A New Vision for the Computer Centre

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The Team

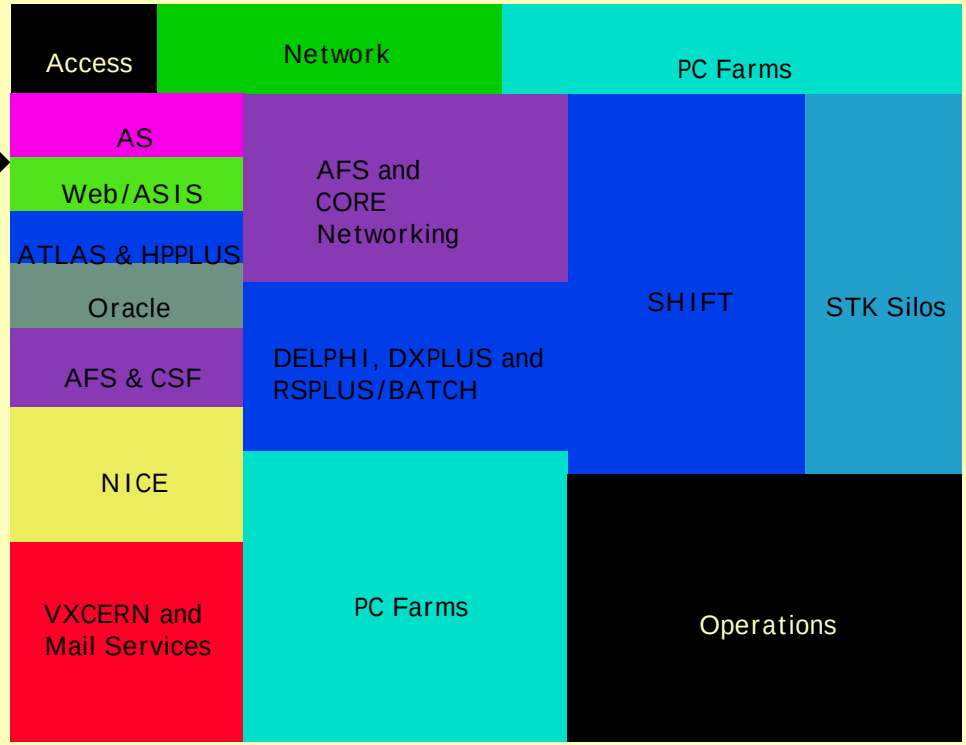
- Tony Cass, Dave Underhill, Mario Vergari, Dick Minchin and Tim Whibley.

- Anne Funken—ST Project Manager and Electrical planning.
- Jukka Lindroos—Air conditioning planning.

- Roland Bachelard—Historical information about B513.
- Nigel Baddams—Civil Engineering consultancy.

Objectives

Turn this ➔



into a computer centre for LHC era computing.

Estimate of LHC infrastructure needs:

- raised floor area of at least 2000m^2
- equipment with total power consumption of 2MW.

Requirements (Logical Order)

- Additional space (at least 1000m^2)
- Additional (and more reliable) power
- Additional cooling

- Improved fire precautions
- Improved isolation/separation of services

- Improved manageability

Requirements (Practical Order)

- Additional space (at least 1000m^2)
- Additional cooling
- Additional (and more reliable) power

- Improved fire precautions
- Improved isolation/separation of services

- Improved manageability

Space, the Final Frontier

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- Where can we find an extra 1000m^2?
  - **Why bother? Use the full machine room height.**

    But, as discussed last year, extra height racking has to be positioned carefully with respect to air conditioning equipment and more clearance is needed. Overall, the space gain is small—4-500m^2.

Space, the Final Frontier

- Where can we find an extra 1000m^2?
  - Why bother? Use the full machine room height.
  - **Use the Barn.**

    *This is **an attractive solution**. The Barn was always imagined as overflow space and the 800m^2 available is OK at a pinch. However, it would probably be difficult to move the current vault occupants in the short term. This is also not a cost free option—equipment in the barn competes with offices for air conditioning capacity.*

    *The Barn is a **good backup solution** if we need more space in the future—if we have underestimated needs or for other purposes (e.g. CIXP)—but is not the best solution now.*

Space, the Final Frontier

- Where can we find an extra 1000m^2?
  - Why bother? Use the full machine room height.
  - Use the Barn.
  - **Use the Vault.**

    *This is **a very attractive solution**. About **1100m^2** of space is available today and **more could be recuperated** if we remove obsolete installations—such as the MG room air conditioning.*

    However, clearance is limited. The height available is only 3470mm and some 700mm is taken up by cable trays and air conditioning ducts. A false floor of even 500mm reduces clearance to just 2270mm—less than is needed for STK silos.

