in the return, low Tdp but high RH
- Tdp (calculated) should be the same at all locations
IEC61000-4-2, Electromagnetic Compatibility—Part 4.2: Testing and Measurement Techniques—Electrostatic Discharge Immunity

All external ports are tested for IEC 61000-4-2. This is a requirement for a CE stamp.
RP-1499 Test Set-up

ESD gun

450MΩ

Electrode

Target

Current 40 dB

SCOPE

Arc length measurement

DVM

RF+DC

15V

RF+DC

RF

RF

12V

RF

Trigger
RP-1499 Test Procedure

• For Personnel discharge testing:
  - Person holds metal electrode in hand
  - Person is charged via a power supply to 5kV or 10kV
  - Charged person approaches current target
    • 6 GHz scope - 20 GigaSamples/second
  - At slow speeds the arc length is 1.1 mm (supports Pashen’s Law calculation)
  - Record E field, H field, arc length and discharge current
RP-1499 Test Equipment

- Agilent scope
- DVM
- Attenuator
- High voltage supply
- 450 Mohm resistors
- Cabinet
- E field sensor
- H field sensor
- Electrode
- Trigger of arc length
- Current
- E
- H
- DC supply
- Arc length equipment
The Effect of Humidity on Static Electricity Induced Reliability Issues of ICT Equipment in Data Centers

Motivation and Setup of the Study

Fayu Wan, Michael Hillstrom, David Swenson, Carlton Stayer

Determination of the Effect of Humidity on the Probability of ESD Failure or Upset in Data Centers

Mahdi Moradian, Abhishek Patnaik, Yunan Han, David E. Swenson
1499 Conclusions

- Conductive flooring and footwear help
- Nothing beats personal grounding straps
  - This is necessary if you are handling components
- Cables pulled underfloor will generate charge but it will dissipate reasonably quickly.

Table 6. Recommendations for Data Centers with Dissipative Floors and Dissipative Footwear

<table>
<thead>
<tr>
<th>Data Center Setup</th>
<th>RH and Temperature Ranges</th>
<th>User Action</th>
<th>Risk Assessment Recommendation</th>
<th>Basis of Risk Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissipative floors, dissipative footwear</td>
<td>A1, A2</td>
<td>Normal operation</td>
<td>Moderate</td>
<td>IEC 61000-4-2 (2001) testing, 4kV contact, 8 kV AD</td>
</tr>
<tr>
<td></td>
<td>Service</td>
<td></td>
<td></td>
<td>All equipment is considered to be safe if the voltages are kept below 500 V.</td>
</tr>
<tr>
<td></td>
<td>A3, A4</td>
<td>Normal operation</td>
<td>High</td>
<td>IEC 61000-4-2 (2001) testing, 4kV contact, 8 kV AD</td>
</tr>
<tr>
<td></td>
<td>Service</td>
<td>Ground strap needed</td>
<td></td>
<td>All equipment is considered to be safe if the voltages are kept below 500 V.</td>
</tr>
<tr>
<td></td>
<td>Service</td>
<td>Ground strap is always needed.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Microsoft’s data center in a tent

“Inside the tent, we had five HP DL585s running Sandra from November 2007 to June 2008 and we had ZERO failures or 100% uptime. In the meantime, there have been a few anecdotal incidents:

- Water dripped from the tent onto the rack. The server continued to run without incident.
- A windstorm blew a section of the fence onto the rack. Again, the servers continued to run.
- An itinerant leaf was sucked onto the server fascia. The server still ran without incident.”

Intel’s side-by-side comparison

Intel conducted a 10-month test to evaluate the impact of using only outside air to cool a high-density data center, even as temperatures ranged between 64 and 92 degrees and the servers were covered with dust.

- Intel’s result: “We observed no consistent increase in server failure rates as a result of the greater variation in temperature and humidity, and the decrease in air quality,” Intel’s Don Atwood and John Miner write in their white paper. “This suggests that existing assumptions about the need to closely regulate these factors bear further scrutiny.

Bay area data centers without humidification controls

• Several dozen different organizations including:
  - Banks
  - Medical service providers
  - Server manufacturers
  - Software firms
  - Co-location facilities
  - Major chip manufacturers
  - Supercomputer facilities
  - Animation studios
Resources


The articles are posted on the website:

http://www.taylor-engineering.com/publications/articles.shtml
Questions?