DATA CENTER WORLD Global Conference

PRM 2.2 Design Starting Correctly is Ending Correctly!

Dennis Julian, PE,ATD,DCEP

Integrated Design Group
ARCHITECTURE|ENGINEERING|PLANNING

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Data Center World – Certified Vendor Neutral

Each presenter is required to certify that their presentation will be vendor-neutral.

As an attendee you have a right to enforce this policy of having no sales pitch within a session by alerting the speaker if you feel the session is not being presented in a vendor neutral fashion. If the issue continues to be a problem, please alert Data Center World staff after the session is complete.

Who is in the audience?
Can we have a show of hands:

1. Developers/Builders?
2. Operators/Managers?
3. End users?
4. Facilities group?
5. IT group?
6. Real Estate?
7. Management?
8. Procurement?
9. Sales/Marketing?

A. Stakeholders:
    1. Real Estate
    2. IT
    3. Corporate
    4. Sales / marketing
    5. Operators
    6. End Users
B. Risk Tolerance
    1. Only mission critical site
    2. Large number of users – concern for reputation or productivity
    3. One of many - systems are software redundant
C. Efficiency
    1. Best in class efficiency
    2. Corporate mandate or goal
    3. Best total cost of ownership (TCO)
D. Operational
    1. Is facility manned 7x24?
    2. How will it be maintained? Internal or outsourced?
    3. How will it be expanded and when?
    4. How will it be tested and commissioned?
    5. Expected growth?

A. Deployment
   1. Single homogeneous user?
   2. Many different system types and requirements?
   3. What will be the minimum load on day 1?
   4. Install all initially or have a scalable modular design?
   5. Average and maximum kW per cabinet.
   6. Will high density cabinets be concentrated or spread out?
   7. One or separate rooms, cages?
   8. Dedicated or shared infrastructure?

B. Availability requirements
   1. Service level agreement (SLA) being marketed?
   2. Single availability level or mixed?
   3. No down time promised?
   4. Temperature and humidity limits?
   5. Redundancy level?
   6. Efficiency/Power usage effectiveness (PUE) goal?

How do you find an experienced mission critical designer?

1. Internet?
2. References from others?
3. What qualifications and experience should they have?
4. Who should lead the project Architect or Engineer or Project Manager?

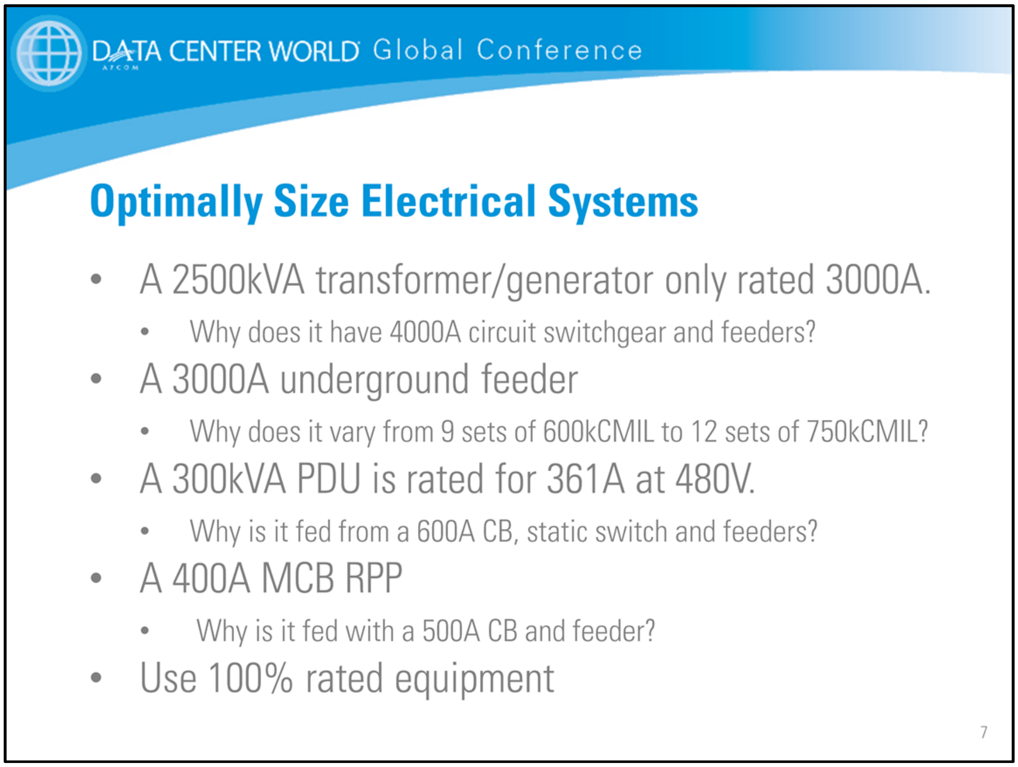
Identical data centers designed by different firms results in in over $350k in difference in electrical costs, $50k in fire alarm costs. Savings of $500-$1000 per kW

Review sizing of underground conductors. Discuss load factor. Calculations by engineer not Installer. Reference APC whitepaper: WP43v3-2011 Dynamic Power Variations in Data Centers and Network Rooms

Revit (BIM) does not cure all. Need experienced designers to do coordination

Design for arc flash to minimize operational costs. Calculations by engineer not vendor.

Use modular repeatable designs so look and feel for operations personnel is consistent.



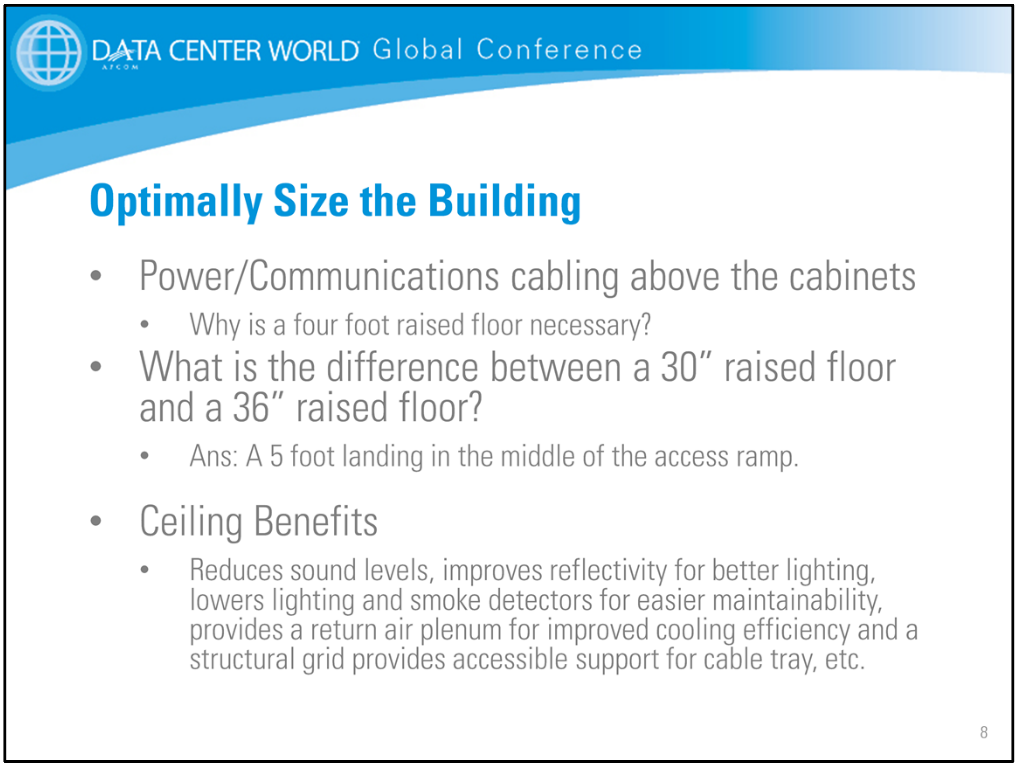
25% - 33% oversized electrical systems.

Modern data centers operate at high power factor (pf). There is no need to size electrical systems for the typical 0.8 power factor generators are rated for since the limiting design load will be kW.
At 480V:
2000kW = 2410A at 0.8pf 2500kVA = 3012A
2000kW = 2410A at 0.95pf 2105kVA = 2537A
2500kW = 3012A at 0.8pf = 3125kVA = 3765A
2500kW = 3012A at 0.95pf = 2632kVA = 3170A

4000A = 3320kVA at 0.95pf = 3154kW

Busway concerns:
1. Annual joint infrared scanning and tightning
2. Hygroscopic - Tendency to absorb moisture if not energized and warm enough to keep dry. This moisture can lead to failure due to insulation failure.
3. Factory built with specific dimensions. Little field flexibility during installation.

Cablebus an engineered system that uses free air ratings to reduce conductors required.



A. High ceiling and raised floor heights increase building size and construction costs of not just the exterior walls but all the interior walls.
   1. When does a raised floor become an OSHA confined space? 4ft?

B. CFD analysis can show that reduced volumes for the computer room still adequately cool the cabinets.

C. Sound levels are increasing due to equipment and fan/air noise. May reach levels requiring special fire alarm annunciation and OSHA required hearing protection.
   1. *OSHA 1910.95(d)(1) - When information indicates that any employee's exposure may equal or exceed an 8-hour time-weighted average of 85 decibels, the employer shall develop and implement a monitoring program.*

D. Ceiling plenum improves hot/cold air separation and increases energy efficiency.

E. Excessive ceiling height increases construction costs and operational costs, and since the heat stratifies at the top, the air circulation is at the lower level and it provides little help as a heat sink during cooling failures due to rapid heating.

F. Structural support built into the ceiling allows supporting cable tray, busway, etc without penetrating the ceiling.

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Optimally Size Project – How Tall is Your Building?

- With a 30” raised floor, 7ft cabinet, two layers of cable tray above at 1ft spacing, 2ft clearance for sprinklers, 12ft ceiling, 3ft plenum above the ceiling and 2ft of structure totals 18.5ft….
  - Why are data center buildings so tall?
- A 25,000sf footprint equals a perimeter of 633 linear feet of wall.
  - How much can be saved by reducing the building height and/or recessing the floor? Save on interior and exterior walls.

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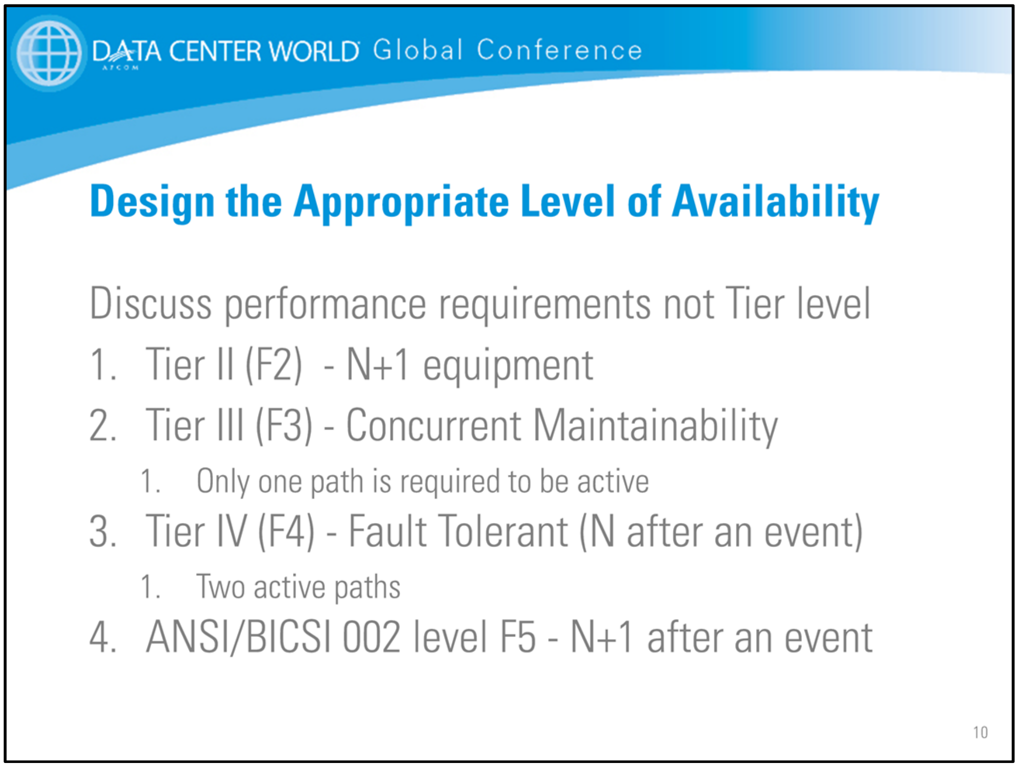
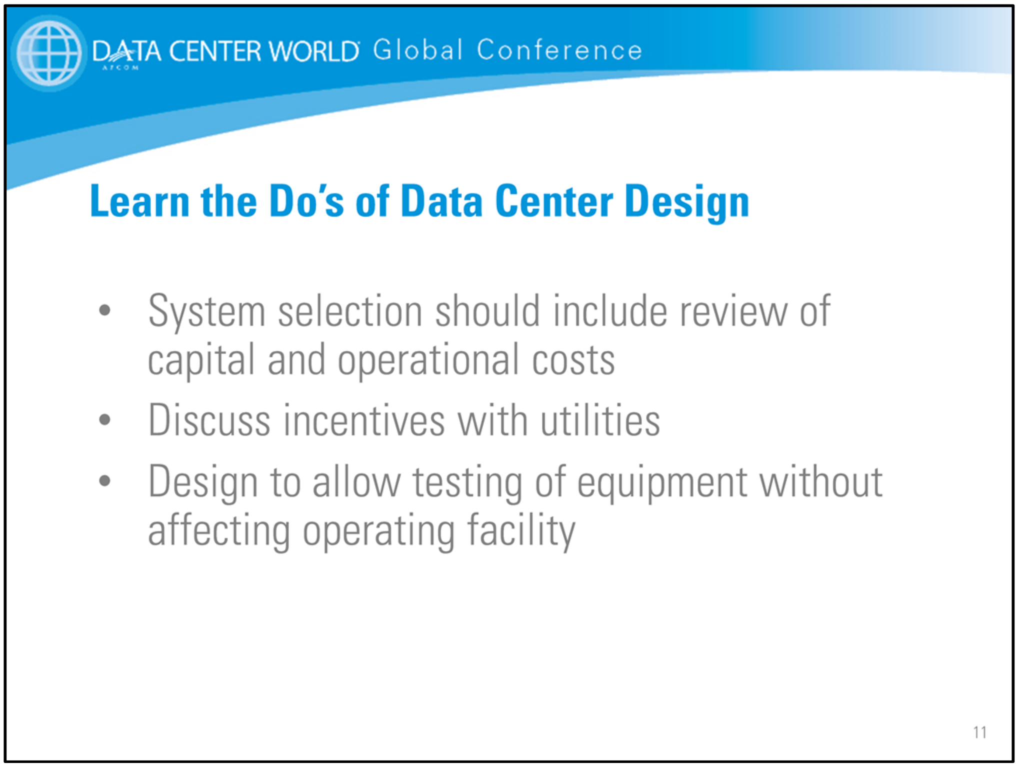
Potentially save $65,000 per foot of height.
A seven foot reduction in height could save $500,000 in construction plus reduce operating expenses.



