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KS Engineers, La Jolla, California
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Summary of topics

Under the Hood: Operations and Maintenance

1 Little quiz
2 General discussion of energy conservation
3 Reduce load
4 Basic challenge: Cool an engine
5 Some theory
6 Where are the savings? (Reduce fan power)
7 ”Under the hood” or how to kick the tires
8 Load Factor
9 Tips how to do it
10 Some attempts at wise cracks

Energy Quiz for Data Center Operators

Answer the following questions:

Do Data Centers room temperatures have to be at least as low as 65°F or even below?

A computer cannot operate in a room temperature of 90°F?

Humidity for today's computers has to be kept between 50% +/- 5% RH?

Energy conservation is "*Penny wise Pound foolish"* because the equipment is too expensive to risk over heating.

Energy Quiz Evaluation of Data Center Operators

If you answered YES to:

4 Questions:	Totally consumed by preconceived ideas. Probably an Energy Hog
2 or 3 Questions:	Needs re-education
1 Question:	Good material to work with
None of the Questions:	Energy conservationist ready for an award.

ANSWERS

Do Data Center room temperatures have to be below 65°F?

No

A computer will fail in a room temperature of 90°F?

No, it is the cooling air temperature that counts

Humidity for today's computers has to be between 50% +/- 5%

NO, 35% to 75% RH is OK

Energy conservation is "*Penny wise Pound foolish"* because the equipment is too expensive to risk over heating.

NO, Energy Conservation does not change the mission, it attempts operation at a better efficiency

Why energy conservation in data centers?

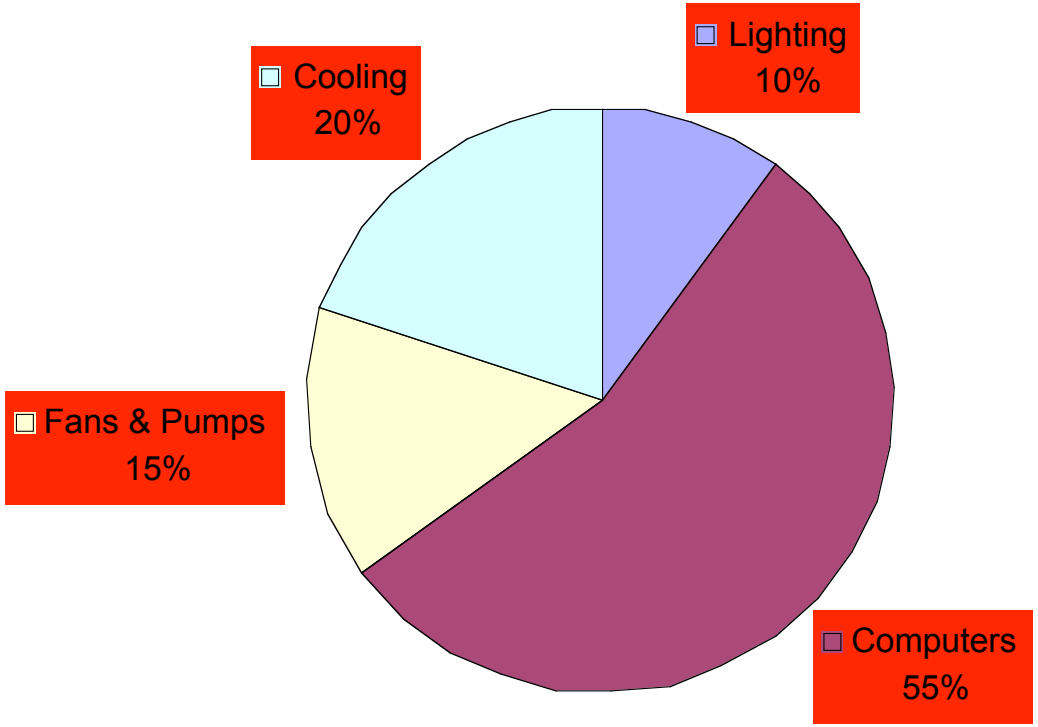
A Interested in energy conservation

B Is it becoming a necessary evil?