Space, the Final Frontier

- Where can we find an extra 1000m^2?
  - Why bother? Use the full machine room height.
  - Use the Barn.
  - Use the Vault.
  - **Install a Mezzanine.**

    Another attractive option*—and one that has been explored before.*

    However, a mezzanine floor above the machine room or the barn creates air conditioning problems for the space below. Money is needed to remedy these problems.

    Additionally, mezzanine installation costs must be added to the costs for equipping the equipment area.

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- A Computer Room consultancy firm favoured the Mezzanine option over adapting the vault.

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  - Use the Vault.
  - Install a Mezzanine.

- A Computer Room consultancy firm favoured the Mezzanine option over adapting the vault.
  - But **only** on the grounds of *limited clearance* in the vault. Can we **increase the clearance**?

Vault Air Conditioning Options

- **Initially**, we considered an air conditioning system with **plant in the old MG room** and **ducts** to **distribute cold air** and **recuperate hot air**.
- However, **all the computer centres** we visited **use "in room" air conditioning units**.
- This solution has been investigated for the vault.
  - In room units **do not need ducts**, thus **increasing clearance** by at least 200mm.
  - In room units require **less space**.
  - In room units **are cheaper**.

Proposal

The **Vault should be used** to provide the additional space required for LHC Computing.

If we have underestimated space requirements then the Barn is available for overflow.

Power Supply to and within B513

- Current arrangements
  - Two 2MVA transformers in B513 are fed by a spur from the sitewide 18kV loop.
  - We have a 1.2MW UPS with battery capacity for 10 minutes at rated load.
  - Low voltage distribution is via Normabars.
- Current disadvantages
  - We are vulnerable to problems in the substation feeding the spur.
  - UPS coverage is insufficient for anything but the shortest interruption.
  - ST have to intervene to install normabar connections.
  - There is no clear division of services across power connections—one Normabar supplies many services.

Upgrading the High Voltage Supply

- ST propose to include B513 in the 18kV loop.
  - Requires extra equipment—such as 18kV switchgear.
- Supporting an active load of 2**MW** requires four 2**MVA** transformers.
  - 2MW > 2MVA given the nature of the load, so two transformers are needed, plus an additional transformer for redundancy and a fourth for critical loads (including air conditioning!).
- The transformers, high voltage and low voltage switchgear must be in close proximity and will occupy some 180m^2.
  - Of this, some 40m^2 for the transformers should normally be external to B513.

UPS considerations

- What are the likely needs for a UPS?
  - To cover microcuts and smooth supply.
    - » This coverage is achieved merely by installing a UPS.
  - To cover problems in the Swiss/French supply to CERN until the French/Swiss supply takes over.
    - » 10 minutes autonomy is largely sufficient.
      - The 7 minute delay in the auto-transfer on June 2nd is exceptional. The system is supposed to function within 2 minutes.
  - To maintain services in the event of a serious failure.
    - » Although the main diesels are being refurbished they will never be able to support a 2MW load in B513.
    - » A serious failure can last up to 2 hours. No static UPS (battery based) can support a 2MW load for 2 hours.
    - » Which services do we need to maintain? ST estimate that serious failures will occur only once every 5 years.

UPS Solutions

- "Infinite" protection for 2MW requires Rotary (diesel based) UPS solutions.
  - Unfortunately, these are expensive (~8MCHF), as is a combination of a static UPS with diesel generators.
- The pragmatic solution is a dual system:
  - a 2MW UPS for 10 minutes, plus
  - a "200"kW UPS for 2hours (or less in combination with site diesels).
- The impact?
  - **Physics load will die abruptly** in case of serious failure.
    - » Can't shut down in 10 mins—and even if we could, we would have to start immediately on failure and look silly if power restored.
  - **The basic computing infrastructure** (n/w, mail, home dir, …) **will be maintained** even across serious failures.
    - » How large is this basic load?

Proposal

Install a **two tier UPS** arrangement.

Accept a sudden loss of physics load. If the level of power failures is found to be unacceptable then a private diesel backup can be added later.

We should rely on site diesels for basic computing infrastructure if this is feasible.

Low Voltage Distribution

- Maintain the Normabar system.
  - This is a tidy and flexible underfloor solution.
- Clearly demarcate power zones.
  - Racks and equipment installed along, not across the normabar direction.
  - Special zone in vault (and later machine room) for the basic computing infrastructure.
- Pre-equip normabars with 1- and 3-phase sockets.
  - No ST intervention required when adding equipment,
  - although separate zones for 1- and 3-phase racks reduces flexibility somewhat.

