Laboratory Facility

Owner's Project Requirements – 2023 ASHRAE Design Competition

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1. Introduction

A research center has decided to design a new laboratory building, which consist of a large single-story building with a rooftop penthouse and located in Cairo, Egypt. Total building area is approximately 2,515 m^2.

2. The Project

As part of the project, new HVAC systems are to be designed for the new laboratory facility. The building consists of a wet bench lab, dry bench lab, research support offices, common area for circulation, secured high density data center room, penthouse, common reception area, researcher offices, storage, resting pods room and social room (refer to the attached drawings and the area table below).

Floor	Space	Space Description
Level 1	General Chemical Lab modules (wet bench)	This general purpose chemical based lab will use acetones, small amounts of hydrochloric, hydrofluoric, sulfuric and nitic acids, Sodium Hydroxide. The lab will include autoclaves, mass spectrometers, drying ovens, balances, and high temperature glass washers. High Purity Nitrogen, Helium and oxygen and argon gas cylinders will be located in the space.
	Inorganic Digestion Lab module (wet bench)	This chemical based earth science lab processes inorganic materials. Substances are digested and analyzed using high temperature acidic solutions including hydrochloric, hydrofluoric, sulfuric, and nitic acids. A significant amount of chemicals will be used in this lab. The lab will include autoclaves, mass spectrometers, balances and sample drying ovens. Nitrogen, oxygen and hydrogen gas cylinders will be located in the space.
	Perchloric Lab Module (wet bench)	The Perchloric Lab will be used daily during regular hours and may require occasional use extended beyond regular working hours. The designer must be aware of the hazards around Perchloric Lab design.
	Biological Lab - Clean	This biological lab will have very minor chemical use. The purpose of this lab is to provide a clean working environment for sampling biological plant specimen. This cannot be contaminated from other activities in the building due to the effects of the research, not for safety.
	Biological Lab – Infections	This biological lab will handle infectious bacterial cultures. The owner has limited research to curable infectious cultures. Any bacterial cultures that have no cure for humans or animals are not allowed in this facility.
	Dry Bench Lab modules	The dry lab modules are only for computational based research. These will have large heat gains but will not have chemicals or biological cultures. The lab user has not finalized the extent of equipment so there is not a specific list. The heat gain will be three or four times higher than what is seen in dense office design.
	Research Support Offices	The research offices are to be safe and clean areas, with no risk of air contamination from other lab modules. There will be no chemicals or biological cultures examined in these spaces.
	Common Area	For circulation
	Secured data center room	The data server room contains the work done by all researchers. Loss of this room can result in millions of research dollars. Security, redundancy and reliability is critical. The load of the data servers will be 20 kW with the possibility to expand to 50 kW in the future.
Level 2	Penthouse	The penthouse is not detailed. It crosses the facility and the designer will need to recommend an optimum size. Currently the elevators are design to access the penthouse and roof for service.

3. Owner's Requirements

The design team shall make every effort to provide a sustainable design, taking into account: energy efficiency, health and safety, occupant comfort, functionality, longevity, flexibility, and serviceability/maintainability.

The design team shall select systems based on the lowest possible life cycle cost that includes first cost of materials and long-term operating costs, as well as other owner goals.

- 3.1 Design the systems to meet ASHRAE Standard 90.1-2019 and 189.1-2019; it is encouraged to set Energy Use Intensity (EUI) target.
- 3.2 Strive to achieve reduced energy consumption and carbon footprint for a high-performance lab approaching a Net Zero Energy (NZE) Building or Carbon Neutral Building; Carbon Neutral Building needs to be defined if it is used in the design.
- 3.3 Provide excellent indoor environmental quality that facilitate occupants' use of the space by providing a comfortable and safe environment.
- 3.4 Incorporate design attributes related to improved HVAC system performance, space utilization, acoustical qualities, interior style, and durability of finishes.
- 3.5 Meet the operation and maintenance needs for an easily serviceable, maintainable, and secure facility that has low utility and maintenance costs.
- 3.6 Design based on the lowest life cycle cost analysis for the applicable climate and the owner's budget.
- 3.7 Maintain thermal comfort in each space per ASHRAE Standard 55.
- 3.8 Provide ventilation to each space per ASHRAE Standard 62.1.
- 3.9 Provide acoustical controls per ASHRAE Handbooks (i.e. the Chapters on Noise and Vibration Control in HVAC Application, and Sound and Vibration in Fundamentals).
- 3.10 Operate the building at positive pressure to prevent unwanted infiltration.
- 3.11 Select building orientation based on optimized building energy performance.
- 3.12 Regular building operating hours are 7:00am to 8:00pm on weekdays and 8:00am to 4:00pm on weekends.
- 3.13 HVAC systems shall comply with the ASHRAE recommendations for COVID-19.
- 3.14 Propose the optimum orientation to minimize energy consumption. Currently plan north is upwards on the drawing A-1.
- 3.15 Ventilation shall comply with the ASHRAE Classification of Laboratory Ventilation Design Levels.
- 3.16 Design exhaust system to avoid adverse re-entrainment of the effluent at critical surrounding locations.

4. Budget Considerations and Limitations

The approach to allocating resources for the HVAC systems is to examine life cycle costs, including capital investment, operating cost, maintenance costs, and employee productivity. The key values are:

- 4.1 Assume the owner's mechanical budget is 59,800,000 LE
- 4.2 Life of the HVAC system: 30 years
- 4.3 Return on investment: 7%
- 4.4 Inflation rate: 3%
- 4.5 Utility escalation rate based on a 10-year average increase for utility provider (water, gas, etc.) in the area

5. Building Assumptions

It is assumed that the new building envelope construction and other building systems (e.g. lighting and plumbing) meet ASHRAE 90.1-2019 requirements, while incorporating the owner's project goals below:

- 5.1 Synergy with surrounding architecture.
- 5.2 Superior acoustic criteria in all spaces with minimal sound transmission from the adjacent spaces and low noise produced from HVAC systems.
- 5.3 Assume the building is standalone, and therefore the HVAC systems are not tied to any central plant or district systems.
- 5.4 Assume all the utilities are provided on site (e.g. natural gas, electricity, city water and sewer).

6. Codes and Standards

Codes as determined by the local Authority Having Jurisdiction (AHJ)

- ASHRAE Standard 15 and 34
- ASHRAE Standard 55
- ASHRAE Standard 62.1
- ASHRAE Standard 90.1
- ASHRAE Standard 189.1
- ASHRAE Handbooks
- ASHRAE Classification of Laboratory Ventilation Design Levels

Use the latest available versions of all ASHRAE Standards and Handbooks.

7. References

The following resources can be helpful during the design

- Smart Labs Toolkit
- I2SL Best Practice Guides
- ANSI Z9.5
- HVAC Resource Map for Laboratories