

# Computer Centre Upgrade

## Status & Plans

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Tony.Cass@[CERN](mailto:Tony.Cass@CERN.ch).ch

# The Plan (June 2001)

- ◆ Configure the vault as a second Machine Room
- ◆ Install new computing equipment in the vault
- ◆ Rework *This Talk* supply to B513
- ◆ Renew the UPS configuration  
*Critical UPS with substation.  
Physics UPS in 06-08*
- ◆ Renew *This Talk* Room power distribution, air conditioning and fire protection





# The Substation

# A New Substation for B513

- ◆ Under the car park between B513 & Restaurant 2.
  - location selected 2001, agreement in principle at Site Committee in February 2002.
- ◆ Initial design in October 2002, refined since.
  - Approved by the Site Committee on 7<sup>th</sup> May
  - Tender sent out on 16<sup>th</sup> May; Deadline for reply is today, envelope opening ~ July 7<sup>th</sup>.
    - » 4 companies seem interested
  - Construction to start in August, finish by March 2004
    - » will lead to temporary loss of ~20 parking spaces so consider using Salève side car park.
    - » some car pool spaces will need relocating permanently.
  - Electrical equipment installation from April/May 2004
  - Commissioning after accelerator shutdown in November 2004.











# Supply Failure & Maintenance Issues

- ◆ In addition to supporting a computing load of up to 2.5MW, the new substation design includes reliability and redundancy features to increase the likelihood that we can run uninterrupted for long periods.
  - This extends to aspects of the design in the machine room—e.g. dual power inputs for the PDUs.
- ◆ The next few slides present the impact of failure at the various different levels
  - 18kV supply
  - 18kV switchboards
  - Transformers
  - 400V switchboards
  - UPS modules.

# 18kV Supply

- ◆ Improved redundancy of 18kV supply as B513 will be in the 18kV loop, not on a spur.
- ◆ Up to 250kW of equipment maintained indefinitely on Diesel power.
  - The Diesel Generators are now tested annually. IT must insist this continues.
- ◆ No power for physics systems if both EDF and EoS supplies fail (i.e. the autotransfer mechanism fails)
- ◆ Temporary supply is available from the West Area to cover tests. The power available is limited to 6.5MVA, but is adequate to cover needs in winter.
- ◆ Frequency:
  - Failure: ??
  - Maintenance: Annual

# 18kV Switchboards

## ◆ Two Cases:

- Switchboard for safety systems and critical IT services
  - » Failover system guarantees continued power. Although this is limited to a maximum of 2MVA, the safety systems and critical service load is anyway limited to less than 2MVA by the power available from the Diesel Generators.
- Switchboard for general and physics services
  - » Maximum of 1.2MVA available from the safety system switchboard. This is enough to support a reduced level of air conditioning in the vault and the machine room, adequate to support the 250kW critical load.
  - » No power available to support the physics load.

## ◆ Frequency:

- Failure: extremely rare
- Maintenance: Every 10 years

# Transformers

## ◆ Two cases

### - Transformer for Physics services

» Failover system ensures continuity of power, but systems behind UPS system connected to failing transformer are at risk from any power fluctuations. Full UPS protection can be assured (even with one transformer down), but this requires a manual intervention.

### - Transformer for general services

» Failure leads to loss of power for part of the overall equipment. This will include part of the air conditioning equipment and the reduced cooling capacity will not be sufficient to maintain acceptable conditions should the failure occur in summer.

» Manual intervention allows load of up to 2MVA which is adequate to support the power needs of air conditioning in winter.

## ◆ Frequency

- Failure: extremely rare

- Maintenance: annual, but cut required only every 3 years

# 400V Switchboards

## ◆ Same two cases

- Switchboard for Physics services
  - » Failover system ensures continuity of power, but systems behind UPS system connected to failing switchboard are at risk from any power fluctuations. Full UPS protection can be assured (even with one switchboard down), but this requires a manual intervention.
- Switchboard for general services
  - » Failure leads to loss of power for part of the overall equipment. This will include part of the air conditioning equipment and the reduced cooling capacity will not be sufficient to maintain acceptable conditions should the failure occur in summer.
  - » Manual intervention allows load of up to 2MVA which is adequate to support the power needs of air conditioning in winter.