Fire Protection - I

- Computer equipment is not halogen free.
  - Even a small fire releases acrid smoke which causes widespread damage.
- TIS recommend the use of smoke curtains to separate room into 3-4 zones.
  - Smoke curtains are small (~50cm) boards hanging from the ceiling which contain lateral flow of smoke.
  - TIS would prefer compartmentalisation of the raised floor area, but this is infeasible.
- Smoke extraction duct runs at right angles to smoke curtains with an inlet per zone.
  - Maximise extraction capacity where it is needed.
  - Ducts for **replacement fresh air** under the false floor.
    - » Fresh air could be preheated if an inrush of air at –12ºC is likely to cause equipment damage.

Fire Protection — II

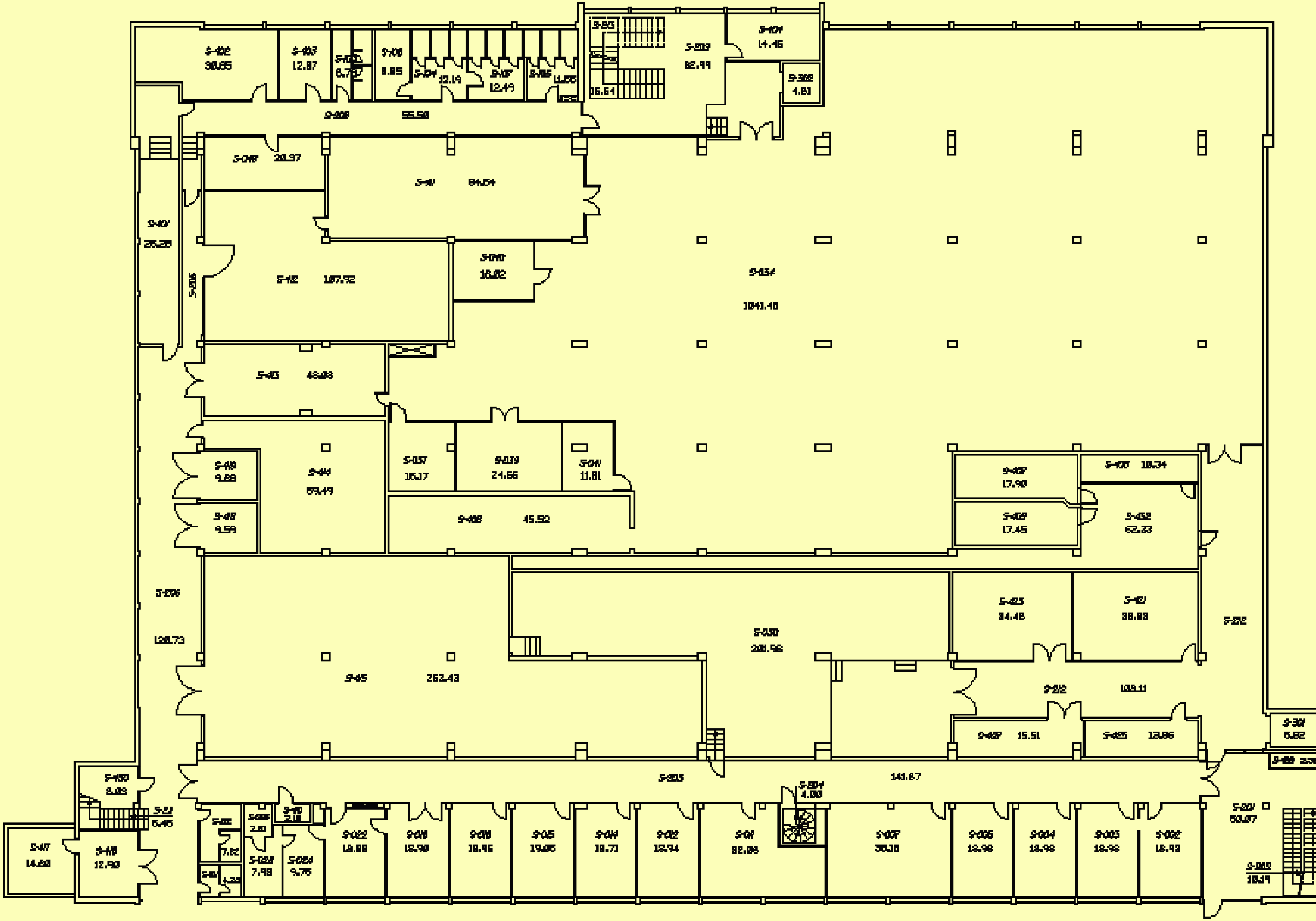
- We will install a VESDA system with at least one detector per zone, if not one per line of racks.
- The PDUs will allow each Normabar to be powered down individually.
  - Smoke detection will lead to normabars being powered off **either** individually **or** by zone.
- **No automatic extinction system** is planned.
  - **Technically feasible** in vault but **practically infeasible**.
  - The **Fire Brigade** is in close proximity.
  - However, we will
    - » ensure adequate provision of CO_2 extinguishers,
    - » develop an intervention plan with the fire brigade, and
    - » investigate mist based sprinkler systems (“Hi-Fog”).

