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

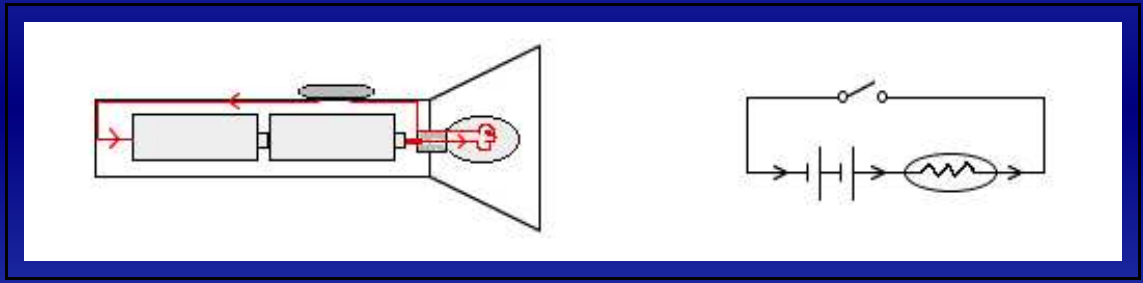


Diagram of a hand torch showing the electrical circuit

Power 101 - Parallel Circuit

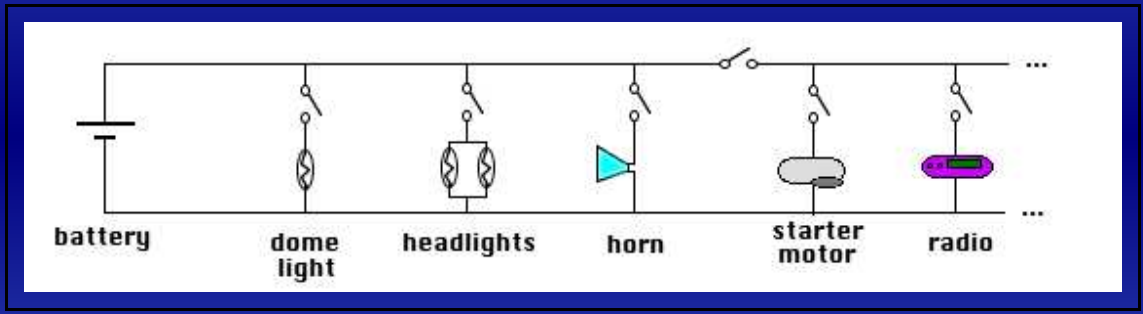


Diagram of the electrical system of a car showing a parallel circuit

Power 101 - Alternating Current (AC)

