DIVISION 11 – EQUIPMENT
11 53 00 LABORATORY EQUIPMENT
11 53 13 LABORATORY FUME HOODS

PART 1 - GENERAL

1.01 SCOPE

A. All fume hood design discussion shall include a representative industrial hygienist from WSU Environmental Health and Safety (EH&S), the Radiation Safety Office (RSO) (as applicable), and the WSU Project Manager.

1.02 FUME HOOD DESIGN

A. Face Velocities

1. Standard hood face velocity requirements for general lab use are listed below:

DESIGN FACE VELOCITIES (fpm)		
Average	Minimum velocity at any location at the face, at 18 inches sash opening	Maximum velocity at any location at the face.
100 ± 20%	80	120

2. WSU will consider lower face velocities than those described above, but these must be in accordance with the manufacturer's recommendations and ASHRAE 110 tested. Lower face velocities than those described above require approval from WSU Engineering Services and WSU EH&S.

B. General Fume Hood Design Characteristics

1. Each fume hood superstructure shall be a free-standing rigid frame structure of steel angle to support exterior and interior panels (e.g., double wall construction). The exterior walls shall be fabricated of cold-rolled steel, phosphate coated, and have a baked chemical-resistant resin finish. The interior lining material will depend on the chemical process but may include stainless steel, high density calcium silicate, fiberglass reinforced polyester, or other approved material.

2. Each hood shall have a "picture frame curved" airfoil at the sides, top, and bottom approximately 6 inches wide.

3. Bottom airfoil shall have an air space between it and the hood bench top. Air space shall be unobstructed by brackets or configurations which cause

turbulence. Airfoils shall allow for inlet of air at bench level when the hood sash is closed.

4. The outside leading edge of an airfoil sill shall be slightly below the hood bench level.

5. Hood Alarms: All hoods shall be equipped with sash stops at 18 inches for normal use. All shall be equipped with local velocity alarms to indicate when airflow conditions greater than +/- 20% out of range occur. The WSU Building Automation System (BAS) shall also receive this alarm.

    i. Where possible, WSU prefers fully automated fume hoods for energy conservation. In these applications, the BAS shall also alarm if the sash position is not closed between 9:00 PM and 6:00 AM daily.

6. The hood bench base shall be dished on all four sides to a depth of approximately one-half inch to contain spills inside hood. This depression (dish) should not be closer than six inches from the front lip of the hood bench top.

7. The hood interior end panels shall be flush with the entrance shape to prevent eddy currents and turbulence. There shall be no shelves or other obstacles within 18 inches of hood face.

8. The hood interior back panel shall contain three horizontal slots located at bench level and at intermediate positions. The slots shall be adjustable, either individually or in combination, to direct air flow within the hood.

9. The slots shall have a stainless steel mesh screen behind to keep paper and debris from being exhausted into the fume hood rear plenum and duct work.

10. Air velocity in the slots shall be equal to or less than the duct velocity range of 1000 to 1600 fpm and preferably less than 1500 fpm.

11. Sinks and service fittings shall be located at least six inches beyond the hood face. Sinks shall be surrounded by a lip (at least ¼ inch) above the hood bench base to prevent spills from entering the sink.

12. A vertical sliding sash made of sheet or laminated safety glass shall be provided for hoods unless otherwise specified. Tempered glass may be required with high temperature functions. Polyethylene or other non-reactive material should be used for sashes for hydrofluoric acid hoods.

13. The fume hood exhaust duct exit should be bell-shaped to provide a smooth transition. The fume hood exhaust collar shall be 316L stainless steel.

14. All materials used in the hood construction shall be asbestos-free.

C. Specific Hood Design and Performance Requirements

1. Bypass Fume Hoods

i. Must meet face velocity requirements of general lab use hoods with the sash at the fully open position.

ii. General Design. An automatic air bypass shall be furnished for hoods with vertical sliding sash at the sash opening. This air bypass shall limit the maximum air velocity through the face of the hood, and provide a relatively constant volume of air through the hood regardless of sash position when hood exhaust blower is in operation. The hood air bypass shall not be dependent on mechanical or electrical linkage and shall be completely positive in operation. The air bypass shall be designed to prevent hot gases, vapors, or debris, generated by fire or explosion within the hood from being ejected through it directly at the operator. If the design has the air bypass on top of the hood or horizontal fixed front face louvers, the louvers shall be directed upward, with louver centerlines not more than one louver width apart.

iii. The fume hood, when properly installed in a laboratory and connected to an exhaust blower of the proper capacity, shall contain and remove fumes generated within the hood. The hood shall operate efficiently at the design velocity. Hood design shall be such that it will exhaust light or heavy gases efficiently when the hood is used for ordinary laboratory work in a room free from cross drafts and without high thermal loads or other special conditions.