## ◆ Frequency

- Failure: extremely rare
- Maintenance: every 6 years

# UPS Modules

- ◆ Each UPS system has N+1 redundancy, i.e. failure of a single module is transparent for the load. Two modules must fail for there to be any impact.
- ◆ UPS module failure normally switches systems to the standard mains supply. If two UPS modules fail:
  - No loss of service, but physics systems would run unprotected.
  - UPS coverage maintained for systems with redundant power supplies connected to critical and physics UPS.
- ◆ If failure of two UPS modules leads to loss of power
  - 1/3<sup>rd</sup> of physics services lost
  - systems with redundant power supplies connected to critical and physics UPS continue running.
- ◆ Frequency
  - Failure: ~once per 10 years catastrophically
  - Maintenance: Annual, but exposure to mains failure only during bypass module maintenance (~2 hours).



# Reliability Conclusions

- ◆ Overall, there is an improved level of reliability and redundancy as compared to the present situation.
  - c.f. changes to earthing arrangements following incident in April.
- ◆ In itself, the electrical supply system should allow continuous operation of the computer centre over a long period.
  - Unfortunately, maintenance on the 18kV switchboards requires a shutdown every 10 years.
- ◆ BUT: both a smooth power supply and adequate air conditioning are required. Improved redundancy of supply to the air conditioning system is desirable. This is being studied now.

# The Machine Room

# Machine Room Upgrade: Why?

## ◆ More Power

- We want to be able to use up to 2MW
  - » c.f. 600kW available today
  - » requires normabarre density for ~3MW for flexibility

## ◆ Better layout

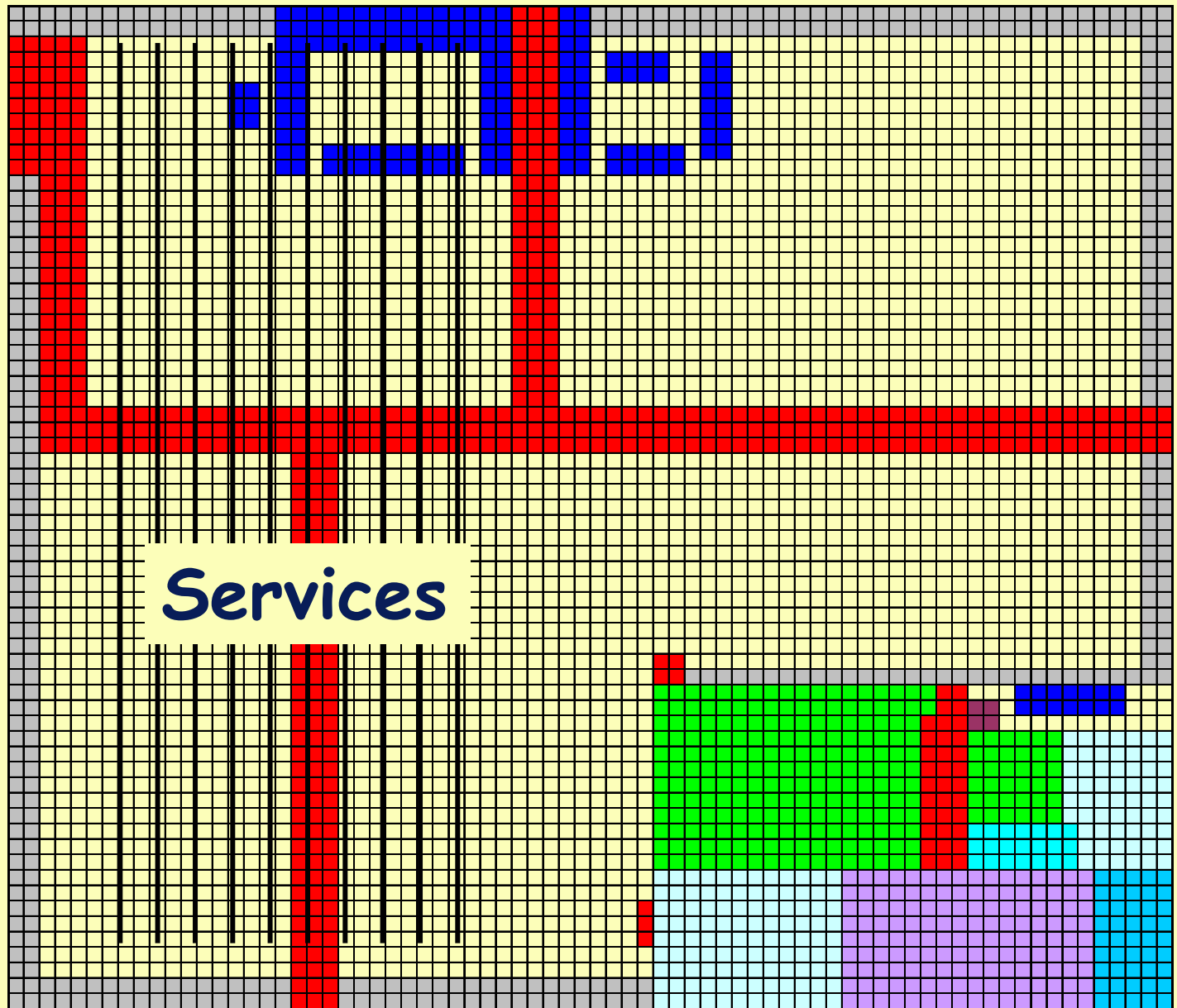
- Have only related services connected to a given normabarre
  - » today's layout causes confusion during power failures
    - ◆ (although these won't happen in future...)