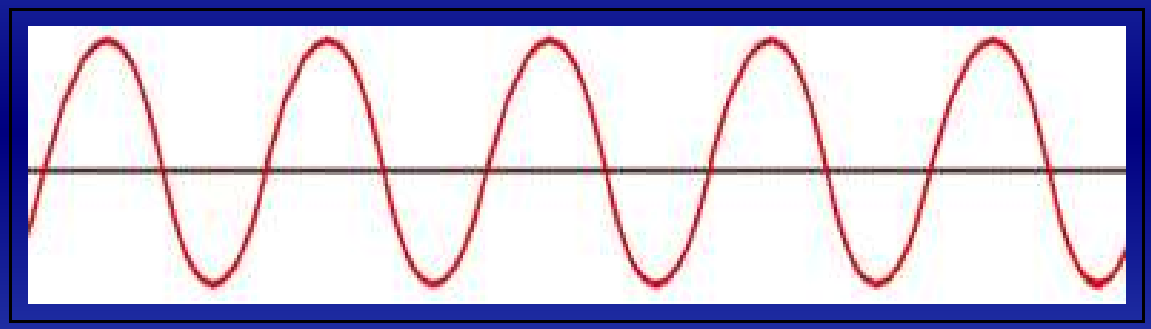


Diagram of a sin wave

Power 101 - Power Factor

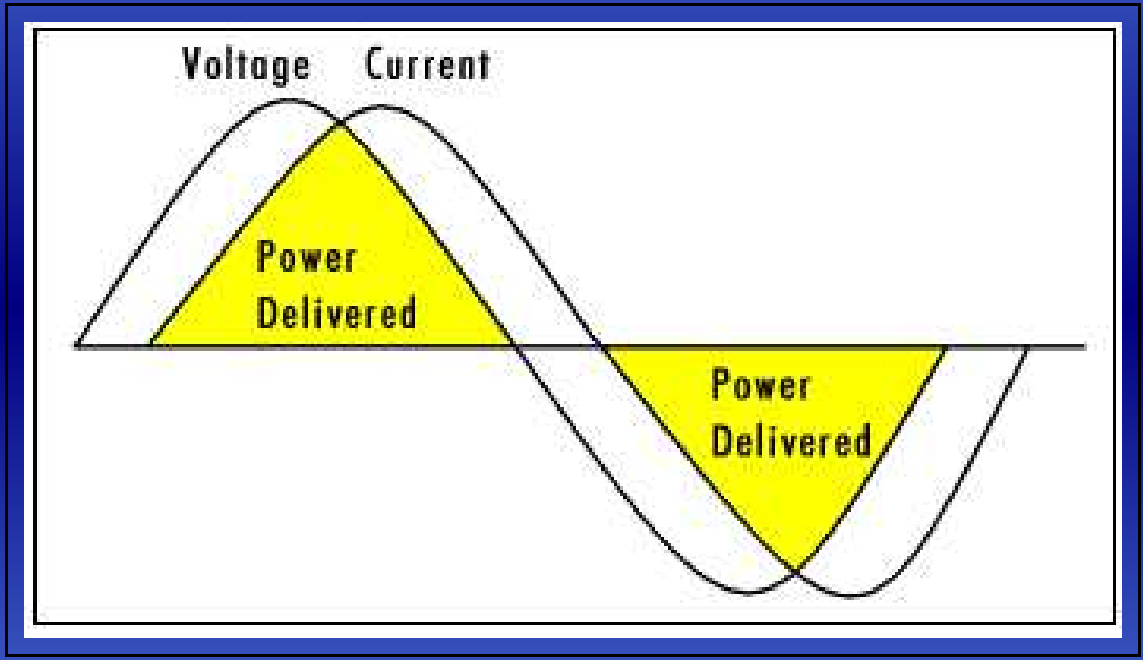
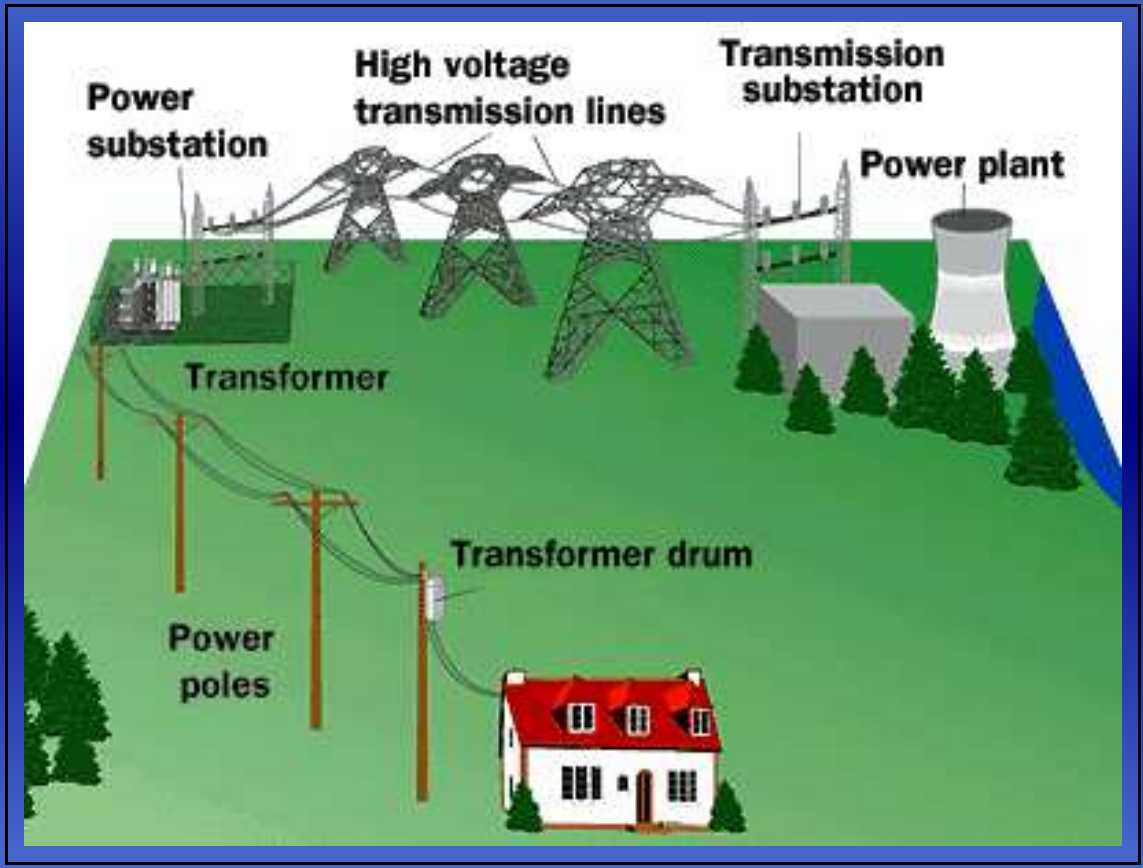


