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Biosafety Cabinets in Laboratory Planning

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Abstract

The purpose of this research and white paper is to design architectural module layouts for practical laboratory use by integrating biosafety cabinets (BSCs) in replacement of traditional fume hood ducting systems and discuss the findings. The desired outcome of this work is to use knowledge gained from research to propose potential BSC layouts within a laboratory type building, and how BSCs can benefit laboratory design. Based on advantages and restrictions between each BSC class, BSCs are strategically placed in appropriate locations throughout the structure. The results show that implementing BSCs reduces the floor-to-floor height and allows for more flexible module layouts. The research findings offer effective credibility for implementing BSCs into United States laboratory designs.

Methodology

- Extensive Research of previous studies and background information
- ZGF Case Studies of previous built projects
- Interviews with ZGF professionals with experience on previous lab projects as designers, project managers and drafters.

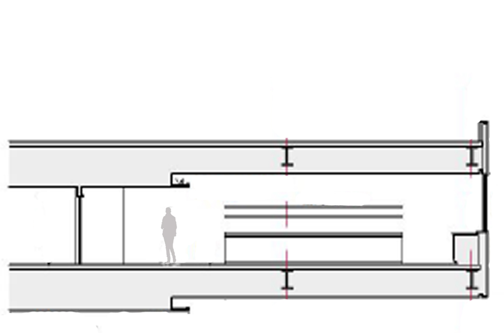
Precedent Study:

Todai Kashiwa Venture Plaza
University of Tokyo
Kashiwa City, Japan

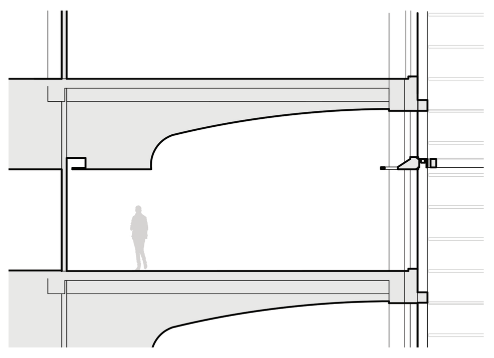
Case Study:

Health Sciences Biomedical Research Facility
University of California, San Diego (UCSD)
La Jolla, California

196,000 GSF
5 stories of laboratories
7 floors of offices

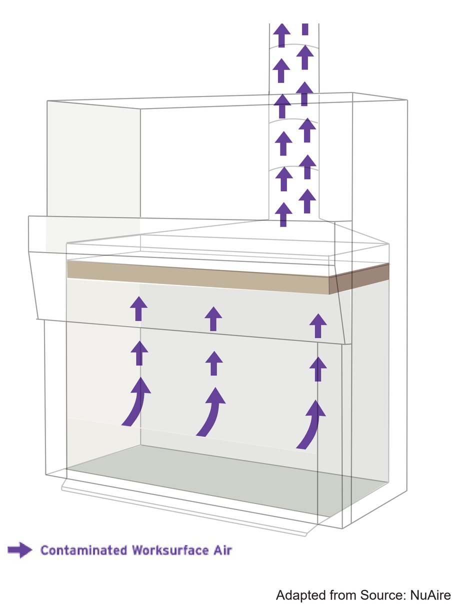


University of Tokyo
12 foot floor to floor height
Use of Ductless Biosafety Cabinets
No designed support services



UCSD
17 foot floor to floor height
Large Ducting systems
Collaborative support services

Ducted Fume Hood



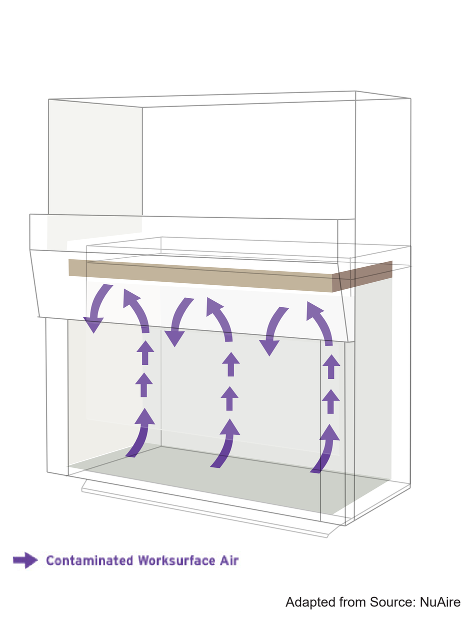
100% Exhausted Air
0% Recirculated Air

Pros:
- Universally Used and Reliable
- No Restrictions on volatile or hazardous chemicals

