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LABORATORY DESIGNING & PLANNING

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Laboratories need to be flexible, open, expandable, adaptable, functional, efficient and most important safe for all users. The process of laboratory designing is a complex one. As such the professionals and experts involved in this should have multi-disciplinary perspective on what an ideal laboratory should be. Ideally the focus should be on functionality, health & safety, convenience, and energy conservation. Currently there are new trends in lab designs today and these trends have greatly been influenced by modernization and innovation

The Basics of Laboratory Design and Development

The first step in the design process is to understand the purpose of the laboratory. A laboratory designed for typical commercial analysis of samples can be far different from a laboratory designed for meeting the needs of a process quality control lab, or an analytical research laboratory.

A general checklist of items can be given below forms a guideline for the overall design process and planning of lab.

1. The first & most important aspect is to define the purpose of setting up the laboratory and Standard operating procedures (SOPs).
2. The physical location of laboratory is the next important aspect that needs to be considered and understood by the designer as well as the user. Carrying out a feasibility report on the determined site is vital to avoid future compromises, disappointments and huge lab setup costs. E.g., setting up a lab in commercial premises or on sites unsuitable for lab will result in deviations & major technical compromises relating to lab layouts and services.
3. The third step would be to understand the lab requirements from operations point of view, establish the workflow and circulation spaces within the lab. This will help in establishing the inter-connectivity of various labs and the outcome to the end user would be a more homogeneous one.

Detail planning considerations

The foundation for setting up a good lab lies upon the precise planning of four main stream services. Those are civil interiors, electrical, HVAC and utility services. Over & above the utmost focus has to be on maintaining the HSE standards.

Civil interiors-The physical separation of lab areas and non-lab areas, one lab from another, the considerations for floor, wall and ceiling finishes, and the flow of spaces between labs and service areas has to be carefully charted out since this forms the starting point for technical detailing.

Electrical work-The required total power supply wrt all equipments, illumination levels, power outlets, voice and data connectivity, arrangements for highly sensitive equipments by supporting them with UPS and LAN connectivity has to be calculated in detail bearing in mind the diversity factor as well as the provision for future expansion. Emergency lighting and power support to equipments is an imperative consideration in case of any crisis.

HVAC-This is the service which generally results into high power consumption due to overloaded HVAC designs and it must be avoided. Typically in R& D centers, treated fresh air is required for highly sensitive and expensive lab equipment and correct & proper balancing of HVAC system vs. fume hoods/exhausts has to be done under critical supervision and monitoring of air conditioning consultants.

Utility lines- Location of central gas supply bank, the tapings on lab furniture tables, flexibility in running the lines along the wall or ceiling, provision of high pressure lines & safety valves, control panels, effective plumbing system and waste management are the important issues.

Safety aspect- provision of gas detection system, fire detection, smoke alarms and fire extinguishers, along with the integration of HVAC system with fire alarm and access control are absolutely mandatory parameters for a lab set up. Further, fire rating considerations for walls, partitions, ceilings, doors and furniture is a value addition to the project in terms of safety.