C "*Do not confuse me with facts, my mind is made up*"

D Because energy conservation is not worth the effort as the mission of the data center is beyond saving a few bucks on air conditioning

Energy usage for data centers

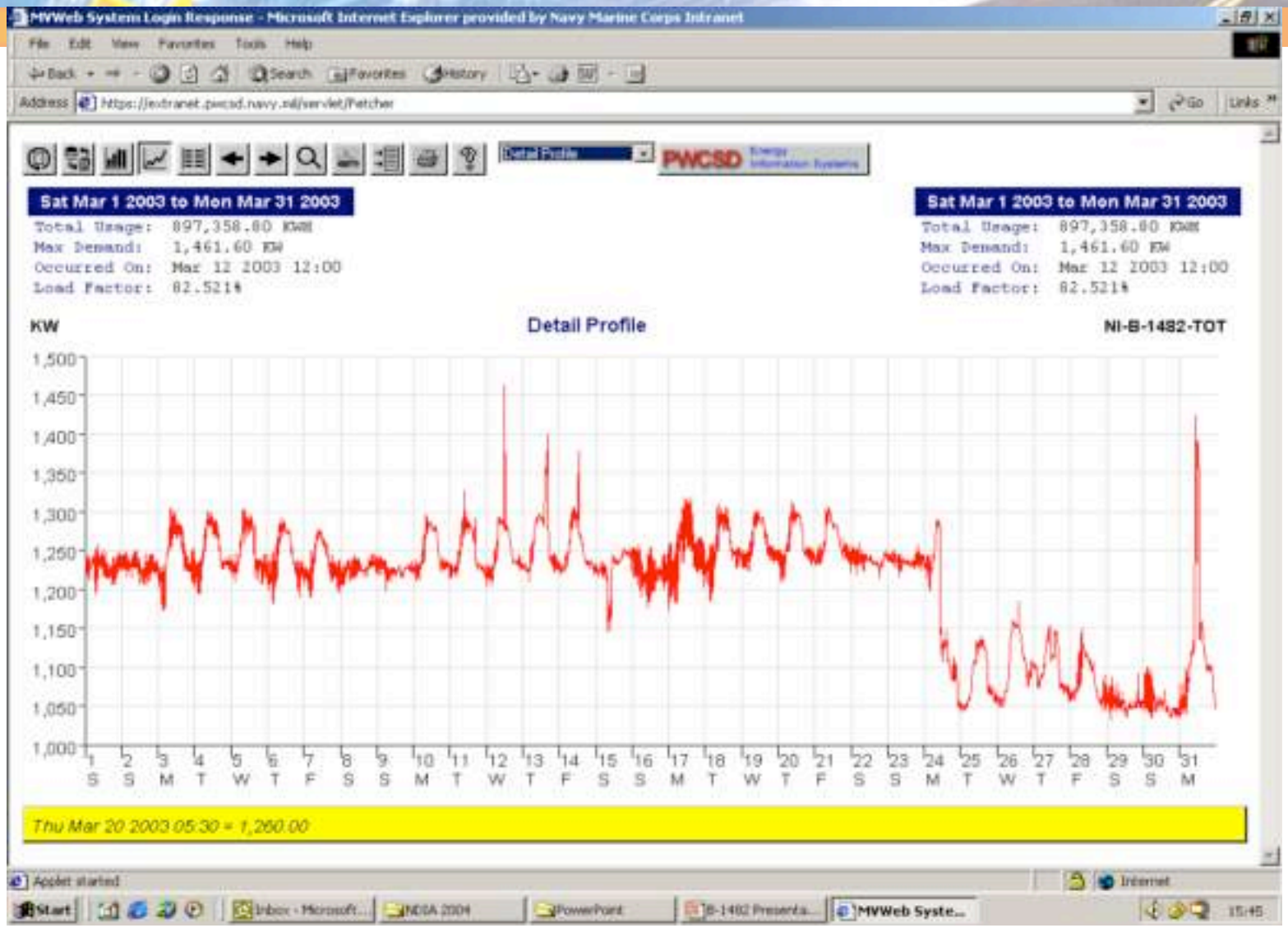


What are we after?