Tier IV fault tolerant does not mean 2N.

Tier III concurrent maintainability does not mean both power paths must be UPS.

Single corded loads in a concurrently maintainable design does not mean both power sources need static transfer switches.

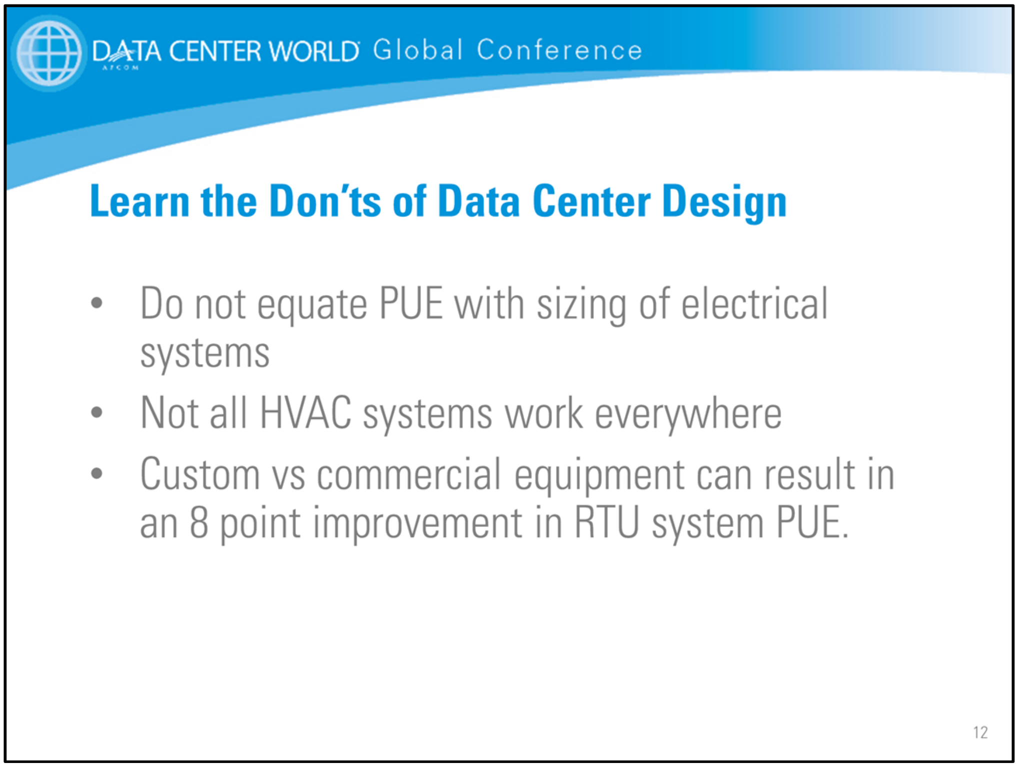


Improved custom equipment vs standard commercial grade can improve PUE by 9 percentage points. Change RTU with air economizer from 1.36 to 1.25 annual PUE

Utility incentives – received $1 million for (2) 1MW data center fit ups
Some utilities provide rebates for:

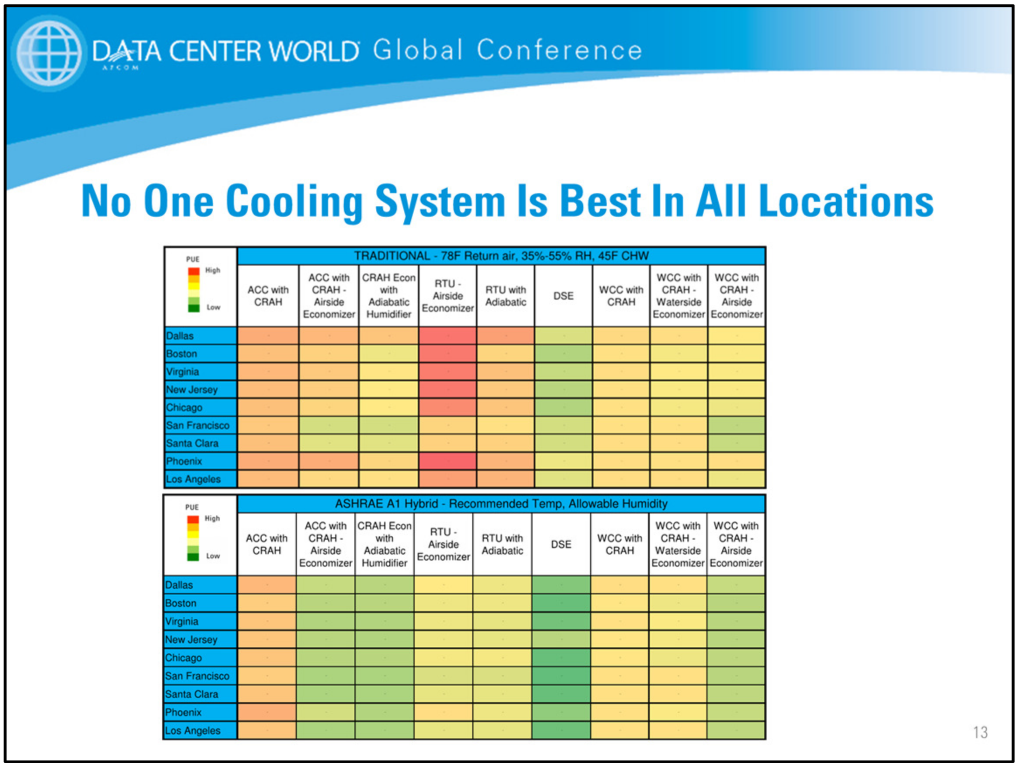
1. Energy star UPS systems
2. Efficient lighting
3. Efficient HVAC
4. Retrofits of existing systems

TCO is important.
Spending a lot of additional money to improve efficiency in an area with low utility costs may not be cost effective.

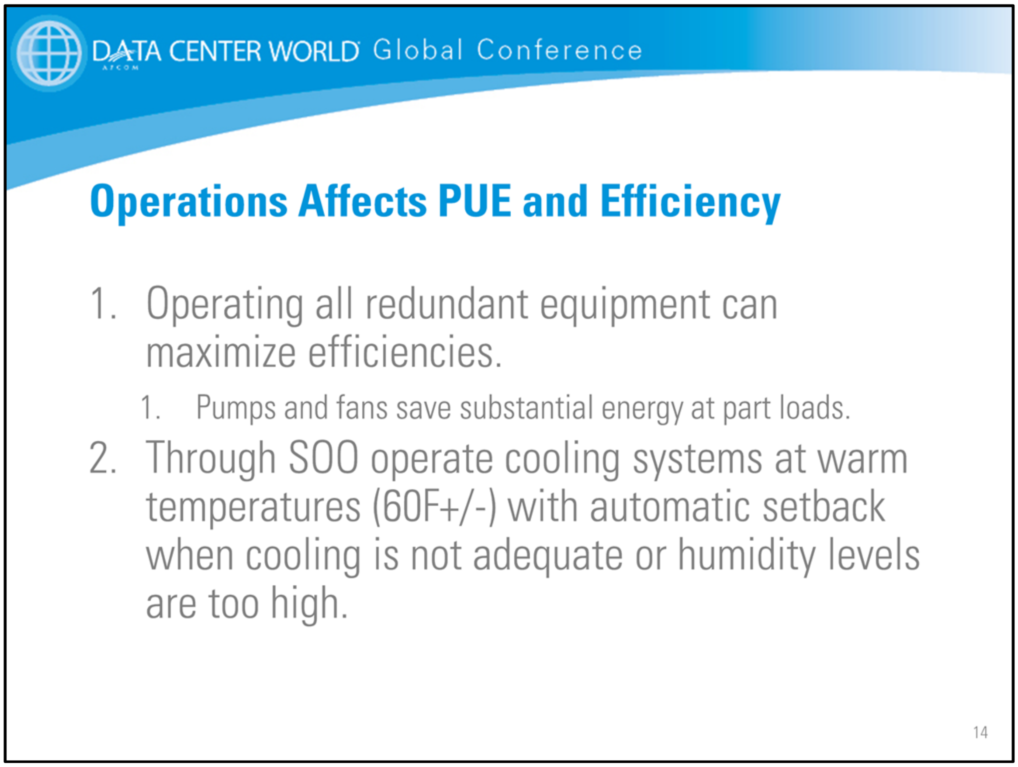


Electrical systems must be sized for peak PUE not annual PUE.

