

DFD HVAC DESIGN GUIDELINES
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Note: Items in red text have been added or changed in the current update.

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I. INTRODUCTION

The purpose of DFD HVAC design guidelines is to publish consistent criteria (do's and don'ts) for design issues typically encountered on state owned buildings. Most of the criteria have been developed from DFD's experience with past project reviews and field inspections. This document is not all-inclusive and is not intended to cover every design situation. Where specific design or equipment criteria is in question and is not included in this document, it is the responsibility of the consultant to discuss the situation with DFD prior to submittal of review documents. Generally, the design criteria applies to most situations, but if an unusual condition exists where a guideline may not necessarily make good engineering sense, discuss the situation with DFD.

On certain complex or technical projects, a preliminary review meeting may be requested between DFD and the HVAC design engineer to ensure that specific criteria is fully understood. On occasion, DFD also reserves the right to review specific engineering load design, sound calculation and equipment sizing criteria during the design phase. This review does not relieve the design engineer of responsibility for accurately determining capacities, loads, sizes and code compliance in order to meet program requirements.

The design criteria are intended to be used in conjunction with master specification commentary to guide consultants with design practice and decision making that is consistent with DFD policy. The consultant should be routinely reviewing these documents as they apply to each particular project prior to the preliminary design. The documents will be updated as necessary to reflect additional information or

changes in criteria. The consultant is required to use the latest edition available at the beginning of their design. The latest editions will always be posted on the DFD Internet Homepage:

[DOA Master Specifications/Design Guidelines \(wi.gov\)](#)

Comments on the design guidelines are welcome from those who use the document. As technology and building practices change and solutions to problem situations are discovered, DFD wants to ensure that good information is shared to continually improve the quality of HVAC design and construction.

Questions and comments may be directed to the DFD mechanical section at (608) 266-1564 (Casey Coddington) or (608) 266-8400 (Doug Schorr).

II. UNACCEPTABLE SYSTEMS AND DESIGN PRACTICES

The following systems and design practices are not acceptable for use on DFD projects unless the application for these systems has been discussed with DFD and prior approval has been granted by the mechanical section of the Bureau of Architecture and Engineering at DFD.

- A. Rooftop air handling systems
- B. Outdoor air-cooled chillers
- C. Electric heat of any type
- D. Two-pipe heating/cooling systems
- E. Unit ventilators (unless replacing existing)
- F. Window air conditioning units
- G. Package terminal air conditioner (PTAC) units
- H. Fan coil systems
- I. VAV systems using direct expansion cooling
- J. Fan powered air terminal units
- K. Electric control systems
- L. Duct liner except as outlined in the DFD master specification
- M. Fiberboard ductwork
- N. Direct buried underground ductwork.
- O. Use of glycol for chilled water comfort cooling systems (this does not include process chilled water or computer room air conditioning systems)
- P. Supplementary mechanical cooling systems or equipment to cover the spring and fall “shoulder” times when the chilled water system is not operational.
- Q. Use of chase or shaft wall construction for air ducting or plenums. Air must be ducted within shafts
- R. Air conditioning buildings and or spaces that have operable windows
- S. Auxiliary air fume hoods
- T. Air conditioning commercial kitchens and food service areas
- U. Air conditioning gymnasiums
- V. Air conditioning locker rooms
- W. Air conditioning mechanical rooms and primary electrical rooms.
- X. Locating supply, return and/or transfer ductwork in unheated spaces
- Y. Locating HVAC heating and/or cooling equipment in unheated spaces.
- Z. Utilizing series (tandem) steam pressure reducing stations to avoid the need for a steam safety valve.

II. SYSTEM COMPONENTS

A. Piping Systems, Valves and Accessories:

1. Connect closed hot water system make up to the domestic soft water system where available.

Remainder Not completed yet.