Machine Room Safety and Isolation

- Industry safety codes make it clear that Machine Room **safety is compromised** by
  - unnecessary access and transit, and
  - presence of unnecessary equipment and, especially, waste material.
- Our situation today is **not satisfactory**.
  - Desktop PCs are delivered to the archive store and then wheeled through the machine room to the barn.
  - New equipment, obsolete equipment and waste are all regularly left in the machine room and the vault for the lack of clear and accessible storage and removal zones.
- Any reworking of B513 should **facilitate improved working practices**.

The Plan

- Configure the vault as a second Machine Room
  - **Physical remodelling once silos are moved to B613**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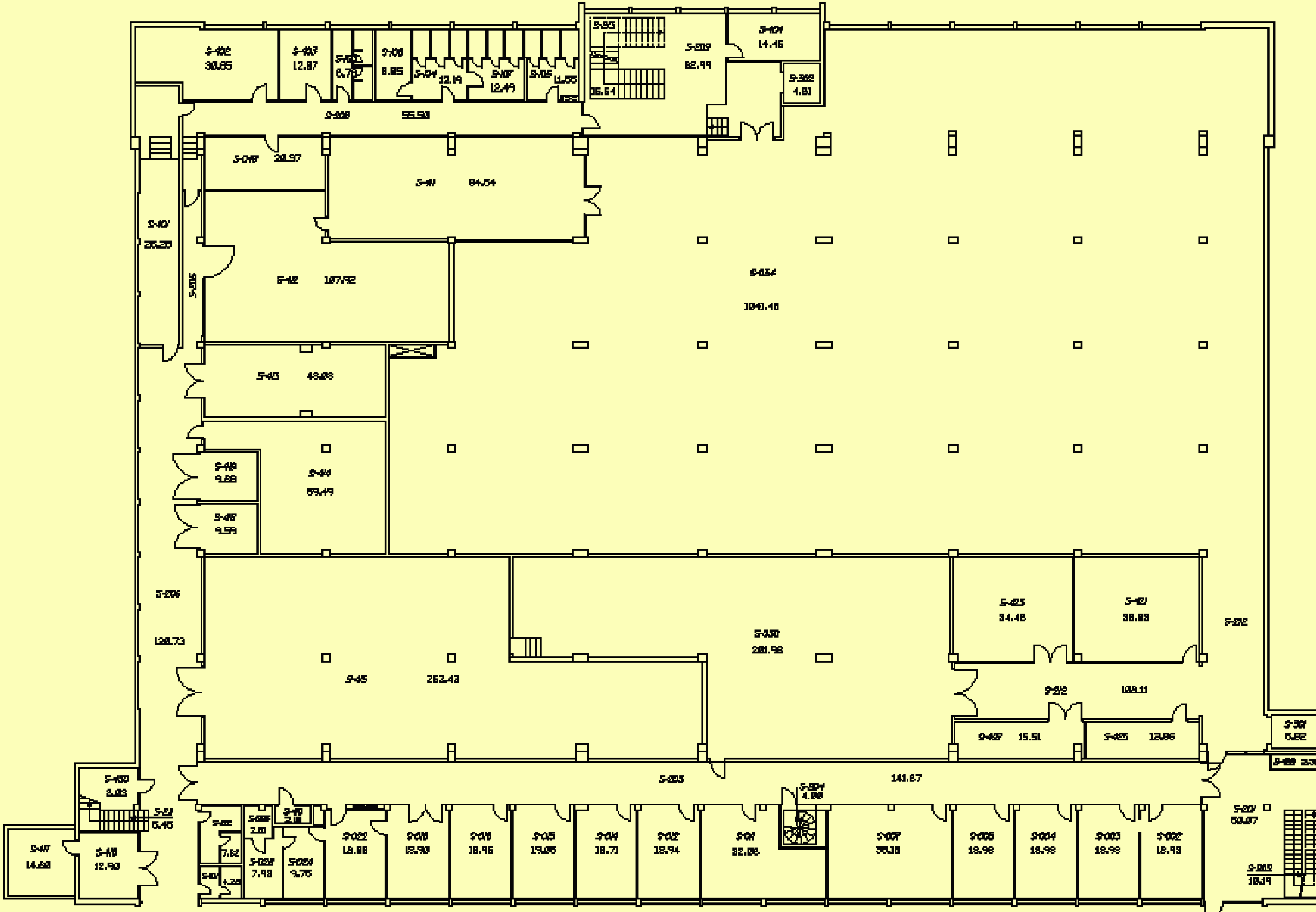
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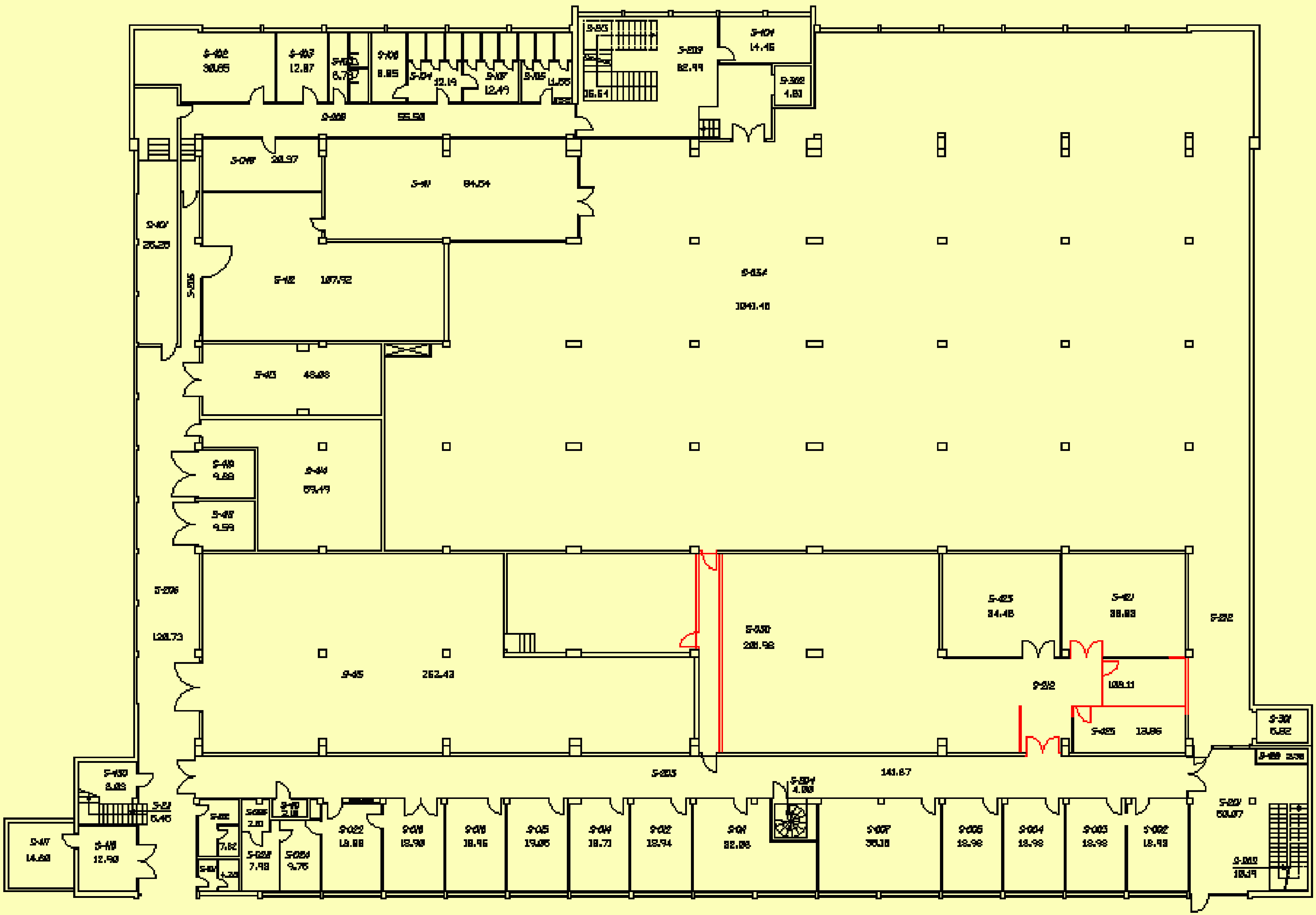