2. Variable Air Volume (VAV) Fume Hoods

i. Must meet face velocity requirements of general lab use hoods with the sash at all positions. Fume hoods shall incorporate VAV function through the use of a Venturi valve. See example Sequence of Operations in section 25 50 00 “Integrated Automation Facility Controls.”

ii. General Design

1) The face velocity shall be maintained at constant 100 fpm (or in accordance with the manufacturer’s specifications), regardless of

changes in the sash position, unless otherwise approved by WSU Engineering Services and EH&S.

2) With the sash closed, a minimum 500 cfm exhaust shall be maintained through a combination of a reduced bypass and horizontal deflector vane below the sash frame. The air bypass on top of the hood or horizontal fixed front face louvers shall be directed upward and not more than one louver width apart.
3) The fume hood, when properly installed in a laboratory and connected to an exhaust system of the proper capacity, shall contain and remove fumes generated within the hood. The hood shall operate efficiently at the required design velocity. Hood design shall be such that it will exhaust light or heavy gases efficiently, when the hood is used for ordinary laboratory work in a room free from cross drafts, and without high thermal loads or other special conditions of this nature. Failure to meet the performance requirements shall be cause for rejection of the equipment.
4) The modulating damper shall be enclosed in a "removable spool assembly," preferably located in the Mechanical Room. Variable frequency fan drives with static pressure sensors are also acceptable in some installations.

D. Fume Hood Utilities

1. Controls for hood utilities shall be located outside the hood including any three-pronged receptacles for 110V power.

2. Hood lighting shall be vapor-proof or explosion proof, depending upon the intended purpose of the hood. Lights should be changeable from outside the hood.

3. Each sink or cup sink in a laboratory hood shall be individually trapped.

4. Hood electrical switches shall have indicator lights.

5. Indicator lights shall be installed to indicate proper blower operation. Where applicable, fan speed selector switch shall be rotary type. It shall be two position, "HIGH" or "LOW". Indicator lights shall be included: blue for "LOW" and green for "HIGH". Two speed fans shall only be connected to individual hoods. There shall not be more than one hood on a two-speed fan. Dual speed fans should only be used on hoods which have a dedicated exhaust system. The fume hood shall never be able to be turned off by the user.

6. Flow Indicator: Each fume hood must have an air flow indicator light.

7. Flow Alarm: Each fume hood shall have an air flow audible alarm which will sound whenever the fume hood is on "HIGH" speed and the face velocity drops below 90 fpm or goes above 110 fpm. For two-speed hood fans, when the fan is set on the "LOW" speed the face velocity shall be maintained at a minimum of 60 fpm and maintain a minimum 500 cfm exhaust within the hood. In addition, the indicator light shall flash under the same conditions. The audible alarm shall be provided with a timed silencing switch, set for five minutes, after which the alarm will sound again if the previous conditions still exist. The indicator light shall remain on (flashing) continuously during the aforementioned conditions.

    i. This requirement shall also be applicable to a single speed fume hood.

    ii. In the "LOW" speed (for two-speed units), the alarm shall not sound but the indicator light shall flash when the velocity drops below 90 fpm. This will remind them to lower the sash to increase the face velocity, in order to stop the flashing light.

8. Fume hoods, if factory wired, must be UL (or equivalent) listed or wired upon installation by licensed electrical contractor.

9. Water faucets in new installations and remodeled fume hoods shall be equipped with a vacuum breaker which is not located within the hood work chamber. It shall be accessible for maintenance and located so as to not become a dripping or flooding hazard.

10. Each fume hood must have a packaged dry chemical fire suppression package with 212°F fusible link spray head.

E. Performance Evaluation

1. The fume hood manufacturer is responsible for performing an evaluation in accordance with ASHRAE 110 for each production run and size; results shall be sent to WSU EH&S for evaluation.

