

Designing Server Rooms

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Designing Server Rooms

- ❖ Why should I do this?
 - Painful and difficult
 - But it can be a lot worse if someone else designs it
- ❖ Because it will make my work easier!
- ❖ Few thoughts about shared rooms

Preliminary Considerations

- ❖ What are the *business* requirements?
- ❖ Who will be responsible for what?
- ❖ What is the likely budget for this exercise?
- ❖ What is the starting point?
 - Renovating an existing room.
 - Building a completely new room

Renovation of Existing

Advantages

- ❖ Already know what equipment is involved
- ❖ May have part of the required infrastructure
- ❖ Easier to estimate requirements for equipment
- ❖ Power and air-conditioning requirements likely to be known
- ❖ May already have a “bad example”

Disadvantages

- ❖ Working around “live” systems
- ❖ Space may be too small
- ❖ Some existing equipment may be junk
- ❖ Can cost more than starting from nothing

Building a New Room

Advantages

- ❖ Can design exactly what is required
- ❖ If part of a complete new structure can have integrated design
- ❖ Not bound by previous decisions
- ❖ Power and air-conditioning requirements
- ❖ May not have organisational standards

Disadvantages

- ❖ Equipment to be installed “appears” after the fact
- ❖ Lead time required may be an issue
- ❖ Cost can be a problem since there’s one big bill
- ❖ Power and air-conditioning requirements partially known
- ❖ Possibly difficult sales job

Requirements

- ❖ Power - clean and reliable
- ❖ Air Conditioning - constant cool temperature and humidity
- ❖ Communications - the systems need to communicate
- ❖ Racks - storage or support as well as power and communications
- ❖ Fire Protection - Ordinary equipment is “not good enough”
- ❖ Security - a major reason for building the room

Planning and Politics

- ❖ Often viewed as a “cost”
- ❖ Calculate the business cost of downtime
 - Employees unable to work
 - Internet presence “off the air”
 - Potential loss of data or other assets
- ❖ Estimates of the probability of the risks
- ❖ How does the room design reduce the risks?

Defining the Goals

- ❖ Why is this room being built?
- ❖ Is it likely to grow?
- ❖ Who uses it?
- ❖ What will the requirement be in 5 years? 10?
- ❖ How much space is required?
- ❖ What is absolutely necessary *right now*?
- ❖ If necessary, what could be added in next year's budget?

Power 101 - Key Terms

- ❖ Volts - V
- ❖ Amperes - A
- ❖ Ohms - Ω
- ❖ Power Factor - $\cos \Theta$
- ❖ Load - the equipment that is doing useful work (and the losses)
- ❖ Power - Watts - W
- ❖ Kilovolt-Amperes - kVA
- ❖ Mains - the cables that eventually connect back to the generators

Power 101 - Direct Current (DC) Circuit

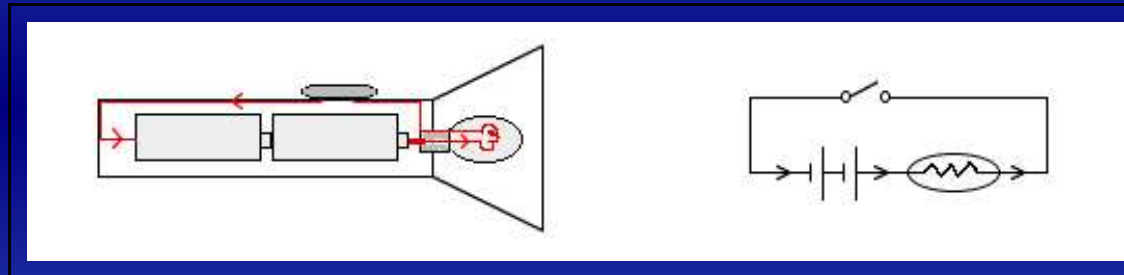


Diagram of a hand torch showing the electrical circuit

Power 101 - Parallel Circuit

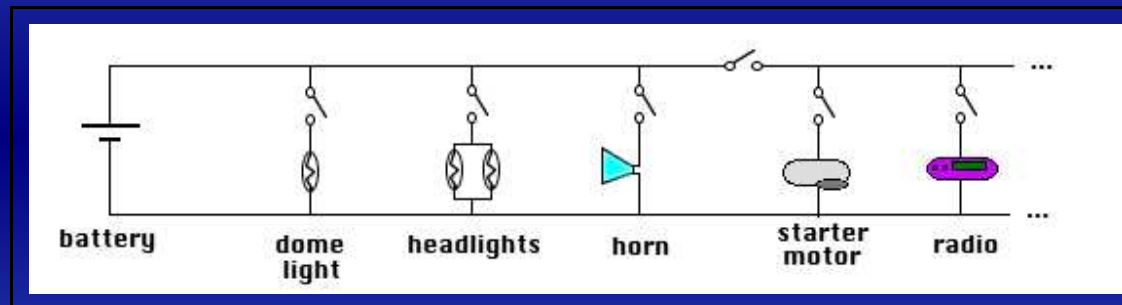


Diagram of the electrical system of a car showing a parallel circuit

Power 101 - Alternating Current (AC)