Cons:
- Not Environmentally Efficient
- Large Ductwork Needed

No particulate or HEPA filter used

Ductless Fume Hood



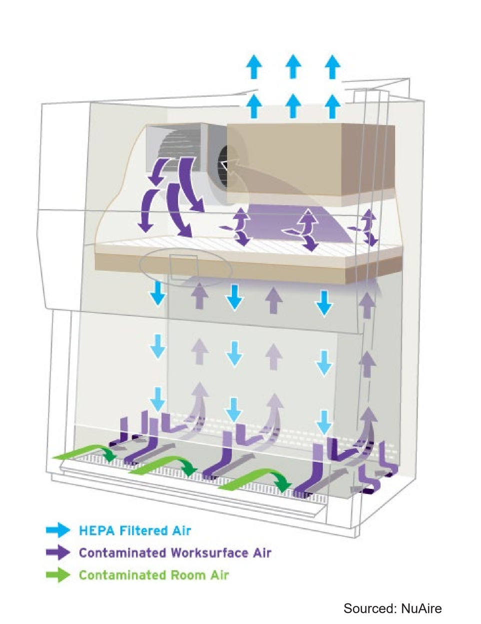
0% Exhausted Air
100% Recirculated Air

Pros:
- No Ductwork Needed
- More Flexible

Cons:
- Limited Use
- Mostly used as a storage cabinet

Particulate or HEPA filter used

Biosafety Cabinet Class II Type A1



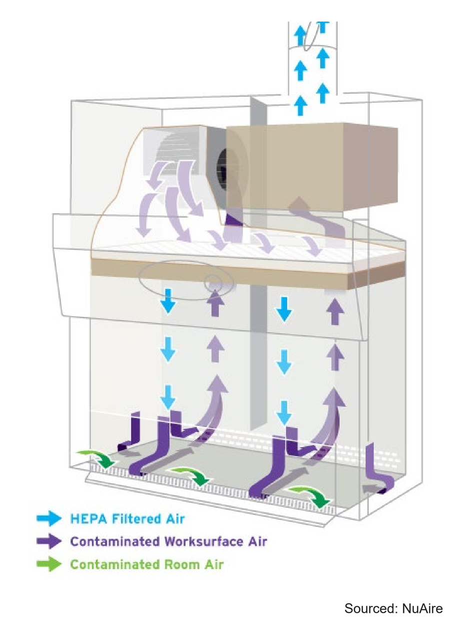
30% Exhausted Air
70% Recirculated Air

Pros:
- More Environmentally Efficient
- Smaller Ductwork
- More Flexible

Cons:
- Not Widely Used
- Potential User Error

Particulate or HEPA filter used

Biosafety Cabinet Class II Type B1



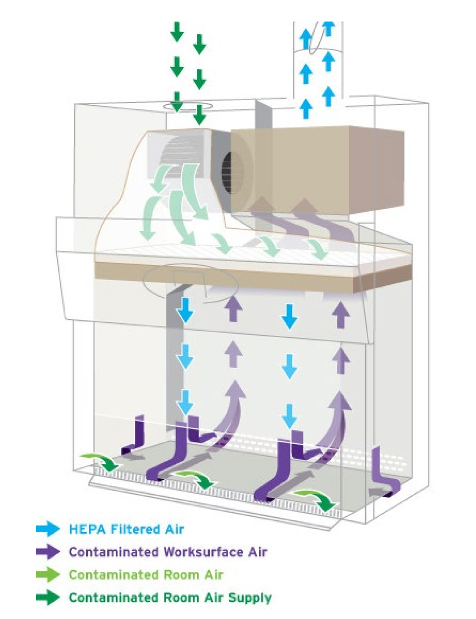
70% Exhausted Air
30% Recirculated Air

Pros:
- More Environmentally Efficient
- Smaller Ductwork
- More Flexible

Cons:
- Not Widely Used
- Potential User Error

Particulate or HEPA filter used

Biosafety Cabinet Class II Type B2



100% Exhausted Air
0% Recirculated Air

Pros:
- More Environmentally Efficient
- Smaller Ductwork
- More Flexible

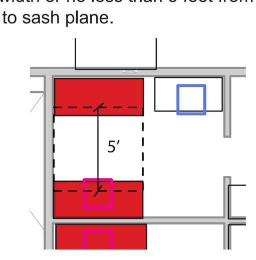
Cons:
- Not Widely Used
- Potential User Error

