National Association
of Physicians
for the
Environment

Pollution Prevention is Disease Prevention

Leadership Conference Biomedical Research and the Environment

November 1-2 , 1999
Natcher Conference Center
National Institutes of Health

The Louis Stokes Laboratories

Building 50

National Institutes of Health

Presented by Frank Kutlak, RA
Office of Research Services
Division of Engineering Services
Design Construction & Alterations Branch

Building A Better NIH

Design. Construction and Alterations Branch | *Division of Engineering Services* | *Office of Research Services*

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Research Laboratories Design

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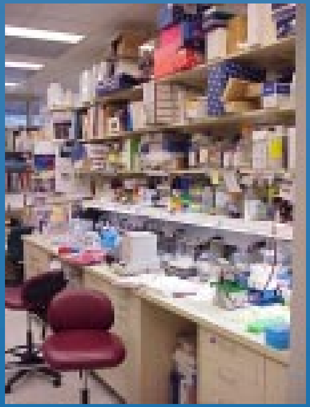
Research laboratories are energy demanding for a variety of reasons:

- Safety requirement for once through air
- Large numbers of containment and exhaust devices
- Large amount of heat generating equipment
- 24 hour access requirement by Scientists
- Irreplaceable experiments require fail safe redundant back up systems, and UPS or emergency power



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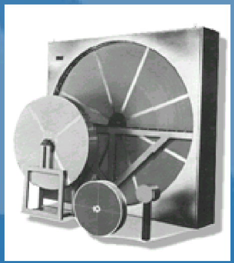
Energy Concerns in the Design of Research Labs

Comply with Executive Order 13123 - "Greening the Government Through Efficient Energy Management", issued June 8, 1999 which requires the Federal Government to improve it's energy management practices.

- Sec. 203 specifically requires that Laboratory Facilities reduce energy consumption by 20% by 2005 and 25% by 2010, relative to 1990

Architectural

- Overall Concern with Energy Issues in Design of Facility
- Building Layout, Mass and Orientation
- Thermal Envelope - Elements of Enclosure / Exterior Skin

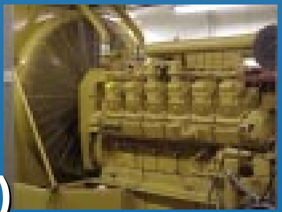


Mechanical

- Building Supply and Exhaust Systems
- Containment Devices (primarily fume hoods)
- Energy Recovery Systems

Electrical

- Power Design Levels
- Lighting - Light Levels, Fixture Types and Controls
- Emergency Power or Uninterruptable Power Supply (UPS)



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Architectural Concerns in the Design of Energy Efficient Research Labs

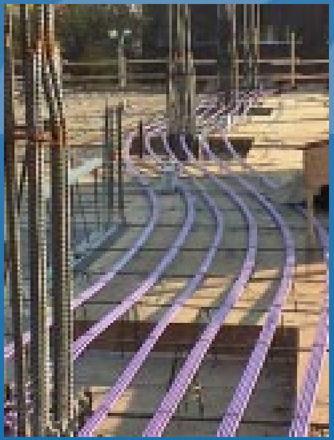
- **Comply with Executive Order 13123** - "Greening the Government Through Efficient Energy Management", issued June 8, 1999 which requires the Federal Government to improve it's energy management practices.
- **Overall Concerns with Energy Issues in the Design of the Facility**
  - Maximum feasible and practical energy efficiency should be a prime design program requirement and one of the major goals of the design
  - square footage and budget must be assigned to energy efficient design
  - the building design must accommodate them
- **Building Layout, Mass and Orientation should enhance energy efficiency**
- **Elements of Enclosure / Exterior Skin should be energy efficient**
  - Design should provide appropriate thermal resistance
  - Design should provide effective moisture resistance
  - Window glazing should be Low "E" Glass - low solar transmission

Waterproofing and Flashing

2" Rigid Insulation

Building 50 Design Features

- 290,000 gross square foot
- 60% efficient (net to gross ratio)
- Open Plan Labs grouped in "neighborhoods" with systems furniture workstations at large windows
- Modified Interstitial Mechanical Level Concept
- Mostly BL2 labs but contains a BL3 Suite
- Animal Vivarium with BL3 and Quarantine areas
- Major EM Suite and NMR Lab Facility
- Central Conference Room Suite
- Proximity Card Access Control
- Post Tension Concrete Structural System
- Multiple Energy Conservation Devices



