GENERAL:

1. This standard applies to new or renovated laboratories at the University of Missouri. Since research laboratories are regularly reassigned, the minimum level allows the vast majority of research to be done within a level of acceptable risk to faculty, staff, and the general public. This level also provides flexibility for research from biocontainment to chemical within the same basic design, thus reducing the cost of modifying labs when research needs change.
2. The first step in any laboratory design is to assess the risk by determining the type of research that is to be accomplished. This standard is a **minimum** and the risks attributed to some research are not addressed. It is the responsibility of the A/E to gather information, assess the risk, and design accordingly.
3. The requirements below are general. For specific requirements on materials, finishes, or systems, consult the technical sections within the **UM Consultant Procedures and Design Guidelines** on that material or system.

APPLICABLE STANDARDS:

In addition to the codes and standards listed in Section 2, the following specifically apply to chemistry laboratories:

1. National Fire Protection Association (NFPA) **45 Standard on Fire Protection for Laboratores Using Chemicals** except where this standard may be more stringent.
2. Current edition of the **ASHRAE Laboratory Design Guide.**
3. Current edition of the **ASHRAE HVAC Applications Handbook.**
4. Related standards in the **UM Consultant Procedures and Design Guidelines**.

DESIGN GUIDELINES:

A. Design General

1. Chemical Laboratory Definition

1.1. Definitions and General

1.1.1. This standard does not apply to engineering or science laboratories such as materials testing, electronics and instrumentation, physics, or other activities where research is based on physical rather than chemical processes. If chemical processes are used in these laboratories then those spaces shall be designed in accordance with this standard unless a determination is made the design criteria exceed those outlined in this standard.

1.1.2. Definition (NFPA 45): Laboratory - A facility where the containers used for reactions, transfers, and other handling of chemicals are designed to be easily and safely manipulated by one person. It is a workplace where chemicals are used or synthesized on a nonproduction basis.

1.1.3. Definition (NFPA 45): Chemical Fume Hood - A ventilated enclosure

designed to contain and exhaust fumes, gases, vapors, mists, and particulate matter generated within the hood interior.

1.1.4. Definition (NFPA 45): Canopy Hood - A suspended ventilating device used only to exhaust heat, water vapor, odors, and other nonhazardous materials. This is not a chemical fume hood and generally is not effective for exhausting toxic or flammable materials.

2. Chemical Laboratories

2.1. Architectural Requirements

2.1.1. Fume Hoods – see section 233816 Fume Hoods

2.1.1.1. Where required by the risk analysis, one or more fume hoods may be required.

2.1.1.2. Fume hoods shall be placed out of the direct traffic pattern and shall be located away from supply diffusers or exhaust intakes.

2.1.2. Laboratory doors shall self close and latch.

2.1.3. Floors shall be VCT or rubber tile with the minimum number of joints. Chemically resistant sheet type flooring with integral cove up the wall is encouraged where the budget allows. Base shall be vinyl or rubber and shall be easily cleaned.

2.1.4. Walls must be sheetrock, or other impervious material and must be smooth finish. Walls shall go to deck so that each room can be sealed. All penetrations of the walls shall be sealed (this includes walls above lay-in ceilings).

2.1.5. Ceilings may be lay-in tiles or sheetrock. If sheetrock is used, the finish shall be the same as for walls. All penetrations through the floor above shall be sealed.

2.1.6. Windows shall meet the requirements noted elsewhere in the Consultant Procedures and Design Guidelines. Windows labs shall not be operable. Windows shall be sealed and caulked to prevent leakage.

2.1.7. Doors are to be a minimum of 36” wide and shall meet the minimum heights required elsewhere in this standard. 7’-0” heights are encouraged. All doors shall be undercut by ½”.

2.1.8. There are no unique standards for door hardware. Labs must be key lockable from the outside. Card Access to some laboratories may also be required.

2.1.9. Bench tops must be smooth surface, impervious to water and resistant to heat, organic solvents, acid, alkalis and other chemicals.

2.1.10. Structural Considerations: Due to the nature of research and the sensitive instrumentation used, the structure shall be designed to minimize the transmission of vibration. The design shall be stiffened and use enough mass that any vibration that is transmitted is high frequency.

2.2. Fire Protection Requirements

2.2.1. Fire protection systems are as required per other sections of the Consultant Procedures and Design Guidelines. Variances to this standard can only be approved by the Authority Having Jurisdiction (AHJ).

2.2.2. In the case of special needs, systems other than water based may be used with the approval of the AHJ.

2.3. HVAC Requirements

2.3.1. Air handlers serving chemical lab spaces shall be 100% outside air and 100% exhaust. Provide MERV 8 rated prefilters and MERV 15 rated final filters.

2.3.2. Heat recovery shall be used where physically possible and economically justified. Heat recovery systems (wheels) shall be allowed for laboratory general exhaust devices only.

2.3.3. Fume Hood exhaust shall be ducted separately from general laboratory exhaust. Fume Hood exhaust shall be manifolded together and ducted to a constant volume exhaust fans with plenum boxes and control dampers located on the roof.

2.3.4. Canopy Hoods shall be interlocked with the equipment they serve. A time delay may be added to the canopy hood to allow it to run for a specified time after the equipment shuts off to exhaust heat until the equipment cools.

2.3.5. Use VAV systems utilizing laboratory air valves for all supply and exhaust systems (see Section 230910). Valves shall have a maximum error of no more than 5% of full range. Do not mix laboratory air valves and standard VAV boxes in the lab areas. VAV boxes may be used outside the lab areas in general office or other uses. All spaces and devices shall be hard ducted both supply and exhaust. Lined duct may be used between the exhaust diffuser and the exhaust valve.

2.3.6. Occupancy Sensors shall be used in all laboratories to control both lighting and the supply air valves. Minimum air changes per hour (ACH) for

occupied laboratories is six (6) and for unoccupied laboratories it is three (3) ACH. If requested by the Project Manager, the consultant will evaluate the use of lab air monitoring systems (such as Aircuity) to reduce the total ventilation required with the potential of lowering the minimum ACH for occupied and unoccupied laboratories. The consultant must provide a design sufficient to allow a laboratory to increase ventilation upon the detection of higher concentrations of identified chemicals to flush out the room (e.g. due to a spill). Ventilation rates may be adjusted over time by comparing measured concentrations with desired thresholds but never lower than four (4) ACH for occupied laboratories and two (2) ACH for unoccupied laboratories, or thermal load requirements.

2.3.7. Air flow shall be from low hazard spaces to high hazard spaces. Corridors shall be provided with adequate supply flow for make-up to labs connected to the corridor. Generally, this will require the corridors to be a separate supply zone.

2.3.8. Each lab shall have a supply air valve and an exhaust air valve as a minimum in order to maintain correct flow and pressure relationships. Manual systems are not allowed in laboratories. Within a lab suite additional pairs of valves may be needed where pressure relationships or directional flow between spaces is required.

2.3.9. Supply and Exhaust Diffuser shall be located in laboratory aisle ways (not above benches or equipment) and not in front of fume hoods. Diffusers shall be 2' x 2' and have a maximum of 400 CFM.

2.3.10. Where constant volume hoods are used on simple lab systems, the hoods and lab ventilation shall have valves to control air flow.

2.3.11. Equipment loads shall be carefully determined. Use actual equipment loads with diversity if available. If not, the maximum allowed allowance for equipment loads is 8.0 w/sq ft. (This is from NIH Design Guidelines).

2.3.12. Supply and Exhaust Quantities

2.3.12.1. Calculation of supply and exhaust airflows requires care and reiterative checking to see what parameter determines each value.

2.3.12.2. Offset is defined as the required difference between the exhaust and supply flows to a space. In chemistry labs the offset is negative, i.e. exhaust flow exceeds supply flow. Offset to be 150 CFM for the first door or operable opening (main door to the lab) and 100 CFM for each additional door or operable opening. Where an opening has more than one leaf the offset shall be multiplied times the number of leaves. Doors or operable openings shall be counted only if air flows through that opening

into the space. Maximum offset for a standard door shall be 200 CFM.

2.3.12.3. Supply shall be sized for heat loads or make-up requirements, whichever is higher. *(Example: If there is one door into a lab and the calculated supply is 1,000 CFM and the required exhaust is 1,600 CFM, the supply shall be raised to 1,400 CFM to reduce the offset to the allowed maximum.)*

2.3.12.4. Exhaust shall be sized for a minimum of 6 air changes or high enough to achieve the required offset, whichever is greater. *(Example: The lab has one door with a required exhaust rate of 1,000 CFM. The calculated load requires a flow of 1,000 CFM. The exhaust shall be increased to 1,150 CFM to meet the minimum required offset.)*
All systems, whether new or replacement, will be designed using VAV hoods and constant volume exhaust fans with plenum boxes and control dampers. If the complete exhaust-supply system cannot be installed at time of fume hood installation, at a minimum, Phoenix Valves, capable of being upgraded to VAV, for the new equipment will be installed. This may require a constant velocity type fume hood be installed. If so, select the fume hood for future modification to a VAV type fume hood. Minor modifications to existing fume hoods that do not increase makeup air requirements or cause other imbalances are exempt from this requirement.

2.4. Plumbing Requirements

2.4.1. Floor penetrations in laboratories are to be avoided. Feed pressurized services from above. Where penetrations must be made, they must be thoroughly caulked and sealed.

2.4.2. Provide emergency shower and eyewash facilities per ANSI standards. Tempered water systems are not required if the system is designed such that the water temperature in the system is equal to or greater than the ambient temperature and has enough volume to sustain warm water flow to the eye wash or shower head. This feature must be approved by the AHJ on a case-by-case basis.

2.4.3. Central lab pure water systems should be provided in the form of a circulating reverse osmosis (RO) system. Higher grade pure water should be provided by polishing units within each lab as required.

2.5 Electrical

2.5.1 Preliminary power loads should be calculated as follows:

Load	**W/Sq Ft.**
Lighting	2.7 – 3.8
Receptacles	4.8 – 21.5
HVAC	9.7 – 10.8
Lab Equipment	4.3 – 8.6
Elevators	1.1 – 1.6
Miscellaneous	1.1 – 2.2
Total	23.7 – 48.5

2.5.2 As the design progresses, these values should be refined and in some cases replaced. Lab equipment should continue to be an allowance but all other values should be re-calculated based on the diversified loads contained in the design.

2.5.3 Electrical panels for labs should not be located in the laboratory, but should be located in a secure space that is accessible by laboratory personnel.

2.5.4 Emergency power should be accommodated in the building wiring even if a generator is not installed. Provide normal and emergency distribution systems that can be separated in the electrical equipment spaces. Leave specific room for transfer switches. This power is primarily laboratory systems that may need back-up power and for future flexibility in the laboratory and is not intended to meet life safety requirements. Life safety systems must have their own back-up which shall be a generator or battery per applicable codes.

2.5.5 Lighting is to conform to the general lighting criteria in the Consultant Procedures and Design Guidelines.