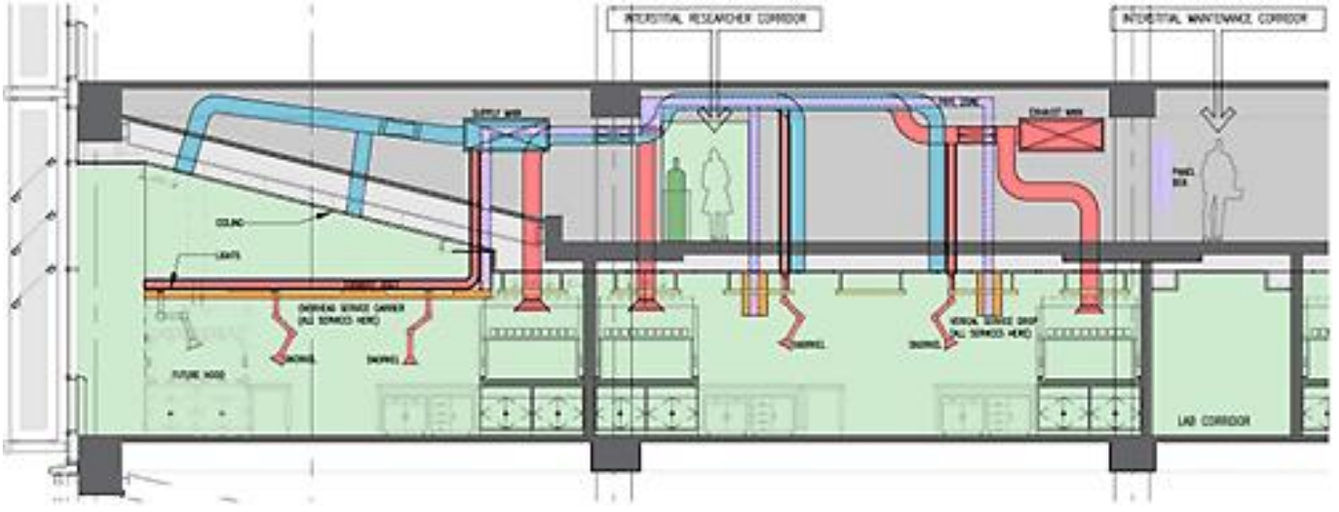
Code Minimum Requirements

Parameter	Value	Source	Standard	Design Target
Ventilation	20 cfm/person	ASHRAE 62/89	same	Maximize outdoor air by using displacement ventilation Deliver air low/ exhaust high
Filtration	none		35-80%	65% pre-filter 85% final filter
Indoor Design Temperature	75F summer 72F winter		same	
Humidity Control	NA			50% RH summer 40% RH winter
Equipment Heat Dissipation	NA		3-4W/ sf	1.5W/ sf or 2W/ sf with 75% diversity factor
Toilet Exhaust	50cfm/ fixture	ASHRAE 62/89	same	2 cfm/ sf
Lighting Power Loads	NA		2W/ sf All direct	0.5-0.75W/ sf Total task/ ambient with Occupancy sensors & Daylight sensors
Lighting Loads	100 ft candles		same	20-30 ft candles with Ambient and task lighting
Building Shell Infiltration	6 /100 sf	ASHRAE	3 /100 sf	1.5 /100 sf (Canadian Standard)
Building Shell Infiltration (alternate)	0.80 cfm/ sf		0.30 cfm/ sf	0.10 cfm/ sf
Exterior Wall Insulation	U= 0.28 btu/ sf-hr F	BOCA Energy Code	U=0.10 btu	U= 0.15 btu/ sf-hr South U=0.05 btu/ sf-hr N,E, W
Exterior Wall Moisture Control				A/B-With insulation both sides
Roof Insulation	U= 0.07 btu/ sf-hr	BOCA Energy Code	U=0.05 btu/ sf-hr	U= 0.05 btu/ sf-hr with low surfacing
Windows				
Glazing type	single/ clear		double/ clear	heat reflecting clear
Visible transmittance	0.80	0.78	0.70	
Shading Coefficient	1.00	0.80	0.43	
U value	1.04	0.48	0.30	
Heating Degree Days	6,155 btu	ASHRAE	Same	determined by DOE2 analysis of TMY data

Trends in Lab Design

As said earlier, a new model of laboratory design is emerging, one that creates lab environments that are responsive to present needs and capable of accommodating future demands.

- Unlike the conventional lab set ups, Team based Research lab concept is gaining fast popularity. It creates more interaction amongst scientists, flexible use of space and sharing of resources takes place. The Laboratory designers can highly support here by creating open labs, plan for flexible engineering systems that encourage teams to operate closely, by establishing clearly defined circulation patterns and by providing interior glazing to allow people to visually connect with each other. A wide variety of labs—from wet biology and chemistry labs, to engineering labs, to dry computer science facilities can be designed as open labs
- Flexible engineering services—supply and exhaust air, water, electricity, voice/data, and vacuum systems—are extremely important to labs. Labs must have easy connects/disconnects at the walls and ceiling to allow for fast, affordable fixation of equipment. The engineering systems may need to be designed to enable fume hoods to be removed or added, to allow the space to be changed from a lab environment to an office and then back again, or to allow maintenance of the controls outside the lab.



In addition to the initial demands at least an additional 25% should be considered for future expansion. Space should be allowed in utility corridors, ceilings, and vertical chases for future HVAC services, plumbing, and electrical needs. Service shutoff valves should be easily accessible, located in a box in the wall at the entry to the lab or in the ceiling at the entry. All pipes, valves, and clean-outs should be clearly labeled to identify the contents, pressure, and temperature

- Sustainability-A typical laboratory currently uses five times as much energy and water per square foot as a typical office building. Due to large numbers of containment and exhaust devices, number of heat-generating equipment, intensive ventilation requirements—including "once through" air, research laboratories form the most energy demanding facilities

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Towards a greener approach

The USGBC (U.S. Green Building Council) has implemented the LEED® (Leadership in Energy and Environmental Design) program to encourage clients and professionals to design, build, and operate more environmentally appropriate Laboratories.

The Key aspects of sustainable design are as follows:

- Increased energy conservation and efficiency - Factors such as- high performance HVAC, high performance Fume hoods, having a combination of sash design for Fume hoods, stress on day Lighting, passive solar heating, occupancy sensors, photo-sensors and time base controls should be critically addressed and adopted during the design stage itself.
- Reduction or elimination of harmful substances and waste - use materials and assemblies with the lowest level of volatile organic compounds (VOCs), eliminate the use of asbestos & lead; avoid ground-level ozone in buildings and such others.
- Improvements to the interior and exterior environments, leading to increased productivity – having aesthetical design, thermal comforts, good ventilation system, acoustical privacy, ergonomics, controlling odours through contamination isolation and good luminosity all lead to enhanced Indoor Environmental Quality and user productivity.
- Efficient use of materials and resources – using environmentally preferable products, eliminate the use of toxic materials and give preference to locally produced materials.
- Recycling and increased use of products with recycled content - encouraging the use of recyclable assemblies and products, maximize the recycled content of all new materials and are biodegradable.

The inference that can be drawn from the above statements is that the designing phase of your laboratory planning project is the perfect time to review your processes and make the advancements and improvements. You may want to benchmark similar laboratories to gather specific ideas on how to enhance your work environment and activities.

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