HLM Design

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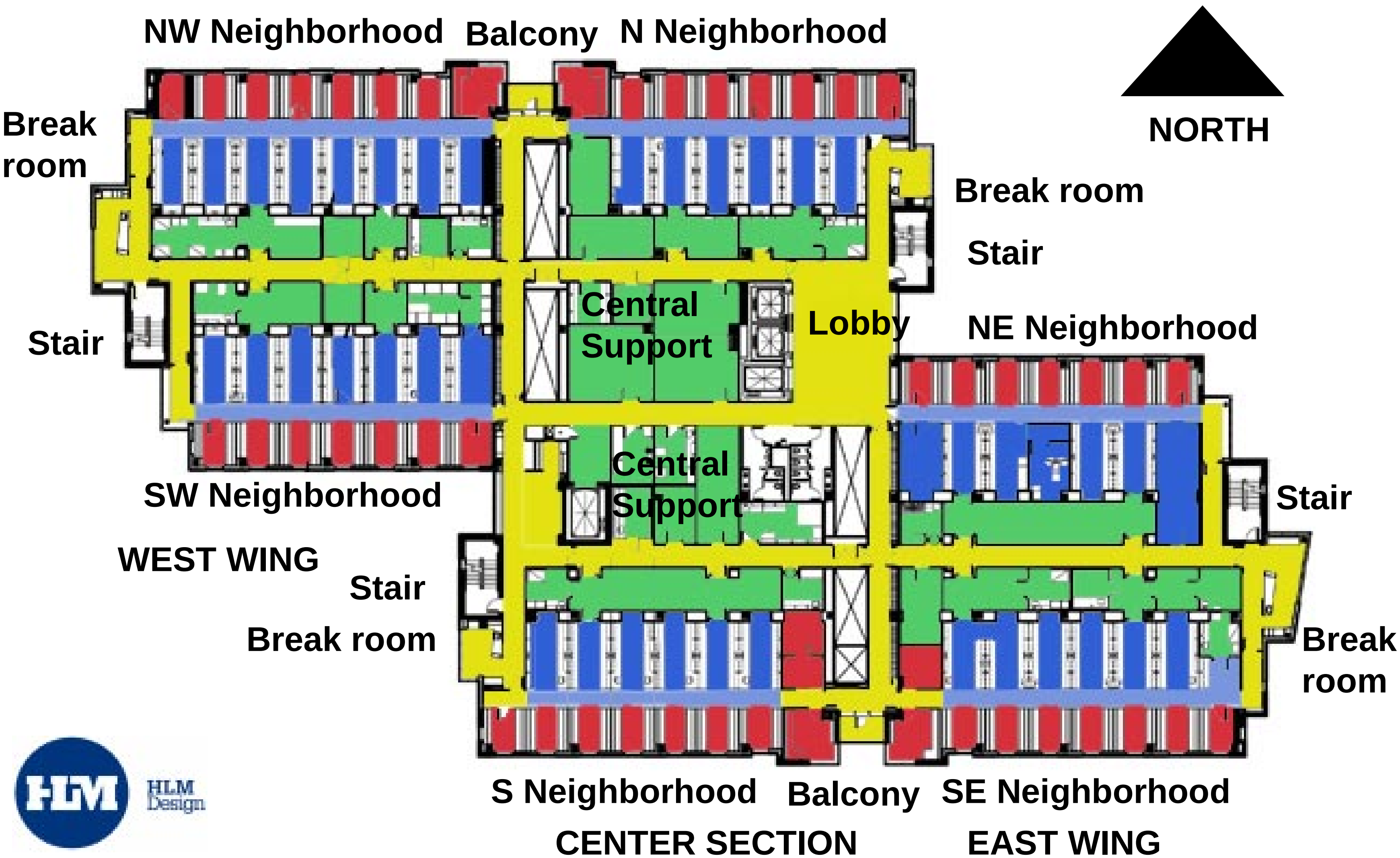
Typical Floor Plan
Neighborhood Concept