Particulate or HEPA filter used

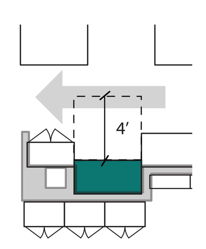
Existing Conditions of Case Study

The UCSD lab building was designed for maximum ventilation needs, creating more fume hoods than necessary and large 17 foot floor to floor heights. Using the placement strategies of fume hoods for more efficient airflow distribution derived from research by Rowan Williams Davies & Irwin, Inc. and Exposure Control Technologies, Inc., the following issues have been identified in the case study:

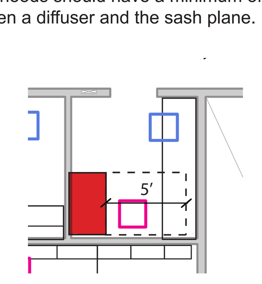
A: Distance Between Fume Hoods
Fume hoods should not face each other within distances of less than the minimum fume hood width or no less than 5 feet from sash plane to sash plane.



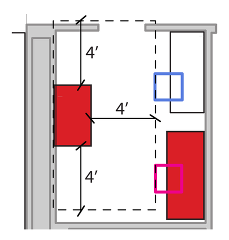
B: Distance from Circulation
Fume hoods should be located at least 4 feet away from main traffic aisle.



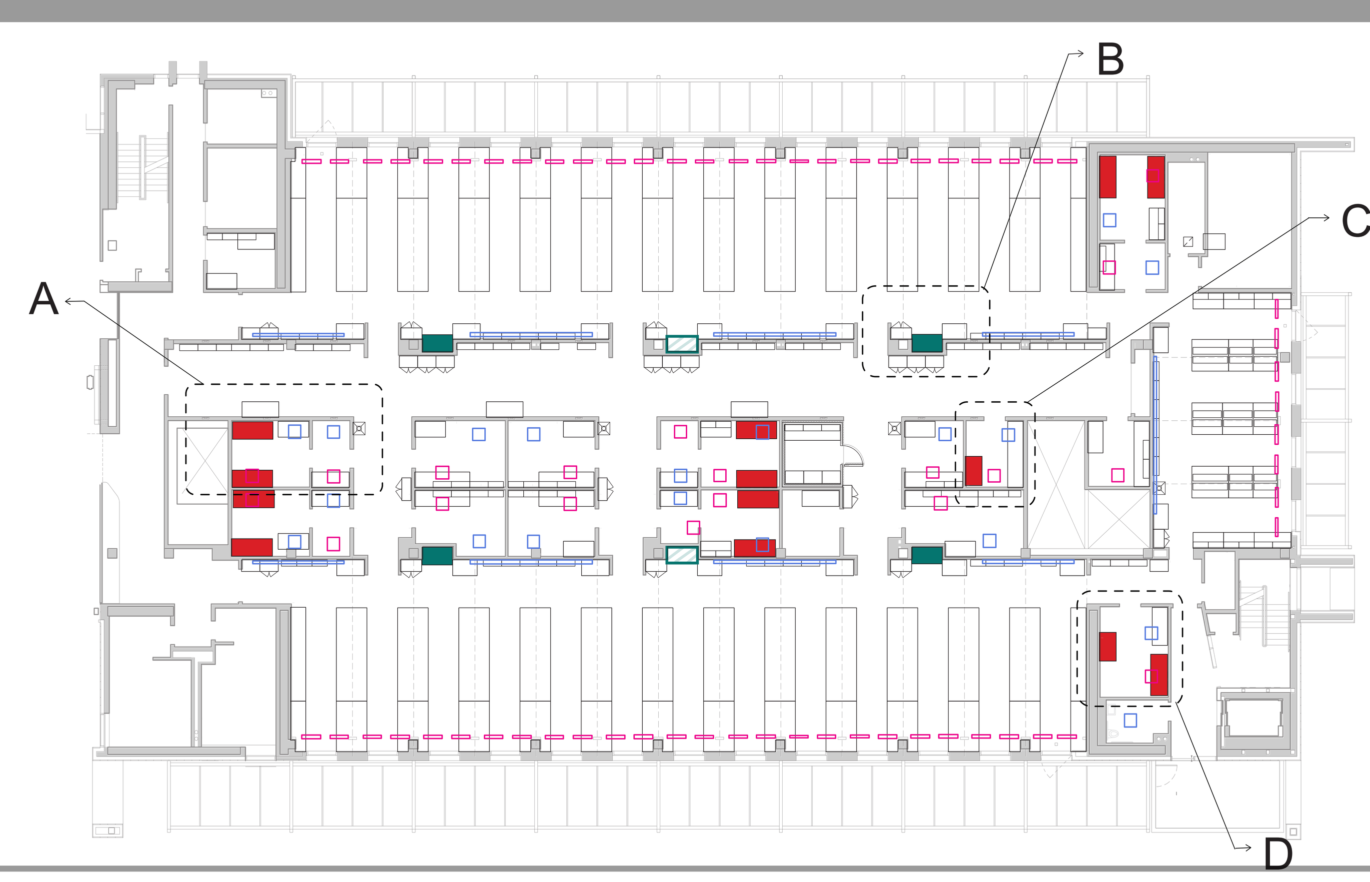
C: Distance from Air Diffuser
Fume hoods should have a minimum of 5 feet between a diffuser and the sash plane.