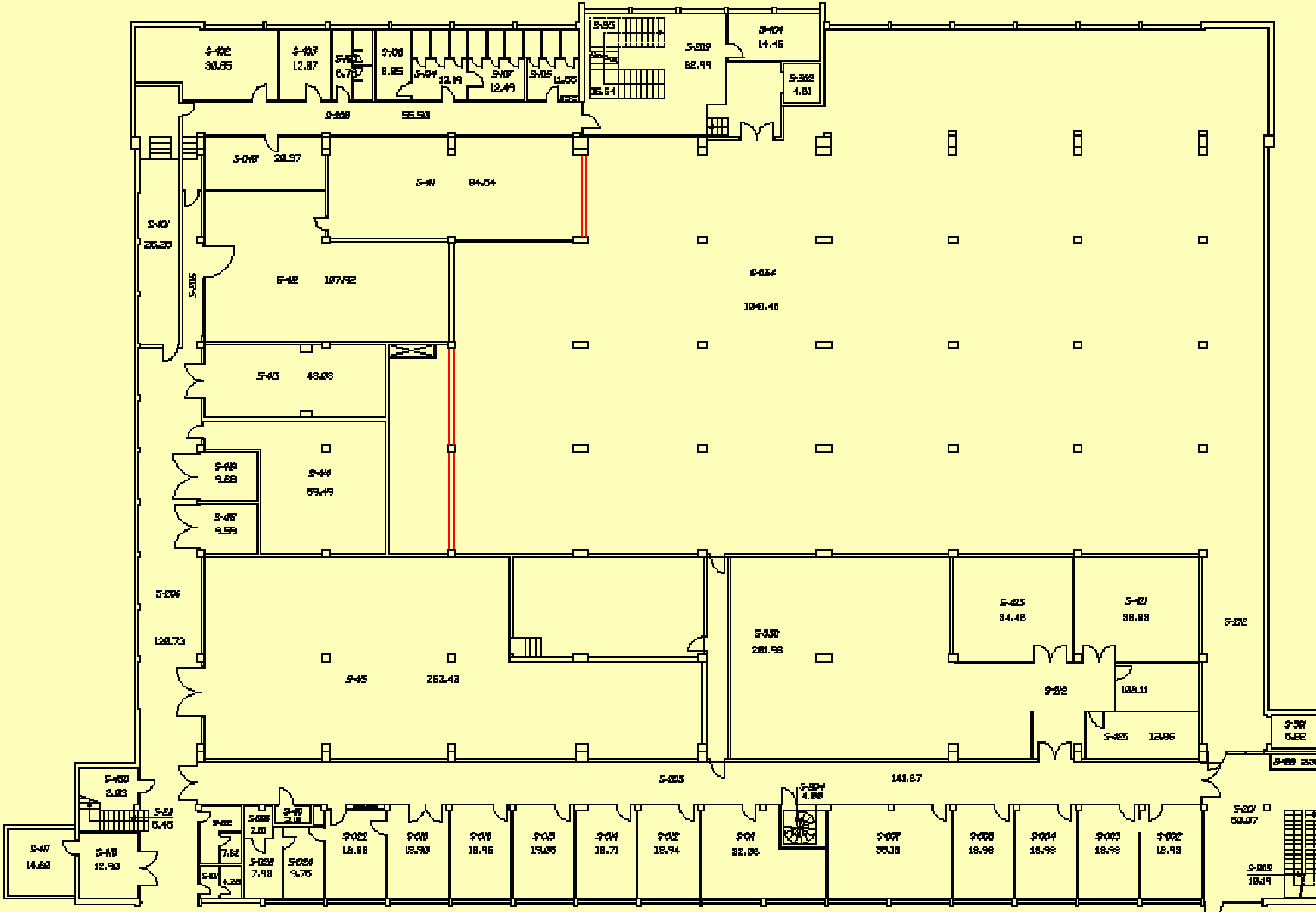
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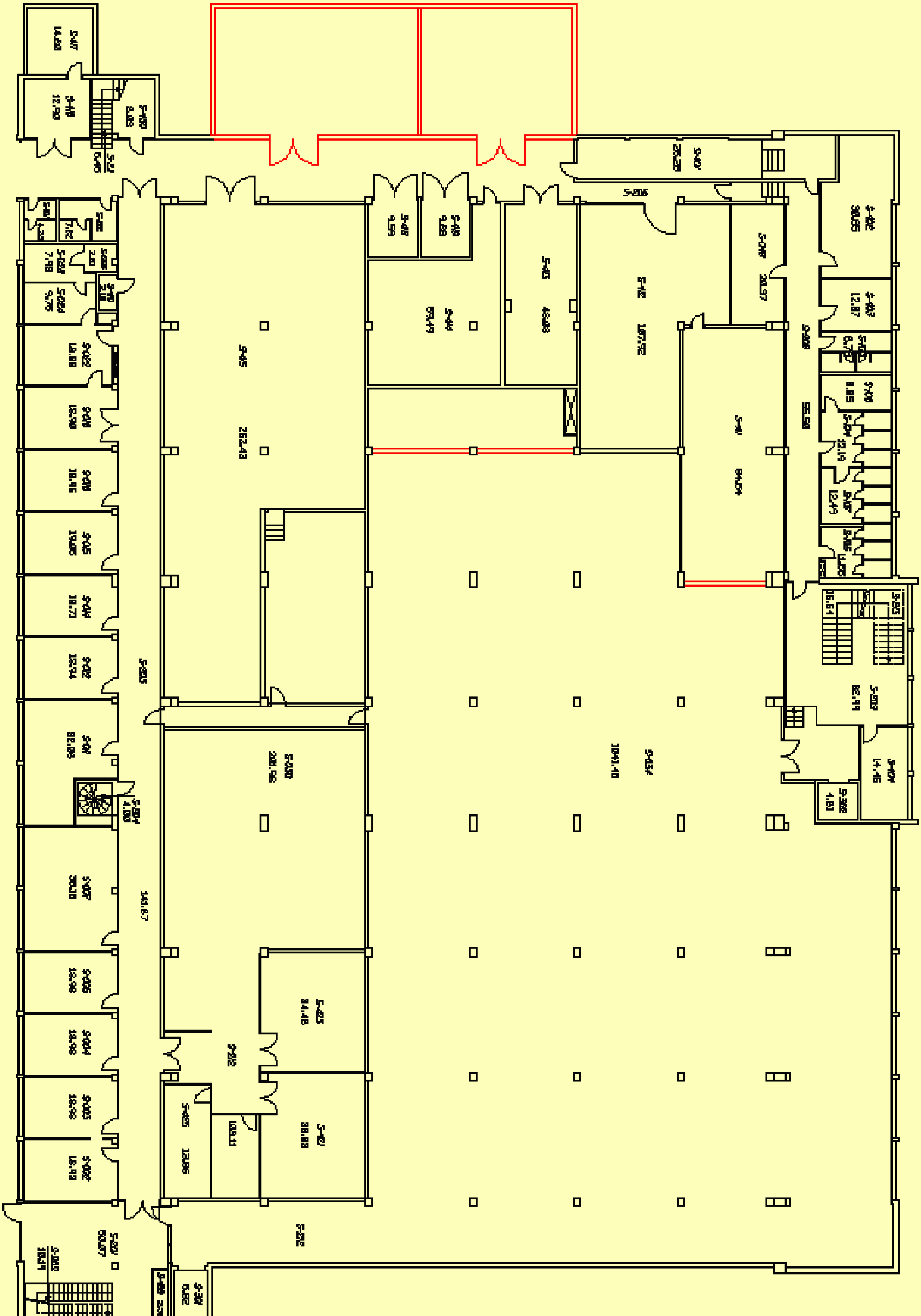