B. Ductwork Systems and Duct Accessories:

1. Fiberboard ductwork is not allowed on DFD projects.
2. Building chases, shafts, tunnels and mechanical rooms shall not be used as supply or return air plenums. Air shall be ducted within these spaces. This criteria is not meant to prohibit the use of ceiling return air plenums.
3. Where return air ceiling plenums are used:
 - a. Return air plenums shall not be used where above ceiling construction has spray-on cellulose or mineral fiber fireproofing or exposed fiberglass building insulation.
 - b. Coordinate fire and smoke rating of all components and insulation above the ceiling to meet plenum rating. Notify other trades of this as well.
 - c. Collect return air at multiple central locations to avoid severe short circuiting of air from large floor areas with single point return.
 - d. Provide transfer openings in walls that extend above ceiling to underside of structure to allow plenum air to transfer freely. Coordinate transfer openings with architect so openings are shown on general construction drawings. Provide smoke and fire dampers in transfer openings where required by partition rating.
4. Duct systems shall be designed using radius elbows without turning vanes wherever possible. Branch takeoffs shall be designed with conical fittings or 45 degree entry taps.
5. Flexible duct is allowed at connections to supply diffusers and grilles. Maximum length of flexible duct is limited to 5 feet.
6. Manual balance dampers shall be shown at each major branch takeoff and at run outs to diffusers and grilles of supply, return and exhaust ductwork. Locate balance dampers back from diffusers and grilles as far as possible to reduce damper generated noise. Avoid the use of registers in grilles wherever possible.
7. Transfer ducts shall be sized for a duct velocity of 300-500 fpm.
8. All duct systems shall be sealed and pressure tested in accordance with section 23 31 00. Where remodeling projects tap into and use existing systems, discuss pressure testing requirements with DFD during design phase.
9. Design and size ductwork systems using SMACNA and ASHRAE criteria for velocities and fitting losses. Do not oversize ductwork unnecessarily to avoid performing sound calculations. Duct layouts should be optimized to minimize static pressure.
10. All outside air intake louvers should be located at or above the 2nd floor level on buildings 2 stories and taller, or at or above the roof level on single story buildings. In any case the bottom of the intake louvers should be located a minimum of 13' above grade. The intent of this requirement is to prevent intentional contamination of the air intake without the aid of a ladder or similar device. Outside air intake louvers and intake hoods should be installed so that the bottom of the intake is a minimum of 30" above the finished roof level or bottom of areaway.
11. Arrange intake louvers and associated duct connections to get even air velocities across entire louver area. Design louvers for the following maximum free area velocities
 - a. 350 fpm for intake louvers on systems with over 75% minimum outside air.
 - b. 450 fpm for intake louvers on constant volume systems with outside air economizer.
 - c. 500 fpm for intake louvers on variable air volume systems with outside air economizer.
 - d. Size relief and exhaust louvers for a reasonable pressure drop.
12. Snow intake must be considered when locating and designing outside air intakes. For high percentage and 100% outside air systems, provide large protective enclosures to shield the intake from snow and allow snow to drop out of the air before entering the air handler intake. Or some other proven method to prevent snow intake should be implemented. This will affect penthouse and/or mechanical room location and size and so must be considered early in the schematic design of the project so that it can be properly addressed as part of the integrated design process. If snow intake is a problem after the project is completed then the consultant will be responsible for providing a design solution and will participate in paying for the construction cost to implement the corrective solution.

13. Provide **duct static pressure safety switches** on VAV duct systems to protect ductwork from damage during control malfunctions. Do not use pressure relief doors. Design relief or provide additional relief from mechanical spaces to prevent mechanical spaces from being over pressurized

C. Insulation:

1. Internal duct lining is allowed only in the following locations:
 - a. Five feet immediately downstream of air terminal unit booster coils.
 - b. Transfer ducts.
 - c. Downstream of air handling unit discharge where required for acoustical purposes. Duct shall be dual wall - internal lined with perforated sheet metal exposed to air stream.
 - d. In return air ducts upstream of air handling units where required for acoustical purposes. Note - air handling unit coils must be protected by filters.