D. Distance from Adjacent Doors
Fume hoods should be at least 4 feet away from adjacent doors.



Plan



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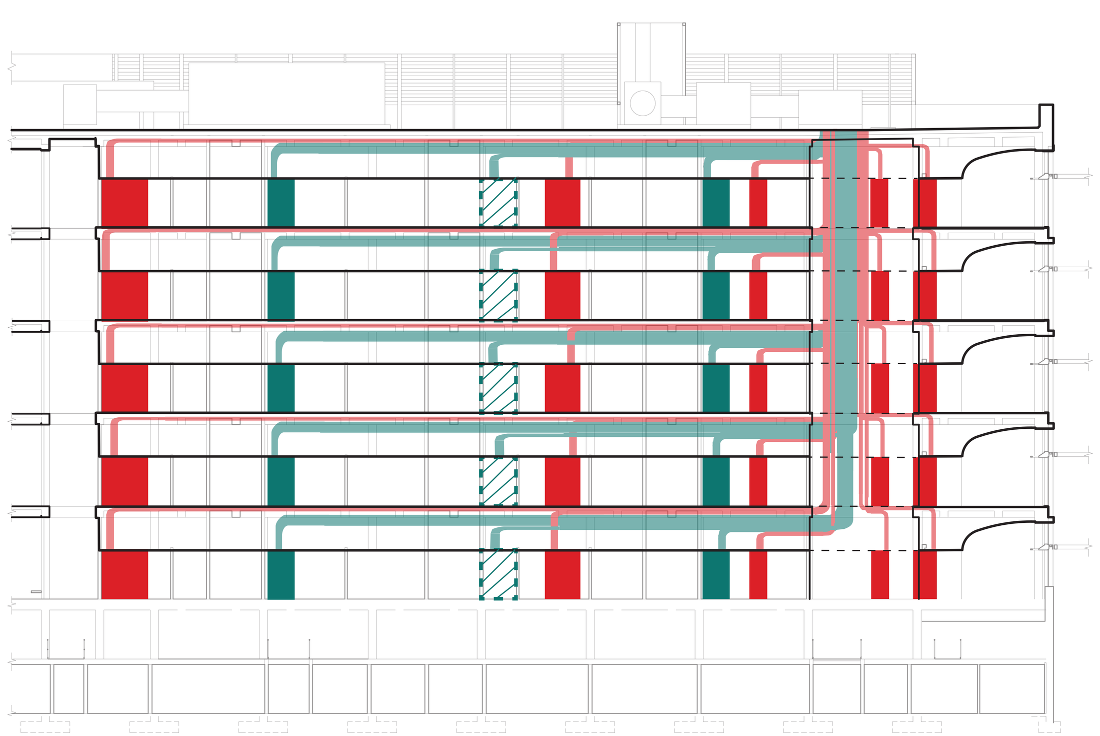
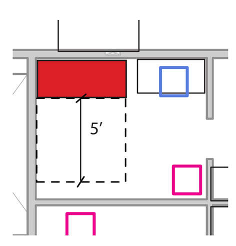