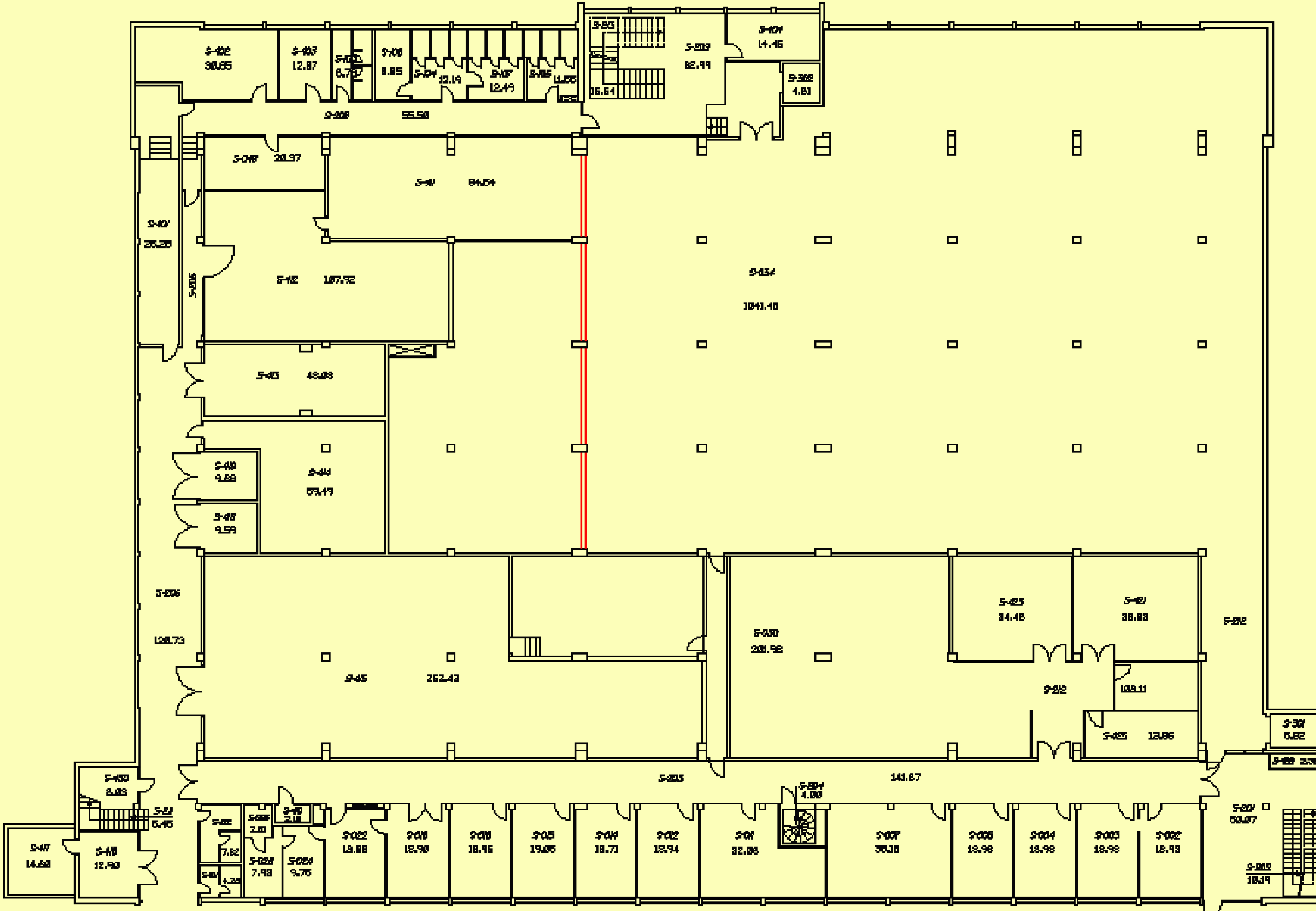
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- Configure the vault as a second Machine Room
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  - Install air-conditioning, smoke curtains & extraction and fire detection
  - Provide “Physics” and “essential” power using normabars pre-equipped with 1- and 3-phase sockets
- Install new computing equipment in the vault

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- Install new computing equipment in the vault
- Rework the 18kV supply to B513
- Renew the UPS configuration
- Renew Machine Room power distribution, air conditioning and fire protection once existing equipment is removed through “natural wastage”.

Timing and Costs

- Real work can only start once silos are removed
  - unlikely to be before end October for operational reasons
    - » B613 expected to be ready at the end of September.
- Still, the **Vault could be usable by end-May 2002.**
- Costs

Vault Conversion (space provision)	
Space Reconfiguration	50-100K
False floor & fittings	160K
Air Conditioning	350K
Smoke Extraction	80K
Network infrastructure	120K
LV Distribution	525K
Total	~1,300K

Future costs	
Energy Centre Building	600-1,000K
New 18kV supply	2,000K
UPS	780K
Chilled water capacity	350K
Machine room LV	1,500K
Machine room HVAC	??

Proposal

We **give ST the go ahead** to start implementing this plan.

Timing and costs to be monitored by TS and Divisional Management.

Machine Room Operations

- Initial discussions between TS, CS, PDP & DB. Common agreement that **greater rigour required**.
- Installation service for hardware will be provided.
  - Only TS have access to the machine room! Well, almost ;->
- Anonymous PCs for ease of installation and management
  - addresses allocated by DHCP
    - » but with consistent MAC⇔IP address mapping
- Power Management will be an issue.
  - Normabars are remotely addressable, but inrush current likely to cause problems if all racks on a normabar start at once.
  - Addressable power distribution on racks?
- We need to **prototype management and operations procedures**, not just hardware!
  - Tim Whibley & Fabio Trevisani are looking into these issues.