

## **SECTION 15100 HVAC SYSTEMS APPLICATIONS**

### **PART 1 – GENERAL**

- 1.1 SCOPE: The intent of this Section is to describe the preferred HVAC systems to be applied in the schools for various spaces and usages. It is recognized that deviations from the preferred systems can occur responsive to special circumstances.
- 1.2 CODES & STANDARDS: HVAC systems shall be designed in compliance with all codes and standards as cited previously.

### **PART 2 – PRODUCTS**

This Section details product and system application; product material and component requirements are described in other sections of this guide.

### **PART 3 – EXECUTION**

#### **3.1 NEW CONSTRUCTION, MODERNIZATIONS, and SIGNIFICANT ADDITIONS**

##### **A. General:**

1. HVAC systems shall predominantly be single-zone water source heat pumps. Ground-coupled geothermal water systems are preferred; however conventional cooling tower and boiler systems may be used as guided by energy analyses, life cycle costs, and other considerations.
2. Ventilation systems shall decouple heating, cooling, and dehumidification of OA for ventilation from sensible heating and cooling in the zones. DOAS shall be equipped with sensible energy recovery device with a minimum effectiveness of at least 50%. Building exhaust air is generally to be extracted through the dedicated outdoor air systems (DOAS).
3. Space and usage specific systems shall be as herein after described.

##### **B. Heat Pump Water Systems: A main and stand-by pump shall be provided for circulating water to the building heat pumps (heat pump water loop); each pump shall be equipped with a variable frequency drive. Piping system differential pressure sensor(s) controlling pump's speed shall be located remotely in the building's piping system (not at the pump). Quantity and location of sensors shall be identified on contract drawings.**

1. Heat pump water loop pump shall run continuously.
  - a. System design and heat pump valving shall take into consideration minimum flow with VFD running at minimum speed.
  - b. 3-way valves shall be installed at piping run extremities to assure constant minimum circulation throughout the building; provide balancing valve in by-pass.
2. Ground coupled systems shall be designed with piping taps suitable for the future addition of a cooling tower or boiler.
3. Conventional condenser water systems employ a cooling tower and boilers. A plate and frame heat exchanger shall decouple the heat pump water loop from the cooling tower water. Gas fired condensing boilers shall be utilized as heat source.

##### **C. Classrooms:**

1. Each classroom shall have comfort control provided by a ducted, vertical heat pump located in mechanical closet.
2. Ventilation air for classrooms shall be provided by dedicated outdoor air systems (DOAS). DOAS shall normally operate during its associated Zone's occupied mode; spaces served by the DOAS establish the control Zone. Units shall be controlled to maintain constant discharge conditions (70°F heating, 72°F/50% RH cooling) during occupancy and space humidity levels when unoccupied (60%).

3. Exhaust air from classrooms shall be ducted back to the DOAS. Some classroom exhaust air may be transferred (via ductwork) to toilet rooms (paying special attention to corridor smoke partition requirements), then ducted to the DOAS.
- D. Administration, Health Suites, Counseling, etc.: These spaces have occupancy schedules distinct from all other spaces in the building and shall be designed as an autonomous control zone.
1. Preferred system consists of water source heat pumps for comfort control and ventilation air provided by a DOAS.
  2. Comfort control can employ console heat pumps for individual space control; ducted heat pumps may be employed to condition several small spaces with like heating/cooling loads.
  3. DOAS shall normally operate during the Zone's occupied mode; controlled to maintain constant discharge air temperature (70°F heating, 72°F/50% RH cooling) during occupancy and space humidity levels when unoccupied (60%).
  4. Exhaust air shall be extracted from the spaces served, including toilet rooms, and ducted to the DOAS.
  5. Combining Admin, Health, Counseling with the Media Center and its ancillary spaces to be served by a single DOAS, thus creating one larger control Zone, is acceptable.
- E. Media Center and Ancillary Spaces: These spaces have occupancy schedules distinct from all other spaces in the building and shall be designed as an autonomous control zone.
1. Preferred system consists of water source heat pumps for comfort control and ventilation air provided by a DOAS.
  2. Comfort control can employ console heat pumps for individual control in small spaces; ducted heat pumps shall be used for the Media Center and larger ancillary spaces.
  3. DOAS shall normally operate during the Zone's occupied mode; controlled to maintain constant discharge air temperature (70°F heating, 72°F/50% RH cooling) during occupancy and space humidity levels when unoccupied (60%).
  4. Exhaust air shall be extracted from the spaces served and ducted to the DOAS.
  5. Combining the Media Center with Admin, Health, Counseling to be served by a single DOAS, thus creating one larger control Zone, is acceptable.
- F. Cafeteria, Multi-Purpose Room: Space shall be treated as a single control Zone; comfort conditioned and ventilated by a water-source heat pump rooftop unit (RTU) or energy recovery unit (ERU). RTU/ERU shall be capable of 100% return air operation for night set-back/warm-up/cool-down; be capable of 100% outdoor air for economizer operation, and provide energy savings thru demand control ventilation (DCV) and/or energy recovery. When utilizing DCV as sole energy savings option the unit must be equipped with part-load dehumidification option such as hot gas reheat. Utilizing energy recovery should be for sensible load only with a minimum effectiveness of at least a 50%. Space temperature sensor shall control RTU/ERU heating and cooling output.
- G. Gym: Space shall be treated as a single control Zone; heated and ventilated, no mechanical cooling.
1. Generally, Gyms shall be served by a water-source heat pump rooftop unit (RTU) or gas-fired heating and ventilating unit (H&V); large Gyms capable of being partitioned may require two RTU's/H&V's.
    - a. RTU/H&V shall be capable of 100% return air operation for night set-back/warm-up/cool-down; be capable of 100% outdoor air for economizer operation, and provide energy savings thru demand control ventilation (DCV). When utilizing DCV the unit must be equipped with part-load dehumidification option such as hot gas reheat. Unit shall be sized to provide 6 Air Changes per Hour.
    - b. Space temperature sensor shall control RTU/H&V heating output; mechanical cooling shall be disabled.

- c. Exhaust air shall be ducted back to the RTU/H&V. Some Gym air may be transferred to adjacent storerooms, locker rooms, toilet rooms; then ducted to the RTU/H&V exhaust.
  2. Additional summer ventilation (additional 6 air changes per hour for a total of 12) shall be provided via outdoor air intakes and exhaust fans.
- H. Kitchens: Elementary and middle school kitchens shall be heated and mechanically cooled; most high school kitchens shall be heated only, no mechanical cooling. Kitchen shall be treated as a single control Zone.
  1. Warming Kitchens (Elementary Schools):
    - a. Water-source heat pump rooftop unit (RTU) or ducted vertical water source heat pump with dedicated, ducted intake for minimum outdoor air.
    - b. Heat Relief: Exhaust fan shall be connected to a Type II hood; 700-1,000 CFM as required by hood size. Hood fan shall be controlled by local switch.
  2. Food Prep Kitchens (Middle & High Schools):
    - a. Commercial Hood (Type I) with exhaust fan, make-up air introduced at hood, make-up air unit, fire protection system. Control of fan, make-up air unit, gas valve interlock, wash-down, etc. shall be by hood manufacturer.
    - b. Space heating by gas fired heating and ventilating unit; control by EMS.
  3. Kitchen Office: Console heat pump; minimum outdoor air intake for ventilation.
  4. Dry Food Storage: Split system direct expansion air cooled, manufacturer furnished controls; system is not tied into the EMS.
  5. Toilet Room: Ceiling fan with local wall switch.
- I. Corridors: Ventilated, air volumes per applicable code requirements, via building DOAS; i.e. corridors are provided air from DOAS in the vicinity. Corridor heating is by electric cabinet heaters, floor or wall mounted preferred; ceiling mounted if necessary; wall mounted electric thermostats with guards.
- J. Auxiliary Gyms, Dance Studios, Wrestling Rooms, Exercise Rooms, etc.: Spaces are heated and air conditioned. Preferred system is a DOAS providing ventilation air to the group of spaces and ducted heat pumps serving individual spaces.
- K. Locker Rooms: Heated and ventilated, no mechanical cooling. Preferred system is a water-source heat pump rooftop unit (RTU). RTU shall be capable of 100% return air operation for night set-back/warm-up/cool-down; be capable of 100% outdoor air for economizer operation, and provide energy savings thru demand control ventilation (DCV) and/or energy recovery. When utilizing DCV as sole energy savings option the unit must be equipped with part-load dehumidification option such as hot gas reheat. Utilizing energy recovery should be for sensible load only with a minimum effectiveness of at least a 50%. Space temperature sensor shall control ERU heating output; mechanical cooling shall be disabled.
- L. Auditoriums/Stage: Space shall be treated as a single control Zone, comfort conditioned and ventilated by water-source heat pump rooftop units (RTU) or energy recovery unit (ERU).
  1. Auditorium/Stage: RTU/ERU shall be capable of 100% return air operation for night set-back/warm-up/cool-down; be capable of 100% outdoor air for economizer operation, and provide energy savings thru demand control ventilation (DCV) and/or energy recovery. Refrigeration hot gas reheat shall be provided for dehumidification cycle responsive to space humidity sensor. Space temperature sensor shall control RTU/ERU heating and cooling output.
- M. Mechanical Rooms (not closets): Electric unit heaters with space mounted heating thermostat. Exhaust fan and outdoor air intake with motor operated damper controlled by space mounted cooling thermostat.
- N. Electrical Closets/Rooms:

1. Main Electrical Room: Exhaust fan and outdoor air intake with motor operated damper controlled by space mounted cooling thermostat.
2. Closets:
  - a. Without Transformers: Exhausted, either ducted back to a DOAS or provided with thermostatic controlled exhaust fan; make-up via transfer.
  - b. With Transformers: Thermostatic controlled exhaust fan; make-up via transfer air or outdoor air intake.
- O. Telecom/LAN Closets: Cooled with ductless split system air cooled air conditioning units; 1.5-2 ton units for main Telecom room, 1 ton for LAN closets.
- P. Nutrition/Food Labs: Provide ducted fume hood exhaust ventilation and residential fire suppression system in nutrition/food lab kitchen units, demonstration counter, and the food science experimental enclosure module. Provide ceiling exhaust ventilation system in the food lab's preparation area.
- Q. Miscellaneous Heat:
  1. Electric Duct Heaters with space temperature sensor: Apply for perimeter zone heating for large areas, such as an outdoor exposure of a Multi-Purpose Room, Media Center, etc.
  2. Entrances, Stair Wells, Toilet Rooms: Heated only via electric wall heaters with integral thermostat or floor mounted cabinet heaters with wall mounted thermostat by ATC.
  3. Trash, Compactor, Storerooms with exterior exposures: Electric unit heaters with space mounted thermostats by ATC.
- R. Exhaust:
  1. Toilet Rooms:
    - a. Group Toilet Rooms: Exhausted via DOAS.
    - b. Individual Toilet Rooms: May be exhausted to a DOAS or provided with dedicated ceiling exhaust fan controlled by wall switch.
  2. Admin Area Workrooms/Copiers:
    - a. Area exhaust, ~300 CFM, ceiling grille directly located over copier ducted to roof mounted exhaust fan, ceiling fan ducted to outdoors, or cabinet in-line fan. Control by wall switch and 6-hour timer.
    - b. Direct exhaust connection to copy machine may be required; coordinate with equipment specified by Architect.
  3. Kilns: Dedicated hood (72"x36"x24") located at each kiln pairing ducted to power roof ventilator; canopy type II hood mounted at 78" AFF, 100 FPM face velocity. Operation shall be by Division 16 and stand-alone from EMS. When key switch is indexed on, exhaust fan is energized through 12 hour timer switch. When airflow is sensed in exhaust air duct through static pressure sensor the coil to contactors serving kiln receptacles is energized. When key switch is indexed off or timer switch has expired the system is deenergized.
  4. Trash, Compactor, Recycling Rooms: Exhaust fan and outdoor air intake with motor operated damper. Fans run continuously; turned off via space mounted thermostat.
  5. Outdoor Storage: Exhaust fan and outdoor air intake with motor operated damper controlled by space mounted cooling thermostat.
  6. Science Rooms:
    - a. Classroom: Room to be under slight negative pressure with respect to corridor.
      - 1) Exhaust hood with stainless steel ductwork to rooftop up-blast exhaust fan; 80 fpm hood face velocity. Control is to be by 2-hour timer switch.
      - 2) General room exhaust to DOAS with ceiling grille in vicinity of teacher's demonstration table, airflow to match hood exhaust.

- b. Prep Rooms: Room to be under slight negative pressure with respect to classroom, minimum 5 AC/Hr.
    - 1) Rooftop up-blast exhaust fan connected to exhaust hood to run continuously via EMS command during occupied mode; transfer duct from classroom. Over-ride control is to be by 6-hour timer switch.
    - 2) Exhaust hood with stainless steel ductwork to rooftop up-blast exhaust fan; 100 fpm hood face velocity.
  - c. General Storage Room (Non-chemical): Return air to DOAS; transfer duct from classroom
  - d. Chemical Storage Room: Continuous exhaust; single speed, 6 AC/Hr minimum. Explosion proof rooftop up-blast exhaust fan, high and low exhaust air grilles in room, stainless steel ductwork. Transfer duct with motorized damper. Exhaust duct differential pressure switch shall, upon loss of flow, close damper in transfer duct, display alarm light at room exterior. Connect exhaust fan to emergency power.
  - e. Hood exhausts to be vertical discharge power roof ventilators.
7. Spray Booths, Dark Rooms, Printing Labs. Provide required filtration, local switch, and timer. Dark rooms and printing labs to include a “sneeze guard” protective exhaust hood suspended above open chemical trays, sinks, and work area.
- S. Clothes Dryers: Vent to outdoors, comply with manufacturer’s recommendations for duct size, length.
- T. Deviations: In cases where the preferred system design is not practical, the following systems apply:
- 1. Auxiliary Gyms, Dance Studios, Wrestling Rooms, Exercise Rooms, etc.: Individual ducted heat pumps with dedicated outdoor air intakes.
  - 2. Gyms, Locker Rooms H&V Units: Gas fired heating and ventilating units capable of 100% return air for unoccupied mode heating; capable of up to 100% outdoor air for “natural cooling” mode. Unit heats to maintain 70°F space temperature heating setpoint with minimum outdoor air for ventilation during occupied mode, utilizes economizer to maintain 76°F space temperature cooling setpoint. Provide means of economizer relief.
  - 3. Water/Air cooled variable refrigerant flow systems (Mitsubishi City Multi; Daikin VRV) for individual space heating and cooling for Administration and other office type space usage; ventilation by a DOAS.
- 3.2 MINOR RENOVATIONS and ADDITIONS: Systems applications shall be consistent with existing mechanical systems unless directed otherwise by MCPS.

**END OF SECTION**

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