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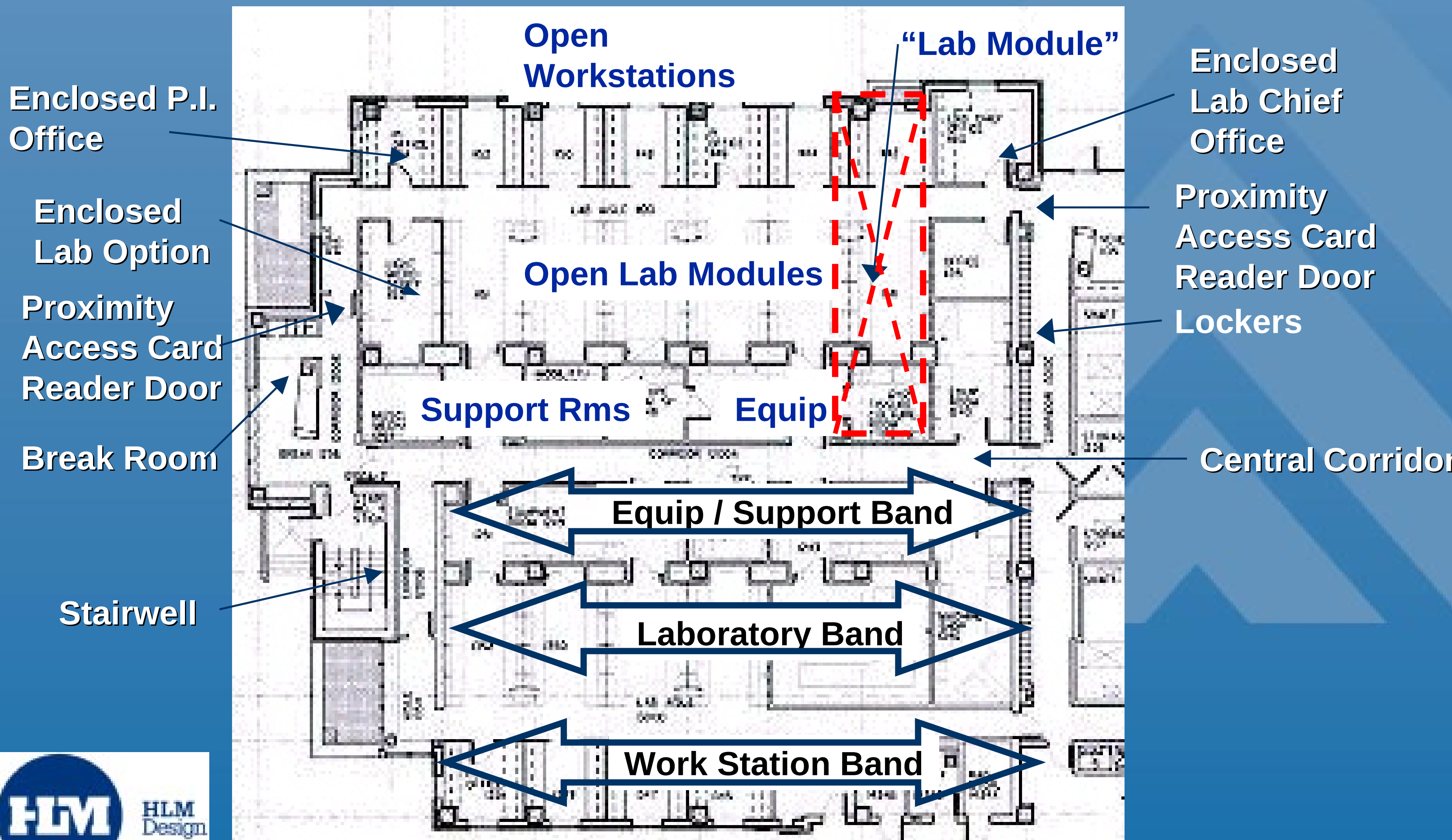
Lab Neighborhood Plan Detail