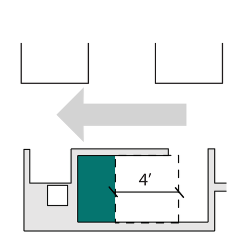
Proposed Efficiency Applications

By using the strategies identified in the airflow distribution research, the placement and amount of fume hoods can be changed, which will lower the ventilation sizing of the ductwork. The issues identified above in the existing plan have been addressed in the following:

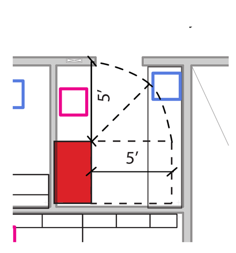
A: Distance Between Fume Hoods
Fume hoods should not face each other within distances of less than the minimum fume hood width or no less than 5 feet from sash plane to sash plane.



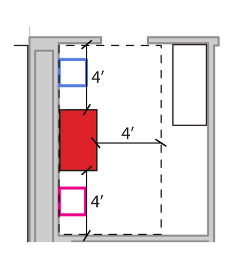
B: Distance from Circulation
Fume hoods should be located at least 4 feet away from main traffic aisle.



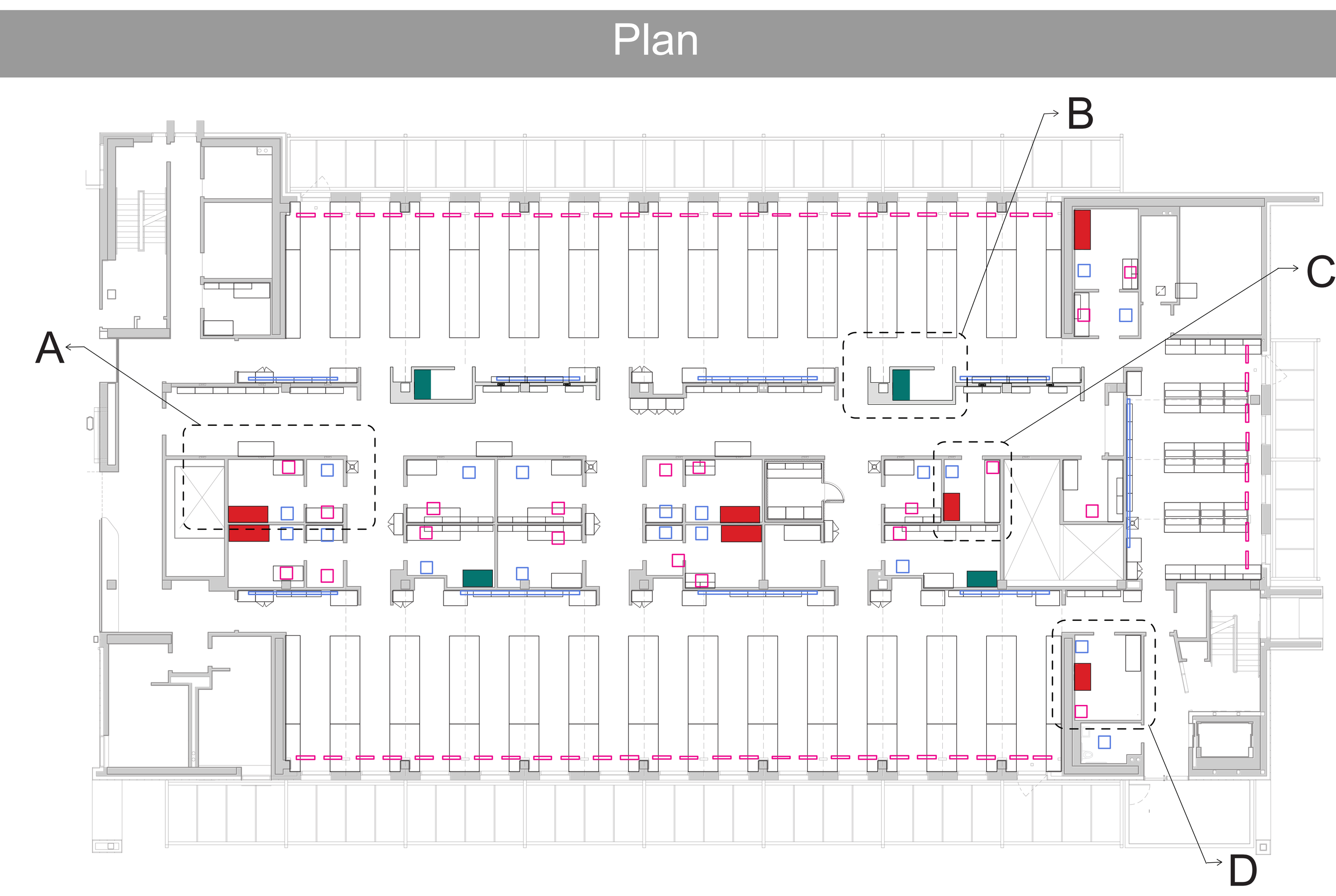
C: Distance from Air Diffuser
Fume hoods should have a minimum of 5 feet between a diffuser and the sash plane.