D. Vibration and Sound Control:

1. In general, follow the vibration isolation schedule in specification 23 05 48 for isolation types used for specific equipment. Where manufacturer's recommendations differ from the schedule, specify the manufacturer's isolation for the application.
2. Avoid redundancy in isolation where rotating or reciprocating equipment is already integrally isolated. (example: isolation may not be required for package AHU and flexible pipe connections to coils may not be warranted where AHU fan is integrally isolated) Review and follow equipment manufacturer's vibration isolation recommendations.
3. In general, inertia bases are not required for equipment that is located on slab-on-grade floors where vibration transmission is not a concern. Concrete housekeeping pads and appropriate isolators are usually adequate for slab-on-grade situations.
4. Sound calculations are expected to be performed for all major sound producing equipment and air terminal units so HVAC systems meet space NC program requirements.
5. Octave band sound power data must be included in equipment schedules on the drawings to establish minimum performance requirements. Do not use sone or dBA data in equipment schedules. Exception: dBA data may be used for outside equipment such as cooling towers and condensers.
6. Use ASHRAE sound criteria for space NC levels when program statement does not address sound criteria. When program statement and ASHRAE sound criteria conflict, discuss criteria with DFD.
7. Consider all sound paths when performing ductwork sound calculations: radiated, duct transmitted, duct breakout, etc.
8. Coordinate placement of new mechanical rooms with architect to avoid locations next to sound sensitive spaces. Where necessary, coordinate sound treatment of existing mechanical spaces with architect in renovation projects.

III. EQUIPMENT

A. Chillers and Air Conditioning Equipment

1. Chiller equipment shall have water cooled condensers using recirculated tower water for heat rejection. Utilize VFDs to modulate cooling tower fans speed instead of two speed motors on cooling towers.
Exceptions:
 - a. Split systems with an indoor chiller and outdoor air cooled condenser may only be used with DFD approval.

- b. New water cooled chillers or packaged AC units with once through condenser water are not acceptable. Replacement water cooled chillers and packaged AC units with once through condenser water may only be used with DFD approval.
2. Air cooled package chillers are not acceptable for use in DFD projects with prior DFD approval.
3. Split system air cooled condensing units with DX air handling unit coils may only be used with DFD approval.

B. Heating Equipment

Not completed yet.

C. Unitary Equipment

1. In general, the following types of unitary equipment are not acceptable for use in DFD projects:
 - a. Package thru-the-wall air conditioners (PTACs).
 - b. Fan coil units used as the primary heating and/or cooling system.
 - c. Units that use “once through” city water for condenser water.

D. Air Handling Equipment

1. Package central station air handling equipment used in DFD projects shall be the indoor type. Air handling systems and make-up air units manufactured for outside and/or rooftop installation are not allowed without DFD approval.
2. Package central station air handling equipment is to be specified with double wall 2” thick insulated housing. Built-up air handling units are to be specified with 4” thick insulated housing. Interior and exterior panels are to be solid metal. Perforated interior panels may be specified in sections where sound attenuation is necessary provided the section of the unit is 1) upstream of cooling coil, and 2) is not the mixing section where there may be a chance of rain or snow accumulation.
3. Coordinate mechanical room size with architect to allow full access for coil and fan shaft removal and filter replacement. Mechanical room layouts using access doors or knockout panels in wall construction to achieve this are not allowed without DFD approval.
4. Designers must allow adequate space for proper design of outside air and return air mixing. This includes space required for air blending devices that should be employed to prevent stratification where ideal mixing cannot be accomplished with ducting arrangement alone. Packaged mixing boxes from AHU manufacturers do not provide adequate mixing on their own. The importance of this criteria cannot be overemphasized since cold air stratification is a leading cause of frozen coils and nuisance low-limit freeze protection trips. The preferred method is to connect outside air and return ducts together prior to the AHU so mixing occurs in the mixed air duct prior to the AHU.

E. Heating and Cooling Coils

1. Water coil selection shall meet ARI requirements including a minimum water tube velocity of 3 feet per second at design conditions.
2. Cooling coils shall be sized for a maximum of 550 fpm air velocity for vav return air systems, and 400 fpm on systems with over 75% minimum outside air.
3. The desired maximum fins is 8 fins per inch. If more than two rows are required to meet heating loads on heating coils or if more than 8 rows are required to meet the cooling load on cooling coils, then the fins may be increased up to a maximum of 12 fins per inch as needed to keep the rows at 2 for heating 8 for cooling.
4. Air Handling Unit Preheat Coils:
 - a. Where coil entering air temperatures are below freezing, a steam face and bypass coil should be used. If there are beneficial reasons and/or where steam is not available in the building, a hot water face and bypass coil or a pumped hot water coil can be used with DFD approval.