2. Two pitot tube test plugs made of non-corrosive material shall be installed in the exhaust duct at 90^{o} to each other around the circumference for the purpose of pitot tube insertion.

    i. Pre-Approved Models: Pete’s Plug II

3. Performance evaluation as part of ASHRAE 110 shall be done by measuring hood face velocities and by measuring the terminal velocity of supply air nearest the fume hood. The supply air velocity should not exceed 50 fpm at the sash opening.

4. In addition, smoke tubes, Rosco smoke generator or dry ice in water should be used to determine the extent to which the hood contains the contaminant and to check for reverse air flow and turbulence. Alternatively, a solution of titanium tetrachloride may be painted on the walls and floor of the hood just inside the sash to provide the same information obtained by use of the smoke tubes.

5. Approval for general lab use may be withheld if the hood does not meet certain physical requirements (e.g., lack of an air foil picture frame, lack of ventilated storage cabinet beneath the hood working surface, lack of air distribution slots at the rear of the hood).

1.03 HOOD INSTALLATION

A. General: Laboratory fume exhaust systems shall be designed as complete operating units considering chemical use factors, room supply air, room configuration, hood type and location, exhaust fan, and ductwork.

B. Hood Location and Disturbance

1. Cross drafts created by the room ventilation system, open windows, operable doors, personnel traffic, etc., can drastically disturb the flow of air entering the fume hood and cause a reverse flow of air out of the front of the fume hood. Such room conditions must be avoided by proper selection of ventilation delivery system, permanently locking windows, and locating hoods 10 feet or more away from doors. In no case should the velocity of cross drafts exceed 50 fpm or 50% of the hood face velocity, whichever is less.

2. Makeup air for hoods shall be supplied through ceiling panels to the extent possible. Throw velocities of diffusers, when used, shall be 60 fpm or less. Diffusers shall never be directed toward the hood or at an oblique angle to the hood.

C. Noise: Noise measurements shall be made at an average distance of one foot from the fume hood with the sash fully open, using a type 2 sound level meter per ANSI standards, and an octave band filter for 31.5 to 4000 Hz.

NOISE CRITERIA	
SCALE SETTING	AVERAGE DECIBELS
A	62
C	79

D. Replacement Air - General Laboratory

1. Air exhausted through laboratory fume hoods shall not be recirculated.

2. Pressure differentials shall be maintained between rooms to insure positive air movement from clean to more contaminated areas. Therefore, air supply should exceed air exhausted to office or classroom space and air exhausted should exceed air supplied to laboratory space. Laboratory units in which chemicals are stored or used must maintain air pressure negative to corridors or adjacent spaces.

E. Design for Growth

When it is anticipated that hoods may be installed at a future date, provisions should be made by setting aside an appropriate location in the laboratory. Adequate space shall be planned for all hood service and utility requirements.

F. Storage

1. Underhood storage units intended for chemical storage shall minimally contain: recessed floor, metal lining, liquid and gas-tight construction and ventilation flow from outside hood through storage unit to hood plenum chamber.

2. Underhood storage units intended for flammable liquids or acids shall be designed for ventilation and installed in accordance with the manufacturer’s recommendations.

1.04 FAN AND DUCT DESIGN

A. Exhaust Fans

1. Fans shall be weather protected and installed near the building roof. Fan installation in fan room lofts, attics, or rooftop penthouses is preferred. Each fan shall be the last element of the system below the exhaust stack to ensure that the ductwork through the building is under negative pressure.

2. All fans shall be readily accessible for maintenance or replacement.

3. Fans shall be provided with:

i. Outboard "split" bearings

ii. Shaft seal

iii. Access door

iv. Multiple 150% rated belts, or direct drive. In designing for explosion and fire control, the fan shall be of the non-sparking construction and the V-belt drive shall be non-conductive.

4. Fan system shall be chemical resistant throughout and shall have a non-sparking wheel.

5. Fan housing shall be welded or permanently sealed to avoid air leakage from the wheel shaft and discharge.

6. Vibration isolators shall be used to mount fan.

7. Each exhaust fan assembly must be individually matched (CFM, SP, BHP, etc.) to each laboratory hood and duct system design.