D. Distance from Adjacent Doors
Fume hoods should be at least 4 feet away from adjacent doors.



Plan



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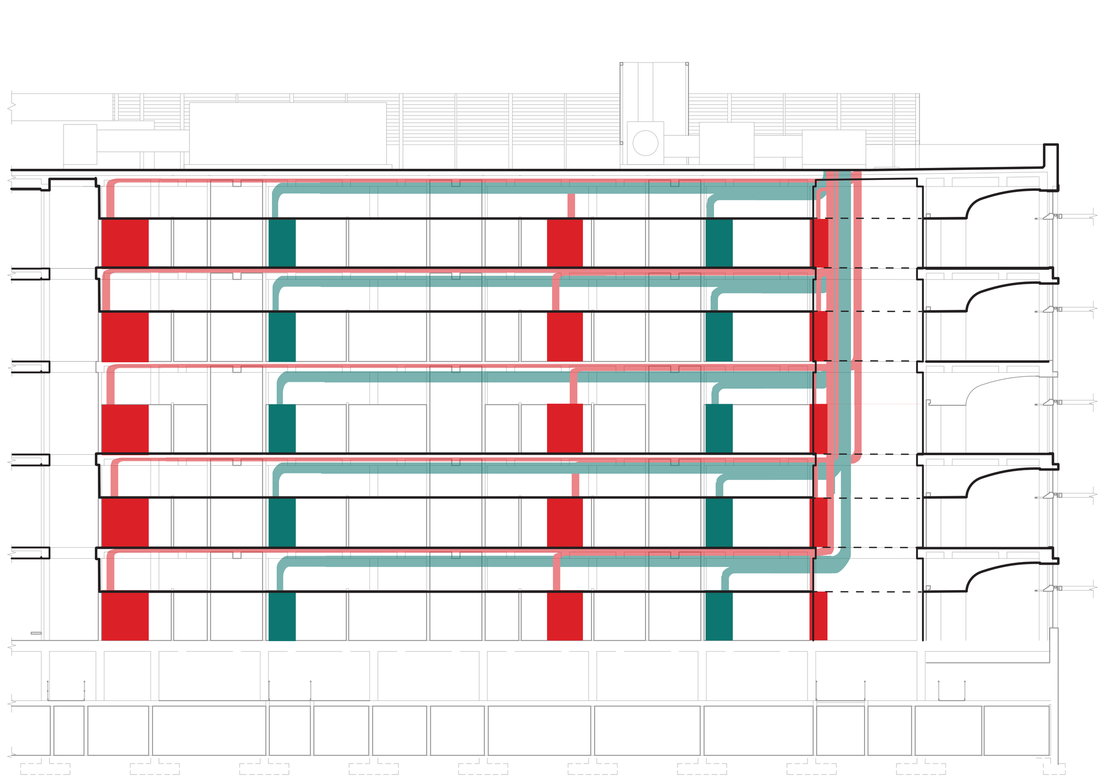


Future Possibilities

A: Integration of Biosafety Cabinets
By replacing traditional chemical fume hoods with biosafety cabinets, ductwork sizing can be minimized due to the recirculating air with the use of a HEPA filter. By eliminating some particulates at the source of the fume hood, the air changes can be lowered. This will minimize ducting size and lower floor to floor height cost.