- b. 100% outside air units shall use a steam vertical integral face and bypass type preheat coil or external face and bypass steam coils or hot water coils when steam is not available in the building.
 - c. All face and bypass coils shall include a two-way control valve to modulate steam or hot water when outside air temperatures are above 40 degrees F. Below 40 degrees F, the control valve will be fully open and the face and bypass shall provide the temperature control.
5. Direct expansion cooling coils, where allowed by DFD, shall be sized for a minimum air velocity of 350 fpm.
 6. The minimum acceptable reheat coil size is 8 inches x 8 inches.

F. Filtration Equipment

1. Specify air filtration equipment in accordance with program requirements. Where program does not address air filtration, use the following guidelines and discuss with DFD.
 - a. Filtration efficiency for air handling systems serving occupied spaces should not be less than 30% dust spot efficiency per ASHRAE 52.
 - b. In most larger, standard buildings, the designer should be specifying 30% pre-filters with 60-85% final bag filters.
 - c. Filtration for ventilation systems serving mechanical spaces or unoccupied areas may have efficiencies less than 30%.
 - d. Filters for research facilities and hospitals with special filtration requirements (example: HEPA, bag-in/bag-out, etc.) should be specified according to established standards for these facilities. Review with DFD.
2. 30% prefilters should be specified as panel type.
3. Provide 1” thick throw away filters on intake air where outside air is used to ventilate utility and similar spaces (to prevent entry of insects).

G. Air Terminal Units

1. Size air terminal units for maximum and minimum airflows and inlet static pressures that are within the controllable range of the velocity reset controller.
2. Reheat coils shall be mounted separately from air terminal units with a 12-18” section of discharge duct or vav box extension between the air terminal unit and the reheat coil. Provide duct access panels adequately sized for inspection and cleaning of coil in ductwork upstream and downstream of coil. Where necessary, detail or specify multiple access panels for larger size reheat coils.
3. The minimum acceptable reheat coil size is 8 inches x 8 inches.
4. Dual duct and fan powered air terminal units are not allowed without DFD approval.

IV. LOAD CALCULATIONS AND VENTILATION GUIDELINES

A. Load Calculations

1. DFD expects an integrated design approach to building design. Provide feedback to architect on architectural issues that impact cooling and heating loads.
2. Prior to starting load calculations, obtain the anticipated building envelope configuration and materials from the architect and obtain the anticipated lighting design or density from the lighting designer. Continue to provide feedback to architect and electrical engineer on issues that impact cooling and heating loads. Refer to the Policy and Procedure Manual for Architects and Engineer part 4G SUSTAINABLE DESIGN AND ENERGY CONSERVATION on the DFD website
https://doa.wi.gov/DFDM_Documents/MasterSpecs/Sustainability/DFDM%20Sustainabi

[lity%20Guidelines%20for%20Capital%20Projects%20-%20V2%20-%20Sept%202020.pdf](#) for more information. Also refer to [Daylighting Standards for State Facilities](#) on the DFD website https://doa.wi.gov/DFDM_Documents/MasterSpecs/Daylighting/DayLtgStdsForStateFacilities.pdf for more information.

3. Use the following indoor design conditions for cooling and heating load calculations:
 - Winter indoor 68 deg F
 - Summer indoor 76 deg FReview winter humidification requirements with the DFD on a case by case basis. If the building program requires space conditions other than indicated above, then review requirements with DFD.

B. Ventilation

1. Provide design ventilation rates in compliance with **SPS 364.0403** except provide 15 cfm per person instead of 7.5 cfm per person (SPS 364.0403 (5)(a)). For systems where the ventilation rate calculated using AHRAE 62.1 results in a lower ventilation rate than calculated using the above method and the calculated rate is in compliance with SPS 364.0403 using the standard 7.5 cfm per person, then the ASHRAE method should be used.

For applications where furnaces or small rooftop units are used in small buildings, the ventilation rates may be reduced down to the code minimum 7.5 cfm per person in order to reduce the problems associated with providing ventilation air through small gas fired units with dx cooling. Consult with DFD engineers where using reduced ventilation rates may be applicable.

For all applications where justified by energy savings payback, utilize CO2 reset, occupancy sensing and/or occupancy level indexing strategies to reduce the outside air ventilation at times when spaces are partially occupied or vacant.