8. Choice of fan type will be determined as follows:

i. Use straight-radial fans for systems handling moderate to heavy quantities of particulate matter in air.

ii. Use backward-curved fans for systems handling relatively clean (low particulate) air.

iii. Axial fans may be used in a vertical mounting for systems requiring washdown as perchloric acid hoods.

iv. Other applications may require special fans.

9. Approved fume hood exhaust fan manufacturers are:

i. New York Blower

ii. Barry Blower

iii. PACE

B. Maintenance Accessibility

1. Adequate space and easy access shall be provided to facilitate inspection, repair, or replacement of exhaust ducts. Fixed ladders and platforms should be accessible for maintenance points over 6 feet high.

2. Utility cores may be central cores large enough for entry; service cores accessible through removable panels opening into corridors; or concealed accessible chases located in outside walls.

3. Fume hood service supply lines (air, gas, vacuum, water, steam, etc.) shall be furnished with screwdriver or loose key shutoff valves, and shall not be located where accessible to the general public.

C. Exhaust Duct Materials and Construction

1. Flexible connection sections of ductwork, such as hypolon or neoprene coated glass fiber cloth, shall be used between the fan and its intake duct when such material is compatible with hood chemical use factors. The transition joint from duct to fan must be of a seamless, constant diameter, inert, corrosion and ultraviolet resistant material as approved by owner. The duct alignment must be within one-half inch at the hood collar and fan.

2. Choice of duct material shall be one based on the compatibility with the materials handled in the hood. Basic characteristics of preferred hood and duct materials are as follows:

   i. New installations shall be of 18 gauge (minimum thickness - except perchloric acid systems shall be 16 gauge) stainless steel. Stainless steels (subject to attack by acid and chloride compounds) vary with the chromium and nickel content of the alloy. Type 316L passive stainless with No. 2B finish shall be used for bacteriological, radiological, and perchloric acid hoods. Alternate materials must be approved by WSU EH&S. (Not suitable for hoods handling concentrated HCL and H_2SO_4)

   ii. All stainless steel joint construction to be continuously butt welded.

      1) If welding is impossible, an alternate corrosion resistant (leak proof) joint may be used, if previously approved by WSU Engineering Services and WSU EH&S. The joints must also pass a pressure test as described below.

   iii. Glazed ceramic ducts and vitrified clay tile ducts are resistant to practically all corrosive agents (except hydrofluoric acid) and should be left in place in currently operating systems. However, if abandoned because of the remodel project, they must be designated as "abandoned", cleaned, and removed.

   iv. Newly installed ducts shall be pressure tested. The duct must hold 6" water gauge pressure for 30 minutes, with allowable leakage rate of 0.10" water gauge per 100 square foot of duct under test. WSU Engineering Services must observe and approve the test.

v. Existing fume hood ducts to be removed during demolition shall be cleaned prior to handling and removal and tested for hazardous materials.

vi. Provide a flanged removable spool piece at each fume hood connection and at each radioisotope fume exhaust fan inlet. Spool sections shall be a minimum of 24 inches long and shall be used for leak tests, inspection and to facilitate removal of equipment. Install acceptable gaskets at flanged joint connections. Provide mock-up of flanged joint connection for WSU Facilities Services inspection to prove that there is sufficient flexibility to allow for spool removal prior to installation.

vii. Duct and fume hood connection: Options for making the connection between the fume hood exhaust collar and stainless steel duct include:

1) Provide a flanged exhaust collar on the fume hood and flanges on each end of the fume hood to duct transition piece. Install chemical-resistant gaskets approved by owner; bolt together.
2) Provide a transition piece that inserts inside the fume hood exhaust collar; seal with silicone and stainless steel draw-band fastened on the outside with a bolt or bolts.
3) Or other approved method that provides leak-tight seal without penetration of the duct with screws.

D. Exhaust Stacks

1. Exhaust fumes shall be discharged through vertical stacks terminating above the wake cavity of the building or through shorter stacks with sufficiently high discharge velocity to project the exhaust through the wake cavity into the non-turbulent air passing over the building. Exhaust fume shall not be re-entrained in building air system.

2. Generally, for one or two story buildings, effective stack height is determined by assuming a minimum of 2.5 duct diameters for 2500 FPM adding one duct diameter for each 1000 FPM. However, minimum stack height shall not be less than 10 feet above the roof and/or work platform.