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HLM Design

Modified Interstitial Concept

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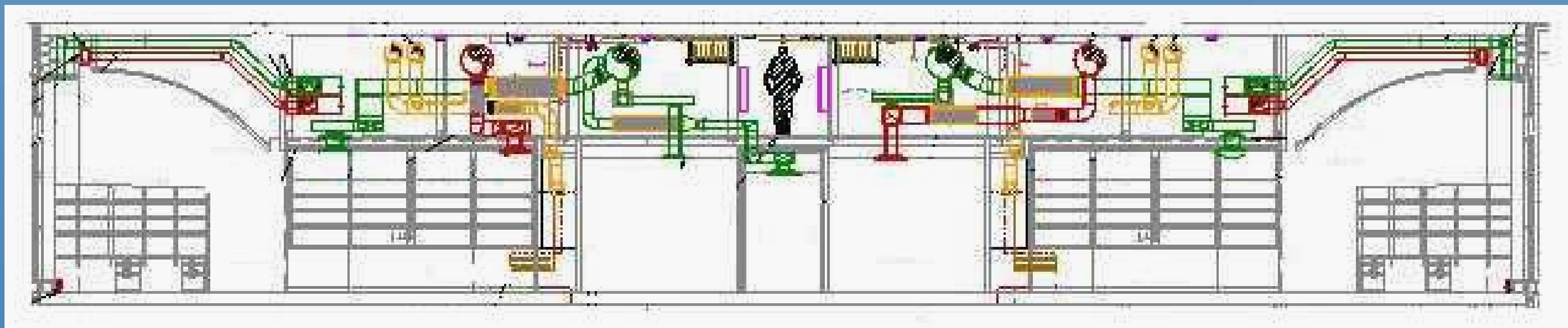

Section through typical laboratory wing

- Cost effective lightweight steel deck
- Contains most HVAC, electrical, LAN plumbing and Telephone LAN closets
- Running Supply and Exhaust down both sides avoids large duct crossovers and allows less interstitial height (7 feet)
- Efficient Improved Constructability
- Effective Future NIH Maintenance

Photos of Interstitial Level

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Lab Module Plan & Section - Daylighting

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Curved High Ceiling

Daylight through large double height windows

Equip Room

Laboratory

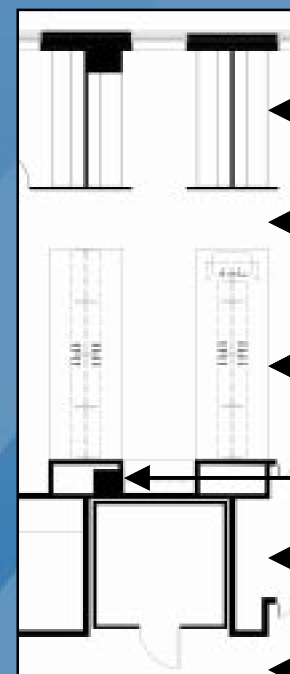
Lab Aisle

Workstations

Section thru Lab and Workstations

11 - 0

44 - 0



Open Workstations or Enclosed Offices

Open Lab Aisle

16 foot long Peninsula Lab Benches

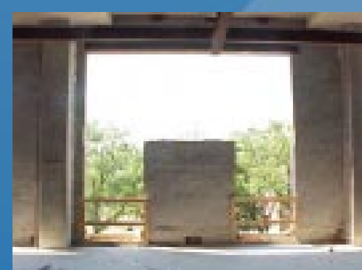
Fume hood Alcove

Support Rooms

Central Corridor

Lab Module Plan

Lab Neighborhood



Lab Window

The mechanical interstitial ends at the line between the laboratory and the open lab aisle which creates a higher ceiling over the aisle and the workstations. This allows the use of double height windows to admit more daylight into the labs

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Model and Renderings

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Laboratory Casework Concept

- The HLM Design team, with GPR Lab Planners and NIH developed a new flexible, easily changed laboratory casework and shelving system
- Lab peninsulas are composed of four 4 foot long modular sections
- All of the shelves are 4 foot long individual heavy duty library shelving
- In the center of each 16 foot long bench is an 8 foot long removable table
- This table serves as the lab bench top but can be adjusted to be low bench
- Beneath this table are various rolling storage cabinets which provide kneespace flexibility, which can be easily changed by the users
- The table can be removed entirely if major equipment has to be located in the lab
- The labs are generally open but if enclosure or separation is required, metal wall panels are inserted between the vertical shelf standards

Post Tension Concrete Structural System

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- The HLM Structural Designers suggested NIH use a Post Tensioned Concrete Structural System
- This system has special steel cables that are tensioned after the concrete reaches it's initial set; which replaces much of the mild steel reinforcement
- NIH reviewed this system and found it acceptable
- The overall amount of steel reinforcing and the volume of concrete was decreased by approximately 40%





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Mechanical Concerns in the Design of Energy Efficient Research Labs

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The single largest energy consumer in Laboratories is the large amount of once thru ventilation air required to maintain a safe environment, thus HVAC design concerns focus on this requirement.

