Fact Sheet No. 1

Building New Laboratory Facilities

Building a new laboratory facility in the 1990's presents the owner, the architect and the engineer with practical and technical challenges not encountered in most other types of construction. These challenges include the following important topics:

- Appropriate facility location
- Exhaust stack and air intake design
- Industrial hygiene and health concerns
- Space utilization and pressurization strategy
- Fire, explosion and spill containment
- Fume hood selection and operation
- Laboratory layout
- Exhaust system design and reliability
- Make-up air supply and energy conservation
- Specialized indoor environmental controls

FACTS:

Selecting an appropriate location for a laboratory facility is extremely important. Local codes and air emissions legislation may affect the facility design and need to be addressed. Local terrain, meteorology, nearby structures, building architecture and stack design can affect the atmospheric dispersion of contaminated air exhausted from the facility. Poor design can cause contaminated air to be recirculated back into the building air supply or into the air supply of a nearby building. Vent permits required by the EPA or local authorities may demand dilution and dispersion calculations. These calculations can be done using computer simulations or by using wind tunnel modeling of the structure and surrounding area. ❑

Laboratory building space can be classified into three major categories: offices, laboratories, and hazardous material storage and handling space. Accidents and spills occur most frequently during transportation and handling of material within the building. These spaces can be provided with an active differential pressure control system to prevent the migration of a contaminant release or fire throughout the building. ❑

Proper laboratory layout is essential to insure efficient fume hood operation. Fume hoods adjacent to air disturbances caused by doors, windows, walls, traffic and air diffusers may suffer capture and containment efficiency reductions. This may lead to occupational exposures to hazardous materials. Proper laboratory layout is one of the most effective and least expensive steps one can take to improve laboratory safety. ❑

Fume hood selection is the cornerstone of a safe and efficient laboratory facility. All fume hoods are not created equal. Some capture and contain fumes better than others at lower face velocities and, therefore, have lower energy consumption. It is recommended that you specify your fume hoods be tested using the ANSI[1]/ASHRAE[2] 110 fume hood test method. Your potential fume hood manufacturers should provide you with their test results prior to purchase. Testing performance after installation is almost as important. Architectural and mechanical system conditions always affect fume hoods and they should always be tested before use after installation or modification. In addition, performance testing at regular intervals should be required by your Chemical Hygiene Plan. ❑

Proper laboratory exhaust system design is essential to safe fume hood operation. System reliability may require backup fans and emergency power generating capability. Materials of construction choices can also greatly effect the lifetime of the exhaust system. Pressure and volume control schemes are many and varied and can effect overall system performance and should be evaluated carefully during the design phase of the project. ❑

Noise and vibration can become a problem in laboratory facilities due to the large volumes of air required to operate these types of facilities.

Excessive noise can be generated by the mechanical equipment and the air distribution system. Vibration from equipment may be transmitted through the building and can affect sensitive analytical equipment. Proper system design, equipment selection, installation techniques and attenuation technology can be employed to minimize both of these potential problems. ❑

Precise temperature and humidity control is required in many laboratories to conform to ASTM[3] and ISO[4] standards. Sophisticated controls may be required to accomplish this. Computerized Direct Digital Controls (DDC) can execute difficult room pressure and duct static pressure control schemes and super-efficient energy conservation control strategies. These require complicated mathematical, logical and expert-system calculations which were not possible using pneumatic controls. Special monitoring, alarming, documentation, remote operation and enhanced system flexibility are also benefits of DDC technology. ❑

Recent advances in laboratory fume hood control technology are quickly making Variable Air Volume (VAV) systems a popular design choice for many new laboratories and renovations. The heart of these designs are fume hood face velocity controls. These controls maintain a constant face velocity at the hood opening by increasing or decreasing the exhaust volume in response to the sash position. All of these controls prevent excessive velocities at reduced sash positions which can cause turbulence and loss of containment. These controls also *monitor* face velocity, the most widely accepted indication of fume hood performance, and warn the operator if it should fall below specifications. Another benefit of these controls is the ability to incorporate a *diversity factor* into the design. *Diversity* is the assumption that all the fume hoods are not open all the way all the time. This assumption allows reductions in equipment and system size and cost as well as significant energy savings due to reductions in exhaust and make-up air volumes. Many variables must be evaluated to determine an appropriate *diversity factor* for each laboratory. ❑

CONTROVERSIES:

Effective contaminant dispersion and building aesthetics are two objectives which often conflict. The owner, architect and laboratory consultant frequently debate the subject of exhaust stack height. After completing atmospheric dispersion calculations and simulations, the laboratory consultant often recommends a stack taller than the architect and owner anticipate. ❑

The switch from pneumatic to DDC controls is still debated in some circles. Cost, reliability, maintenance and fear of new technology are usually the basis for these arguments. Improved reliability and cost reductions for DDC controls have narrowed this issue mainly to maintenance considerations. ❑

The entire field of VAV laboratory technology sometimes appears controversial because it is so new to the industry. Once the concepts are fully understood by the owner and the engineer, and all of the benefits are explained, many laboratory owners are choosing this option. ❑

CONCLUSION:

Laboratory design is a very specialized engineering discipline which is changing at a rapid pace. Keeping abreast of the state-of-the-art and rapidly changing OSHA, EPA and building regulations demands a specialist in this field. ❑

As an owner, the specialized services of a laboratory consultant can save you time and money in your laboratory construction process. A laboratory consultant will help you to better meet the needs of your laboratory personnel with a level of safety and energy efficiency rarely achieved by the general practitioner of engineering. An expertly designed laboratory can also reduce your maintenance costs, improve reliability and reduce nuisance noise, vibration and temperature control problems. ❑

As an engineering firm, having a laboratory consultant on your team can make your organization more efficient and allow you to provide your client with the expertise they expect and deserve. ❑

Perhaps the greatest benefit to both the owner and the engineer is the reduction of exposure to potential litigation for chemical exposures to workers and for errors and omissions by assuring the use of best available technology and experience. ❑

A laboratory consultant can be of greatest benefit to you at the beginning of the conceptual design phase before the building envelope design and layout have been completed. ❑

References:

1 American National Standards Institute
2 American Society of Heating Refrigerating and Air Conditioning Engineers, Inc.
3 American Society for Testing of Materials
4 International Standards Institute

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