1 Applicable Industry Design Guidelines, Standards, and References:
1.1 ANSI/AIHA Z9.5-2012 (or latest version), American Industrial Hygiene Association
1.2 2015 ASHRAE Handbook (or latest version), HVAC Applications, Chapter 16, Laboratories
1.3 ASHRAE Energy (90.1) and Ventilation (62.1) Standards – latest versions
1.4 The National Institute of Health (NIH) Design Requirements Manual for Biomedical Laboratories and Animal Research Facilities (DRM)
1.5 ACGIH Industrial Ventilation, A Manual of Recommended Practice for Design – latest edition
1.6 ANSI Z358.1-2004 Compliance Checklist for Emergency Eyewash and Shower Equipment
1.7 Center for Disease Control (CDC) Biosafety in Microbiological and Biomedical Laboratories

2 Room Layout
2.1 Wall-mounted bench depth is 30”.
   2.1.1 For the standard 22” deep base cabinet, this leaves a 1” overhang in front and a 7” space behind that is used as a utility chase.
2.2 Aisle width is 5'-0” minimum where knee spaces occur back to back.
2.3 Occupant-provided equipment lists should be obtained early in the design process, so that accurate size, electrical, and HVAC requirements can be factored into the design. When possible, plan shared equipment space for energy and space efficiency.
2.4 Service sinks are normally 21” to 24” long, 15” to 18” wide, and 7” to 10” deep with a hot and cold mixing faucet and an RO water faucet.
   2.4.1 Pegboards are provided at service sink locations above the backsplash with a drip trough.
2.5 If the lab requires a higher degree of water purification than is provided by the building RO system, then provide space for a polisher (Millipore-type unit) at a central service sink along with a 120v outlet located at 7’-0” AFF and a stubbed RO water line.
2.6 At least one door into the lab should provide a 48” wide opening filled with a 36” active leaf and a 12” inactive leaf. This provides adequate space to get large equipment into and out of the lab.
2.7 Desks and extended work spaces should be separated from lab hazards. When provided within the lab, give close attention to egress and air quality.

3 Laboratory Room Finishes
3.1 Room finishes are intended to provide long life and low maintenance.
3.2 Floors are typically sealed concrete, sheet vinyl with welded seams, quartz epoxy, or 12” x 12” vinyl composition tile. Vinyl base is installed at all walls and in toe spaces of base cabinets.
3.3 Ceilings, when installed, are 24”x 48” lay-in acoustical tile. When no ceiling is installed, everything above 8’-0” - the building structure, ductwork, conduit, and wall surface - is painted white.
3.4 Walls, whether block, drywall, or plaster, are painted with a color that has a light reflectance value of 70+.

4 Laboratory Furniture
4.1 Base and wall cabinets are to be either oak or metal, and certified by Scientific Equipment and Furniture Association (SEFA).
   4.1.1 Base cabinets have removable back panel to provide access to the utility chase.
   4.1.2 Minimum 24” wide knee spaces with finished back panels and electrical outlet are provided where requested by the lab occupant.
   4.1.3 The lab occupant determines the proportional mix of drawers and doors provided by the cabinets.
   4.1.4 Knee space is sometimes provided for under-counter refrigerators, ice machines or glassware washers.
4.2 Countertops are 1” thick chemical resistant material (e.g. modified epoxy, Trespa “TopLab”) in grey, taupe, or black. Consider higher light reflectance values to improve the illumination.
4.3 A 4” backsplash occurs at peninsula end-sink and at all wall-mounted locations. Countertops are continuously flat surfaces at peninsulas penetrated only by shelving support systems, utility lines and cup sinks.
4.4 Shelving above countertops should be flexible and adjustable to accommodate changes in countertop equipment. Task lighting under lower shelf is recommended, and should also be adjustable with the shelf.

5 Power Distribution
5.1 Electrical power and data is provided at the counter and perimeter as needed.
5.2 Emergency power requirements need to be
identified prior to beginning design work. Generators may need to be sized to accommodate building needs.