Design and control for dew point not relative humidity



TRADITIONAL - 78F Return air, 35%-55% RH, 45F CHW
HYBRID – 80.6F Supply air, 105F Return air, 20%-80% RH, 60F CHW



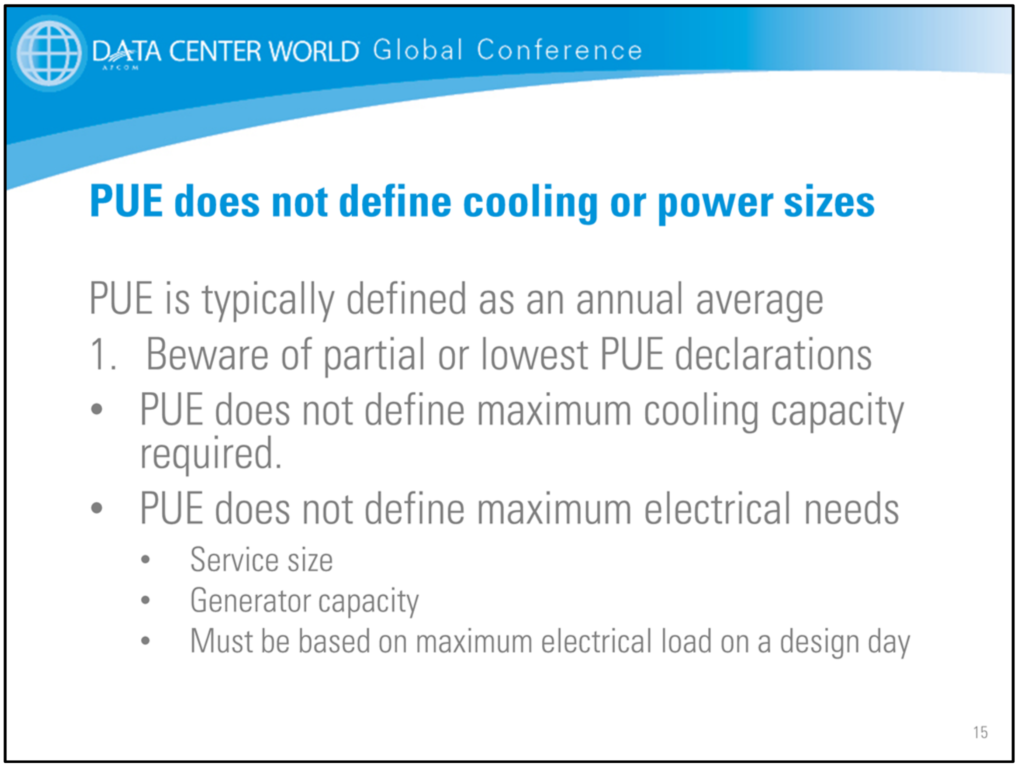
Sequence of Operations (SOO) and interior conditions have the greatest effect on PUE.

Fan Laws:
1. Horsepower (HP) varies with the cube of the speed (RPM)
2. Air volume in cubic feet per minute (CFM) varies directly with RPM.

Pump Affinity Laws:
1. Brake Horsepower (BHP) varies with the cube of the speed (RPM)
2. Flow varies directly with RPM.

Example (for illustration):

A 10HP fan is required to provide the air volume required.
If two 10HP fans are operating then each does the work of ??HP?? Possibly 5HP?
ACTUALLY
Each fan provides only 1/2 of the air volume therefore by the cube law above:
$HP1/HP2 = (RPM1/RPM2)^3$
For a typical 1800 RPM motor: $10/HP2 = (1800/900)^3 = 8$
HP2 = 10/8 = 1.25HP of power required vs 10HP.



PUE does not equal electric service size or generator capacity. Power Usage Effectiveness (PUE) is a measure of the ratio of total data center power divided by the total IT power. PUE that is measured instantaneously is not valid to determine the total electrical power required unless it is measured at the precise peak power usage of the facility. A correctly calculated PUE uses annual averages to account for seasonal variations. It is possible for the PUE to vary from a monthly high of 1.9 to a monthly low of 1.3 (RTU system in the Northeast) with an annual average of 1.4. If the electrical service was designed based on the 1.4 PUE the service and the engine-generator system would be undersized.

Example: Assuming a 1000kW IT load:

At an average PUE of 1.4 the electrical service and generator system would be sized for 1400kW.

At the peak PUE of 1.9 the electrical service and generator system would be sized for 1900kW.

The system would be short 500kW at peak load, undersized by approximately 35%.