## ◆ And, while we're at it, clean up rubbish and obsolete cables from the false floor void.

- Likely to be air flow under the false floor

# Current Machine Room Layout

Problem:  
Normabarres  
run one way,  
services run the  
other....



# Proposed Machine Room Layout

9m double rows  
of racks for  
critical servers

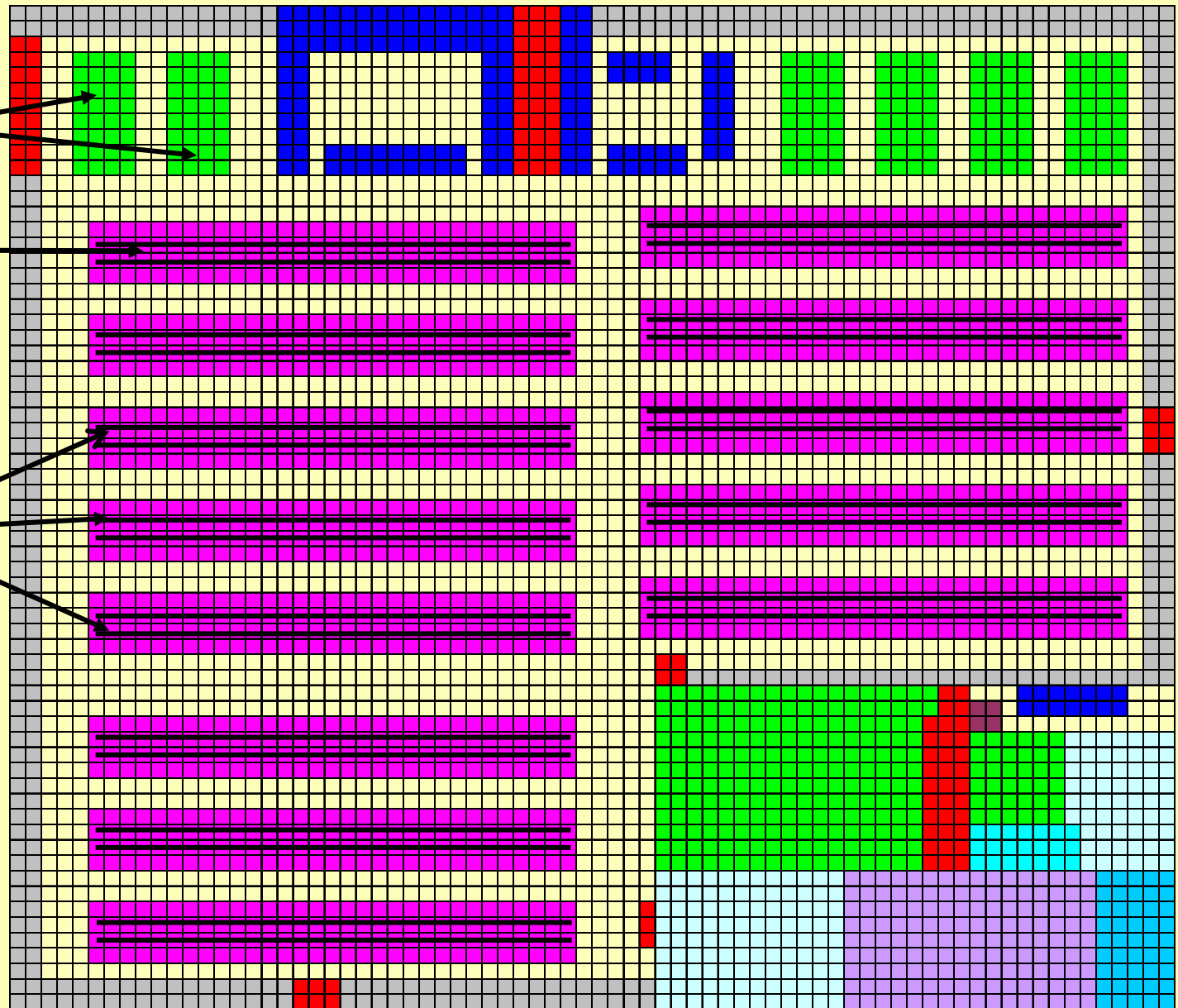
Aligned  
normabarres

18m double  
rows of racks  
12 Mario racks  
or 36 19" racks

528 box PCs  
105kW

1440 1U PCs  
288kW

324 disk servers  
120kW(?)