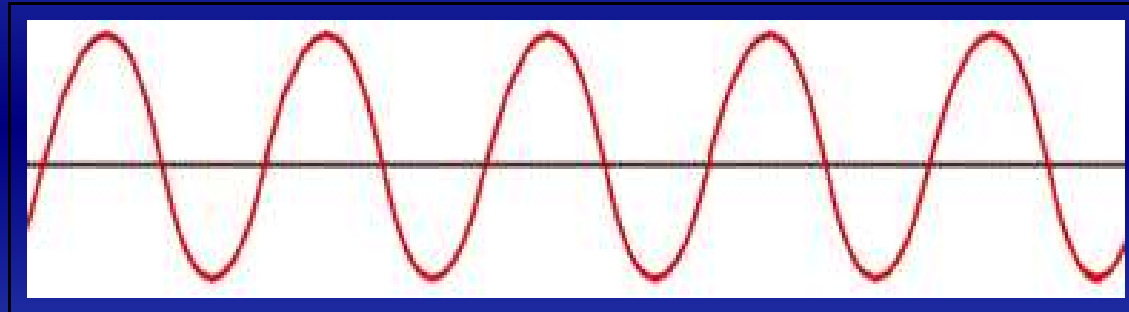


Diagram of a sin wave

Power 101 - Power Factor

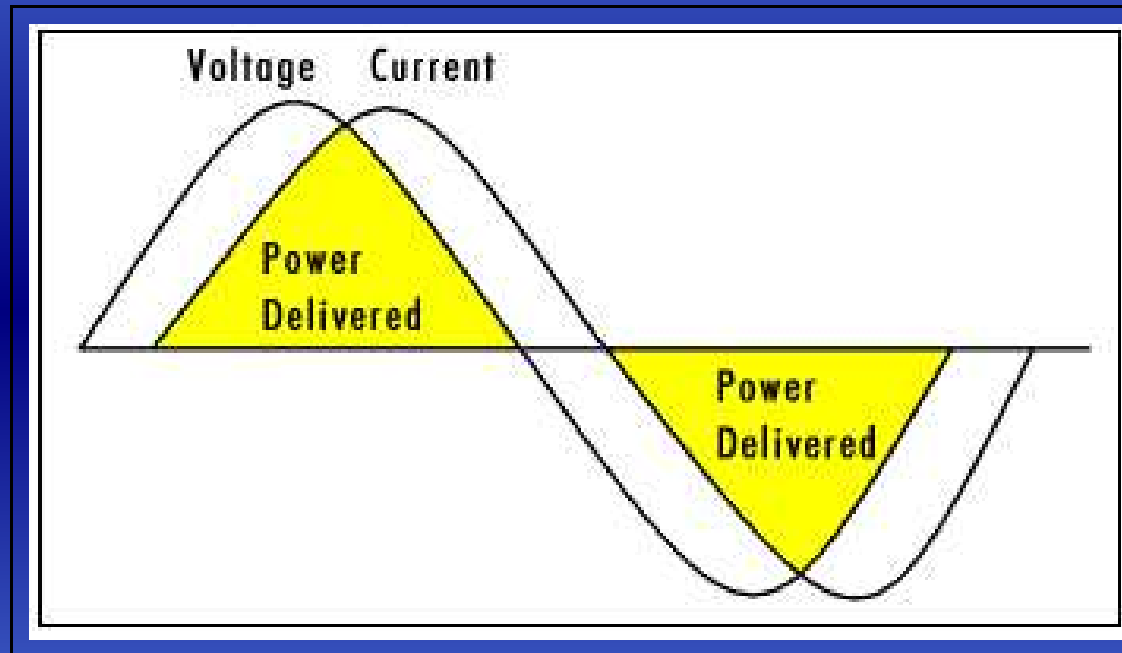
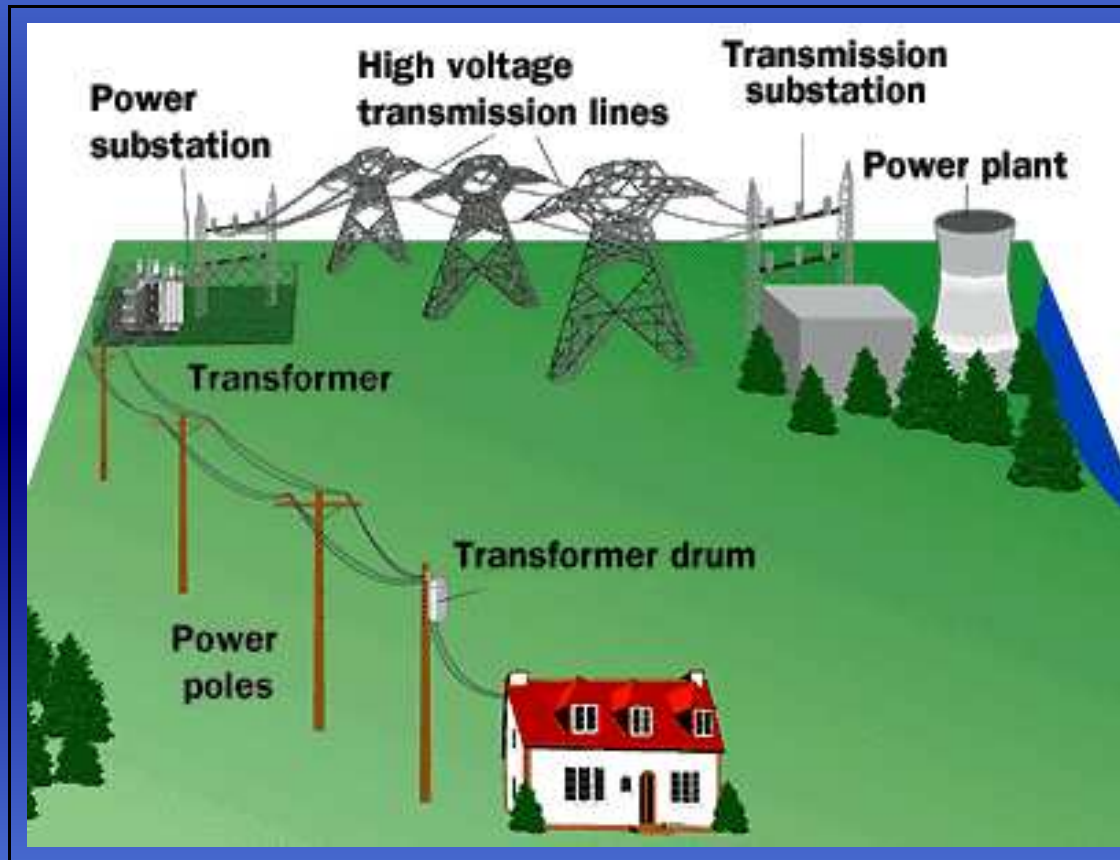