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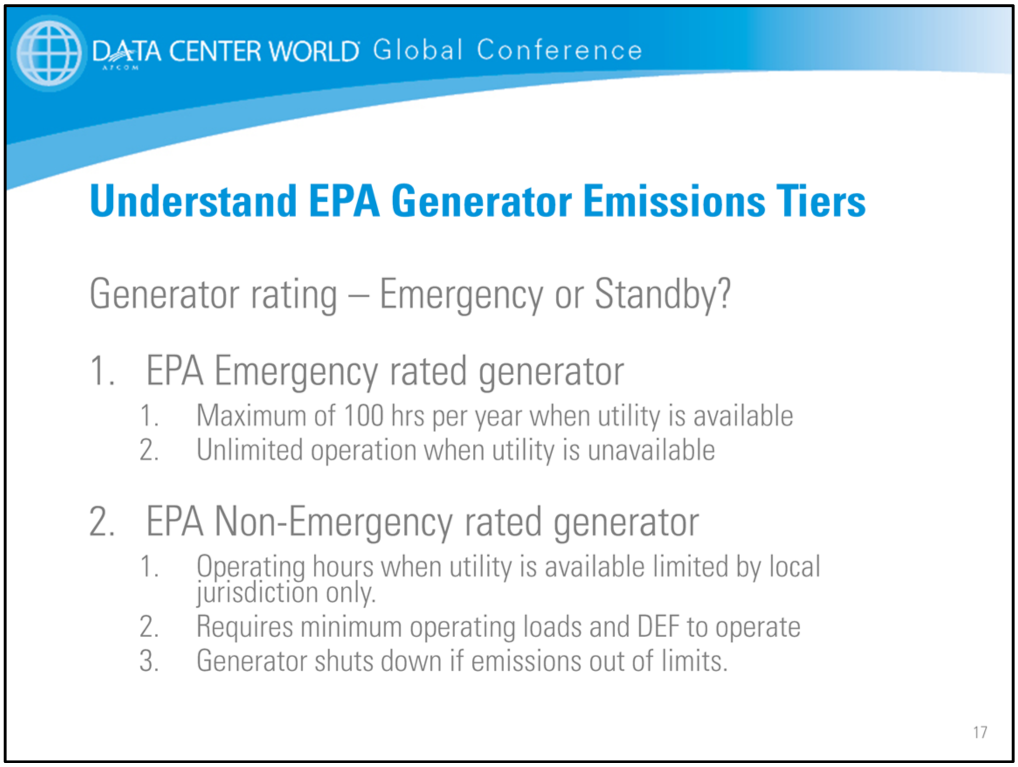
Affect of Codes on Data Centers

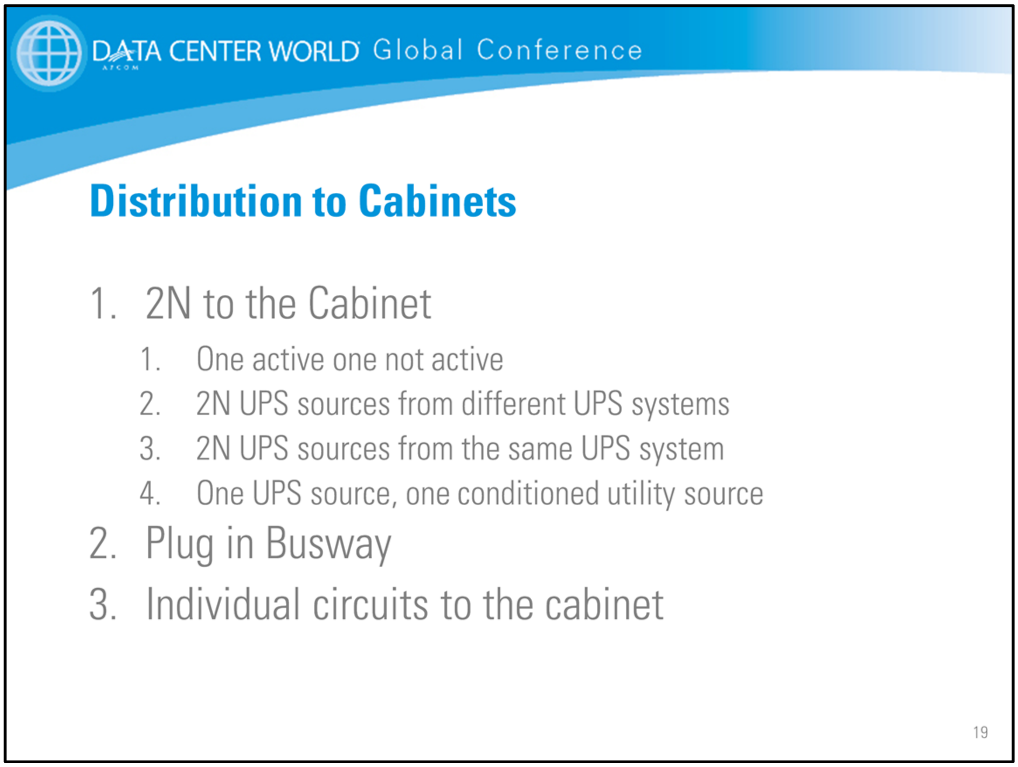
1. Energy codes now specifically address data centers
2. Electrical code requirements
   1. Modular data center covered by NEC Article 646
   2. Arc flash reduction requirements for 1200A and larger CBs
   3. Ability to remove or restrict access to EPO
   4. Removal of smoke detection shutdown of air systems



