Laboratory Ventilation

Only personnel who are properly trained and thoroughly knowledgeable regarding the potential hazards of the chemicals and other materials present in the laboratory as well as safety control measures that may be used to mitigate those hazards may supervise or independently perform hazardous material storage and handling operations at FSU.

The array of safety control measures that may be chosen to address potential hazards fall into three general categories: engineering controls, administrative (work practice) controls, and the use of personnel protection equipment (PPE). These controls shall always be considered and utilized to the greatest extent practical to ensure that an ample margin of safety is provided. An adequate margin of safety can be assured when safety control measures are incorporated as an adjunct to sound scientific methods and laboratory safety practices. The purpose of an added measure of protection is to allow these operations to be done safely and to mitigate the potential for an adverse impact if problems arise.

The design and construction of laboratories incorporates many engineering controls. This process is guided by very detailed and prescriptive building codes and industry best practice standards. One important aspect of these requirements is the ability to provide continual ventilation by a non-recirculating HVAC system with air exchange rates sufficiently high to prevent the buildup of contaminants above concentrations which might be harmful to exposed persons or the environment. Specifically constructed ventilation systems are greatly relied upon to ensure the reduction of airborne contaminants, released during handling operations or as fugitive emissions from stored chemical containers, to below acceptable levels. However, the afforded protection that these systems may provide can easily be degraded through system misuse or component failures. To preserve the ventilation system's ability to function as intended, laboratory users must have a basic familiarity with the routine operating parameters and modes, know the system limitations and be able to immediately recognize significant problems when they occur. System maintenance should only be performed by qualified personnel and performance testing and inspections must be done frequently, including after major work or changes to system settings or components. Environmental Health & Safety (EH&S) and Facilities personnel should always be contacted whenever any repair, modification or testing may be necessary.

Our University research laboratories were built utilizing the most sound technology and conservative design parameters warranted by the anticipated use at the time of their construction. Many improvements have been made through the years to enhance performance and save energy through updated and more modern building components and system designs. Our newer buildings are more likely to have monitoring systems that can actively assess the overall performance and status of each major component. They are also likely to have remote control capabilities and the flexibility for each laboratory area to be independently optimized without adversely affecting ventilation in neighboring areas of the building. New laboratory ventilation systems have the airflow measured and balanced, and they typically are quantitatively and qualitatively tested near the end of the construction phase to ensure that they actually can perform as designed. Research buildings built or renovated prior to the year 2000 do not generally possess modern control features or have as flexible designs. These older laboratory buildings are still able to function properly but they require greater operator attentiveness to system changes or failures that could negatively impact performance.

Everyone involved with chemical use in a laboratory environment must be especially cognizant that even subtle changes to the normal airflow patterns in the laboratory (such as: opening laboratory doors, improperly locating items inside fume hoods, using incorrect sash working heights, or even walking by another user during exposed chemical operations) can have serious negative impacts on the control and containment of airborne materials.

Users should be cognizant of the purpose, capabilities, limitations and normal operating characteristics of their laboratory building ventilation systems and devices. Work should stop when problems are suspected and these conditions should be reported immediately to Facilities and EH&S for investigation and correction.

Ventilation Methods

There are two principal ventilation methods employed to control chemical and other hazardous emissions. The first type, used in all laboratories, provides fresh conditioned air (humidity and temperature adjusted) to the entire space as "general", or "dilution", ventilation. This method is primarily intended to address typical indoor air quality issues and sufficiently mix fugitive emissions and other slow release contaminants to minimize concentration levels throughout the entire area. This type of control will not adequately protect occupants from high quantity or concentrated emissions which can be found near their emanation points or after events such as a sudden or significant release for which a fume hood or other installed exhaust system is required.

General ventilation is similar to the centralized air conditioning systems typically found in offices, classrooms and other non-laboratory spaces within large buildings. The difference for laboratories is that air is provided via a single pass system with an absolute minimum rate of four air changes per hour (4 ACH) and it must be provided continually at or above this rate to all areas where chemicals are used or stored. In contrast, offices and other non-laboratory areas operate at only 1-1.5 ACH, and about 80% of that air is filtered and recirculated, in order to provide comfort while minimizing total energy consumption. Most science laboratories are initially designed to provide 10 to 12 ACH of fresh non-recirculated air therefore, a typical chemistry laboratory may use the same amount of air and energy in one hour that an equivalently sized non-laboratory space would use for the entire day. This has been the standard followed for decades primarily because it is simple and these ventilation rates have proven to be protective for most typical laboratory facilities. These high air exchange rates are almost never required 24/7/365 and this translates to a rather large waste of energy without any benefit during times when the protection is not necessary. Fine tuning this relationship between the goals of protection and environmental sustainability with respect to laboratory ventilation schemes is receiving a lot of national attention and there are great opportunities for cooperative efforts between researchers, safety personnel and HVAC control professionals to program cost-effective systems that will optimize protection and minimize energy consumption without increasing risks.

One obvious way to more effectively protect personnel and reduce contaminant concentrations throughout laboratory areas is to remove potential contaminants closer to their source; this is referred to as "direct" or "local" ventilation. Direct ventilation is utilized to remove contaminants from between the point where they are generated and nearby personnel before they are able to mix with much of the laboratory air. This method drastically reduces the overall exposure to hazardous emissions while using much less energy than would be required to produce the same concentration reduction than through the use of only general ventilation. This is also an ideal way to provide spot removal of excess heat or moisture that may be produced by laboratory equipment to protect the general indoor air quality in an equivalently efficient manner.

Common devices used to provide local ventilation include chemical fume hoods, glove boxes, gas cabinets, downdraft tables and flexible exhaust ducts. All work with corrosive, flammable, odoriferous, toxic or otherwise noxious materials shall be conducted using properly operating direct exhaust devices. Please remember though that while these systems are designed to remove airborne hazards generated during operations in order to protect personnel and minimize concentrations released to the environment, federal laws prohibit the intentional release of hazardous chemicals solely for the purpose of disposal.

General and direct ventilation systems are integrated into the overall system within a laboratory building and are intended to ensure concentrated contaminants and large heat loads are directly exhausted and not recirculated, that a slightly negative pressure differential is maintained within the laboratory spaces relative to surrounding areas and that all other building spaces have a slightly positive pressure differential relative to the outdoor environment. These pressure differentials are maintained by adjusting the balance between all of the system supplies and exhausts serving each area. The overall intent is to keep potentially contaminated laboratory air from leaking into common spaces and ensure that the building will not draw dust, dirt, humidity and other contaminants into the building envelope with outside air that has not been properly filtered and conditioned. All laboratory exhausts pass through engineered discharge stacks located and designed with sufficient velocity (> 3000 fpm) and height (> 10 feet, equivalent) above the roofline to keep concentrated contaminants away from nearby people and building fresh air supply intakes. Fresh air supplies should be located away from any other exhausts or areas that might negatively impact air quality, such as loading docks or parking areas.

Equipment

- Fumehoods
- Gloveboxes
- Gas Cabinets
- Biological Safety Cabinets
- Laminar Flow Devices
- Flexible Exhaust Ducting
- Chemical Storage Lockers and Flammable Cabinets Exhausts
- HEPA Filters

Additional Information and Resources

- Practical Guide for Applying Laboratory Ventilation System Knowledge to Ensure a Safe and Healthy Work Environment