V. SPECIAL SYSTEM DESIGN GUIDELINES

A. Variable Air Volume Systems

1. Variable Air Volume air handling systems shall be designed with a minimum outside air duct/control damper and a maximum (economizer) outside air duct/control damper. The minimum outside air duct shall be sized for the minimum system outside air cfm and shall be provided with an air flow measuring device for verifying outside air flow rate. Air handling unit controls shall be employed to sequence the outside air damper and return dampers to maintain the minimum outside air flow rate.

B. Laboratory Design Guidelines

1. In general, the laboratory design guidelines have been developed using information from the following standards and codes:
 - a. ACGIH Industrial Ventilation - A Manual of Recommended Practice (latest edition)
 - b. ANSI/AIHA Z9.5 1992 - Laboratory Ventilation Standard
 - c. NFPA 45 - Fire Protection for Laboratories Using Chemicals
 - d. NFPA 30 - Flammable and Combustible Liquids Code
 - e. OSHA 29 CFR Part 1910 - Occupational Exposures to Hazardous Chemicals in Laboratories

- f. Wisconsin Administrative Code - Comm 32
- g. ASHRAE Standard 110-1995 - Method of Testing Performance of Laboratory Fume Hoods

2. Laboratory Layout

- a. In new facilities, the laboratory layout must consider fume hood locations with respect to exit routes and traffic aisles.
 - 1) Fume hoods shall be located at least 10 feet or as far as practical from a primary exit door of a laboratory when a secondary exit is not provided.
 - 2) Fume hoods shall not be located in a position that will require an occupant to pass by a fume hood to reach a laboratory exit.
 - 3) Desk work areas shall not be located adjacent to fume hoods.
 - 4) Fume hoods shall be located or positioned to avoid facing main traffic aisle in order to minimize the potential for accidents from personnel traveling directly behind fume hood user and to minimize disruption of hood containment from traffic induced airflow.
- b. In existing facility remodeling, the above guidelines shall be implemented within practical and economical limitations.
 - 1) Where remodeling involves fume hood replacement or relocation, every effort shall be made to follow the new facility guidelines for hood location.
 - 2) Where small project remodeling does not include replacement or relocation of fume hoods, the above guidelines for location may be waived. In this case, the design shall provide fire extinguishers in dead end or end of path locations where occupants need to pass by a fume hood to reach the laboratory exit.
 - 3) Where existing fume hoods may be subject to traffic induced airflow, the proper face velocity criteria must be applied (see guideline number 4.d below).
- c. New facilities and existing facility remodeling may incorporate ceilings in laboratory spaces where above ceiling mechanical/electrical system maintenance access is required provided the new ceilings are fully accessible lay-in type. Inaccessible ceilings with access panels to service and inspect mechanical equipment are not acceptable.
- d. Operable windows are not acceptable in new or existing laboratory facilities if the existing mechanical ventilation system adequately meets the lab ventilation needs. Existing facility remodeling involving new ventilation system installation or upgrading of existing ventilation systems to meet lab ventilation needs shall address a means to fix operable windows in place so they are not operable.

3. Ventilation Equipment and Layout

- a. Fume Exhaust Fan Location:
 - 1) New fume hood exhaust fans shall be located outside on the building roof. New fume exhaust fans shall not be located inside buildings or in penthouses.
 - 2) Existing fume hood exhaust fans and positively pressurized fume exhaust ductwork located in normally occupied areas of a building that are being remodeled shall be relocated to place fans and positively pressurized ductwork outside the building on the roof.
 - 3) Existing fume hood exhaust fans located in mechanical equipment penthouses that serve areas being remodeled shall be relocated to the roof when this work is

within practical and economical limitations of the project. Review each situation with DFD and user agency.