A. DEF/SCR typically required over 800kW
B. Emissions performance affected by:
   - Properly working equipment
   - Ambient temperature
   - Viable Diesel Exhaust Fluid (DEF, i.e. Urea)
     - Must be kept cool but not freezing to extend life
   - Exhaust temperature
     - Could require load on generator up to 30% or more of nameplate
     - Could be internal load bank in generator exhaust
C. Engine will be shut down and will require factory technician to reset if emissions fall out of tolerance.
D. Designs must account for EPA Tier 4 restrictions on system operation:
   1. Install in warmer air environment (recirculate radiator exhaust to keep room and engine warm).
   2. Provide proper enviroment for DEF – cool and heat. Be aware of short shelf life of DEF.
   3. Provide quantity of DEF to match fuel capacity.
   4. Need DEF delivery arrangements to match fuel deliveries.

UPS System Topologies

1. Transformer or transformerless design
2. Distributed or Central Static Switch
3. UPS Systems
    1. 2N
    2. N+1
    3. Distributed redundant
    4. Block redundant
    5. Iso Redundant
    6. Modified Iso Redundant

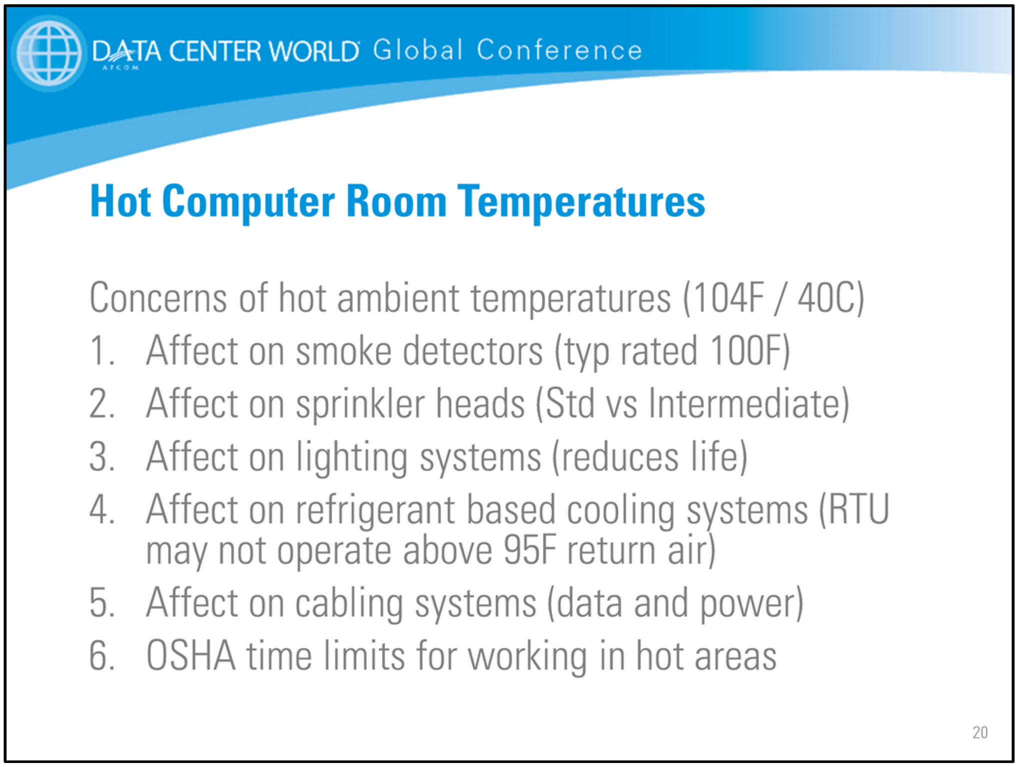


Plug in busway may not the most cost effective in an environment where standard circuit sizes are installed for cabinets.

Short circuit rating of busways can be a concern, especially at 400V.

Busway Connection points for full load commissioning.

Busway joint maintenance. Are they maintenance free or require annual infrared scanning and tightning?



ANSI/TIA 568C.2 standard – Attenuation/insertion loss based on 20C(68F). At 40C (104F) derate almost 10%

3 Key Things You Have Learned During this Session

1. Design can have a large impact on construction cost vs the design fee and design time saved.
2. Interior operating conditions have the largest impact on PUE.
3. Effects of hot computer room temperatures

Thank you

Dennis R Julian, PE,ATD,DCEP
Principal A/E Services
Email: djulian@idgroupae.com
Twitter: DRJulianPE
LinkedIn: www.linkedin.com/in/dennisrjulianpe

Contact me and I will forward some articles on these topics.

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Published articles I will forward if requested

1. 2014 Electrical Code Impact On Data Centers
2. 11 Data Center Myths and Design Issues
3. Load-on Demand Delivery Systems and Innovative Design Techniques
4. Design Considerations for Highly Reliable Electrical Systems
5. Impacts on Data Centers from the new ASHRAE 90.1-2010 Energy Standard