We do not want to change the mission or conditions

We just want to improve the efficiency

2006 Energy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Sat Mar 1 2003 to Mon Mar 31 2003
Total Usage: 897,358.80 KWH
Max Demand: 1,461.60 KW
Occurred On: Mar 12 2003 12:00
Load Factor: 82.521%
Sat Mar 1 2003 to Mon Mar 31 2003
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Max Demand: 1,461.60 KW
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Load Factor: 82.521%
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Reduce the Cooling Load

Heat into space is the heat that has to be taken out

1 External Heat

2 Internal Heat

External Heat

Transmission:

Insulate Envelope

Solar Heat Gain:

Reduce or Eliminate

Ventilation and Infiltration:

Reduce outside air to satisfy people load

Reduce or eliminate infiltration

Internal Heat

Lighting Load:

Turn off unnecessary lights by:

Use Alternate Rows of Lights only

Use motion detectors to turn off lights not needed

People:

Can’t do much about that

Computers:

Turn off computers not in use

Now to the Computers

What is the challenge?

What is the challenge?

Air cooled engines

Air flow

Thermodynamics

Getting under the hood

Attempt at giving some practical hints:

If you understand the theory then the rest is easy (easier).

A Little Theory:
Low Delta Temperature Syndrome

- The low delta T syndrome experienced in chilled water system applies equally to air systems
- Heat out = k x flow rate x delta T
- Heat out (Btu/Hr) = k x cfm x delta T (°F)

Cooling coils are designed for a delta T of 15° to 20°F with

a supply temperature of 55° to 60°F

If room air is 65°F then delta T = 10°F

If room is 75°F then delta T is 20°F

Half the cfm means energy savings

How to achieve low flow and high delta T

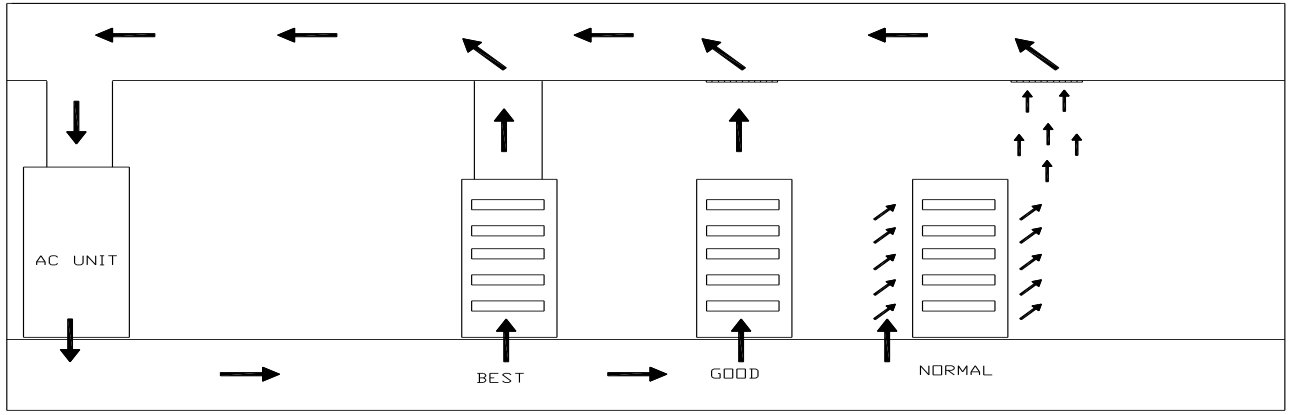
- Provide cool air where it is needed, at front of computers (air intake)
- Try to get hot air to air handling unit without blending it again with cool air

How to achieve low flow and high delta T

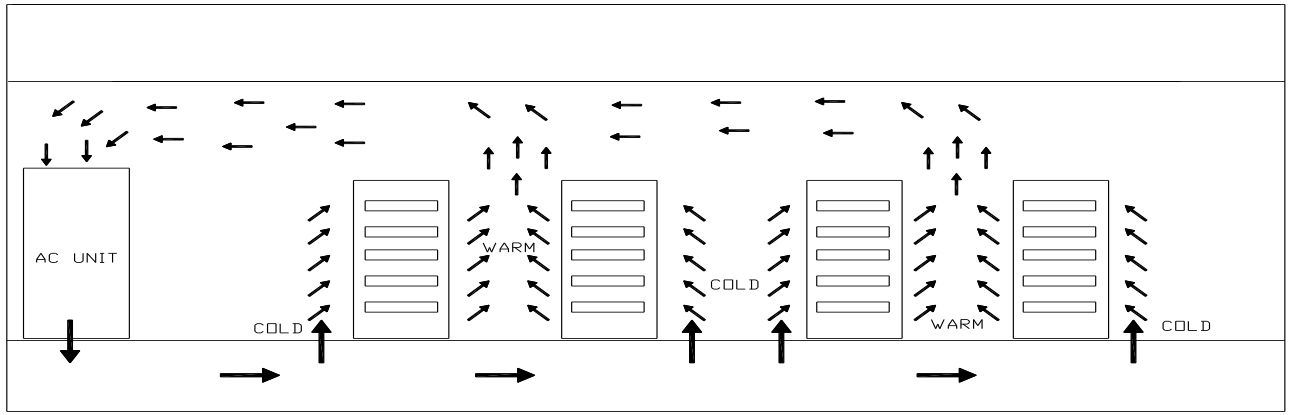
Create cold and hot alleys

Seal all leaks and by-passes

Set controls to provide coolest air to floor space



UTILIZING CEILING PLENUM



HOT AND COLD ALLEYS

Quick “under the hood” opportunity check

COOLING LOAD FACTOR =

$$\frac{\text{ACTUAL DATA CENTER COOLING LOAD}}{\text{NOMINAL COOLING CAPACITY OF ALL CRAC UNITS}}$$

The most efficient way to operate would be all operating CRAC units to be fully loaded

Check out that no CRAC unit is in heating mode

Quick "under the hood" opportunity check

Add all the individual products of (%percentage cooling) x (nominal tons) of all operating CRAC units in the data center.

Example: 20 ton x 25% = 5 tons

10 tons x 75% = 7.5 tons

10 tons x 50% = 5 tons

Total cooling tons = 17.5 tons

Nominal load = 40 tons

Load Factor = 17.5 / 40 = 44%

In other words the 20 ton unit can be turned off

Energy Savings

Less cfm means less fan HP

No heating and cooling occurring at same time

Load factor of chilled water CRAC units

- The % percentage opening of the valve gives an indication of the percentage cooling done in relation of its total nominal cooling capacity
- Example: If the valve opening is shown as 75% open in a 20 ton unit, then for the purpose of this estimate, it can be assumed that the cooling load is 15 tons
- If the unit shows that it is in dehumidification and reheat mode then ….explain
- If the CRAC unit indicates that it is heating then it indicates that the space is too cold and the unit can most likely be turned off

Load factor of DX CRAC units

- Controlling Direct Expansion cooling coils is more difficult than chilled water. Chilled water is like an automatic gear box while DX is stick shift with only two or four gears.

- CRAC units with two compressors operate either at 50% or 100% capacity. Anything in between will be done by cycling the unit on and off. This is not good for compressor longevity, nor is it energy efficient.

- Unloaders are provided to facilitate 25% and 75% capacity. Unloaders render half the cylinders of the compressors inactive.

- Another problem is that the supply air temperature fluctuates and often over dehumidifies the air. This then requires humidification and reheat. This is where DX units can waste a lot of energy. Reheat is most of the time done by electric strip heaters.