Diagram of the sin waves for current and voltage in an example circuit

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

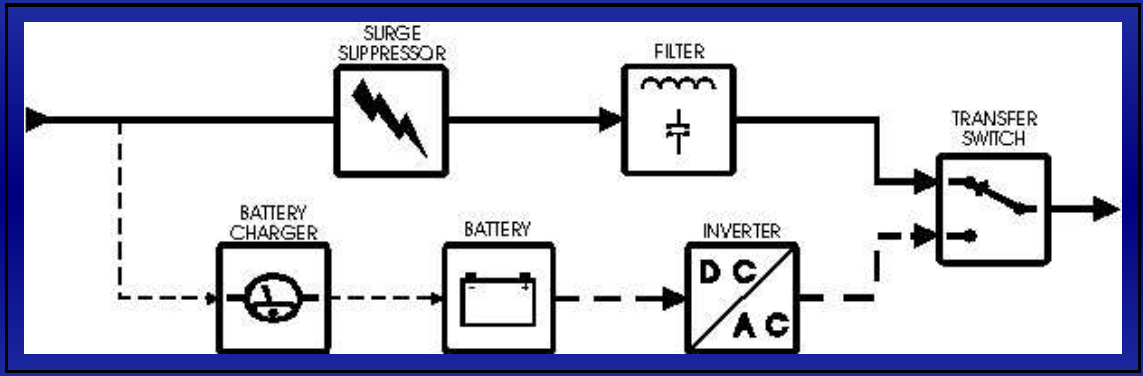
Power 101 - Line Conditioning

- Electrical Filter - reduces the waveform disturbances
- Typically a "passive" device
- Cannot fix everything
- Equipment is still connected to the mains
- Really *b*ig 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

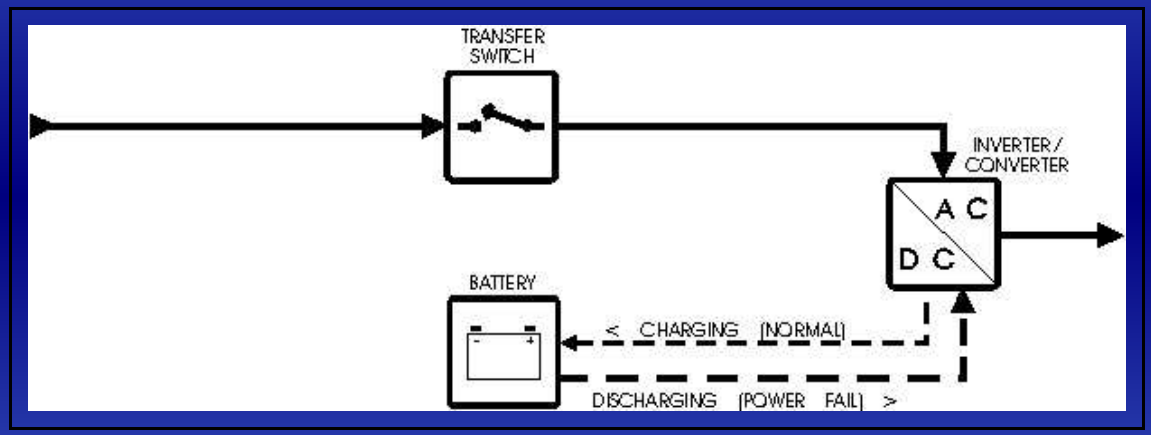


Block schematic of a standby UPS. Image ©American Power Conversion Corp.