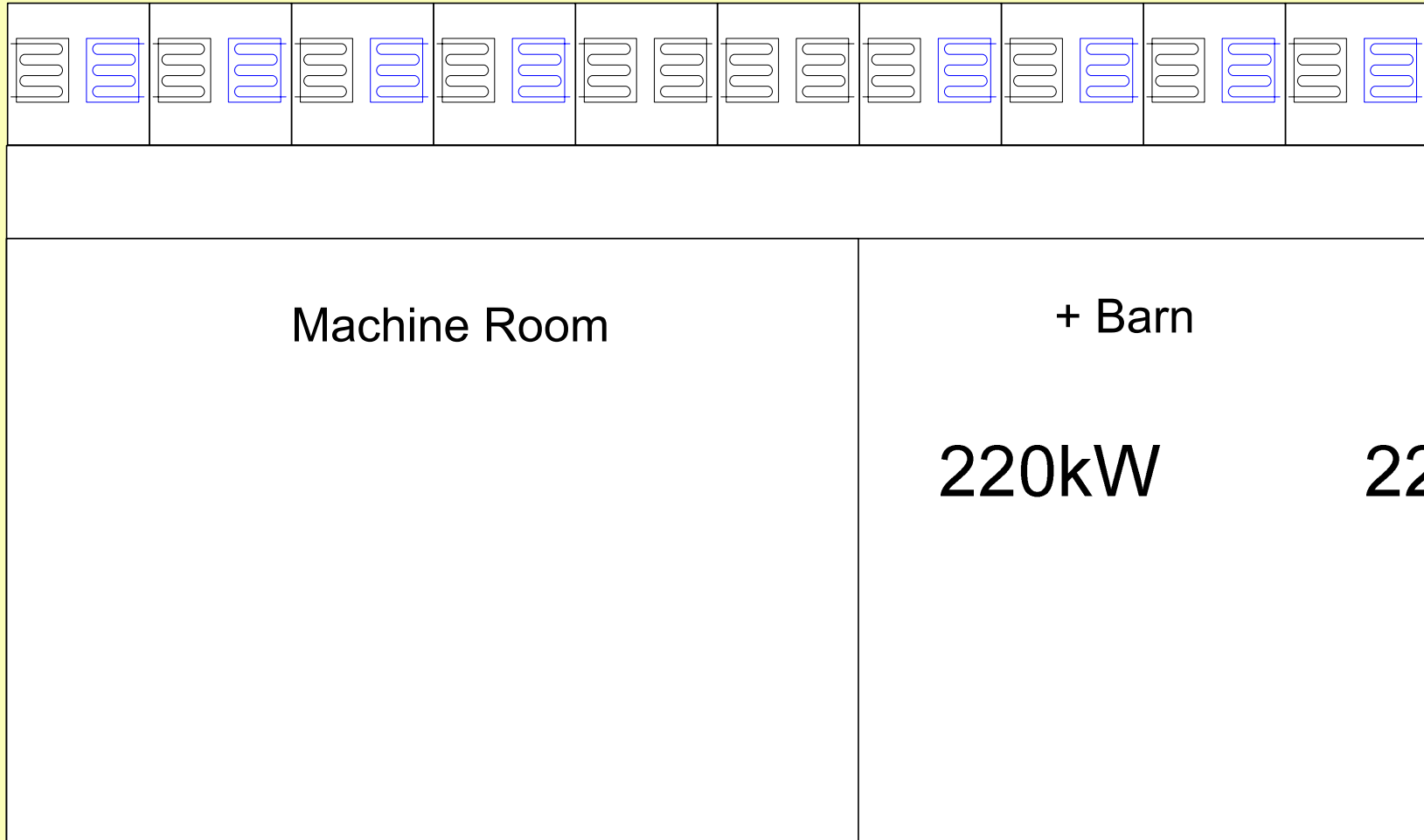
# Power Distribution

- ◆ One PDU per 18m double row
  - 400A/phase, supports load up to 260kW
  - 4 9m normabarres in 2 pairs
    - » 27 connections
    - » 50A/phase for systems without power factor correction
    - » 100A/phase for power factor corrected systems
  - 1 18m normabarre
  - 1 outlet unused
- ◆ 12 PDUs for Physics
  - 3.1MW total
    - » we will not be (greatly) limited by the available power when locating racks and services
      - ◆ BUT: problems with, e.g. disk servers which need 3 16A sockets each. We need to reduce the impact redundant power supplies have on the use of normabarre connections.
- ◆ Other PDUs as necessary for critical equipment
  - including power to networking areas in Salève side corridor

# Power Factor Correction

- ◆ Power supplies on early PCs had a power factor of only 0.7.
  - This gives high currents in the neutral conductor and the electrical distribution must be designed carefully.
  - Filters installed at the PDU level give overall power factor correction so the UPS sees a well behaved load.
    - » Without filters, bigger UPS and upstream PDUs are required
- ◆ EU directive requires PC systems delivered after 1<sup>st</sup> January 2002 to have power factor correction.
  - Latest batch of PCs have power factor better than 0.95.
- ◆ We propose to assume power factor of 0.95 for future equipment.
  - Avoids purchase and installation of filters (save ~500KCHF)
  - PDUs can support full 400A/phase, (without correction, current in neutral conductor reaches 400A at about 250A/phase).
    - » Need ~14 PDUs, not ~21 → further financial saving.

# Machine Room Air Conditioning



- ◆ Upgrade needed...
- ◆ B513 corridors will not be able to take cold air from the machine room.

Upgrade

445kW

445kW

445kW