6 Laboratory Ventilation

6.1 The laboratory ventilation system should remove, dilute, and control the buildup of air contaminants and odors in the laboratory. The ventilation rate must satisfy the general codes and standards that apply to the occupancy class. Minimum air changes per hour (ACH) must be at least 6 ACH occupied and 4 ACH unoccupied.

6.1.1 Higher ventilation rates and dilution may be required.

6.1.2 Lower ventilation rates may be possible with central Demand Controlled Ventilation (cDCV) and air quality sensing.

6.2 Control of temperature variations, humidity, particulates, differential pressure, air velocity, noise, and other environmental factors shall be designed to meet the critical laboratory environmental requirements of lab processes, equipment, and specific applications.

6.3 Follow industry best practices and criteria for fume hood and biological safety cabinet (BSC) placement with respect to occupant traffic, walls, doors, benches, structural details, airflow diffusers and grilles, and other hoods.

6.4 A ‘low air flow zone’ is required at each hood and BSC. Supply air diffusers shall be selected and located so to have no deleterious effect on fume hood aerodynamics.

6.5 Select appropriate lab controls and offset between the laboratory supply and exhaust airflow to maintain the required pressure differential to the corridor and adjacent spaces.

7 Laboratory Fume Hoods: Selection, Testing, & Operation

7.1 Complete the Fume Hood Selection form, Section 13, for each fume hood as the basis of design, defining the location, application, usage, type, size, utilities, expected chemical use, and sash type.

7.2 All new fume hoods shall be “High Performance, Low Velocity” type, engineered, manufactured, and tested to safely contain hazards at a minimum face velocity of less than or equal to 60 fpm with the sash in the fully open, set-up position.

7.3 Specified fume hood models must provide third-party, independent ASHRAE 110 - “As Manufactured” (AM) testing for each fume hood model planned for the project.

7.3.1 As-Manufactured (AM) Containment tests must demonstrate passing performance and include flow visualization, smoke testing, face velocity measurements, and tracer gas containment testing with as-used challenges representing sash movement effect, walk-by tests, and cross draft conditions of at least 30 fpm.

7.3.2 ASHRAE 110 – (AM) test reports must be pre-approved by the Purdue University Radiological and Environmental Management (REM) department and Physical Facilities Engineering Services to qualify for specification.

7.4 All new fume hood installations must be tested and pass the ASHRAE 110 - “As Installed” (AI) test as determined per project requirements for the most challenging sash operating configuration.

7.4.1 For small installations of 1-2 fume hoods, testing may be provided in-house by the Purdue University REM department. For 3 or more fume hoods, testing shall be performed by a 3rd party independent fume hood testing professional and must comply with REM ASHRAE 110 Testing Criteria, available upon request.

7.5 The fume hood exhaust volume used as the basis-of-design must include the hood bypass and duct leakage airflow.

7.6 Constant air volume (CAV) fume hoods shall have bypass grilles/openings of adequate size to maintain an acceptable face velocity over the entire range of sash movement.

7.7 Variable air volume (VAV) fume hoods shall have a restricted bypass to allow for exhaust airflow reduction as sash closes.

7.8 Fume hoods shall have access ports for cords, tubes, wires, etc. to be run through the side sills or front airfoil to the interior of the hood.

7.9 Fume hoods must have a visual and audible face velocity indicator to be installed and calibrated by a representative of the manufacturer.

7.10 Training on the calibration, operation, and maintenance of the fume hood controls must be provided by the manufacturer.

7.11 For traditional or existing fume hoods that were engineered and tested for 80 to 120 FPM, the design operating face velocity is 100 FPM. For high performance fume hoods that are engineered and tested to 60 FPM, the design operating face velocity shall be no lower than 80 FPM, providing a margin for safety.

7.12 The maximum fume hood exhaust (CFM) is determined by the greater of the following two
conditions:

7.12.1 The fume hood operating at the design operating face velocity with the sash open to working area (height x width). The vertical sash working height is 18”.

7.12.2 The fume hood operating at the manufacturers recommended minimum face velocity with the sash fully open.

7.13 The minimum fume hood exhaust (CFM) with the sash closed is defined by ANSI/AIHA Z9.5 Lab Ventilation Standard Z9.5 - latest version and risk assessment by REM, but not less than 15 CFM/SF fume hood worktop.

7.14 Perchloric acid and Radio-isotope fume hoods and exhaust fans must be specifically designed for that use.

7.14.1 Ducts may not be more than 45 degrees off vertical with no more than four offsets (two to get into a chase, and two to get out of the chase).

7.14.2 Perchloric acid systems are to have a water wash down (see “Laboratories – Plumbing Guidelines”).

7.14.3 Perchloric acid hoods must be attached to a dedicated exhaust system using FRP, PVC or welded stainless steel ductwork.

7.14.4 Radio-isotope hoods must be attached to a dedicated exhaust system using welded stainless steel ductwork.

8 Laboratory and Fume Hood Exhaust Fan Systems

8.1 Lab air control valves which impact the fan static pressure requirement should have a pressure drop less than or equal to 0.3” water gauge at design flow.

8.2 For energy efficiency and safe dispersion of laboratory and fume hood exhaust, a Variable Air Volume (VAV) central Manifold Hood Exhaust Roof (MHER) system is required for multiple fume hoods and labs.

8.3 CAV fume hoods are acceptable where hood exhaust is less than the minimum lab ventilation rate or if VAV is not feasible with existing infrastructure.

8.4 Where cost effective with a life cycle analysis, consider energy efficiency approaches such as heat recovery, central demand control ventilation, and lab exhaust optimization (wind engineering and dispersion model testing).

8.5 The exhaust stack must discharge vertically at least 10’ above the roof with no rain cap. Exhaust stack exit air velocity shall be determined by an approved engineering approach, at least 3,000 fpm unless a lower velocity is justified.

8.6 Fume hood exhaust ducts should be designed with a velocity of 1,000 to 2,000 fpm. For VAV fume hood systems, an exhaust diversity factor may be used for the maximum duct velocity. Assume no diversity factor when sizing exhaust fan capacity and total static pressure.

8.7 General purpose fume hood exhaust duct material is typically galvanized steel with a chemical resistant epoxy coating from the hood discharge to the point of significant dilution (manifold exhaust system main duct).

8.7.1 Uncoated galvanized steel may be used on manifold exhaust systems where enough fume hood and lab exhaust combine to provide adequate dilution.

8.7.2 Stainless Steel is rarely used for general fume exhaust and will require justification.

Note: The exceptions to this are the welded stainless steel systems for perchloric or radioisotope hoods. PVC is acid resistant but has poor solvent resistance. PVC may be used only when exhaust system is being specifically designed and marked for acid only use.

9 Fume Hood Plumbing Considerations:

9.1 Fume hoods should be purchased pre-plumbed and with all pipes pre-insulated.

9.2 Laboratory water in fume hoods must have a reduced pressure backflow preventer or a vacuum breaker.

9.2.1 Vacuum breakers must be located out of the contaminated air and mounted high on the exterior face of the hood, with forward extended piping so that leakage that may occur under normal operation does not damage equipment below.

9.2.2 Do not locate vacuum breakers in inaccessible or concealed space.

10 Plumbing for Perchloric and Radio-Isotope Hoods

10.1 The exhaust system must include a backflow protected wash-down system. This system must be carefully designed to guarantee the proper flow to each of the spray nozzles. It may require multiple risers and/or pump(s).

10.2 The system will be designed using the following parameters:

- Spray head nozzles should be installed below and after each elbow, and every five feet in straight duct runs.
• Nozzles and components should be made of stainless steel and/or fluorocarbon plastic.

• Nozzles and components must be accessible for maintenance.

• Each hood enclosure should be equipped with a minimum of two spray heads.

• Flow from spray heads should be allowed to drain back to hood. Verify acceptance flow for drains in hoods. For flow greater than hood drain acceptance wash down spray heads should be sequenced to prevent overflow.

• A timed, field adjustable wash down sequence must occur after each perchloric acid hood usage, at least daily. Show timer location on the drawings.

10.3 Flow to spray nozzles must have a means of testing, adjusting, and balancing.

11 Laboratory Water Systems

11.1 Laboratories shall utilize a segregated laboratory water distribution system, independent of the building’s domestic potable water.

Note: The intent of the separated water distribution approach is to minimize the need for point of use backflow preventers, while still maintaining potable water supplies to required areas and sufficiently clean water for laboratory research and general non-potable demand purposes. The laboratory water system shall not serve any outlets intended for ingestion, bathing, or pharmaceutical applications for humans or animals; however, the system shall still be protected to ensure a clean water supply. This includes the use of reduced-pressure principal devices or vacuum breakers at equipment outlets of particularly high hazard or probability of cross connection.

11.2 In general reverse osmosis quality purified water (> 0.05 Mohm-cm) is to be made available in laboratories.

Note: It is the responsibility of the researcher to provide water purification equipment if higher quality water is required.

12 Emergency Eyewash and Safety Shower Equipment

12.1 Each lab unit must be equipped with an eyewash station. Each lab unit where the use of hazardous chemicals is anticipated must be equipped with a combination eyewash/safety shower.

12.2 The eyewash must have a face wash feature and hands-free operation. Once activated it should continue to provide water flow until manually shut off.

12.3 Safety showers shall be located in an immediately accessible area within the laboratory unit or other work areas where the user shall not have to pass through a corridor door to reach the unit.

12.4 Eyewash and safety showers should be located near the door. If the door location is not practical, an alternate location is at the end of a peninsula bench next to a 3’-0” wide sink unit.

12.5 For laboratories sharing a common suite or area not separated by closed doors one emergency shower may be sufficient.

12.6 All emergency eyewashes and safety showers shall be tied into the potable water system.

12.7 The water supply line in the lab must have a manual shutoff valve below the ceiling within 48” of each eyewash or safety shower.

12.8 For new construction all emergency eyewashes and safety showers will be supplied with tepid (60°F to 100°F) water using a mixing valve specifically designed for this use. A typical set point is 75°F to 80°F. For renovation projects where difficult to attain, discuss the options with the PM for direction to proceed.

12.9 All new eyewash stations are to be hard-piped to a waste line. All new safety showers are to have a floor drain in the vicinity of the shower discharge area, but located away from chemical spill risk.
# Fume Hood Selection Guide - General Information

<table>
<thead>
<tr>
<th>Project Name</th>
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<tbody>
<tr>
<td>Hood Location</td>
<td>Date</td>
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<tr>
<td>A&amp;E Firm</td>
<td>Preparer’s Name</td>
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## Contact Information for Faculty & Staff Responsible For Hood Operation

<table>
<thead>
<tr>
<th>Faculty Name</th>
<th>Title</th>
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<tbody>
<tr>
<td>Staff contact</td>
<td>Title</td>
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<tr>
<td>Department</td>
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### Campus Address

<table>
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## Hood Use information

**Application** (describe expected use of hood):

**Apparatus** (describe anticipated equipment use):

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<tr>
<th>Hood usage (circle):</th>
<th>CAV / VAV (Constant or Variable Air Volume)</th>
<th>24/7 continuous</th>
<th>Occasional/intermittent</th>
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<th>Air</th>
<th>RO</th>
<th>DI</th>
<th>CW / HW</th>
<th>Cup sink(s)</th>
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<th>Flammable</th>
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<th>Other:</th>
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## Chemicals Expected to be Used

(Attach additional pages as needed)

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<tr>
<th>Name or Chemical Type</th>
<th>Concentration</th>
<th>Process Temperature Range*</th>
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<tr>
<td></td>
<td></td>
<td>*example: room temperature, betw. #° C to #° C, liquid N2 boiling point</td>
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## Hood Type

(Check all that apply. Physical Facilities may select based on above info.)

<table>
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<tr>
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<th>Acid Resistant</th>
<th>Perchloric Acid</th>
<th>Radio-isotope</th>
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<td>Conventional</td>
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<tr>
<td>Acid Resistant</td>
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<th>Lab Control System</th>
<th>Fume hood mfg. provided</th>
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