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

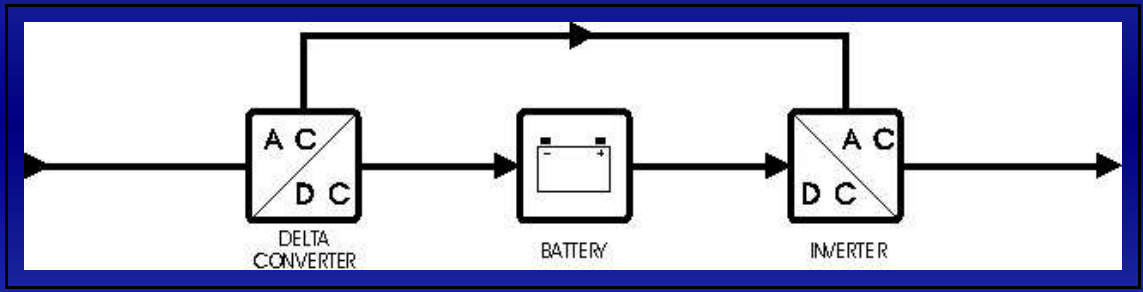


Block schematic of a Line-Interactive UPS. Image ©APC Corp.

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

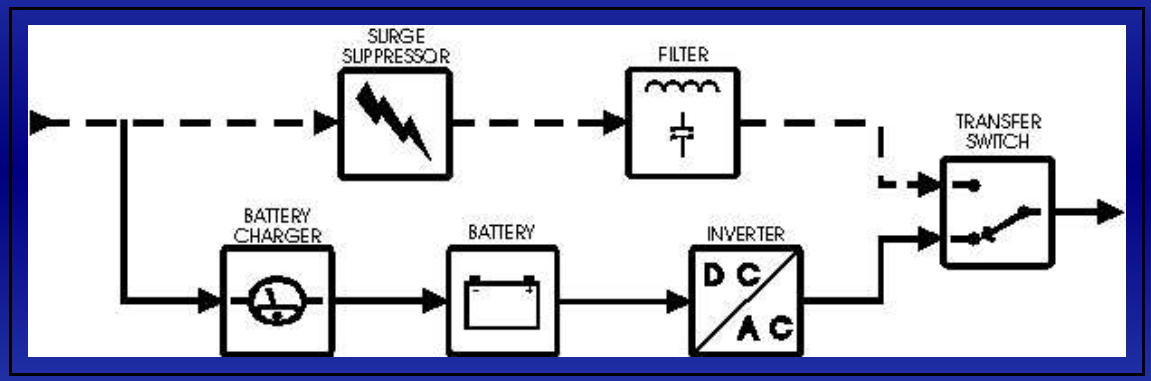


Block schematic of an APC Delta-Conversion UPS. Image ©APC Corp.

Power 101 - "True - Online" UPS

- "Traditional" UPS system
- Not available in small units - starts at $\approx$ 20 kVA
- Price is $\approx$ \$1000-1250 AUD / kVA
- Line losses due to double conversion $AC \Longrightarrow DC \Longrightarrow AC$
- 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