- b. The fume exhaust discharge shall terminate at least 8 feet above the highest roof level. Where visual screens are incorporated to hide exhaust fans and roof mounted equipment, the fume exhaust stack shall extend at least 8' above the top of the screen as well. Large fans shall incorporate a self-standing discharge stack. Smaller fans may incorporate a discharge stack mounted directly on the vertical outlet of the fan provided support is adequate. **Where two redundant fume exhaust fans are used, each should be provided with its own stack so each fan can be serviced without back pressure from the operating fan.**
- c. The minimum discharge velocity from fume exhaust stacks shall be 3500 fpm. Higher discharge velocities may be required where analysis indicates the necessity.
- d. The design shall pay particular attention to relationship of exhaust discharge locations with respect to fresh air intakes in laboratory buildings and surrounding buildings. Exhaust systems and fresh air intakes shall be segregated to prevent re-entrainment of fume exhaust into building ventilation systems. Code required minimum separation distances may not be adequate.
- e. In general, standard fume exhaust design shall incorporate centrifugal SWSI type fans, arrangement 10 with motor, drive and bearings outside of air stream, AMCA type B spark resistant construction, and corrosion resistant coating of all surfaces exposed to air stream. Other fans specifically designed for fume exhaust application may be used with prior review and approval by DFD.
- f. Fume exhaust and supply system redundancy (backup capabilities) and emergency power service shall be designed according to approved program requirements. This issue should be reviewed with DFD in the preliminary design phase on every project.
- g. Design of future capacity into fume exhaust and supply systems shall be implemented according to approved program requirements. This issue should be reviewed with DFD in the preliminary design phase on every project.
- h. In general, fume hood exhaust ductwork shall be PCD (polyvinyl coated steel duct) with a 4 mil coating on both the inside and outside of ductwork. Alternative ductwork material may be required if specific chemicals used in the laboratory hoods are not compatible with PCD. (example: 316 ss is required for perchloric acid exhaust) Review applications with user agency and DFD.

4. Laboratory Ventilation

a. Air Change Rates:

- 1) In general, laboratories with chemical use shall be designed for a minimum of 6-12 air changes per hour - occupied and 4 air changes per hour - unoccupied. For this guideline, occupied shall be defined as a laboratory containing occupants whether or not fume hoods are in use. Air change rates may be reduced below this guideline depending upon usage and hazard. Consult with DFD if air change rates can potentially be reduced below the guideline levels.
- 2) In general, air change rates for laboratories with no chemical use shall be based on thermal loads or occupancy loads that determine total cfm for the space.

- 3) Maximum air change rate for all laboratories shall be no greater than 25 ac/hr. Where design air change rates exceed this, review load and ventilation criteria with DFD.
 - 4) Air supply and exhaust diffusers should be selected and located to provide excellent ventilation effectiveness to effectively remove effluent from the space. The ventilation effectiveness is just as important as the air change rate since high air change rates will only provide benefit if the ventilation effectiveness is good.
- b. Air Recirculation and Transfer
- 1) General room air from laboratories using chemicals shall not be recirculated and supplied back to other laboratories or spaces that have a lower level of hazard.
 - 2) Recirculation within a lab space by self-contained air conditioning equipment (i.e. fan coils) for the purpose of reducing internal thermal loads is allowed.
 - 3) Laboratories using chemicals shall be designed for a negative pressure relationship with respect to adjacent spaces of a lower hazard and adjacent non-lab spaces unless program requirements specify otherwise. As a general rule, provide transfer air of 100 cfm per standard door size to achieve pressurization.
 - 4) Where visual confirmation of pressure relationships between spaces is required, provide a wall mounted gauge at the passageway from lower to higher hazard spaces. Specify an appropriate pressure range and markings to indicate safe conditions between the spaces.
- c. Supply air distribution in laboratory spaces with fume hoods shall be accomplished with low throw, non-directional, perforated type diffusers or ductwork. Diffusers shall not be placed near fume hoods where air distribution may challenge fume hood containment. Size and locate diffusers so terminal throw velocity at fume hood is no greater than 50 fpm or no greater than one-half the fume hood face velocity, whichever is less.
- d. Fume hood air volumes for standard constant volume bypass fume hoods shall be established using a face velocity of 100 fpm at full open sash or lowered sash stop position. Vertical sash fume hoods designed to operate with a lowered sash stop position shall have a minimum sash opening height of at least 18 inches above the fume hood work surface. Vertical sash fume hoods operating at sash stop positions shall have an alarm that annunciates when the sash is raised above the sash stop position.
- e. Low flow fume hoods designed for operation at face velocities less than 100 fpm must pass the ASHRAE 110-1995 tracer gas test with the following criteria:
- 1) SF6 concentration sensed by sampling probe shall at no time exceed 0.05 ppm.
 - 2) Release rate of SF6 shall be 8.0 liters/minute.
 - 3) Sampling shall be conducted both at 26 inches above the fume hood work surface and at 18 inches above the fume hood work surface.
 - 4) 50 fpm cross drafts shall be induced across the face of the fume hood.
 - 5) The fume hood shall be loaded to simulate an “as-used” condition.

