Developing Best Practices Manual for Indian Data Centers

Presentation by HVAC Core Group

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POWER USAGE EFFECTIVENESS

PUE - Power usage effectiveness is

Total incoming power(IT equipment + electrical

And mechanical support system) /

IT equipment Load

PUE average is 2.5 goes down even to lowest level 1.21

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An important first concept is the energy end-use breakdown between computer room equipment and cooling systems that serve them. Depending upon the type and efficiency (kW/ton) of the cooling equipment, the proportion of cooling energy to computer equipment use varies from 15-25 percent, with the higher percentage being from air cooled equipment – the least efficient.

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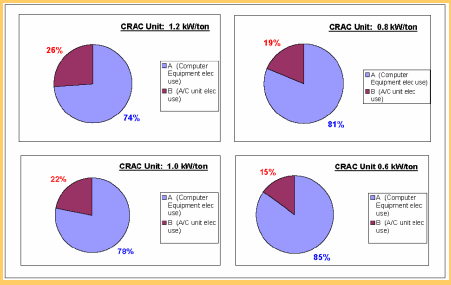
End-use energy breakdown: Computer Room Equipment vs. Cooling Units



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Core Group-2 : HVAC Equipment & Systems Top-5 Focus Areas

1. Definition of cooling system based on load
   - Ø Lower, Medium, High end
2. Indoor Air conditioning
   - Ø Temp, RH & Cleanliness of Air
   - Ø Recommended Room specifications
     - q Insulation, Glass, Door & Window, Wall & Roof
   - Ø Understanding the Load
     - q Best Placement (Hot & Cold Aisle)
     - q Different categories of Rack
3. Selection of Cooling equipment
   - Ø Indoor
   - Ø Outdoor
   - Ø Integration of cooling system w r t variation in load

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Core Group-2 : HVAC Equipment & Systems

4. Air Management System
   - Ø Guidance of Air,
   - Ø Recommended solution for various categories of Racks
   - Ø Placement of CRAC Units
5. Recommended Energy Efficient Measures
   - Ø Energy Efficiency measures
   - Ø Basic recommended control strategies
     - q Humidity control

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1. Definition of cooling system based on load Focus areas

- v Definition of cooling system based on load
  - Ø Defining Data Centre load
  - Ø Recommended cooling system
  - Ø Defining precision air conditioning units
  - Ø Lower, Medium, High end
- v Case Studies e.g.
  - Ø DX Vs Chilled Water – High Density Data Centre

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2. Design Guidelines Focus areas

- v Design Guidelines
  - Ø Temp, RH & Cleanliness of Air
  - Ø Recommended Room specifications
    - q Insulation, Glass, Door & Window, Wall & Roof
  - Ø Understanding the Load
    - q Best Placement (Hot & Cold Aisle)
    - q Different categories of Rack

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3. Selection of Cooling Equipment Focus areas

- Selection of Cooling equipment
  - Indoor
  - Outdoor
  - Integration of cooling system w r t variation in load
  - Energy & Environment considerations
- Case Studies e.g.
  - Selection of Indoor unit based on SHR

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4. Air Management Focus areas

- Air Management System
  - Guidance of Air,
  - Recommended solution for various categories of Racks
  - Placement of CRAC Units
  - Recommended grill placement, sizes & specifications
  - Response to variable loads
- Case Studies
  - CFD based studies

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HVAC Core Group

- Identified some of the best practices
  - Use of water-cooled cabinets
  - Use of economizer
  - Thermal storage
  - Electronically commuted fans
  - VFD for CRAC units
  - Equipment orientation and hot air containment
  - Optimum raised floor design
  - Optimum indoor conditions
  - Humidifier optimization
  - Integrated demand control of CRAC units – CRAC unit demand fighting
  - Operate IT equipment cooling system at higher delta-T
  - Positioning cooling system closer to load

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Water Cooled Cabinets

- Background
  - Need to add thousands of blade or 1U servers to support rapid growth
  - Existing air cooling could not handle
- Action
  - Installed 26 water cooled cabinets containing 2184 blade servers
    - Doubled the capacity while adding only 600 kW to the power load

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Water Cooled Cabinets

- v Project implementation
  - Ø Water cooled cabinets installed in 5000 sft server room
  - Ø Chilled water supplied to cabinets using pipes beneath the raised floor
    - q Effective cooling was observed
  - Ø Sealed water cooled cabinets produced very little external heat – 1 kW/cabinet

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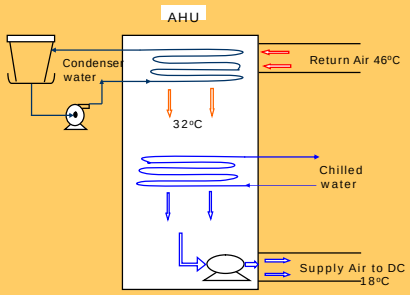
Air Side Economizer



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Air Side Economizer

- v Project details
  - Ø Return air from DC is pre-cooled by using condenser water
- v Advantages
  - Ø Reduced load on chillers
  - Ø Better temp control during transients
    - q At the time of starting & stopping of chillers
  - Ø More flexibility in shifting cooling loads b/w economiser and chilled water system

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Thermal Storage

- v A power sag or complete outage can cause rapid increase in temperature
  - Ø Servers keep producing heat as they are supplied from UPS
- v Project details
  - Ø 3 x 1200 TR centrifugal chillers
    - q Supply cooling water at 13°C – sensible cooling
  - Ø 2 x 175 TR scroll chillers
    - q Supply cooling water at 6°C – latent cooling

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Thermal Storage

- v Project details...
  - Ø 6ºC chilled water is also supplied to thermal reserve tanks
    - q 2 x 100 m^3
    - q Enough capacity to cool for 7 minutes
      - ü Longer than UPS battery life

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Electronically Commuted Fans

- v Project details
  - Ø Replaced 4 CRAC units with PAC with EC fans
    - q Resulted in reduction of power consumption by 41%
  - Ø In the max air flow range, EC fans require 15% less power input than conventional centrifugal fans
    - q EC fans have better efficiency
  - Ø At partial loadings – resulted in more saving

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Electronically Commuted Fans

Comparison of Centrifugal fans and EC fans		
UNITS	CRAC with Centrifugal Fans	CRAC with EC Fans
Number of Units	4	4
Air Flow m^3/h	96,000	96,000
Cooling capacity (total) (kW)	300	300
Cooling capacity (sensible) (kW)	296	296
Fan power consumption (kW)	40	23.5
Savings (kW)		16.5

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VFD for CRAC Units

- v Background
  - Ø CRAC unit fans – one of the major energy consumers
  - Ø CRAC unit fans operated at full speed continuously
  - Ø Load on servers not 100% all the time
    - q Temperature varies based on loading

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VFD for CRAC Units

- Potential to optimise the operation of CRAC unit fans
- Installed VFD for the fans
  - Operated based on temperature
    - Lower the temperature – lower the speed
      - Power • $(speed)^3$ – for centrifugal fans
  - Resulted in 30% reduction in power consumption

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Equipment orientation & hot air containment

- Hot/cold aisle containment through proper orientation of IT equipments
  - Avoid mixing of hot and cold air
  - Blanking panels, brush groommet, etc
- Reduces cooling load on CRAC
- Reduces CRAC fan power consumption

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Raised floor design

- Raised floor – plenum, dumping of cables
  - Burden on cooling system
- Solution
  - Cable runs under hot aisle
  - Specific tiles for low and high density areas
  - Overhead cable distribution

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Indoor conditions in Datacenter

- Indoor temperature kept colder to achieve marginal inlet conditions in worst case locations
  - Introduces inefficiency in overall cooling system
- Optimization strategies
  - Air flow balance
  - Shifting IT equipments to cooler area
  - Supplemental cooling for hot spots
  - Air containment
  - Optimize temperature and humidity levels

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Humidifier optimization

- v Higher humidity levels
  - Ø Wastage of Energy and water
- v Maintain humidity at minimum recommended levels as possible
- v Set point at lower end of recommended range
  - Ø Changes heat removal capacity and reduces humidifier operating time

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Integrated demand control of CRACs

- v Applicable for installation with multiple CRAC units
- v CRAC units conflict
  - Ø One unit humidify, other unit dehumidify
- v Centralized control
- v Coordinated control
- v Turn off one or more humidifiers
- v Dead band setting

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Higher delta-T across IT equipments

- v Delta-T inversely proportional to air flow in IT equipments
  - Ø Less fan power in PACs due to reduced flow
- v Higher equipment delta-T is higher return air temperature at PAC
  - Ø Capacity utilization of cooling system
  - Ø Few PACs for same IT load

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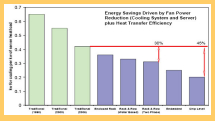
Cooling system close to the load

- v Fan power consumption proportional to flow and distance to the load



- v Provide high density loads near cooling units and vice versa
  - Ø Hybrid approach
  - Ø High density supplemental cooling & traditional rack cooling

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LET US AIM FOR
GREEN DATA CENTER
WITH MORE POWER SAVINGS!
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