B: Multiple Duct Shafts
Multiple shafts in the building will create five zones where fume hoods or biosafety cabinets would be located. The increase in shafts would be more expansive than one shaft, but it would decrease the length and size of the plenum. This decrease would minimize the floor to floor height, decreasing the overall cost of the building.

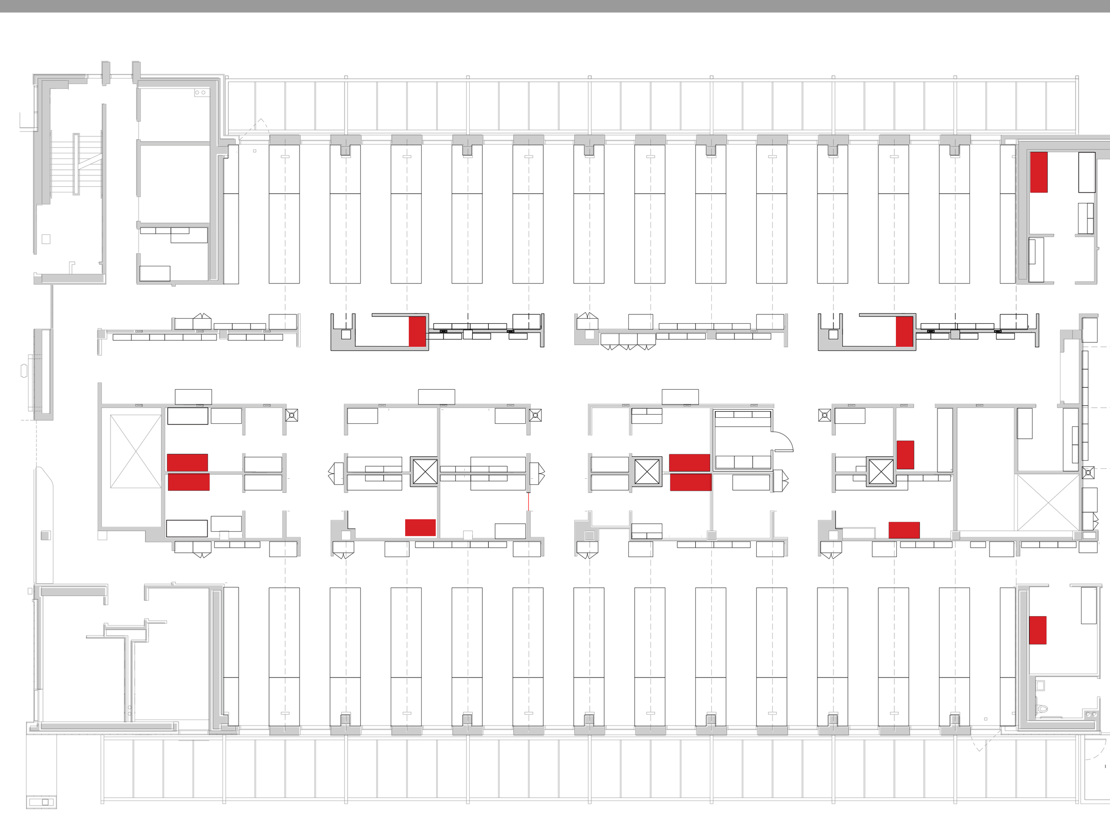
C: Zones of Laboratory Use
The uses of the laboratory could be divided into zones where research with volatile or hazardous chemical are only used on the first and fifth floor. The first floor would use traditional fume hoods where larger floor to floor height is necessary for structural supports. On the fifth floor, Class II type B2 biosafety cabinets would be used to direct exhaust out through the roof. The intermediary levels would use more moderate chemicals with Class II Type A1 biosafety cabinets.

D. Placement of Biosafety Cabinets
By using the strategies presented in the earlier studies, the airflow of the biosafety cabinets will be unaffected by its specific placement. By placing all the fume hoods or biosafety cabinets in alcoves or separated rooms and away from doors and air diffusers, the airflow of the fume hoods or biosafety cabinets will not be disturbed by outside forces.

E: Smaller Ducting Systems
With the integration of all of the previous strategies and future possibilities presented in these studies, the ducting of necessary ventilation systems would be minimized.

F. Lower Floor to Floor Height
With the integration of biosafety cabinets, zones of laboratory use, placement of biosafety cabinets, and smaller ducting systems, the floor to floor height of the overall building would be minimized, lowering the cost of the entire building.

Plan



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