Low flow fume hood face velocity shall not be lower than 50 fpm at a full open sash. An alarm shall be provided on low flow fume hoods that annunciates when the sash face velocity falls below 50 fpm. **Face velocity of the hood should be designed for 100 fpm in the as used sash position and 50 fpm at full open sash position. Hoods may have flow setback to 50 fpm when the sash is in the as used position when there is not a user sensed in front of the hood. Variable flow control can also be used to**

maintain 100 fpm or minimum flow requirements as specified by the current version ANSI/AIHA/ASSE Z9.5 Laboratory Ventilation Standard

- f. Systems serving other non-standard fume hoods (biosafety, laminar flow, radioisotope, perchloric acid, etc.) shall be designed to specific program requirements or established criteria. Where criteria is in question, discuss with DFD and user agency safety personnel.

5. Fume Hoods, Storage Cabinets, and Benchtop Hoods

- a. General laboratory fume hoods shall be bypass type and restricted bypass type. Auxiliary air type fume hoods are not acceptable.
- b. ADA requirements identified in program statement and shall be incorporated into laboratory layout and fume hood selection.
- c. Fume hoods may specified with vertical sashes or combination vertical/horizontal sashes.
- d. Fume hoods may be specified with sash stop mechanisms for operation at a reduced sash position. Fume hoods may also be specified with fixed arrow label on sash post to identify operational position of sash. Review whether these approaches suite the operational methods of the user.
- e. OSHA 29 CFR Part 1910 recommends “each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use”. The specification of monitoring and alarm systems shall be discussed with the user agency and DFD to meet the needs and operational practices of the user agency.
- f. Chemical storage needs must be identified in the program to insure adequate storage capacity is available for the needs of each laboratory. Fume hoods shall not be designed or used for storage. Evaluate storage needs using the following guidelines:
 - 1) NFPA 30 standards shall be satisfied.
 - 2) Assess and review the risks of base cabinet storage beneath fume hoods with the user to determine if standalone storage is preferred.
 - 3) Flammable Storage: If contents emit strong odors, venting may be required. Note that NFPA 30 does not require flammable storage cabinets to be vented. NFPA 30, addresses requirements of vented and non-vented flammable storage. Vented cabinets shall be exhausted with minimal cfm requirements needed to maintain a negative pressure in the cabinet.
 - 4) Acid Storage: Cabinets shall be vented with minimal cfm requirements needed to maintain a negative pressure in the cabinet.
- g. Benchtop hoods, in some instances, may be a lower cost alternative to full service fume hoods. Generally, benchtop hood use can be considered in teaching type labs where multiple stations are required, and low toxicity experimentation is performed. Review lab applications with user agency and DFD to determine if benchtop hoods are an acceptable alternative to fume hoods.

6. Ventilation System Types

- a. Constant volume, two position and variable volume exhaust systems may be considered for use in laboratory building ventilation design.

Selection of the appropriate system type will depend on lab airflow requirements which may be driven by any of the following design factors:

- Total fume hood exhaust quantity within the lab
- Thermal and/or occupancy loads within the lab
- Air change rate criteria

The difference between the maximum required lab airflow and maximum/minimum lab air change rate criteria will usually determine whether two position or vav system types are viable.

Examples:

- A chemical use lab having a maximum design airflow of 24 air changes per hour determined by fume hood exhaust or thermal loads is a candidate for two position or vav systems. A 50% reduction in airflow can be achieved before the minimum occupied 12 air changes per hour is reached (reference para. 4.a.). A 75% reduction in airflow can be achieved before the minimum unoccupied 4 air changes per hour is reached (reference para. 4.a.).
- A chemical use lab that has a maximum design fume hood or thermal load airflow close to or below 12 air changes per hour would require a constant volume approach to maintain the minimum prescribed air change rate during occupied conditions. Two position control could be employed to reduce the airflow to 4 air changes per hour during unoccupied conditions.
- A fume hood laboratory with very high (but necessary) air change rates above 25 air changes per hour would likely incorporate variable air volume so lower air change rates could be achieved through partially open fume hood sash positions during both occupied and unoccupied conditions.