# Air Conditioning Upgrade Plans

- ◆ Detailed air conditioning upgrade plan still in preparation. Key points as they are understood today are
  - additional chiller to be installed in 2005 (once the new substation is commissioned)
  - Machine room cooling probably requires at least some cold air to be routed under the false floor
    - » some ducting exists already on Salève wall. More may be needed.
  - Need to improve redundancy
    - » or, at least, understand the impact and frequency of the different possible failures of critical elements (including the difference between failure in winter and in summer).
- ◆ Major upgrade foreseen for Winter of 2004/5.

# Some Small Issues

# Two concerns

- ◆ Will power demand exceed capacity of current UPS before 2006?
  - If so, use the 250kW UPS to provide additional capacity (850kW total). Supply redundancy delayed until 2007.
- ◆ 61cm<sup>2</sup> floor tiles are no longer available.
  - 520 tiles bought in 2001—all of the remaining stock from Steel Systems.
    - » They said we would be able to buy more later, although at a significantly higher price, but now say they can no longer do this.
  - Stock expected to be enough for 10 years, but we should go carefully.
  - Long term, consider replacing the false floor in offices, corridors and the barn to liberate tiles for the machine room.

# Summary

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- ◆ Substation construction to start soon
  - Apologies for the disruption...
  - Commissioning at end of 2004
- ◆ Future Machine Room Layout firming up
  - Comments/objections soon!
  - Electrical supply upgrade to start from September.
- ◆ Power factor of at least 0.95 assumed for future equipment.
- ◆ Air conditioning upgrade being planned now
  - Would like increased redundancy
  - Almost certain to be air flow under the false floor
  - B513 corridors will no longer be able to extract cold air from the machine room.