Remote spying

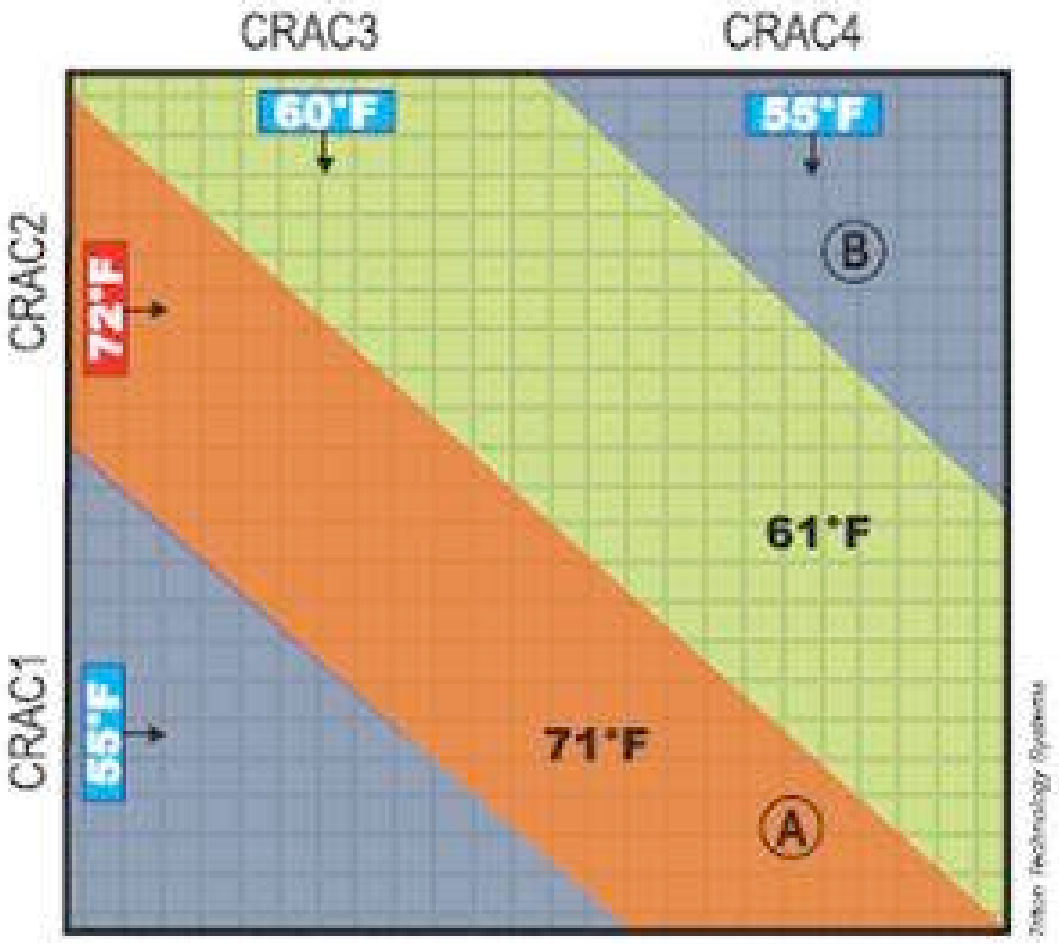
Turning off of units must be done strategically

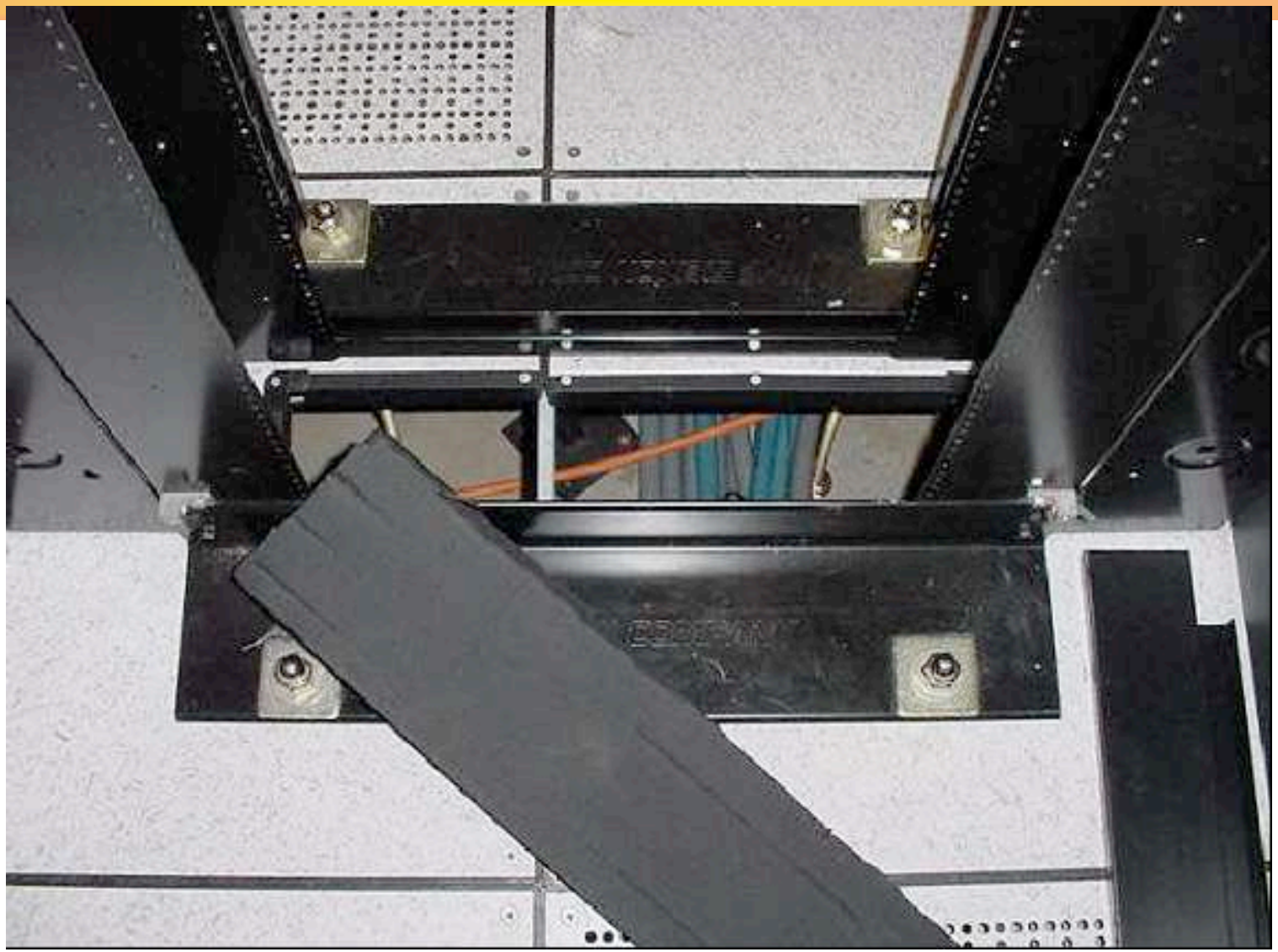
Under floor static pressure distribution

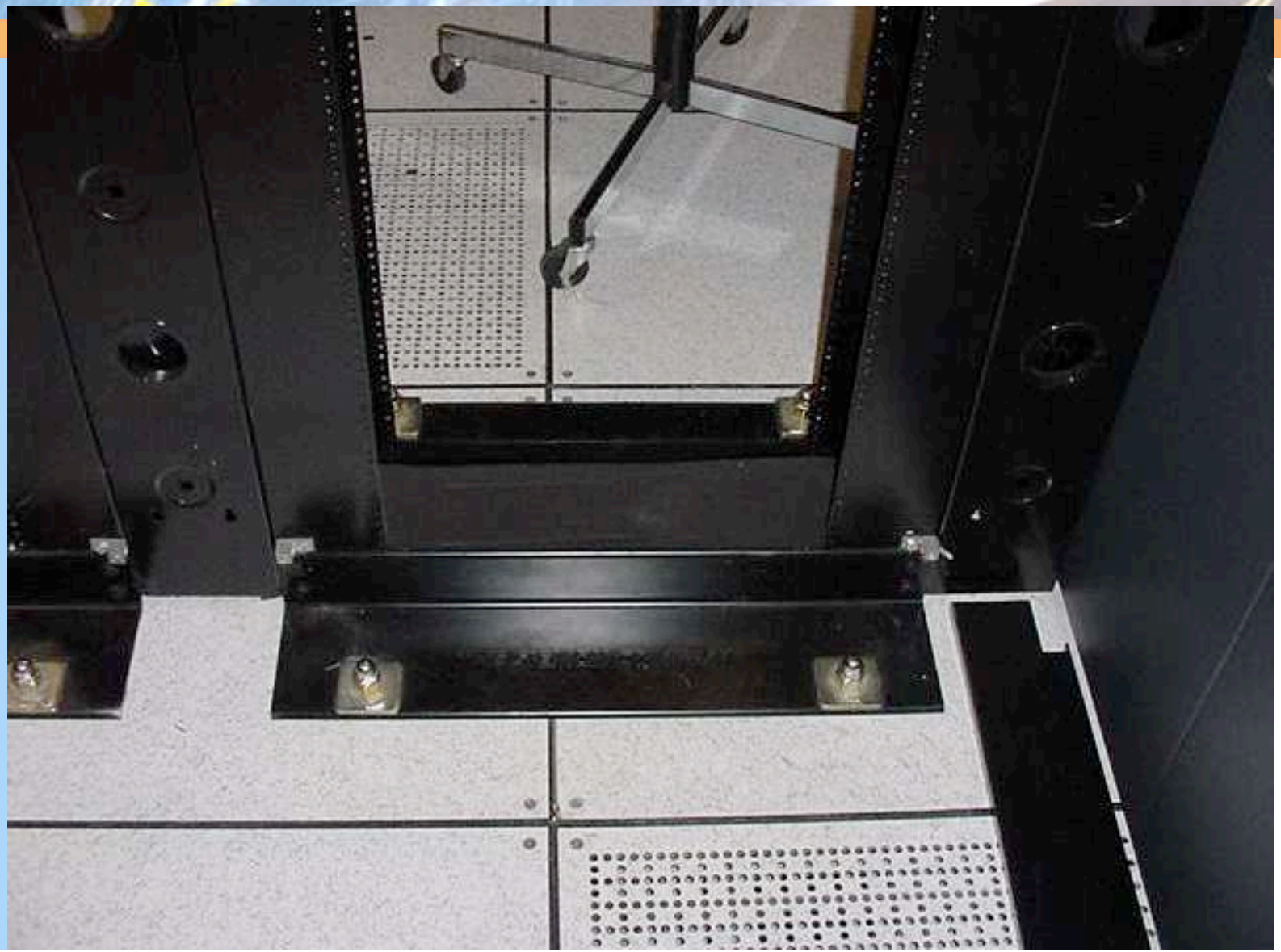
Holes also reduce the static pressure of the supply air within the floor space requiring more fan power to supply air to where it is needed.

The under floor space is supposed to be an open plenum. Remove any redundant cables, cable trays or any equipment that clutters up the floor space to allow air to flow freely.

Turning off of units must be done strategically







Data Center Results

- Half the air handler units can be turned off
- No heating and cooling going on
- Fan power saved
- More comfortable for personnel
- Avoids cycling of compressors for DX units, longevity of equipment

Data Center Recommendations

- Team work and coordination required by:
  - Manufacturer of computers
  - Room layout architecture
  - Air conditioning engineer

- Educate personnel to be aware of principles

Question: What is more detrimental?

Temperature or Temperature variation (creep)

Some Klaus Slogans

In spite of all recent efforts

"We are still doing too much energy conversation
And too little Energy conservation"

Automatic controls

"Any automatic control reverts to the level of competence of

the operator"

Automatic controls

Or alternatively to

“CBC” controls

“As built” drawings

“Any similarity between the
“As-built” drawings and the installation is purely coincidental”

Energy Conservation = Happiness

Energy Conservation is,
(like Happiness),

not a Destination
but a Way of Traveling

Any Questions?

Now?

or later

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Thanks for your interest!