SVLG Panel on Data Center Cooling
04-15-2015

Mark Hydeman, PE, FASHRAE
Taylor Engineering, LLC
mhydeman@taylor-engineering.com
(510) 263-1543
http://www.taylor-engineering.com

Taylor Engineering

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

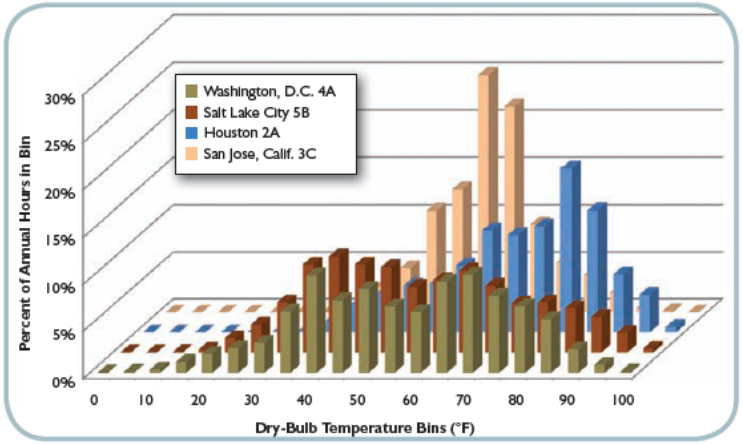
Upper humidity limit

- 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

	Washington, D.C. 4A		Salt Lake City 5B		Houston 2A		San Jose, Calif. 3C	
	T_{db}<=70°F	T_{db}<=80°F	T_{db}<=70°F	T_{db}<=80°F	T_{db}<=70°F	T_{db}<=80°F	T_{db}<=70°F	T_{db}<=80°F
No Upper or Lower Humidity Limits	76%	91%	79%	89%	47%	76%	88%	97%
Lower Humidity Limit: T_{dp}>=42°F	30%	45%	13%	20%	32%	60%	67%	76%
Both Upper and Lower Limits: T_{dp}>=42°F and T_{dp}<=59°F	21%	25%	13%	20%	20%	24%	67%	75%
Both Upper and Lower Limits: T_{dp}>=42°F, T_{dp}<=59°F, and RH<=60%	3%	6%	7%	13%	2%	5%	10%	18%



Issues with humidity control

	Vaisala Probe			CRAC Unit Panel			
	Temp	RH	Tdp	Temp	RH	Tdp	Mode
AC 005	84.0	27.5	47.0	76	32.0	44.1	Cooling
AC 006	81.8	28.5	46.1	55	51.0	37.2	Cooling & Dehumidification
AC 007	72.8	38.5	46.1	70	47.0	48.9	Cooling
AC 008	80.0	31.5	47.2	74	43.0	50.2	Cooling & Humidification
AC 010	77.5	32.8	46.1	68	45.0	45.9	Cooling
AC 011	78.9	31.4	46.1	70	43.0	46.6	Cooling & Humidification
Min	72.8	27.5	46.1	55.0	32.0	37.2	
Max	84.0	38.5	47.2	76.0	51.0	50.2	
Avg	79.2	31.7	46.4	68.8	43.5	45.5	

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

IEC61000-4-2, Electromagnetic Compatibility—Part 4.2: Testing and Measurement Techniques—Electrostatic Discharge Immunity

IEC 61000-4-2: Electrostatic Discharge Immunity Test

IEC 61000-4-2 outlines the international immunity standard for electronic equipment ability to withstand ESD generated from a human body or metal objects with a built up static charge. The standard assumes that the source is an electrified human body discharge, and testing simulates the current waveform generated in those conditions.