- Building Supply and Exhaust Systems
  - Constant Volume or Variable Air Volume System
- Containment Devices (primarily fume hoods)
  - Constant Volume or Variable Air Volume Fume Hoods
- Use and Extent of Variable Frequency Drives
- Controls and Building Automation System
- Energy Recovery Systems
  - Decisions about extent and types of energy recovery
  - Initial Costs vs Life Cycle Costs

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Mechanical System Basis of Design

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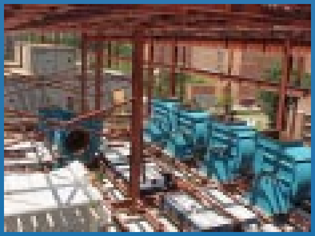
- The design is based on an interstitial mechanical level concept
- Design Loads are 14 W / Sq Ft Building wide
- Major utilities are supplied from an adjacent utility tunnel; including chilled water supply and return and high pressure steam & condensate return as well as city water and compressed air
- A basement mechanical room serves as the utility point of entrance and contains pumps, wet service and heat exchanger equipment.
- Piping distribution originates at the basement mech room and extends upward through the building in two major shafts
- A mechanical penthouse contains the main AHU's and exhaust fans
- The Supply and Exhaust system is Variable Air Volume with VFD fans
- 100% once thru air is tempered in eight 50,000 CFM VFD AHU's equipped with Energy Recovery wheels. The vivarium has a dedicated 50,000 CFM AHU
- Fume Hoods are VAV and do not exhaust through the Energy Wheels

Utility Tunnel

Basement Mech room

Utility Shafts



Mech Penthouse

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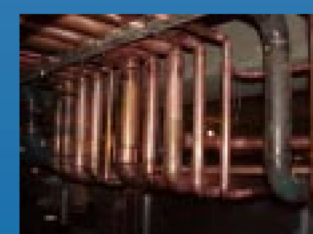
Mechanical System Basis of Design (Cont)

- There are separate exhaust systems for general lab, fume hood, bathrooms, BL3 labs, vivarium, fermentation lab, cagewash and vivarium BL3.
- Exhausts exit the building 10 feet above the roof at 3000 FPM discharge
- Controls are Direct Digital Controls (DDC) Building Automation System
- The Energy Recovery Wheel provides pre heat, there is also a pre heat coil, but the primary heat is provided by terminal reheat coils in the terminal boxes. There also is perimeter hydronic room controlled baseboard heating at exterior glass areas.
- Lab utilities include vacuum, air, natural gas, CO2,lab industrial water, lab waste, secondary chilled water, reverse osmosis (R.O.) water, Nitrogen.
- A clean steam system services the autoclaves and humidifies the building.
- Liquid Nitrogen is provided to specific limited locations in the NMR, freezer room and EM suites in the basement.
- An exterior tank farm is provided at the loading dock to supply bulk storage of Liquid Nitrogen, CO2 and nitrogen.
- The building is fully fire sprinklered, including the interstitial levels.

VAV Exhaust Fans

VAV Terminal Box

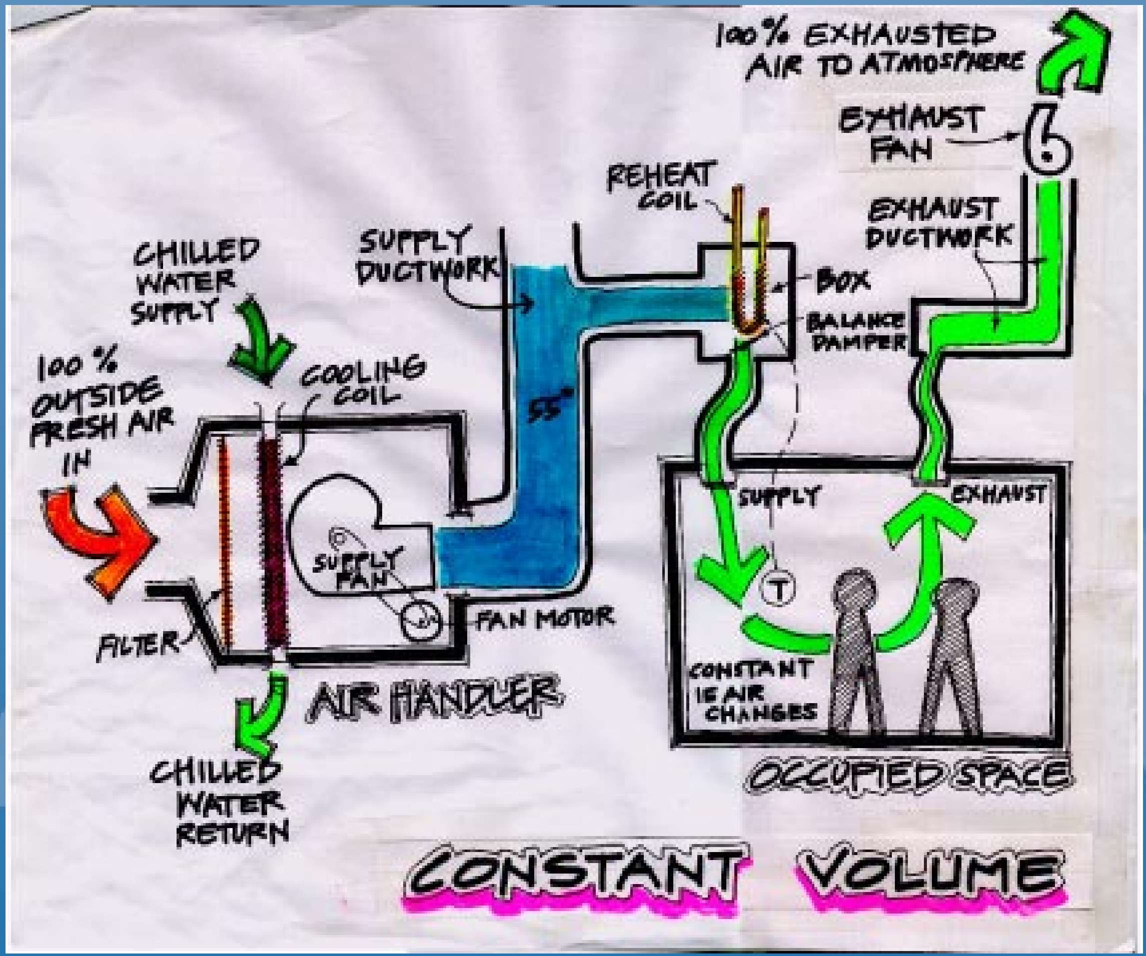
Energy Wheel



Lab Piping

Constant Volume (CV) Systems

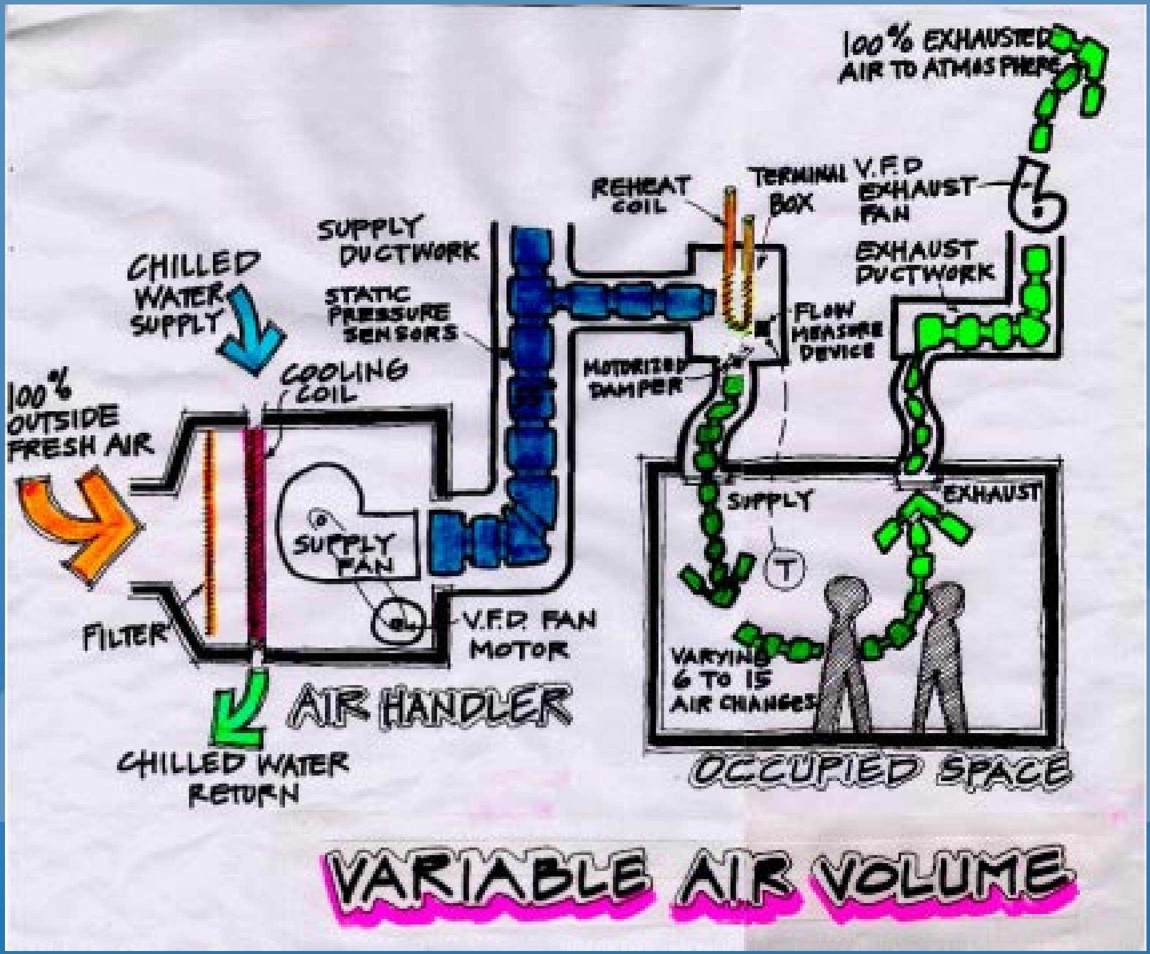
- Airflow / volume is constant
- Vary the temperature to meet demand
- Simple reliable and safe
- Easy to design, install, balance and maintain
- Very energy intensive
- Designers cannot apply diversity
- Systems not flexible to changes



Drawing by Frank Kutlak

Variable Air Volume (VAV) Systems

- **Airflow / volume and temperature is varied to demand**
- Much more complicated and expensive controls
- Consumes 30% to 50% less energy than constant volume
- Designers can apply diversity
- System is very flexible to change



Drawing by Frank Kutlak

Considerations in Comparing CV and VAV Systems

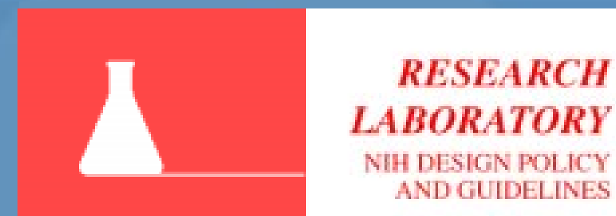
- Design Guidelines of Users
- Load Profiles
- Climate - range of temperature and humidity deltas
- Initial Cost vs. Life Cycle Cost
- Energy Cost
- Maintenance staff capabilities
- Need for Flexibility

VAV Terminal Box

VAV Exhaust Fans

Building 50 selected a VAV Supply and Exhaust System because:

- The NIH Design Guidelines require once through air and allowed VAV and a turn down ratio of a min of 6 to a max of 15 Air Changes per hour.



- Load Profiles - there are varying loads in the building
- Climate - the range of temperature and humidity levels in Bethesda is moderate to high
- Cost - A Life Cycle Cost Study concluded short payback periods
- Energy Costs in the Mid Atlantic area are moderate
- NIH Maintenance staff has the capabilities for VAV
- Need for Flexibility - Change is frequent at NIH

VAV Terminal Box