Occupancy of labs may also determine whether two position or vav systems are viable.

Examples:

- A 24 hour/day chemical use research lab that has a maximum design lab airflow of 12 air changes per hour would incorporate constant volume. Two position control is not viable since there is no unoccupied condition.
 - A chemical use teaching lab that operates 12 hours/day with an occupied airflow of 12 air changes per hour could potentially take advantage of two position operation that would lower the airflow to 4 air changes per hour during the unoccupied time.
- b. **Two position exhaust airflow control and activation shall be accomplished through use of fume hood sash position sensors or presence sensors. Occupied lab airflow rates shall be in effect when any fume hood sash is open (as identified by sash position sensor) or when the presence sensor senses a user in front of the fume hood. The system shall reduce airflow to unoccupied levels only when all fume hood sashes are proved closed by sash position sensors or when a presence sensor does not sense a user in front of the hood for 10 minutes.**

- c. VAV exhaust airflow control shall be accomplished by sash position sensing controls or volumetric flow sensing in the exhaust airstream. Review application of VAV systems with DFD during preliminary design.
- 6) Control of pressure relationships between chemical use labs and lower hazard adjacent spaces shall be accomplished by volumetric tracking of exhaust and supply air terminal units with a differential cfm offset. Through-the-wall type pressure sensing controls shall not be used to control pressure relationships between labs and adjacent spaces.

C. Wood Dust Collection Systems:

- 1. Wood dust collection systems shall be designed using criteria established in the ACGIH Industrial Ventilation Manual, latest edition. Minimum transport velocities shall be designed for heavy/wet wood dust.
- 2. In general, dust collection systems shall be designed to exhaust all pieces of woodworking equipment at their respective design air flow rates simultaneously (with the exception of floor sweeps). Blast gates are to be adjusted to achieve design air flow rates and then fixed and labeled or marked in their respective position to prevent tampering and disruption of system balance.
- 3. Carefully design exhaust collection hoods for each piece of woodworking equipment. Custom hoods for each piece of equipment must be fully detailed on a project by project basis in order to provide adequate source capture. The designer shall not rely on standard details that do not apply to conditions of their project. The designer shall not rely on the HVAC contractor to design the collection hoods.
- 4. Dust collection systems shall be exhausted to the outdoors. Recirculation is prohibited. Rare exceptions may be allowed where exhaust to outdoors is entirely impractical and proper filtration is employed. The designer must review conditions carefully and obtain DFD approval before this is considered.
- 5. **Do not** combine other hazardous exhausts with the dust collection system (metal grinding, solvent storage, welding, etc.)

D. Animal Holding Systems

Not completed yet.

E. TB and Other Isolation Type Systems

Not completed yet.

F. Computer A/C Systems

Not completed yet.

G. Heat Recovery Systems

Not completed yet.

H. Smoke Control Systems

Not completed yet.

VII. GENERAL DRAWING REQUIREMENTS

- A. The DFD website contains details and equipment schedules that should be utilized on all projects. If there is no DFD detail and/or schedule for a particular item, then the consultant should utilize their own “in house” detail/schedule or develop a new version if needed for the project. Consultants may utilize their own “in house” schedules and details when a DFD

version does exist provided that all of the features, items and performance information included on the DFD Schedules/details are incorporated into the consultant's schedules/details.

- B.** Pipe drawing standards: On 1/4" scale drawings show all piping 4" and above double line. On 1/8" scale drawings show all piping 8" and above double line.
- C.** Tagging for mechanical equipment should follow the DFD Mechanical Equipment Tagging Guidelines for all projects that utilize Direct Digital Controls (DDC). These provide standards that will be incorporated into the software of the DDC system.

VIII. GENERAL SPECIFICATION REQUIREMENTS

- A.** The DFD website contains master specifications that should be utilized on all projects. If there is no DFD specification section for a particular item, then the consultant should utilize their "in house" spec section or develop a new version if needed for the project.
- B.** Submit 35% review specifications in an edited format so that deleted text is included with a line through it and added text is underlined. This may be accomplished either utilizing the "track changes" feature in Microsoft Word or by manually crossing out text with a pen or pencil. Submit final review documents fully edited (deleted text removed) as they will be for the construction documents.

END OF HVAC DESIGN GUIDELINES