Level	Test Voltage (Contact Discharge)	Test Voltage (Air Discharge)
1	2kV	2kV
2	4kV	4kV
3	6kV	8kV
4	8kV	15kV

Discharge Current Waveform

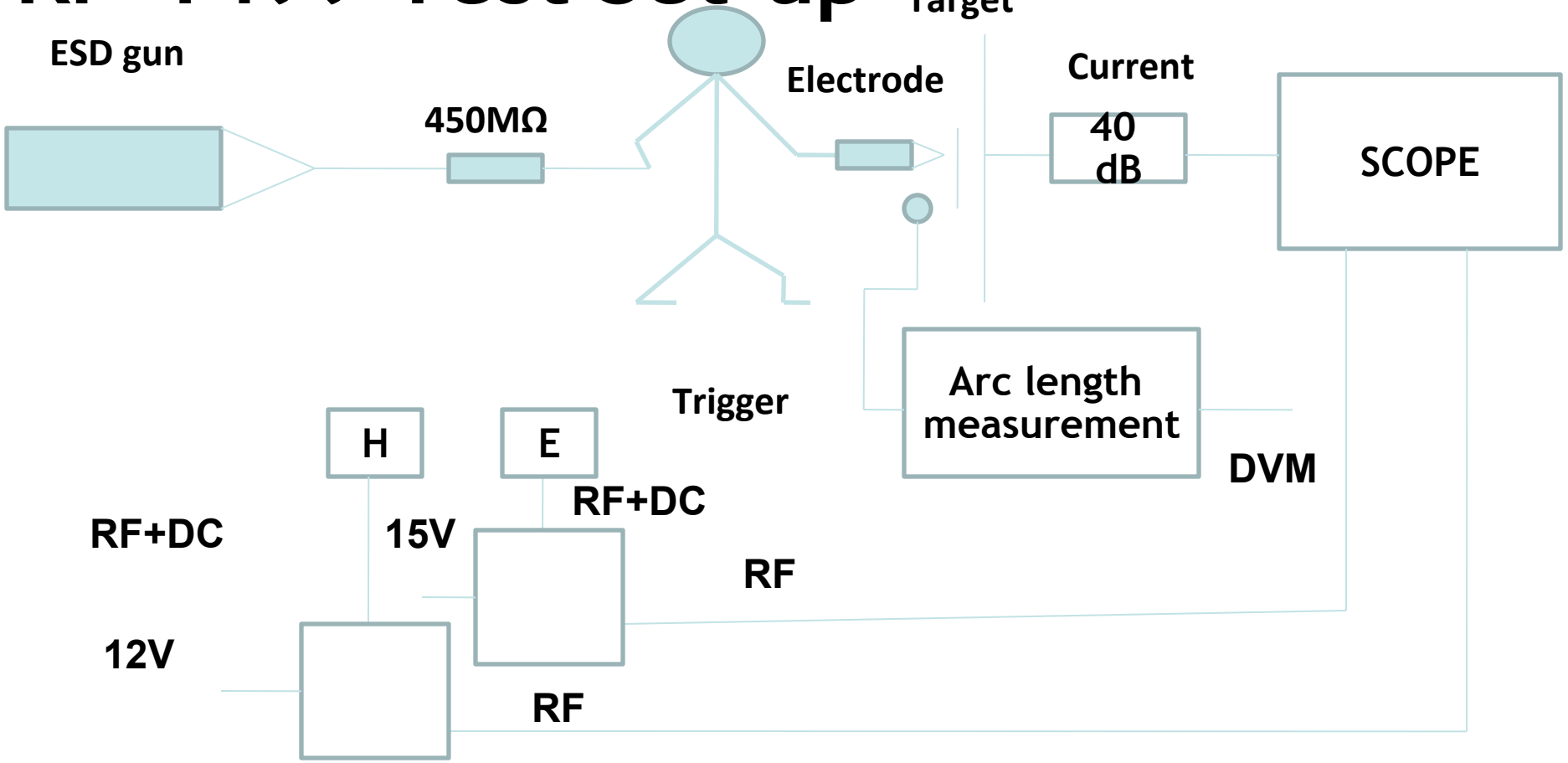
The ESD discharge simulator (ESD Gun) must meet the following specifications:

- Energy accumulation capacity: 150pF (typical)
- Discharge Resistance: 330Ω (typical)
- Charging Resistance: 50MΩ - 100MΩ
- Output Voltage: 8kV for contact discharge, 15kV for air discharge
- Tolerance: ±5%
- Polarity: Positive and Negative
- Hold time: >= 5 Sec.

All external ports are tested for IEC 61000-4-2. This is a requirement for a CE stamp

The **European Union** (consisting of Austria, Belgium, Denmark, Cyprus, Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden and the United Kingdom) has set up rules for selling certain types of products within the **EU**. For example, there are rules for medical devices, machines with moving parts, electronic devices, etc.

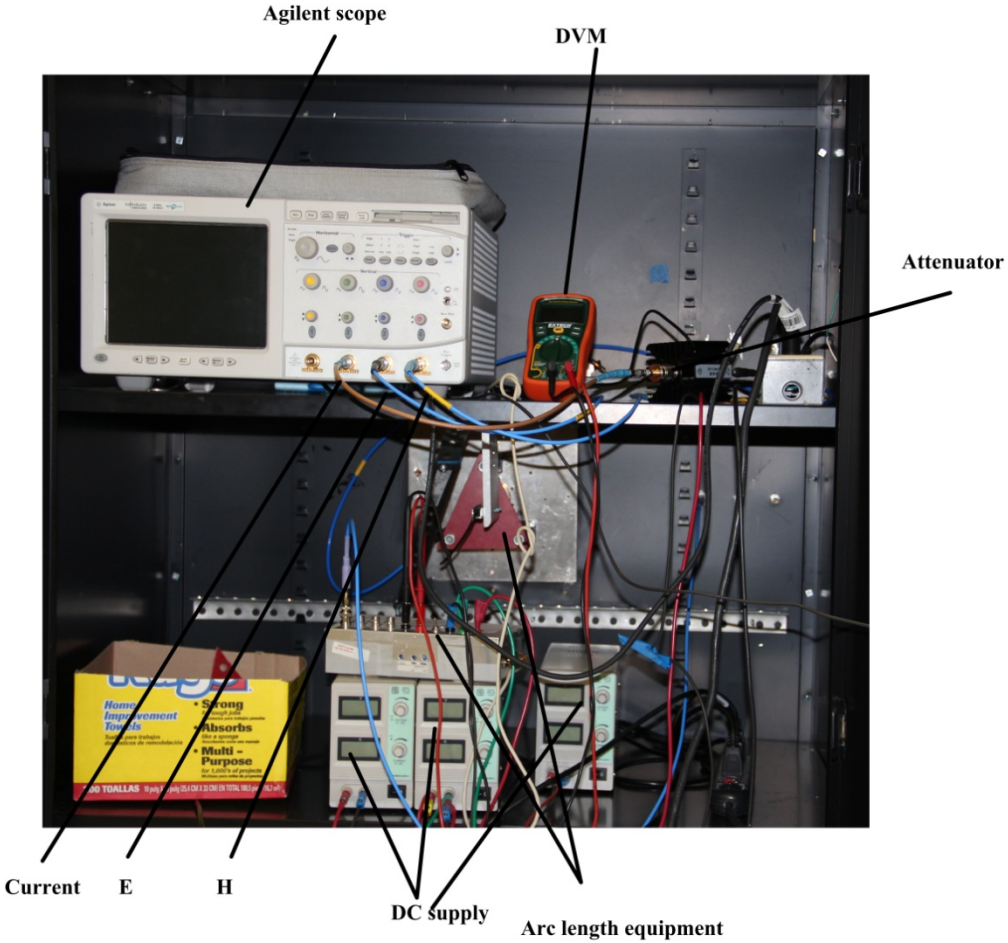
RP-1499 Test Set-up

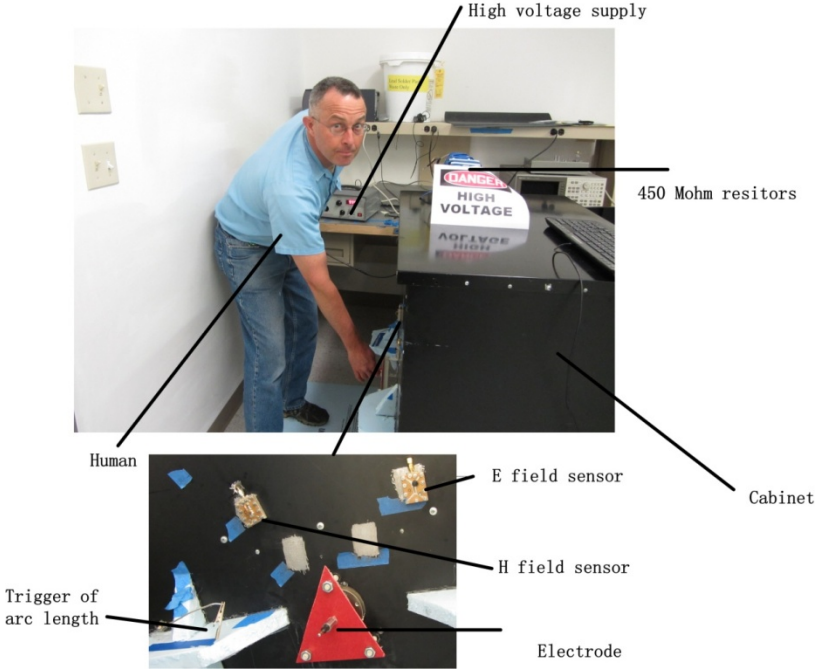


RP-1499 Test Procedure

- 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





RP-1499: 5 Papers – www.ashrae.org

DE-13-031

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, Carlton Stayer, David Swenson, David Pommerenke

SE-14-003

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

Mahdi Moradian, Abhishek Patnaik, Yunan Han, Fayu Wan, David Pommerenke, David E. Swenson

1499 Conclusions

- Conductive flooring and footware 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

Data Center Setup	RH and Temperature Ranges	User Action	Risk Assessment Recommendation	Basis of Risk Assessment
Dissipative floors, dissipative footwear	A1, A2	Normal operation	Moderate	IEC 61000-4-2 (2001) testing, 4kV contact, 8 kV AD