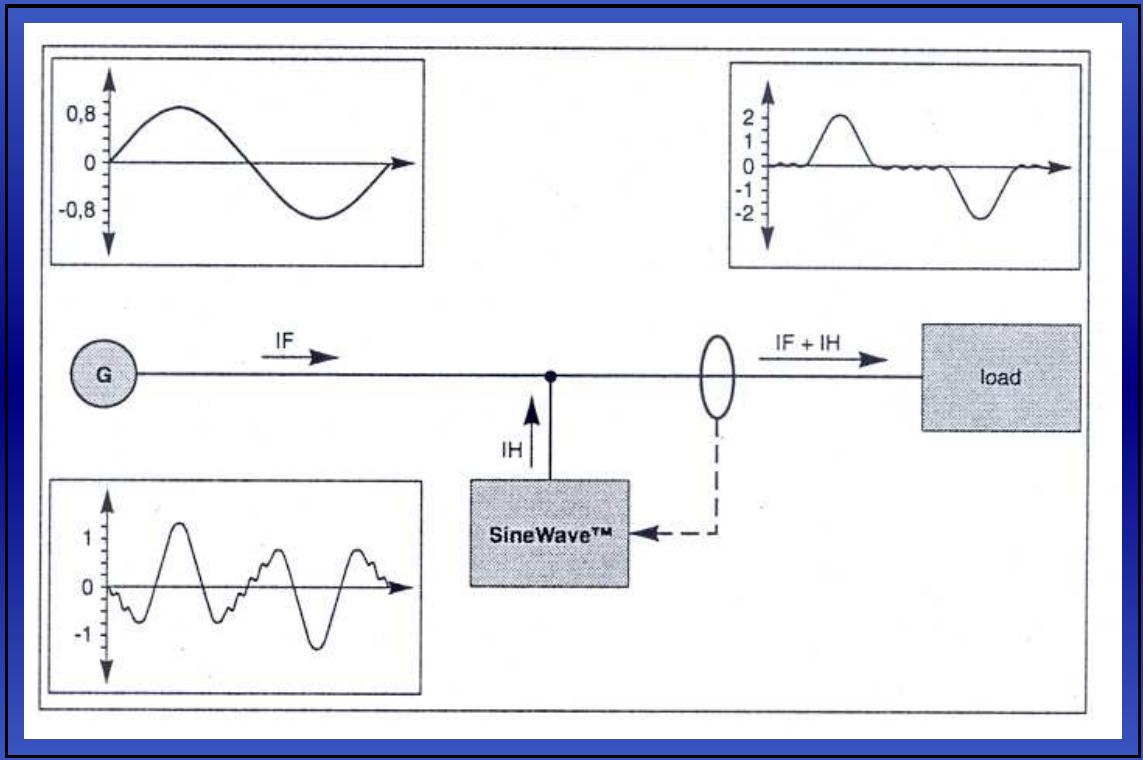


Diagram of an MGE SineWave Active Harmonic Filter with input and output waveforms. ©MGE UPS Systems.

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

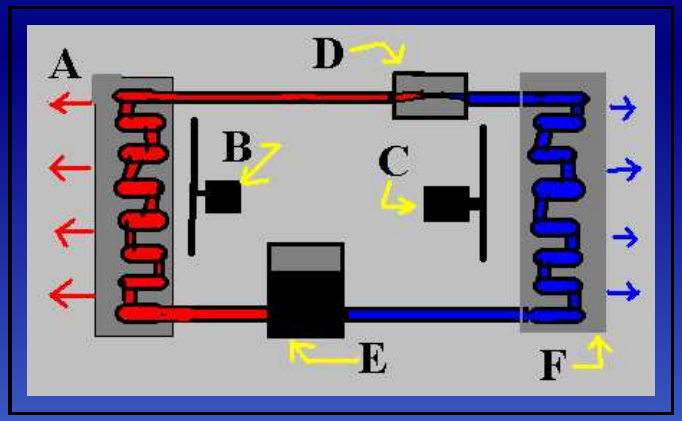
Other Floor Considerations

- 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

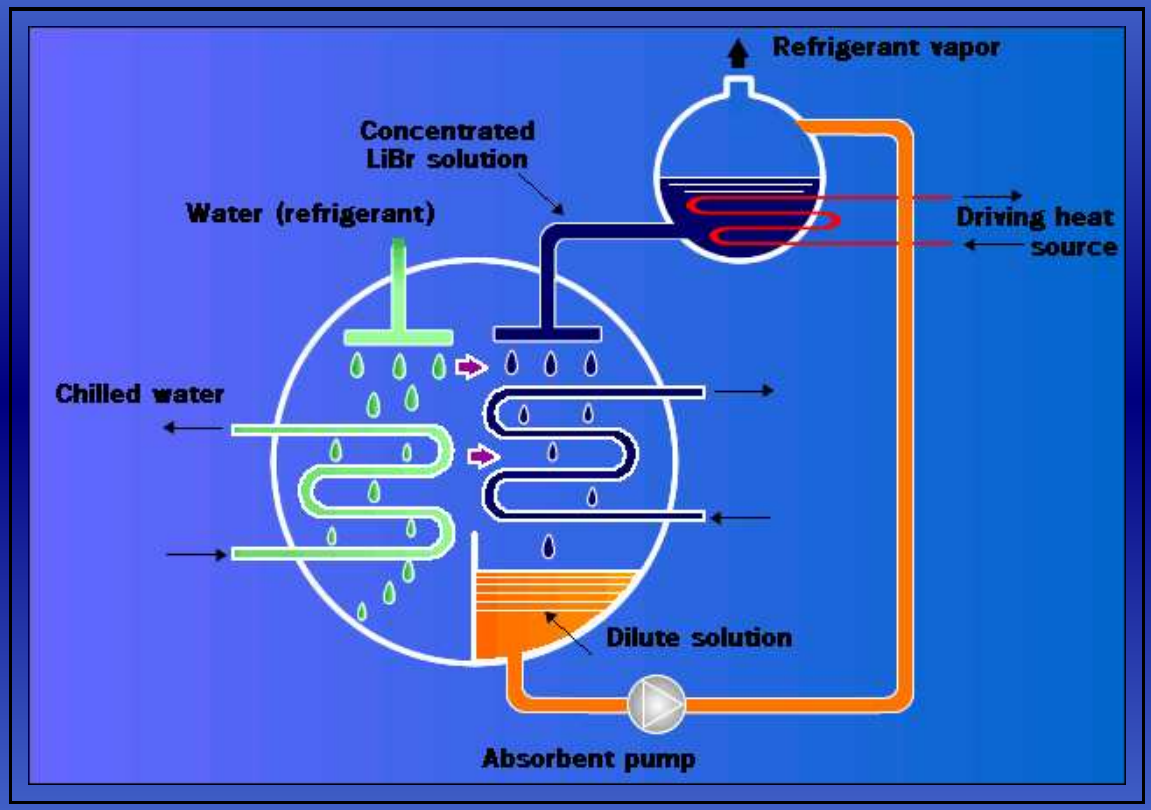


Diagram of a chilled water air conditioning system that operates from heat input

Chilled Water Air Conditioning

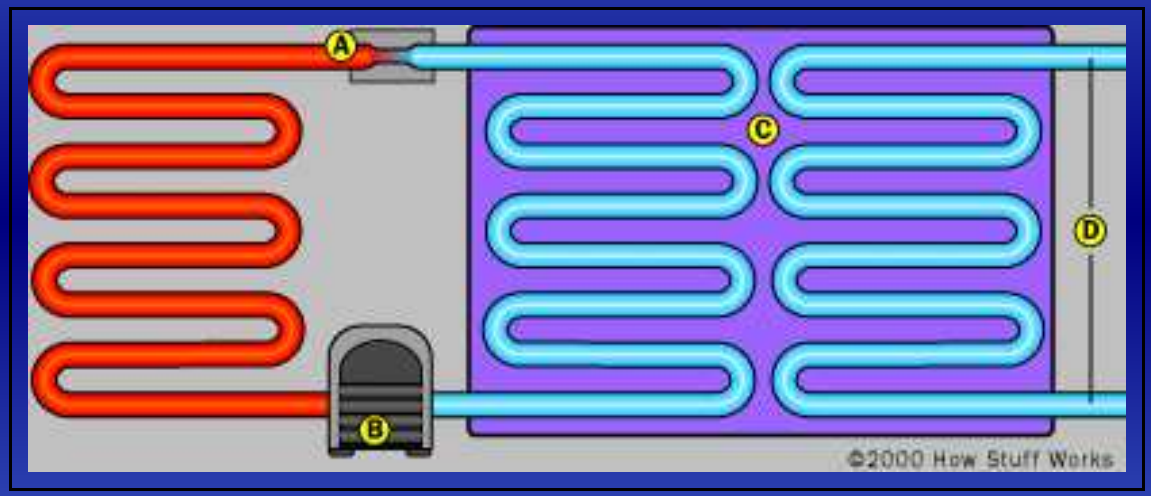


Diagram of a chilled water air conditioning system

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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- More air conditioning and chiller stuff -
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