Diagram of the sin waves for current and voltage in an example circuit

Power 101 - How it Gets to Us



Representation of the electricity distribution system

Power 101 - What is Out There

- ❖ Reliability of the power supply
 - Car hits power pole
 - Underground cable hit by backhoe
 - Generator workers strike
 - Lightening hits cable or transformer
- ❖ Quality of the power supply
 - Welder in the building next door
 - High power motors stoping and starting
 - Lights at the MCG switch on
 - Trams drive past

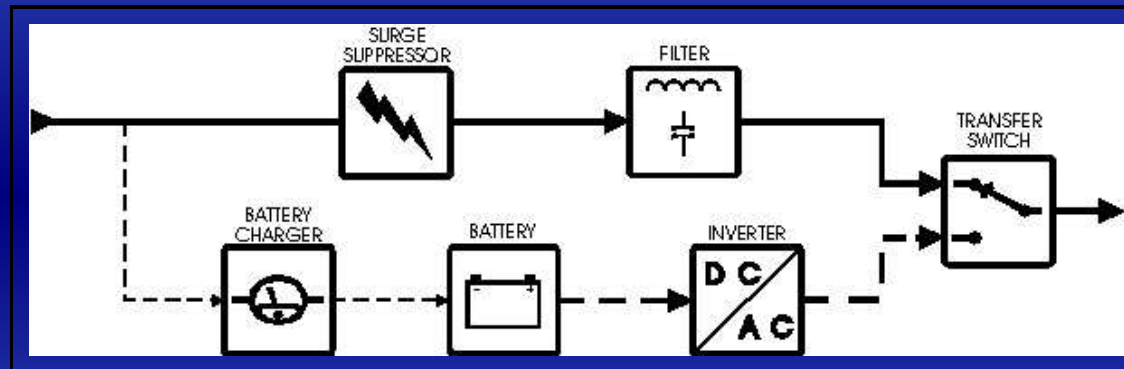
Power 101 - Line Conditioning

- ❖ Electrical Filter - reduces the waveform disturbances
- ❖ Typically a “passive” device
- ❖ Cannot fix everything
- ❖ Equipment is still connected to the mains
- ❖ Really *big* spike or voltage dip will still get through
- ❖ Could not prevent shutdown due to 1/2 – 1 second outage

Power 101 - Standby UPS

- ❖ Least expensive option
- ❖ 350 VA for under \$200 in shops
- ❖ Might be OK for home
- ❖ Originally had mechanical switching - now “solid-state”
- ❖ Saves money by simplicity and reduced requirement for high power components
- ❖ Filter equivalent to line conditioner

Power 101 - Standby UPS

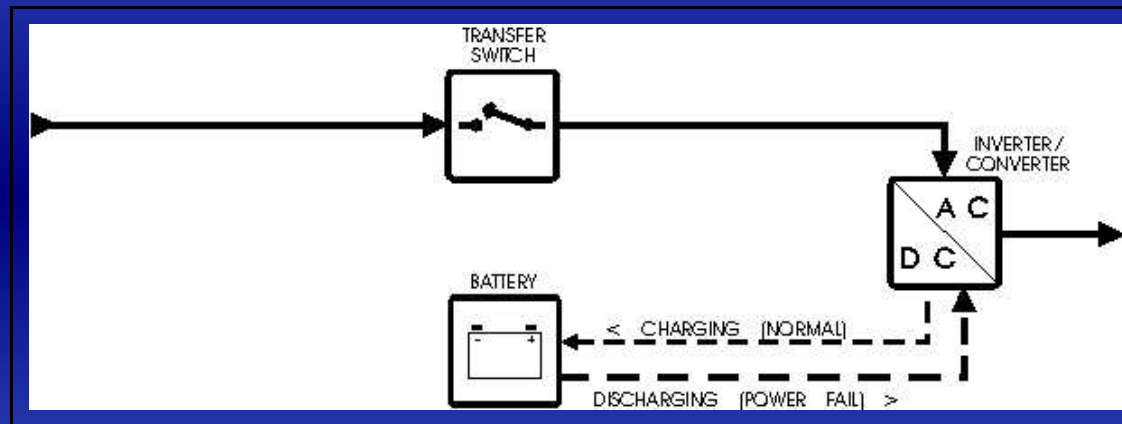


Block schematic of a standby UPS. Image ©American Power Conversion Corp.

Power 101 - Line-Interactive UPS

- ❖ More expensive and sophisticated system
- ❖ 350 VA for under \$500 in shops
- ❖ Probably still primarily a home unit
- ❖ Uses extensive semi-conductor circuits
- ❖ No switching time lag if mains power fails
- ❖ Filter effect superior to line conditioner

Power 101 - Line-Interactive UPS

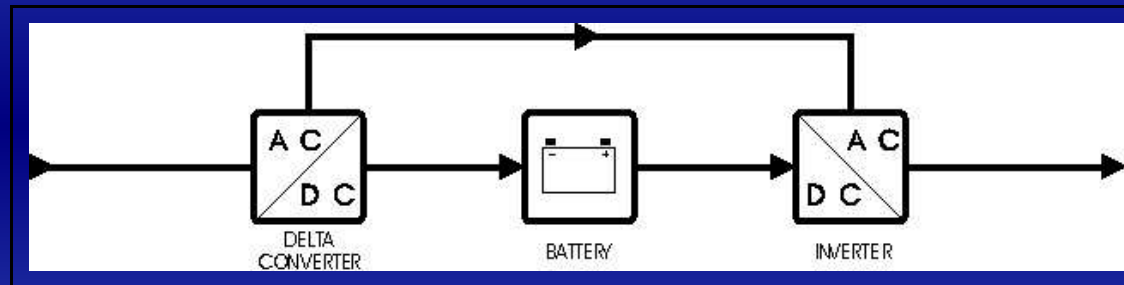


Block schematic of a Line-Interactive UPS. Image ©APC Corp.

Power 101 - Delta-Conversion UPS

- ❖ More expensive and sophisticated system
- ❖ Not available in small units - starts at ≈ 20 kVA
- ❖ Less expensive than “true-online”
- ❖ Less expensive to operate than “true-online”
- ❖ No switching time lag if mains power fails
- ❖ Filter effect superior to line conditioner
- ❖ Frequency could be an issue
- ❖ Sophisticated electronics counteract flaws in the input waveform

Power 101 - Delta-Conversion UPS

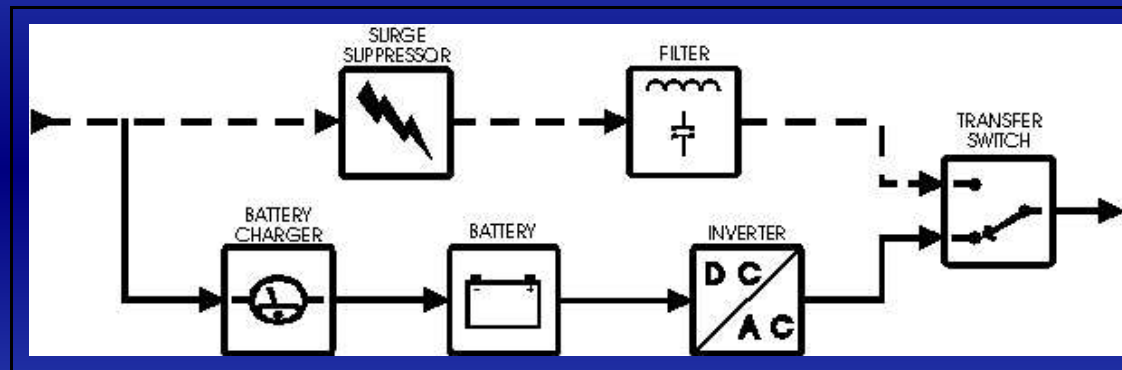


Block schematic of an APC Delta-Conversion UPS. Image ©APC Corp.

Power 101 - “True - Online” UPS

- ❖ “Traditional” UPS system
- ❖ Not available in small units - starts at ≈ 20 kVA
- ❖ Price is \approx \$1000-1250 AUD / kVA
- ❖ Line losses due to double conversion $AC \implies DC \implies AC$
- ❖ No switching time lag if mains power fails since continuously online
- ❖ Filter effect superior to line conditioner since the AC in and out are isolated from each other
- ❖ Will maintain constant frequency if connected to a generator

Power 101 - "True - Online" UPS



Block schematic of a Line-Interactive UPS. Image ©APC Corp.

Power 101 - “True - Online” UPS Problems

- ❖ All power is first rectified (converted to DC)
- ❖ DC power is inverted (Converted to AC)
- ❖ Full wave rectifiers push harmonics onto the supply system
- ❖ Harmonics can affect other electricity users
- ❖ Utilities are beginning to charge extra for harmonic distortion
- ❖ Power factor problems can also occur
- ❖ Power factor affects utility bills

Power 101 - Power Conditioning

- ❖ Interactive system similar to the Delta-Conversion circuit)
- ❖ Provides the inverse of the harmonics to remove them from the line
- ❖ Can provide savings of $\approx 10-20\%$ on electricity bills
- ❖ Cost of \$10,000 for 40 kVA unit
- ❖ Simpler and less expensive systems that use large capacitors are also available
- ❖ Capacitor systems primarily improve power factor

Power 101 - Power Conditioning

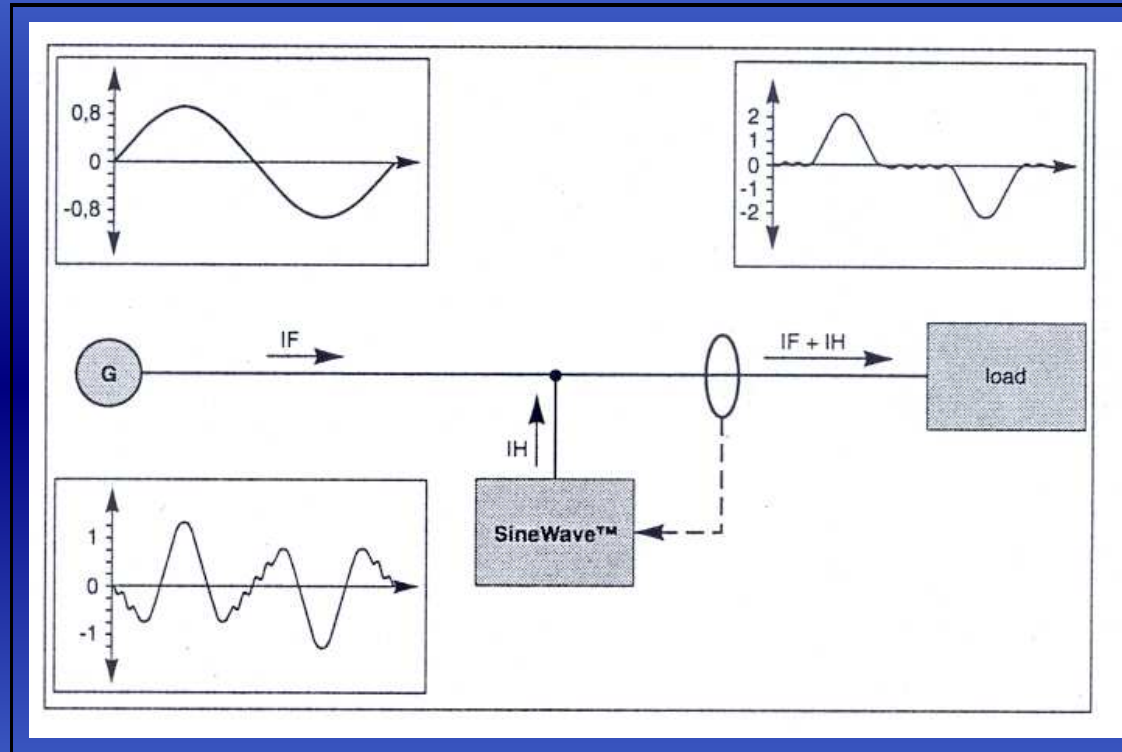


Diagram of an MGE SineWave Active Harmonic Filter with input and output waveforms. ©MGE UPS Systems.

Power 101 - Continuity of Supply

- ❖ Generally the continuity of electrical supply is good
- ❖ In CBD areas an outage of more than $1\frac{1}{2}$ to 2 hours is highly unlikely
- ❖ Away from the CBD but still in urban areas still reasonably safe
- ❖ But if continuous operation is critical just an UPS may not be enough

Power 101 - Transfer Switch

- ❖ Big electrical systems are typically supplied from multiple sources
- ❖ Unsafe to connect these sources continuously
- ❖ Automatic transfer switch connects to secondary supply if the primary fails
- ❖ UPS maintains the continuity of supply during the switchover
- ❖ UPS protects against switching spikes and noise

Power 101 - Generators

- ❖ High cost option
- ❖ Purchase price
- ❖ Maintenance and testing
- ❖ Remember to make sure the fuel tank is full
- ❖ Depending on the size of the tank can supply power for days

Power 101 - Conclusions

- ❖ More money = more security of supply
- ❖ A classic case of the “90 / 10” rule
- ❖ When setting up UPS systems remember ancillary equipment
 - Air-conditioning
 - Lighting
 - Security systems
- ❖ *Test* the system
- ❖ Set up automatic monitoring and shutdown to protect data
- ❖ Also needs an easily accessible “Panic Button”

Floor Systems

- ❖ Conventional approach to computer rooms is to have a raised floor
- ❖ Power supply system under the floor
- ❖ Communications cables may route under the floor
- ❖ Air-conditioning may also be supplied through the under floor space
- ❖ Easily removable floor tiles for access to the underfloor space

Floor Systems

A good floor system should:

- ❖ Be strong enough to support the equipment
- ❖ Be able to support moving equipment
- ❖ Be designed to be anti-static to reduce the danger to equipment
- ❖ Be relatively dust free to reduce the need for cleaning
- ❖ Have a suitable ramp to allow movement of equipment *or*
- ❖ Be on the same level as the normal floor

Available Floor Systems

- ❖ MDF Core tiles (with or without metal sheathing)
- ❖ All Steel tiles
- ❖ Concrete supports at the corners of the tiles
- ❖ Steel adjustable supports at the corners (These may have pins to lock into the tiles)
- ❖ Steel adjustable supports with steel “stringers” to connect the supports and support the edge of the tiles

Floor System Cost and Specifications

- ❖ Costs can range from \$125 to \$275 per square meter
- ❖ Installation is generally included
- ❖ Installation will cost more on weekends - this may be necessary for a renovation project
- ❖ Floor loads are expressed as the load on a 25mm square
 - Low end equipment at around 3kN or \approx 300kg
 - Top of the range ratings are \approx 6kN or 600kg
- ❖ Remember that the “real” floor also needs to support this mass
- ❖ A properly designed raised floor will distribute the load to the “real” floor

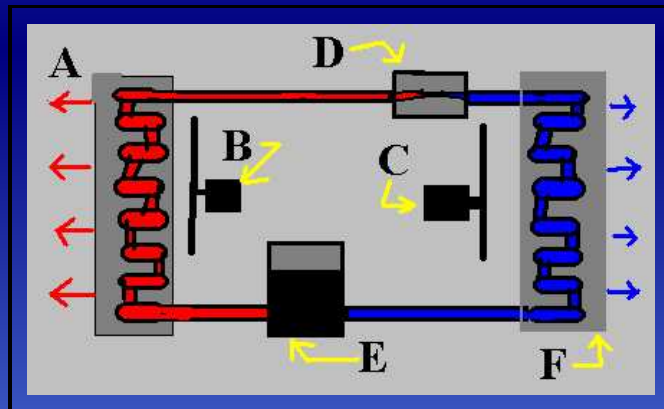
Other Floor Considerations

- ❖ Removing the old floor for a renovation job
- ❖ In a new building - consider having *all* of the floor raised
- ❖ Have the contractor cut holes in a number of the tiles
- ❖ Get extra tiles for future modification requirements
- ❖ If the room is designed for expansion - make sure the floor takes this into consideration
- ❖ UPS battery cabinets and data storage safes are *heavy*

Air Conditioning - General Issues

- ❖ Machine room air conditioning is special
 - Lower temperatures than offices (20°C)
 - 24x7 operation
 - Cooling in mid-winter - not quite as unusual any more
 - Potential problems with humidity
- ❖ Property services groups often do not appreciate these issues
- ❖ Consultants may miss the issues also, depending on their focus

Refrigeration Type Air Conditioning



- A - Hot air to Outside
- B - Fan to help improve heat transfer from coils to outside.
- C - Fan for more efficient transfer of cool air to inside.
- D - Expansion Valve
- E - Compressor
- F - Cool Air to Inside

Diagram of Refrigerant Type Air-Conditioner

Chilled Water Air Conditioning

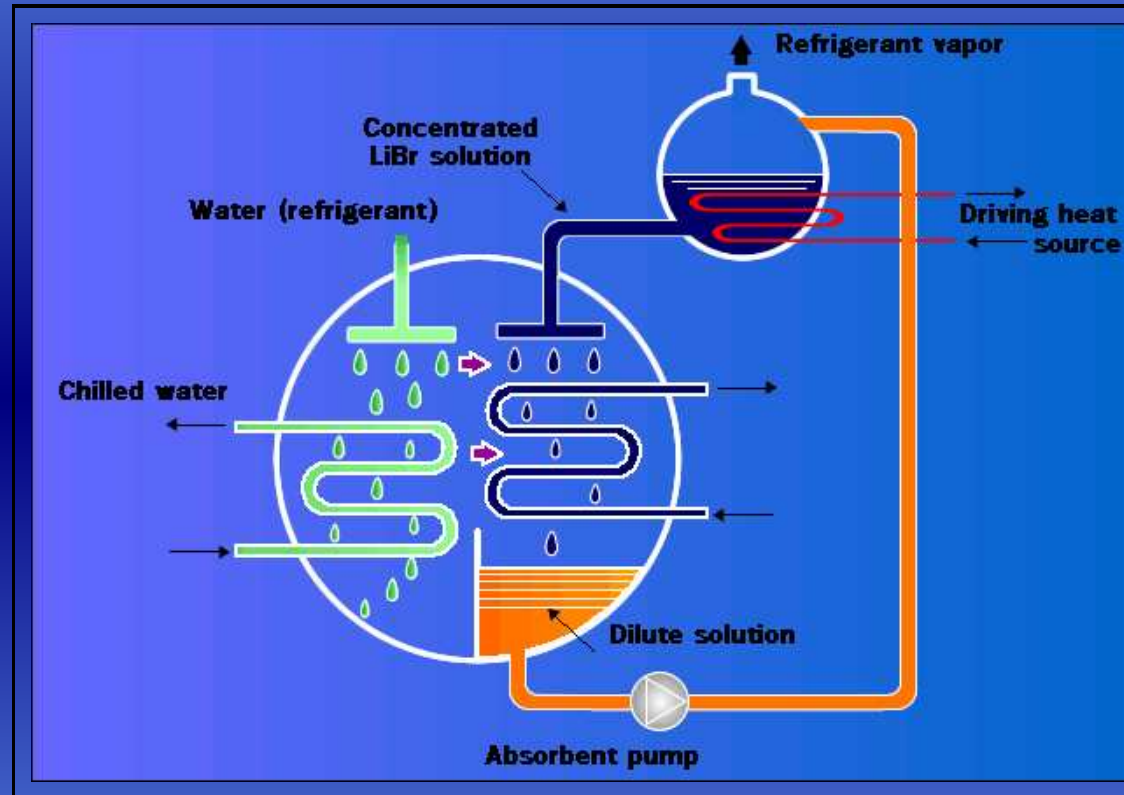


Diagram of a chilled water air conditioning system that operates from heat input

Chilled Water Air Conditioning

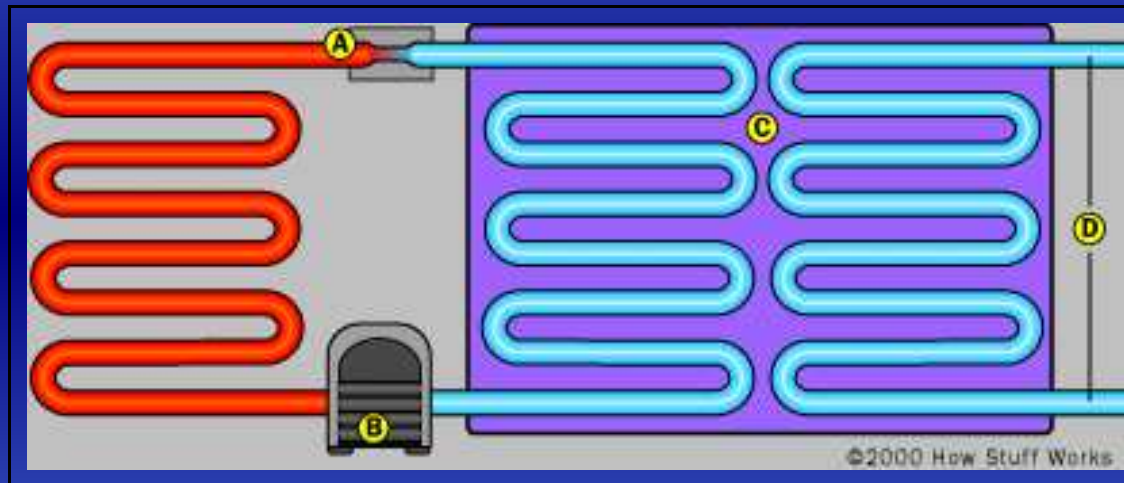


Diagram of a chilled water air conditioning system

Air Conditioning - Chillers

Refrigeration systems are not the only option

- ❖ Chilled water
- ❖ Large system on roof or in mechanical room
- ❖ Generally uses a “cooling tower”
 - Can be a source of Legionella
 - High maintenance
- ❖ Water in the vicinity of the machine room is a risk
- ❖ But can be used to achieve lower temperatures

Air Conditioning - Chillers *continued*

- ❖ Depending on property management strategy may not run 24x7
- ❖ Potentially a single point of failure
- ❖ Will probably still need humidity control
- ❖ Can have the wet part in the next room
 - Use ducting to carry cold air to where it is needed
 - Both output and return ducts may be required
 - Suitable drains to protect the machine room

Air Conditioning - Conclusions

- ❖ Make sure that property services and consultants understand requirements
- ❖ At a room temperature of 20°C the CPU temperature may approach 50°C
- ❖ This will only get worse as the speed of systems increase
- ❖ Relying on a single system may be too much of a risk
- ❖ If using several smaller systems the controls should allow integrated operation

Air Conditioning - Humidity

- ❖ Low Humidity is not an obvious issue
 - Static electricity
 - Air conditioner icing problems
 - 50% is about right
- ❖ High humidity is no good either
 - Moisture and electrical circuits
 - Corrosion
 - Non-condensing
- ❖ Why low humidity can contribute to icing
- ❖ PHB and the evaporative cooler

Security

- ❖ If an attacker gains physical access to machines - game over
- ❖ But remember that backup tapes are potentially an equal risk
- ❖ Access control is required
 - Keyed lock
 - Digital keypad locking system
 - Swipe card system - centrally controlled
- ❖ Central control can mean that *they* think that they control who has access

Security

- ❖ Swipe cards can control both who and when
- ❖ Who needs to be on the access list?
- ❖ When do they need access?
- ❖ Political hot potato - management support of policy is required
 - CEO and managers do not really need access
 - Better to escort them and be able to explain features
 - Tradespeople
 - Contract cleaners
- ❖ Maybe it's just paranoia, but a cleaner seems to have an ideal opportunity for espionage

Security

- ❖ Escort anyone who is not an administrator
 - Unintentional damage
 - Power disturbances
 - Moving delicate equipment
 - Dust and dirt

Security

- ❖ Video recording system
 - A record of what happened
 - May be important if there are access issues
 - Possibly vital in a shared room

Tape Storage

- ❖ Off site storage is best
- ❖ But some on site storage improves speed of restore
- ❖ Fire-resistant safe
- ❖ These are seriously heavy
- ❖ Consider making duplicates to send off site

Fire Suppression

- ❖ Sprinkler systems - **Help!**
- ❖ Dry chemical fire extinguishers - **Oh No!**
- ❖ Ordinary CO_2 fire extinguishers - still a problem
- ❖ Specialised systems are required
 - Halon was great - but an environmental disaster
 - Bulk CO_2 is an option
 - Inergen seems like a good idea since it allows breathing
 - Automatic system

Rack Systems

The argument in favour of generic racks

- ❖ Generic racks can be adapted to a variety of equipment
- ❖ Can provide a consistent and integrated appearance
- ❖ Can be customised to meet local needs
 - Adding a communications conduit on the side opposite the power
 - Three-phase power for large systems
 - Two single phase supplies for redundant power supplies
- ❖ Can be cheaper than proprietary racks of equal quality

Proprietary Racks

- ❖ May be a problem to mount “Brand *x*” equipment
- ❖ May provide specialised features for the particular equipment
- ❖ Built-in UPS systems
- ❖ A “Beige Wall” of a particular brand equipment may look impressive
- ❖ But this may lock you into equipment from the supplier

Communications Cabling

- ❖ Under floor
- ❖ On walls
- ❖ Suspended from the roof

Under Floor

- ❖ Out of sight
- ❖ Power is usually there also
- ❖ Electrical induction can be an issue
- ❖ Induction not an issue with fibre
- ❖ Disciplined approach to installing and removing cables

Roof or Walls

- ❖ In clear view
- ❖ Usually away from the power circuits
- ❖ In cable trays - clear covers? - easily removable
- ❖ Could look messy - even if it is a lot neater than an under floor

Who Owns the Communications

- ❖ Central group
 - Problem with the control
 - May need large risers into the room and a local patch panel
 - Having a requirement that the central group does all comms is often inefficient
- ❖ Locally administered
 - Communications hub in a corner of the room is easy to manage
 - Main routers and backbone switching
 - Interconnections for the systems in the room
- ❖ Whatever you do - remember spare ports for growth

Other issues

- ❖ Mains panel with space for more circuit breakers
 - Saves or eliminates downtime when adding powerpoints
 - Upgrading the panel in future is expensive
 - Price difference upfront is minimal
- ❖ Monitoring systems
 - Temperature
 - Humidity
 - Power supply
 - Critical systems

Finding Suppliers

- ❖ Organisation may have preferred contractors
- ❖ The World Wide Web - many companies publish a lot of information
- ❖ The Yellow Pages
- ❖ SAGE-AU Mailing list
 - Off the record
 - Good and bad stories
 - Still your decision

Project Management and Co-Ordination

- ❖ Keeping it all on track
- ❖ Define the critical path
- ❖ Check with the contractors to make sure they can meet their targets
- ❖ Build a bit of slack into the timetable
- ❖ Possibly work backwards from the target time

Renovation Project Considerations

- ❖ Keeping critical systems online
- ❖ Protecting systems from the works
- ❖ Liaison with the contractors
 - Get them what they need
 - Make sure they meet the requirements
- ❖ Is temporary power or air conditioning an option?
- ❖ The inevitable spanner in the works

Machine Room Projects

Good Luck!

References

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