		Service	Ground strap needed	All equipment is considered to be safe if the voltages are kept below 500 V.
	A3, A4	Normal operation	High	IEC 61000-4-2 (2001) testing, 4kV contact, 8 kV AD
		Service	Ground strap is always needed.	All equipment is considered to be safe if the voltages are kept below 500 V.

Microsoft's data center in a tent

http://www.datacenterknowledge.com/archives/2008/09/22/new-from-microsoft-data-centers-in-tents/

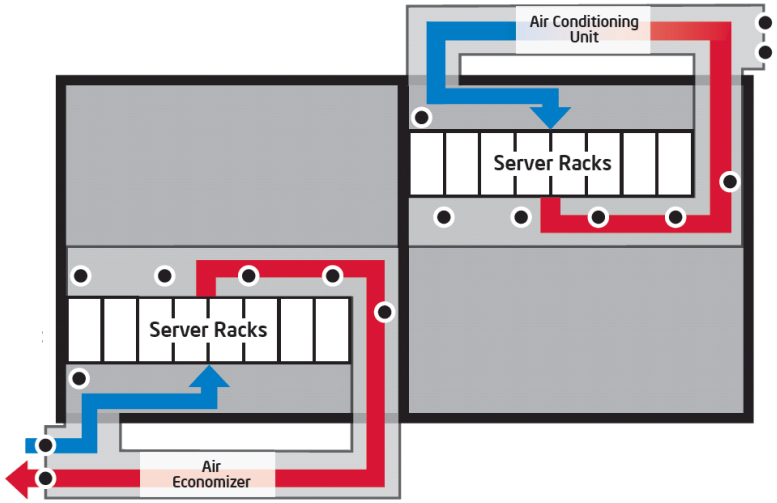
"Inside the tent, we had five HP DL585s running Sandra from November 2007 to June 2008 and we had **ZERO failures** or 100% uptime. In the meantime, there have been a few anecdotal incidents:

- 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



See http://www.datacenterknowledge.com/archives/2008/09/18/intel-servers-do-fine-with-outside-air/

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

- Implications of Current Thermal Guidelines for Data Center Energy Use. ASHRAE Journal August 2010.
- Humidity Controls for Data Centers, Are They Necessary? ASHRAE Journal March 2010.
- ANSI/ESDA Standard 20.20 2007 (http://www.esda.org/standards.html).

The articles are posted on the website:

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

Questions?