3. Discharge shall be directed upward at a velocity of at least 3,000 fpm for stacks extending 10 feet or more above the building.

4. Exhaust stacks shall not have weather protection, weather caps, or louvers which require the air to change direction or causes turbulence upon discharge.

5. To overcome aesthetic objections, it is important for the design team to plan for exhaust stacks in the conceptual stage of the design by incorporating an exhaust tower or a cluster of exhaust stacks as an architectural element of the building. Consolidation of exhaust stacks has the added advantage of creating a mass of exhaust gases, which is much less readily deflected from upward vertical flow by wind gusts.

1.05 SPECIAL SYSTEMS

A. General

1. All specialized fume hoods addressed in this section require specific approval from WSU EH&S before inclusion in the project scope and design.

2. Hoods and devices handling materials classified as “special” shall be specifically designed to suit such materials.

B. Perchloric Acid Fume Exhaust Systems

1. Perchloric acid deposits in hoods and ductwork are potentially explosive and, therefore, such systems must be considered to be hazardous.

2. Each perchloric acid hood shall be provided with a separate stainless steel bifurcated straight flow through with motor outside the air stream of the fume exhaust fan and must be totally independent from any other exhaust.

   i. Approved perchloric acid fan manufacturers are:

      1) Ametek DeBothezet Bifurcator Model
      2) Approved equal

3. Preferably, perchloric acid hoods shall be located on the building top floor to reduce the extent of ductwork required to a minimum.

4. The hoods must be specifically designed as perchloric acid hoods.

5. The ductwork must be 16 gauge welded (TIG process) type 316L stainless steel with No. 2B finish installed vertically from hood through fan to discharge with few (preferably none) elbows. All ductwork shall drain thoroughly back to the fume hood.

6. Fans shall be located where a violent reaction will not harm adjacent equipment or personnel. Depending on the location, some type of protective screening may be desirable.

7. The entire system, including duct fans and hood, shall be provided with an internal washdown system. The system shall be designed to provide as complete a washdown as possible. The washdown system shall be actuated by an automated or timed valve located adjacent to the fume hood. Prior to acceptance, testing of the washdown system must be witnessed and approved by WSU Engineering Services and EH&S.

8. Fan casings and hood bottoms must be provided with continuous gravity drainage to the sanitary sewer.

9. Perchloric acid shall not be used in hoods not specifically designated for this use. The use of perchloric acid in hoods not designated for this use poses extreme problems for any subsequent hood use and for duct removal during renovation projects. Perchloric acid materials shall not be used in standard lab fume hoods.

10. Perchloric acid hood ductwork shall not be manifolded or joined to non-perchloric acid hood exhaust discharge.

C. High Level Radioisotope Fume Hoods

1. All radioisotope fume hoods require specific approval from the WSU Radiation Safety Office (RSO) before inclusion in the project scope and design.

2. The WSU Radiation Safety Office (RSO) shall determine whether these hoods require a caisson and HEPA filter.

3. Each high level radioisotope fume hood shall be provided with a separate fume hood exhaust fan, duct and be totally independent from any other exhaust.

4. Provide a removable spool section within the room so that a filter housing can be added if necessary.

5. The fume hood interior finish shall be 304 stainless steel, coved corners welded and ground smooth to eliminate any possibility of material build-up.

D. Special Systems: Each special system shall be investigated and a design developed to meet the specific requirements of WSU EH&S. Other materials used in duct construction may be used, such as plastics, only when approved by WSU EH&S on a case-by-case basis according to intended application.

E. Filters: Consult WSU EH&S concerning proper filters, air cleaning devices, scrubbers, incinerators, ultraviolet lights, and other devices for special

purpose hoods in which radioactive materials, pathogens, or carcinogens or corrosive chemicals are to be used.

1.06 PRE-APPROVED FUME HOOD MODELS

A. Bypass Type Fume Hoods

Manufacturer	Models
1. Kewaunee Scientific Equipment	Airflow Supreme and Hoodaire
2. St. Charles Manufacturing	Aerostream Bench Vertical Sash Hood
3. Taylor Division	American Type 200 (with Desk Manufacturing Co. fixed louver vanes)
4. Hamilton Industries	Safeaire
5. Ly-Line	With back center slot

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION